Q1 (20 July 2021 Shift 1)

According to the valence bond theory the hybridization of central metal atom is dsp^2 for which one of the following compounds?

(1) $NiCl_2 \cdot 6H_2O$

(2) $K_2[Ni(CN)_4]$

(3) $[Ni(CO)_4]$

(4) $Na_2[NiCl_4]$

Q2 (20 July 2021 Shift 1)

The correct order of intensity of colors of the compounds is:

(1) $[Ni(CN)_4]^{2-} > [NiCl_4]^{2-} > [Ni(H_2O)_6]^{2+}$

(2) $[Ni(H_2O)_6]^{2+} > [NiCl_4]^{2-} > [Ni(CN)_4]^{2-}$

(3) $[NiCl_4]^{2-} > [Ni(H_2O)_6]^{2+} > [Ni(CN)_4]^{2-}$

(4) $[NiCl_4]^{2-} > [Ni(CN)_4]^{2-} > [Ni(H_2O)_6]^{2+}$

Q3 (20 July 2021 Shift 1)

The spin-only magnetic moment value for the complex $[Co(CN)_6]^{4-}$ is ___ BM.

[At. no. of Co = 27]

Q4 (20 July 2021 Shift 2)

Spin only magnetic moment of an octahedral complex of Fe^{2+} in the presence of a strong field ligand in BM is :

(1) 4.89

(2) 2.82

(3) 0

(4) 3.46

Q5 (20 July 2021 Shift 2)

An aqueous solution of $NiCl_2$ was heated with excess sodium cyanide in presence of strong oxidizing agent to form $[Ni(CN)_6]^{2-}$. The total change in number of unpaired electrons on metal centre is ___

Q6 (22 July 2021 Shift 1)

The total number of unpaired electrons present in $\left[Co(NH_3)_6\right] Cl_2$ and $\left[Co(NH_3)_6\right] Cl_3$ is

Q7 (25 July 2021 Shift 1)

Which one of the following species responds to a external magnetic field?

(1) $\left[Fe(H_2O)_6\right]^{3+}$

(2) $[Ni(CN)_4]^{2-}$

(3) $[Co(CN)_6]^{3-}$

(4) $[Ni(CO)_4]$

Q8 (25 July 2021 Shift 1)

Three moles of AgCl get precipitated when one mole of an octahedral co-ordination compound with empirical formula $CrCl_3.3NH_3.3H_2O$ reacts with excess of silver nitrate. The number of chloride ions satisfying the secondary valency of the metal ion is

Q9 (25 July 2021 Shift 2)

Which one of the following metal complexes is

most stable?

(1) $\left[Co(en)(NH_3)_4\right] Cl_2$

(2) $[Co(en)_3] Cl_2$

(3) $\left[Co(en)_2(NH_3)_2\right] Cl_2$

(4) $\left[Co(NH_3)_6\right] Cl_2$

Q10 (27 July 2021 Shift 1)

The type of hybridisation and magnetic property of the complex $[MnCl_6]^{3-}$, respectively, are :

(1) $sp^3\ d^2$ and diamagnetic

(2) d^2sp^3 and diamagnetic

(3) d^2sp^3 and paramagnetic

(4) $sp^3\ d^2$ and paramagnetic

Q11 (27 July 2021 Shift 1)

The number of geometrical isomers found in the metal complexes $[PtCl_2(NH_3)_2]$ $[Ni(CO)_4]$, $[Ru(H_2O)_3Cl_3]$ and $[CoCl_2(NH_3)_4]^+$ respectively, are :

(1) $1, 1, 1, 1$

(2) $2, 1, 2, 2$

(3) $2, 0, 2, 2$

(4) $2, 1, 2, 1$

Q12 (27 July 2021 Shift 1)

The number of geometrical isomers possible in triamminetrinitrocobalt (III) is X and in trioxalatochromate (III) is Y. Then the value of $X + Y$ is

Q13 (27 July 2021 Shift 2)

Given below are two statements :

Statement **I** : $[Mn(CN)_6]^{3-}$, $[Fe(CN)_6]^{3-}$ and $[Co(C_2O_4)_3]^{3-}$ are d^2sp^3 hybridised.

Statement II : $[MnCl_6]^{3-}$ and $[FeF_6]^{3-}$ are paramagnetic and have 4 and 5 unpaired electrons, respectively.

In the light of the above statements, choose the correct answer from the options given below:

(1) Statement I is correct but statement II is false

(2) Both statement I and statement II are false

(3) Statement I is incorrect but statement II is true

(4) Both statement I and statement II are are true

Q14 (27 July 2021 Shift 2)

3 moles of metal complex with formula $Co(en)_2Cl_3$ gives 3 moles of silver chloride on treatment with excess of silver nitrate. The secondary valency of

Co in the complex is

(Round off to the nearest integer)

Answer Key

Q1 (2) **Q2** (3) **Q3** (2) **Q4** (3)

Q5 (2) **Q6** (1) **Q7** (1) **Q8** (0)

Q9 (2) **Q10** (4) **Q11** (2) **Q12** (2)

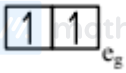
Q13 (4) **Q14** (6)

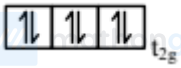
Q1

(1) $NiCl_2 \cdot 6H_2O$

$Ni^{+2} \rightarrow [Ar]_{18} 3\,d^8 4\,s^0$

C.N. $= 6$ octahedral splitting





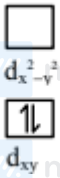
Hybridisation

$sp^3\,d^2$

(2) $K_2[Ni(CN)_4]$

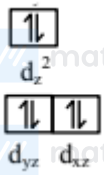
C.N. 4 $Ni^{+2} \rightarrow [Ar]_{18} 3\,d^8 4\,s^0$

$CN^- \rightarrow$ Strong field ligand



Hybridisation dsp^2

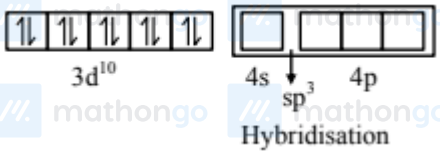
Square planar splitting



(3) $Ni(CO)_4$

CO - Strong field ligand

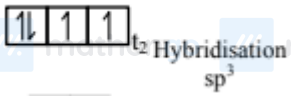
$Ni \rightarrow [Ar]_{18}$



(4) $Na_2[NiCl_4]$ $Ni \rightarrow [Ar]_{18} 3d^8 4s^0$

$Cl^{\ominus} \rightarrow$ weak

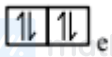
field ligand



C.N. 4

tetrahedral

splitting



Q2

$[NiCl_4]^{2-} > [Ni(H_2O)_6]^{2+} > [Ni(CN)_4]^{2-}$

Splitting $\Delta_t < \Delta_0 < \Delta_{3q}$

energy order

energy order absorbed $[NiCl_4]^{2-} < [Ni(H_2O)_6]^{2+} < [Ni(CN)_4]^{2-}$

energy order

intensity of $[NiCl_4]^{2-} > [Ni(H_2O)_6]^{2+} > [Ni(CN)_4]^{2-}$

colour of compound

Q3

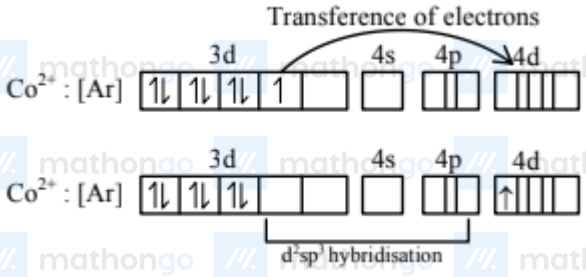
$[Co(CN)_6]^{4-}$

$x + 6 \times (-1) = -4$

$x = +2$

$Co^{2+}: [Ar] 3\,d^7$

and CN^- is a strong field ligand which can pair electron of central atom.



It has one unpaired electron (n) in 4 d-subshell. So spin only magnetic moment $(\mu) = \sqrt{n(n+2)}$ B.M

where n = number of unpaired electrons.

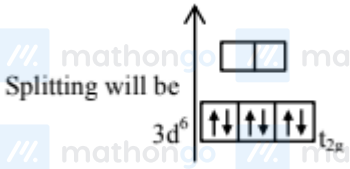
$\mu = \sqrt{3}$ B.M

$\mu = 1.73$BM

Q4

In presence of SFL $\Delta_0 > P$ means pairing occurs therefore

For $Fe^{+2} \rightarrow 3\,d^6$



$\therefore$ No of unpaired $e^-(s) = 0$

$\therefore \mu = \sqrt{n(n+2)}BM = 0$

[n = No of unpaired $e^-(s)$]

In $NiCl_2 Ni^{+2}$ is having configuration $3\,d^8$

$\therefore$ Number of unpaired electron = 2 After formation of oxidised product $[Ni(CN)_6]^{-2} Ni^{+4}$ is obtained

$Ni^{+4} \Rightarrow 3\,d^6$ and CN^- is strong field ligand

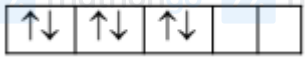
$\therefore$ number of unpaired electrons = 0

$\therefore$ The charge is $2 - 0 = 2$

Q5

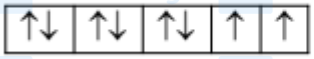
$[Ni(CN)_6]^{2-}$

$Ni^{+4} \rightarrow d^6$ strong field ligand



Pairing will be there zero unpaired electron

$NiCl_2 \rightarrow Ni^{2+} \rightarrow d^8$

 $\rightarrow$ two unpaired e^-

Chamge = 2

Q6

$[Co(NH_3)_6]\ Cl_2$

Co^{2+} : $[Ar]3\ d^7 4\ s^0 4p^0$

For this complex $\Delta_0 <$ P.E., so pairing of electron does not take place. $sp^3\ d^2$ hybridisation

Total 3 unpaired electrons are present.

$[Co(NH_3)_6]\ Cl_3$

Co^{3+} : $[Ar]3\ d^6 4\ s^0 4p^0$

d^2sp^3 hybridisation

NH_3 acts as SFL because $\Delta_0 >$ P.E.

So here all electrons becomes paired.

Q7

1 . $[Fe(H_2O)_6]^{3+}$

Fe^{3+} : $[Ar]3\ d^5$

Hybridisation : $sp^3\ d^2$ Magnetic nature : Paramagnetic (so this comple response to external magnetic field)

2 . $[Ni(CN)_4]^{2-}$

Ni^{2+} : $[Ar]3\,d^8$

Hybridisation : dsp^2 Magnetic nature : diamagnetic

3 . $[Co(CN)_6]^{3-}$

Co^{3+} : $[Ar]3\,d^6$

Hybridisation : d^2sp^3 Magnetic nature : diamagnetic

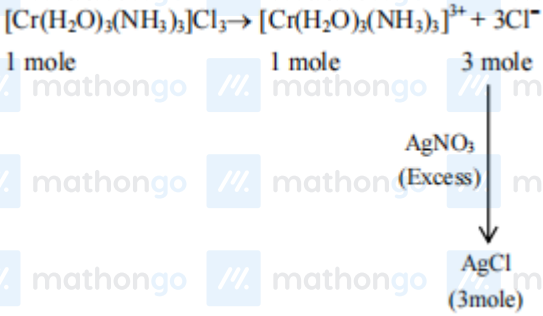
4 . $[Ni(CO)_4]$

Ni : $[Ar]3\,d^8 4\,s^2$

Hybridisation : sp^3 Magnetic nature : diamagnetic

Q8

Mole of AgCl precipitated is equal the mole of Cl^- present in ionization sphere.



Since none of Cl^- is present in the co-ordination sphere. Therefore answer is zero.

Q9

Complex $[Co(en)_3]\,Cl_2$ is most stable complex among the given complex compounds because more number of chelate rings are present in this complex as compare to others.

(1) $[Co(en)(NH_3)_4]\,Cl_2$ 1 chelate ring

(2) $[Co(en)_3]\,Cl_2$

3 chelate ring

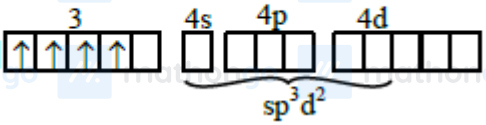
(3) $[Co(en)_2(NH_3)_2]\,Cl_2$ 2 chelate ring

(4) $\left[Co(NH_3)_6\right] Cl_2$

0 chelate ring

Q10

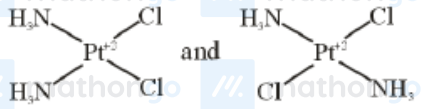
$[MnCl_6]^{3-}$

$Mn^{3+} \rightarrow [Ar]$ 

Paramagnetic and having 4 unpaired electrons.

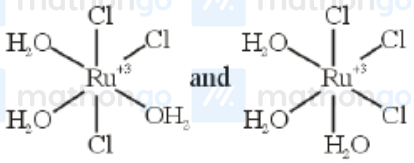
Q11

$[PtCl_2(NH_3)_2]$

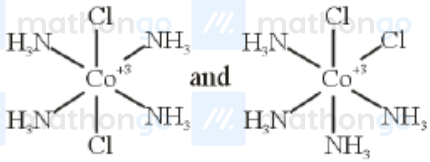
 and 2 Geometrical isomers

$[Ni(CO)_4] \rightarrow$ All ligands are same Zero Geometrical isomers

$[Ru(H_2O)_3Cl_3]$

 and 2 Geometrical isomers

$[CoCl_2(NH_3)_4]^+$

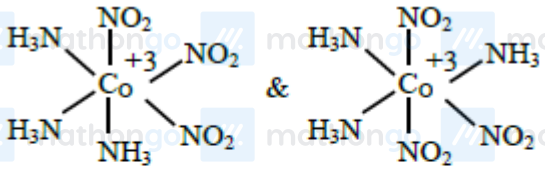
 and 2 Geometrical isomers

Q12

Triamminetrinitrocobalt(III) $\rightarrow \left[Co(NO_2)_3(NH_3)_3\right]$

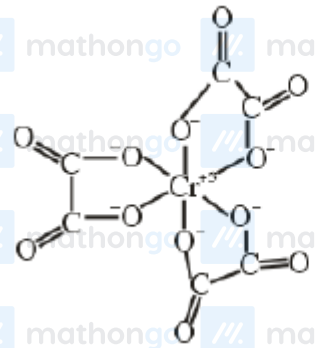
ion $\rightarrow \left[Cr(C_2O_4)_3\right]^{3-}$

$[Co(NO_2)_3(NH_3)_3]$



Two geometrical isomers (X)

$[Cr(C_2O_4)_3]^{3-}$



Zero geometrical isomer (Y)

$X + Y = 2 + 0 = 2.0$

Q13

$[Mn(CN)_6]^{3-}$ $[Fe(CN)_6]^{3-}$ $[Co(C_2O_4)_3]^{3-}$

$\downarrow$

$Mn^{3+}CN^-$ Fe^{3+}, CN^- $Co3+, C_2O_4^{2-}$

d^4 configuration, SFL d^5 configuration, SFL d^6 configuration, Chelating ligand $\Rightarrow$ All will have larger splitting hence d^2sp^3 hybridisation

$[MnCl_6]^{3-}$ and $[FeF_6]^{3-}$

d^4 configuration, Cl^- d^5 configuration, F^- WFL WFL

$\frac{1}{1}$

1

$1\frac{1}{\sqrt{l}}\frac{1}{r}$

$1\frac{1}{\sqrt{l}}\underline{1}$

$4\text{unpaired} \quad 5 \text{ unpaired}$

electrons

Q14

$$3\,[\mathrm{Co(en)_2Cl_2}]\,\mathrm{C}\ell + \underset{(\text{excess})}{\mathrm{AgNO_3}} \rightarrow \underset{(\text{white ppt})}{3\mathrm{AgCl}}$$

Secondary valency of $\mathrm{Co} = 6$
(C. N.)