One Two academy | Coordination Chemistry

Maximum Mark: 25 **Chemistry** **Time: 50 minutes**

Choose the correct answer: **3 x 1 = 3**

1. Which type of isomerism is exhibited by [Pt $(NH_3)_2$ Cl_2]?
   a) Coordination isomerism b) Linkage isomerism
   c) Optical isomerism d) Geometrical isomerism
2. An example of double salt is
   a) $FeSO_4$ b) $FeSO_4(NH_4)_2SO_46H_2O$ c) $K_4[Fe\ (CH)_6]$ d) $K_2SO_42H_2O$
3. IUPAC name of the complex K_3 [Al $(C_2O_4)_3$] is
   a) Potassiumtrioxalatoaluminium(III)
   b) Potassiumtrioxalatoaluminate(II)
   c) Potassiumtrisoxalatoaluminate(III)
   d) Potassiumtrioxalatoaluminate(III)

Answer Any four of the following: **4 x 2 = 8**

4. Write the formula for the following coordination compounds.
   a) Hexaamminecobalt (III)sulphate
   b) Sodiumtetrafluoridodihydroxidochromate(III)
5. Give the difference between double salt and coordination compounds.
6. Define coordination entity.
7. What is crystal field splitting energy?
8. What is coordination polyhedron?

Answer any three of the following: **3 x 3 = 9**

9. What are the limitations of VB theory?
10. In an octahedral crystal field, draw the figure to show splitting of d orbitals
11. Write a note on stability constant.
12. Explain Optical Isomerism in coordination compounds with an example.

Answer the following: **1 x 5 = 5**

1. a) Write the postulates of Werner's theory.

(Or)

b) Discuss briefly the nature of bonding in metal carbonyls.

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All the Best

Answer Key attached in the next page !!!

This page is to prevent seeing answer key

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Answer Key

Choose the Correct answer:

1. – d) 2. – b) 3. – d)

Answer any four of the following:

4. a) Hexaamminecobalt (III)sulphate – $[Co(NH_3)_6]_2(SO_4)_3$
   b) Sodiumtetrafluoridodihydroxidochromate (III) – $Na_3[CrF_4(OH)_2]$
5.

Double salts	Coordination compounds
The double salts lose their identity and dissociate into their constituent simple ions in solutions.	The complex ion in coordination compound does not lose its identity and never dissociates to give simple ions.
They give tests for all the constituent ions.	They do not show tests for all their constituent ions
Ex: $K_2SO_4.Al_2(SO_4)_3.24H_2O \rightarrow 2K^+ + 2Al^{3+} + 4SO_4^{2-} + 24H_2O$	Ex: $K_4[Fe(CN)_6] \rightarrow 4K^+ + [Fe(CN)_6]^{4-}$

6. **Coordination entity:** Coordination entity is an ion or a neutral molecule, composed of a central atom, usually a metal and the array of other atoms or groups of atoms (ligands) that are attached to it. In the formula, the coordination entity is enclosed in square brackets. For example, in potassium ferrocyanide, $K_4[Fe(CN)_6]$, the coordination entity is $[Fe(CN)_6]^{4-}$.
7. **Crystal field splitting energy:** The splitting of the five d-orbitals of the metal iron in the presence of ligand field into two sets having different energies is called crystal field splitting. The difference in the energy of two sets is called crystal field splitting energy.
8. **Coordination polyhedron:** The three-dimensional spatial arrangement of ligand atoms/ions that are directly attached to the central atom is known as the coordination polyhedron (or polygon). For example, in $K_4[Fe(CN)_6]$, the coordination polyhedra is octahedral.

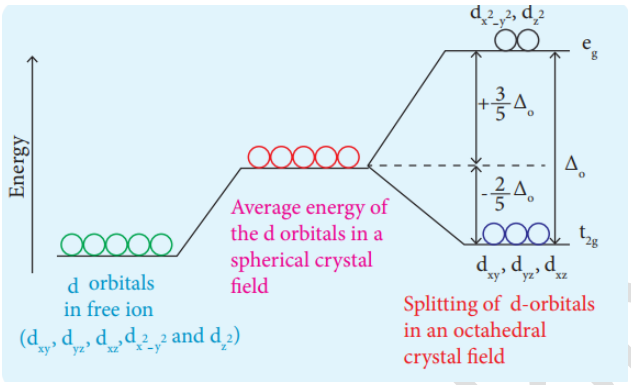
Answer any three of the following:

9. **Limitations of VBT:**
   - It does not explain the colour of the complex.
   - It considers only the spin only magnetic moments and does not consider the other components of magnetic moments.
   - It does not provide a quantitative explanation as to why certain complexes are inner orbital complexes and the others are outer orbital complexes for the same metal. For example, $[Fe(CN)_6]^{4-}$ is diamagnetic (low spin) whereas $[FeF_6]^{4-}$ is paramagnetic (high spin).

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10. **Crystal field splitting in octahedral complexes:**

During crystal field splitting in octahedral field, in order to maintain the average energy of the orbitals (barycentre) constant, the energy of the orbitals $d_{x^2-y^2}$ and d_{z^2} (represented as e_g orbitals) will increase by $3/5\Delta o$ while that of the other three orbitals d_{xy}, d_{yz} and d_{zx} (represented as t2g orbitals) decrease by $2/5\Delta_o$. Here, Δ_o represents the crystal field splitting energy in the octahedral field.



11. **Stability constant:** The stability of a coordination complex is a measure of its resistance to the replacement of one ligand by another. The stability of a complex refers to the degree of association between two species involved in an equilibrium. Let us consider the following complex formation reaction

$$Cu^{2+} + 4NH_3 \rightleftharpoons \left[Cu(NH_3)_4\right]^{2+}$$

$$\beta = \frac{\left[Cu(NH_3)_4\right]^{2+}}{\left[Cu^{2+}\right]\left[NH_3\right]^4}$$

So, as the concentration of $[Cu(NH_3)_4]^{2+}$ increases the value of stability complexes also increases. Therefore, the greater the value of stability constant greater is the stability of the complex.

12. **Optical Isomerism:**

- Coordination compounds which possess chirality exhibit optical isomerism.
- The pair of two optically active isomers which are mirror images of each other are called enantiomers.
- Their solutions rotate the plane of the plane polarised light either clockwise or anticlockwise and the corresponding isomers are called 'd' (dextro rotatory) and 'l' (laevo rotatory) forms respectively.

The octahedral complexes of type $[M(xx)_3]^{n\pm}$, $[M(xx)_2AB]^{n\pm}$ and $[M(xx)_2B_2]^{n\pm}$ exhibit optical isomerism.

Answer the following:

13. a) **Postulates of Werner's theory**:

i. Most of the elements exhibit two types of valences namely primary valence and secondary valence.

ii. In modern terminology, the primary valence is referred as the oxidation state of the metal atom and the secondary valence as the coordination number.

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iii. The primary valence of a metal ion is positive in most of the cases and zero in certain cases. They are always satisfied by negative ions.

iv. The secondary valence is satisfied by negative ions, neutral molecules, positive ions or the combination of these.

v. According to Werner, there are two spheres of attraction around a metal atom/ion in a complex. The inner sphere is known as coordination sphere and the groups present in this sphere are firmly attached to the metal. The outer sphere is called ionisation sphere.

vi. The Primary valences – non-directional
The secondary valences – directional

vii. The geometry of the complex is determined by the spacial arrangement of the groups which satisfy the secondary valence.
Six – octahedral geometry
Four – either tetrahedral or square planar geometry

(Or)

b) **Bonding in metal carbonyls:**

- In metal carbonyls, the bond between metal atom and the carbonyl ligand consists of two components.
- The first component is an electron pair donation from the carbon atom of carbonyl ligand into a vacant d-orbital of central metal atom.
- This electron pair donation forms M $\xleftarrow{\sigma\ bond}$ CO sigma bond. This sigma bond formation increases the electron density in metal d orbitals and makes the metal electron rich.
- In order to compensate for this increased electron density, a filled metal d-orbital interacts with the empty π* orbital on the carbonyl ligand and transfers the added electron density back to the ligand. This second component is called π-back bonding.
    - Thus, in metal carbonyls, electron density moves from ligand to metal through sigma bonding and from metal to ligand through pi bonding, this synergic effect accounts for strong MC ← O bond in metal carbonyls.

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