SHIKSHA CLASSES

Subject : Chemistry **BOARD ANSWER PAPER** **Total Marks : 20**

Class : XII **Topic: 9. Co-ordination Compound**

Q.1 : A) Select and write the most appropriate answer from given alternatives in each sub-question . [4]

i) The complex ion $[Co(NH_3)_3Br]SO_4$ and $[Co(NH_3)_3 SO_4]$ Br are

Ans:a) Ionization Isomer

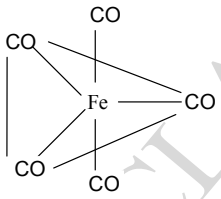
$[CO(NH_3)_3 Br] SO_4$ and

$[CO(NH_3)_3SO_4] Br$

are the exemple of ioniation isomer two atoms (Br and SO_4) are ionised to each other.

ii) Which of the following complex shows Trigonal bi-pyramidal Geometry?

Ans: a) $[Fe(CO)_5]$



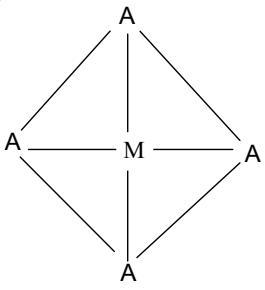
Trigonal bi-pyramidal (SP^3d)

iii) A Complex involved sp^3 Hybridization is

Ans: a) Tetrahedral

$SP^3 \rightarrow \underline{AB_4} \rightarrow \underline{[MA_4]}$

Hence SP^3 –Hybridisation. It posses tetrahedral geomerty



Tetrahedral geometry. (SP^3 –Hybridisation)

iv) Cobalt contain in Vitamin

Ans: a) B_{12} cobalt contain in Vitamin - B_{12}

Q.1 : B) Very short answer type Question. [2]

i) What is primary valency in co-ordinate complex?

Ans. : "The oxidation state of co-ordination compound is primary valency"

For Ex. $\left[Ti(H_2O)_6\right]^{2+}$

Oxidation state = 2 $\therefore$ Primary Valency = 2

ii) What is the geometry of $\left[Ni(CN)_4\right]^{2-}$ complex?

Ans. : "Square Planar" geometry of $\left[Ni(CN)_4\right]^{2-}$

Q.2 : Answer the following question. (Any three) [6]

i) **What are the Isomer in Co-ordination Compound of Linkage Isomer Explain with an example ?**

Ans: Isomer :

'The compound having same Molecular formula but different physical chemical properties. in differnet arrangment of atoms.'

They are of two types

i) Stereo isomer.

ii) Structural isomer.

Linkage isomer :

It is the types of strutural isomer the same ligand is bonded to the central metal atom or ion through the differnt atoms is known

as linkage isomer

i) Linkage isomer :

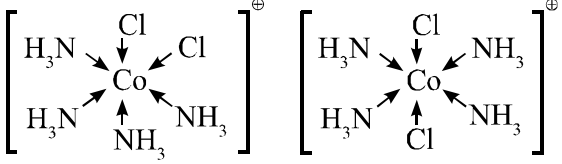
Example $[CO(CNH_3)_5NO_2]Cl_2$ and $[CO(NH_3)_5ONO]Cl_2$.

Here in NO_2 is ligand which is bonded to central metal through 'N' and 'O' atom by the different way.

ii) Explain the structure of complex: $[CO(NH_3)_4Cl_2]$ in Geometrical Isomer.

Ans: The octahedral complexes of the type MA_4B_2, MA_4BC and $M(AA)_2B_2$ exist as cis and trans isomers. (AA) is a bidentate ligand.

$[Co(NH_3)_4Cl_2]^{\oplus}$, ($MA_4B_2$ type)



cis isomer

trans isomer

iii) What are the Assumption of Valence Bond Theory?

Ans: Assumption of VBT:

1) A central metal atom present in a complex provide definite number of vacant s.p. and d-orbitals for the formation of bond with ligand.
2) The number of vacant orbital provided by central atom is same as co-ordination number.
3) The vacant orbital undergoes hybridization to form same number of hybrid orbitals. i.e. Four vacant Cu^{2+} undergoes dsp^2H_3. From the complex of $[Cu(NH_3)_4]SO_4$
4) Each ligand has at least one orbital containing lone pair of electron.
5) The vacant hybrid orbital of the metal in overlap with filled hybrid orbital of ligand to form 'Co-ordinate bond'.
6) The geometrical shape of complex depend upon the hybridization.

iv) What are the Effective Atom Number (EAN). Explain with an Example.

Ans: (EAN) 'Effective atomic number' :

It is the total number of electrons around the central metal ion present in a complex and calculated as the sum of the electrons on the metal ion and the number of electrons donated by the ligands. It can be calculated using the formula

EAN = Z – X + Y

Z = Atomic number of the metal

X = Number of electrons lost during the formation of the metal ion from its atom

Y = Number of electrons donated by the ligands.

Example :

a) $K_4[Fe(CN)_6]$

Z = 26

X = 2

Y = 36

EAN = Z – X + Y = 26 – 2 + 12 = 36

b) $Cr(CO)_6$

Z = 24

X = 0

Y = 12

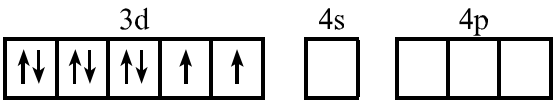
EAN = Z – X + Y = 24 – 0 + 12 = 36

Q.3 : Answer the following question. (Any one) [3]

i) Explain the structure of $[Ni(CN)_4]^{2-}$ On the basis of Valence Bond Theory.

Ans: i. Oxidation state of nickel is + 2

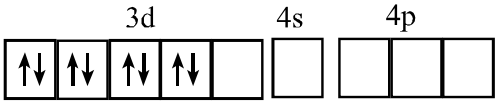
ii. Valence shell electronic configuration of $Ni^{2\oplus}$



iii. Number of $CN^{\ominus}$ ligands is 4, so number of vacant metal ion orbitals required for bonding with ligands would be four.

iv. Complex is square planar so $Ni^{2\oplus}$ ion uses dsp^2 hybrid orbitals.

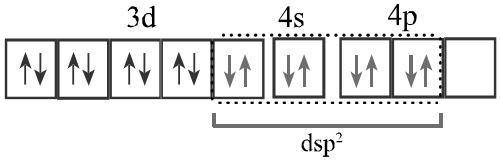
v. 3d electrons are paired prior to the hybridisation and electronic configuration of $Ni^{2\oplus}$ becomes :



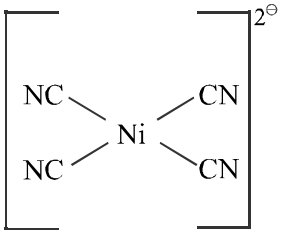
vi. Orbitals available for hybridisation are one 3d, one 4s and two 4p which give dsp^2 hybridization.

vii. Four vacant dsp2 hybrid orbitals of $Ni^{2\oplus}$ overlap with four orbitals of $CN^{\ominus}$ ions to form Ni - CN coordinate bonds.

vii. Configuration after the complex formation becomes.



viii. The complex has no unpaired electrons and hence, dimagnetic.



ii) Write the formula for following compounds.

a) Tris(ethylenediammine) Cobalt (III)

b) Potassium hexacyano ferrate (III) Chloride

c) Tetracarbonyl Nickel (0)

Ans: Formula of co-ordination compound.

i) $[COCl_2(en)_3]^+$
Tris (Ethylenediammine) cobalt (III) chloride.

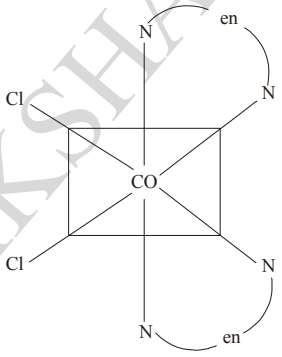
ii) $K_4[Fe(CN)_6]$
Potassium hexacyanoferate (II)

iii) $[Ni(CO)_4]$
Tetracarbonyl Nickel (0)

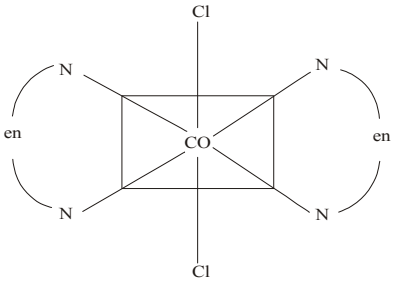
Q.4 : Answer the following question. (Any two) [5]

i) Explain the geometrical Isomer of $[COCl_2(en)_2]^+$

Ans: $[COCl_2(en)_2]^+$



(i) Cis-form



(ii) Trans form

2) Explain the application of co-ordination compound.

Ans: i) **In biology :** Several biologically important natural compound are metal complexes. They play important role in number of processes occuring in plant & animals e.g. chlorophlyll present in plant contain Mg.

ii) **In medicines :** a) Pt complex cisplatin used in treatment of cancer. b) EDTA is used for treatment of lead poisoning.

iii) **To estimate hardness of water :** Hardness of water is due to the presence of Ca^{2+} and Mg^{2+} ion. The ligand EDTA forms stable complex with Ca^{2+} and Mg^{2+}. It can therfore, be used to estimate hardness.

iv) **In electroplating :** When the co-ordination complex are used the ligands in the complex keep the metal atom well seprated from each other. These metal atom tend to form a protective layer on the surface.

3) Explain types of ligands.

Ans: There are two types of ligand.

i) Monodentate ligand

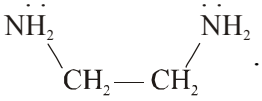
ii) Polydentate ligand.

i) **Monodentate ligand :** A monodentate ligand is defined as the ligand contain a single donar atom shares an electron pair to form a co-ordinate bond with the central metal atom.

e.g. $Cl^{\odot}$, $OH^{\odot}$ or CN^-

ii) **Polydentate ligand :** A polydentate ligand has two or more donar atoms linked to the central metal atom e.g. ethylenediamine and oxalate ion.

Each of these ligands possesses two doner atoms. They are bidentate ligands.

e.g. 

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