# COORDINATION COMPOUNDS

**PROBLEMS BASED ON GIVEN TOPICS**

- Double salt and coordination compounds
- Werner's work
- More recent methods of studying complexes
- Classification of ligands
- Effecive atomic number (EAN)
  - Sidgwick EAN rule
- Shape of d orbitals
- Bonding in transition metal complexes
  - Valence bodn theory
  - Crystal field theory
  - Molecular orbitals theory
- Valence bond theory
- Crystal field theory
  - Octahedral complexes
- Effects of crystal field splitting
- Tetragonal distortion of octahedral complexes (Jahn-Teller Distortion)
- Square planar arrangements
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- Extension of the crystal field theory to allow for some covalency
- Nomenclature of coordination compounds
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  - Coordination position isomerism
  - Geometrical isomerism and optical isomerism

CHAPTER 2

# Coordination Compounds

## EXERCISE # I

☐ **Only one correct answer :**

**1.** The formula of sodium nitropruside is $Na_2[Fe(CN)_5NO]$. In sodium nitropruside, the oxidation state, coordination number and EAN of iron are respectively :-

(*a*) +3, 6, 36 (*b*) +2, 6, 36

(*c*) +3, 3, 36 (*d*) 6, +3, 35

**2.** What is the oxidation state of Th in organometallic compound $[ThHOR(C_5Me_5)_2]$ ?

(*a*) +1

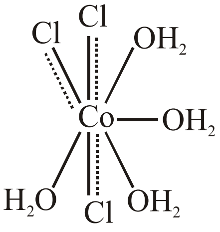
(*b*) +2

(*c*) +4

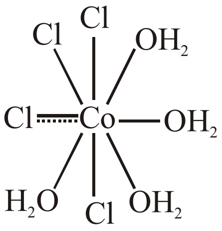
(*d*) +3

**3.** $CoCl_3.4H_2O$ is an anhydrous binary soluble compound. Hence its Werner's representation is:-

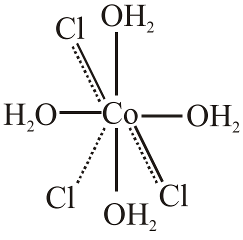
(*a*)



(*b*)



(*c*)



(*d*) None

**4.** Concentrated $H_2SO_4$ will not dehydrate which of the following complex

(*a*) $[Cr(H_2O)_5Cl]\ Cl_2.H_2O$

(*b*) $[Cr(H_2O)_6]Cl_3$

(*c*) $[Cr(H_2O)_4Cl_2]\ Cl.2H_2O$

(*d*) All of these

**5.** On adding $AgNO_3$ solution to a solution of $Pt(NH_3)_3Cl_4$, the percentage of total chloride ion precipitated is :-

(*a*) 100 (*b*) 75

(*c*) 50 (*d*) 25

**6.** The effective atomic number of iron in complex $[(n^5C_5H_5)Fe(CO)_2Cl]$ :-

(*a*) 34 (*b*) 36

(*c*) 38 (*d*) 32

**7.** If EAN of metal is 36 in $[M(CO)_2(\sigma C_5H_5)(\pi C_5H_5)]$, then what is the atomic number of metal M ?

(*a*) 23 (*b*) 24

(*c*) 25 (*d*) 26

**8.** What is the coordination number of central atom of the complex $[M(NH_3)_4SO_4]Br$ which has one ring ?

(*a*) 4 (*b*) 5

(*c*) 6 (*d*) None

**9.** Oxidation state of Co in $Ag[Co(CO)_4]$ and Mo in oxo complex species $[Mo_2O_4(C_2H_4)(H_2O)_2]^{2-}$ are respectively :-

(*a*) +1, +3 (*b*) –1, –3

(*c*) +1, –3 (*d*) –1, +3

**10.** In Tollen's reagent, the oxidation number, coordination number and effective atomic number of central metal ion are respectively. (At. no. of Ag = 47) :-

(*a*) +1, +2, 50

(*b*) +1, +2, 51

(*c*) +2, +1, 50

(*d*) +1, +1, 50

**11.** Which will not give test of all the anions present in it ?

(*a*) $K_2Fe_2(SO_4)_4.24H_2O$

(*b*) $(NH_4)_2Fe(SO_4)_2.6H_2O$

(*c*) $K_3[Fe(CN)_6]$

(*d*) All

**12.** In the compound $CoCl_3.4NH_3$ :-

(*a*) All the Cl shows primary valency only

(*b*) Two Cl show primary valency and two Cl shows secondary valency

(*c*) Two Cl show primary valency and one Cl shows primary valency as well as secondary valency

(*d*) 3 Cl shows primary valency and two Cl shows primary valency as well as secondary valency

**13.** For which of the following complex, metal carbon linkage is present :-

(*a*) $Cr(acac)_3$ (*b*) $Ni(DMG)_2$

(*c*) $Fe(CO)_5$ (*d*) $[Co(C_2H_5O)_6]^{3-}$

**14.** Which of the following ligand can act as chelating ligand with more than one chiral centre ?

(*a*) 1, 2 propanediamine (pn)

(*b*) 2,3 butane diamine (bn)

(*c*) Nitrilotriacetato(nta$^{-3}$)

(*d*) glycinato

**15.** Which one of the following is example of 1 : 3 electrolyte :-

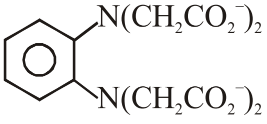
(*a*) $PtCl_4 . 6NH_3$ (*b*) $CrCl_3 . 6NH_3$

(*c*) $CoBr_3 . 5NH_3$ (*d*) $PtCl_4 . 3NH_3$

**16.** Which of the following are examples of hexadentate chelating ligand where four oxygen atoms and two nitrogen atoms act as donor atoms ?

(*a*) $[EDTA]^{4-}$

(*b*)



(*c*) both (*a*) and (*b*)

(*d*) None

**17.** Which of the following are examples of tetradentate ligand where all donor atoms are same ?

(*a*) $N(CH_2CH_2NH_2)_3$

(*b*) $N(CH_2CO_2^-)_3$

(*c*) $NH_2(CH_2)_2NH(CH_2)_2NH(CH_2)_2NH_2$

(*d*) Both (*a*) & (*c*)

**18.** In which case Pt has +2 oxidation state :-

(*a*) $[Pt(NH_3)_4]$ $[PtCl_4]$ (*b*) $[Pt(NH_3)_2Cl_2]$

(*c*) $[Pt(C_2H_4)Cl_3]^{-1}$ (*d*) All

**19.** $KCN(excess) + CuSO_4 \longrightarrow$ Product (Complex). Complex is :-

(*a*) $K_2[Cu(CN)_4]$ (*b*) $K[Cu(CN)_2]$

(*c*) $K_3[Cu(CN)_4]$ (*d*) None

**20.** Mohr salt in aqueous solution gives :-

(*a*) 3 different ions (*b*) 2 different ions

(*c*) 4 different ions (*d*) 5 different ions

**21.** Which of the following statement is correct ?

(*a*) $NH^{2-}$ will be named as amido

(*b*) $SO_4^{2-}$ will be named as sulphito

(*c*) $CH_3^-$ will be named as methylo

(*d*) $SnCl_3^-$ will be named as trichloro stannito

**22.** Which of the following ligand forms only two ring towards a central atom ?

(*a*) en (*b*) bn

(*c*) dien (*d*) trien

**23.** For which of the following complex, chelate is not formed ?

(*a*) Bis(dimethyl glyoximato)nickel(II)

(*b*) Potassium ethylene diamine tetrathiocyanato chromate(III)

(*c*) Pentaammine carbonato cobalt(III) nitrate

(*d*) Trans-diglycinatoplatinum(II)

**24.** Which of the following pair of molecule have identical shape ?

(*a*) $[NiCl_4]^{2-}$ & $XeF_4$ (*b*) $[Ag(NH_3)_2]^{+1}$ , $H_2S$

(*c*) $[Zn(H_2O)_4]^{2+}$, $SiCl_4$ (*d*) $Fe(CO)_5$ , $XeOF_4$

**25.** A complex of Pt, ammonia & chlorine produces four ions per molecule in the solution. The solution consistent with the observation is :-

(*a*) $[Pt(NH_3)_5Cl]Cl_3$ (*b*) $[Pt(NH_3)_4Cl_2]Cl_2$

(*c*) $[Pt(NH_3)_3Cl_3]Cl$ (*d*) All of these

**26.** $[M(H_2O)_6]^{2+}$ complex typically absorbs light at around 600 nm. It is allowed to react with ammonia to form a new complex $[M(NH_3)_6]^{2+}$. It will absorb light at around :-

(*a*) 800 nm (*b*) 620 nm

(*c*) 580 nm (*d*) 320 nm

**27.** Arrange the following compound according to decreased C–C bond length :-

(I) $C_2F_4$

(II) $C_2H_4$

(III) $[PtCl_3(C_2H_4)]^{-1}$

(*a*) I > II > III (*b*) III > II > I

(*c*) II > I > III (*d*) II > III > I

**28.** 1 mole of which complex produce minimum number of $K^+$ ions on dissociation :-

(*a*) Potassium tris(oxalato)coblaltate(III)

(*b*) Potassium tetrahydroxido zincate(II)

(*c*) Potassium hexacyanidoferrate(II)

(*d*) Potassium ammine penta chlorido platinate(IV)

**29.** Facial and Merdional isomers are associated with which of the general formula of complex -

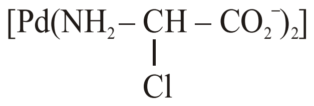
A,B,C,D are example of monodentate ligand.

& AA is example of bidentate ligand.

(*a*) $[M(AA)_2]$ (*b*) $[M(AA)_3]$

(*c*) [MABCD] (*d*) $[MA_3B_3]$

**30.** How many geometrical isomers possible for



$[\mathrm{Pd}(\mathrm{NH_2}-\underset{\mathrm{Cl}}{\underset{|}{\mathrm{CH}}}-\mathrm{CO_2^-})_2]$

(*a*) 2 (*b*) 3

(*c*) 4 (*d*) 6

**31.** In $[Fe(EDTA)]^{-1}$, which of the following statements are correct ?

(*a*) It shows optical isomerism

(*b*) C.N. of $Fe^{+3}$ is 6

(*c*) 5 chelates are formed in the complex

(*d*) All

**32.** A coordination complex of type $Mx_2y_2$ (M metal ion ; x, y monodentate ligands). can have either a tetrahedral or a square planar geometry. The number of structures in these two cases are respectively:-

(*a*) 1 & 2 (*b*) 2 & 1

(*c*) 1 & 3 (*d*) 3 & 2

**33.** The ratio of trans and cis isomers of the complex $[Ma_2bcde]$ ?

(*a*) 2 : 3 (*b*) 2 : 1

(*c*) 1 : 2 (*d*) 3 : 5

**34.** Which of the following can show geometrical isomerism -

(*a*) $[Co(en)_2(NH_3)Cl]$

(*b*) $(Ph_3P)ClPdCl_2PdCl(PPh_3)$

(*c*) Both (*a*) and (*b*)

(*d*) $K_4[Fe(CN)_6]$

**35.** Which will give a pair enantiomers (which are optically active) ?

(*a*) $[Co(NH_3)_4Cl_2]NO_2$

(*b*) $[Cr(NH_3)_6][Co(CN)_6]$

(*c*) $[Co(en)_2Cl_2]Cl$

(*d*) $[Pt(NH_3)_4]PtCl_6]$

**36.** For the complex, $K[CoBr_2(CN)(NO_2)(NH_3)(H_2O)]$

X = Number of possible stereoisomer where both Br are at cis position

Y = Number of possible stereoisomer where both Br are at trans position

Find out X & Y :-

(*a*) 6, 3 (*b*) 3, 6

(*c*) 12, 3 (*d*) 3, 12

**37.** A complex with the composition $[MA_3B]^{x\pm}$ is found to have no geometrical isomers. The possible structures of the complex is (where A and B are monodentate ligands) :-

(*a*) Tetrahedral (*b*) Square planar

(*c*) Octahedral (*d*) (*a*) & (*b*) both

**38.** Select incorrect option code about complex $[Cr(NO_2)(NH_3)_5][ZnCl_4]$ :-

(*a*) IUPAC name of the compound is pentaammine nitrito-N-chromium(III) tetrachlorido zincate(II)

(*b*) It shows geometrical isomers

(*c*) It shows linkage isomerism

(*d*) It shows coordination isomerism

**39.** Select the correct code regarding total number of stereoisomers for the following compounds :-

$[Ma_3b_2c]$ (I) ; $[M(AB)_3]^{x\pm}$ (II) $[Ma_2b_2c_2]^{x\pm}$

| | I | II | III |
|---|---|---|---|
| (*a*) | 4 | 4 | 6 |
| (*b*) | 4 | 3 | 5 |
| (*c*) | 3 | 3 | 5 |
| (*d*) | 3 | 4 | 6 |

**40.** For the complex dichlorido bis(ethylenediamine) cobalt(III) ion,

Select the correct statement :-

(*a*) It has three isomers, two of them are optically active and one is optically inactive.

(*b*) It has three isomers, all of them are optically active

(*c*) It has three isomers, all of them are optically inactive

(*d*) It has one optically active isomer & two geometrical isomer.

**41.** When $[Co(CO_3)(NH_3)_4]^+$ is reacted with concentrated HCl, the violet coloured $[CoCl_2(NH_3)_4]Cl$ compound is formed. Predict the geometry of the product formed.

(*a*) Only cis isomer

(*b*) Only trans isomer

(*c*) Cis and trans isomer both

(*d*) Can't be predicted

**42.** Which of the following complex only show linkage isomerism ?

(*a*) $[Co(NH_3)_4(H_2O)Cl]CN$

(*b*) $[Co(NH_3)_5(SCN)]^{2+}$

(*c*) $[Co(H_2O)_6]Cl_3$

(*d*) $[Co(NH_3)_5SO_4]Br$

**43.** Which of the following complex only show ionisation isomerism ? (among all type of structural isomerism)

(*a*) $[Co(NH_3)_4(H_2O)Cl]Br$

(*b*) $[Co(NH_3)_5(SCN)]^{2+}$

(*c*) $[Co(H_2O)_6]Cl_3$

(*d*) $[Co(NH_3)_5Br]Br_2$

**44.** Total possible geometrical isomers and stereoisomers are existing respectively for $[M(gly)_2(en)]$ type octahedral complex :-

(*a*) 3, 6 (*b*) 3, 4

(*c*) 4, 8 (*d*) 3, 4

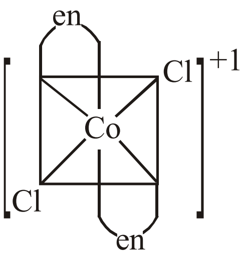
**45.** How many coordination isomers of $[Pt(NH_3)_4][PtCl_4]$ showing geometrical isomers :-

(*a*) Four (*b*) One

(*c*) Two (*d*) Zero

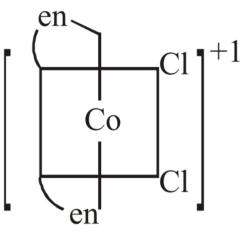
**46.** Which of the following ions are optically active (exists as pair of enantiomers) ?

(*a*)



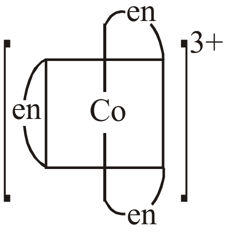
X

(*b*)



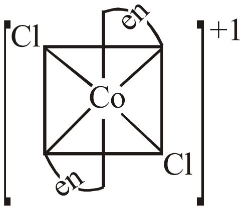
Y

(*c*)



Z

(*d*)



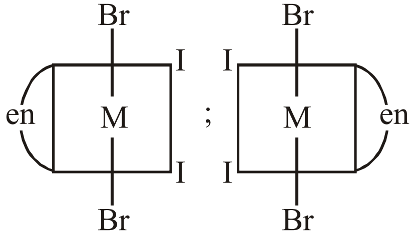
W

(*a*) X only (*b*) Y only

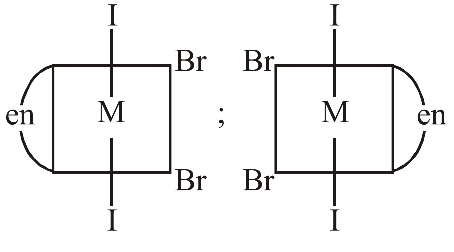
(*c*) Y & Z both (*d*) W only

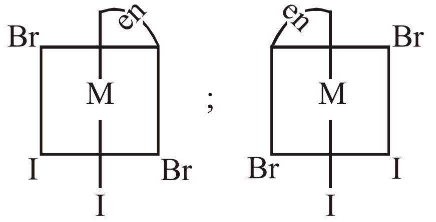
**47.** The complex has two optical isomers which are related as enantiomers. Their correct structures are-

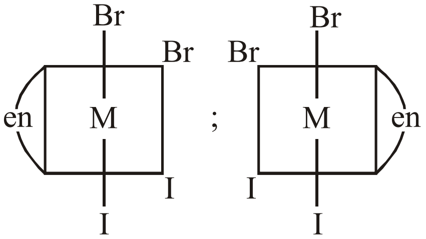
(*a*)



(*b*)



(*c*) 

(*d*) 

**48.** Find complex which has maximum number of geometrical isomers ?

(*a*) $Ma_3b_3$ (*b*) $Ma_3b_2c$

(*c*) $Ma_2b_2c_2$ (*d*) $M(AA)a_2b_2$

**49.** The formula for the compound tris (ethane-1,2-diamine)cobalt(III) sulphate is -

(*a*) $[Co(en)_3]SO_4$ (*b*) $[Co(SO_4)_4(en)_3]$

(*c*) $[Co(en)_3(SO_4)_2]$ (*d*) $[Co(en)_3]_2(SO_4)_3$

**50.** For which of the following $d^n$ configuration , octahedral complexes can not exist in both high and low spin forms -

**I. $d^3$** **II. $d^5$** **III. $d^6$** **IV. $d^8$**

(*a*) I, II (*b*) I, IV

(*c*) III, IV (*d*) II, III

**51.** Correct option regarding complex $[Co(en)_3]_2(SO_4)_3$ :-

(*a*) low spin inner orbital octahedral complex with $d^2sp^3$ hybridisation

(*b*) optically active

(*c*) $C_2$ axis of symetry is present

(*d*) All

**52.** In which ligand, only two nitrogen acts as donor site ?

(*a*) $nta^{3-}$ (*b*) $NH_3$

(*c*) en (*d*) $H_2N–CH_2–CO_2^-$

**53.** $[Ru(NH_3)_5(NO_2)]Cl$ vs $[Ru(NH_3)_5Cl]NO_2$ & $[Ru(NH_3)_5(NO_2)]Cl$ vs $[Ru(NH_3)_5(ONO)]Cl$ are related as -

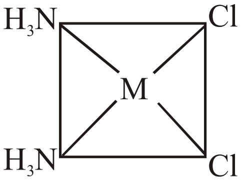
(*a*) Ionisation isomer and linkage isomer respectively

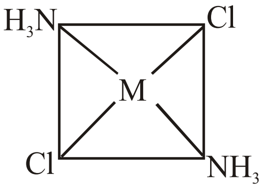
(*b*) Linkage isomer and ionisation isomer respectively

(*c*) Ionisation and coordination isomer respectively

(*d*) Coordination isomer and coordination position isomer respectively

**54.** Which of the following isomers of $[M(NH_3)_2Cl_2]$ would react with silver oxalate $Ag_2C_2O_4$ ?

(*a*) 

(*b*) 

(*c*) Both

(*d*) None

**55.** In Zieses salt C–C bond length is -

(*a*) 1.37°A (*b*) 1.19°A

(*c*) 1.87°A (*d*) 1.34°A

**56.** Identify incorrect statement for the behaviour of ethane 1,2-diamine as a ligand.

(*a*) It is a neutral ligand

(*b*) It is a didentate ligand

(*c*) It is a chelating ligand

(*d*) It is a unidentate ligand

**57.** The stabilisation of coordination compounds due to chelation is called the chelate effect. Which of the following is most stable complex species ?

(*a*) $Fe(CO)_5$ (*b*) $[Fe(CN)_6]^{3-}$

(*c*) $[Fe(C_2O_4)_3]^{3-}$ (*d*) $[Fe(H_2O)_6]^{3+}$

**58.** Which of the following complex formed by $Cu^{2+}$ ion is most stable ?

(*a*) $Cu^{2+} + 4NH_3 \longrightarrow [Cu(NH_3)_4]^{2+}$ log k = 11.6

(*b*) $Cu^{2+} + 4CN^- \longrightarrow [Cu(CN)_4]^{3-}$ log k = 27.3

(*c*) $Cu^{2+} + 2en \longrightarrow [Cu(en)_2]^{2+}$ log k = 15.4

(*d*) $Cu^{2+} + 4H_2O \longrightarrow [Cu(H_2O)_4]^{2+}$ log k = 8.9

**59.** The correct IUPAC name of $[Pt(NH_3)_2Cl_2]$ is -

(*a*) Diamminedichloridoplatinum(II)

(*b*) Diamminedichloridoplatinum(IV)

(*c*) Dichloridoammineplatinum(II)

(*d*) Diamminedichloridoplatinum(0)

**60.** The colour of the coordination compound depend on the crystal field splitting. What will be the correct order of absorption of wavelength of light in the visible region for complex ?

$[Co(NH_3)_6]^{3+}$; $[Co(CN)_6]^{3-}$; $[Co(H_2O)_6]^{3+}$

(*a*) $[Co(CN)_6]^{3-} > [Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+}$
(*b*) $[Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+} > [Co(CN)_6]^{3-}$
(*c*) $[Co(H_2O)_6]^{3+} > [Co(NH_3)_6]^{3+} > [Co(CN)_6]^{3-}$
(*d*) None

**61.** The type of isomerism arises due to presence of ambidentate ligands attached to central metal ion is

(*a*) Linkage isomerism (*b*) Ligand isomerism
(*c*) Hydrate isomerism (*d*) Ionisation isomerism

**62.** The type of isomerism arises due to presence of isomeric ligands is

(*a*) Ionisation isomerism
(*b*) Coordination position isomerism
(*c*) Ligand isomerism
(*d*) Linkage isomerism

**63.** $[Fe(CN_6)]^{3-}$ ion shows magnetic moment coressponding to -

(*a*) 2 unpaired electrons
(*b*) 3 unpaired electrons
(*c*) 1 unpaired electron
(*d*) None

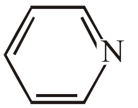
**64.** Toxic metal ions are removed by chelating ligand. The chelating ligand used can be -

(*a*) en (*b*) pn
(*c*) $H_2N–CH_2–CO_2^-$ (*d*) EDTA

**65.** Complex $[Fe(H_2O)_6]^{3+}$ ion has magnetic moment-

(*a*) 2.83 B.M. (*b*) 3.87 B.M.
(*c*) 4.92 B.M. (*d*) 5.92 B.M.

**66.** A chelating ligand has two or more than two donor atoms to bind to a single metal ion. Which of the following is not a chelating ligand ?

(*a*) 

(*b*) Oxalato
(*c*) Glycinato (*d*) Ethan-1, 2 diamine

**67.** What kind of isomerism exist between violet colour $[Cr(H_2O)_6]Cl_3$ & green colour $[Cr(H_2O)_5Cl]Cl_2 . H_2O$.

(*a*) Linkage isomerism
(*b*) Solvent isomerism
(*c*) Ionisation isomerism
(*d*) Coordination isomerism

**68.** The CFSE for octahedral $[CoCl_6]^{4-}$ is 18000 cm$^{-1}$. The CFSE for tetrahedral $[CoCl_4]^{2-}$ will be -

(*a*) 18000 cm$^{-1}$ (*b*) 16000 cm$^{-1}$
(*c*) 8000 cm$^{-1}$ (*d*) 20000 cm$^{-1}$

**69.** $[Co(NH_3)_5(CO_3)]ClO_4$, for this complex the coordination number, oxidation number, number of d-electrons and number of unpaired d electrons are respectively -

(*a*) 4, 2, 6, 0 (*b*) 6, 3, 6, 0
(*c*) 4, 2, 6, 3 (*d*) 6, 3, 6, 3

**70.** Select correct statement for $[Cu(CN)_4]^{3-}$, $[Cd(CN)_4]^{2-}$, $[Cu(NH_3)_4]^{2+}$ :-

(*a*) Both $[Cd(CN)]_4^{2-}$ & $[Cu(NH_3)_4]^{2+}$ have square planar geometry
(*b*) $[Cu(CN)_4]^{3-}$ & $[Cu(NH_3)_4]^{2+}$ have equal number of unpaired electron
(*c*) $[Cu(CN)]_4^{3-}$ & $[Cd(CN)_4]^{2-}$ can be distinguished by passing $H_2S$ gas.
(*d*) All complexes have magnetic moment equal to zero.

**71.** Which of the following cation is colourless in aqueous solution ?

(*a*) $Ni^{2+}$ (*b*) $Co^{3+}$
(*c*) $Cr^{3+}$ (*d*) $Ti^{4+}$

**72.** What is the magnetic moment of high spin octahedral complex that has 6 electron in 3d orbitals?

(*a*) 0 B.M. (*b*) $\sqrt{24}$ B.M.
(*c*) $\sqrt{8}$ B.M. (*d*) $\sqrt{15}$ B.M.

**73.** For the complex, $[Fe^{II}(en)_3]_n[Co^{III}(NH_3)_2(NO_2)_4]_2$ the value of n is -

(*a*) 1 (*b*) 2
(*c*) 3 (*d*) 4

**74.** In which of the following pair , hybridisation , magnetic moment and geometry are same :-

(*a*) $[IrF_6]^{3-}$, $[Co(NH_3)_6]^{3+}$

(*b*) $[CrF_6]^{3-}$, $[Co(H_2O)_6]^{2+}$

(*c*) $[Cu(NH_3)_4]^{2+}$, $[Ni(NH_3)_4]^{2+}$

(*d*) $[Co(H_2O)_6]^{3+}$, $[Co(H_2O)_6]^{4-}$

**75.** What is the oxidation state, magnetic moment of central metal cation in the following oxo complex $[Os(ONO)(O)_2(O_2)(SCN)(H_2O)]OH$ ?

(*a*) +8, $\sqrt{15}$ B.M. (*b*) +6 ; 0

(*c*) +6, $\sqrt{35}$ B.M. (*d*) +8, 0 BM

**76.** If $10Dq_0 < P$ then crystal field splitting energy for $d^7$ ion in octahedral field will be :-

(*a*) 20 Dq – 2P (*b*) 4 Dq

(*c*) 8 Dq (*d*) 24 Dq – 2p

**77.** Which of the following complex is low spin as well as diamagnetic ?

(*a*) $K_4[Fe(CN)_6]$ (*b*) $[Co(C_2O_4)_3]^{3-}$

(*c*) $[Ni(H_2O)_6]^{2+}$ (*d*) both (*a*) & (*b*)

**78.** Correct statements about complex consisting Ni, $NH_3$, $H_2O$ and $NO_3^-$ ion -

(*a*) If magnetic moment is zero, then the formula of the complex will be $[Ni(NH_3)_4](NO_3)_2 . 2H_2O$

(*b*) If magnetic moment is $2\sqrt{2}$ & conducts electricity, then the formula of the complex is $[Ni(NH_3)_4(H_2O)_2](NO_3)_2$ BM

(*c*) The higher and lower value of magnetic moment of the given complex corresponds to octahedral and square planar complex.

(*d*) All

**79.** Which of the following complex is paramagnetic as well as square planar ?

(*a*) $NiCl_4^{2-}$ (*b*) $[Cu(CN)_4]^{3-}$

(*c*) $[Cu(DMG)_2]$ (*d*) $[PtBr_4]^{2-}$

**80.** Which of the following complex has lowest number of unpaired electron ?

(*a*) $[NiF_6]^{2-}$ (*b*) $[Cu(NH_3)_4]^{2+}$

(*c*) $[CoF_6]^{3-}$ (*d*) $[Fe(EDTA)]^{-1}$

**81.** The spin magnetic moment of $K_3[Fe(C_2O_4)_3]$ is :-

(*a*) $\sqrt{15}$ B.M. (*b*) $\sqrt{35}$ B.M.

(*c*) $\sqrt{24}$ B.M. (*d*) $\sqrt{2}$ B.M.

**82.** What is the magnetic nature of Co(II) in tetrahedral and octahedral complexes respectively ?

(*a*) Paramagnetic, Paramagnetic

(*b*) Paramagnetic, Diamagnetic

(*c*) Diamagnetic, Diamagnetic

(*d*) Diamagnetic, Paramagnetic

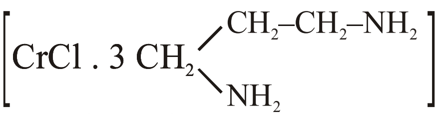
**83.** For octahedral complex the value of the spin only magnetic moment for one of the following configuration is 2.84 B.M. The correct one is :-

(*a*) $d^4$ (strong field ligand)

(*b*) $d^4$ (weak field ligand)

(*c*) $d^3$ (in weak as well as strong field ligand)

(*d*) $d^5$ (strong field ligand)

**84.** 
$\left[CrCl . 3\ CH_2 \begin{smallmatrix} CH_2–CH_2–NH_2 \\ NH_2 \end{smallmatrix}\right]$ shows which type of isomerism :-

(*a*) Ligand isomerism

(*b*) Polymerisation isomerism

(*c*) Linkage isomerism

(*d*) Ionisation isomerism

**85.** Which of the following property of $[Ni(H_2O)_6]SO_4$ can not be explained by valence bond theory ?

(*a*) It has 6 M-L coordinate bond

(*b*) Geometry of $Ni^{2+}$ is octahedral

(*c*) Total six Ni–O linkage is present

(*d*) It is green solution

**86.** The correct order of magnetic moment (spin only magnetic moment in BM) among is :-

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

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

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

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

**87.** Which of the following is paramagnetic ?

(*a*) $K_2[NiF_6]$

(*b*) $[Co(H_2O)_6]^{3+}$

(*c*) $K_4[Fe(CN)_5O_2]$ $[O_2^{2-}$ = Peroxido]

(*d*) None of these

**88.** For which complex compound, optical activity does not depend upon the orientation of the ligand arround metal cation :-

(*a*) $[CoCl_3(NH_3)_3]$

(*b*) $[Co(en)_3]Cl_3$

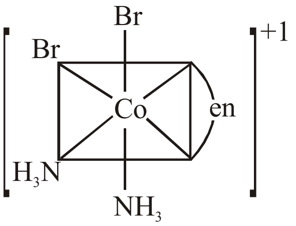
(*c*) $[Co(C_2O_4)_2(NH_3)_2]^-$

(*d*) $[CrCl_2(NH_3)_2en]$

**89.** Which of the following complex is paramagnetic as well as low spin complex ?

(*a*) $[Cr(CN)_6]^{4-}$ (*b*) $[Ni(NH_3)_6]^{2+}$

(*c*) $[Fe(CN)_6]^{4-}$ (*d*) $[Co(H_2O)_6]^{3+}$

**90.** 

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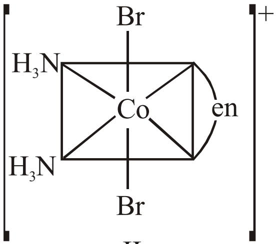
I



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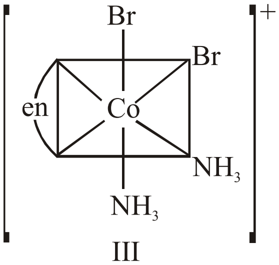
II



III

Incorrect statement are :-

(*a*) I, II are G.I.

(*b*) II, III are optical isomers

(*c*) I, III are optical isomers

(*d*) II & III are Geometrical isomers

**91.** Which of the following option has maximum number of unpaired electrons?

(*a*) A tetrahedral $d^6$ ion

(*b*) $[Co(H_2O)_6]^{3+}$

(*c*) A square planar complex with $d^7$ ion

(*d*) A coordination compound with magnetic moment of 5.92 B.M.

**92.** In $NiCl_4^{2-}$, the magnetic moment is :-

(*a*) 2.82 B.M. (*b*) 1.41 B.M.

(*c*) 1.82 B.M. (*d*) 5.46 B.M.

**93.** Geometrical isomerism is found in coordination compounds having coordination number :-

(*a*) 2 (*b*) 3

(*c*) 4 (tetrahedral) (*d*) 6

**94.** Cis trans isomerism is found in square planar complexes of molecular formula (a & b are monodentate ligand) :-

(*a*) $Ma_4$ (*b*) $Ma_3b$

(*c*) $Ma_2b_2$ (*d*) $Mab_3$

**95.** The complexes $[Pt(NH_3)_4]$ $[PtCl_6]$ & $[Pt(NH_3)_4Cl_2]$ $[PtCl_4]$ are :-

(*a*) Linkage isomers

(*b*) Optical isomers

(*c*) Coordination isomers

(*d*) Ionisation isomers

**96.** $[Sc(H_2O)_6]^{3+}$ ion is :-

(*a*) Coloured and paramagnetic

(*b*) Colourless and paramagnetic

(*c*) Colourless and diamagnetic

(*d*) Coloured and octahedral

**97.** Maximum paramagnetism in 3d series is shown by:-

(*a*) Mn (*b*) Co

(*c*) Ni (*d*) Fe

**98.** Which of the following complexes has geometry different from others :-

(*a*) $[NiCl_4]^{2-}$ (*b*) $[Ni(CO)_4]$

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

**99.** Which of the following is a high spin complex ?

(*a*) $[Co(NH_3)_6]^{3+}$ (*b*) $[Fe(CN)_6]^{4-}$

(*c*) $[Ni(CN)_4]^{2-}$ (*d*) $[FeF_6]^{3-}$

**100.** In the complex $Co(NH_3)_3Cl_3$ chloride ion satisfy :-

(*a*) only primary valency

(*b*) only secondary valency

(*c*) both primary and secondary valencies

(*d*) None

**101.** A complex cation is formed by $Pt^{+4}$ ion with ligands. Which of the following can be its correct IUPAC name :-

(*a*) Diammineethylenediaminedithiocyanato-s platinum(II)ion

(*b*) Diamineethylenediamminedithiocyanato-s platinum(IV)ion

(*c*) Diamminebis(ethylenediamine)dithiocyanato-s platinum(IV)ion

(*d*) Diammineethylenediaminedithiocyanato-s platinum(IV)ion

**102.** The number of geometrical isomers possible for complex $[M(gly)_2Br_2]$ is -

(*a*) 3 (*b*) 5

(*c*) 7 (*d*) 9

**103.** If NO reacts with $[Cr(CO)_6]$ , how many CO groups can be replaced by NO ?

(*a*) All 6 CO groups are replaced by 6 NO groups.

(*b*) 4 CO groups are replaced by 6 NO groups.

(*c*) 2 CO groups are replaced by 3 NO groups.

(*d*) All the 6 CO groups are replaced by 4 NO groups.

**104.** During developing of a photographic plates , one of the step involves washing the plate with hypo solution. The purpose of this is to :-

(*a*) Reduce reacted AgBr to Ag

(*b*) Convert unreacted AgBr to silver thiosulphate complex $[Ag(S_2O_3)_2]^{3-}$

(*c*) Convert unreacted AgBr to $Ag_2SO_4$

(*d*) Convert reacted AgBr to $Ag_2S_2O_3$

**105.** $$\underset{\textbf{Green colour complex}}{\left[(NH_3)_5\,Co-O-O-Co(NH_3)_5\right]^{4+}} \xrightarrow[\text{Oxidised}]{S_2O_8^{2-}}$$

$$\underset{\textbf{Brown colour complex}}{\left[(NH_3)_5\,Co-O-O-Co(NH_3)_5\right]^{5+}}$$

The magnetic moment of green complex is 1.73 B.M. and for brown complex magnetic moment is zero. (O–O) is same in all replaced in both the complex. The oxidation state of Co in brown complex and green complex respectively are :-

(*a*) III, II ; IV, III
**Brown Green**

(*b*) III, II ; III, III
**Brown Green**

(*c*) III, III ; III, II
**Brown Green**

(*d*) III, IV ; III, III
**Brown Green**

**106.** A complex $K_n[MnF_6]$ has magnetic moment 4.9 B.M. What is the value of n -

(*a*) 2 (*b*) 3

(*c*) 4 (*d*) 5

**107.** WhiCh of the following is copper (I) compound :-

(*a*) $[Cu(H_2O)_4]^{2+}$ (*b*) $[Cu(CN)_4]^{3-}$

(*c*) $[Cu(NH_3)_4]^{2+}$ (*d*) All of these

**108.** $Cu^{2+}(aq) + KCN(aq)\,(excess) \longrightarrow$ Complex $X_1$

$Co^{2+}(aq) + KNO_2(s) + H^+(aq) \longrightarrow$ Complex $X_2$

$Zn^{2+}(aq) + NaOH(aq)\,(excess) \longrightarrow$ Complex $X_3$

$X_1$, $X_2$, $X_3$ are respectively :-

(*a*) Tetrahedral , Octahedral and Square planar

(*b*) Tetrahedral , Octahedral and Tetrahedral

(*c*) Square planar, Octahedral and Tetrahedral

(*d*) Octahedral, Tetrahedral and Square planar

**109.** Which of the following is not correctly matched ?

(*a*) Sodium (ethylenediaminetetraacetato) chromate(II) : $Na_2[Cr(CH_3COO)_4(en)]$

(*b*) Dichloridobis(ethane-1,2-diamine)cobalt(III) ion : $[Co(en)_2Cl_2]^+$

(*c*) Tris(bipyridine) iron(II)ion : $[Fe(NH_4C_5-C_5H_4N)_3]^{2+}$

(*d*) Ammineaquadibromidocopper(II) : $[Cu(H_2O)(NH_3)Br_2]$

**110.** Which of the following has total 18 valence electron:-

(*a*) $[Fe(CO)_3(\eta^4-C_8H_8)]$

(*b*) $[Cr(\eta^6-C_6H_6)_2]$

(*c*) $[Mo(CO)_3(\eta^6-C_7H_7)]^{+1}$

(*d*) All

**111.** Jahn-Teller distortion in octahedral field will occur for :-

(*a*) $d^1$ ion (*b*) $d^4$ ion

(*c*) $d^9$ ion (*d*) All

**112.** Jahn-Teller distortion in octahedral field will not occur for :-

(*a*) $d^3$ ion (*b*) $d^8$ ion

(*c*) $d^5$ ion (*d*) (*a*) & (*b*) both

**113.** Which of the following is incorrect about :- Tetraamminedithiocyanato-S-cobalt(III) tris(oxalato)cobaltate(III)

(*a*) Formula of the complex is $[Co(SCN)_2(NH_3)_4][Co(Ox)_3]$

(*b*) It is a chelating complex and show linkage isomerism

(*c*) It shows optical isomerism

(*d*) It shows geometrical isomerism

**114.** Irrespective of the nature of ligand, inner orbital octahedral complex is formed by :-

(*a*) $d^1$ ion
(*b*) $d^2$ ion
(*c*) $d^3$ ion
(*d*) All

**115.** $CoCl_4^{2-}$ is observed to be tetrahedral whereas $CoCl_6^{4-}$ is observed to be high spin octahedral complex. The configuration in tetrahedral field and octahedral field are respectively :-

(*a*) $e^4t_2^3$ ; $t_{2g}^5e_g^2$
(*b*) $e^4t_2^3$ ; $t_{2g}^6e_g^1$
(*c*) $t_2^4e^3$ ; $t_{2g}^6e_g^1$
(*d*) $t_2^4e^3$ ; $t_{2g}^5e_g^2$

**116.** Incorrect statement regarding dichromate ion :-

(*a*) Six Cr–O bond lengths are identical

(*b*) Cr in dichromate ion is $sp^3$ hybridisation

(*c*) the colour is due to d–d transition

(*d*) the colour is due to L→M charge transfer (where M - Metal ion, L - Ligand)

**117.** In crystal field theory, each of p orbitals in octahedral field :-

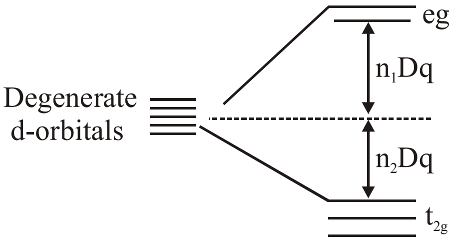
(*a*) equally face two ligands along the coordinate axis

(*b*) unequally face two ligands along the coordinate axis

(*c*) equally face two ligands in between the coordinate axis

(*d*) unequally face two ligands in between the coordinate axis

**118.**



Splitting in Octahedral field

$n_1$ and $n_2$ are :-

(*a*) 4 & 6
(*b*) 7 & 3
(*c*) 3 & 7
(*d*) 6 & 4

**119.** The order of $\Delta_0$ :-

(*a*) $Co^{3+} > Rh^{3+} > Ir^{3+}$ (for same ligand)

(*b*) $F^- > Br^- > Cl^-$ (for same metal ion)

(*c*) $CN^- > NH_3 > S^{2-}$ (for same metal ion)

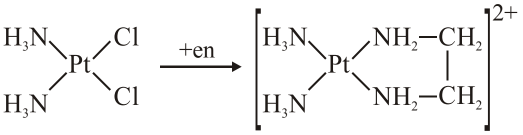
(*d*) $Fe^{2+} > Fe^{3+}$ (for same ligand)

**120.** If the splitting energy of octahedral field is $\Delta_0$ and if the splitting energy of tetrahedral field is $\Delta_t$ then :-

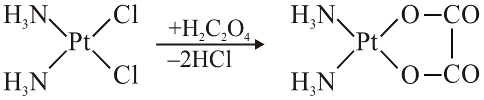
(*a*) $\Delta_0 = \Delta_t$
(*b*) $\Delta_0 < \Delta_t$
(*c*) $\Delta_0 = \frac{2}{3}\Delta_t$
(*d*) $\Delta_t = \frac{4}{9}\Delta_0$

**121.** In which of the following reactions, correct product is given ?

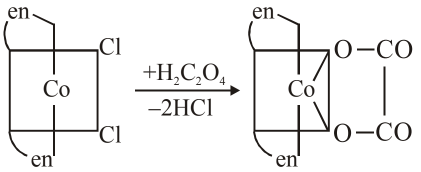
(*a*)



(*b*)



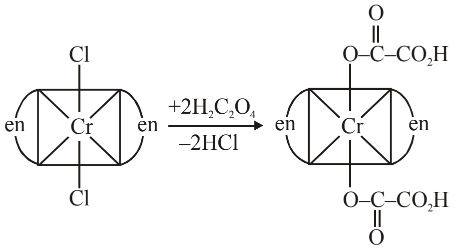
(*c*)



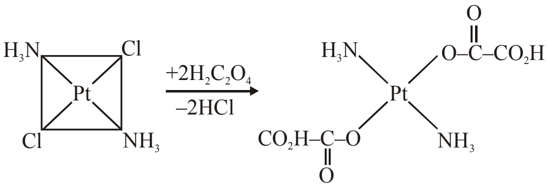
(*d*) All

**122.** In which of the following reactions, correct product is given :-

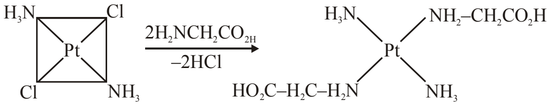
(*a*)



(*b*)



(*c*)



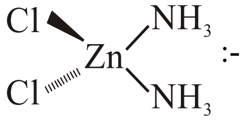
(*d*) All

**123.** For $Xe[PtF_6]$ ; oxidation state of Xe and Pt are respectively :-

(*a*) +4, +2 (*b*) +2, +4

(*c*) +1, +5 (*d*) +6, 0

**124.** Name the following coordination species



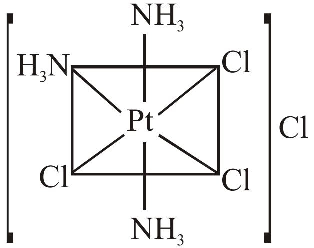
(*a*) Cis-diamminedichloridozinc(II)

(*b*) Trans-diamminedichloridozinc(II)

(*c*) Diamminedichloridozinc(II)

(*d*) Dichloridodiamminezinc(II)

**125.**



IUPAC name of given complex :-

(*a*) Cis-triamminetrichloridoplatinum(IV)chloride

(*b*) Trans-triamminetrichloridoplatinum(IV)chloride

(*c*) Fac-triamminetrichloridoplatinum(IV)chloride

(*d*) Mer-triamminetrichloridoplatinum(IV)chloride

**126.** IUPAC name of $Xe[PtF_6]$ is :-

(*a*) Xenoniumhexafluoridoplatinum(V)

(*b*) Xenonhexafluoridoplatinate(V)

(*c*) Xenonhexafluoridoplatinate(VI)

(*d*) Hexafluoridoxenoniumplatinum(VI)

**127.** Type of isomerism which may be possible for six coordinated complex of metal M having formula $Cr(NO_2)_2 \cdot 6H_2O$ :-

(*a*) Hydrate isomerism

(*b*) Linkage isomerism

(*c*) Geometrical isomerism

(*d*) All of them

**128.** $[NiCl_2(PMe_3)_2]$ is a paramagnetic complex of Ni(II). How many isomers are possible of analogous diamagnetic complex of $Pd^{2+}$ :-

(*a*) Zero (*b*) Five

(*c*) Two (*d*) Three

**129.** Which of the following complex can have optical isomer ?

(*a*) $[Pt(bn)_2]^{2+}$ (*b*) $[PtCl_4]^{2-}$

(*c*) $[Pt(en)_2]^{2+}$ (*d*) $[Pt(NH_3)_3Cl]^{1+}$

**130.** Geometrical isomerism can be shown by :-

(*a*) $[Ag(CN)(NH_3)]$ (*b*) $Na_2[Cd(NO_3)_4]$

(*c*) $[PtCl_4I_2]^{2-}$ (*d*) $[PtCl(NH_3)_3]$

**131.** Which of the following options is correct :-

(*a*) Pi-acid ligands favour spin pairing

(*b*) In low spin complex, the number of unpaired electrons is equal to that present in the free ion

(*c*) In high spin complex, the number of unpaired electron is minimum

(*d*) $Ti(H_2O)_6{}^{3+}$ ; $V(H_2O)_6{}^{3+}$ ; $Cr(H_2O)_6{}^{3+}$ all are $sp^3d^2$ hybridised

**132.** $[Cr(H_2O)_6]^{3+}$ ; $[Fe(H_2O)_6]^{3+}$ ; $[Co(H_2O)_6]^{3+}$ are:-

(*a*) $sp^3d^2$ ; $sp^3d^2$ ; $sp^3d^2$ hybridised

(*b*) $d^2sp^3$ ; $d^2sp^3$ ; $d^2sp^3$ hybridised

(*c*) $d^2sp^3$ ; $sp^3d^2$ ; $d^2sp^3$ hybridised

(*d*) $sp^3d^2$ ; $d^2sp^3$ ; $sp^3d^2$ hybridised

**133.** In $[Cu(NH_3)_4]^{2+}$, $dsp^2$ hybridisation takes place for $Cu^{2+}$ ion . The d orbital involved is :-

(*a*) $(n-1)d_{z^2}$ (*b*) $(n-1)d_{x^2-y^2}$

(*c*) $(n-1)d_{xy}$ (*d*) $(n-1)d_{xz}$

**134.** $[BeCl_4]^{2-}$ ; $[MnCl_4]^{2-}$ ; $[CoCl_4]^{2-}$ all are $sp^3$ hybridised with :-

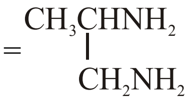
(*a*) 2,5,3 unpaired electron respectively

(*b*) 0,5,2 unpaired electron respectively

(*c*) 1,5,1 unpaired electron respectively

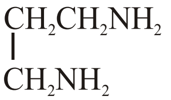
(*d*) 0,3,3 unpaired electron respectively

**135.** If pn =



$$\begin{matrix} CH_3CHNH_2 \\ | \\ CH_2NH_2 \end{matrix}$$

and tn =



$$\begin{matrix} CH_2CH_2NH_2 \\ | \\ CH_2NH_2 \end{matrix}$$

then $CoCl_2(pn)_2$ and $CoCl_2(tn)_2$ are example of :-

(*a*) ligand isomerism

(*b*) linkage isomerism

(*c*) coordinate position isomerism

(*d*) ionisation isomerism

**136.** Which of the following is optically active :-

(*a*) $[Zn(gly)_2]^{-1}$ (*b*) $[Ca(EDTA)]^{-2}$

(*c*) $[Co(Ox)_3]^{-3}$ (*d*) All of these

**137.** For the complex ion, dichloridobis (ethylenediamine) cobalt(III), which of the following is incorrect:-

(*a*) it has two optically active isomers

(*b*) it has two optically inactive isomers

(*c*) it is example of cationic complex

(*d*) it is example of octahedral complex

**138.** In $[Cu(NH_3)_4]^{2+}$ outermost electron is present in :-

(*a*) 3d orbital (*b*) 4s orbital

(*c*) 4p orbital (*d*) 4d orbital

**139.** The type of hybridisation of $Fe(CO)_5$ is :-

(*a*) $d_{x^2-y^2}sp^3$ (*b*) $sp^3d_{x^2-y^2}$

(*c*) $d_{z^2}sp^3$ (*d*) $sp^3d_{z^2}$

**140.** The hybridisation of metal ion and shape of $[CuCl_5]^{3-}$ are respectively :-

(*a*) $d_{x^2-y^2}sp^3$, square pyramidal

(*b*) $sp^3d_{x^2-y^2}$, trigonal bipyramidal

(*c*) $d_{z^2}sp^3$, trigonal bipyramidal

(*d*) $sp^3d_{z^2}$, tetrahedral

**141.** $VO_4^{3-}$ :-

(*a*) square planar geometry with $dsp^2$ hybridisation

(*b*) tetrahedral geometry with $sp^3$ hybridisation

(*c*) tetrahedral geometry with $d^3s$ hybridisation

(*d*) None

**142.** In crystal field splitting diagram for square planar complex the d-orbital having highest energy is :-

(*a*) $d_{x^2-y^2}$ (*b*) $d_{xy}$

(*c*) $d_{z^2}$ (*d*) $d_{xz}$ & $d_{yz}$

**143.** In crystal field splitting diagram for square planar complex the d-orbital having least energy is :-

(*a*) $d_{x^2-y^2}$ (*b*) $d_{xy}$

(*c*) $d_{z^2}$ (*d*) $d_{xz}$ & $d_{yz}$

**144.** Among the following the compound that is both paramagnetic and coloured is :-

(*a*) $K_2Cr_2O_7$ (*b*) $(NH_4)_2[TiCl_6]$

(*c*) $VOSO_4$ (*d*) $K_3[Cu(CN)_4]$

**145.** Which of the following is correct electronic configuration of 3d orbital in excited state of central metal ion, when $[Ti(H_2O)_6]^{3+}$ absorbed yellow - green light :-

(*a*) $3d^1$ (*b*) $t_{2g}^{\ 1}e_g^{\ 1}$

(*c*) $t_{2g}^{\ 1}e_g^{\ 0}$ (*d*) $t_{2g}^{\ 0}e_g^{\ 1}$

**146.** $[Fe(H_2O)_6]^{2+}$ has crystal field splitting energy value 10,400 $cm^{-1}$ and pairing energy value 17,600 $cm^{-1}$ then it is :-

(*a*) low spin complex

(*b*) paramagnetic in nature

(*c*) diamagnetic in nature

(*d*) none of these

**147.** An ion $M^{2+}$ forms the complexs $[M(H_2O)_6]^{2+}$, $[M(en)_3]^{2+}$ and $[MBr_6]^{4-}$, match the complex with the appropriate colour :-

(*a*) Green , blue and red

(*b*) Blue , red and green

(*c*) Green , red and blue

(*d*) Red , blue and green

**148.** Which one of the following species does not represent cationic species of vanadium formed in aqueous solution :-

(*a*) $VO_2^{\ +}$ (*b*) $VO^{2+}$

(*c*) $[V(H_2O)_6]^{3+}$ (*d*) $VO_2^{\ 2+}$

**149.** In which of the following C–O bond length is shorter as compared to CO.

(*a*) $CO^+$ (*b*) $H_2CO$

(*c*) $[Ni(CO)_4]$ (*d*) $[V(CO)_6]^{-1}$

**150.** $PtCl_4 . 3NH_3$ is example of :-

(*a*) 1 : 1 electrolyte (*b*) 1 : 2 electrolyte

(*c*) 1 : 3 electrolyte (*d*) 1 : 4 electrolyte

## EXERCISE # II

### ☐ One or More Than One Correct Answer :

**1.** To fom a coordination bond, one needs a ligand. Which of the following species can not be a ligand?

(*a*) $NH_4^{\ +}$ (*b*) $PH_4^{\ +}$

(*c*) $H_3O^+$ (*d*) $NO^+$

**2.** Which of the following are examples of bidentate ligand ?

(*a*) $C_2O_4^{\ 2-}$ (*b*) en

(*c*) Glycinato (*d*) $NH_2$–$NH_2$

**3.** Among the properties of $CN^-$ (cyanid ion), which of the following properties are correct :-

(*a*) oxidising (*b*) reducing

(*c*) acidic (*d*) complexing

**4.** Which of the following are anionic didentate ligands where oxygen is donor atom ?

(*a*) $H_2O$ (*b*) Acetato

(*c*) Carboxylato (*d*) Oxalato

**5.** Which of the following is example of ambidentate monodentate ligand ?

(*a*) $SC\overline{N}$ (*b*) $NO_2^-$

(*c*) $S_2O_3^{2-}$ (*d*) $CN^-$

**6.** Which of the following are colourless ?

(*a*) $[Cu(CN)_4]^{3-}$ (*b*) $[Ti(NO_3)_4]$

(*c*) $[Co(NH_3)_6]^{3+}$ (*d*) $[Cu(NH_3)_4]^{2+}$

**7.** The complex ion which has no d electrons in the central metal atom is :-

(*a*) $MnO_4^{-1}$ (*b*) $[Co(M\ell_3)_6]^{3+}$

(*c*) $[Cr(H_2O)_6]^{3+}$ (*d*) $CrO_4^{2-}$

**8.** Select the correct statement about metal carbonyl complex compound :-

(*a*) metal carbon bond in metal carbonyls possess both σ & π character

(*b*) due to synergic bonding metal carbon bond becomes weak

(*c*) due to synergic bonding carbon oxygen bond strength increases

(*d*) in metal carbonyles extent of synergic bonding will increase with increases in negative change on central metal ion.

**9.** Paramagnetic species are :-

(*a*) $H_2[NiF_6]$ (*b*) $K_3[CoF_6]$

(*c*) $O_2$ (*d*) $B_2$

**10.** Which ligands are examples σ donor ligand ?

(*a*) Propylene

(*b*) Propylene diamine

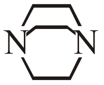
(*c*) $NH_2^-$

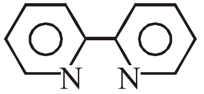
(*d*) 1, 2,3-triaminopropane

**11.** Which of the following are example of bidentate chelating ligand ?

(*a*)


(*b*)


(*c*)


(*d*)


**12.** Which ligand are examples of π donor ligand ?

(*a*) cyclobutadiene (*b*) benzene

(*c*) $SO_4^{2-}$ (*d*) $CO_3^{2-}$

**13.** Which can act as +ve charged ligand ?

(*a*) $\overset{+}{N}O_2$ (*b*) $NH_2-\overset{+}{N}H_3$

(*c*) $\overset{+}{C}H_3$ (*d*) $CN^-$

**14.** Which can act as reducing agent :-

(*a*) $Fe(CO)_4$ (*b*) $[Co(CO)_4]$

(*c*) $[V(CO)_6]$ (*d*) $[Mb(CO)_6]$

**15.** Which of the following statements are correct :-

(*a*) In first transition series Cr can show highest value of magnetic moment in the ground state.

(*b*) $[Cr(NH_3)_6]\,[Cr(NO_2)_6]$ & $[Cr(NH_3)_4(NO_2)_2]\,[Cr(NH_3)_2(NO_2)_4]$ can be distinguished from conductivity measurment in aqous solution.

(*c*) $[Ti(H_2O)_6]^{3+}$ is coloured white $[Sc(H_2O)_6]^{3+}$ is colourless

(*d*) $[Al(H_2O)_6]^{3+}$ can act as proton donor Bronsted acid.

**16.** Which of the following statements are incorrect ?

(*a*) Among $TiCl_3$, $MnCl_2$, $FeSO_4$ , $CuSO_4$ ; $MnCl_2$ contains highest number of unpaired electron

(*b*) In forming metal complex, metal ion functions as lewis acid and ligand functions as lewis base

(*c*) In aq. solution, $Mn^{3+}$ is stronger oxidising reagent as compared to $Co^{3+}$

(*d*) All

**17.** For which of the following complex, correct IUPAC name is given :-

(*a*) $K_2[SiF_6]$ : Potassiumhexafluorido Silicate(IV)

(*b*) $[Cr(NH_3)_6]ClSO_4$ : Hexaamminechromium (III) chloridesulphate

(*c*) $[Ru(NH_3)_5(N_2)]Cl_3$ : Pentaammine(dinitrogen) ruthenium(III)chloride

(*d*) $[Pt(PPh_3)_4]$ : Tetrakis(triphenylphosphane) platinum(0)

**18.** When metal is present in anionic part of the complex, then correct naming of metal will be :-

(*a*) Ag : Silverate (*b*) Co : Cobaltate

(*c*) Fe : Ferrate (*d*) Zn : Zincate

**19.** For which ligand in IUPAC nomenclature the term bis / tris / tetrakis is used up , when more than one such type of ligands is present :-

(*a*) $(CH_3)_2NH$ (*b*) $NH_2CH_2CH_2NH_2$

(*c*) $\eta^5C_5H_5$ (*d*) $NH_3$

**20.** What are the correct statements ?

(*a*) $[Co(en)_3]Cl_3$ has four optically active stereoisomers

(*b*) $Ma_3bcd$ has total five stereoisomers out of which two are optically active and three are optically inactive.

(*c*) Resolution of cis$[CoCl_2(en)_2]Cl$ is possible

(*d*) Resolution of trans$[CoCl_2(en)_2]Cl$ is not possible

**21.** Which of the following statements are incorrect ?

(*a*) Charge on the complex of ferric ion with EDTA is –1

(*b*) $[Ni(en)_3]Cl_2$ has lower stability than $[Ni(NH_3)_6]Cl_3$

(*c*) $NF_3$ is a weaker ligand than $NMe_3$

(*d*) The complex $[Cr(H_2O)_6]Cl_3$ looses six water moleculer to concentrated $H_2SO_4$ and does not give any precipitate with $AgNO_3$.

**22.** Which of the following statement are correct ?

(*a*) Identification of cis-trans isomers of compound $Ma_2b_2$can be done by measuring dipole moment.

(*b*) Aqueous solution of copper sulphate solution gives green precipitate with aquous potassium fluoride.

(*c*) The magnetic moment changed when $CN^-$ ligands in octahedral complex are replaced by $Cl^-$ ligand for $d^6$ ion.

(*d*) The magnetic moment remains same when $CN^-$ ligands in octahedral complex are replaced by $Cl^-$ for $d^3$ ion.

**23.** For which complex , facial and merdional isomers are possible ? :-

(*a*) $[Cr(gly)_3]$ (*b*) $[CrCl_3(NH_3)_3]$

(*c*) $[RuCl_3(OH)_3]$ (*d*) $[PtCl_2(NH_3)_2(py)_2]$

**24.** The reactivity of cis and trans isomeric compounds may differ widely. It may help to distinguish the cis-trans isomers :-

$$[PtCl_2(NH_3)_2] \xrightarrow{\text{aquation}} [PtCl(NH_3)_2(OH_2)]^{+1} \xrightarrow{\text{aquation}} [Pt(NH_3)_2(OH_2)_2]^{+2} \quad ..........(i)$$

$$[CoCl_2(en)_2]^{+1} \xrightarrow{\text{aquation}} [CoCl(en)_2(OH_2)]^{+2} \quad ..........(ii)$$

Correct statements :

(*a*) Reactivity order in (I) : cis >>> trans

(*b*) Reactivity order in (I) : trans >>> cis

(*c*) Reactivity order in (II) : cis >>> trans

(*d*) Reactivity order in (II) : trans >>> cis

**25.** Which of the following $\pi$ bonded organometallic compound follow Sidgwick EAN rule ?

(*a*) Ferrocene (*b*) Zeises salt

(*c*) Cisplatin (*d*) $Cr(C_6H_6)_2$

**26.** Aqueous solution of potash alum gives :-

(*a*) white precipitate with $BaCl_2$

(*b*) violet colour flame

(*c*) green colour flame

(*d*) white gelatinous ppt. with NaOH

**27.** Which of the following are the correct naming regarding ligand ?

(*a*) $NH_3 \rightarrow$ Ammine

(*b*) $CH_3–NH_2 \rightarrow$ Methylamine

(*c*) $(CH_3)_2NH \rightarrow$ Dimethylamine

(*d*) $(CH_3)_3N \rightarrow$ Trimethylamine

**28.** Which of the following statements are correct :-

(P) $[Cr(H_2O)_4Cl_2]Br.2H_2O$

(Q) $[Cr(H_2O)_4Br_2]Cl.2H_2O$

(R) $[Cr(H_2O)_5Cl]Br_2.H_2O$

(S) $[Cr(H_2O)_6]Cl_3$

(*a*) P & Q are example of ionisation isomers.

(*b*) Q & R are example of hydrated isomers.

(*c*) S is most conducting.

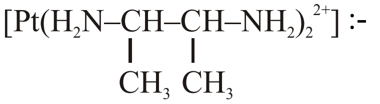
(*d*) P & R are example of ionisation isomers.

**29.** Which of the following have two stereoisomeric forms ?

(*a*) $[Cr(NO_3)_3(NH_3)_3]$ (*b*) $K_3[Fe(C_2O_4)_3]$

(*c*) $[Fe(en)Br_3Cl]^{-1}$ (*d*) $[CoBrCl(Ox)_2]^{3-}$

**30.** Which of the following statements are correct for



$[Pt(H_2N\text{–}\underset{CH_3}{CH}\text{–}\underset{CH_3}{CH}\text{–}NH_2)_2^{2+}]$ :-

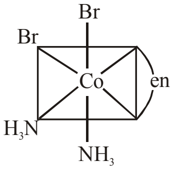
(*a*) It has total 6 geometrical isomers

(*b*) It has total 5 geometrical isomers

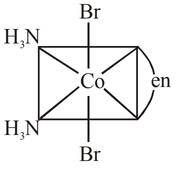
(*c*) One geometrical isomers has COS and 4 geometrical isomers have POS

(*d*) Two geometrical isomers has POS and 4 geometrical isomers have COS

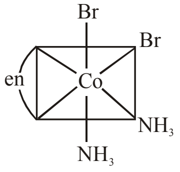
**31.** Which of the following statements are correct ?



I



II



III

(*a*) I, II are diastereoisomers

(*b*) II, III are enantiomers

(*c*) I, III are enantiomers

(*d*) II, III are diastereoisomers

**32.** Which of the following statements are incorrect ?

(*a*) In Mabcd, square planar complexes show both optical as well as geometrical isomerism

(*b*) In Mabcd, tetrahedral complex, optical isomerism & geometrical isomerism both are observed

(*c*) $[Fe(EDTA)]^{-1}$ shows geometrical isomerism

(*d*) tris(ethan-1,2-diamine)nickel(II)chloride is homoleptic outer orbital complex

**33.** Which of the following statements are correct ?

(*a*) In $[PtCl_2(NH_3)_2]^{2+}$, the cis form is optically inactive while trans form is optically active

(*b*) In $[Cr(C_2O_4)_3]^{3+}$, geometrically isomerism does not exist while optical isomerism exists

(*c*) $[Co(en)_2Br_2]^{+1}$, cis form is optically active while trans form is optically inactive

(*d*) $[Co(Ox)_2Cl(NO_2)]$, cis form is optically active while trans form is optically inactive (Ox - oxalato)

**34.** $(PPh_3)$ Cl Pd $Cl_2$Pd Cl $(PPh_3)$ shows -

(*a*) geometrical isomerism

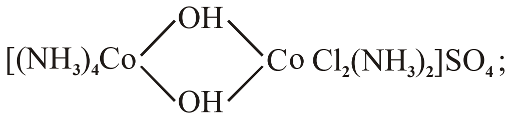
(*b*) optical (space) isomerism

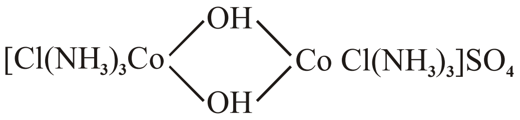
(*c*) co-ordination position isomerism

(*d*) ionisation isomerism

**35.** Which of the following relationship between complex are correct ?

(*a*)





: Coordination position isomers

(*b*) $[Pt(NH_3)_4]$ $[PtCl_6]$ ; $[PtCl_2(NH_3)_4]$ $[PtCl_4]$ : Coordination isomers

(*c*) $[Co(NH_3)_3(NO_3)_3]$ ; $[Co(NO_2)(NH_3)_5]$ $[Co(NH_3)_2(NO_2)_4]_2$ : Polymerisation isomers

(*d*) $[Co(NH_3)_5SCN]^{2+}$ ; $[Co(NH_3)_5NCS]^{2+}$ : Linkage isomers

**36.** Which of the following compounds show optical isomerism ?

(*a*) $[Pt(bn)_2]^{2+}$ (*b*) $[CrCl_2(en)_2]^{+1}$

(*c*) $[Co(en)_3]$ $[CoF_6]$ (*d*) $[Zn(gly)_2]$

**37.** Which of the following statements are correct about the complex ion $[CrCl(NO_2)(en)_2]^{+1}$ (en = ethylenediamine) ?

(*a*) It has two geometrical isomers ; cis and trans isomer

(*b*) Cis and trans isomers are diastereomers w.r.t. to each other

(*c*) Only cis isomer is optically active, exists as d and ℓ pair

(*d*) It has three stereomers ; two of which are optically active and one is optically inactive which is meso form.

**38.** Which of the following statements are correct regarding the following compound $[Pt(NH_3)_4]$ $[PtCl_4]$:-

(*a*) It is the polymerisation isomer of $[Pt(NH_3)_2Cl_2]$

(*b*) E.A.N. of metal in cationic part and anionic part both are same

(*c*) It is the coordination isomer of $[Pt(NH_3)_3Cl]$ $[Pt(NH_3)Cl_3]$

(*d*) Synergic bonding is not involved in the complex.

**39.** Correct option regarding Tetrakis (pyridine) dithiocyanato-N cobalt(III)nitrate.

(*a*) It is chelating complex

(*b*) It exist in linkage isomeric form

(*c*) It exist in geometrical isomeric form

(*d*) Number of ions formed in solution of the complex > 2

**40.** Wilkinson catalyst $[RhCl(PPh_3)_3]$ is -

(*a*) square planar complex with $dsp^2$ hybridisation

(*b*) optically inactive

(*c*) diamagnetic

(*d*) example of heterogeneous catalyst

**41.** Which of the following are $dsp^2$ hybridised ?

(*a*) $[AuCl_4]^{-1}$

(*b*) $[Pt(NH_3)_4]^{2+}$

(*c*) $[AuBr_2Cl_2]^{-1}$

(*d*) $Ni(CO)_4$

**42.** Which of following are $sp^3$ hybridised for Ni-complexes ?

(*a*) $[NiCl_4]^{2-}$

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

(*c*) $[Ni(CN)_4]^{4-}$

(*d*) $[Ni(NH_3)_6]^{2+}$

**43.** $[Zn(gly)_2]$ is -

(*a*) $sp^3$ hybridised

(*b*) optically inactive

(*c*) $dsp^2$ hybridised

(*d*) optically active

**44.** $[Pt(NH_3)_4(NO_2)_2]$ exists in 2 geometrical isomers. Which of the following options are correct ?

(*a*) Cis & trans isomer both have plane of symmetry

(*b*) Cis & trans isomer both have $C_2$ axis of symmetry

(*c*) both are optically active

(*d*) both have centre of symmetry

**45.** Brown ring - having molecular formula $[Fe(H_2O)_5NO]SO_4$. Which of the following statemens are correct regarding brown ring -

(*a*) Outer orbital octahedral complex with $sp^3d^2$ hybridisation

(*b*) Fe has (+2) configuration and NO is example of neutral ligand

(*c*) It has 2 unpaired electron and magnetic moment 2.73 B.M.

(*d*) It has 3 unpaired electron and magnetic moment 3.82 B.M.

**46.** Which of the following are inner orbital octahedral complex ions and diamagnetic ?

(*a*) $[Co(NH_3)_6]^{3+}$

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

(*c*) $[Fe(CN)_6]^{4-}$

(*d*) $[Fe(CN)_6]^{3-}$

**47.** Which of the following are outer orbital octahedral complex with same number of unpaired electrons ?

(*a*) $[MnCl_6]^{3-}$

(*b*) $[FeF_6]^{3-}$

(*c*) $[CoF_6]^{3-}$

(*d*) $[Ni(NH_3)_6]^{2+}$

**48.** Correct statement regarding $[MnCl_4{}^{2-}]$ :-

(*a*) It has magnetic moment 5.92 B.M.

(*b*) It has five unpaired electrons

(*c*) It is tetrahedral complex

(*d*) The hybridisation of Mn in the complex is $sp^3$

**49.** Correct order of ligand strength -

(*a*) $CN^- > CO$

(*b*) $F^- > Cl^-$

(*c*) $NO_2{}^- > NO_3{}^-$

(*d*) $H_2O > NH_3$

**50.** Which of the following complexes are homoleptic?

(*a*) $[Co(NH_3)_6]^{3+}$

(*b*) $[Co(NH_3)_4]^{+1}$

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

(*d*) $[Ni(NH_3)_4Cl_2]$

**51.** Which of the following complexes are heteroleptic?

(*a*) $[Cr(NH_3)_6]^{3+}$

(*b*) $[Fe(NH_3)_4Cl_2]^{+1}$

(*c*) $[Mn(CN)_6]^{4-}$

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

**52.** Which of the following complexes are optically active?

(*a*) $[Co(en)_3]^{3+}$

(*b*) trans $[Co(en)_2Cl_2]^{+1}$

(*c*) Cis$[Co(en)_2Cl_2]^{+1}$

(*d*) $[Cr(NH_3)_5Cl]^{2+}$

**53.** An aqueous pink solution of cobalt(III)chloride changes to deep blue on addition of excess HCl. This is because -

(*a*) $[Co(H_2O)_6]^{3+}$ is transformed into $[CoCl_6]^{4-}$

(*b*) $[Co(H_2O)_6]^{3+}$ is transformed into $[CoCl_4]^{2-}$

(*c*) Tetrahedral complexes have smaller crystal field splitting than octahedral complex

(*d*) Tetrahedral complexes have larger crystal field splitting than octahedral complex

**54.** Which of the following complex is tetrahedral but diamagnetic ?

(*a*) $K_3[Cu(CN)_4]$

(*b*) $Ni(CO)_4$

(*c*) $K_4[Ni(CN)_4]$

(*d*) $[Zn(H_2O)_4]^{2+}$

**55.** Which of the following are correct statements ?

(*a*) Pd(II), Pt(II) forms mostly 4 coordination, square planar diamagnetic coordination compounds.

(*b*) In $Mn_2(CO)_{10}$ there are total 70 electrons present

(*c*) $[Ni(CN_4)]^{4-}$ & $[Ni(CN_4)]^{2-}$ have different dipole moment

(*d*) The difference of the number of unpaired electron in $Zn^{2+}$ and $[Zn(NH_3)_4]^{2+}$ is zero

**56.** $FeCl_3 + K_4[Fe(CN)_6] \rightarrow$ Complex product. Correct statement regarding complex product :-

(*a*) IUPAC name of complex product is iron(II) hexacyanidoferrate(III)

(*b*) Total number of Fe ions in the solution is 4

(*c*) Average oxidation state of Fe is 2.57

(*d*) EAN of central metal atom of complex is 36

**57.** Which complex compound having $t_{2g}^{6}e_{g}^{0}$ configuration ?

(*a*) $K_3[Co(NO_2)_6]$ (*b*) $K_4[Fe(CN)_6]$

(*c*) $K_3[Fe(CN)_6]$ (*d*) $Na_2[Fe(CN)_5NO]$

**58.** Which complex compound having $t_{2g}^{3}\ e_{g}^{2}$ configuration ?

(*a*) $[Mn(H_2O)_6]^{2+}$ (*b*) $[Mn(NH_3)_6]^{2+}$

(*c*) $[Mn(CN)_6]^{4-}$ (*d*) $MnO_2$

**59.**

| Co-ordination entity | Wave length of light absorbed (nm) |
|---|---|
| $[CoCl(NH_3)_5]^{2+}$ | P |
| $[Co(NH_3)_5(H_2O)]^{3+}$ | Q |
| $[Co(NH_3)_6]^{3+}$ | R |
| $[Co(CN)_6]^{3-}$ | S |
| $[Cu(H_2O)_4]^{2+}$ | T |

Select the correct orders :-

(*a*) P > R > Q (*b*) T > P > Q > R > S

(*c*) P > Q > R (*d*) T > Q > P > R > S

**60.** What are the basic features of crystal field theory?

(*a*) ligands are considered as point like charge

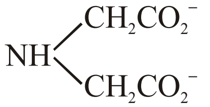
(*b*) the metal ligands interaction are purely electrostatic in nature

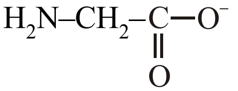
(*c*) metal electrons are considered as non bonding electrons

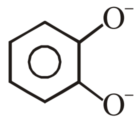
(*d*) covalent interaction takes place between ligand and metal ion

**61.** Which of the following are examples of bidentate chelating ligand ?

(*a*) $[NH_3–CH_2–CH_2–NH_3]^{2+}$

(*b*)

$NH(CH_2CO_2^-)_2$

(*c*)

$H_2N–CH_2–C(=O)–O^-$

(*d*)


**62.** In $[Fe_2(CO)_9]$, which of following statements are correct :-

(*a*) Fe has zero oxidation state

(*b*) EAN of each Fe atom is 36

(*c*) EAN of each Fe atom is 35

(*d*) None

**63.** For which of the following compound secondary valency of metal is six :-

(*a*) $PdCl_2.4NH_3$ (*b*) $NiCl_2.6H_2O$

(*c*) $PtCl_2.2NH_3$ (*d*) $CoCl_3.4NH_3$

**64.** Which of the following are example of symmetrical electronic configuration :-

(*a*) $d^5$ in weak field ligand

(*b*) $d^7$ in strong field ligand

(*c*) $d^8$ in weak field ligand

(*d*) $d^{10}$ in strong field ligand

**65.** Which of the following are example of asymmetrical electronic configuration :-

(*a*) $d^3$ in strong or weak field ligand

(*b*) $d^7$ in strong field ligand

(*c*) $d^4$ in weak field ligand

(*d*) $d^9$ in strong or weak field ligand

**66.** Which of the complex give same number of particles as that of $LaCl_3$ :-

(*a*) $K_3[CO(NO_2)_6]$

(*b*) $Co(NO_2)_3.KNO_2.2NH_3$

(*c*) $CoCl_3.3NH_3$

(*d*) $CoCl_3.6NH_3$

**67.** Correct option regarding Pentaamminethiocyanato-N cobalt(III) trioxalatochromate(III) -

(*a*) It is chelating complex

(*b*) It exist in linkage isomeric form

(*c*) It exist in geometrical isomeric form

(*d*) Number of ions formed in solution of the complex > 2

**68.** Which of the following IUPAC names are correct:-

(*a*) $[(CO)_3Fe(CO)_3Fe(CO)_3]$ : Tri-μ-carbonyl-bis(tricarbonyliron(0))

(*b*) $[(NH_3)_5CoNH_2Co(NH_3)_5](NO_3)_5$ : μ-amido-bis[pentaamminecobalt(III)]nitrate]

(*c*) $Na_3[Ag(S_2O_3)_2]$ : Sodiumbis(thiosulphato) argentate(I)

(*d*) $K_2[Cr^{VI}(CN)_2O_2(O_2)NH_3]$ : Potassiumammine dicyanidodioxoperoxochromate(VI)

**69.** Which of the following statements are incorrect :-

(*a*) Maximum coordination number of $Ag^{+1}$ is 6

(*b*) Maximum coordination number of $Pt^{2+}$ is 6

(*c*) Maximum coordination number of $Al^{3+}$ is 6

(*d*) Maximum coordination number of $Ni^{2+}$ is 6

**70.** Which of the following have $e_g^0 t_{2g}^0$ configuration :-

(*a*) $FeO_4^{2-}$ (*b*) $MnO_4^-$

(*c*) $TiCl_4$ (*d*) $ZnCl_4^{2-}$

**71.** Which of the following statements are incorrect :-

(*a*) $[HgI_3]^-$ is planar and diamagnetic

(*b*) In Zeise's salt central metal act as π donor, σ acceptor

(*c*) Zeise's salt has planar anion

(*d*) $NO_3^-$ is example of ambidentate ligand

**72.** Which of the following complexes/compounds, atleast one metal ion has +3 oxidation state:-

(*a*) Ferric alum (*b*) Cryolite

(*c*) Blue vitriol (*d*) Potassium fericyanide

**73.** A complex which is meso isomer can :-

(*a*) Have plane of symmetry

(*b*) Have one chiral centre

(*c*) Have centre of symmetry

(*d*) Have nonsuperimposable mirror image

**74.** In spherical octahedral crystal field, average energy of the 3d orbital is :-

(*a*) higher than $e_g$ orbital

(*b*) lower than $e_g$ orbital

(*c*) higher than $t_{2g}$ orbital

(*d*) lower than $t_{2g}$ orbital

**75.**

| **Complex** | **Absorption peak ($cm^{-1}$)** |
|---|---|
| (A) $[Cr^{(III)}Cl_6]^{3-}$ | x |
| (B) $[Cr^{(III)}(H_2O)_6]^{3+}$ | y |
| (C) $[Cr^{(III)}(NH_3)_6]^{3+}$ | z |
| (D) $[Cr^{(III)}(CN)_6]^{3-}$ | w |

Correct order between x,y,z,w are :-

(*a*) x > y (*b*) y > z

(*c*) w > z (*d*) w > z > y > x

**76.**

| **Complex** | **$\Delta_0$ ($cm^{-1}$)** |
|---|---|
| (A) $[Co^{(III)}(NH_3)_6]^{3+}$ | x |
| (B) $[Rh^{(III)}(NH_3)_6]^{3+}$ | y |
| (C) $[Ir^{(III)}(NH_3)_6]^{3+}$ | z |

Correct order between x,y,z are :-

(*a*) z > y (*b*) z > x

(*c*) y > x (*d*) x = y = z

**77.** Which of the following do not act as an oxidizing agent :-

(*a*) $Mn(CO)_5$ (*b*) $Fe(CO)_5$

(*c*) $Mn_2(CO)_{10}$ (*d*) $Fe_2(CO)_9$

**78.** Prussian blue is formed by combining between :-

(*a*) $Fe^{3+}$ (*b*) $[Fe(CN)_6]^{3-}$

(*c*) $Fe^{2+}$ (*d*) $[Fe(CN)_6]^{4-}$

**79.** For $d^7$ ion like $Co^{2+}$ with very strong ligand like $NO_2^-$ :-

(*a*) $Co^{2+}$ ion can be reduced to Co

(*b*) $Co^{2+}$ ion can be oxidised to $Co^{3+}$

(*c*) The excited 7th electron resides in 5s orbital which is of higher energy level.

(*d*) The complex formed is $d^2sp^3$ hybridised

**80.** Which of the following complexes are examples of ternary complexes :-

(*a*) $[CoCl(NH_3)_5]^{2+}$ (*b*) $[Cu(bpy)en]^{2+}$

(*c*) $[Cu(bpy)ox]$ (*d*) $[Co(NH_3)_5(OH_2)]^{3+}$

(bpy = bipyridine ; en = ethylene diamine ; ox = oxalato)

**81.** Which of the following statements are incorrect ?

(*a*) $NO^+$ has lower p accepting tendency than CO

(*b*) The C-O bond length in bridging carbonyl compound is shorter than that of terminal carbonyl group

(*c*) The C-O bond length in bridging carbonyl compound is longer than that of terminal carbonyl group

(*d*) $Ni(H_2O)_6^{2+}$ is green in colour but $[Ni(CN)_4]^{2-}$ is colourless

**82.** Correct order of CO bond length :-

(*a*) $[M(CO)_3PF_3] < [M(CO)_3PCl_3]$

(*b*) $[M(CO)_3PF_3] > [M(CO)_3PCl_3]$

(*c*) $[M(CO)_3PF_3] < [M(CO)_3PMe_3]$

(*d*) $[M(CO)_3PCl_3] < [M(CO)_3PMe_3]$

**83.** The value of x in :-

(*a*) $[Hg(CN)_4]^x$ can be –2

(*b*) $[Fe(CN)_6]^x$ can be –3

(*c*) $[Fe(CN)_6]^x$ can be –4

(*d*) $[Co(NH_3)_2Cl_4]^x$ can be –1

**84.** Which of the following ligands can act as flexidentate ligand ?

(*a*) $SO_4^{2-}$ ion (*b*) $CH_3CO_2^-$ ion

(*c*) $CO_3^{2-}$ ion (*d*) $HCO_2^-$ ion

**85.** Which of the following are example of perfect complex :-

(*a*) $[Fe(CN)_6]^{4-}$ (*b*) $[Ag(CN)_2]^{-1}$

(*c*) $[Cu(CN)_4]^{3-}$ (*d*) $[Cu(NH_3)_4]^{2+}$

**86.** Which of the following are example of inperfect complex :-

(*a*) $[Cd(CN)_4]^{2-}$ (*b*) $[CdI_4]^{2-}$

(*c*) $[Co(NH_3)]^{3+}$ (*d*) $[Fe(CN)_6]^{4-}$

**87.** Which of the following are example of anionic complex :-

(*a*) $K_2[HgI_4]$ (*b*) $K_3[Co(NO_2)_6]$

(*c*) $Ni(CO)_4$ (*d*) $H[AuCl_4]$

**88.** Which of the following are example of cationic complex :-

(*a*) $[Rh(PPh_3)Cl_3]$ (*b*) $[Ag(NH_3)_2]Cl$

(*c*) $[Co(NH_3)_6]Cl_3$ (*d*) $[Co(NH_3)_5SO_4]Br$

**89.** $Cr_2O_7^{2-} + Fe^{II} + H_2SO_4 \rightarrow$ Final solution (*a*)

Correct option regarding A :-

(*a*) A is $[Cr(SO_4)_3]^{3-}$ (*b*) A is $[Cr(H_2O)_6]^{3+}$

(*c*) A is violet in colour (*d*) A is green in colour

**90.** In the crystal structure of $MnSO_4.4H_2O$, which of the following statement are correct ?

(*a*) $SO_4^{2-}$ acts as bidentate ligand where 2 oxygen atoms of $SO_4^{2-}$ form chelate with $Mn^{2+}$

(*b*) There are 6 water molecule associated with each $Mn^{2+}$ ion

(*c*) $SO_4^{2-}$ acts as bridging ligand.

(*d*) $Mn^{2+}$ has coordination number six

**91.** Incorrect statements are :-

(*a*) $Ni^{4+}$ is more stable than $Ni^{2+}$

(*b*) $Ni^{2+}$ is more stable than $Ni^{4+}$

(*c*) $Pt^{2+}$ is more stable than $Pt^{4+}$

(*d*) $Pt^{4+}$ is more stable than $Pt^{2+}$

**92.** X forms pentacarboyl of the type $X(CO)_5$

Y forms tetracarboyl of the type $Y(CO)_4$

Z forms hexacarboyl of the type $Z(CO)_6$

If in all the complexes metal follows EAN rule then:-

(*a*) X can be Fe (*b*) Y can be Ni

(*c*) Z can be V (*d*) Z can be Cr

**93.** When Gold is attacked by aqua regia :-

(*a*) the coordination number of Au in complex formed is +2

(*b*) the coordination number of Au in complex formed is +4

(*c*) the complex formed can act as a bronsted acid

(*d*) $NO_2$ gas is evolved

**94.** An aqueous solution of Fe(III) sulphate is paramagnetic but when an excess of KCN is added to the solution which of the following properties are changed :-

(*a*) Shape of the molecule

(*b*) Hybridisation of Fe(III)

(*c*) Number of unpaired electron

(*d*) magnetic behaviour

**95.** Correct statement regarding $[Co(en)_3]^{3+}$ :-

(*a*) It exists as cis and trans isomer

(*b*) It is nonresolvable

(*c*) It is resolvable

(*d*) It is optically active

**96.** Correct statement regarding Ferrocene :-

(*a*) It is an orange solid with melting point 174°C

(*b*) It is prepared as $2C_5H_5MgBr + FeCl_2 \rightarrow Fe(C_5H_5)_2 + MgCl_2 + MgBr_2$

(*c*) IUPAC name of ferrocene is bis (cyclopentadienyl) iron(II)

(*d*) It is an example of sandwich compound

**97.** Which of the following statements are correct :-

(*a*) In an octahedral ligand field the five fold degenerate 3d level will split into doubly degenerate $e_g$ set and triply degenerate $t_{2g}$ set

(*b*) The symbol g denotes the presence of centre of inversion

(*c*) In the square ligand field, the 3d orbitals will be split into four levels

(*d*) In the square ligand field, the 3d orbitals will be split into two levels

**98.** The substance $CoBr_3 . 4NH_3 . 2H_2O$ has a molar conductivity of 420 $ohm^{-1}$ at infinite dilution. Which corresponds to (3+, 1–) electrolyte like $AlCl_3$. Correct option regarding that substance :-

(*a*) Substance is $[Co(NH_3)_4(H_2O)_2]Br_3$

(*b*) IUPAC name of substance is tetraammine diaquacobalt(III)bromide

(*c*) Substance is $[Co(NH_3)_3(H_2O)_3]Br_3$

(*d*) IUPAC name of substance is tetraammine diaquacobalt(II)bromide

**99.** Select the correct IUPAC name for $[(NH_3)_4Co(OH)(NH_2)Co(NH_3)_4]^{4+}$ :-

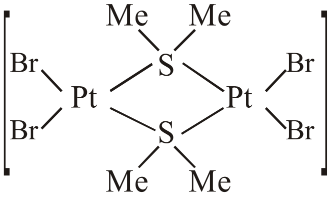
(*a*) μ-Amido-μ-hydroxidobis {tetraamminecobalt (4+)} ion

(*b*) μ-Amido-μ-hydroxidobis{tetraamminecobalt (III)} ion

(*c*) μ-Amido-μ-hydroxidobis{tetraamminecobaltate (4+)} ion

(*d*) μ-Amido-μ-hydroxidobis{tetraamminecobaltate (III)} ion

**100.** Select the correct IUPAC name for the following complex



(*a*) Dibromidoplatinum(II)bis-μ-(dimethylthioether) dibromidoplatinum(II)

(*b*) Bis{μ(dimethylthioether) dibromidoplatinum(II)}

(*c*) Bis-μ-dimethylthioethertetrabromidoplatinum(II)

(*d*) Bis-μ-dimethylthioethertetrabromidoplatinate(II)

## EXERCISE # III

### ☐ Linked Comprehension Type :

### Paragraph for Q.1 to Q.2

An octahedral complex of cobalt has its composition $Co(NH_3)_3(H_2O)_3(SO_4)(NO_3)$ and it exists in four isomeric forms A, B, C and D . Simple heating of either A or B loses 5.6% of its original weight whereas similar treatment on C causes 11.2% loss in its original weight D did not lose any weight on simple heating. Either A or C did not result in any precipitation if treated with aqueous $BaCl_2$ solution, whereas B and D resulted a white precipitate when treated with aqueous $BaCl_2$ solution. Also C does not conduct electricity in its aqueous solution,

**1.** A is :-

(*a*) $[Co(NH_3)_3(H_2O)_3]SO_4.NO_3$

(*b*) $[Co(NH_3)_3(H_2O)_2NO_3]SO_4.H_2O$

(*c*) $[Co(NH_3)_3(H_2O)_2SO_4]NO_3.H_2O$

(*d*) $[Co(NH_3)_3(H_2O)SO_4NO_3]2H_2O$

**2.** B & C are respectively :-

(*a*) $[Co(NH_3)_3(H_2O)_3]SO_4.NO_3$ ; $[Co(NH_3)_3(H_2O)SO_4.NO_3]2H_2O$

(*b*) $[Co(NH_3)_3(H_2O)_2NO_3]SO_4.H_2O$ ; $[Co(NH_3)_3(H_2O)SO_4]NO_3.H_2O$

(*c*) $[Co(NH_3)_3(H_2O)_2NO_3]SO_4.H_2O$ ; $[Co(NH_3)_3(H_2O)SO_4.NO_3]2.H_2O$

(*d*) $[Co(NH_3)_3(H_2O)_2SO_4]NO_3.H_2O$ ; $[Co(NH_3)_3(H_2O)_2.NO_3]SO_4.H_2O$

**3.** D is :-

(*a*) $[Co(NH_3)_3(H_2O)_3]SO_4.NO_3$

(*b*) $[Co(NH_3)_3(H_2O)_2NO_3]SO_4.H_2O$

(*c*) $[Co(NH_3)_3(H_2O)_2SO_4]NO_3.H_2O$

(*d*) $[Co(NH_3)_3(H_2O)SO_4NO_3]2H_2O$

### Paragraph for Q.4 to Q.6

A, B and C are three complexes of chromium (ii) with their formula $H_{12}O_6Cl_3Cr$. Complex A does not react with concentrated $H_2SO_4$ solution whereas complexes B and C loses 6.75% and 13.5% of their weight, respectively, on treatment with concentrated $H_2SO_4$ solution.

**4.** Correct option regarding A :-

(*a*) A is violet with 3 chloride ions/unit formula

(*b*) B is light green colour with 2 chloride ions / unit formula

(*c*) C is dark green colour with 1 chloride ions / unit formula

(*d*) All

**5.** Electrical conductivity order of A,B,C

(*a*) A > B > C (*b*) B > A > C

(*c*) C > A > B (*d*) C > B > A

**6.** A,B,C are related as

(*a*) Ionisation isomers (*b*) Hydrate isomers

(*c*) Optical isomers (*d*) Geometrical isomers

### Paragraph for Q.7 to Q.9

A light green coloured substance A has 27.55% $H_2O$. A gives the following reaction, :-

(i) it gives white ppt. with $BaCl_2$ which is soluble in conc. $HNO_3$

(ii) it gives brown colour ppt when reacts with alkaline $K_2[HgI_4]$ solution

(iii) it gives dark blue ppt when reacts with $K_3[Fe(CN)_6]$

**7.** A is :-

(*a*) $KCl.MgCl_2.6H_2O$

(*b*) $Fe_2(SO_4)_3.(NH_4)_2SO_4.6H_2O$

(*c*) $Cr_2(SO_4)_3.K_2SO_4.6H_2O$

(*d*) $FeSO_4.(NH_4)_2SO_4.6H_2O$

**8.** The white ppt is :-

(*a*) $BaSO_4$ (*b*) $BaCl_2$

(*c*) $Ba(NO_3)_2$ (*d*) $BaCO_3$

**9.** The brown and blue colour ppt are respectively :-

(*a*) I HgO Hg $NH_2$ & ferro-ferri cyanide

(*b*) I HgO Hg $NH_2$ & ferri-ferro cyanide

(*c*) $Fe(OH)_3$ & $Fe(CN)_3$

(*d*) $Fe(OH)_3$ ; $[Cn(NH_3)_4]SO_4$

### Paragraph for Q.10 to Q.11

In metal carbonyls, synergic bonding takes place between metal and carbonmonooxide. This leades to increase in strength of metal ligand bond and decrease in bond order of CO in carbonyl complex as compared to bond order in carbon monooxide.

**10.** Which among the following metal carbonyls are inner orbital complexes with diamagnetic property ?

(X) $Ni(CO)_4$ ; (Y) $Fe(CO)_5$ ; (Z) $V(CO)_6$ ; (W) $Cr(CO)_6$

(*a*) (X) and (Y) only (*b*) (Y), (Z) and (W) only

(*c*) (Y) and (W) only (*d*) (X), (Y) and (W) only

**11.** Which of the following metal carbonyls involve the $d^2sp^3$ hybridisation for the formation of metal carbon σ bonds and is paramagnetic ?

(*a*) $[Cr(CO)_6]$ (*b*) $[V(CO)_6]$

(*c*) $[Mo(CO)_6]$ (*d*) $[W(CO)_6]$

### Paragraph for Q.12 to Q.14

$Co^{2+}(aq.) + SCN^-(aq.) \longrightarrow$ Complex (X)

$Ni^{2+}(aq.)$ + Dimethylglyoxime $\xrightarrow{NH_4OH}$ Complex (Y)

The coordination number of cobalt and nickel in complexes X and Y is four.

**12.** The IUPAC names of the complexes (X) and (Y) are respectively :-

(*a*) tetrathiocyanato-S-cobalt(II)ion and bis(dimethylglyoximate) nickel(II)

(*b*) tetrathiocyanato-S-cobaltate(II)ion and bis(dimethylglyoximato) nickel(II)

(*c*) tetrathiocyanato-S-cobaltate(II)ion and bis(dimethylglyoximato) nickelate(II)

(*d*) tetrathiocyanato-S-cobaltate(III)ion and bis(dimethylglyoximato) nickel(II)

**13.** The geometry of complexes (X) and (Y) are respectively :-

(*a*) tetrahedral and square planar

(*b*) both tetrahedral

(*c*) square planar and tetrahedral

(*d*) both square planar

**14.** Select the correct statement for the complexes (X) and (Y) :-

(*a*) (X) is paramagnetic with two unpaired electrons

(*b*) (Y) is diamagnetic and shows intermolecular H-bonding

(*c*) (X) is paramagnetic with three unpaired electrons and (Y) is diamagnetic

(*d*) (X) and (Y) both are diamagnetic

**Paragraph for Q.15 to Q.17**

Paramagnetism is a property due to the presence of unpaired electrons. In case of transition of metals, as they contain unpaired electrons in the (n – 1) d orbitals, most of the transition metal ions and their compounds are paramagnetic. Paramagnetism increases with increase in number of unpaired electrons. Magnetic moment is calculated from 'Spin only formula' vis.

$\mu = \sqrt{n(n+2)}$ B.M. n = number of unpaired electrons

Similarly the colour of the compounds of transition metals may be attributed to the presence of incomplete (n – 1) d subshell. When an electron from a lower energy of d-orbital is excited to a higher energy d-orbital, the energy of excitation corresponds to the frequency of light absorbed. This frequency generally lies in the visible region. The colour observed corresponds to complementary colour of the light. The frequency of the light absorbed is determined bt the nature of the ligand.

**15.** Which of the followig pair of compounds is expected to exhibit same colour in aqueous solution?

(*a*) $FeCl_2, CuCl_2$ (*b*) $VOCl_2, CuCl_2$

(*c*) $VOCl_2, FeCl_2$ (*d*) $FeCl_2, MnCl_2$

**16.** Titanium shows magnetic moment of 1.73 B.M. in its compounds. What is the oxidation state of titanium in the compound ?

(*a*) +2 (*b*) +1

(*c*) +3 (*d*) +4

**17.** Identify the incorrect statement :-

(*a*) $Mn^{2+}$ has the highest paramagnetism amongst the bivalent cations of the Ist transition series

(*b*) The coloured ions or compounds of transition elements are due to d-d transition, polarisation of anion and charage transfer spectrum

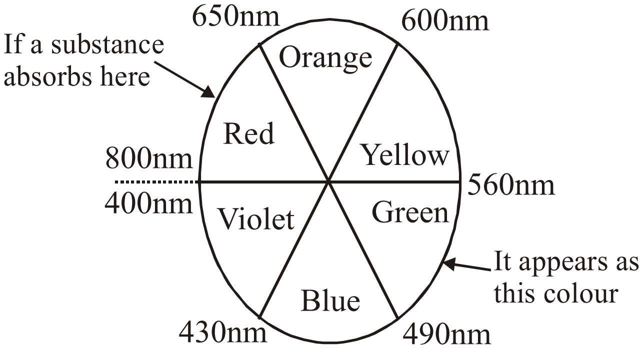
(*c*) In 3d series the paramagnetic character first increase to maximum and then starts decreasing

(*d*) None of these

**Paragraph for Q.18 to Q.20**

In general, the crystal field splitting energy Δ corresponds to wavelengths of light in visible region of the spectrum, and coloures of the complexes can therefore be attributed to electronic transition between the lower- and higher energy sets of d-orbitals.

In general, the colour that we see is complementry to the colour absorbed.



Different metal ions have different values of Δ, which explains why their complexes with the same ligand have different colour.

Similarly the crystal field splitting also depends on the nature of ligands and as the ligand for the same metal varies from $H_2O$ to $NH_3$ to ethylenediamine, Δ for complexes increases. Accordingly, the electronic transition shifts to higher energy (shorter wavelength) as the ligand varies from $H_2O$ to $NH_3$ to en, thus accounting for the variation in colour.

Crystal field theory accounds for the magnetic properties of complexes in terms of the relative values of Δ and the spin pairing energy P. Small Δ values favour high spin complexex, and large Δ values favour low spin complexed.

**18.** The $[Ti(NCS)_6]^{3-}$ ion exhibits a single absorptin bond at 544 nm. What will be the crystal field splitting energy (in kJ $mol^{-1}$) of the complex ?

(h = $6.626 \times 10^{-34}$ J.s ; C = $3.0 \times 10^8$ m/s ; $N_A = 6.02 \times 10^{23}$ ions.mjole.)

(*a*) 240 (*b*) 220

(*c*) 270 (*d*) 250

**19.** Whcih of the following statement is incorrect :-

(*a*) The $Ni^{2+}$ (aq) cation is coloured because $Ni^{2+}$ ion can absorb light , which promotes electrons from the filled d-orbitals to the higher half filled d - orbitals

(*b*) The $Zn^{2+}$ (aq) cation is coloured because the d orbitals are completely filled and no electrons can be promoted, so no light is absorbed

(*c*) A complex which has just one absorption band at 455 nm, must be red coloured.

(*d*) None

**20.** Which of the following complexes are diamagnetic:-

| | | | |
|---|---|---|---|
| $[Pt(NH_3)_4]^{2+}$ | $[Co(SCN)_4]^{2-}$ | $[Cu(en)_2]^{2+}$ | $[HgI_4]^{2-}$ |
| square planar | tetrahedral | square planar | tetrahedral |
| (i) | (ii) | (iii) | (iv) |

(*a*) (i) and (ii) (*b*) (ii) and (iii)

(*c*) (i) and (iv) (*d*) (iii) and (iv)

### Paragraph for Q.21 to Q.23

In the octahedral systems there are two possible ways to distribute the d-electron in the $t_{2g}$ and eg level for each $d^n$ system. There will be two opposing factors. The crystal field splitting energy , i.e., $10Dq_0$ (or $\Delta_0$) will try to place the electrons into the more stable $t_{2g}$ level as many as possible while the pairing energy (P) required to pair two electrons in the same orbital will try to avoid the pairing as far as possible.

**21.** If $10Dq_0 > P$ the correct electronic configuration for $d^4$ ion is :-

(*a*) $t_{2g}^3 eg^1$ (*b*) $t_{2g}^4 eg^0$

(*c*) $t_{2g}^2 eg^2$ (*d*) $eg^3 t_{2g}^1$

**22.** If $10Dq_0 < P$ then correct electronic configuration for $d^5$ ion is :-

(*a*) $t_{2g}^5 eg^0$ (*b*) $eg^3 t_{2g}^2$

(*c*) $t_{2g}^3 eg^2$ (*d*) $t_{2g}^4 eg^1$

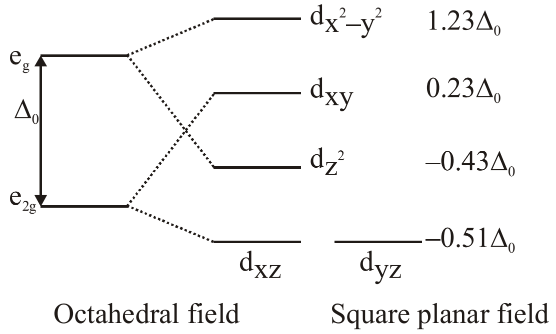
**23.** If $10Dq_0 > P$ then crystal field splitting energy for $d^6$ ion in octahedral field will be :-

(*a*) 20 Dq – 2P (*b*) 4 Dq

(*c*) 8 Dq (*d*) 24 Dq – 2p

### Paragraph for Q.24 to Q.25

The splitting diagram for square planar complexes is more complex than for octahedral and tetrahedral complexes and is shown below with the relative energies of each orbital.



**24.** Crystal field stabilisation energy for a diamagnetic square planar $d^8$ metal complex with the help of above diagram neglecting pairing energy (P) :-

(*a*) – 4.88 $\Delta_0$ (*b*) – 2.44 $\Delta_0$

(*c*) – 0.68 $\Delta_0$ (*d*) – 3.88 $\Delta_0$

**25.** Which of the following set of d electrons have same crystal field stabilisation energy value for tetrahedral complex neglecting pairing energy (P):-

(I) $d^1$, $d^6$ (II) $d^2$, $d^7$

(III) $d^3$, $d^8$ (IV) $d^4$, $d^9$

(V) $d^5$, $d^{10}$

(*a*) Only V (*b*) II, III, V

(*c*) I, III, IV (*d*) I, II, III, IV, V

### Paragraph for Q.26 to Q.27

According to crystal field theory, the electronic configuration of ions are given below :

$d^1$ : $t^1_{2g}d^8$ : $t^6_{2g}e_g^{\ 2}$
$d^2$ : $t^2_{2g}d^9$ : $t^6_{2g}e_g^{\ 3}$
$d^3$ : $t^3_{2g}d^{10}$ : $t^6_{2g}e_g^{\ 4}$

**26.** Irrespective of the nature of ligand outer orbital octahedral complex is formed by :-

(*a*) $d^8$ ion (*b*) $d^9$ ion

(*c*) $d^{10}$ ion (*d*) All

**27.** Irrespective of the nature of ligand inner orbital octahedral complex is formed by :-

(*a*) Only $d^1$ ion (*b*) $d^1$ , $d^2$ ion

(*c*) Only $d^3$ ion (*d*) $d^1$ , $d^2$ , $d^3$ ion

### Passage for Q.28 to Q.29

$AlF_3$ is not soluble in analysis HF but not soluble in KF. When $BrF_3$ is added to the above solution, $AlF_3$ is precipitated.

**28.** What will be the product when $AlF_3$ is dissolved in KF ?

(*a*) $K[AlF_4]$ (*b*) $K_2[AlF_5]$

(*c*) $K_3[AlF_6]$ (*d*) $K_4[AlF_7]$

**29.** What will be the product when this dissolved solution combines with $BF_3$ ?

(*a*) $K[BF_4]$ (*b*) $K_2[BF_5]$

(*c*) $K_3[BF_6]$ (*d*) $K_4[BF_7]$

### Passage for Q.30 to Q.32

Electrostatic theory of bonding in coordination compound consider the electrostatic attraction between the positively charged metal ion and negatively charge ligads or negative ends of polar molecule acting as the ligands. Thus complexing power of particular metal ion depends on the charge density called ionic potential. In fact ionic potential is a good parameter to measure the complexing power of metal ion.

**30.** Metal ion like $Cs^+$ , $Rb^+$ , $K^+$ , $Na^+$ , $Li^+$ , complexing power is very low. It is because these metal ions have :-

(*a*) very high ionic potential (in the range of 3.7 - 5.2 )

(*b*) moderately high ionic potential (in the range of 1.5 - 2.5)

(*c*) low ionic potential (in the range of 0.55 - 1.11)

(*d*) moderately high ionic potential (in the range of 2 - 3)

**31.** Ionic potential of $Co^{3+}$ , $Al^{3+}$ , $Sn^{4+}$, $Be^{2+}$, $Pt^{4+}$ are very high. So these ions have :-

(*a*) very poor complexing ability with ligands

(*b*) moderate complexing ability with ligands

(*c*) very high or most pronounced complexing ability with ligands

(*d*) do not form complex at all

**32.** Ionic potential of :-

(*a*) $Zn^{2+}$ is in between $Fe^{3+}$ and $Cd^{2+}$

(*b*) $Cu^{2+}$ is in between $Cr^{3+}$ and $Cu^+$

(*c*) $Mn^{2+}$ is in between $Rh^{3+}$ and $Ba^{2+}$

(*d*) All

### Passage for Q.33 to Q.35

According to Sidgwick's Effective Atomic Number rule, the ligands donate the electrons to the central metal ion through the covalent coordinate bonds and the total number of electrons on the central metal ion including those gained from ligands is the atomic number of nearest noble gas.

Given :At. No. of Cd & Pt are 48, 78 respectively.

**33.** In $[Cd(NH_3)_4]^{2+}$ , EAN value of metal ion :-

(*a*) is same as atomic number of Kr

(*b*) is same as atomic number of Xe

(*c*) is same as atomic number of Rn

(*d*) does not match any noble gas configuration

**34.** In $[Pt(NH_3)_4Cl_2]^{2+}$ , EAN value of metal ion :-

(*a*) is same as atomic number of Kr

(*b*) is same as atomic number of Xe

(*c*) is same as atomic number of Rn

(*d*) does not match any noble gas configuration

**35.** In $[Pt(\eta^2 C_2H_4)Cl_3]^{-1}$ , EAN value of metal ion :-

(*a*) is same as atomic number of Kr

(*b*) is same as atomic number of Xe

(*c*) is same as atomic number of Rn

(*d*) does not match any noble gas configuration

### Passage for Q.36 to Q.38

The following complexes are given below :

| | |
|---|---|
| $[Ag(NH_3)_2]^+$ ;<br>X | $[Ag(CN)_2]^{-1}$ ;<br>Y |
| $[Ag(SCN)_2]^{-1}$ ;<br>Z | $[Pt(CN)_4]^{2-}$<br>W |

**36.** Which of the following complex is linear in shape having all 5 atoms including metal ion are in a straight line :-

(*a*) X (*b*) Y

(*c*) Z (*d*) W

**37.** Which of the following complex is square planar in shape having at least 5 atoms including metal ion are in a straight line :-

(*a*) X (*b*) Y

(*c*) Z (*d*) W

**38.** Which of the following complex is linear in shape having at least 7 atoms including metal ion are in a straight line :-

(*a*) X (*b*) Y

(*c*) Z (*d*) W

**Passage for Q.39 to Q.41**

The following complexes are given below :

| | |
|---|---|
| $[Ni(H_2O)_6]^{2+}$;<br>$X_1$ | $[Ni(H_2O)_4en]^{2+}$;<br>$X_2$ |
| $[Ni(H_2O)_2(en)_2]^{2+}$;<br>$X_3$ | $[Ni(en)_3]^{2+}$<br>$X_4$ |

**39.** Correct statement regarding $X_4$ :-

(*a*) $X_4$ has 2 stereoisomers

(*b*) $X_4$ has 3 stereoisomers

(*c*) $X_4$ has 4 stereoisomers

(*d*) $X_4$ has 2 optically inactive stereoisomers

**40.** Correct statement regarding $X_3$ :-

(*a*) $X_3$ has 2 stereoisomers

(*b*) $X_3$ has 3 stereoisomers

(*c*) $X_3$ has 4 stereoisomers

(*d*) $X_3$ has 2 optically inactive stereoisomers

**41.** Correct statement regarding $X_1$ and $X_2$:-

(*a*) $X_1$ , $X_2$ both are optically inactive

(*b*) $X_1$ , $X_2$ both are optically active

(*c*) $X_1$ is optically inactive but $X_2$ is optically active

(*d*) $X_2$ is optically inactive but $X_1$ is optically active

**Passage for Q.42 to Q.44**

A complex of cobalt , X has magnetic moment 4.89 BM and EAN value 36. Another complex of cobalt, Y has magnetic moment 3.87 BM and EAN value 37.

Third complex of cobalt , Z has magnetic moment 0 BM and EAN value 36.

**42.** Z can be :-

(*a*) $[Co(H_2O)_6]SO_4$ (*b*) $[CoCl_4]^{2-}$

(*c*) $K_3[Co(NO_2)_6]$ (*d*) $[CoBr_4]^{2-}$

**43.** X can be :-

(*a*) $[Co(NH_3)_6]Cl_3$ (*b*) $K_3[Co(C_2O_4)_3]$

(*c*) $[Co(H_2O)_6]SO_4$ (*d*) $[CoCl_4]^{2-}$

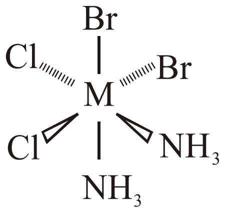
**44.** Y can be :-

(*a*) $[CoBr_6]^{4-}$ (*b*) $[Co(CO)_4]^{-1}$

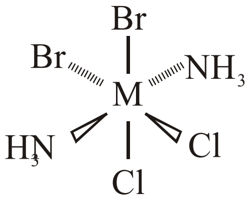
(*c*) $[Co_2(CO)_8]$ (*d*) $[CoF_6]^{3-}$

**Passage for Q.45 to Q.47**

The following complexes P and Q are given as follows



P



Q

**45.** P and Q are related as :-

(*a*) Structural isomers (*b*) Geometrical isomers

(*c*) Optical isomers (*d*) None

**46.** P :-

(*a*) can exist as enantiomeric pair.

(*b*) can not exist as enantiomeric pair.

(*c*) is resolvable

(*d*) both (*a*) and (*c*)

**47.** Q :-

(*a*) can exist as enantiomeric pair.

(*b*) can not exist as enantiomeric pair.

(*c*) is resolvable

(*d*) both (*a*) and (*c*)

**Passage for Q.48 to Q.51**

A qualitative correlation between the various Lewis acids and bases is done by classifying the acids or bases into two classes hard and soft. Acid base reactions are then treated by the general principle that hard acid prefer to combine with hard bases and soft acids prefer to combine with soft bases. A firmly held electron - cloud with low polarisability makes a species "hard" while an easily polarisable electron cloud characterises the species as "soft".

**48.** Which of the following are example of hard acids?

(*a*) $Co^{3+}$ (*b*) $Fe^{3+}$

(*c*) $Mg^{2+}$ (*d*) $Cr^{3+}$

**49.** Which of the following are example of soft acids ?

(*a*) $Cu^+$ (*b*) $Ag^+$

(*c*) $Hg^{2+}$ (*d*) $Pd^{2+}$

**50.** Which of the following are example of hard bases?

(*a*) $NO_3^-$ (*b*) $F^-$

(*c*) $NH_3$ (*d*) ROH

**51.** Which of the following are example of soft base ?

(*a*) RSH (*b*) $R_3P$

(*c*) $I^-$ (*d*) $CN^-$

**Passage for Q.52 to Q.53**

Irving and Williams calculated the series of stability constants of octahedral complexes of the bivalent metal ions of first transition series with the common ligands having the donor sites like oxygen, sulphur, nitrogen and halogen. This series is called Irving and Williams stability order of octahedral complexes.This occurs due to the following contributing factors.

- decrease of ionic radii, i.e., increase of electronegativity along the series.
- increase of crystal field stabilization energy along the series.

**52.** The stability constant of the octahedral complexes for d block ions :-

(*a*) $Mn^{2+} < Fe^{2+} < Co^{2+}$

(*b*) $Mn^{2+} > Fe^{2+} > Co^{2+}$

(*c*) $Co^{2+} < Ni^{2+} < Cu^{2+} > Zn^{2+}$

(*d*) $Ni^{2+} < Cu^{2+} < Zn^{2+}$

**53.** The stability constant of the octahedral complexes for s-block & d-block ions :-

(*a*) $Ba^{2+} < Ca^{2+} < Mg^{2+}$

(*b*) $Ba^{2+} > Ca^{2+} > Mg^{2+}$

(*c*) $Ca^{2+} < Mg^{2+} < Mn^{2+}$

(*d*) $Mg^{2+} < Ba^{2+} < Ca^{2+}$

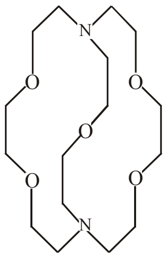
**Passage for Q.54 to Q.56**

The crown ethers are monocyclic while the cryptands are bicyclic or tricyclic. The multi cyclic cryptands are basically the amino ethers where the N-sites acts as bridgehed atoms. The cryptands can provide the cage structure to accommodate the metal ion and other suitable guest species. Thus these multicyclic ligands provide the heterocyclic rings to encapsulate the metal ion in a cage-like structure.

**54.** The donor atoms of cryptands :-

(*a*) O, O (*b*) O, N

(*c*) N, N (*d*) None

**55.**  is example of :-

(*a*) crypt-[2,2,1] (*b*) crypt-[2,2,2]

(*c*) crypt-[2,3,2] (*d*) crypt-[0,2,0]

**56.** Which of the following statements are correct :-

(*a*) Four member chelate ring produced by $\eta^2$ didentate ligands like acetato, carbonato, sulphato and nitrato are fairly stable and preferred in complexes of high coordination number 8,10,12

(*b*) The five member chelate ring formed by amino acid or amino carboxylate are more stable than six member chelate ligands formed by similar ligands

(*c*) Resonance or delocalisation of charge stabilises the six membered chelate rings

(*d*) Generally chelate rings less than five membered or more than six membered will be less stable

**Passage for Q.57 to Q.58**

$$K_6\,[(CN)_5\text{–}Co\text{–}O\text{–}O\text{–}Co(CN)_5] \xrightarrow{\text{oxidised}} K_5$$

X

$$[(CN)_5\text{–}Co\text{–}O\text{–}O\text{–}Co(CN)_5]$$

Y

**57.** In both the complex Co have $t2g^6eg^0$ congiguration. The bond energy of (O–O) in X & Y is :-

(*a*) B.E. of (O–O) in Y < B.E. of (O–O) in X

(*b*) B.E. of (O–O) in X < B.E. of (O–O) in Y

(*c*) B.E. of (O–O) in X = B.E. of (O–O) in Y

(*d*) None

**58.** Both the complex are :-

(*a*) Tetrahedral and Diamagnetic

(*b*) Octahedral and Paramagnetic

(*c*) Diamagnetic

(*d*) Paramagnetic

### Passage for Q.59 to Q.60

| Complex | $\Lambda_M$ ($Ohm^{-1}$ $cm^2$ $mol^{-1}$) | No. of ions per molecule | No. of ionic $Cl^{-1}$ per molecule for AgCl ppt. |
|---|---|---|---|
| $COCl_3.6NH_3$<br>(Lutecobaltic chloride) | $m_1$ | x | p |
| $COCl_3.5NH_3$<br>(Purpurecobaltic chloride) | $m_2$ | y | q |
| $COCl_3.4NH_3$<br>(Praseocobaltic chloride) | $m_3$ | z | r |
| $COCl_3.5NH_3.H_2O$<br>(Roseocobaltic chloride) | $m_4$ | w | s |

**59.** Correct option is :-

(*a*) $m_1 > m_2 > m_3 > m_4$ (*b*) $m_1 > m_4 > m_2 > m_3$

(*c*) $m_1 > m_3 > m_4 > m_2$ (*d*) $m_1 > m_2 > m_4 > m_3$

**60.** Correct option is :-

(*a*) w = x = 4 ; s = p = 3

(*b*) y = 3 ; q = 2

(*c*) z = 2 ; r = 1

(*d*) All

### Passage for Q.61 to Q.62

The metal carbon bond in metal carbonyls possess both σ and π character. The M–C σ bond is formed by donation of lone pair of electrons on the metal carbonyls into a vacant orbital of the metal. The M–C π bond is formed by the donation of a pair of electrons from a filled d orbital of metal into the vacant antibonding π*orbital of carbon monooxide. The metal to ligand bonding creates a synergic effect.

**61.** For the complexes -

$Ni(CO)(PF_3)_3$ (I) $Ni(CO)(PCl_3)_3$ (II) $Ni(CO)(PPh_3)_3$ (III)

Which of the following option is correct ?

(*a*) M–C bond order : III < II < I

(*b*) C–O bond order : III < II < I

(*c*) C–O vibrational frequency : I < II < III

(*d*) All

**62.** For the complexes -

$M(CO)$ (I) $M_2(CO)$ (II) $M_3(CO)$ (III)

Which of the following option is correct ?

(*a*) M–C bond length : III > II > I

(*b*) M–C vibrational frequency : III > II > I

(*c*) Synergic effect order : I > II > III

(*d*) C–O vibrational frequency : III > II > I

### Passage for Q.63 to Q.65

The stability of a complex in solution refers to the degree of association between the two species involved in the state of equilibrium. The magnitude of the equilibrium constant expresses the stability. Thus, for the reaction of the type : $M + 4L \rightleftharpoons ML_4$ if equilibrium constants $K_1$, $K_2$, $K_3$, $K_4$ for the stepwise formation of the successive complexes $ML$, $ML_2$, $ML_3$, $ML_4$ respectively are called the stepwise stability constants.

**63.** If overall stability constant is $\beta_4$ for the above reaction then

(*a*) $\beta_4 = K_1 + K_2 + K_3 + K_4$

(*b*) $\beta_4 = K_1 - K_2 + K_3 - K_4$

(*c*) $\beta_4 = K_1 \times K_2 \times K_3 \times K_4$

(*d*) None

**64.** Thermodynamic stability of the complex -

(*a*) Reflects how slowly it reacts with the ligand

(*b*) Reflects how fast it reacts with the ligand

(*c*) Measures the strength of metal-ligand bond in the complex

(*d*) Measures how easily it dissociates

**65.** A complecx is kinetically stable provided -

(*a*) it reacts very fast with the ligand

(*b*) it reacts very slow with the ligand

(*c*) complex is extremely stable in nature of bonding

(*d*) activation energy for the complex formation is very low

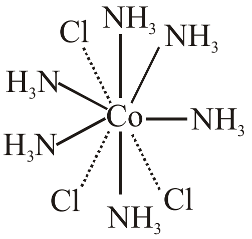
### Passage for Q.66 to Q.68

According to Werner's coordination theory complex has two types of valencies.

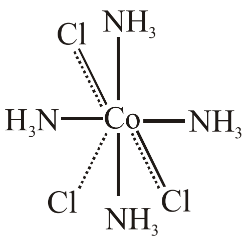
(i) Primary valency : It is the oxidation state of the metal ion in the complex

(ii) Secondary valency : It is number of ligands atoms coordinatated to metal ion

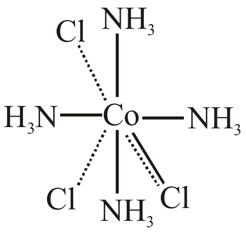
Three complexes are given



**(X)**



**(Y)**



**(Z)**

**66.** X is represented as -

(*a*) $[Co(NH_3)_6]Cl_3$ (*b*) $[Co(NH_3)_4Cl_2]Cl$

(*c*) $[Co(NH_3)_5Cl]Cl_2$ (*d*) None

**67.** Z is represented as -

(*a*) $[Co(NH_3)_6]Cl_3$ (*b*) $[Co(NH_3)_4Cl_2]Cl$

(*c*) $[Co(NH_3)_5Cl]Cl_2$ (*d*) None

**68.** In Y which of the following option is correct ?

(*a*) 1 Cl shows primary valency only

(*b*) 2 Cl shows secondary valency only

(*c*) 2 Cl shows primary valency as well as secondary valency

(*d*) both (*a*) and (*c*)

### Passage for Q.69 to Q.70

$$[CoF_6]^{n\pm} \xrightarrow[\text{step-I}]{} [Co(H_2O)_3F_3]^{n\pm} \xrightarrow[\text{step-II}]{} [Co(H_2O)_6]^{n\pm} \xrightarrow[\text{step-III}]{} [Co(NH_3)_6]^{n\pm} \xrightarrow[\text{step-IV}]{} [Co(NO_2)_6]^{n\pm}$$

**69.** Magnetic behaviour is changed in -

(*a*) Step-I (*b*) Step-II

(*c*) Step-III (*d*) Step-IV

**70.** Total charge of the complex is unchanged in -

(*a*) Step-I (*b*) Step-II

(*c*) Step-III (*d*) Step-IV

### ☐ Match the Column Type

**71.** Match the column :-

| **Column - I**<br>**Complex** | **Column - II**<br>**Features** |
|---|---|
| (*a*) $Fe(CO)_5$ | (P) can act as reducing agent |
| (*b*) $Mn(CO)_6$ | (Q) can undergo dimerisation |
| (*c*) $Mn(CO)_5$ | (R) can act as oxidising reagent |
| (*d*) $[Ti(CO)_6]$ | (S) follows Sidgwick E.A.N. rule |
| | (T) does not follow Sidgwick E.A.N. rule |

**72.** Match the column :-

| **Column - I**<br>**Complex** | **Column - II**<br>**Features** |
|---|---|
| (*a*) $[Co(NH_3)_5SO_4]^{+1}$ | (P) only monodentate ligand is present |
| (*b*) $[Co(NH_3)_4SO_4]^{+1}$ | (Q) only bidentate ligand is present |
| (*c*) $[Co(en)_3]^{+3}$ | (R) monodentate & bidentate ligand both are present |
| (*d*) $[Co(NH_3)_6]^{2+}$ | (S) chelating ligand present |
| | (T) metal has +3 oxidation state |

**73.** Match the column :-

| **Column - I**<br>**Complex** | **Column - II**<br>**Features** |
|---|---|
| (*a*) $[Co(H_2O)BrClI]$ | (P) show optical isomerism |
| (*b*) $[Co(gly)_3]$ | (Q) show geometrical isomerism |
| (*c*) $[Co(NH_3)_2Cl_2(en)]NO_3$ | (R) metal is in +3 oxidation state |
| (*d*) $K_3[CoCl_2(C_2O_4)_2]$ | (S) aqueous solution acts as non-electrolyte |
| | (T) homoleptic complex |

**74.** Match the column :-

| **Column - I** | **Column - II** |
|---|---|
| **Complex** | **Features** |
| (*a*) $[Co(H_2O)_6]^{3+}$ | (P) $d^2sp^3$ |
| (*b*) $[CoF_6]^{3-}$ | (Q) $sp^3d^2$ |
| (*c*) $[Co(NO_2)_6]^{3-}$ | (R) diamagnetic |
| (*d*) $[CoF_3(H_2O)_3]$ | (S) paramagnetic |
| | (T) central metal ion with +3 oxidation state |

**75.** Match the column :-

| **Column - I** | **Column - II** |
|---|---|
| **Complex** | **Features** |
| (*a*) $[AuF_4]^-$ | (P) $dsp^2$ hybridisation |
| (*b*) $[Cu(CN)_4]^{3-}$ | (Q) $sp^3$ hybridisation |
| (*c*) $[Ni(NH_3)_6]^{2+}$ | (R) $sp^3d^2$ hybridisation |
| (*d*) $[Fe(CN)_5NOS]^{4-}$ | (S) $d^2sp^3$ hybridisation |
| | (T) contains two unpaired electron |

**76.** Match the column :-

| **Column - I** | **Column - II** |
|---|---|
| **Ligand** | **Name** |
| (*a*) $N_3^-$ | (P) azido |
| (*b*) $N^{3-}$ | (Q) nitrido |
| (*c*) $\overline{O}NO$ | (R) nitrito-O |
| (*d*) $NO_3^-$ | (S) nitrato |

**77.** Match the column :-

| **Column - I** | **Column - II** |
|---|---|
| **Ligand** | **Features** |
| (*a*) $NH_2–NH_2$ | (P) didentate nonbridging ligand |
| (*b*) $NH_2CH_2CO_2^-$ | (Q) didentate symmetrical chelating ligand |
| (*c*) $CH_3NH_2$ | (R) didentate unsymmetrical chelating ligand |
| (*d*) $NH_2CH_2CH_2NH_2$ | (S) monodentate ligand |
| | (T) at least one lone pair of electron is present |

**78.** Match the column :-

| **Column - I** | **Column - II** |
|---|---|
| **Ions** | **Colour in aqueous solution** |
| (*a*) $Cu^{2+}$ | (P) Purple |
| (*b*) $Ni^{2+}$ | (Q) Green |
| (*c*) $Co^{2+}$ | (R) Blue |
| (*d*) $Ti^{3+}$ | (S) Pink |

**79.** Match the column :-

| **Column - I** | **Column - II** |
|---|---|
| **Complex** | **Type of s, p, d orbitals participated in hybridisation** |
| (*a*) $[Ti(H_2O)_6]^{3+}$ | (P) 4s, 4p, $4d_{x^2-y^2}$, $4d_{z^2}$ |
| (*b*) $[Ni(NH_3)_6]^{2+}$ | (Q) $3d_{x^2-y^2}$, $3d_{z^2}$, 4s, 4p |
| (*c*) $[Zn(NH_3)_4]^{2+}$ | (R) $3d_{x^2-y^2}$, 4s, $4p_x$, $4p_y$ |
| (*d*) $[Cu(NH_3)_4]^{2+}$ | (S) 4s, $4p_x$, $4p_y$, $4p_z$ |

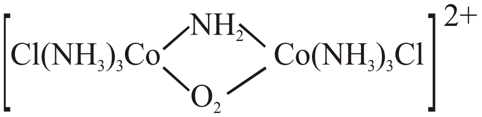
**80.** Match the column :-

**Column - I (Complex)**

(*a*) $[PtCl(NO_2)(NH_3)_4]SO_4$

(*b*) $[Mn(NH_3)_5(\sigma C_3H_5)]$

(*c*) $[Pt(NH_3)_4][Cr(NCS)(NO_2)_2(NH_3)_2I]$

(*d*) 

$\left[\mathrm{Cl(NH_3)_3Co}\begin{matrix}\mathrm{NH_2}\\ \\ \mathrm{O_2}\end{matrix}\mathrm{Co(NH_3)_3Cl}\right]^{2+}$

**Column - II (Isomerism shown)**

(P) shows linkage isomerism

(Q) shows coordination position isomerism

(R) shows ionisation isomerism

(S) shows coordination isomerism

(T) shows ligand isomerism

**81.** Match the column :-

| **Column - I** | **Column - II** |
|---|---|
| **Ions** | **Colour in aqueous solution** |
| (*a*) $V^{4+}$ | (P) Blue |
| (*b*) $V^{3+}$ | (Q) Green |
| (*c*) $V^{2+}$ / $Cr^{3+}$ / $Mn^{3+}$ | (R) Violet |
| (*d*) $Fe^{3+}$ | (S) Yellow |

**82.** Match the column :-

**Column - I (Complex / Colour of light absorbed)**

(*a*) $[CoCl(NH_3)_5]^{2+}$ / Yellow

(*b*) $[Co(NH_3)_5(H_2O)]^{3+}$/ Blue Green

(*c*) $[Co(NH_3)_6]^{3+}$/ Blue

(*d*) $[Cu(H_2O)_4]^{2+}$/ Red/Orange

**Column - II (Colour of complex)**

(P) Violet

(Q) Red

(R) Yellow Orange

(S) Blue

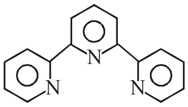
**83.** Match the column :-

**Column - I (Ligand)**

(*a*) $\overline{O}_2CCH_2NHCH_2CO_2^-$

(*b*) $\overline{O}_2CCH_2N = C(O^-)CH_2CO_2^-$

(*c*) $NH_2(CH_2)_2NH(CH_2)_2NH_2$

(*d*) 

**Column - II (Characteristic feature)**

(P) tridentate ligand

(Q) chelating ligand

(S) nitrogen and oxygen can act as donor atom

(R) only nitrogen can act as donor atom

(T) two oxygen atoms and one nitrogen atom act as donor atom

**84.** Match the column :-

| Column - I | Column - II |
|---|---|
| (*a*) $[Ti(CO)_6]^{2-}$ | (P) Highest C–O bond vibration streching frequency |
| (*b*) $[V(CO)_6]^{1-}$ | (Q) Longest M–C bond length |
| (*c*) $[Cr(CO)_6]$ | (R) Follows sidgwick rule |
| (*d*) $[Mn(CO)_6]^{+1}$ | (S) Synergic effect is observed |

**85.** Formula of complex features -

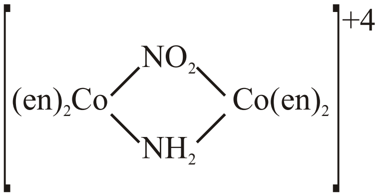
| Column-I | Column-II |
|---|---|
| (*a*) $Ma_3b_2c$ | (P) All stereoisomers are optically inactive |
| (*b*) $Ma_3b_3$ | (Q) Number of Geometrical isomers = 2 |
| (*c*) $Ma_3bcd$ | (R) Number of Geometrical isomers = 4 |
| (*d*) $Ma_4bc$ | (S) Total 3 stereoisomers are possible |
| | (T) Only one ENT pair is possible |

**86.** Match the column :-

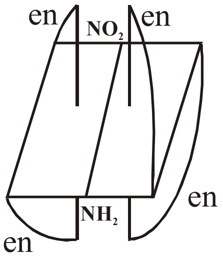
| Column-I<br>Complex | Column-II<br>Type of isomerism exhibited |
|---|---|
| (*a*) $Na_2[Pt(SCN)_2(Ox)_2]$ | (P) Ionisation |
| (*b*) $[CrCl_2(NH_3)_4]NO_3$ | (Q) Linkage |
| (*c*) $[Pt(NO_2)(gly)(NH_3)]$ | (R) Geometrial |
| (*d*) $K_3[Fe(OH)_2(C_2O_4)_2]$ | (S) Optical |

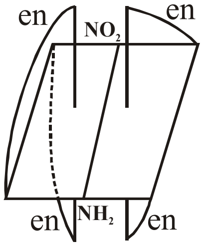
**87.** Match the following :-

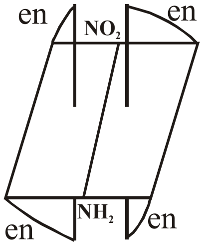
**Column-I**

(*a*) 

$$\left[(en)_2Co\begin{matrix}NO_2\\ \\ NH_2\end{matrix}Co(en)_2\right]^{+4}$$

(*b*) 

(*c*) 

(*d*) 

**Column-II**

(P) Meso form

(Q) Optically active form (either d or s form)

(R) Polynuclear complex

(S) Plane of symmetry if present

**88.** Match the column :-

| **Column - I** | **Column - II** |
|---|---|
| **Complex** | **Features** |
| (*a*) $[Cr(CN)_3(NO_2)_3]^{4-}$ | (P) Outer orbital octahedral complex |
| (*b*) $[Co(C_2O_4)_3]^{3-}$ | (Q) Inner orbital octahedral complex |
| (*c*) $[Fe(EDTA)]^{-1}$ | (R) $\mu = 2\sqrt{2}$ B.M. |
| (*d*) $[Ni(en)_3]\,(NO_3)_2$ | (S) Shows optical activity |

**89.** Match the column :-

| **Column - I** | **Column - II** |
|---|---|
| **Complex** | **Features** |
| (*a*) $[Co(CN)(NH_3)_5]SO_4$ | (P) Diamagnetic |
| (*b*) $K[Co(CO)_4]$ | (Q) O.N. of metal $\leq 0$ |
| (*c*) $K_4[Co(C_2O_4)_3]$ | (R) Metal - Metal linkage |
| (*d*) $Co_2(CO)_8$ | (S) Paramagnetic |
| | (T) Optically active |

**90.** Match the column :-

| **Column - I** | **Column - II** |
|---|---|
| **Complex** | **Features** |
| (*a*) Sodiumnitroprusside | (P) $\mu = 0$ BM |
| (*b*) Brown ring complex | (Q) Octahedral |
| (*c*) Complex of Ag used for its extraction | (R) $\mu = \sqrt{15}$ B.M. |
| (*d*) Potassium ferrocyanide | (S) $NO^+$ acts as ligand |

**91.** Match the column :-

| **Column - I** | **Column - II** |
|---|---|
| **Types of complex** | **Total possible geometrical isomers** |
| (*a*) $[M(AB)_2ab]^{n\pm} \xrightarrow[-a/+b]{}$ | (P) 2 |
| (*b*) $[Ma_2b_2c_2]^{n\pm} \xrightarrow[-b/+d]{}$ | (Q) 6 |
| (*c*) $[M(AA)_2a_2]^{n\pm} \xrightarrow{-a/+c}$ | (R) 3 |
| (*d*) $[M(AB)a_3b] \xrightarrow{-a/+b}$ | (S) 5 |
| | (T) 0 |

**92.** Match the column :-

| **Column - I** | **Column - II** |
|---|---|
| **Complex** | **Features** |
| (*a*) $[Ni(H_2O)_6]Cl_2$ | (P) $d^2sp^3$ hybridised |
| (*b*) $[Co(CN)_2(NH_3)_4]OEt$ | (Q) Ionisation isomerism |
| (*c*) $[IrCl_6]^{3-}$ | (R) $\mu = 2.83$ B.M. |
| (*d*) $[PtCl_2(NH_3)_4]Br_2$ | (S) 2 unpaired electron is present |

**93.** Match the column :-

| **Column - I** | **Column - II** |
|---|---|
| **Complex** | **Features** |
| (*a*) $[NiCl_2(PPh_3)_2]$ | (P) Paramagnetic with 1 unpaired electron |
| (*b*) $V(CO)_6$ | (Q) Paramagnetic with 2 unpaired electron |
| (*c*) $[Cr(CN)_6]^{4-}$ | (R) C.N. of metal ion = 4 |
| (*d*) $Ni(CO)_4$ | (S) Diamagnetic |
| | (T) C.N. of metal ion = 6 |

**94.** Match the column :-

**Column - I (Compound)**

(*a*) Double salt

(*b*) Ethylene diaminetriacetato

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

(*d*) $t_{2g}$

**Column - II (Features)**

(P) $FeSO_4.(NH_4)_2SO_4.6H_2O$

(Q) Pentadentate ligand

(R) Paramagnetic

(S) Triply degenrate orbitals

**95.** Match the column :-

| **Column - I** | **Column - II** |
|---|---|
| **Geometry** | **Complex** |
| (*a*) Trigonal bipyramidal | (P) $[Cu(NH_3)_4]^{2+}$ |
| (*b*) Tetrahedral | (Q) $[Cr(H_2O)_6]^{3+}$ |
| (*c*) Square planar | (R) $[Ni(CN)_5]^{3-}$ |
| (*d*) Octahedral | (S) $[NiCl_4]^{2-}$ |

**96.** Match the column :-

| **Column - I** (Ion) | **Column - II** (cfse in high-spin octahedral complex) |
|---|---|
| (*a*) $d^6$ | (P) $4Dq_0$ |
| (*b*) $d^7$ | (Q) $8Dq_0$ |
| (*c*) $d^8$ | (R) $12Dq_0$ |
| (*d*) $d^9$ | (S) $6Dq_0$ |

**97.** Match the column :-

| **Column - I** (Ion) | **Column - II** (cfse in high-spin octahedral complex) |
|---|---|
| (*a*) $d^4$ | (P) $16Dq_0 - P$ |
| (*b*) $d^5$ | (Q) $20Dq_0 - 2P$ |
| (*c*) $d^6$ | (R) $24Dq_0 - 2P$ |
| (*d*) $d^7$ | (S) $18Dq_0 - P$ |

**98.** Match the column :-

| **Column - I** Formula of complex | **Column - II** Number of stereoisomers |
|---|---|
| (*a*) M(AA)(BC)de | (P) 4 (AA = Bidentate symmetrical ligand) |
| (*b*) M(AB)(AB)cd | (Q) 13 (CD/BC/AB = Bidentate non symmetrical ligand) |
| (*c*) Mabcdef | (R) 11 (abcdef = Monodentate ligand) |
| (*d*) $M(AB)_3$ | (S) 10 |

**99.** Match the column :-

| **Column - I** Complex | **Column - II** Total number of ions |
|---|---|
| (*a*) $PtCl_4 . 6NH_3$ | (P) 2 |
| (*b*) $PtCl_4 . 5NH_3$ | (Q) 3 |
| (*c*) $PtCl_4 . 4NH_3$ | (R) 4 |
| (*d*) $PtCl_4 . 3NH_3$ | (S) 5 |

**100.** Match the column :-

**Column - I**

(*a*) $CoCl_3 . 5NH_3 . H_2O$

(*b*) $Co(NH_3)_5BrSO_4$

(*c*) $CrCl_3 . 6H_2O$

(*d*) $Cr(NO_2)_2 . 6H_2O$

**Column - II**

(P) In one of the isomeric forms, the metal satisfies its secondary valences by only neutral molecules

(Q) The magnetic moment of one of the isomeric form is 3.87 B.M.

(R) Show ionisation isomerism

(S) Show hydrate isomerism

(T) Show linkage isomerism

**101.** Match the column :-

**Column - I (Ligands)**

(*a*) CO, $CN^-$, $C_2H_4$, $NO^+$

(*b*) $H^-$, $NH_3$

(*c*) $H_2O$, $NH_2^-$, ROH, $R_2S$

(*d*) $PF_3$, $PR_3$, $AsMe_3$

**Column - II (Nature of ligands)**

(P) σ donor ligand

(Q) π donor ligand

(R) π acceptor ligand

(S) strong field ligand

(T) weak field ligand

## EXERCISE # IV

❑ **Integer Type :**

**1.** How many compounds are expected to yield a white precipitate with $AgNO_3$ solution ?

$PtCl_4.4NH_3$ ; $CoCl_3.3NH_3$ ; Vinyl chloride ; Allyl chloride, Carnalite ; Tertiary butyl chloride

**2.** What is the coordination number of central atom in $[Pt(trien)]^{2+}$ ?

**3.** Find out number of compleses which follow sidgwick's rule of EAN :-

$H[AuCl_4]$ ; $[Pt(NH_3)_4Cl_2]^{2+}$ ; $[HgI_4]^{2-}$ ; $NiCl_4^{2-}$ ; $[Ti(\sigma C_5H_5)_2\ (\pi C_5H_5)_2]$ ; $K_3[Fe(CN)_6]$ ; $K_4[Fe(CN)_6]$ ; $[Ag(S_2O_3)_2]^{-1}$ ; $[Fe(H_2O)_5NO]^{2+}$

**4.** How many statements are correct regarding $[Ni(DMG)_2]$ ?

(i) the complex is diamagnetic.

(ii) the complex forming 5 membered chelate with ligand and metal ion.

(iii) the complex forming hydrogen bonding and 6 membered chelation is possible.

(iv) the complex forming 6 membered chelate with ligand and metal ion.

(v) it is rosy red colour.

(vi) it is tetrahedral complex.

(vii) it is square planar complex.

(viii) O, O is the donor atom for ligand.

(ix) N, N is the donor atom for ligand.

**5.** How many ligands are example of non classical ligand ?

$C_2H_4$, CO, $\overset{+}{NO}$, $\overset{-}{CN}$, $PF_3$, $PR_3$ . $C_2(CN)_4$

**6.** In Zeise's salt, how many statements are correct :-

(a) oxidation state of Pt is +2 & corrdination number of Pt is 4

(b) first organometallic complex discovered

(c) it is example of cationic complex

(d) the carbon atom exhibit some electrophilic character

(e) HCH bond angle is 115°

(f) carbon atom is Zeise's salt is perfectly $sp^3$ hybridised

(g) ethylene moiety of Zeise's salt looses planarity

(h) C–C bond length in $C_2H_4$ < C–C bond length in Zeises salt

(i) synergic effect takes place (back donation takes place) between filled d orbital of Pt to π* ABMO of ethylene molecule

**7.** How many isomers are possible for the complex $[Ir(CO)Cl(PPh_3)_2]$ ?

**8.** How many type of isomerism is exhibited by the complex $[Co(NH_3)_4(NO_2)_2]Cl$ ?

**9.** How many total stereoisomers are possible for the complex $[Rh(en)_2(NO_2)(SCN)]^+$ ?

**10.** Find the number of ions which have higher splitting energy than the $Mn^{2+}$ in octahedral complex considering same ligands for all ions :-

$Cu^{2+}$; $Ni^{2+}$; $Co^{2+}$; $Fe^{2+}$; $Cr^{3+}$

**11.** Find out the number of bidentate ligands where both oxygen atoms act as donor atom :-

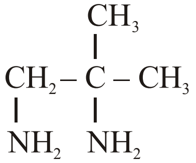
(a) acetylacetonato (b) biuret

(c) dimethylglyoximato (d) glycinato

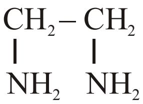
(e) biguanido (f) oxalato

(g) dimethylglycol

**12.** Find out number of bidentate ligand where both nitrogen atom act as donor atom and 5 member chelate is formed with metal ion :-

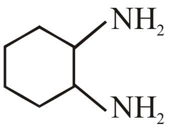


;



$CH_2-CH_2$ with $NH_2$ $NH_2$

;



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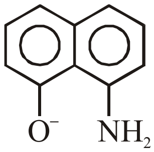


; $NH_2CH_2CH_2CH_2NH_2$

**13.** What is the coordination number of aluminium in cryolite ?

**14.** Number of optically active isomers of Mabcdef in which a and e are on opposite position.

**15.** $[M(NH_3)_2(py)_2(NO_2)_2] \xrightarrow[-NO_2]{+NH_3} [M(NH_3)_3(py)_2(NO_2)]$

Number of geometrical isomers reduced in product side as compared to reactants -

**16.** Total number of isomers for the complex $K_2[PtCl_2BrSCN]$.

**17.** Number of geometrical isomer in Mabcdef where a,b,c are at adjacent position with respect to each other.

**18.** Find out number of linkage isomers possible for $K_4[Fe(CN)_6]$ :-

**19.** Find out number of coordination isomers for the complex $[Cr(NH_3)_6][Co(NO_2)_6]$ :-

**20.** Find out number of coordination isomers for the complex $[Pt(NH_3)_4][CuCl_4]$

**21.** Find out geometrical isomers are possible for complex $[Mab(AB)_2]^{n\pm}$

**22.** How many geometrical isomers are possible for compound $[Co(gly)Cl_2(pn)]$.

**23.** How many ligands forming dπ-dπ back bonding (synergic bonding) with metal ion,

CO ; $NO^+$ ; $CN^-$, $PF_3$ ; $PPh_3$ ; $H_2O$ ; en ; $AsR_3$

**24.** In $[Co(EDTA)]^{-1}$ number of N–Co–O linkage present ?

**25.** Find the total number of stereo isomers present in $[Pt(bn)_2]$ :-

**26.** Find the change in magnetic moment of the complex formed in following process :-

$$\left[\mathrm{Fe}\left(\mathrm{NH}_3\right)_6\right]^{2+} \xrightarrow[-6\mathrm{NH}_3]{+6\mathrm{H}_2\mathrm{O}} \left[\mathrm{Fe}\left(\mathrm{H}_2\mathrm{O}\right)_6\right]^{2+}$$

**27.** Find the maximum number of atoms lying in one plane for $[Cr(CN)_6]^{3-}$ :-

**28.** How many hexagonal rings are present for $C_{84}$ fullerene :-

**29.** How many of the following have square planar geometry ?

$[PtCl_4]^{2-}$, $PdCl_4^{2-}$, $AgF_4^{-1}$, $AuCl_4^-$, $ICl_4^-$, $CoCl_4^-$, $FeCl_4^{2-}$, $NiCl_4^{2-}$

**30.** What are the number of all possible constitutional isomers of $Rn(NH_3)_5(NO_2)Cl$ ? :-

**31.** Maximum numebr of atoms which are in same plane in $Ni(CO)_4$ :-

**32.** Find the number of ligands which are stronger ligand as compound to ethylenediamine(en)

$NO_2^-$ ; $H_2O$ ; $NO_3^-$ ; $F^-$ ; $C_2O_4^{2-}$ ; $NH_3$ ; $Cl^-$ ; $CN^-$

**33.** Find the number of optically active isomers for

$\underset{\text{cation}}{\left[Pd(en)_2(NH_3)(H_2O)\right]}$ :-

**34.** What are the number of all possible isomeric compound for a square planar palladiium(II) complex that contant two $Cl^-$ and two $SCN^-$ ligands ?

**35.** Find out the number of unpaired electron present in $FeCl_4^{2-}$ :-

**36.** Find out the number of unpaired electron present in $NiCl_4^{2-}$ :-

**37.** In $MnCl_4^{2-}$, how many unpaired electron present in e orbital according to CFT :-

**38.** In $CoCl_4^{2-}$, how many unpaired electron present in $t_2$ orbital according to CFT :-

**39.** Find out the number of stereoisomer present in $M(AB)_2a_2$ :-

Where AB is bidentate nonsymmetrical ligand and a is monodentate ligand.

**40.** Find out the number of stereoisomer present in $M(AB)_2ab$ :-

Where AB is bidentate nonsymmetrical ligand and a & b is monodentate ligand.

**41.** If crystal field stabilization energy of $[ML_6]^{+n}$ is $-0.8\Delta_0$. ($\Delta_0$ = 10dq)

Find minimum number of electron in $t_{2g}$ orbital of metal ion ?

**42.** A co-ordination compound have magnetic moment 3.83 B.M.. Find out the number of unpaired electron(s) in the compound:-

**43.** Find number of ligands which are stronger ligand as compared to pyridine :-

$NO_2^-$ ; $H_2O$ ; $NO_3^-$ ; $F^-$ ; en ; $C_2O_4^-$ ; $Cl^-$ ; $CN^-$ ; CO ; o-phenanthroline ; dipyridyl.

**44.** In $K_2[Ni(EDTA)]$ total number of 5 member ring is m and total number of G.I. possible is n. Find out m × n :-

**45.** In $[Co(gly)_3]$ how many O–Co–N linkage is present -

**46.** Find out number of unpaired electron for $d^5$ ion having $d^2sp^3$ hybridisation :-

**47.** Find out number of unpaired electron for $d^7$ ion having $sp^3d^2$ hybridisation :-

**48.** If number of unpaired electron for $d^6$ ion having $sp^3d^2$ hybridisation is $n_1$ and number of unpaired electron for $d^6$ ion having $d^2sp^3$ hybridisation is $n_2$ then find out $n_1 - n_2$ :-

**49.** What is the number of valence shell electron for the following complex : $[Fe(CO)_2(NO)_2]$

**50.** Total isomeric complex salt isolated having formula $CrCl_3.6H_2O$

## EXERCISE # V(A) JEE–MAIN

**1.** In $[Cr(C_2O_4)_3]^{3-}$, the isomerism shown is :– **[AIEEE 2002]**

(*a*) Ligand
(*b*) Optical
(*c*) Geometrical
(*d*) Ionisation

**2.** In the complexes $[Fe(H_2O)_6]^{3+}$, $[Fe(SCN)_6]^{3-}$, $[Fe(C_2O_4)_3]^{3-}$ and $[FeCl_6]^{3-}$, most stability is shown by :– **[AIEEE 2002]**

(*a*) $[Fe(H_2O)_6]^{3+}$
(*b*) $[Fe(SCN)_6]^{3-}$
(*c*) $[Fe(C_2O_4)_3]^{3-}$
(*d*) $[FeCl_6]^{3-}$

**3.** One mole of the complex compound $Co(NH_3)_5Cl_3$, gives 3 moles of ions on dissolution in water. One mole of the same complex reacts with two moles of $AgNO_3$ solution to yield two moles of AgCl(s).

The structure of the complex is :– **[AIEEE 2003]**

(*a*) $[Co(NH_3)_3Cl_3].2NH_3$

(*b*) $[Co(NH_3)_4Cl_2]Cl.NH_3$

(*c*) $[Co(NH_3)_4Cl].Cl_2.NH_3$

(*d*) $[Co(NH_3)_5Cl]Cl_2$

**4.** In the coordination compound $K_4[Ni(CN)_4]$, the oxidation state of nickel is :– **[AIEEE 2003]**

(*a*) 0 (*b*) +1

(*c*) +2 (*d*) –1

**5.** The number of 3d–electrons remained in $Fe^{2+}$ (At. no. of Fe = 26) ion is :– **[AIEEE 2003]**

(*a*) 4 (*b*) 5

(*c*) 6 (*d*) 3

**6.** Ammonia forms the complex ion $[Cu(NH_3)_4]^{2+}$ with copper ions in alkaline solutions but not in acidic solution. What is the reason for it :– **[AIEEE 2003]**

(*a*) In acidic solutions hydration protects copper ions

(*b*) In acidic solutions protons coordinate with ammonia molecules forming $NH_4^+$ ions and $NH_3$ molecules are not available.

(*c*) In alkaline solutions insoluble $Cu(OH_2)$ is precipitated which is soluble in excess of any alkali

(*d*) Copper hydroxide is an amphoteric substance

**7.** Among the properties

(a) reducing (b) oxidising (c) complexing,

the set of properties shown by $CN^-$ ion towards metal species is :– **[AIEEE 2004]**

(*a*) c,a (*b*) b,c

(*c*) a,b (*d*) a,b,c

**8.** The coordination number of a central metal atom in a complex is determined by :– **[AIEEE 2004]**

(*a*) The number of ligands around a metal ion bonded by sigma and pi–bonds both

(*b*) The number of ligands around a metal ion bonded by pi –bonds

(*c*) The number of ligands around a metal ion bonded by sigma bonds

(*d*) The number of only anionic ligands bonded to the metal

**9.** Which of the following complex is an outer orbital complex :– **[AIEEE 2004]**

(*a*) $[Co(NH_3)_6]^{3+}$ (*b*) $[Mn(CN)_6]^{4-}$

(*c*) $[Fe(CN)_6]^{4-}$ (*d*) $[Ni(NH_3)_6]^{2+}$

**10.** Coordination compounds have great importance in biological systems. In this context which of the following statement is incorrect ? **[AIEEE 2004]**

(*a*) Cyanocobalamin is vitamin $B_{12}$ and contains cobalt

(*b*) Haemoglobin is the red pigment of blood and contains iron

(*c*) Chlorophylls are green pigment in plants and contains calcium

(*d*) Carboxypeptidase – A is an enzyme and contains zinc

**11.** The correct order of magnetic moments (spin only values in B.M.) among is :– **[AIEEE 2004]**

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

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

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

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

**12.** For octahedral complex , the value of the 'spin only' magnetic moment for one of the following configuration is 2.84 B.M. The correct one is :– **[AIEEE 2005]**

(*a*) $d^4$ (in strong ligand field)

(*b*) $d^4$ (in weak ligand field)

(*c*) $d^3$ (in weak as well as strong field)

(*d*) $d^5$ (in strong ligand field)

**13.** The IUPAC name for the complex $[Co(NO_2)(NH_3)_5]Cl_2$ is :– **[AIEEE 2006]**

(*a*) pentaammine nitrito–N–cobalt(II)chloride

(*b*) pentaammine nitrito–N–cobalt(III)chloride

(*c*) nitrito–N–pentaamminecobalt(III)chloride

(*d*) nitrito–N–pentaamminecobalt(II)chloride

**14.** Nickel (Z = 28) combines with a uninegative monodentate ligand $X^-$ to form a paramagnetic complex $[NiX_4]^{2-}$. The number of unpaired electron in the nickel and geometry of this complex ion are, respectively :– **[AIEEE 2006]**

(*a*) one , square planar (*b*) two , square planar

(*c*) one, tetrahedral (*d*) two , tetrahedral

**15.** In $Fe(CO)_5$ , the Fe–C bond possesses :– **[AIEEE 2006]**

(*a*) ionic character

(*b*) σ–character only

(*c*) π–character only

(*d*) both σ and π character

**16.** How many EDTA (ethylenediaminetetraacetate) molecule are required to make an octahedral complex with a $Ca^{2+}$ ion ? **[AIEEE 2006]**

(*a*) One (*b*) Two

(*c*) Six (*d*) Three

**17.** The "spin–only" magnetic moment [in units of Bohr magneton, $(\mu_B)$] of $Ni^{2+}$ in aqueous solution would be (At. no. Ni = 28) :– **[AIEEE 2006]**

(*a*) 0 (*b*) 1.73

(*c*) 2.84 (*d*) 4.90

**18.** Which one of the following has a square planar geometry :– **[AIEEE 2007]**

(Co = 27, Ni = 28, Fe = 26, Pt = 78)

(*a*) $[CoCl_4]^{2-}$ (*b*) $[FeCl_4]^{2-}$

(*c*) $[NiCl_4]^{2-}$ (*d*) $[PtCl_4]^{2-}$

**19.** The coordination number and the oxidation state of the element 'E' in the complex $[E(en)_2(C_2O_4)]NO_2$ (where en is ethylenediamine) are, respectively :– **[AIEEE 2008]**

(*a*) 6 and 2 (*b*) 4 and 2

(*c*) 4 and 3 (*d*) 6 and 3

**20.** In which of the following octahedral complex of Co(at. no. 27), will the magnitude of $\Delta_0$ be the highest :– **[AIEEE 2008]**

(*a*) $[Co(CN)_6]^{3-}$ (*b*) $[Co(C_2O_4)_3]^{3-}$

(*c*) $[Co(H_2O)_6]^{3+}$ (*d*) $[Co(NH_3)_6]^{3+}$

**21.** Which of the following pairs represents linkage isomers :– **[AIEEE 2009]**

(*a*) $[Co(NH_3)_5NO_3]SO_4$ and $[Co(NH_3)_5SO_4]NO_3$

(*b*) $[PtCl_2(NH_3)_4]Br_2$ and $[PtBr_2(NH_3)_4]Cl_2$

(*c*) $[Cu(NH_3)_4][PtCl_4]$ and $[Pt(NH_3)_4][CuCl_4]$

(*d*) $[Pd(PPh_3)_2(NCS)_2]$ and $[Pd(PPh_3)_2(SCN)_2]$

**22.** Which of the following has an optical isomer :– **[AIEEE 2009]**

(*a*) $[Co(H_2O)_4(en)]^{3+}$ (*b*) $[Co(en)_2(NH_3)_2]^{3+}$

(*c*) $[Co(NH_3)_3Cl]^{+}$ (*d*) $[Co(en)(NH_3)_2]^{2+}$

**23.** Which one of the following has an optical isomer ? (en = ethylene diamine) **[AIEEE 2010]**

(*a*) $[Zn(en)_2]^{2+}$ (*b*) $[Zn(en)(NH_3)_2]^{2+}$

(*c*) $[Co(en)_3]^{3+}$ (*d*) $[Co(H_2O)_4(en)]^{3+}$

**24.** A solution containing 2.675 g of $CoCl_3 . 6NH_3$ (molar mass = 267.5 g $mol^{-1}$) is passed through a cation exchanger. The chloride ions obtained in solution were treated with excess of $AgNO_3$ to give 4.78 g of AgCl (molar mass = 143.5 g $mol^{-1}$). The formula of the complex is :– **[AIEEE 2010]**

(At. mass of Ag = 108 u)

(*a*) $[CoCl(NH_3)_5]Cl_2$ (*b*) $[Co(NH_3)_6]Cl_3$

(*c*) $[CoCl_2(NH_3)_4]Cl$ (*d*) $[CoCl_3(NH_3)_3]$

**25.** Which of the following facts about the complex $[Cr(NH_3)_6]Cl_3$ is wrong :– **[AIEEE 2011]**

(*a*) The complex is an outer orbital complex

(*b*) The complex gives white precipitate with silver nitrate solution

(*c*) The complex involves $d^2sp^3$ hybridisation and is octahedral in shape

(*d*) The complex is paramagnetic

**26.** The magnetic moment (spin only) of $[NiCl_4]^{2-}$ is :– **[AIEEE 2011]**

(*a*) 2.82 B.M. (*b*) 1.41 B.M.

(*c*) 1.82 B.M. (*d*) 5.46 B.M.

**27.** Among the ligands $NH_3$ , en, $CN^-$ and CO the correct order of their increasing field strength, is :– **[AIEEE 2011]**

(*a*) $CO < NH_3 < en < CN^-$

(*b*) $NH_3 < en < CN^- < CO$

(*c*) $CN^- < NH_3 < CO < en$

(*d*) $en < CN^- < NH_3 < CO$

**28.** Which one of the following complex ions has geometrical isomers :– **[AIEEE 2011]**

(*a*) $[Co(en)_3]^{3+}$ (*b*) $[Ni(NH_3)_5Br]^{+}$

(*c*) $[Co(NH_3)_2(en)_2]^{3+}$ (*d*) $[Cr(NH_3)_4(en)]^{3+}$

**29.** Which among the following will be named as dibromidobis (ethylene diamine) chromium (III) bromide **[AIEEE 2012]**

(*a*) $[Cr(en)Br_2]Br$ (*b*) $[Cr(en)_3]Br_3$

(*c*) $[Cr(en)_2Br_2]Br$ (*d*) $[Cr(en)Br_4]^-$

**30.** The complex ion $[Pt(NO_2)(Py)(NH_3)(NH_2OH)]^+$ will give :– **[JEE–MAIN–2012, Online]**

(*a*) 4 isomers (Geometrical)

(*b*) 2 isomers (Geometrical)

(*c*) 3 isomers (Geometrical)

(*d*) 6 isomers (Geometrical)

**31.** Which of the following complex ions will exhibit optical isomerism :– **[JEE–Main–2012, Online]**

(en = 1,2–diamine ethane)

(*a*) $[Co(en)_2Cl_2]^+$ (*b*) $[Zn(en)_2]^{2+}$

(*c*) $[Co(NH_3)_4Cl_2]^+$ (*d*) $[Cr(NH_3)_2Cl_2]^+$

**32.** Which of the following complex species is not expected to exhibit optical isomerism :–

**[JEE–Main–2013]**

(*a*) $[Co(en)_3]^{3+}$ (*b*) $[Co(en)_2Cl_2]^+$

(*c*) $[Co(NH_3)_3Cl_3]$ (*d*) $[Co(en)(NH_3)_2Cl_2]^+$

**33.** Type of isomerism which exist between $[Pd(C_6H_5)_2(SCN)_2]$ and $[Pd(C_6H_5)_2(NCS)_2]$ is :– **[JEE–Main–2002, Online]**

(*a*) Solvate isomerism

(*b*) Ionisation isomerism

(*c*) Linkage isomerism

(*d*) Coordination isomerism

**34.** Which of the following is diamagnetic ? **[JEE–MAIN–2013, Online]**

(*a*) $[CoF_6]^{3-}$ (*b*) $[FeF_6]^{3-}$

(*c*) $[Fe(CN)_6]^{3-}$ (*d*) $[Co(Ox)_3]^{3-}$

**35.** The magnetic moment of the complex anion $[Cr(NO)(NH_3)(CN)_4]^{2-}$ is :–

**[JEE–Main–2013, Online]**

(*a*) 2.82 B.M. (*b*) 5.91 B.M.

(*c*) 1.73 B.M. (*d*) 3.87 B.M.

**36.** The octahedral complex of a metal ion $M^{3+}$ with four monodentate ligands $L_1$, $L_2$, $L_3$ and $L_4$ absorb wavelength in the region of red, green, yellow and blue respectively. The increasing order of ligand strength of the four ligands is : **[JEE–Main–2014]**

(*a*) $L_3 < L_2 < L_4 < L_1$ (*b*) $L_1 < L_2 < L_4 < L_3$

(*c*) $L_4 < L_3 < L_2 < L_1$ (*d*) $L_1 < L_3 < L_2 < L_4$

**37.** The equation which is balanced and represents the correct product (s) is : **[JEE–MAIN–2014|**

(*a*) $[Mg(H_2O)_6]^{2+} + (EDTA)^{4-} \xrightarrow{\text{excess NaOH}} [Mg(EDTA)]^{2+} + 6H_2O$

(*b*) $CuSO_4 + 4KCN \rightarrow K_2[Cu(CN)_4] + K_2SO_4$

(*c*) $Li_2O + 2KCl \rightarrow 2LiCl + K_2O$

(*d*) $[CoCl(NH_3)_5]^+ + 5H^+ \rightarrow Co^{2+} + 5NH_4^+ + Cl^-$

**38.** The correct statement about the magnetic properties of $[Fe(CN)_6]^{3-}$ and $[FeF_6]^{3-}$ is : (Z = 26). **[J–MAIN–2014, Online]**

(*a*) $[Fe(CN)_6]^{3-}$ is paramagnetic, $[FeF_6]^{3-}$ is diamagnetic.

(*b*) both arc diamagnetic.

(*c*) $[Fe(CN)_6]^{3-}$is diamagnetic, $[FeF_6]^{3-}$ is paramagnetic.

(*d*) both are paramagnetic

**39.** An octahedral complex of $Co^{3+}$ is diamagnetic. The hybridisation involved in the formation of the complex is **[J–MAIN–2014]**

(*a*) $d^2sp^3$ (*b*) $sp^3d$

(*c*) $dsp^2$ (*d*) $sp^3d^2$

**40.** Which of the following name formula combinations is not correct? **[J–MAIN–2014, Online]**

| **Formula** | **Name** |
|---|---|
| (*a*) $K[Cr(NH_3)_2.Cl_4]$ | Potassium diammine Tetrachlorochromate (III) |
| (*b*) $[Co(NH_3)_4(H_2O)I]SO_4$ | Tetraammine aquaiodo cobalt (III) sulphate |
| (*c*) $[Mn(CN)_5]^{2-}$ | Pentacyanomagnate (II) ion |
| (*d*) $K_2[Pt(CN)_4]$ | Potassiumtetracyanoplatinate(II) |

**41.** Consider the coordination compound, $[Co(NH_3)_6]Cl_3$. In the formation of this complex, the species which acts as the Lewis acid is :

**[J–MAIN–2014, Online]**

(*a*) $[Co(NH_3)_6]^{3+}$ (*b*) $NH_3$

(*c*) $Co^{3+}$ (*d*) $Cl^-$

**42.** Among the following species the one which causes the highest CFSE, $\Delta_0$as a ligand is:

**[J–MAIN–2014, Online]**

(*a*) $CN^-$ (*b*) $NH_3$

(*c*) CO (*d*) $F^-$

**43.** Which one of the following complexes will most likely absorb visible light ?

**[J–MAIN–2014, Online]**

(At. nos. Sc = 21, Ti = 22, V = 23, Zn = 30) :–

(*a*) $[Ti(NH_3)_6]^{4+}$ (*b*) $[V(NH_3)_6]^{3+}$

(*c*) $[Zn(NH_3)_4]^{2+}$ (*d*) $[Sc (H_2O)_6]^{3+}$

**44.** Nickel(Z = 28) combines with a uninegative monodentate ligand to form a diamagnetic complex $[NiL_4]^{2-}$. The hybridisation involved and the number of unpaired electrons are respectively:

**[J–MAIN–2014, Online]**

(*a*) $sp^3$, zero (*b*) $sp^3$; two

(*c*) $dsp^2$, one (*d*) $dsp^2$, zero

**45.** The number of geometrical isomers that can exist for square planar $[Pt(Cl)](py)(NH_3)(NH_2OH)]^+$ is (py = pyridine) :- **[J–MAIN–2015]**

(*a*) 4 (*b*) 6

(*c*) 2 (*d*) 3

**46.** The colour of $KMnO_4$ is due to :-

**[J–MAIN–2015]**

(*a*) L → M charge transfer transition

(*b*) $\sigma - \sigma^*$ transition

(*c*) M → L charge transfer transition

(*d*) d – d transition

**47.** Which of the following complex ions has electrons that are symmetrically filled in both $t_{2g}$ and $e_g$ orbitals ? **[J–MAIN–2015, Online]**

(*a*) $[CO(H_2O)_6]^{2+}$ (*b*) $[CoCl_6]^{3-}$

(*c*) $[CoCl_4]^{2-}$ (*d*) $[CoCl_6]^{4-}$

**49.** The correct statement on the isomerism associated with the following complex ions,

(a) $[Ni(H_2O)_5NH_3]^{2+}$ **[J–MAIN–2015, Online]**

(b) $[Ni(H_2O)_4(NH_3)_2]^{2+}$ and

(c) $[Ni(H_2O)_3(NH_3)_3]^{2+}$ is

(*a*) (a) and (b) show geometrical and optical isomerism

(*b*) (b) and (c) show geometrical and optical isomerism

(*c*) (a) and (b) show only geometrical isomerism

(*d*) (b) and (c) show only geometrical optical isomerism

**50.** Which one of the following complexes shows optical isomerism :- **[J–MAIN–2016]**

(*a*) $[Co(NH_3)_4Cl_2]Cl$

(*b*) $[Co(NH_3)_3Cl_3]$

(*c*) cis $[Co(en)_2Cl_2]Cl$

(*d*) trans$[Co(en)_2Cl_2]Cl$

(en = ethylenediamine)

**51.** The pair having the same magnetic moment is :-

**[J–MAIN–2016]**

(At. No. : Cr = 24, Mn = 25, Fe = 26, Co = 27)

(*a*) $[CoCl_4]^{2-}$ and $[Fe(H_2O)_6]^{2+}$

(*b*) $[Cr(H_2O)_6]^{2+}$ and $[CoCl_4]^{2+}$

(*c*) $[Cr(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{2+}$

(*d*) $[Mn(H_2O)_6]^{2+}$ and $[Cr(H_2O)_6]^{2+}$

**52.** Which one of the following complexes will consume highest equivalents of aqueous solution of $Ag(NO_3)$? **[J–MAIN–2016-Online]**

(*a*) $[Cr(H_2O)_6]Cl_3$ (*b*) $Na_2[CrCl_5(H_2O)]$

(*c*) $Na_3[CrCl_6]$ (*d*) $[Cr(H_2O)_5Cl]Cl_2$

**53.** Identify the correct trend given below :-

**[J–MAIN–2016, Online]**

(At. No. : Ti = 22, Cr = 24 and Mo = 42)

(*a*) $\Delta_0$ of $[Cr(H_2O)_6]^{2+} < [Mo(H_2O)_6]^{2+}$ and $\Delta_0$ of $[Ti(H_2O)_6]^{3+} < [Ti(H_2O)_6]^{2+}$

(*b*) $\Delta_0$ of $[Cr(H_2O)_6]^{2+} < [Mo(H_2O)_6]^{2+}$ and $\Delta_0$ of $[Ti(H_2O)_6]^{3+} > [Ti(H_2O)_6]^{2+}$

(*c*) $\Delta_0$ of $[Cr(H_2O)_6]^{2+} > [Mo(H_2O)_6]^{2+}$ and $\Delta_0$ of $[Ti(H_2O)_6]^{3+} > [Ti(H_2O)_6]^{2+}$

(*d*) $\Delta_0$ of $[Cr(H_2O)_6]^{2+} > [Mo(H_2O)_6]^{2+}$ and $\Delta_0$ of $[Ti(H_2O)_6]^{3+} < [Ti(H_2O)_6]^{2+}$

## EXERCISE # V(B) JEE-ADVANCED

**True/False**

1. Tho electron density in the xy plane in $3_{dx^2-y^2}$ orbital is zero. **[JEE 1986]**

2. Amongst the following the lowest degree of paramangetism per mole of the compound at 298 K will shown by ; **[JEE1988]**

(*a*) $MnSO_4 . 4H_2O$ (*b*) $CuSO_4 . 5H_2O$

(*c*) $FeSO_4 . 6H_2O$ (*d*) $NiSO_4 . 6H_2O$

**True/False**

3. Both potassium ferrocyanide and potassium ferricyanide are diamagnetic. **[JEE 1989]**

4. Mixture X = 0.02 mole of $[Co(NH_3)_5SO_4]Br$ and 0.02 mole of $[Co(NH_3)_5Br]SO_4$ was prepared in 2 L of solution. **[JEE 1991]**

1 L of mixture X + excess $AgNO_3 \longrightarrow Y$

1 L of mixture X + excess $BaCl_2 \longrightarrow Z$

Number of moles of Y and Z are

(*a*) 0.01, 0.01 (*b*) 0.02, 0.01

(*c*) 0.01, 0.02 (*d*) 0.02, 0.02

5. Amongst $[Ni(CO)_4]$, $[Ni(CN)_4]^{2-}$ and $[NiCl_4]^{2-}$ **[JEE 1991]**

(*a*) $[Ni(CO)_4]$ and $[Ni(CN)_4]^{2-}$ are diamagnetic and $[NiCl_4]^{2-}$ is paramagnetic

(*b*) $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ are diamagnetic and $[Ni(CO)_4]$ is paramagnetic

(*c*) $[Ni(CO)_4]$, $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ are diamagnetic.

(*d*) $[Ni(CO)_4]$ is diamagnetic and $[Ni(CN)_4]^{2-}$, $[NiCl_4]^{2-}$ are paramagnetic

6. The compound which does not show paramagnetism is **[JEE 1992]**

(*a*) $[Cu(NH_3)_4]Cl_2$ (*b*) $[Ag(NH_3)_2]Cl$

(*c*) NO (*d*) $NO_2$

7. The number of d–electron is $[Cr(H_2O)_6]^{3+}$ [At No.. of Cr = 24] is **[JEE 1993]**

(*a*) 2 (*b*) 3

(*c*) 4 (*d*) 5

8. Amongst the following ions which one has the highest paramagnetism **[JEE 1993]**

(*a*) $[Cr(H_2O)_6]^{3+}$ (*b*) $[Fe(H_2O)_6]^{2+}$

(*c*) $[Cu(H_2O)_6]^{2+}$ (*d*) $[Zn(H_2O)_6]^{2+}$

**Fill in the Blanks**

9. The type of magnetism exhibited by $[Mn(H_2O)_6]^{2+}$ ion is (paramagnetic) **[JEE 1994]**

10. The IUPAC name of $[Co(NH_3)_6]Cl_3$, is **[JEE 1994]**

11. Identify the complexes which are expected to be coloured **[JEE 1994]**

(*a*) $Ti(NO_3)_4$

(*b*) $[Cu(NCCH_3)_4]^+BF_4^-$

(*c*) $[Cr(NH_3)_6]Cl_3$

(*d*) $K_3[VF_6]$

12. Which of the following is formed when excess of KCN is added to aqueous solution of copper sulphate ? **[JEE 1996]**

(*a*) $Cu[CN]_2$ (*b*) $K_2[Cu[CN]_4]$

(*c*) $K[Cu[CN]_2]$ (*d*) $K_3[Cu(CN)_4]$

13. Which of the following is an organometallic compound **[JEE 1997]**

(*a*) Lithium methoxide

(*b*) Lithium acetate

(*c*) Lithium dimethylamide

(*d*) Methyl lithium

14. In nitroprusside ion, the iron and NO exist as $Fe^{II}$ and $NO^+$ rather than $Fe^{III}$ and NO. These forms can be differentiated by **[JEE 1998]**

(*a*) estimating the concentration of iron

(*b*) measuring the concentration of $CN^-$

(*c*) measuring the solid state magnetic moment

(*d*) thermally decomposing the compound

15. The geometry of $Ni(CO)_4$ and $Ni(PPh_3)_2Cl_2$ are **[JEE 1999]**

(*a*) both square planar

(*b*) tetrahedral and square planar

(*c*) both tetrahedral

(*d*) square planar and tetrahedral

16. The complex ion which has no 'd' electrons in the central atom is : **[JEE 2001]**

(*a*) $[MnO_4]^-$ (*b*) $[Co(NH_3)_6]^{3+}$

(*c*) $[Fe(CN)_6]^{3-}$ (*d*) $[Cr(H_2O)_6]^{3+}$

**17.** The correct order of hybridisation of the central atom in the following species. **[JEE2001]**
$NH_3$, $[PtCl_4]^{2-}$, $PCl_5$ and $BCl_3$, is [At No. Pt = 78]
(*a*) $dsp^2, sp^3d, sp^2$ and $sp^3$
(*b*) $sp^3, dsp^2, sp^3d, sp^2$
(*c*) $dsp^2, sp^2, sp^3$ and $sp^3d$
(*d*) $dsp^2, sp^3, sp^2$ and $sp^3d$

**18.** The species having tetrahedral shape is : **[JEE2004]**
(*a*) $[PdCl_4]^{2-}$ (*b*) $[Ni(CN)_4]^{2-}$
(*c*) $[Pd(CN)_4]^{2-}$ (*d*) $[NiCl_4]^{2-}$

**19.** The pair of compounds having metals in their highest oxidation state is **[JEE2004]**
(*a*) $MnO_2$, $FeCl_3$
(*b*) $[MnO_4]^-$, $CrO_2Cl_2$
(*c*) $[Fe(CN)_6]^{3-}$, $[Co(CN)_3]$
(*d*) $[NiCl_4]^{2-}$, $[CoCl_4]^-$

**20.** Spin only magnetic moment of the compound Hg $[Co(SCN)_4]$ is **[JEE2004]**
(*a*) $\sqrt{3}$ (*b*) $\sqrt{15}$
(*c*) $\sqrt{24}$ (*d*) $\sqrt{8}$

**21.** Which of the following pair is expected to exhibit same colour in solution? **[JEE2005]**
(*a*) $VOCl_2$ ; $FeCl_2$ (*b*) $CuCl_2$; $VOCl_2$
(*c*) $MnCl_2$ ; $FeCl_2$ (*d*) $FeCl_2$;$CuCl_2$

**22.** Which type of isomerism is shown by $Co(NH_3)_4Br_2Cl$? **[JEE2005]**
(*a*) Geometrical and Ionisation
(*b*) Optical and Ionisation
(*c*) Geometrical and Optical
(*d*) Geometrical only

**Question No. 23 to 25 (3 questions)**

The coordination number of $Ni^{2+}$ is 4. **[JEE2006]**

$NiCl_2$ + KCN (excess) → A (cyano complex)

$NiCl_2$ + KC1 (excess) → B (chloro complex)

**23.** The IUPAC name of A and B are
(*a*) Potassium tetracyanidonickelate (II), potassium tctrachloridonickelate (II)
(*b*) Tetracyanidopotassiumnickelate (II), tctcrachloridopolassiumnickelate (II)
(*c*) Tctracyanidonickel (II), tetrachloridonickel (II)
(*d*) Potassium tetracyanidonickcl (II), potassium tetrachloridonickel (II)

**24.** Predict the magnetic nature of A and B.
(*a*) Both are diamagnetic
(*b*) A is diamagnetic and B is paramagnetic with two unpaired electrons
(*c*) A is diamagnetic and B is paramagnetic with one unpaired electron
(*d*) Both are paramagnetic

**25.** The hybridisation of A and B –
(*a*) $dsp^2$, $sp^3$ (*b*) $sp^3$, $sp^3$
(*c*) $dsp^2$, $dsp^2$ (*d*) $sp^3d^2$, $d^2sp^3$

**26.** If the bond length of CO bond in carbon monoxide is 1.128 Å, then what is the value of CO bond length in $Fe(CO)_5$? **[JEE 2006]**
(*a*) 1.15 Å (*b*) 1.128 Å
(*c*) 1.72 Å (*d*) 1.118 Å

**27.** Among the following metal carbonyls, the C–O bond order is lowest in **[JEE 2007]**
(*a*) $[Mn(CO)_6]^+$ (*b*) $[Fe(CO)_5]$
(*c*) $[Cr(CO)_6]$ (*d*) $[V(CO)_6]^-$

**28.** Match the complexes in Column I with their properties listed in Column II. Indicate your answer by darkening the appropriate bubbles of the 4 x 4 matrix given in the ORS. **[JEE 2007]**

**Column I**
(*a*) $[Co(NH_3)_4(H_2O)_2]Cl_2$
(*b*) $[Pt(NH_3)_2Cl_2]$
(*c*) $[Co(H_2O)_5Cl]Cl$
(*d*) $[Ni(H_2O)_6]Cl_2$

**Column II**
(P) Geometrical isomers
(Q) Paramagnetic
(R) Diamagnetic
(S) Metal ion with 2+ oxidation state

**29.** Among the following, the coloured compound is **[JEE 2008]**
(*a*) CuCl (*b*) $K_3[Cu(CN)_4]$
(*c*) $CuF_2$ (*d*) $[Cu(CH_3CN)_4]BF_4$

**30.** The [UPAC name of $[Ni(NH_3)_4]$ $[NiCl_4]$ is **[JEE2008]**

(*a*) Tetrachloronickel (II)–tetraamminenickel (II)

(*b*) Tetraamminenickel (II)–tetrachloronickel (II)

(*c*) Tetraamminenickel (II)–tetrachloronickelate (II)

(*d*) Tetrachloronickel (II)–tetraamminenickelate (0)

**31.** Both $[Ni(CO)_4]$ and $[Ni(CN)_4]^{2-}$ are diamagnetic. The hybridisations of nickel in these complexes, respectively, are **[JEE 2008]**

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

(*c*) $dsp^2$, $sp^3$ (*d*) $dsp^2$, $dsp^2$

**32. Statement–1 :** The geometrical isomers of the complex $[M(NH_3)_4Cl_2]$ are optically inactive.

**Statement–2 :** Both geometrical isomers of the complex $[M(NH_3)_4Cl_2]$ possess axis of symmetry.

(*a*) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1

(*b*) Statement–1 is True, Statement–2 is True ; Statement–2 is NOT a correct explanation for Statement–1

(*c*) Statement–1 is True, Staicment–2 is False

(*d*) Statement–1 is False, Statement–2 is True

**33. Statement–1 :** $[Fe(H_2O)_5NO]SO_4$ is paramagnetic.

**Statement–2 :** Fe in $[Fe(H_2O)_5NO]SO_4$ has three unpaired electrons. **[JEE 2008]**

(*a*) Statement–1 is True. Statcment–2 is True ; Statemcnt–2 is a correct explanation for Statement–1

(*b*) Statement–1 is True, Statement–2 is True ; Statement–2 is NOT a correct explanation for Statcmcnt–1

(*c*) Statement–1 is True. Statemcnt–2 is False

(*d*) Statement–1 is False. Statcmcnt–2 is True

**34.** The spin only magnetic moment value (in Bohr magneton units) of $Cr(CO)_6$ is **[JEE2009]**

(*a*) 0 (*b*) 2.84

(*c*) 4.90 (*d*) 5.92

**35.** The compound(s) that exhibit(s) geometrical isomerism is (are): **[JEE 2009]**

(*a*) $[Pt(cn)Cl_2]$ (*b*) $[Pt(en)_2]Cl_2$

(*c*) $[Pt(en)_2Cl_2]Cl_2$ (*d*) $[Pt(NH_3)_2Cl_2]$

**36.** The number of water molccule(s) directly bonded to the metal centre in $CuSO_4 . 5H_2O$is is. **[JEE 2009]**

**37.** The ionization isomer of $[Cr(H_2O)_4Cl(NO_2)]Cl$ is–

(*a*) $[Cr(H_2O)_4(O_2N)]Cl_2$ **[JEE 2010]**

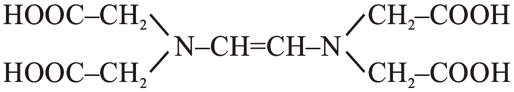
(*b*) $[Cr(H_2O)_4Cl_2](NO_2)$

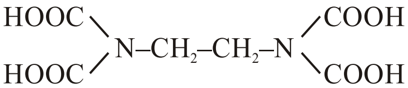
(*c*) $[Cr(H_2O)_4Cl(ONO)]Cl$

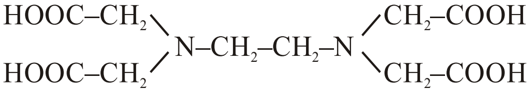
(*d*) $[Cr(H_2O)_4Cl_2(NO_2)].H_2O$

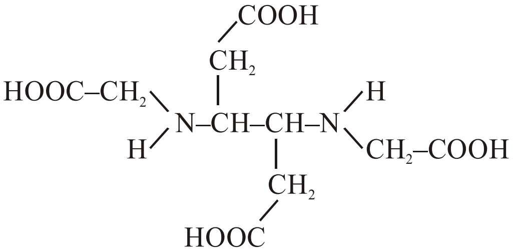
**38.** Total number of geometrical isomers for the complex $[RhCl(CO)(PPh_3)(NH_3)]$ is. **[JEE2010]**

**39.** The correct structure of ethylenediaminetetraacetic acid (EDTA) is – **[JEE2010]**

(*a*)


(*b*)


(*c*)


(*d*)


**40.** Geometrical shapes of the complexes formed by the reaction of $Ni^{2+}$ with $F^-$ ,$CN^-$ and $H_2O$ respectively– **[JEE 2011]**

(*a*) octahedral, tetrahedral and square planar

(*b*) tetrahedral, square planar and octahedral

(*c*) square planar, tetrahedral and octahedral

(*d*) octahedral, square planar and octahedral

**41.** Among the following complexes (K–P) **[JEE 2011]**

$K_3[Fe(CN)_6]$ (K), $[Co(NH_3)_6]Cl_3$ (L), $Na_3[Co(oxalate)_3]$(M), $[Ni(H_2O)_6]Cl_2$ (N), $K_2[Pt(CN)_4]$ (O) and $[Zn(H_2O)_6]$ $(NO_3)_2$(P)
The diamagnetic complex are –

(*a*) K, L, M, N (*b*) K, M, O, P

(*c*) L, M, O, P (*d*) L, M, N, O

**42.** The volume (in mL) of 0.1 M $AgNO_3$ required for complete precipitation of chloride ions present in 30 mL of 0.01 M solution of $[Cr(H_2O)_5Cl]Cl_2$, as silver chloride is close to. **[JEE 2011]**

**43.** As per IUPAC nomenclature, the name of the complex $[Co(H_2O)_4(NH_3)_2]Cl_3$ is : **[JEE 2011]**

(*a*) Tetraaquadiaminccobalt(III)chloride

(*b*) Tetraaquadiaminccobalt(III)chloride

(*c*) Diaminetetraaquaccobalt(III)chloride

(*d*) Diamminetetraaquaccobalt(III)chloride

**44.** The colour of light absorbed by an aqueous solution of $CuSO_4$ is **[JEE 2012]**

(*a*) orange-red (*b*) blue-green

(*c*) yellow (*d*) violet

**45.** $NiCl_2\{P(C_2H_5)_2(C_6H_5)\}_2$ exhibits temperature dependent magnetic behaviour (paramagnetic / diamagnetic). The coordination geometries of $Ni^{2+}$ in the paramagnetic and diamagnetic states are respectively : **[JEE 2012]**

(*a*) tetrahedral and tetrahedral

(*b*) square planar and square planar

(*c*) tetrahedral and square planar

(*d*) square planar and tetrahedral

**46.** Consider the following complex ions P, Q and R ,

$P = [FeF_6]^{3-}$, $Q = [V(H_2O)_6]^{2+}$

and $R = [Fe(H_2O)_6]^{2+}$

The correct order of the complex ions, according to their spin–only magnetic moment values (in B.M) **[JEE 2013]**

(*a*) R < Q < P

(*b*) Q < R < P

(*c*) R < P < Q

(*d*) Q < P < R

**48.** The pair(s) of coordination complex/ion exhibiting the same kind of isomerism **[JEE2013]**

(*a*) $[Cr(NH_3)_5Cl]Cl_2$ and $[Cr(NH_3)_4Cl_2]Cl$

(*b*) $[Co(NH_3)_4Cl_2]^+$ and $[Pt(NH_3)_2(H_2O)Cl]^+$

(*c*) $[CoBr_2Cl_2]^{2-}$and$[PtBr_2Cl_2]^{2-}$

(*d*) $[Pt(NH_3)_3(NO_3)]$ Cl and $[Pt(NH_3)_3Cl]$ Br

**49.** Match each coordination compound in List–I with an appropriate pair and select the correct answer using the code given below the lists,

{en = $H_2NCH_2CH_2NH_2$ ' atomic numbers ; Ti = 22 ; Cr = 24 ; Co = 27 ; Pt = 78}

**List–I**

(P) $[CrCNH_3)_4Cl_2]Cl$

(Q) $[Ti(H_2O)_5Cl](NO_3)_2$

(R) $[Pt(en)(NH_3)Cl]NO_3$

(S) $[Co(NH_3)_4(NO_3)_2]NO_3$

**List–II**

(1) Paramagnetic and exhibits ionisation isomerism

(2) Diamagnetic and exhibits cis–trans isomerism

(3) Paramagnetic and exhibits cis–trans isomerism

(4) Diamagnetic and exhibits ionisation isomerism

**Code :**

| | P | Q | R | S |
|---|---|---|---|---|
| (*a*) | 4 | 2 | 3 | 1 |
| (*b*) | 3 | 1 | 4 | 2 |
| (*c*) | 2 | 1 | 3 | 4 |
| (*d*) | 1 | 3 | 4 | 2 |

**50.** A list of speCles having the formula $XZ_4$ is given below : **[JEEAdv.2014]**

$XeF_4$, $SF_4$, $SiF_4$, $BF_4^-$, $BrF_4^-$, $[Cu(NH_3)_4]^{2+}$, $[FeCl_4]^{2-}$, $[CoCl_4]^{2-}$ and $[PtCl_4]^{2-}$.

Defining shape on the basis of the location of X and Z atoms, the total number of species having a square planar shape is–

**Subjective :**

**51.** Give reasons in two or three sentences only for the following :

"The species $[CuCl_4]^{2-}$ exists, while $[CuI_4]^{2-}$ does not exist" **[JEE 1992]**

**52.** Write the IUPAC name of the following compounds **[JEE1995]**

(i) $[Co(NH_3)_5ONO]Cl_2$

(ii) $K_3[Cr(CN)_6]$

**53.** Write the IUPAC name for $[Cr(NH_3)_5CO_3]Cl$ **[JEE 1996]**

**54.** Write the formulae of the following complexes : **[JEE 1997]**

(*i*) Pentamminechlorocobalt (III) ion

(*ii*) Lithium tetrahydridoaluminate (III)

**55.** A, B and C are three complexes of chromium (III) with the empirical formula $H_{12}O_6Cl_3Cr$. All the three complexes have water and chloride ion as ligands. Complex A does not react with concentrated $H_2SO_4$, whereas complexes B and C loose 6.75% and 13.5% of their original mass, respectively, on treatment with concentrated $H_2SO_4$. Identify A, B and C. **[JEE1989]**

**56.** Draw the structures of $[Co(NH_3)_6]^{3+}$, $[Ni(CN)_4]^{2-}$ and $[Ni(CO)_4]$. Write the hybridisation of atomic orbitals of the transition metal in each case. **[JEH 2000]**

**57.** A metal complex having composition $Cr(NH_3)_4Cl_2Br$ has been isolated in two forms A and B. The form A reacts with $AgNO_3$ to give a white precipitate readily soluble in dilute aqueous ammonia, whereas B gives a pale yellow precipitate soluble in concentrated ammonia. Write the formula of A and B and state the hybridisation of chromium in each. Calculate their magnetic moments (spin–only value). **[JEE 2001]**

**58.** Deduce the structures of $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ considering the hybridisation of the metal ion. Calculate the magnetic moment (spin only) of the species. **[JEE 2002]**

**59.** Write the IUPAC name of the compound $K_2[Cr(NO)(CN)_4(NH_3)]$. Spin magnetic moment of the complex $\mu = 1.73$ BM. Give the structure of anion. **[JEE 2003]**

**60.** $NiCl_2$ in the presence of dimethyl glyoxime (DMG) gives a complex which precipitates in the presence of $NH_4OH$. giving a bright red colour. **[JEE 2004]**

(*a*) Draw its structure and show H–bonding

(*b*) Give oxidation state of Ni and its hybridisation

(*c*) Predict whether it is paramagnetic or diamagnetic

**61.** For the octahedral complexes of $Fe^{3+}$ in $SCN^-$ (thiocyanato-S) and in $CN^-$ ligand environments, the difference between the spin only magnetic moment in Bohr magnetons (when approximated to the nearest integer) is :

[Atomic number of Fe = 26] **[JEEAdv.2015]**

**62.** In the complex acetylbromidodicarbonylbis (triethylphosphine)iron(II), the number of Fe–C bond(s) is :- **[JEEAdv.2015]**

**63.** Among the complex ions, $[Co(NH_2–CH_2–CH_2–NH_2)_2Cl_2]^+$, $[CrCl_2(C_2O_4)_2]^{3-}$, $[Fe(H_2O)_4(OH)_2]^+$, $[Fe(NH_3)_2(CN)_4]^-$, $[Co(NH_2–CH_2–CH_2–NH_2)_2(NH_3)Cl]^{2+}$ and $[Co(NH_3)_4(H_2O)Cl]^{2+}$, the number of complex ion(s) that show(s) cis-trans isomerism is :- **[JEEAdv.2016]**

**64.** Among $[Ni(CO)_4]$, $[NiCl_4]^{2-}$, $[Co(NH_3)_4Cl_2]Cl$, $Na_3[CoF_6]$, $Na_2O_2$ and $CsO_2$, the total number of paramagnetic compounds is :- **[JEEAdv.2016]**

(*a*) 2 (*b*) 3

(*c*) 4 (*d*) 5

**65.** The number of geometric isomers possible for complex $[CoL_2Cl_2]^-$ ($L = H_2NCH_2CH_2O^-$) is :- **[JEEAdv.2016]**

**66.** The geometries of the ammonia complexes of $Ni^{+2}$, $Pt^{2+}$ and $Zn^{2+}$ respectively are :-**[JEEAdv.2016]**

(*a*) octahedral, square planar and tetrahedral

(*b*) square planar, octahedral and tetrahedral

(*c*) tetrahedral, square planar and octahedral

(*d*) octahedral, tetrahedral and square planar

## CH-2 COORDINATION COMPOUNDS

### EXERCISE # I

**1.** (*b*) **2.** (*c*) **3.** (*c*) **4.** (*c*) **5.** (*d*) **6.** (*b*) **7.** (*d*) **8.** (*c*) **9.** (*d*) **10.** (*a*)
**11.** (*c*) **12.** (*d*) **13.** (*c*) **14.** (*b*) **15.** (*b*) **16.** (*c*) **17.** (*d*) **18.** (*d*) **19.** (*c*) **20.** (*a*)
**21.** (*d*) **22.** (*c*) **23.** (*c*) **24.** (*c*) **25.** (*a*) **26.** (*c*) **27.** (*b*) **28.** (*d*) **29.** (*d*) **30.** (*c*)
**31.** (*d*) **32.** (*a*) **33.** (*c*) **34.** (*c*) **35.** (*c*) **36.** (*c*) **37.** (*d*) **38.** (*b*) **39.** (*d*) **40.** (*a*)
**41.** (*a*) **42.** (*b*) **43.** (*a*) **44.** (*a*) **45.** (*d*) **46.** (*c*) **47.** (*d*) **48.** (*c*) **49.** (*d*) **50.** (*b*)
**51.** (*d*) **52.** (*c*) **53.** (*a*) **54.** (*a*) **55.** (*a*) **56.** (*d*) **57.** (*c*) **58.** (*b*) **59.** (*a*) **60.** (*c*)
**61.** (*a*) **62.** (*c*) **63.** (*c*) **64.** (*d*) **65.** (*d*) **66.** (*a*) **67.** (*b*) **68.** (*c*) **69.** (*b*) **70.** (*c*)
**71.** (*d*) **72.** (*b*) **73.** (*a*) **74.** (*a*) **75.** (*d*) **76.** (*c*) **77.** (*d*) **78.** (*d*) **79.** (*c*) **80.** (*a*)
**81.** (*b*) **82.** (*a*) **83.** (*a*) **84.** (*a*) **85.** (*d*) **86.** (*b*) **87.** (*c*) **88.** (*b*) **89.** (*a*) **90.** (*b*)
**91.** (*d*) **92.** (*a*) **93.** (*d*) **94.** (*c*) **95.** (*c*) **96.** (*c*) **97.** (*a*) **98.** (*c*) **99.** (*d*) **100.** (*c*)
**101.** (*d*) **102.** (*d*) **103.** (*d*) **104.** (*b*) **105.** (*c*) **106.** (*b*) **107.** (*b*) **108.** (*b*) **109.** (*a*) **110.** (*d*)
**111.** (*d*) **112.** (*d*) **113.** (*a*) **114.** (*d*) **115.** (*a*) **116.** (*c*) **117.** (*a*) **118.** (*d*) **119.** (*c*) **120.** (*d*)
**121.** (*d*) **122.** (*d*) **123.** (*c*) **124.** (*c*) **125.** (*d*) **126.** (*d*) **127.** (*d*) **128.** (*c*) **129.** (*a*) **130.** (*c*)
**131.** (*a*) **132.** (*c*) **133.** (*b*) **134.** (*b*) **135.** (*a*) **136.** (*d*) **137.** (*b*) **138.** (*c*) **139.** (*c*) **140.** (*c*)
**141.** (*c*) **142.** (*a*) **143.** (*d*) **144.** (*c*) **145.** (*d*) **146.** (*b*) **147.** (*b*) **148.** (*d*) **149.** (*d*) **150.** (*a*)

### EXERCISE # II

**1.** (*a,b,c*) **2.** (*a,b,c*) **3.** (*b,d*) **4.** (*b,c,d*) **5.** (*a,b,d*) **6.** (*a,b*)
**7.** (*a,d*) **8.** (*a,d*) **9.** (*b,c,d*) **10.** (*b,c*) **11.** (*a,d*) **12.** (*a,b*)
**13.** (*a,b*) **14.** (*a,b,c*) **15.** (*a,b,c,d*) **16.** (*a,b,c,d*) **17.** (*a,b,c,d*) **18.** (*b,c,d*)
**19.** (*a,b,c*) **20.** (*a,b,c,d*) **21.** (*b,d*) **22.** (*a,b,c,d*) **23.** (*a,b,c*) **24.** (*b,c*)
**25.** (*a,d*) **26.** (*a,b,d*) **27.** (*a,b,c,d*) **28.** (*b,c*) **29.** (*a,b,c*) **30.** (*b,c*)
**31.** (*c,d*) **32.** (*a,b,c*) **33.** (*b,c,d*) **34.** (*a,c*) **35.** (*a,b,c,d*) **36.** (*a,b,c*)
**37.** (*a,b,c*) **38.** (*b,c,d*) **39.** (*b,c*) **40.** (*a,b,c*) **41.** (*a,b,c*) **42.** (*a,c*)
**43.** (*a,d*) **44.** (*a,b*) **45.** (*a,d*) **46.** (*a,c*) **47.** (*a,c*) **48.** (*a,b,c,d*)
**49.** (*b,c*) **50.** (*a,b,c*) **51.** (*b,d*) **52.** (*a,c*) **53.** (*b,c*) **54.** (*b,c,d*)
**55.** (*a,b,d*) **56.** (*c,d*) **57.** (*a,b,d*) **58.** (*a,b*) **59.** (*b,c*) **60.** (*a,b,c*)
**61.** (*b,c,d*) **62.** (*a,b*) **63.** (*b,d*) **64.** (*a,c,d*) **65.** (*b,c,d*) **66.** (*a,d*)
**67.** (*a,b,d*) **68.** (*a,b,c,d*) **69.** (*a,b*) **70.** (*c,d*) **71.** (*c,d*) **72.** (*a,b,d*)
**73.** (*a,c*) **74.** (*b,c*) **75.** (*c,d*) **76.** (*a,b,c*) **77.** (*b,c,d*) **78.** (*a,b,d*)
**79.** (*b,c,d*) **80.** (*a,b,c,d*) **81.** (*a,b*) **82.** (*a,c,d*) **83.** (*a,b,c,d*) **84.** (*a,b,c,d*)
**85.** (*a,b,c,d*) **86.** (*a,b*) **87.** (*a,b,d*) **88.** (*b,c,d*) **89.** (*b,c*) **90.** (*a,c,d*)
**91.** (*b,d*) **92.** (*a,b,d*) **93.** (*b,c*) **94.** (*b,c,d*) **95.** (*c,d*) **96.** (*a,b,c,d*)
**97.** (*a,b,c*) **98.** (*a,b*) **99.** (*a,b*) **100.** (*a,b,c*)

# EXERCISE # III

**Paragraph Type :**

**1.** (*c*) **2.** (*c*) **3.** (*a*) **4.** (*d*) **5.** (*a*) **6.** (*b*) **7.** (*d*) **8.** (*a*) **9.** (*a*) **10.** (*c*)

**11.** (*b*) **12.** (*b*) **13.** (*a*) **14.** (*c*) **15.** (*b*) **16.** (*c*) **17.** (*d*) **18.** (*b*) **19.** (*c*) **20.** (**c**)

**21.** (*b*) **22.** (*c*) **23.** (*d*) **24.** (*b*) **25.** (*d*) **26.** (*d*) **27.** (*d*) **28.** (*c*) **29.** (*a*) **30.** (*c*)

**31.** (*c*) **32.** (*d*) **33.** (*b*) **34.** (*c*) **35.** (*d*) **36.** (*b*) **37.** (*d*) **38.** (*c*) **39.** (*a*) **40.** (*b*)

**41.** (*a*) **42.** (*c*) **43.** (*c*) **44.** (*a*) **45.** (*b*) **46.** (*d*) **47.** (*b*) **48.** (*a*,*b*,*c*,*d*)

**49.** (*a*,*b*,*c*,*d*) **50.** (*a*,*b*,*c*,*d*) **51.** (*a*,*b*,*c*,*d*) **52.** (*a*,*c*) **53.** (*a*,*c*) **54.** (*b*) **55.** (*a*)

**56.** (*a*,*b*,*c*,*d*) **57.** (*b*) **58.** (*c*) **59.** (*b*) **60.** (*d*) **61.** (*b*) **62.** (*b*) **63.** (*c*) **64.** (*c*)

**65.** (*c*) **66.** (*a*) **67.** (*c*) **68.** (*a*) **69.** (*b*) **70.** (**c**)

**Matrix Match Type :**

| | (*a*) | (*b*) | (*c*) | (*d*) | | (*a*) | (*b*) | (*c*) | (*d*) |
|---|---|---|---|---|---|---|---|---|---|
| **71.** | S; | -P,T ; | Q,R,T; | R,T | **72.** | -P,T; | -R,S,T; | -Q,S,T; | -P |
| **73.** | -P, R, S; | -P,Q,R,S,T; | -P,Q,R; | -P,Q,R | **74.** | -P, R, T; | -Q,S,T; | -P,R,T; | -Q,S,T |
| **75.** | -P; | -Q; | -R,T; | -S | **76.** | -P; | -Q; | -R; | -S |
| **77.** | -S,T; | -R,T; | -S,T; | -Q,T | **78.** | -R; | -Q; | -S; | -P |
| **79.** | -Q; | -P; | -S; | -R | **80.** | -P,R; | -T; | -P,S; | -Q |
| **81.** | -P; | -Q; | -R; | -S | **82.** | P; | -Q; | -R; | -S |
| **83.** | -P, Q, S; | -P,Q,S,T; | -P,Q,R; | -P,Q,R | **84.** | P,R,S; | -R, S; | -R, S; | -W,R,S |
| **85.** | -P,S; | -P,Q; | -R,T; | -P,Q | **86.** | -Q,R,S; | -P,R; | -Q,R; | -R,S |
| **87.** | -P,Q,R,S; | -Q,R; | -Q,R; | -P,R,S | **88.** | Q,R; | -Q,S; | -Q,S; | -P,R,S |
| **89.** | P; | -P,Q; | -S,T; | -P,Q,R | **90.** | -P,Q; | -Q,R,S; | -P; | -P,Q |
| **91.** | -R; | -T; | -P; | -P | **92.** | -R,S; | -P,Q; | -P; | -P,Q |
| **93.** | -Q,R; | -P,T; | -Q,R; | -S,T | **94.** | -P; | -Q; | -R; | -S |
| **95.** | -R; | -S; | -P; | -Q | **96.** | -P; | -Q; | -R; | - S |
| **97.** | - P; | - Q; | - R; | - S | **98.** | - S; | - R; | - Q; | - P |
| **99.** | - S; | - R; | - Q; | - P | **100.** | - P,S; | - R; | - P,Q,S; | - P,S,T |
| **101.** | - P,R,S; | - P,T; | - P,Q,T; | - P,R,S | | | | | |

# EXERCISE # IV

**1.** (4) **2.** (4) **3.** (4) **4.** (6) **5.** (7) **6.** (7) **7.** (2) **8.** (3) **9.** (3) **10.** (5)

**11.** (4), a,b,f,g **12.** (3) **13.** (6) **14.** (6) **15.** (2) **16.** (4) **17.** (6) **18.** (7) **19.** (6)

**20.** (4) **21.** (6) **22.** (5) **23.** (3) **24.** (8) **25.** (7) **26.** (0) **27.** (9) **28.** 32/5 **29.** (5)

**30.** (4) **31.** (5) **32.** (2) **33.** (2) **34.** (6) **35.** 5 **36.** 2 **37.** 2 **38.** 3 **39.** 8

**40.** 11/2 **41.** 2 **42.** 3 **43.** 6 **44.** 0 **45.** 9 **46.** 1 **47.** 3 **48.** 4 **49.** 9/18

**50.** 3

## 10.6 ANSWERS

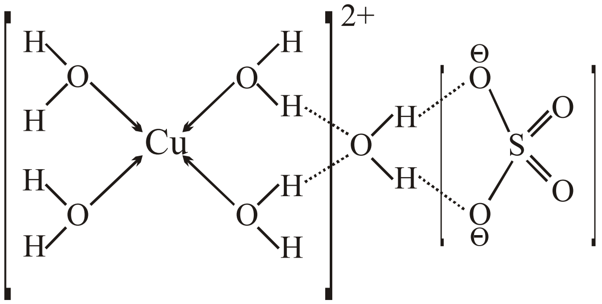
### EXERCISE # V(A) JEE-MAIN

**1.** (*b*) **2.** (*c*) **3.** (*d*) **4.** (*a*) **5.** (*c*) **6.** (*b*) **7.** (*a*) **8.** (*c*) **9.** (*d*) **10.** (*c*)
**11.** (*c*) **12.** (*a*) **13.** (*b*) **14.** (*d*) **15.** (*d*) **16.** (*a*) **17.** (*c*) **18.** (*d*) **19.** (*d*) **20.** (*a*)
**21.** (*d*) **22.** (*b*) **23.** (*c*) **24.** (*b*) **25.** (*a*) **26.** (*a*) **27.** (*b*) **28.** (*c*) **29.** (*c*) **30.** (*c*)
**31.** (*a*) **32.** (*c*) **33.** (*c*) **34.** (*d*) **35.** (*c*) **36.** (*d*) **37.** (*d*) **38.** (*d*) **39.** (*a*)**40.** (*c*)
**41.** (*c*) **42.** (*c*) **43.** (*b*) **44.** (*d*) **45.** (*d*) **46.** (*a*) **47.** (*c*) **48.** (*c*) **49.** (*d*)**50.** (*c*)
**51.** (*c*) **52.** (*a*) **53.** (*b*)

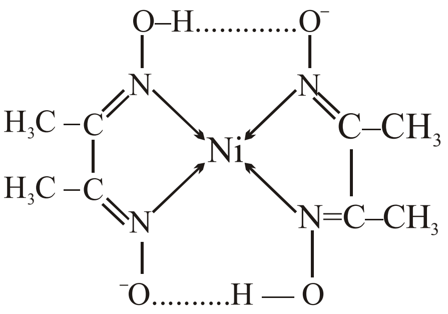
### EXERCISE # V(B) JEE-ADVANCED

**True/False**

**1.** (F) **2.** (*b*) **3.** (F) **4.** (*a*) **5.** (*a*) **6.** (*b*) **7.** (*b*) **8.** (*b*) **9.** Paramagnetism
**10.** Hexaamminecobalt(III)chloride **11.** (*c*,*d*) **12.** (*d*) **13.** (*d*) **14.** (*c*) **15.** (*c*) **16.** (*a*)
**17.** (*b*) **18.** (*d*) **19.** (*b*) **20.** (*b*) **21.** (*b*) **22.** (*a*) **23.** (*a*) **24.** (*c*) **25.** (*a*) **26.** (*a*)
**27.** (*d*) **28.** (*a*)-P,Q,S ; (*b*)-P,R,S ; (*c*)-Q,S ; (*d*)-Q,S **29.** (*c*) **30.** (*c*) **31.** (*b*) **32.** (*b*)
**33.** (*a*) **34.** (*a*) **35.** (*c*,*d*) **36.**



**37.** (*b*) **38.** (3)
**39.** (*c*) **40.** (*b*) **41.** (*c*) **42.** (6) **43.** (*d*) **44.** (*a*) **45.** (*c*) **46.** (*b*) **47.** (8) **48.** (*b*,*d*)
**49.** (*b*) **50.** (4) **51.** $I^-$ is reducing agent than $cl^-$ **52.** (i) Pentaamminenitritocobalt(III) chloride (ii) Potassiumhexacyanochromate(III) **53.** Pentaamminecarnonatochromium(III)chloride
**54.** (i) $[co(NH_3)_5cl]^{2+}$ (ii) $Li[alH_4]$ **55.** (*a*) → $[cr(H_2O)_6]cl_3$ ; (*b*) → $[cr(H_2O)_5cl]cl_2.H_2O$ ; (*c*) → $[cr(H_2O)_4cl_2]cl.H_2O$ **56.** $d^2sp^3$, $dsp^2$ and $sp^3$ **57.** (*a*) → $[cr(NH_3)_4clbr]cl$ ;
(*b*) → $[cr(NH_3)_4cl_2]br$ In both *cr* is $d^2sp^3$ hybridised and magnetic moment is $\sqrt{15}BM$ .
**58.** $[Nicl_4]^{2-} \rightarrow sp^3, \sqrt{8}BM$ $[Ni(cN)_4]^{2-} \rightarrow dsp^2, 0$ **59.** Potassium amminetetracyanonitrosochromate(I) → $d^2sp^3$, octahedral **60.**



$dsp^2$ , $Ni^{2+}$, diamagnetic

**61.** (4) **62.** (3)

**63.** (6) **64.** (*b*) **65.** (5) **66.** (*a*)