Chemistry Study Materials for Class 12

(NCERT Based Questions - Answers of Chapter - 09)

Ganesh Kumar Date:- 02/09/2021

Co-ordination Compounds

Question 25: What is meant by stability of a coordination compound in solution? State the factors which govern stability of complexes.

Solution 25: The stability of a complex in a solution refers to the degree of association between the two species involved in a state of equilibrium. Stability can be expressed quantitatively in terms of stability constant or formation constant.

$$M + 3L \longrightarrow ML_3$$

Stability constant, $\frac{[ML_3]}{[M]\,[L]^3}$

For this reaction, the greater the value of the stability constant, the greater is the proportion of ML_3 in the solution.

Stability can be of two types:

(a)Thermodynamic stability: The extent to which the complex will be formed or will be transformed into another species at the point of equilibrium is determined by thermodynamic stability.

(b) Kinetic stability: This helps in determining the speed with which the transformation will occur to attain the state of equilibrium.

Factors that affect the stability of a complex are:

(i) Charge on the central metal ion: The greater the charge on the central metal ion, the greater is the stability of the complex.

(ii) Basic nature of the ligand: A more basic ligand will form a more stable complex.

(iii) Presence of chelate rings: Chelation increases the stability of complexes.

Question 26: What is meant by the *chelate* effect? Give an example.

Solution 26: When a ligand attaches to the metal ion in a manner that forms a ring, then the metal- ligand association is found to be more stable.

In other words, we can say that complexes containing chelate rings are more stable than complexes without rings. This is known as the chelate effect.

For example:

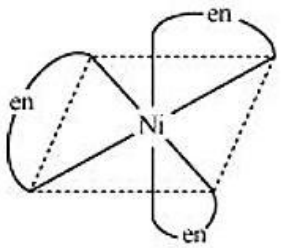
$Ni^{2+}(aq) + 6NH_3(aq) \longrightarrow [Ni(NH_3)_6]^{2+}(aq)$

$\log \beta = 7.99$

$Ni^{2+}(aq) + 3en(aq) \longrightarrow [Ni(en)_3]^{2+}(aq)$

$\log \beta = 18.1$

(more stable)



Question 27: Discuss briefly giving an example in each case the role of coordination compounds in:

(i) Biological system (ii) Medicinal chemistry

(iii) Analytical chemistry (iv) Extraction / metallurgy of metals

Solution 27:

(i) Role of coordination compounds in biological systems:

We know that photosynthesis is made possible by the presence of the chlorophyll pigment. This pigment is a coordination compound of magnesium. In the human biological system, several coordination compounds play important roles. For example, the oxygen-carrier of blood, i.e., haemoglobin, is a coordination compound of iron.

Vitamin B12 cyanocobalamine the anti-pernicious anaemia factor is a coordination compound of cobalt. Among the other compounds of biological importance with coordinated metal ions are the enzymes like carboxypeptidase A and carbonic anhydrase

(ii) **Role of coordination compounds in medicinal chemistry:**

Certain coordination compounds of platinum (for example, *cis*-plat in) are used for inhibiting the growth of tumours.

The excess of metal ions present in toxic proportions in plant and animal systems like copper and iron are removed by chelating ligands D-penicillamine and desferrioxime B via the formation of coordination compounds. EDTA is used in the treatment of lead poisoning.

(iii) **Role of coordination compounds in analytical chemistry:**

During salt analysis, a number of basic radicals are detected with the help of the colour changes they exhibit with different reagents. These colour changes are a result of the coordination compounds or complexes that the basic radicals form with different ligands. E.g. EDTA, DMG, Cupron etc

(iv) **Role of coordination compounds in extraction or metallurgy of metals:**

The process of extraction of some of the metals from their ores involves the formation of complexes. For example, in aqueous solution, gold combines with cyanide ions to form *Au*(*CN*)2. From this solution, gold is later extracted by the addition of zinc metal.

Question 28: How many ions are produced from the complex $Co(NH_3)_6Cl_2$ in solution? (i) 6 (ii)4 (iii)3 (iv)2

Solution 28: (iii) The given complex can be written as $Co(NH_3)_6Cl_2$

Thus, $[Co\ (NH_3)_6]^+$ along with two Cl^- ions are produced.

Question 29: Amongst the following ions which one has the highest magnetic moment value? (i) $[Cr\ (H_2O)_6]^{3+}$ (ii) $[Fe\ (H_2O)_6]^{2+}$ (iii) $[Zn\ (H_2O)_6]^{2+}$

Solution 29:

(i) No. of unpaired electrons in $[Cr\ (H_2O)_6]^{3+} = 3$

Then, $\mu = \sqrt{n(n+2)} = \sqrt{3(3+2)} = \sqrt{15} = 3.87BM$

(ii) No. of unpaired electrons in $[Fe\ (H_2O)_6]^{2+} = 4$

Then, $\mu = \sqrt{n(n+2)} = \sqrt{4(4+2)} = \sqrt{24} = 4.89BM$

(iii) No. of unpaired electrons in $[Zn\ (H_2O)_6]^{2+} = 0$

Then, $\mu = \sqrt{n(n+2)} = \sqrt{0(0+2)} = \sqrt{0} = 0.00BM$

Hence, $[Fe\ (H_2O)_6]^{2+}$ has the highest magnetic moment value.

Question 30: The oxidation number of cobalt in $K\ [Co\ (Co)_4]$ is

(i) +1 (ii) +3 (iii) –1 (iv) –3

Solution 30: We know that CO is a neutral ligand and K carries a charge of +1. Therefore, the complex can be written as $K\ Co(Co)_4$ Therefore, the oxidation number of Co in the given complex is –1. Hence, option (iii) is correct.

****