Chapter 23. Coordination Compounds

1. An example of a sigma bonded organometallic compound is
(a) Grignard's reagent (b) ferrocene
(c) cobaltocene (d) ruthenocene.
(NEET 2017)

2. The correct order of the stoichiometries of AgCl formed when $AgNO_3$ in excess is treated with the complexes : $CoCl_3.6NH_3$, $CoCl_3.5NH_3$, $CoCl_3.4NH_3$ respectively is
(a) 3AgCl, 1AgCl, 2AgCl
(b) 3AgCl, 2AgCl, 1AgCl
(c) 2AgCl, 3AgCl, 2AgCl
(d) 1AgCl, 3AgCl, 2AgCl *(NEET 2017)*

3. Correct increasing order for the wavelengths of absorption in the visible region for the complexes of Co^{3+} is
(a) $[Co(H_2O)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$
(b) $[Co(H_2O)_6]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$
(c) $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(H_2O)_6]^{3+}$
(d) $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(H_2O)_6]^{3+}$
(NEET 2017)

4. Pick out the correct statement with respect to $[Mn(CN)_6]^{3-}$.
(a) It is sp^3d^2 hybridised and tetrahedral.
(b) It is d^2sp^3 hybridised and octahedral.
(c) It is dsp^2 hybridised and square planar.
(d) It is sp^3d^2 hybridised and octahedral.
(NEET 2017)

5. The correct increasing order of *trans*-effect of the following species is
(a) $NH_3 > CN^- > Br^- > C_6H_5^-$
(b) $CN^- > C_6H_5^- > Br^- > NH_3$
(c) $Br^- > CN^- > NH_3 > C_6H_5^-$
(d) $CN^- > Br^- > C_6H_5^- > NH_3$
(NEET-II 2016)

6. Jahn-Teller effect is not observed in high spin complexes of
(a) d^7 (b) d^8 (c) d^4 (d) d^9
(NEET-II 2016)

7. Which of the following has longest C—O bond length? (Free C—O bond length in CO is 1.128 Å.)
(a) $[Fe(CO)_4]^{2-}$ (b) $[Mn(CO)_6]^+$
(c) $Ni(CO)_4$ (d) $[Co(CO)_4]^-$
(NEET-I 2016)

8. The hybridization involved in complex $[Ni(CN)_4]^{2-}$ is (At. No. Ni = 28)
(a) sp^3 (b) d^2sp^2 (c) d^2sp^3
(d) dsp^2 *(2015)*

9. The name of complex ion, $[Fe(CN)_6]^{3-}$ is
(a) hexacyanitoferrate (III) ion
(b) tricyanoferrate (III) ion
(c) hexacyanidoferrate (III) ion
(d) hexacyanoiron (III) ion. *(2015)*

10. 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
(a) 6 (b) 7 (c) 8 (d) 9
(2015)

11. Number of possible isomers for the complex $[Co(en)_2Cl_2]Cl$ will be (*en* = ethylenediamine)
(a) 1 (b) 3 (c) 4 (d) 2
(2015)

12. 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?
(a) $CoCl_3 \cdot 5NH_3$ (b) $CoCl_3 \cdot 6NH_3$
(c) $CoCl_3 \cdot 3NH_3$ (d) $CoCl_3 \cdot 4NH_3$
(2015, Cancelled)

13. Which of these statements about $[Co(CN)_6]^{3-}$ is true?
(a) $[Co(CN)_6]^{3-}$ has four unpaired electrons and will be in a high-spin configuration.
(b) $[Co(CN)_6]^{3-}$ has no unpaired electrons and will be in a high-spin configuration.

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

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

(2015, Cancelled)

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

(a) $[Mn(H_2O)_6]^{3+}$ (b) $[Fe(H_2O)_6]^{3+}$

(c) $[Co(H_2O)_6]^{2+}$ (d) $[Co(H_2O)_6]^{3+}$

(2014)

15. Which of the following complexes is used to be as an anticancer agent?

(a) *mer*-$[Co(NH_3)_3Cl_3]$ (b) *cis*-$PtCl_2(NH_3)_2]$

(c) *cis*-$K_2[PtCl_2Br_2]$ (d) Na_2CoCl_4

(2014)

16. A magnetic moment at 1.73 BM will be shown by one among of the following

(a) $TiCl_4$ (b) $[CoCl_6]^{4-}$

(c) $[Cu(NH_3)_4]^{2+}$ (d) $[Ni(CN)_4]^{2-}$

(NEET 2013)

17. An excess of $AgNO_3$ is added to 100 mL of a 0.01 M solution of dichlorotetraaqua-chromium (III) chloride. The number of moles of AgCl precipitated would be

(a) 0.003 (b) 0.01 (c) 0.001 (d) 0.002

(NEET 2013)

18. Crystal field splitting energy for high spin d^4 octahedral complex is

(a) $-1.2\ \Delta_o$ (b) $-0.6\ \Delta_o$

(c) $-0.8\ \Delta_o$ (d) $-1.6\ \Delta_o$

(Karnataka NEET 2013)

19. In a particular isomer of $[Co(NH_3)_4Cl_2]^0$, the Cl – Co – Cl angle is 90°, the isomer is known as

(a) optical isomer (b) *cis*-isomer

(c) position isomer (d) linkage isomer.

(Karnataka NEET 2013)

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

(a) five membered (b) four membered

(c) six membered (d) three membered.

(Karnataka NEET 2013)

21. The correct IUPAC name for $[CrF_2(en)_2]$ Cl is

(a) chloro difluorido ethylene diaminechromium (III) chloride

(b) difluoridobis (ethylene diamine) chromium (III) chloride

(c) difluorobis-(ethylene diamine) chromium (III) chloride

(d) chloro difluoridobis (ethylene diamine) chromium (III) *(Karnataka NEET 2013)*

22. Which among the following is a paramagnetic complex?

(a) $[Co(NH_3)_6]^{3+}$ (b) $[Pt(en)Cl_2]$

(c) $[CoBr_4]^{2-}$ (d) $Mo(CO)_6$

(At. No. Mo = 42, Pt = 78)

(Karnataka NEET 2013)

23. Which is diamagnetic?

(a) $[Co(F)_6]^{3-}$ (b) $[Ni(CN)_4]^{2-}$

(c) $[NiCl_4]^{2-}$ (d) $[Fe(CN)_6]^{3-}$

(Karnataka NEET 2013)

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

(a) $[Ni(NH_3)_6]^{2+}$ (b) $[Zn(NH_3)_6]^{2+}$

(c) $[Cr(NH_3)_6]^{3+}$ (d) $[Co(NH_3)_6]^{3+}$

(2012)

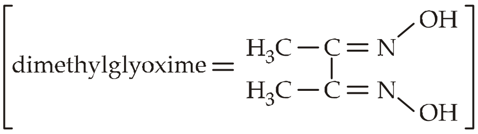
25. Red precipitate is obtained when ethanol solution of dimethylglyoxime is added to ammoniacal Ni(II). Which of the following statements is not true?

(a) Red complex has a square planar geometry.

(b) Complex has symmetrical H-bonding.

(c) Red complex has a tetrahedral geometry.

(d) Dimethylglyoxime functions as bidentate ligand.



(Mains 2012)

26. Low spin complex of d^6-cation in an octahedral field will have the following energy

(a) $\frac{-12}{5}\Delta_o + P$ (b) $\frac{-12}{5}\Delta_o + 3P$

(c) $\frac{-2}{5}\Delta_o + 2P$ (d) $\frac{-2}{5}\Delta_o + P$

(Δ_o = crystal field splitting energy in an octahedral field, P = Electron pairing energy)

(2012)

27. Of the following complex ions, which is diamagnetic in nature?
(a) $[NiCl_4]^{2-}$
(b) $[Ni(CN)_4]^{2-}$
(c) $[CuCl_4]^{2-}$
(d) $[CoF_6]^{3-}$ *(2011)*

28. 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?
(a) Linkage isomerism
(b) Ionization isomerism
(c) Coordination isomerism
(d) Geometrical isomerism *(2011)*

29. The complex, $[Pt(Py)(NH_3)BrCl]$ will have how many geometrical isomers?
(a) 3 (b) 4 (c) 0 (d) 2 *(2011)*

30. 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?
(a) $[Mn(H_2O)_6]^{2+}$ (b) $[Fe(H_2O)_6]^{2+}$
(c) $[Co(H_2O)_6]^{2+}$ (d) $[Cr(H_2O)_6]^{2+}$
(At. nos. Cr = 24, Mn = 25, Fe = 26, Co = 27) *(2011)*

31. Which of the following carbonyls will have the strongest C – O bond?
(a) $Mn(CO)_6^+$ (b) $Cr(CO)_6$
(c) $V(CO)_6^-$ (d) $Fe(CO)_5$ *(2011)*

32. Which of the following complex compounds will exhibit highest paramagnetic behaviour?
(a) $[Ti(NH_3)_6]^{3+}$ (b) $[Cr(NH_3)_6]^{3+}$
(c) $[Co(NH_3)_6]^{3+}$ (d) $[Zn(NH_3)_6]^{2+}$
(At. No. Ti = 22, Cr = 24, Co = 27, Zn = 30) *(2011)*

33. Which of the following complex ions is not expected to absorb visible light?
(a) $[Ni(CN)_4]^{2-}$ (b) $[Cr(NH_3)_6]^{3+}$
(c) $[Fe(H_2O)_6]^{2+}$ (d) $[Ni(H_2O)_6]^{2+}$ *(2010)*

34. Crystal field stabilization energy for high spin d^4 octahedral complex is
(a) $-1.8\ \Delta_o$ (b) $-1.6\ \Delta_o + P$
(c) $-1.2\ \Delta_o$ (d) $-0.6\ \Delta_o$ *(2010)*

35. The existance of two different coloured complexes with the composition of $[Co(NH_3)_4Cl_2]^+$ is due to
(a) linkage isomerism
(b) geometrical isomerism
(c) coordination isomerism
(d) ionization isomerism. *(2010)*

36. Which one of the following complexes is not expected to exhibit isomerism?
(a) $[Ni(NH_3)_4(H_2O)_2]^{2+}$ (b) $[Pt(NH_3)_2Cl_2]$
(c) $[Ni(NH_3)_2Cl_2]$ (d) $[Ni(en)_3]^{2+}$ *(2010)*

37. 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
(a) Cu_2Cl_2 and $NiCl_4^{2-}$
(b) TiF_6^{2-} and Cu_2Cl_2
(c) CoF_6^{3-} and $NiCl_4^{2-}$
(d) TiF_6^{2-} and CoF_6^{3-}. *(2009)*

38. Which of the following does not show optical isomerism?
(a) $[Co(NH_3)_3Cl_3]^0$
(b) $[Co(en)Cl_2(NH_3)_2]^+$
(c) $[Co(en)_3]^{3+}$
(d) $[Co(en)_2Cl_2]^+$
(*en* = ethylenediamine) *(2009)*

39. Which of the following complex ions is expected to absorb visible light?
(a) $[Ti(en)_2(NH_3)_2]^{4+}$ (b) $[Cr(NH_3)_6]^{3+}$
(c) $[Zn(NH_3)_6]^{2+}$
(d) $[Sc(H_2O)_3(NH_3)_3]^{3+}$
[At. nos. Zn = 30, Sc = 21, Ti = 22, Cr = 24] *(2009)*

40. Which of the following complexes exhibits the highest paramagnetic behaviour?
(a) $[Co(ox)_2(OH)_2]^-$
(b) $[Ti(NH_3)_6]^{3+}$
(c) $[V(gly)_2(OH)_2(NH_3)_2]^+$
(d) $[Fe(en)(bpy)(NH_3)_2]^{2+}$
where *gly* = glycine, *en* = ethylenediamine and *bpy* = bipyridyl moities. (At. nos. Ti = 22, V = 23, Fe = 26, Co = 27) *(2008)*

41. In which of the following coordination entities the magnitude of Δ_o (CFSE in octahedral field) will be maximum?
(a) $[Co(CN)_6]^{3-}$ (b) $[Co(C_2O_4)_3]^{3-}$
(c) $[Co(H_2O)_6]^{3+}$ (d) $[Co(NH_3)_6]^{3+}$
(At. No. Co = 27) *(2008)*

42. Which of the following will give a pair of enantiomorphs?

(a) $[Cr(NH_3)_6][Co(CN)_6]$

(b) $[Co(en)_2Cl_2]Cl$

(c) $[Pt(NH_3)_4][PtCl_6]$

(d) $[Co(NH_3)_4Cl_2]NO_2$ *(2007)*

(en = $NH_2CH_2CH_2NH_2$)

43. The d electron configurations 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 minimum paramagnetic behaviour?

(a) $[Fe(H_2O)_6]^{2+}$ (b) $[Ni(H_2O)_6]^{2+}$

(c) $[Cr(H_2O)_6]^{2+}$ (d) $[Mn(H_2O)_6]^{2+}$.

(At. No. Cr = 24, Mn = 25, Fe = 26, Ni = 28) *(2007)*

44. $[Cr(H_2O)_6]Cl_3$ (At. no. of Cr = 24) has a magnetic moment of 3.83 B.M. The correct distribution of $3d$ electrons in the chromium of the complex is

(a) $3d_{x}{}^{1}{}_{y}$, $3d_{y}{}^{1}{}_{z}$, $3d_{z}{}^{12}$

(b) $3d^{1}_{(\ x2-y2)}$, $3d_{z}{}^{1}{}_{2}$, $3d_{x}{}^{1}{}_{z}$

(c) $3d_{x}{}^{1}{}_{y}$, $3d^{1}_{(\ x2-y2)}$, $3d_{y}{}^{1}{}_{z}$

(d) $3d_{x}{}^{1}{}_{y}$, $3d_{y}{}^{1}{}_{z}$, $3d_{x}{}^{1}{}_{z}$ *(2006)*

45. $[Co(NH_3)_4(NO_2)_2]Cl$ exhibits

(a) linkage isomerism, geometrical isomerism and optical isomerism

(b) linkage isomerism, ionization isomerism and optical isomerism

(c) linkage isomerism, ionization isomerism and geometrical isomerism

(d) ionization isomerism, geometrical isomerism and optical isomerism. *(2006)*

46. Which one of the following is an inner orbital complex as well as diamagnetic in behaviour?

(a) $[Zn(NH_3)_6]^{2+}$ (b) $[Cr(NH_3)_6]^{3+}$

(c) $[Co(NH_3)_6]^{3+}$ (d) $[Ni(NH_3)_6]^{2+}$

(Atomic number : Zn = 30, Cr = 24, Co = 27, Ni = 28) *(2005)*

47. Which one of the following is expected to exhibit optical isomerism?

(en = ethylenediamine)

(a) *cis*-$[Pt(NH_3)_2Cl_2]$

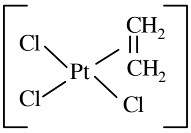
(b) *trans*-$[Pt(NH_3)_2Cl_2]$

(c) *cis*-$[Co(en)_2Cl_2]^+$

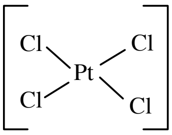
(d) *trans*-$[Co(en)_2Cl_2]^+$ *(2005)*

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

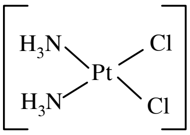
(a)



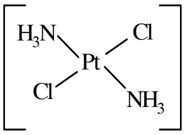
(b)



(c)



(d)



(2004)

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

(a) Pentaamminenitrocobalt(III) iodide

(b) Diamminedichloroplatinum(II)

(c) *trans*-Dicyanobis(ethylenediamine) chromium (III) chloride

(d) tris-(Ethylenediamine)cobalt(III) bromide. *(2004)*

50. Among $[Ni(CO)_4]$, $[Ni(CN)_4]^{2-}$, $[NiCl_4]^{2-}$ species, the hybridisation states at the Ni atom are, respectively

(a) sp^3, dsp^2, dsp^2 (b) sp^3, dsp^2, sp^3

(c) sp^3, sp^3, dsp^2 (d) dsp^2, sp^3, sp^3.

[Atomic number of Ni = 28] *(2004)*

51. CN^- is a strong field ligand. This is due to the fact that

(a) it carries negative charge

(b) it is a pseudohalide

(c) it can accept electrons from metal species

(d) it forms high spin complexes with metal species. *(2004)*

52. 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)

(a) three (b) five

(c) two (d) four. *(2004)*

53. Which of the following does not have a metal - carbon bond?
(a) $Al(OC_2H_5)_3$ (b) C_2H_5MgBr
(c) $K[Pt(C_2H_4)Cl_3]$ (d) $Ni(CO)_4$ *(2004)*

54. In an octahedral structure, the pair of *d* orbitals involved in d^2sp^3 hybridisation is
(a) $d_{x^2-y^2}, d_{z^2}$ (b) $d_{xz}, d_{x^2-y^2}$
(c) d_{z^2}, d_{xz} (d) d_{xy}, d_{yz}. *(2004)*

55. The number of unpaired electrons in the complex ion $[CoF_6]^{3-}$ is
(a) 2 (b) 3 (c) 4 (d) zero
(Atomic no. : Co = 27) *(2003)*

56. Among the following which is not the p-bonded organometallic compound?
(a) $K[PtCl_3(\eta^2 - C_2H_4)]$
(b) $Fe(\eta^5 - C_5H_5)_2$
(c) $Cr(\eta^6 - C_6H_6)_2$ (d) $(CH_3)_4Sn$
(2003)

57. Atomic number of Cr and Fe are respectively 24 and 26, which of the following is paramagnetic with the spin of electron?
(a) $[Cr(CO)_6]$ (b) $[Fe(CO)_5]$
(c) $[Fe(CN)_6]^{4-}$ (d) $[Cr(NH_3)_6]^{3+}$
(2002)

58. The hypothetical complex chloro diaquatriammine cobalt(III) chloride can be represented as
(a) $[CoCl(NH_3)_3(H_2O)_2]Cl_2$
(b) $[Co(NH_3)_3(H_2O)Cl_3]$
(c) $[Co(NH_2)_3(H_2O)_2Cl]$
(d) $[Co(NH_3)_3(H_2O)_3]Cl_3$ *(2002)*

59. In the silver plating of copper, $K[Ag(CN)_2]$ is used instead of $AgNO_3$. The reason is
(a) a thin layer of Ag is formed on Cu
(b) more voltage is required
(c) Ag^+ ions are completely removed from solution
(d) less availability of Ag^+ ions, as Cu can not displace Ag from $[Ag(CN)_2]^-$ ion. *(2002)*

60. $CuSO_4$ when reacts with KCN forms CuCN, which is insoluble in water. It is soluble in excess of KCN, due to formation of the following complex
(a) $K_2[Cu(CN)_4]$ (b) $K_3[Cu(CN)_4]$
(c) $CuCN_2$ (d) $Cu[KCu(CN)_4]$.
(2002)

61. Which of the following will give maximum number of isomers?
(a) $[Co(NH_3)_4Cl_2]$ (b) $[Ni(en)(NH_3)_4]^{2+}$
(c) $[Ni(C_2O_4)(en)_2]^{2-}$
(d) $[Cr(SCN)_2(NH_3)_4]^+$ *(2001)*

62. Coordination number of Ni in $[Ni(C_2O_4)_3]^{4-}$ is
(a) 3 (b) 6 (c) 4 (d) 2
(2001)

63. Which of the following organometallic compounds is σ and π bonded?
(a) $[Fe(\eta^5 - C_5H_5)_2]$
(b) $K[PtCl_3(\eta^2 - C_2H_4)]$
(c) $[Co(CO)_5NH_3]^{2+}$
(d) $Fe(CH_3)_3$ *(2001)*

64. Which statement is incorrect?
(a) $Ni(CO)_4$ - tetrahedral, paramagnetic
(b) $Ni(CN)_4^{2-}$ - square planar, diamagnetic
(c) $Ni(CO)_4$ - tetrahedral, diamagnetic
(d) $[Ni(Cl)_4]^{2-}$ - tetrahedral, paramagnetic.
(2001)

65. Which of the following will exhibit maximum ionic conductivity?
(a) $K_4[Fe(CN)_6]$ (b) $[Co(NH_3)_6]Cl_3$
(c) $[Cu(NH_3)_4]Cl_2$ (d) $[Ni(CO)_4]$
(2001)

66. Shape of $Fe(CO)_5$ is
(a) octahedral (b) square planar
(c) trigonal bipyramidal
(d) square pyramidal. *(2000)*

67. Which complex compound will give four isomers?
(a) $[Fe(en)_3]Cl_3$ (b) $[Co(en)_2Cl_2]Cl$
(c) $[Fe(PPh_3)_3NH_3ClBr]Cl$
(d) $[Co(PPh_3)_3Cl]Cl_3$ *(2000)*

68. The total number of possible isomers for the complex compound $[Cu^{II}(NH_3)_4][Pt^{II}Cl_4]$ are
(a) 5 (b) 6 (c) 3 (d) 4
(1998)

69. A coordination 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 precipitate. The ionic formula for this complex would be
(a) $[Co(NH_3)_5(NO_2)]Cl_2$
(b) $[Co(NH_3)_5Cl][Cl(NO_2)]$
(c) $[Co(NH_3)_4(NO_2)Cl][(NH_3)Cl]$
(d) $(Co(NH_3)_5][(NO_2)_2Cl_2]$ *(1998)*

70. IUPAC name of $[Pt(NH_3)_3(Br)(NO_2)Cl]Cl$ is
(a) Triamminebromochloronitroplatinum(IV) chloride
(b) Triamminebromonitrochloroplatinum(IV) chloride
(c) Triamminechlorobromonitroplatinum(IV) chloride
(d) Triamminenitrochlorobromoplatinum(IV) chloride *(1998)*

71. The formula of dichlorobis(urea)copper(II) is
(a) $[Cu\,\{O=C(NH_2)_2\}\,Cl]Cl$
(b) $[CuCl_2]\,\{O=C(NH_2)_2\}$
(c) $[Cu\,\{O=C(NH_2)_2\}Cl_2$
(d) $[CuCl_2\,\{O=C(NH_2)_2\}_2]$. *(1997)*

72. The number of geometrical isomers of the complex $[Co(NO_2)_3(NH_3)_3]$ is
(a) 4 (b) 0 (c) 2 (d) 3
(1997)

73. The structure and hybridisation of $Si(CH_3)_4$ is
(a) octahedral, sp^3d (b) tetrahedral, sp^3
(c) bent, sp (d) trigonal, sp^2.
(1996)

74. The coordination number and oxidation state of Cr in $K_3Cr(C_2O_4)_3$ are respectively
(a) 3 and + 3 (b) 3 and 0
(c) 6 and + 3 (d) 4 and + 2
(1995)

75. The number of geometrical isomers for $[Pt(NH_3)_2Cl_2]$ is
(a) 3 (b) 4 (c) 1 (d) 2
(1995)

76. In metal carbonyl having general formula $M(CO)_x$ where M = metal, $x = 4$ and the metal is bonded to
(a) carbon and oxygen (b) $C\equiv O$
(c) oxygen (d) carbon. *(1995)*

77. Which of the following ligands is expected to be bidentate?
(a) CH_3NH_2 (b) $CH_3C\equiv N$
(c) Br (d) $C_2O_4^{2-}$ *(1994)*

Answer Key

1.	(a)	**2.**	(b)	**3.**	(d)	**4.**	(b)	**5.**	(b)	**6.**	(b)	**7.**	(a)	**8.**	(d)	**9.**	(c)	**10.**	(d)
11.	(b)	**12.**	(c)	**13.**	(c)	**14.**	(b)	**15.**	(b)	**16.**	(c)	**17.**	(c)	**18.**	(b)	**19.**	(b)	**20.**	(c)
21.	(b)	**22.**	(c)	**23.**	(b)	**24.**	(a)	**25.**	(c)	**26.**	(b)	**27.**	(b)	**28.**	(c)	**29.**	(a)	**30.**	(c)
31.	(a)	**32.**	(b)	**33.**	(a)	**34.**	(d)	**35.**	(d)	**36.**	(c)	**37.**	(b)	**38.**	(a)	**39.**	(b)	**40.**	(d)
41.	(a)	**42.**	(b)	**43.**	(b)	**44.**	(d)	**45.**	(c)	**46.**	(c)	**47.**	(c)	**48.**	(c)	**49.**	(d)	**50.**	(b)
51.	(b)	**52.**	(b)	**53.**	(a)	**54.**	(a)	**55.**	(c)	**56.**	(d)	**57.**	(d)	**58.**	(a)	**59.**	(d)	**60.**	(b)
61.	(d)	**62.**	(b)	**63.**	(c)	**64.**	(a)	**65.**	(a)	**66.**	(c)	**67.**	(b)	**68.**	(d)	**69.**	(a)	**70.**	(a)
71.	(b)	**72.**	(c)	**73.**	(b)	**74.**	(c)	**75.**	(d)	**76.**	(d)	**77.**	(d)						

EXPLANATIONS

1. (a)

2. (b) : $[Co(NH_3)_6]Cl_3 + 3AgNO_3 \rightarrow 3AgCl\downarrow + [Co(NH_3)_6](NO_3)_3$

$[Co(NH_3)_5Cl]Cl_2 + 2AgNO_3 \rightarrow 2AgCl\downarrow + [Co(NH_3)_5Cl](NO_3)_2$

$[Co(NH_3)_4Cl_2]Cl + AgNO_3 \rightarrow AgCl\downarrow + [Co(NH_3)_4Cl_2]NO_3$

3. (d) : Increasing order of crystal field splitting energy is : $H_2O < NH_3 < en$

Thus, increasing order of energy for the given complexes is :

$$[Co(H_2O)_6]^{3+} < [Co(NH_3)_6]^{3+} < [Co(en)_3]^{3+}$$

As, $E = \dfrac{hc}{\lambda}$

Thus, increasing order of wavelength of absorption is:

$$[Co(en)_3]^{3+} < [Co(NH_3)_6]^{3+} < [Co(H_2O)_6]^{3+}$$

4. (b) : $[Mn(CN)_6]^{3-}$

Let oxidation state of Mn be x.

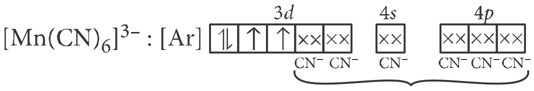
$x + 6 \times (-1) = -3$

$x = +3$

Electronic configuration of Mn : $[Ar]4s^2\,3d^5$

Electronic configuration of Mn^{3+} : $[Ar]3d^4$

CN^- is a strong field ligand thus, it causes pairing of electrons in $3d$-orbital.



d^2sp^3 hybridisation

Then, $[Mn(CN)_6]^{3-}$ has d^2sp^3 hybridisation and has octahedral geometry.

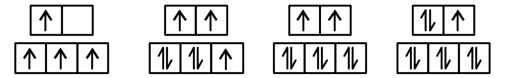
5. (b) : The intensity of the trans-effect (as measured by the increase in rate of substitution of the *trans* ligand follows the sequence :

$$CN^- > C_6H_5^- > Br^- > NH_3$$

6. (b) : Jahn–Teller distortion is usually significant for asymmetrically occupied e_g orbitals since they are directed towards the ligands and the energy gain is considerably more.

In case of unevenly occupied t_{2g} orbitals, the Jahn–Teller distortion is very weak since the t_{2g} set does not point directly at the ligands and therefore, the energy gain is much less.

High spin complexes :



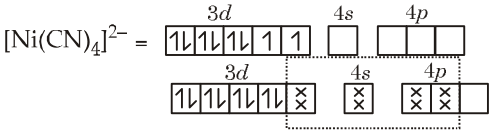
d^4, unsymmetrical d^7, unsymmetrical d^8, symmetrical d^9, unsymmetrical

7. (a) : The greater the negative charge on the carbonyl complex, the more easy it would be for the metal to permit its electrons to participate in the back bonding, the higher would be the M—C bond order and simultaneously there would be larger reduction in the C—O bond order. Thus, $[Fe(CO)_4]^{2-}$ has the lowest C—O bond order means the longest bond length.

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

Oxidation number of Ni = +2

Electronic configuration of Ni^{2+} : $3d^8 4s^0$



dsp^2 hybridization

[Pairing of electrons in d-orbital takes place due to the presence of strong field ligand (CN^-)]

9. (c)

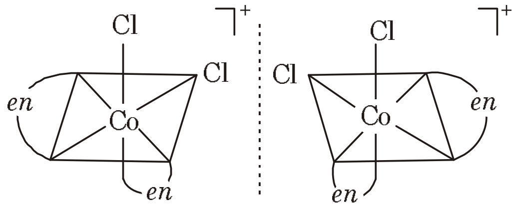
10. (d) : $[M(en)_2(C_2O_4)]Cl$:

Oxidation number of metal = +3

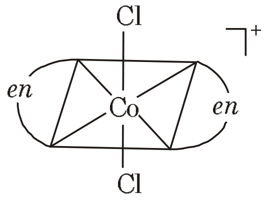
Coordination number of metal = 6

∴ Sum of oxidation number and coordination number = 3 + 6 = 9

11. (b) : Possible isomers of $[Co(en)_2Cl_2]Cl$:



cis-isomer
(d and l forms)



trans-isomer

12. (c) : For octahedral complexes, coordination number is 6.

Hence, $CoCl_3 \cdot 3NH_3$ *i.e.*, $[Co(NH_3)_3Cl_3]$ will not ionise and will not give test for Cl^- ion with silver nitrate.

13. **(c) :** $[Co(CN)_6]^{3-}$, oxidation no. of Co = +3
$Co^{3+} = 3d^6$

As CN^- is a strong field ligand, so all electrons will be paired up and complex will be low spin complex.

14. **(b) :** H_2O is a weak field ligand, hence
$\Delta_o <$ pairing energy.
$CFSE = (-0.4x + 0.6y)\Delta_o$
where, x and y are no. of electrons occupying t_{2g} and e_g orbitals respectively.

For $[Fe(H_2O)_6]^{3+}$ complex ion,
$Fe^{3+}(3d^5) = t_{2g}^3 e_g^2 = -0.4 \times 3 + 0.6 \times 2 = 0.0$ or 0 Dq

15. **(b)**

16. **(c) :** Oxidation state of Cu in $[Cu(NH_3)_4]^{2+}$ is +2
$Cu^{2+} = 3d^9$

It has one unpaired electron (n = 1).

$$\mu = \sqrt{n(n+2)}\ \text{BM}$$
$$\mu = \sqrt{1(1+2)} = \sqrt{3} = 1.73\ \text{BM}$$

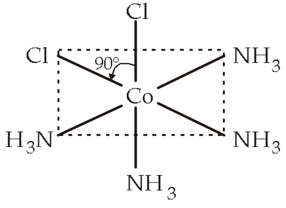
17. **(c) :** $[Cr(H_2O)_4Cl_2]Cl + AgNO_3 \rightarrow [Cr(H_2O)_4Cl_2]NO_3 + \underset{\text{ppt.}}{AgCl}$

No. of mole $= \dfrac{100}{1000} = 10^{-3}$

So, mole of AgCl = 0.001

18. **(b) :** $CFSE = (-0.4\,x + 0.6\,y)\,\Delta_o$
where, x = No. of electrons occupying t_{2g} orbitals
y = No. of electrons occupying e_g orbitals
$= (-0.4 \times 3 + 0.6 \times 1)\,\Delta_o$
[∵ High spin $d^4 = t_{2g}^3\, e_g^1$]
$= (-1.2 + 0.6)\Delta_o = -0.6\,\Delta_o$

19. **(b) :**

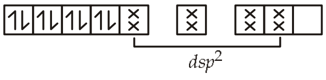


cis isomer

20. **(c) :** Chelating ligands having conjugated double bonds form more stable six membered rings.

21. **(b)**

22. **(c) :** $Co^{2+} = (3d^5)$
Bromine is a weak ligand but it is known that all tetrahedral complexes are high-spin regardless of the splitting power of the ligand. The low spin arrangement has five unpaired electrons in the d-orbital. So it is paramagnetic in nature.

23. **(b) :** In $[Ni(CN)_4]^{2-}$ all orbitals are doubly occupied, hence, it is diamagnetic.
$Ni^{2+} = 3d^8$
$[Ni(CN)_4]^{2-} =$


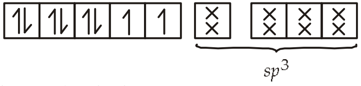
CN is a strong ligand and causes pairing of $3d$-electrons of Ni^{2+}.

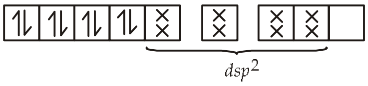
24. **(a) :**
$[Ni(NH_3)_6]^{2+}$ sp^3d^2 (outer), octahedral, paramagnetic
$[Zn(NH_3)_6]^{2+}$ sp^3d^2 (outer), octahedral, diamagnetic
$[Cr(NH_3)_6]^{3+}$ d^2sp^3 (inner), octahedral, paramagnetic
$[Co(NH_3)_6]^{3+}$ d^2sp^3 (inner), octahedral, diamagnetic

25. **(c) :** $[Ni(dmg)_2]$ is square planar in structure not tetrahedral.

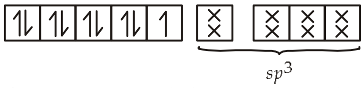
26. **(b) :** $C.F.S.E. = (-0.4x + 0.6y)\Delta_o + zP$
where x = number of electrons occupying t_{2g} orbital
y = number of electrons occupying e_g orbital
z = number of pairs of electrons

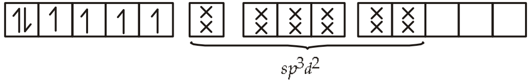
For low spin d^6 complex electronic configuration
$= t_{2g}^6\, e_g^0$ or $t_{2g}^{2,\,2,\,2}\, e_g^0$
$\therefore\ x = 6, y = 0, z = 3$
$C.F.S.E. = (-0.4 \times 6 + 0 \times 0.6)\Delta_o + 3P$
$= \dfrac{-12}{5}\Delta_o + 3P$

27. **(b) :** $[NiCl_4]^{2-}$:


Number of unpaired electrons = 2
Hence $[NiCl_4]^{2-}$ is paramagnetic.
$Ni(CN)_4]^{2-}$:


Number of unpaired electrons = 0, so it is diamagnetic in nature.

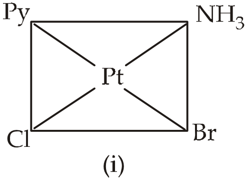
$[CuCl_4]^{2-}$:


No. of unpaired electron = 1, so it is paramagnetic.
$[CoF_6]^{3-}$:


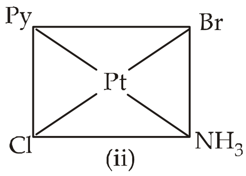
No. of unpaired electrons = 4, so it is paramagnetic.

28. **(c) :** Coordination isomerism arises from the interchange of ligands between cationic and anionic entities of different metal ions present in the complex.
e.g., $[Co(NH_3)_6][Cr(CN)_6]$ and $[Cr(NH_3)_6][Co(CN)_6]$

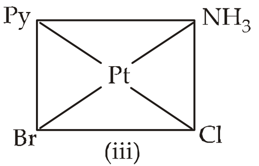
29. **(a) :** $[Pt(Py)(NH_3)BrCl]$ can have three isomers.



(i)



(ii)



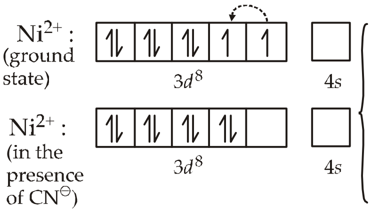
(iii)

30. **(c) :** $[Mn(H_2O)_6]^{2+}$: $Mn^{2+} = 3d^5$
∴ Number of unpaired electron = 5
$[Fe(H_2O)_6]^{2+}$: $Fe^{2+} = 3d^6$
∴ Number of unpaired electrons = 4
$[Co(H_2O)_6]^{2+}$: $Co^{2+} = 3d^7$
∴ Number of unpaired electrons = 3
$[Cr(H_2O)_6]^{2+}$: $Cr^{2+} = 3d^4$
∴ Number of unpaired electrons = 4
Minimum paramagnetic behaviour is shown by $[Co(H_2O)_6]^{2+}$.

31. **(a) :** The presence of positive charge on the metal carbonyl would resist the flow of the metal electron charge to π* orbitals of CO. This would increase the CO bond order and hence CO in a metal carbonyl cation would absorb at a higher frequency compared to its absorption in a neutral metal carbonyl.

32. **(b) :** $Ti \rightarrow [Ar]\ 3d^2\ 4s^2$, $Ti^{3+} \rightarrow [Ar]\ 3d^1\ 4s^0$
(1 unpaired electron)
$Cr \rightarrow [Ar]\ 3d^4\ 4s^2$, $Cr^{3+} \rightarrow [Ar]\ 3d^3\ 4s^0$
(3 unpaired electrons)
$Co \rightarrow [Ar]\ 3d^7\ 4s^2$, $Co^{3+} \rightarrow [Ar]\ 3d^6\ 4s^0$
(0 unpaired electrons because of pairing)
$Zn \rightarrow [Ar]\ 3d^{10}\ 4s^2$, $Zn^{2+} \rightarrow [Ar]\ 3d^{10}$
(no unpaired electrons)
$[Cr(NH_3)_6]^{3+}$ exhibits highest paramagnetic behaviour as it contains 3 unpaired electrons.

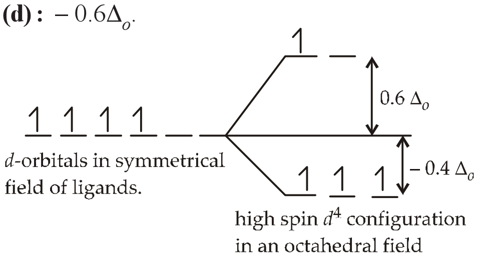
33. **(a) :** A transition metal complex absorbs visible light only if it has unpaired electrons.



CN^- is a strong field ligand so induces pairing of electrons.

No unpaired electron so does not absorb visible light.

34. **(d) :** $-0.6\Delta_o$.



$$CFSE = 3(-0.4)\Delta_o + 0.6\Delta_o = -1.2\Delta_o + 0.6\Delta_o$$
$$CFSE = -0.6\Delta_o$$

35. **(d)** **36.** **(c)**

37. **(b) :** A species is coloured when it contains unpaired d-electrons which are capable of undergoing d-d transition on adsorption of light of a particular wavelength.
In TiF_6^{2-}, Ti^{4+} : $3d^0$, colourless
In CoF_6^{3-}, Co^{3+} : $3d^6$, coloured
In Cu_2Cl_2, Cu^+ : $3d^{10}$, colourless
In $NiCl_4^{2-}$, Ni^{2+} : $3d^8$, coloured.
Thus TiF_6^{2-} $(3d^0)$ and Cu_2Cl_2 $(3d^{10})$ with empty and fully filled d-orbitals appear colourless as they are not capable of undergoing d-d transition.

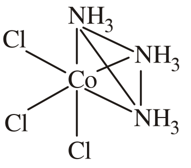
38. **(a) :** Optical isomerism is shown by :

(i) complexes of the type $[M(AA)X_2Y_2]$, *i.e.*, $[Co(en)Cl_2(NH_3)_2]^+$ containing one symmetrical bidentate ligand.

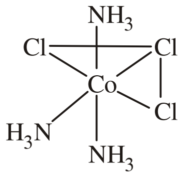
(ii) complexes of the type $[M(AA)_3]$, *i.e.*, $[Co(en)_3]^{3+}$ containing a symmetrical bidentate ligand.

(iii) complexes of the type $[M(AA)_2X_2]$, *i.e.*, $[Co(en)_2Cl_2]^+$. However compexes of the type $[MA_3B_3]$ show geometrical isomerism, known as *fac-mer* isomerism.

∴ $[Co(NH_3)_3Cl_3]$ exhibits *fac-mer* isomerism.



fac-isomer



mer-isomer

39. **(b) :** $Ti^{4+} \rightarrow 3d^0$, $Cr^{3+} \rightarrow 3d^3$
$Zn^{2+} \rightarrow 3d^{10}$, $Sc^{3+} \rightarrow 3d^0$
Transition metal ions containing completely filled d-orbitals or empty d-orbitals are colourless species.

40. **(d) :** O.S of Ti in the complex $[Ti(NH_3)_6]^{3+}$
$Ti^{3+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^1$
no. of unpaired electron in d orbital is one.
O.S of V in complex $[V(gly)_2(OH)_2(NH_3)_2]^+$
$= x + 2 \times 0 + 2 \times (-1) + 2 \times 0 = +1$
∴ $x = +3$
$V^{3+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2$
no. of unpaired electron in d orbital is two.
O.S of Fe in the given complex is +2
∴ $Fe^{2+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6$
no. of unpaired electron in d orbital is four.
O.S of Co in the given complex $[Co(ox)_2(OH)_2]^-$
$= x + 2 \times (-2) + 2 \times (-1) = -1$
$= x - 4 - 2 = -1$
∴ $x = +5$
(not possible, common ox. no. of Co = +2, +3, +4)
$Co^{5+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4$
It should be an inner orbital complex (d^2sp^3 hybridisation) containing only one unpaired

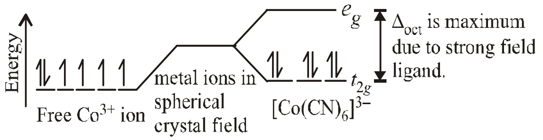
electron. So the complex having highest paramagnetism would be the complex of iron containing four unpaired electrons.

41. **(a) :** When the ligands are arranged in order of the magnitude of crystal field splitting, the arrangement, thus, obtained is called spectrochemical series.

Arranged in increasing field strength as

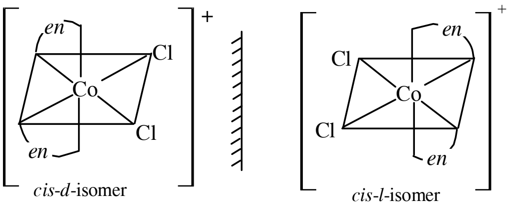
$$I^- < Br^- < Cl^- < NO_3^- < F^- < OH^- < C_2O_4^{2-} < H_2O$$
$$< NH_3 < en < NO_2^- < CN^- < CO$$

It has been observed that ligands before H_2O are weak field ligands while ligands after H_2O are strong field ligands.



CFSE in octahedral field depends upon the nature of ligands. Stronger the ligands larger will be the value of Δ_{oct}.

42. **(b) :** Either a pair of crystals, molecules or compounds that are mirror images of each other but are not identical, and that rotate the plane of polarised light equally, but in opposite directions are called as enantiomorphs.



cis-d-isomer *cis-l*-isomer

43. **(b) :** 3*d*

Cr^{2+} ⇒ $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{}$

⇒ 4 unpaired electrons

Mn^{2+} ⇒ $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$

⇒ 5 unpaired electrons

Fe^{2+} ⇒ $\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$

⇒ 4 unpaired electrons

Ni^{2+} ⇒ $\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}$

⇒ 2 unpaired electrons

Greater the number of unpaired electrons, higher is the paramagnetism. Hence Ni^{2+} will exhibit the minimum paramagnetic behaviour.

44. **(d) :** Magnetic moment = $\sqrt{n(n+2)}$

$3.83 = \sqrt{n(n+2)}$ or, $(3.83)^2 = n(n+2)$

or, $14.6689 = n^2 + 2n$

On solving the equation, $n = 3$

$Cr^{3+} \rightarrow [Ar]\ 3d^3$

$$\begin{array}{ccccc} \boxed{\uparrow} & \boxed{\uparrow} & \boxed{\uparrow} & \boxed{} & \boxed{} \\ d_{xy} & d_{yz} & d_{zx} & d_{x^2-y^2} & d_{z^2} \end{array}$$

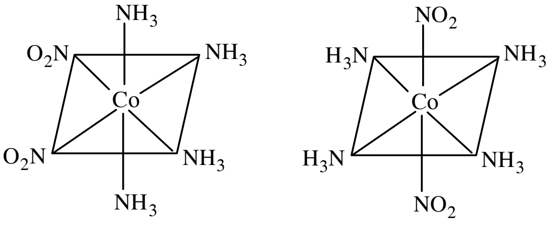
45. **(c) :** Ionization isomerism arises when the coordination compounds give different ions in solution.

$[Co(NH_3)_4(NO_2)_2]Cl \rightleftharpoons [Co(NH_3)_4(NO_2)_2]^+ + Cl^-$

Linkage isomerism occurs in complex compounds which contain ambidentate ligands like NO_2^-, SCN^-, CN^-, $S_2O_3^{2-}$ and CO.

$[Co(NH_3)_4(NO_2)_2]Cl$ and $[Co(NH_3)_4(ONO)_2]Cl$ are linkage isomers as NO_2^- is linked through N or through O.

Octahedral complexes of the type Ma_4b_2 exhibit geometrical isomerism.



cis- *trans-*

46. **(c) :** $[Co(NH_3)_6]^{3+}$ Co(27) $[Ar]^{18}$

$$\begin{array}{ccc} 3d & 4s & 4p \\ \boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow} & \boxed{\uparrow\downarrow} & \boxed{}\boxed{}\boxed{} \end{array}$$

Co^{3+}(24) $[Ar]^{18}$

$$\begin{array}{ccc} 3d & 4s & 4p \\ \boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\underbrace{\boxed{}\boxed{}} & \underbrace{\boxed{}} & \underbrace{\boxed{}\boxed{}\boxed{}} \end{array}$$

$$d^2sp^3$$

$$\underbrace{\boxed{:}\boxed{:}\boxed{:}\boxed{:}\boxed{:}\boxed{:}}$$

electron pair from six ligands (NH_3)

$d^2sp^3 \rightarrow$ inner octahedral complex and diamagnetic.

$[Zn(NH_3)_6]^{2+} \longrightarrow sp^3d^2$ (outer)and diamagnetic.

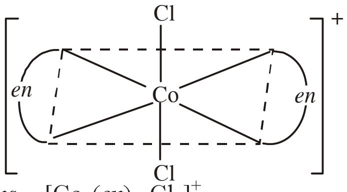
$[Cr(NH_3)_6]^{3+} \longrightarrow d^2sp^3$ (inner)and paramagnetic.

$[Ni(NH_3)_6]^{2+} \longrightarrow sp^3d^2$ (outer)and paramagnetic.

47. **(c) :** Optical isomerism is not shown by square planar complexes.

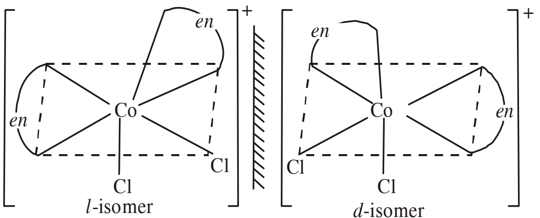
Octahedral complexes of general formulae, $[Ma_2b_2c_2]^{n\pm}$, $[Mabcdef]$, $[M(AA)_3]^{n\pm}$, $[M(AA)_2a_2]^{n\pm}$

(where AA = symmetrical bidentate ligand), $[M(AA)_2ab]^{n\pm}$ and $[M(AB)_3]^{n\pm}$ (where AB = unsymmetrical ligands) show optical isomerism.



trans - $[Co(en)_2Cl_2]^+$

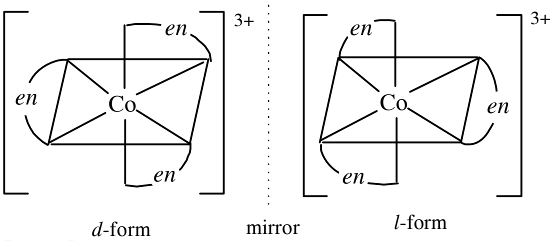
does not show optical isomerism (superimposable mirror image). But *cis*-form shows optical isomerism.



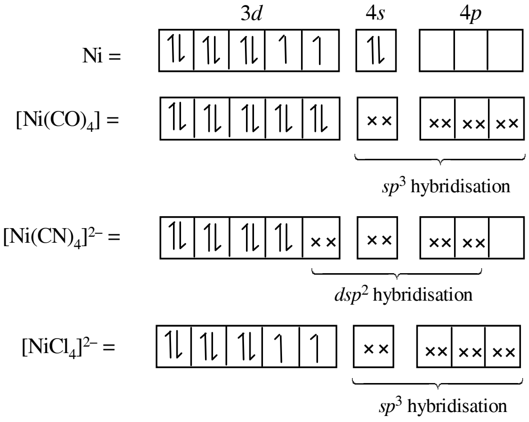
cis - $[Co(en)_2Cl_2]^+$

48. (c) : *Cis* isomer of $[Pt(NH_3)_2Cl_2]$ is used as an anticancer drug for treating several types of malignant tumours. When it is injected into the blood stream, the more reactive Cl groups are lost. So the Pt atom bonds to a N atom in guanosine (a part of DNA). This molecule can bond to two different guanosine units and by bridging between them it upsets the normal reproduction of DNA.

49. (d) : $[Co(en)_3]^{3+}$

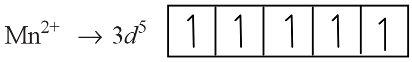


50. (b) :



51. (b) : Cyanide ion is strong field ligand because it is a pseudohalide ion. Pseudohalide ions are stronger coordinating ligands and they have the ability to form σ-bond (from the pseudohalide to the metal) and π bond (from the metal to pseudohalide).

52. (b) : Mn 25 → $3d^54s^2$

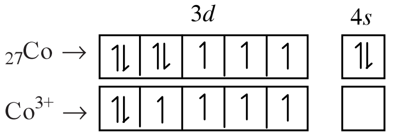


In presence of weak field ligand, there will be no pairing of electrons. So it will form a high spin complex, *i.e.* the number of unpaired electrons = 5.

53. (a) : $Al(OC_2H_5)_3$ contains bonding through O and thus it does not have metal - carbon bond.

54. (a) : In the formation of d^2sp^3 hybrid orbitals, two $(n-1)d$ orbitals of e_g set [*i.e.* $(n-1)d_{z^2}$ and $(n-1)d_{x^2-y^2}$ orbitals)], one ns and three np (np_x, np_y and np_z) orbitals combine together and form six d^2sp^3 hybrid orbitals.

55. (c) : $[CoF_6]^{3-}$



(in weak ligand field)

Thus, the number of unpaired electrons = 4.

56. (d) : π-bonded organometallic compound includes organometallic compounds of alkenes, alkynes and some other carbon containing compounds having electrons in their p orbitals.

57. (d) : Odd electrons, ions and molecules are paramagnetic.

In $Cr(CO)_6$ molecule 12 electrons are contributed by CO group and it contains no odd electron.

$$Cr \rightarrow 3d^5\ 4s^1$$

$Fe(CO)_5$ molecule also does not contain odd electron.

$$Fe \rightarrow 3d^6\ 4s^2$$

In $[Fe(CN)_6]^{4-}$ ion Fe(+II) → $3d^6\ 4s^0$

∴ No odd electrons.

In $[Cr(NH_3)_6]^{3+}$ ion Cr(+III) → $3d^3\ 4s^0$

This ion contains odd electron so it is paramagnetic.

58. (a) : Chlorodiaquatriamminecobalt(III)chloride can be represented as $[CoCl(NH_3)_3(H_2O)_2]Cl_2$.

59. (d) : Copper being more electropositive readily precipitate silver from their salt (Ag^+) solution.

$$Cu + 2AgNO_3 = Cu(NO_3)_2 + Ag.$$

In $K[Ag(CN)_2]$ solution a complex anion $[Ag(CN)_2]^-$ is formed so Ag^+ ions are less available in the solution and Cu cannot displace Ag from this complex ion.

60. (b) : Copper sulphate reacts with potassium cyanide giving a white precipitate of cuprous cyanide and cyanogen gas. The cuprous cyanide dissolves in excess of KCN forming potassium cuprocyanide $K_3[Cu(CN)_4]$.

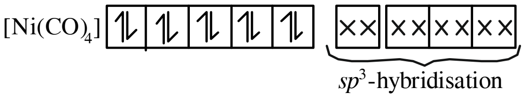
$2CuSO_4 + 4KCN \rightarrow 2CuCN + (CN)_2 + 2K_2SO_4$
$CuCN + 3KCN \rightarrow K_3[Cu(CN)_4]$

61. (d) : $[Cr(SCN)_2(NH_3)_4]^+$ shows linkage, geometrical and optical isomerisms.

62. (b) : $C_2O_4 \rightarrow$ bidentate ligand.
3 molecules attached from two sides with Ni makes co-ordination number 6.

63. (c) : $[Co(CO)_5NH_3]^{2+}$ - In this complex, Co-atom is attached with NH_3 through σ bonding and with CO with dative π-bond.

64. (a) : In $Ni(CO)_4$ complex, $Ni(CO)_4$ will have $3d^{10}$ configuration.



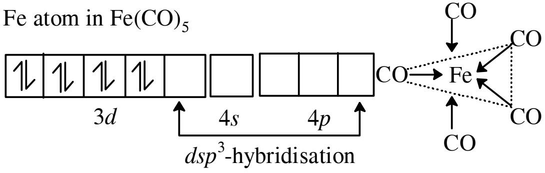
Hence $[Ni(CO)_4]$ will have tetrahedral geometry but diamagnetic as there are no unpaired electrons.

65. (a) : Ionic conductance increases with increasing the number of ions, produced after decomposition.

Compound	No. of ions produced
$K_4[Fe(CN)_6]$	5
$[Co(NH_3)_6]Cl_3$	4
$[Cu(NH_3)_4]Cl_2$	3
$[Ni(CO)_4]$	0

66. (c) : In $Fe(CO)_5$, the 'Fe' atom is dsp^3 hybridised, therefore shape of the molecule is trigonal bipyramidal.

Fe atom in $Fe(CO)_5$



67. (b) : $[Fe(PPh_3)NH_3ClBr]Cl$ can give two optical and two geometrical isomers. While other complexes do not form geometrical isomers.

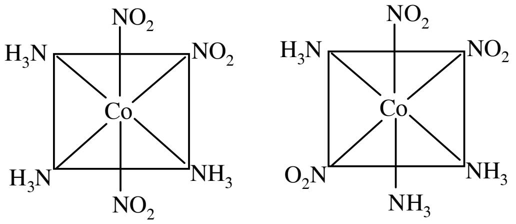
68. (d) : The isomers of the complex compound $[Cu^{II}(NH_3)_4][Pt^{II}Cl_4]$ are :
(i) $[Cu(NH_3)_3Cl]\ [Pt(NH_3)Cl_3]$
(ii) $[Pt(NH_3)_3Cl][Cu(NH_3)Cl_3]$ (iii) $[Pt(NH_3)_4][CuCl_4]$
So the total no. of isomers are = 4.

69. (a) : As the complex gives two moles of AgCl ppt. with $AgNO_3$ solution, so the complex must have two ionisable Cl atoms. Hence the probable complex, which gives three mole ions may be $[Co(NH_3)_5NO_2]Cl_2$.
$[Co(NH_3)_5NO_2]Cl_2 \rightarrow [Co(NH_3)_5NO_2]^{2+} + 2Cl^-$
one mole → 3 mole ions.

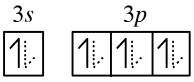
70. (a) : The ligands are named in the alphabatic order according to latest IUPAC system. So the name of $[Pt(NH_3)_3Br(NO_2)Cl]Cl$ is Triamminebromochloronitroplatinum(IV) chloride. (The oxidation no. of 'Pt' is +4).

71. (b)

72. (c) : Possible geometrical isomers are :

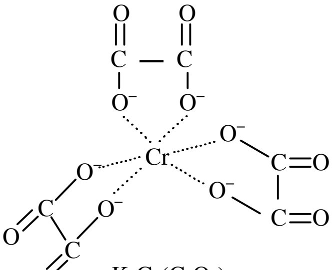


73. (b) : $Si(CH_3)_4$ - tetramethyl silane

Hybridisation - Si 

Therefore, there is sp^3 hybridisation. Structure is tetrahedral.

74. (c) :



$K_3Cr(C_2O_4)_3$

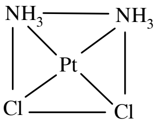
As the number of atoms of the ligands that are directly bound to the central metal is known as coordination number. It is six here (see in figure).

Oxidation state :

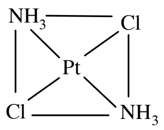
Let oxidation state of Cr be x.

$\Rightarrow \quad 3(+1) + x + 3(-2) = 0 \Rightarrow 3 + x - 6 = 0 \Rightarrow x = 3$

75. (d) :

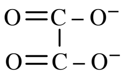


and



The two geometrical isomers are given above.

76. (d) : In $M(CO)_4$ metal is bonded to the ligands via carbon atoms with both σ and π-bond character. Both metal to ligand and ligand to metal bonding are possible.

77. (d) : When a ligand has two groups that are capable of bonding to the central atom, it is said to be bidentate. Thus the only ligand,which is expected to be bidentate is $C_2O_4^{2-}$ as 

$$\begin{array}{c} O{=}C-O^- \\ | \\ O{=}C-O^- \end{array}.$$