Chapter 9

Coordination Compounds

Solutions

SECTION - A

Objective Type Questions

(Classification of Ligands and Nomenclature of Coordination Compounds)

1. IUPAC name of $H_2[PtCl_6]$ is

   (1) Dihydrogen hexachloridoplatinum (IV)
   (2) Hexachloridoplatinic (IV) acid
   (3) Dihydrogen hexachloridoplatinic (IV) acid
   (4) Hexachloridoplatinum (IV) acid

Sol. Answer (2)

IUPAC name of $H_2[PtCl_6] \Rightarrow$ Hexachloridoplatinate (IV) acid.

2. Naming of ligand in $[M(en)_2]^{n+}$ starts with

   (1) Di (2) Bi (3) Bis (4) Any of these

Sol. Answer (3)

en is ethylene diamine $\Rightarrow$ an organic compound. Here it is used as a ligand so 'bis' will be used.

3. Which of the following has primary valency "2"?

   (1) $[Co(NH_3)_5Cl]Cl$ (2) $[Co(NH_3)_4Cl_2]Cl$ (3) $[Co(NH_3)_3Cl_3]$ (4) $[Co(H_2O)_4Cl_2]Cl$

Sol. Answer (1)

$[Co(NH_3)_5Cl]Cl \Rightarrow [Co(NH_3)_5Cl]Cl^+ \Rightarrow Co^{2+}$

4. Ligand to form a complex which is used to treat hard water

   (1) NH_3 (2) ox (3) en (4) EDTA

Sol. Answer (4)

EDTA is used to treat hard water. Because EDTA is a chelating ligand and forms stable complexes with Ca^{2+} and Mg^{2+} present in the hard water.

5. Which of the following is not bidentate ligand?

   (1) acac (2) ox (3) en (4) dien

Sol. Answer (4)

Dien is not a bidentate ligand.

6. Which of the following is flexidentate?

(1) CO (2) en (3) EDTA (4) Cl^-

Sol. Answer (3)

EDTA is a flexidentate because it has 6 binding sites.

(Isomerism in coordination compounds)

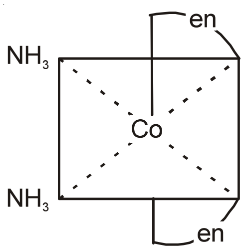
7. Which of the following will show optical activity?

(1) Cis – $[Co(NH_3)_2(en)_2]^{3+}$ (2) Trans – $[Co(NH_3)_2(en)_2]^{3+}$

(3) $[Co(NH_3)_6]^{3+}$ (4) Trans – $[Co(H_2O)_4Cl_2]^+$

Sol. Answer (1)

Cis – $[Co(NH_3)_2(en)_2]^{3+}$ ⇒



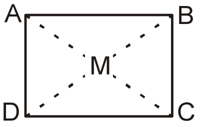
⇒ Will show optical activity.

8. How many optical isomers are possible for [MABCD]?

(1) 1 (2) 2 (3) 3 (4) Zero

Sol. Answer (4)

[MABCD] ⇒



⇒ No any optical isomers.

9. Number of geometrical isomers possible for [MABCDEF] is

(1) 6 (2) 10 (3) 15 (4) 12

Sol. Answer (3)

[MABCDEF] ⇒ 6 different ligands

Possbile geometrical isomers = $^6C_4 = \frac{6!}{4!2!} = 15$.

10. $[Ni(gly)_2]$ shows two stereoisomers. Those are

(1) Geometrical (2) Optical

(3) Does not show isomerism (4) Both (1) & (2)

Sol. Answer (2)

11. Which octahedral coordination compound will show maximum conductivity in aqueous solution if all NH_3 act as ligands?

(1) $CoCl_3.6NH_3$

(2) $CoCl_3.5NH_3$

(3) $CoCl_3.4NH_3$

(4) All will have same conductivity as every compound has got 3Cl

Sol. Answer (1)

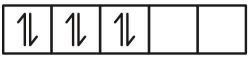
If all NH_3 acts as ligand, then in case of $CaCl_3 \cdot 6NH_3$, 3 Cl^- ions will be outside the co-ordination sphere and participate in the enhancement of conductivity.

(Bonding in coordination compounds)

12. Which is a diamagnetic complex?

(1) $[Fe(H_2O)_6]^{3+}$ (2) $[Fe(H_2O)_6]^{2+}$ (3) $[Fe(CN)_6]^{3-}$ (4) $[Fe(CN)_6]^{4-}$

Sol. Answer (4)

$[Fe(CN)_6]^{4-} \Rightarrow Fe^{2+} \Rightarrow 3d^6 \Rightarrow$  $\Rightarrow$ Zero unpaired electron

($\because$ CN^- is a strong field ligand)

$\Rightarrow$ Magnetic moment is zero

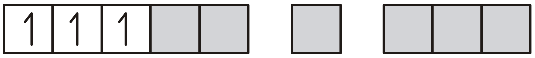
$\Rightarrow$ Diamagnetic.

13. The hybridization of 'Cr' in the complex $[Cr(NO_2)_4(NH_3)_2]^-$ is

(1) sp^3d^2 (2) sp^3d (3) d^2sp^3 (4) sp^3

Sol. Answer (3)

$[Cr(NO_2)_4(NH_3)_2]^- \Rightarrow Cr^{3+} \Rightarrow 3d^3$

$\Rightarrow$ 

$\Rightarrow d^2sp^3$.

14. The geometry of $[Ni(CO)_4]$ and $[PdCl_4]^{2-}$ respectively are

(1) Both are tetrahedral (2) Both are square planar

(3) Square planar and tetrahedral (4) Tetrahedral and square planar

Sol. Answer (4)

$[Ni(CO)_4] \Rightarrow sp^3 \Rightarrow$ Tetrahedral

$[PdCl_4]^{2-} \Rightarrow dsp^2 \Rightarrow$ Square planar

15. Write the increasing order of the value is CFSES (Δ_0) for the following species

I. $[Co(NH_3)_6]^{3+}$

II. $[Rh(NH_3)_6]^{3+}$

III. $[Ir(NH_3)_6]^{3+}$

(1) III < II < I (2) I < II < III (3) II < I < III (4) I < III < II

Sol. Answer (2)

With the increase of the size of central metal ion, *d-d* splitting increases.

$\Rightarrow$ CFSE increases

$\Rightarrow$ The correct order should be

| < || < |||

16. Which of the following is correct statement?

(1) $[Ti(H_2O)_6]^{3+}$ is coloured complex

(2) $[Si(H_2O)_6]^{4+}$ is colourless complex

(3) *d - d* transition is not possible in $[Si(H_2O)_6]^{4+}$ complex

(4) All of these

Sol. Answer (4)

$[Ti(H_2O)_6]^{3+}$ ⇒ Purple coloured complex

$[Si(H_2O)_6]^{4+}$ ⇒ Colourless, because no any transition

⇒ All the statements are correct.

17. Which of the following will have greatest molar conductance at infinite dilution?

(1) $[Pt(NH_3)_5Cl]Cl_3$ (2) $[Pt(NH_3)_4Cl_2]Cl_2$ (3) $[Pt(NH_3)_2Cl_4]$ (4) $[Pt(NH_3)_6]Cl_4$

Sol. Answer (4)

$[Pt(NH_3)_6]Cl_4$ has highest conductance because there are 4 Cl^- ions in the primary valency and they are responsible for the enhanced molar conductance.

18. Which of the following is the high spin complex?

(1) $[Cr(gly)_3]$ (2) $[CoBr_2Cl_2(SCN)_2]^{3-}$ (3) $[Fe(CN)_6]^{3-}$ (4) $Na[PtBrCl(NO_2)_2(NH_3)_2]$

Sol. Answer (2)

$[CoBr_2Cl_2(SCN)_2]^{3-}$ will form spin complex because Br^- and Cl^- are weak field ligands and they will not compell the d-electrons to be paired.

19. The coordination number and magnetic moment of the complex $[Cr(C_2O_4)_2(NH_3)_2]^-$ respectively is

(1) 6, 3.87 BM (2) 4, 3.87 BM (3) 6, 3.46 BM (4) 4, 1.73 BM

Sol. Answer (1)

$[Cr(C_2O_4)_2(NH_3)_2]^- \Rightarrow Cr^{3+} \Rightarrow 3d^3$

Octahedral complex ⇒ Co-ordination number = 6

$$\text{Magnetic moment} = \sqrt{3(3+2)}\ \text{BM}$$

$$= \sqrt{3\times5}\ \text{BM}$$

$$= \sqrt{15}\ \text{BM} = 3.87\ \text{BM}$$

20. If the value of C.F.S.E. for "Ni" is Δ_0 then it is for Pd should be

(1) 1.1 Δ_0 (2) 0.5 Δ_0 (3) 1.5 Δ_0 (4) 2 Δ_0

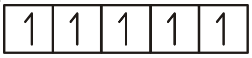
Sol. Answer (3)

21. The value of 'spin only' magnetic moment, follows the correct order?

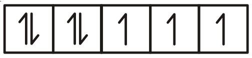
(1) $[Fe(CN)_6]^{4-} > [CoCl_4]^{2-} > [MnCl_4]^{2-}$ (2) $[MnCl_4]^{2-} > [Fe(CN)_6]^{4-} > [CoCl_4]^{2-}$

(3) $[Fe(CN)_6]^{4-} > [MnCl_4]^{2-} > [CoCl_4]^{2-}$ (4) $[MnCl_4]^{2-} > [CoCl_4]^{2-} > [Fe(CN)_6]^{4-}$

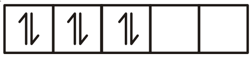
Sol. Answer (4)

$[MnCl_4]^{2-} \Rightarrow Mn^{2+} \Rightarrow 3d^5 \Rightarrow$  ⇒ Five unpaired electrons

$\Rightarrow \mu = \sqrt{5(5+2)} = \sqrt{35}$ BM = 5.92 BM

$[COCl_4]^{2-} \Rightarrow Co^{2+} \Rightarrow 3d^7 \Rightarrow$  ⇒ Three unpaired electrons

$\Rightarrow \mu = \sqrt{3(3+2)} = \sqrt{15}$ BM = 3.87 BM

$[Fe(CN)_6]^{4-} \Rightarrow Fe^{2+} \Rightarrow 3d^6 \Rightarrow$  $\Rightarrow \mu = 0$

The correct order is $[MnCl_4]^{2-} > [CoCl_4]^{2-} > [Fe(CN)_6]^{4-}$

22. How many hydrogen bonded water molecules are present in blue vitriol?

(1) Zero (2) One (3) Four (4) Five

Sol. Answer (2)

Blue vitriol ⇒ $CuSO_4{\cdot}5H_2O$

In this structure, there is 1 hydrogen bonded water molecule (fact).

23. If Δ_0 is the crystal field stabilisation energy of a ligand and P is the energy required for electron pairing in an orbital, then ligand is called weak ligand if

(1) $\Delta_0 > P$ (2) $\Delta_0 < P$ (3) $\Delta_0 = P$ (4) Unpredictable

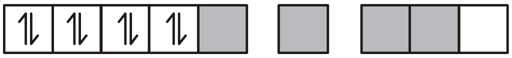
Sol. Answer (2)

If pairing energy (p) is greater than the CFSE (Δ_0) then, the ligand would not be able to pair the d-electrons of metal ion and the ligand is said to be weak field ligand.

24. The complex compound bearing square planar geometry is

(1) $Ni(CO)_4$ (2) $[Ni(CN)_4]^{2-}$ (3) $[Mn(CN)_6]^{3-}$ (4) $[MnCl_4]^{2-}$

Sol. Answer (2)

$[Ni(CN)_4]^{2-}$ ⇒ $3d^8$ ⇒ 

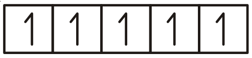
⇒ dsp^2

⇒ Square planar

25. The complex compound having maximum magnetic moment is

(1) $[CoF_6]^{3-}$ (2) $[Cr(NH_3)_6]^{3+}$ (3) $[FeF_6]^{3-}$ (4) $[Mn(CN)_6]^{4-}$

Sol. Answer (3)

$[FeF_6]^{3-}$ ⇒ Fe^{3+} ⇒ $3d^5$ ⇒  (∵ F^- is a weak field ligand)

⇒ Five unpaired electrons

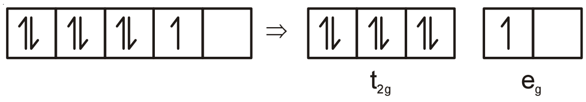
⇒ $\mu = \sqrt{5(5+2)}$ BM = $\sqrt{35}$ BM = 5.92 BM

26. CFSE(Δ_0) for metal ion in d^7 configuration in presence of strong ligand field is

(1) $-0.6\ \Delta_0$ (2) $-0.8\ \Delta_0$ (3) $-1.6\ \Delta_0$ (4) $-1.8\ \Delta_0$

Sol. Answer (4)

d^7 configuration in strong field ligand,



$$\text{CFSE} = (-0.4 \times 6 + 0.6)\Delta_0$$
$$= (-2.4 + 0.6)\Delta_0$$
$$= -1.8\ \Delta_0$$

27. In case of high spin situation

(1) $\Delta_0 = P$ (2) $\Delta_0 > P$ (3) $\Delta_0 < P$ (4) $\Delta_0 . P = 1$

Sol. Answer (3)

In case of high spin complexes $\Delta_0 < P$.

28. The EAN of Fe in $[Fe(CN)_6]^{3-}$ is

(1) 26 (2) 35

(3) 38 (4) 29

Sol. Answer (2)

EAN = 26 – 3 + 6 × 2 = 35

29. Which of the following is not π-acid ligand?

(1) CO (2) F^-

(3) C_2H_4 (4) NO^+

Sol. Answer (2)

F^- is not π-acid ligand.

30. The complex compound in which metal is not present in zero oxidation state?

(1) $Mn_2(CO)_{10}$ (2) $[Ni(CO)_4]$

(3) $[Cr(C_6H_6)_2]$ (4) $K[PtCl_3(C_2H_4)]$

Sol. Answer (4)

In $K[PtCl_3(C_2H_4)]$, Cl^- is in –1 oxidation state and here Pt is in +4 state.

SECTION - B

Previous Years Questions

1. What is the correct electronic configuration of the central atom in $K_4[Fe(CN)_6]$ based on crystal field theory?

[NEET-2019]

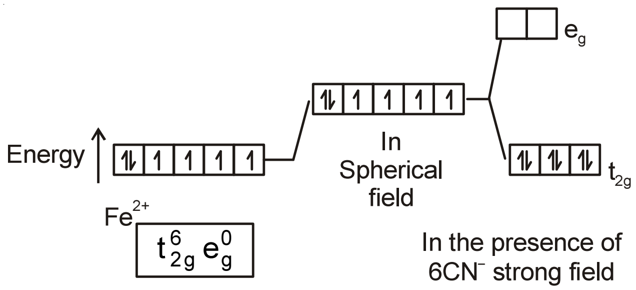
(1) $t_{2g}^4 e_g^2$ (2) $t_{2g}^6 e_g^0$ (3) $e^3 t_2^3$ (4) $e^4 t_2^2$

Sol. Answer (2)

$K_4[Fe(CN)_6]$

Fe ground state: $[Ar]3d^64s^2$

Fe^{2+}: $3d^64s^0$



2. Iron carbonyl, $Fe(CO)_5$ is **[NEET-2018]**

(1) Tetranuclear (2) Mononuclear (3) Dinuclear (4) Trinuclear

Sol. Answer (2)

Based on the number of metal atoms present in a complex, they are classified into mononuclear, dinuclear, trinuclear and so on.

eg: $Fe(CO)_5$: mononuclear

$Co_2(CO)_8$: dinuclear

$Fe_3(CO)_{12}$: trinuclear

Hence, option (2) should be the right answer.

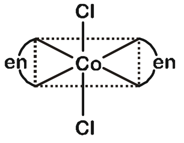
3. The type of isomerism shown by the complex $[CoCl_2(en)_2]$ is **[NEET-2018]**

(1) Geometrical isomerism (2) Coordination isomerism

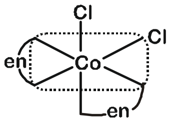
(3) Linkage isomerism (4) Ionization isomerism

Sol. Answer (1)

In $[CoCl_2(en)_2]$, Coordination number of Co is 6 and this compound has octahedral geometry.



Trans-form
(optically inactive)



cis-form
(optically active)

- As per given option, type of isomerism is geometrical isomerism.

4. The geometry and magnetic behaviour of the complex $[Ni(CO)_4]$ are **[NEET-2018]**

(1) Square planar geometry and diamagnetic (2) Tetrahedral geometry and diamagnetic

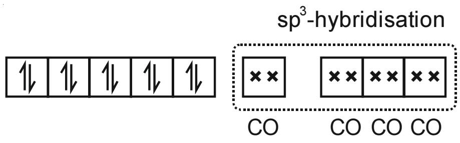
(3) Tetrahedral geometry and paramagnetic (4) Square planar geometry and paramagnetic

Sol. Answer (2)

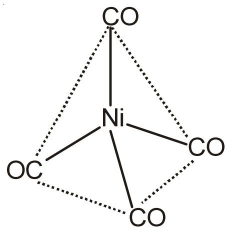
Ni(28) : $[Ar]3d^8\ 4s^2$

$\because$ CO is a strong field ligand

Configuration would be :



For, four 'CO'-ligands hybridisation would be sp^3 and thus the complex would be diamagnetic and of tetrahedral geometry.



5. Match the metal ions given in Column I with the spin magnetic moments of the ions given in Column II and assign the **correct** code. **[NEET-2018]**

Column I		**Column II**
a.	Co^{3+}	i.	$\sqrt{8}$ BM
b.	Cr^{3+}	ii.	$\sqrt{35}$ BM
c.	Fe^{3+}	iii.	$\sqrt{3}$ BM

d. Ni^{2+} iv. $\sqrt{24}$ BM

v. $\sqrt{15}$ BM

	a	**b**	**c**	**d**
(1)	iv	v	ii	i
(2)	i	ii	iii	iv
(3)	iii	v	i	ii
(4)	iv	i	ii	iii

Sol. Answer (1)

Co^{3+} = [Ar] $3d^6$, Unpaired e^-(n) = 4

Spin magnetic moment = $\sqrt{4(4+2)} = \sqrt{24}$ BM

Cr^{3+} = [Ar] $3d^3$, Unpaired e^-(n) = 3

Spin magnetic moment = $\sqrt{3(3+2)} = \sqrt{15}$ BM

Fe^{3+} = [Ar] $3d^5$, Unpaired e^-(n) = 5

Spin magnetic moment = $\sqrt{5(5+2)} = \sqrt{35}$ BM

Ni^{2+} = [Ar] $3d^8$, Unpaired e^-(n) = 2

Spin magnetic moment = $\sqrt{2(2+2)} = \sqrt{8}$ BM

6. Correct increasing order for the wavelengths of absorption in the visible region for the complexes of Co^{3+} is **[NEET-2017]**

(1) $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(H_2O)_6]^{3+}$
(2) $[Co(H_2O)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$
(3) $[Co(H_2O)_6]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$
(4) $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(H_2O)_6]^{3+}$

Sol. Answer (1)

The order of the ligand in the spectrochemical series $H_2O < NH_3 <$ en

Hence, the wavelength of the light observed will be in the order $[Co(H_2O)_6]^{3+} < [Co(NH_3)_6]^{3+} < [Co(en)_3]^{3+}$

Thus, wavelength absorbed will be in the opposite order *i.e.*, $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(H_2O)_6]^{3+}$

7. The correct order of the stoichiometries of AgCl formed when $AgNO_3$ in excess is treated with the complexes : $CoCl_3 \cdot 6NH_3$, $CoCl_3 \cdot 5NH_3$, $CoCl_3 \cdot 4NH_3$ respectively is **[NEET-2017]**

(1) 1 AgCl, 3 AgCl, 2 AgCl
(2) 3 AgCl, 1 AgCl, 2 AgCl
(3) 3 AgCl, 2 AgCl, 1 AgCl
(4) 2 AgCl, 3 AgCl, 1 AgCl

Sol. Answer (3)

Complexes are respectively $[Co(NH_3)_6]Cl_3$, $[Co(NH_3)_5Cl]Cl_2$ and $[Co(NH_3)_4Cl_2]Cl$

8. An example of a sigma bonded organometallic compound is **[NEET-2017]**

(1) Ruthenocene (2) Grignard's reagent (3) Ferrocene (4) Cobaltocene

Sol. Answer (2)

Grignard's reagent *i.e.*, RMgX is σ-bonded organometallic compound.

9. Pick out the correct statement with respect $[Mn(CN)_6]^{3-}$ **[NEET-2017]**

(1) It is sp^3d^2 hybridised and octahedral
(2) It is sp^3d^2 hybridised and tetrahedral
(3) It is d^2sp^3 hybridised and octahedral
(4) It is dsp^2 hybridised and square planar

Sol. Answer (3)

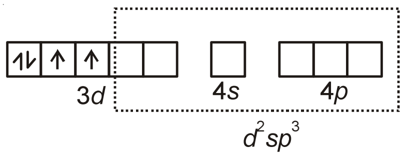
$[Mn(CN)_6]^{3-}$

Mn(III) = $[Ar]3d^4$

CN^- being strong field ligand forces pairing of electrons

This gives $t_{2g}^4 e_g^0$

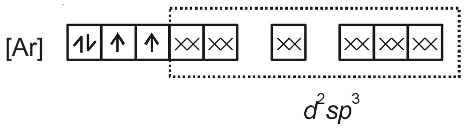
∴ Mn(III) = [Ar]



∵ Coordination number of Mn = 6

∴ Structure = octahedral

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



10. The **correct** increasing order of trans-effect of the following species is **[NEET(Phase-2)-2016]**

(1) $NH_3 > CN^- > Br^- > C_6H_5^-$ (2) $CN^- > C_6H_5^- > Br^- > NH_3$

(3) $Br^- > CN^- > NH_3 > C_6H_5^-$ (4) $CN^- > Br^- > C_6H_5^- > NH_3$

Sol. Answer (2)

Fact.

11. Which of the following has longest C – O bond length? (Free C – O bond length CO is 1.128 Å) **[NEET-2016]**

(1) $[Mn(CO)_6]^+$ (2) $Ni(CO)_4$

(3) $[Co(CO)_4]^{\ominus}$ (4) $[Fe(CO)_4]^{2-}$

Sol. Answer (4)

Due to increase in –ve charge on metal atom bond length of C – O bond increases.

12. The name of complex ion, $[Fe(CN)_6]^{3-}$ is **[Re-AIPMT-2015]**

(1) Tricyanoferrate (III) ion (2) Hexacyanidoferrate (III) ion

(3) Hexacyanoiron (III) ion (4) Hexacyanitoferrate (III) ion

Sol. Answer (2)

$[Fe(CN)_6]^{3-}$: Hexacyanidoferrate(III) ion.

13. The hybridization involved in complex $[Ni(CN)_4]^{2-}$ is (At. No. Ni = 28) **[Re-AIPMT-2015]**

(1) d^2sp^2 (2) d^2sp^3 (3) dsp^2 (4) sp^3

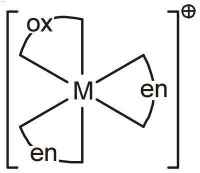
Sol. Answer (3)

The shape of $[Ni(CN)_4]^{2-}$ is square planar, where CN^- is a strong ligand and the hybridisation of Ni is dsp^2.

14. The sum of coordination number and oxidation number of the metal M in the complex $[M(en)_2(C_2O_4)]Cl$ (where en is ethylenediamine) is **[Re-AIPMT-2015]**

(1) 7 (2) 8 (3) 9 (4) 6

Sol. Answer (3)



Coordination number of M is 6.

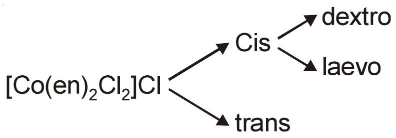
Oxidation state of M is 3.

∴ Sum of coordination number and oxidation number of the metal M is 9.

15. Number of possible isomers for the complex $[Co(en)_2Cl_2]Cl$ will be (en = ethylenediamine) **[Re-AIPMT-2015]**

(1) 3 (2) 4 (3) 2 (4) 1

Sol. Answer (1)



16. Which of these statements about $[Co(CN)_6]^{3-}$ is true? **[AIPMT-2015]**

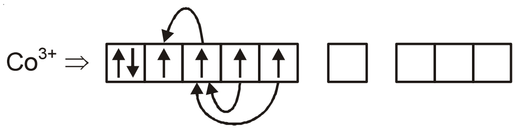
(1) $[Co(CN)_6]^{3-}$ has no unpaired electrons and will be in a high-spin configuration

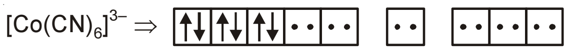
(2) $[Co(CN)_6]^{3-}$ has no unpaired electrons and will be in a low-spin configuration

(3) $[Co(CN)_6]^{3-}$ has four unpaired electrons and will be in a low-spin configuration

(4) $[Co(CN)_6]^{3-}$ has four unpaired electrons and will be in a high-spin configuration

Sol. Answer (2)





17. Cobalt(III) chloride forms several octahedral complexes with ammonia. Which of the following will not give test for chloride ions with silver nitrate at 25°C? **[AIPMT-2015]**

(1) $CoCl_3.6NH_3$ (2) $CoCl_3.3NH_3$ (3) $CoCl_3.4NH_3$ (4) $CoCl_3.5NH_3$

Sol. Answer (2)

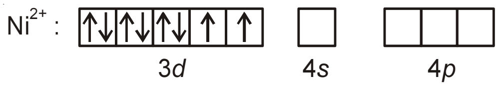
The compound will be $[Co(NH_3)_3Cl_3]$

18. Magnetic moment 2.84 B.M. is given by (At. nos, Ni = 28, Ti = 22, Cr = 24, Co = 27) **[AIPMT-2015]**

(1) Co^{2+} (2) Ni^{2+} (3) Ti^{3+} (4) Cr^{2+}

Sol. Answer (2)

Magnetic moment $\mu = \sqrt{n(n+2)}$ B.M.



It has two unpaired electrons.

19. Among the following complexes the one which shows zero crystal field stabilization energy (CFSE) is

[AIPMT-2014]

(1) $[Mn(H_2O)_6]^{3+}$ (2) $[Fe(H_2O)_6]^{3+}$ (3) $[Co(H_2O)_6]^{2+}$ (4) $[Co(H_2O)_6]^{3+}$

Sol. Answer (2)

$Fe^{+3} = d^5 = t_{2g}^3 e_g^2$, CFSE = 0.

20. Which of the following complexes is used to be as an anticancer agent? **[AIPMT-2014]**

(1) mer - $[Co(NH_3)_3Cl_3]$ (2) cis - $[PtCl_2(NH_3)_2]$ (3) cis - $K_2[PtCl_2Br_2]$ (4) Na_2CoCl_4

Sol. Answer (2)

Fact.

21. A magnetic moment of 1.73 BM will be shown by one among the following **[NEET-2013]**

(1) $[Ni(CN)_4]^{2-}$ (2) $TiCl_4$ (3) $[CoCl_6]^{4-}$ (4) $[Cu(NH_3)_4]^{2+}$

Sol. Answer (4)

Magnetic moment $\mu = \sqrt{n(n+2)}$ [n = number of unpaired electrons]

$\Rightarrow \sqrt{n(n+2)} = 1.732$

$\Rightarrow n = 1$

In case of $[Cu(NH_3)_4]^{2+} \Rightarrow Cu^{2+} \Rightarrow 3d^9 \Rightarrow \begin{array}{|c|c|c|c|c|}\hline \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow \\ \hline\end{array} \Rightarrow$ One unpaired electron $\Rightarrow n = 1 \Rightarrow \mu = 1.73$ BM

22. An excess of $AgNO_3$ is added to 100mL of a 0.01M solution of dichlorotetraaquachromium(III) chloride. The number of moles of AgCl precipitated would be **[NEET-2013]**

(1) 0.002 (2) 0.003 (3) 0.01 (4) 0.001

Sol. Answer (4)

23. Which one of the following is an outer orbital complex and exhibits paramagnetic behaviour ?

[AIPMT (Prelims)-2012]

(1) $[Cr(NH_3)_6]^{3+}$ (2) $[Co(NH_3)_6]^{3+}$ (3) $[Ni(NH_3)_6]^{2+}$ (4) $[Zn(NH_3)_6]^{2+}$

Sol. Answer (3)

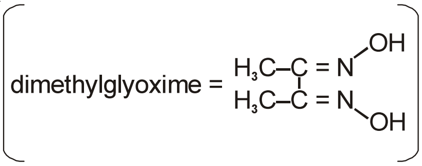
$[Ni(NH_3)_6]^{2+} \Rightarrow Ni^{2+} \Rightarrow 3d^8 \Rightarrow \begin{array}{|c|c|c|c|c|}\hline \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow & \uparrow \\ \hline\end{array}$ forms outer orbital complex

$\Rightarrow$ Two unpaired electrons $\Rightarrow$ Paramagnetic behaviour

24. Red precipitate is obtained when ethanol solution of dimethylglyoxime is added to ammoniacal Ni(II). Which of the following statements is not true ? **[AIPMT (Mains)-2012]**

(1) Red complex has a square planar geometry (2) Complex has symmetrical H-bonding

(3) Red complex has a tetrahedral geometry (4) Dimethylglyoxime functions as bidentate ligand



Sol. Answer (3)

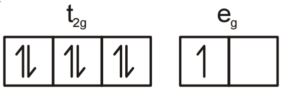
In this process [Ni(DMG)$_2$] complex is formed and the structure of this complex is square planar due to *dsp*^{2} hybridization

⇒ Statement (3) is incorrect.

25. Low spin complex of d^6–cation in an octahedal field will have the following energy
(Δ_o = crystal field splitting energy in an octahedral field, P = electron pairing energy) **[AIPMT (Mains)-2012]**

(1) $\frac{-12}{5}\Delta_o + P$ (2) $\frac{-12}{5}\Delta_o + 3P$ (3) $\frac{-2}{5}\Delta_o + 2P$ (4) $\frac{-2}{5}\Delta_o + P$

Sol. Answer (2)

Low spin d^6 ⇒ 

There are 3 pairs ⇒ Pairing energy = 3P

$$\text{CFSE} = -\frac{2}{5}\times 6 = -\frac{12}{5}\Delta_0$$

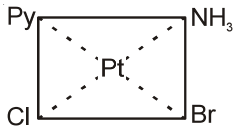
$$\therefore \quad \text{Total energy} = -\frac{12}{5}\Delta_0 + 3P$$

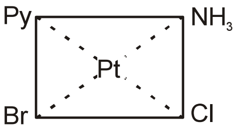
26. The complex, [Pt (Py) (NH$_3$) Br Cl] will have how many geometrical isomers? **(AIPMT (Prelims)-2011]**

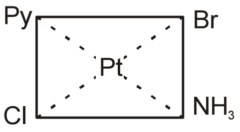
(1) 2 (2) 3 (3) 4 (4) 0

Sol. Answer (2)

Geometrical isomers, possible for the complex, [Pt (Py) (NH$_3$) Br Cl]







⇒ 3

27. The complexes [Co(NH$_3$)$_6$][Cr (CN)$_6$] and [Cr (NH$_3$)$_6$] [Co(CN)$_6$] are the examples of which type of isomerism? **[AIPMT (Prelims)-2011]**

(1) Geometrical isomerism (2) Linkage isomerism

(3) Ionization isomerism (4) Coordination isomerism

Sol. Answer (4)

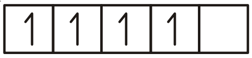
The given species have co-ordination isomerism.

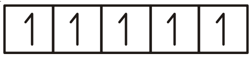
28. The d-electron configurations of Cr^{2+}, Mn^{2+}, Fe^{2+} and Co^{2+} are d^4, d^5, d^6 and d^7 respectively. Which one of the following will exhibit minimum paramagnetic behaviour? (At. Nos. Cr = 24, Mn = 25, Fe = 26, Co = 27) **[AIPMT (Prelims)-2011]**

(1) [Cr (H$_2$O)$_6$]$^{2+}$ (2) [Mn (H$_2$O)$_6$]$^{2+}$ (3) [Fe (H$_2$O)$_6$]$^{2+}$ (4) [Co(H$_2$O)$_6$]$^{2+}$

Sol. Answer (4)

H$_2$O is a moderate field ligand

Cr^{2+} ⇒ 3d^4 ⇒  ⇒ Four unpaired electrons

Mn^{2+} ⇒ 3d^5 ⇒  ⇒ Five unpaired electrons

$Fe^{2+} \Rightarrow 3d^6 \Rightarrow$ $\boxed{\upharpoonleft\downharpoonright}\boxed{\upharpoonleft}\boxed{\upharpoonleft}\boxed{\upharpoonleft}\boxed{\upharpoonleft}$ $\Rightarrow$ Four unpaired electrons

$Co^{2+} \Rightarrow 3d^7 \Rightarrow$ $\boxed{\upharpoonleft\downharpoonright}\boxed{\upharpoonleft\downharpoonright}\boxed{\upharpoonleft}\boxed{\upharpoonleft}\boxed{\upharpoonleft}$ $\Rightarrow$ Three unpaired electrons

More magnetic moment more paramagnetic behaviour

$\Rightarrow$ Co^{2+} state will exhibit minimum paramagnetic behaviour.

29. Of the following complex ions, which is diamagnetic in nature? **[AIPMT (Prelims)-2011]**

(1) $[Co\ F_6]^{3-}$ (2) $[Ni\ Cl_4]^{2-}$ (3) $[Ni\ (CN)_4]^{2-}$ (4) $[Cu\ Cl_4]^{2-}$

Sol. Answer (3)

$[Ni(CN)_4]^{2-} \Rightarrow Ni^{2+} \Rightarrow 3d^8 \Rightarrow$ $\boxed{\upharpoonleft\downharpoonright}\boxed{\upharpoonleft\downharpoonright}\boxed{\upharpoonleft\downharpoonright}\boxed{\upharpoonleft\downharpoonright}\boxed{}$

$\Rightarrow$ Completely paired

$\Rightarrow$ Diamagnetic in nature.

30. Which of the following complex compounds will exhibit highest paramagnetic behaviour ? (At. no. Ti = 22, Cr = 24, Co = 27, Zn = 30) **[AIPMT (Mains)-2011]**

(1) $[Co(NH_3)_6]^{3+}$ (2) $[Zn(NH_3)_6]^{2+}$ (3) $[Ti(NH_3)_6]^{3+}$ (4) $[Cr(NH_3)_6]^{3+}$

Sol. Answer (4)

$Co^{3+} \Rightarrow 3d^6 \Rightarrow$ $\boxed{\upharpoonleft\downharpoonright}\boxed{\upharpoonleft\downharpoonright}\boxed{\upharpoonleft\downharpoonright}\boxed{0}\boxed{0}$ (pairing takes place)

$Zn^{2+} \Rightarrow 3d^{10} \Rightarrow$ completely paired $\Rightarrow$ Zero unpaired electrons

$Ti^{3+} \Rightarrow 3d^1 \Rightarrow$ $\boxed{\upharpoonleft}\boxed{}\boxed{}\boxed{}\boxed{}$

$Cr^{3+} \Rightarrow 3d^3 \Rightarrow$ $\boxed{\upharpoonleft}\boxed{\upharpoonleft}\boxed{\upharpoonleft}\boxed{}\boxed{}$ $\Rightarrow$ Three unpaired electron $\Rightarrow$ Highest paramagnetic behaviour.

31. Which of the following carbonyls will have the strongest C – O bond ? **[AIPMT (Mains)-2011]**

(1) $[V(CO)_6]^-$ (2) $[Fe(CO)]_5$ (3) $[Mn(CO)_6]^+$ (4) $[Cr(CO)_6]$

Sol. Answer (3)

$Mn(CO)_6^+$ will have the strongest C–O bond because in this case C–O bond has the highest bond order.

32. Which of the following complex ion is not expected to absorb visible light ? **[AIPMT (Prelims)-2010]**

(1) $[Ni(CN)_4]^{2-}$ (2) $[Cr(NH_3)_6]^{+3}$ (3) $[Fe(H_2O)_6]^{2+}$ (4) $[Ni(H_2O)_6]^{2+}$

Sol. Answer (1)

In $[Ni(CN)_4]^{2-}$, the scenario is like $Ni^{2+} \Rightarrow 3d^8 \Rightarrow$ $\boxed{\upharpoonleft\downharpoonright}\boxed{\upharpoonleft\downharpoonright}\boxed{\upharpoonleft\downharpoonright}\boxed{\upharpoonleft\downharpoonright}$▨ ▨ ▨▨▨

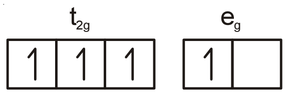
$\Rightarrow$ No possibility of transition

$\Rightarrow$ Will not absorb visible light

33. Crystal field stabilization energy for high spin d^4 octahedral complex is **[AIPMT (Prelims)-2010]**

(1) $-1.8\ \Delta_0$ (2) $-1.6\ \Delta_0+P$ (3) $-1.2\ \Delta_0$ (4) $-0.6\ \Delta_0$

Sol. Answer (4)

High spin d^4 configuration $\Rightarrow$ 

$\therefore$ CFSE $= 3 \times (-0.4) + 1 \times 0.6\ \Delta_0$

$= -1.2 + 0.6\ \Delta_0$

$= -0.6\ \Delta_0$

34. The existence of two different coloured complexes with the composition of $[Co(NH_3)_4Cl_2]^+$ is due to

[AIPMT (Prelims)-2010]

(1) Linkage isomerism (2) Geometrical isomerism

(3) Coordination isomerism (4) Ionization isomerism

Sol. Answer (2)

35. Which one of the following complexes is not expected to exhibit isomerism ? **[AIPMT (Mains)-2010]**

(1) $[Ni(NH_3)_4(H_2O)_2]^{2+}$ (2) $[Pt(NH_3)_2Cl_2]$ (3) $[Ni(NH_3)_2Cl_2]$ (4) $[Ni(en)_3]^{2+}$

Sol. Answer (3)

36. Out of TiF_6^{2-}, COF_6^{3-}, Cu_2Cl_2 and $NiCl_4^{2-}$ (Z of Ti = 22, Co = 27, Cu = 29, Ni = 28) the colourless species are

[AIPMT (Prelims)-2009]

(1) Cu_2Cl_2 and $NiCl_4^{2-}$ (2) TiF_6^{2-} and Cu_2Cl_2 (3) CoF_6^{3-} and $NiCl_4^{2-}$ (4) TiF_6^{2-} and CoF_6^{3-}

Sol. Answer (2)

37. Which of the following does not show optical isomeism ? **[AIPMT (Prelims)-2009]**

(1) $[Co(NH_3)_3Cl_3]^0$ (2) $[Co(en)Cl_2(NH_3)_2]^+$

(3) $[Co(en)_3]^{3+}$ (4) $[Co(en)_2Cl_2]^+$ (en=ethylenediamine)

Sol. Answer (1)

$[MA_3B_3]$ type complexes do not show optical isomerism.

38. Which of the following complex ions is expected to absorb visible light ? (At. No. Zn=30, SC=21, Ti = 22, Cr = 24)

[AIPMT (Prelims)-2009]

(1) $[Ti(en)_2(NH_3)_2]^{4+}$ (2) $[Cr(NH_3)_6]^{3+}$ (3) $[Zn(NH_3)_6]^{2+}$ (4) $[Sc(H_2O)_3(NH_3)_3]^{3+}$

Sol. Answer (2)

In Zn^{2+}, the t_{2g} and e_g orbitals are completely filled $\Rightarrow$ no transition $\Rightarrow$ no absorption of visible light while in case of

$Cr^{3+} \Rightarrow 3d^3 \Rightarrow$ transition will take place.

39. Which of the following complexes exhibits the highest paramagnetic behaviour ? (Where gly = glycine, en = ethylenediamine and bpy = bipyridyl moities). (At. number Ti = 22, V = 23, Fe = 26, Co = 27)

[AIPMT (Prelims)-2008]

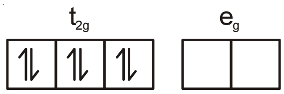
(1) $[Ti(NH_3)_6]^{3+}$ (2) $[V(gly)_2(OH)_2(NH_3)_2]^+$ (3) $[Fe(en)(bpy)(NH_3)_2]^{2+}$ (4) $[Co(OX)_2(OH)_2]^-$

Sol. Answer (4)

40. In which of the following coordination entities the magnitude of Δ_o(CFSE in octahedral field) will be maximum (at. no. Co = 27)? **[AIPMT (Prelims)-2008]**

(1) $[Co(C_2O_4)_3]^{3-}$ (2) $[Co(H_2O)_6]^{3+}$ (3) $[Co(NH_3)_6]^{3+}$ (4) $[Co(CN)_6]^{3-}$

Sol. Answer (4)

$[Co(CN)_6]^{3-} \Rightarrow Co^{3+} \Rightarrow 3d^6 \Rightarrow$ 

$$\text{CFSE} = -0.4 \times 6\ \Delta_0$$
$$= -2.4\ \Delta_0$$

41. Which one of the following aqua complexes will exhibit the minimum paramagnetic behaviour? Atomic number. Cr = 24, Mn = 25, Fe = 26, Ni = 28) **[AIPMT (Prelims)-2007]**

(1) $[Cr(H_2O)_6]^{2+}$ (2) $[Mn(H_2O)_6]^{2+}$ (3) $[Fe(H_2O)_6]^{2+}$ (4) $[Ni(H_2O)_6]^{2+}$

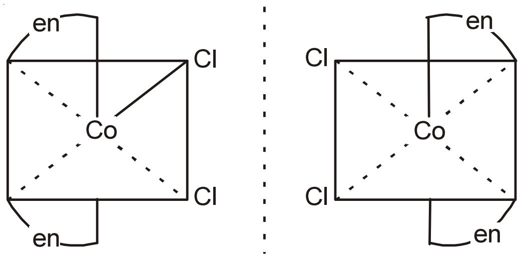
Sol. Answer (4)

42. Which of the following will give a pair of enantiomorphs? **[AIPMT (Prelims)-2007]**

(1) $[Pt(NH_3)_4][PtCl_6]$ (2) $[Co(NH_3)_4Cl_2]NO_2$

(3) $[Cr(NH_3)_6][Co(CN)_6]$ (4) $[Co(en)_2Cl_2]Cl$ (en = $NH_2CH_2CH_2NH_2$)

Sol. Answer (4)



43. $[Co(NH_3)_4(NO_2)_2]Cl$ exhibits **[AIPMT (Prelims)-2006]**

(1) Linkage isomerism, ionization isomerism and optical isomerism

(2) Linkage isomerism, ionization isomerism and geometrical isomerism

(3) Ionization isomerism, geometrical isomerism and optical isomerism

(4) Linkage isomerism, geometrical isomerism and optical isomerism

Sol. Answer (2)

$[Co(NH_3)_4(NO_2)_2]Cl$ can show linkage, ionization and geometrical isomerism.

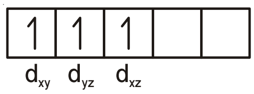
44. $[Cr(H_2O)_6]Cl_3$ (at. no of Cr = 24) has a magnetic moment of 3.83 BM, the correct distribution of 3d electrons in the chromium of the complex is **[AIPMT (Prelims)-2006]**

(1) $3d^1_{x^2-y^2}, 3d^1_{z^2}, 3d^1_{xz}$ (2) $3d^1_{xy}, 3d^1_{x^2-y^2}, 3d^1_{yz}$

(3) $3d^1_{xy}, 3d^1_{zy}, 3d^1_{xz}$ (4) $3d^1_{xy}, 3d^1_{yz}, 3d^1_{z^2}$

Sol. Answer (3)

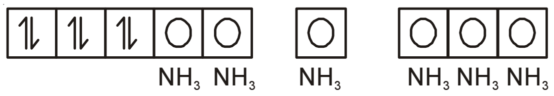
μ = 3.83 BM ⇒ Number of unpaired electrons = 3

In $[Cr(H_2O)_6]Cl_3 \Rightarrow Cr^{3+} \Rightarrow 3d^3 \Rightarrow$ 

45. Which one of the following is an inner orbital complex as well as diamagnetic in behaviour? (Atomic No. : Zn = 30, Cr = 24, Co = 27, Ni = 28) **[AIPMT (Prelims)-2005]**

(1) $[Zn(NH_3)_6]^{2+}$ (2) $[Cr(NH_3)_6]^{3+}$ (3) $[Co(NH_3)_6]^{3+}$ (4) $[Ni(NH_3)_6]^{2+}$

Sol. Answer (3)

$[Co(NH_3)_6]^{3+} \Rightarrow Co^{3+} \Rightarrow 3d^6 \Rightarrow$ 

$\Rightarrow$ Zero unpaired electrons $\Rightarrow$ Diamagnetic

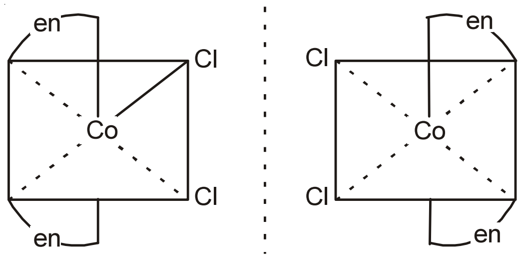
$\Rightarrow$ Low spin inner-orbital complex

46. Which one of the following is expected to exhibit optical isomerism ? (en = ethylenediamine)

[AIPMT (Prelims)-2005]

(1) cis -$[Pt(NH_3)_2Cl_2]$
(2) trans -$[Co(en)_2Cl_2]^+$
(3) trans -$[Pt(NH_3)_2Cl_2]$
(4) cis -$[Co(en)_2Cl_2]^+$

Sol. Answer (4)



47. A co-ordination complex compound of cobalt has the molecular formula containing five ammonia molecules, one nitro group and two chlorine atoms for one cobalt atom. One mole of this compound produces three mole ions in an aqueous solution. On reacting this solution with excess of $AgNO_3$ solution, we get two moles of AgCl as precipitate. The ionic formula for this complex would be

(1) $[Co(NH_3)_5(NO_2)]Cl_2$
(2) $[Co(NH_3)_5Cl][Cl(NO_2)]$
(3) $[Co(NH_3)_4(NO_2)Cl](NH_2)Cl$
(4) $[Co(NH_3)_5][(NO_2)_2Cl_2]$

Sol. Answer (1)

2 moles of AgCl means there are $2Cl^-$ ions in the primary valency.

S, $[Co(NH_3)_5(NO_2)]Cl_2$.

48. IUPAC name of $[Pt(NH_3)_3(Br)(NO_2)Cl]Cl$ is

(1) Triamminebromochloronitroplatinum (IV) chloride
(2) Triamminebromonitrochloroplatinum (IV) chloride
(3) Triamminechlorobromonitroplatinum (IV) chloride
(4) Triamminenitrochlorobromoplatinum (IV) chloride

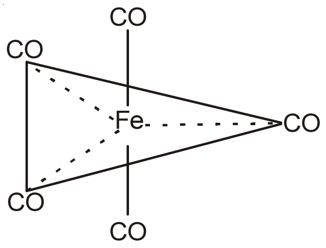
Sol. Answer (1)

IUPAC name of $[Pt(NH_3)_3(Br)(NO_2)Cl]Cl$ = Triamminebromochloronitroplatinum (IV) chloride.

49. Shape of $Fe(CO)_5$ is

(1) Octahedral
(2) Square planar
(3) Trigonal bipyramidal
(4) Square pyramidal

Sol. Answer (3)

$Fe(CO)_5 \Rightarrow$  $\Rightarrow$ Trigonal bipyramidal

50. Which of the following will give maximum number of isomers?

(1) $[Co(NH_3)_4Cl_2]$ (2) $[Ni(en)(NH_3)_4]^{2+}$ (3) $[Ni(C_2O_4)(en)_2]^{2-}$ (4) $[Cr(SCN)_2(NH_3)_4]^+$

Sol. Answer (4)

$[Cr(SCN)_2(NH_3)_4]^+$ is $[MA_2B_4]$ type complex and here SCN^- is an ambidentate ligand. So, this will give maximum number of isomers.

51. Coordination number of Ni in $[Ni(C_2O_4)_3]^{4-}$ is

(1) 3 (2) 6 (3) 4 (4) 2

Sol. Answer (2)

$[Ni(C_2O_4)_3]^{4-}$, $C_2O_4^{2-}$ is a bidentate ligand. So, it forms octahedral complex with co-ordination number 6.

52. Which of the following organometallic compounds is σ and π bonded?

(1) $[Fe(\eta^5-C_5H_5)_2]$ (2) $K[PtCl_3(n^2-C_2H_4)]$ (3) $[Co(CO)_5NH_3]^{2+}$ (4) $Fe(CH_3)_3$

Sol. Answer (3)

$[Co(CO)_5NH_3]^{2+}$ forms σ and π bonded complexes (structure).

53. Which statement is incorrect?

(1) $Ni(CO)_4$ - tetrahedral, paramagnetic

(2) $Ni(CN)_4^{-2}$ - square planar, diamagnetic

(3) $Ni(CO)_4$ – tetrahedral, diamagnetic

(4) $[Ni(Cl)_4]^{-2}$ – tetrahedral, paramagnetic

Sol. Answer (1)

$Ni(CO)_4$ is diamagnetic in nature.

54. Atomic number of Cr and Fe are respectively 24 and 26, which of the following is paramagnetic?

(1) $[Cr(CO)_6]$ (2) $[Fe(CO)_5]$ (3) $[Fe(CN)_6]^{4-}$ (4) $[Cr(NH_3)_6]^{3+}$

Sol. Answer (4)

$[Cr(NH_3)_6]^{3+} \Rightarrow Cr^{3+} \Rightarrow 3d^3 \Rightarrow$ Three unpaired electrons $\Rightarrow$ Paramagnetic.

55. The hypothetical complex chloro diaquatriammine cobalt (III) chloride can be represented as

(1) $[CoCl(NH_3)_3(H_2O)_2]Cl_2$ (2) $[Co(NH_3)_3(H_2O)Cl_3]$

(3) $[Co(NH_2)_3(H_2O)_2Cl]$ (4) $[Co(NH_3)_3(H_2O)_3]Cl_3$

Sol. Answer (1)

Chloro diaquatriammine cobalt (III) chloride $\Rightarrow [CoCl(NH_3)_3(H_2O)_2]Cl_2$

56. According to IUPAC nomenclature sodium nitroprusside is named as

(1) Sodium nitroferricyanide (2) Sodium nitroferrocyanide

(3) Sodium pentacyanonitrosyl ferrate (II) (4) Sodium pentancyanonitrosyl ferrate (III)

Sol. Answer (3)

Sodium nitroprusside $\Rightarrow Na_2[Fe(CN)_5(NO)] \Rightarrow$ Sodium pentacyanonitrosyl ferrate (II).

57. The number of unpaired electrons in the complex ion $[CoF_6]^{3-}$ is (Atomic no. : Co = 27)

(1) 2 (2) 3 (3) 4 (4) Zero

Sol. Answer (3)

$[CoF_6]^{3-} \Rightarrow Co^{3+} \Rightarrow 3d^6 \Rightarrow \boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$

$\Rightarrow$ Four unpaired electrons

58. The anion of acetylacetone (acac) forms Co(acac)$_3$ chelate with Co^{3+}. The rings of the chelate are

(1) Three membered (2) Five membered (3) Four membered (4) Six membered

Sol. Answer (4)

(acac) forms six membered complex (structure).

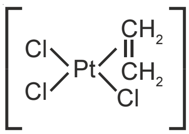
59. Which one of the following octahedral complexes will not show geometric isomerism? (A and B are monodentate ligands)

(1) $[MA_2B_4]$ (2) $[MA_3B_3]$ (3) $[MA_4B_2]$ (4) $[MA_5B]$

Sol. Answer (4)

$[MA_5B]$ will not show geometrical isomerism.

60. Which of the following is considered to be an anticancer species?

(1)


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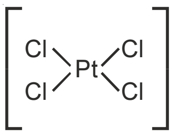

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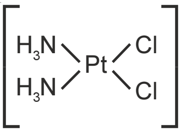

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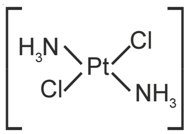


Sol. Answer (3)

Cis-platin is considered to be an anticancer species.

61. Which of the following coordination compounds would exhibit optical isomerism?

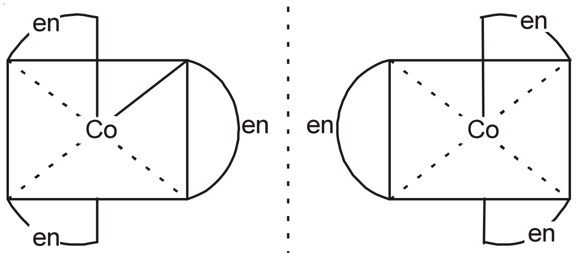
(1) Pentaamminenitrocobalt (III) iodide

(2) Diamminedichloroplatinum (II)

(3) Trans dicyanobis (ethylenediamine) chromium (III) chloride

(4) Tris-(ethylenediamine) cobalt (III) bromide

Sol. Answer (4)



62. Among $[Ni(CO)_4]$, $[Ni(CN)_4]^{2-}$, $[NiCl_4]^{2-}$ species, the hybridization states at the Ni atom are, respectively [Atomic number of Ni = 28]

(1) sp^3, dsp^2, dsp^2 (2) sp^3, dsp^2, sp^3 (3) sp^3, sp^3, dsp^2 (4) dsp^2, sp^3, sp^3

Sol. Answer (2)

$[Ni(CO)_4] \Rightarrow sp^3$

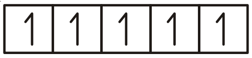
$[Ni(CN)_4]^{2-} \Rightarrow dsp^2$

$[NiCl_4]^{2-} \Rightarrow sp^3$

63. Considering H_2O as a weak field ligand, the number of unpaired electrons in $[Mn(H_2O)_6]^{2+}$ will be (atomic number of Mn = 25)

(1) Three (2) Five (3) Two (4) Four

Sol. Answer (2)

$[Mn(H_2O)_6]^{2+} \Rightarrow Mn^{2+} \Rightarrow 3d^5 \Rightarrow$ 

$\Rightarrow$ Five unpaired electrons.

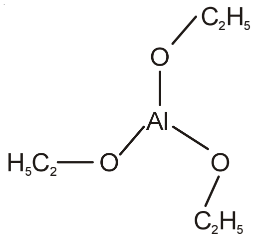
64. Which of the following does not have a metal carbon bond?

(1) $Al(OC_2H_5)_3$ (2) C_2H_5MgBr

(3) $K[Pt(C_2H_4)Cl_3]$ (4) $Ni(CO)_4$

Sol. Answer (1)

$Al(OC_2H_5)_3 \Rightarrow$



65. The *d* electron configuration of Cr^{2+}, Mn^{2+}, Fe^{2+} and Ni^{2+} are $3d^4$, $3d^5$, $3d^6$ and $3d^8$ respectively. Which one of the following aqua complexes will exhibit the maximum paramagnetic behaviour? (At. No. Cr = 24, Mn = 25, Fe = 26, Ni = 28)

(1) $[Fe(H_2O)_6]^{2+}$ (2) $[Ni(H_2O)_6]^{2+}$ (3) $[Cr(H_2O)_6]^{2+}$ (4) $[Mn(H_2O)_6]^{2+}$

Sol. Answer (4)

H_2O is a weak field ligand and Mn^{2+} has maximum numbers of unpaired electrons *i.e.*, 5. So, $[Mn(H_2O)_6]^{2+}$ will exhibit the maximum paramagnetic behaviour.

SECTION - C

Assertion - Reason Type Questions

1. A : The complex $[Co(NH_3)_3Cl_3]$ gives white ppt. with $AgNO_3$ solution.

R : Chlorine always gives white ppt with $AgNO_3$ solution.

Sol. Answer (4)

$[Co(NH_3)_3Cl_3]$ will not give while ppt. with $AgNO_3$ solution. Because there is no any Cl^- in the primary valency i.e. outside the co-ordination sphere.

Chlorine does not give white ppt. with $AgNO_3$ always.

2. A : Glycinate ion is an unsymmetrical bidentate ligand.

R : Glycinate ion is a conjugate base of glycine.

Sol. Answer (2)

Glycinate ion $\Rightarrow NH_2–CH_2–COO^- \Rightarrow$ unsymmetrical

$$\underset{\text{Glycine}}{NH_2–CH_2–COOH} \xrightarrow{-H^+} \underset{\text{Conjugate base}}{NH_2–CH_2–COO^-}$$

But the reason is not any explanation.

3. A : $K_4[Fe(CN)_6]$ is less stable than $K_3[Fe(CN)_6]$.

R : In $K_4[Fe(CN)_6]$, the EAN of Fe is 36.

Sol. Answer (2)

$K_4[Fe(CN)_6] \Rightarrow Fe^{2+} \Rightarrow 3d^6$

$\Rightarrow$ CFSE = $-\ 2.4\ \Delta_0$

$K_4[Fe(CN)_6] \Rightarrow Fe^{3+} \Rightarrow 3d^5$

$\Rightarrow$ CFSE = $-\ 2.0\ \Delta_0$

⇒ $K_3[Fe(CN)_6]$ is less stable then $K_4[Fe(CN)_6]$

$K_4[Fe(CN)_6]$ ⇒ Fe^{2+} ⇒ 24 electrons

∴ EAN = 24 + 2 × 6 = 36 ⇒ But not the correct explanation.

4. A : All square planar complexes can exhibit geometrical isomerism.

   R : In square planar complexes metal assumes sp^3 hybridisation.

Sol. Answer (4)

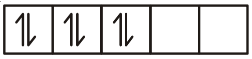
Square planar complexes of type $[MA_4]$ and $[MA_3B]$ can not exhibit geometrical isomerism.

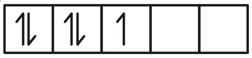
In square planar complexes, metal is dsp^2 hybridized.

5. A : $K_4[Fe(CN_6)]$ and $K_3[Fe(CN_6)]$ have different magnetic moment.

   R : Magnetic moment is decided by the number of unpaired electron and both have different number of unpaired electrons.

Sol. Answer (1)

$K_4[Fe(CN_6)]$ ⇒ Fe^{2+} ⇒ $3d^6$ ⇒  ⇒ μ = 0 BM

$K_3[Fe(CN_6)]$ ⇒ Fe^{3+} ⇒ $3d^5$ ⇒  ⇒ μ = 1.73 BM

6. A : The degeneracy of d-orbitals is lost under strong field ligand.

   R : The degeneracy of d-orbitals does not get lost under chelated ligand field.

Sol. Answer (3)

In strong field, the *d*-orbital splits into t_{2g} and e_g orbitals. t_{2g} and e_g have different energies.

Chelated ligand fields are generally strong

⇒ Statement (2) is false.

7. A : Transition metal ion forming octahedral complex having d^2sp^3 or sp^3d^2 hybridisation.

   R : Under the influence of strong field ligand inner d-orbitals take part in the hybridisation.

Sol. Answer (2)

Octahedral ⇒ d^2sp^3 or sp^3d^2

Under strong field, electrons of d-orbital get paired and the orbital takes part in hybridization. But it is not the correct explanation for hybridization.

8. A : Higher the charge density on the central ion, greater will be stability of the complex.

   R : Hard acid show a greater tendency for forming complexes with hard ligands such as F^-.

Sol. Answer (2)

Both the statements are facts. But 2nd one is not giving the reason, why charge density on metal ion is responsible for stability.

9. A : $Al_2(CH_3)_6$ is a dimeric compound and has similar structure to diborane.

   R : $Al_2(CH_3)_6$ in a sigma bonded complex.

Sol. Answer (2)

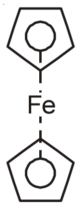
Both are true as per the structure of $Al_2(CH_3)_6$ but not the correct explanation.

10. A : Ferrocene may prepared by the reaction of Grignard reagent ferrous chloride.

R : Ferrocene is a σ and π-bonded complex.

Sol. Answer (3)

Assertion is correct (fact). But reason is wrong, because Ferrocen forms π-bonded complex.



Ferrocene

11. A : dien is bidentate ligand.

R : dien donates two pairs of electron.

Sol. Answer (4)

Dien is not a bidentate ligand and does not donate two pairs of electrons.

12. A : CN^- is an acid ligand.

R : CN^- accepts electron pair also.

Sol. Answer (4)

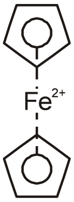
CN^- donates electron to the metal ion.

13. A : Coordination number of Fe^{2+} in ferrocene is 10.

R : Ferrocene is π bonded complex.

Sol. Answer (2)

Ferrocene ⇒



⇒ Co-ordination number of Fe^{2+} is 10

⇒ π-bonded complex

But not the correct explanation.

14. A : $[MA_3B_3]^{n+}$ shows optical isomerism.

R : $[MA_3B_3]^{n+}$ deviates plane polarized light.

Sol. Answer (4)

$[MA_3B_3]$ type complexes do not show optical isomerism.

15. A : $[Fe(CN)_6]^{4-}$ follows EAN rule.

R : Number of electrons in Fe in this complex ion is 36.

Sol. Answer (1)

$[Fe(CN)_6]^{4-} \Rightarrow Fe^{2+} \Rightarrow 24$ electrons

6 CN^- ligands ⇒ $6 \times 2 = 12$ electrons

⇒ Total $24 + 12 = 36$ electrons in the complex ion.

16. A : According to C.F.T. complex compound contain point charges.

R : The bonding between central metal ion and ligand is electrostatic.

Sol. Answer (2)

Both the statements are true. But not the correct explanation.

17. A : $[Cr(H_2O)_6]^{3+}$ is inner orbital complex.

R : H_2O is strong ligand generally.

Sol. Answer (4)

H_2O is a moderate field ligand.

$[Cr(H_2O)_6]^{3+} \Rightarrow Cr^{3+} \Rightarrow 3d^3 \Rightarrow$ forms outer orbital complex.

18. A : $[Ni(CO)_4]$ is organometallic compound.

R : CO is not a π-acid ligand.

Sol. Answer (3)

19. A : CH_3COONa is an organometallic compound.

R : CH_3COOH is organic compound and Na is transition metal.

Sol. Answer (4)

Na is a metal. CH_3COONa is a salt.

20. A : The energy gap $\Delta_0 = \frac{4}{9}\Delta_t$.

R : Δ_0 is always greater than Δ_t for same metal ion and ligand.

Sol. Answer (2)

Both the statements are true. But not the correct explanation.