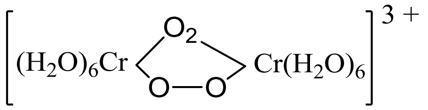
9.COORDINATION COMPOUNDS

Single Correct Answer Type

1. Oxidation number of Cr in the following complex is



a) 3
b) 6
c) 4
d) 5

2. What type of isomerism is present in the pair of complexes $[Co(NH_3)_5Br]SO_4$ and $[Co(NH_3)_5SO_4]Br$

a) Linkage isomerism
b) Ligand isomerism
c) Ionisation isomerism
d) Coordination isomerism

3. Test tube I contains (aq) KI, II contains (aq)$HgCl_2$,III contains mixture of I and II in 4:1 ratio, Select the correct statement

a) I and III give test for I^- and K^+
b) II and III both give test for Hg^{2+}
c) Both (a) and (b) are correct
d) None of the above is correct

4. The number of unpaired electrons expected for the complex ion$[Cr(NH_3)_6]^{2+}$

a) 2
b) 3
c) 4
d) 5

5. Isomerisms exhibited by $[Cr(NH_3)_2(H_2O)_2Cl_2]^+$ are

a) Ionisation, optical
b) Hydrate, optical
c) Eometrical, optical
d) Coordinate, geometrical

6. The complex showing a spin-only magnetic moment of 2.82 BM is

a) $Ni(CO)_4$
b) $[NiCl_4]^{2-}$
c) $Ni(PPh_3)_4$
d) $[Ni(CN)_4]^{2-}$

7. The complex showing a spin-only magnetic moment of 2.82 BM is

a) $Ni(CI)_4$
b) $[NiCl_4]^{2-}$
c) $Ni(PPh_3)_4$
d) $[Ni(CN)_4]^{2-}$

8. 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 BM) is

a) $R < Q < P$
b) $Q < R < P$
c) $R < P < Q$
d) $Q < P < R$

9. $[Ni(CN)_4]^{2-}$and $[NiCl_4]^{2-}$ have similarity but not in

a) Magnetic moment
b) C.N. and O.N
c) Structure
d) Both (a) and (c)

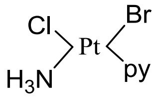
10. Consider the following statements in respect of $[CoCl_6]^{4-}$ complex ion
I. It is paramagnate
II. It is low-spin complex
III. Oxidation number of cobalt is -4
IV. The coordination number of cobalt is 6
Select the correct statement

a) All of the above
b) III and IV only
c) I and IV only
d) I and II only

11. $[Ni(CN)_4]^{2-}$ and $[Ni(CO)_4]$have

a) sp^3hybridised Ni in both cases
b) sp^3 and sp^2d hybridised Ni
c) dsp^2 and sp^3hybridised Ni
d) dsp^2in both cases

12. The complex



Can be formally formed from $K_2[PtCl_4]$ by which one of the following sequences of substitution of the chloride ions?

a) Py, Br^-, NH_3
b) Br^-, Py, NH_3
c) Br^-, NH_3, Py
d) NH_3, Br^-, Py

13. Consider the following complexes:
I. K_2PtCl_6II.$PtCl_4 \cdot 2NH_3$III.$PtCl_4 \cdot 3NH_3$IV.$PtCl_4 \cdot 5NH_3$
Their electrical conductances in aqueous solutions are

a) 256,0,97,404
b) 404,0,97,256
c) 256,97,0,404
d) 404,97,256,0

14. Of the following complex ions, the one that probably has the largest overall formation constant, K_f, is

a) $[Co(NH_3)_6]^{3+}$ b) $[Co(H_2O)_6]^{3+}$ c) $[Co(H_2O)_4(NH_3)_2]^{3+}$ d) $[Co(en)_3]^{3+}$

15. Which of the following complex species is not expected to exhibit optical isomerism?

a) $[Co(en)_3]^{3+}$ b) $[Co(en)_2Cl_2]^{+}$ c) $[Co(NH_3)_3Cl_3]$ d) $[Co(en)(NH_3)Cl_2]^{+}$

16. The ions or molecules attached to the central metal atom or ion in a complex are called

a) Ligands b) Chelates c) Ambident d) Lewis acid

17. $[Co(NH_3)_5(NO_2)]^{2+}$and$[Co(NH_3)_5(ONO)]^{2+}$will differ in

a) Colour b) Structure c) Hybridisation d) magnetic moment

18. Potassium diamminedicyanosulphatosuperoxo palatinate (IV) is

a) $K[Pt(CN)_2(O_2)(SO_4)(NH_3)_2]$ b) $K_4[Pt(NH_3)_2(CN)_2(SO_4)(O_2)]$

c) $K_2[Pt(NH_3)_2(CN)_2(SO_4(O_2)]$ d) $K_3[Pt(NH_3)_2(CN)_2(SO_4)(O_2)]$

19. Arrange the following in order of decreasing number of unpaired electrons

I. $[Fe(H_2O)_6]^{2+}$II. $[Fe(CB)_6]^{3-}$

III. $[Fe(CN)_6]^{4-}$IV. $[Fe(Fe(H_2O)_6]^{3+}$

a) IV, I, II, III b) I, II, III, IV c) III, II, I, IV d) II, III, I, IV

20. Among the following metal carbonyls, C— O bond order is lowest in

a) $[Mn(CO)_6]^{+}$ b) $[Fe(CO)_5]$ c) $[Cr(CO)_6]$ d) $[V(CO)_6]^{-}$

21. Of the following complex ions, one exhibits optical isomerism, That one is

a) $cis-[Co(en)_2Cl_2]^{+}$ b) $[Co(NH_3)_4Cl_2]^{+}$

c) $[Co(NH_3)_2Cl_4]^{-}$ d) $trans-[Co(en)_2Cl_2]^{+}$

22. In spectrochemical series chlorine is above than water *i.e*., Cl $> H_2O$, this is due to

a) Good π-acceptor properties of Cl

b) Strong σ −donor and good π-acceptor properties of Cl

c) Good π −donor properties of Cl

d) Larger size of Cl than H_2O

23. Which pair is not associated with complimentary colour

a) Orange−blue b) Yellow−purple c) Green − red d) Red− yellow

24. Coordination number of Cr is six, A complex with , $C_2O_4^{2-}$, en and superoxide O_2^- will be in the ratio to make complex $\left[Cr(C_2O_4)_x(en)_y(O_2)_z\right]^-$

X Y Z

a) 1 1 1 b) 1 1 2

c) 1 2 2 d) 2 1 1

25. Which has maximum number of unpaired electrons

a) $[Cr(NH_3)_6]^{3+}$ b) $[CoF_6]^{3-}$ c) $[Co(NH_3)_6]^{3+}$ d) $Ni(CO)_4$

26. Pentamminechloroplatinum (IV) chloride ionizes to give

a) Two ions b) Three ions c) Four ions d) Five ions

27. If excess of $AgNO_3$ solution is added to 100 mL of a 0.024 M solution of dichlorobis (ethylendiamine) cobalt (III) chloride, how many moles ofAgCl be precipitated

a) 0.0012 b) 0.0016 c) 0.0024 d) 0.0048

28. Complex $[Co(en)_2Cl_2]^{+}$ can

a) Exist as *cis*-and trans-isomer

b) Enantiomorphic pair *d* and*l* are formed if the isomer in which two unidentate liands have to be cis-cis to each other

c) Both (a) & (b) correct

d) None of the above is correct

29. Which of the following reactions are kinetically favourable

1. $[Cu(H_2O)_4]^{2+} + 4NH_3 \longrightarrow [Cu(NH_3)_4]^{2+} + 4H_2O$
2. $[Cu(H_2O)_4]^{2+} + 4Cl^- \longrightarrow [CuCl_4]^{2-} + 4\,H_2O$
3. $[Co(H_2O)_6]^{3+} + 6Cl^- \longrightarrow [CoCl_6]^{3-} + 4H_2O$

a) I,III b) II,III c) I,II d) I,II,III

30. $CrCl_3 \cdot 4H_2O$ will exist as

a) $[Cr(H_2O)_3Cl_3] \cdot H_2O$
b) $[Cr(H_2O)_4Cl_2]Cl$
c) Both (a) and (b)
d) None of these

31. Coordination number of calcium is six in
a) $[Ca(EDTA)]^{2-}$ b) CaC_2O_4 c) $[Ca(C_2O_4)_2]^{2-}$ d) $CaSO_4 \cdot 4H_2O$

32. Which has aromatic ring in complex
a) DNG in dimethyl glyoximate b) Cyclopenta-dienyl anion in ferrocene
c) Both (a) and (b) d) None of the above

33. If Δ_0 and Δ_t represent crystal field splitting energies for d-orbitals for octahedral and tetrahedral geometries respectively, then for d^6 (high spin in both cases) what are CFSE (ignore the pairing energy) respectively?
a) 0.6 Δ_0 and 0.6 Δ_t b) 0.4 $\Delta_0$and 0.6 Δ_t c) 0.6 $\Delta_0$and 0.6 Δ_t d) 0.6 $\Delta_0$and 0.4 Δ_t

34. Total number of geometrical isomers for the complex $[RhCl(CO)(PPh_3)(NH_2)]$ is
a) 1 b) 2 c) 3 d) 4

35. Spin only magnetic moment of the compound $Hg[Co(SCN)_4]$is
a) $\sqrt{3}$ b) $\sqrt{15}$ c) $\sqrt{24}$ d) $\sqrt{8}$

36. Of the following complex ions, one is a Bronsted-Lowry acid That one is
a) $[Cu(NH_3)_4]^{2+}$ b) $[FeCl_4]^-$ c) $[Fe(H_2O)_6]^{3+}$ d) $[Zn(OH)_4]^{2-}$

37. Select the correct statement
a) Complex ion $[MoCl_6]^{3-}$ is paramagnetic b) Complex ion $[Co(en)_3]^{3+}$ is diamagnetic
c) Both (a) and (b) are correct d) None of the above is correct

38. $[Cr(NH_3)_5Br)Cl$ and $[Cr(NH_3)_5Cl]Br$can be distinguished by / and isomerism shown is
a) $BaCl_2$, ionization b) $AgNO_3$, ionization c) $AgNO_3$, coordinate d) $BaCl_2$,linkage

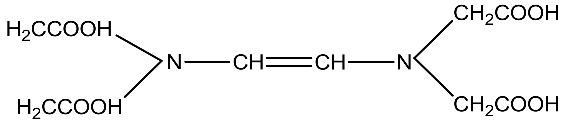
39. In the complex $[CoCl_3 \cdot 4NH_3]$
a) Coordination entity is $[Co(NH_3)_4Cl_2]^+$ b) Counter ion is Cl^-
c) Both (a) & (b) correct d) None of the above is correct

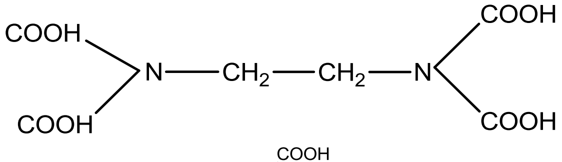
40. The pair of compounds having metals in their highest oxidation state is
a) $MnO_2, FeCl_3$ b) $[MnO_4]^-, CrO_2Cl_2$
c) $[Fe(CN)_6]^{3-}$, $[Co(CN)_3]$ d) $[NiCl_4]^{2-}$, $[CoCl_4]^-$

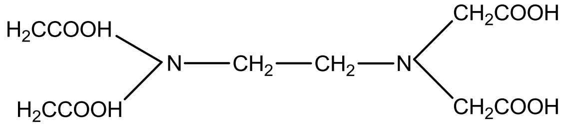
41. Geometrical shapes of the complexes formed by the reaction of Ni^{2+} with Cl^-, CN^- and H_2O , respectively, are
a) Octahedral, tetrahedral and square planar b) Tetrahedral ,square planar and octahedral
c) Square planar ,tetrahedral and octahedral d) Octahedral , square planar and octahedral

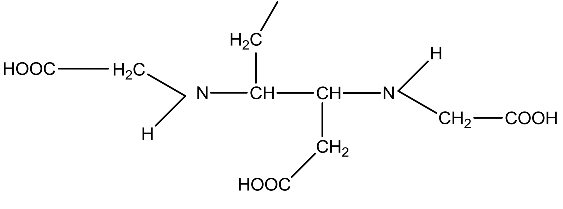
42. Geometrical shapes of the complexes formed by the reaction of Ni^{2+} with $CN^- \cdot CN^-$andH_2O respectively, are
a) Octahedral, tetrahedral and square planar
b) Tetrahedral, square planar and octahedral
c) Square planar, tetrahedral and octahedral
d) Octahedral, square planar and octahedral

43. The correct structure of ethylenediaminetetraacetic acid (EDTA) is

a)


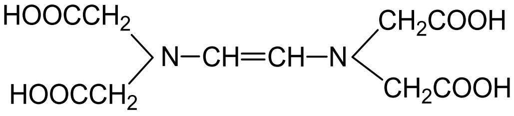
b)


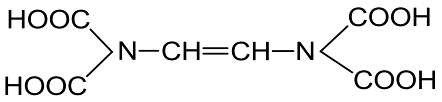
c)


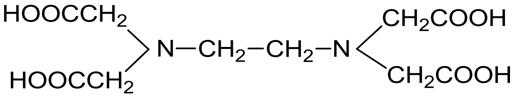
d)


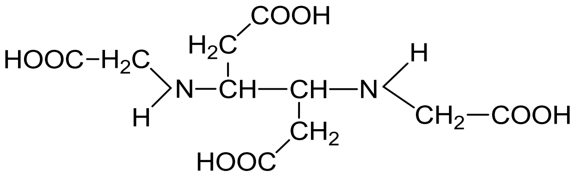
44. Which has maximum coordinating (donor) points?
a) DMG b) EDTA c) En d) Py

45. The correct structure of ethylenediaminetetraacetic acid (EDTA) is

a) 

b) 

c) 

d) 

46. 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
a) 3 b) 4 c) 5 d) 6

47. The ionisation isomer of $[Cr(H_2O)_4Cl(NO_2)C]$ is
a) $[Cr(H_2O)_4(O_2N)]Cl_2$
b) $[Cr(H_2O)_4Cl_2](NO_2)$
c) $[Cr(H_2O)_4Cl\ (ONO)]\ Cl$
d) $[Cr(H_2O)_4Cl_2(NO_2)].H_2O$

48. Which of the following complexes is not a chelate?
a) Bis (dimethylglyoximato) nickel (II)
b) Potassium ethylenediaminetetrathiocyanato chromate (III)
c) Tetrammine carbonatocobalt (III) nitrate
d) Trans-diglycinatoplatinum (II)

49. Dipole moment will be zero in complexes
I. $[Ni(CN)_4]^{2-}$II. $Cis - Pt[(NH_3)_2Cl_2$III. $trans - [Pt(NH_3)_2Cl_2]$
a) I and II b) I and III c) II and III d) I,II and III

50. A compound has the empirical formula $CoCl_3 \cdot 5NH_3$, When an aqueous solution of this compound is mixed with excess silver nitrate, 2 moles ofAgCl precipitate per mol of compound. On reaction with excess HClno NH_4^+ is detected. Hence, it is
a) All theCl show primary valency (PV)
b) Two Clshow (PV) and one Cl secondary valency (SV)
c) Two Cl show (PV) and one Cl (PV) as well as (SV)
d) All the Cl show (SV)

51. Aqueous Fe (III) ion develops intense red colour with SCN^-while Fe(II) does not. It is due to
a) Fe (III) ion forms a chare transfer complex with transfer complex with SCN^- ions
b) Fe(III) is reduced to Fe(I) which is deep red in colour
c) SCN^- ion oxidizes to CN^- ion that forms red complex with Fe (III) ion
d) SCN^- ion does not form any complex with Fe (II) ion

52. Select the incorrect statement
a) $[Ni(en)_3]^{2+}$ is less stable than $[Ni(NH_3)_6]^{2+}$
b) Increase in stability of the complexes due to presence of multidentate cyclic ligand is called macrocyclic effect
c) A complex ion that exchanges ligands slowly is said to be non-labile or inert
d) For a given ion and ligand, greater the charge on the metal ion, greater the stability

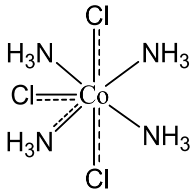
53. Why is $[Ni(en)_3]^{2+}$ nearly10^{10} times more stable than $[Ni(NH_3)_6]^{2+}$
a) NH_3evaporates easily and causes instability to$[Ni(NH_3)_6]^{2+}$ complex
b) Six NH_3 ligands cause steric hindrance around the Ni^{2+}centre
c) ‘en’ is a chelating ligand and forms thermodynamically more stable complexes
d) $NH_3$is the weakest ligand known

54. The complex $[Co(NH_3)_5(NO_2)]^{2+}$and $[Co(NH_3)_5(ONO)]^{2+}$ are called
a) Ionization isomer b) Linkage isomers c) Coordination isomer d) Geometrical isomer

55. Ink contains Fe^{3+}.Spot of ink can be removed by addition of $C_2O_4^{2-}$, Complex formed is

a) $[Fe(C_2O_4)_6]^{3-}$ b) $[Fe(C_2O_4)_3]^{3-}$ c) $[Fe(C_2O_4)_3]^{2-}$ d) $[Fe(C_2O_4)_3]^{4-}$

56. The complex



a) Is the molecular complex b) Has four ions in the aqueous solution
c) Primary valency of cobalt is six d) All the above are correct

57. Lead poisoning in the body can be removed by
a) EDTA in the form of calcium dihydrogen salt b) *cis*-platin
c) Zeise's salt d) DMG

58. What is CFSE of a free Co(II) ion on forming the tetrahedral chloro complex $[CoCl_4]^{2-}$ (in the units of Δ_0)
a) 0.6 b) 1.2 c) 1.8 d) 2.4

59. Potassium trisoxalatochromate (III) is
a) $K_3[Cr(C_2O_4)_3]$ b) $K[Cr(C_2O_4)_3]$ c) $K_2[Cr(C_2O_4)_3]$ d) $\boldsymbol{K_4[Cr(C_2O_4)_3]}$

60. Which of the following complexes exhibit optical isomerism?
a) Trans-tetramminedithiocyanatochromium (III) ion
b) Cis-diamminedicarbonatocobaltate (III) ion
c) Trans-diamminedicarbonatocobaltate (III) ion
d) Cis-glycinatoplatinum (II)

61. Select the correct statement
a) Chelation effect is maximum for five or six-membered rings
b) Complex ions in which ligands can be interchanged rapidly are said to be labile
c) Both (a) and (b) are correct
d) None of the above is correct

62. IUPAC name of is $K_4[Fe(CN)_6]$ is
a) Potassium hexacyano iron (II) b) Potassium iron (II) hexacyano
c) Tetrapotassium iron (II) hexacyano d) Potassium hexacyanoferrate (II)

63. Among $Ni(CO)_4 \cdot [Ni(CN)_4]^{2-}$ and $NiCl_4^{2-}$
a) $Ni(CO)_4$and$[Ni(CN)_4]^{2-}$ diamagnetic and$NiCl_4^{2-}$ is paramagnetic
b) $Ni(CO)_4$and $NiCl_4^{2-}$are diamagnetic and$[Ni(CN)_4]^{2-}$ are paramagnetic
c) $Ni(CO)_4$is diamagnetic and$[Ni(CN)_4]^{2-}$and $NiCl_4^{2-}$ are paramagnetic
d) $NiCl_4^{2-}$and$[Ni(CN)_4]^{2-}$are diamagnetic and $Ni(CO)_4$ is paramagnetic

64. Cu^{2+} and $Cd^{2+}$are distinguished through formation of complex $[Cu(CN)_4]^{3-}$ and $[Cs(CN)_4]^{2-}$, when H_2S gas is passed
a) There is yellow precipitate due to CdS b) There is black precipitate due to CuS
c) There is blue precipitation due to CuS d) There is precipitation of CuS and CdS together

65. Which one of the following complex species does not obey the EAN rule?
a) $[Cu(CN)_4]^{3-}$ b) $[Cr(NH_3)_6]^{3+}$ c) $[Fe(CN)_6]^{4-}$ d) $[Ni(CO)_4]$

66. Zeisse's salt is
a) $[Pt(NH_3)_2Cl_2]$ b) $K[PtCl_3(C_2H_4)]$ c) $Fe(C_5H_5)_2$ d) None of these

67. $[Co(NO_2)(NH_3)_5]^{2+}$ is yellow in colour, then its linkage isomer is
a) Yellow b) Red c) Blue d) orange

68. Select the correct statement
a) Excess of copper and iron are removed by the chelating ligands D-penicillamine and desferrioxime B via the formation of coordination compounds
b) Cis-platin is used in the treatment of cancer
c) Both (a) and (b) are correct
d) None of the above is correct

69. $[Fe^{II}(O_2)(CN)_4Cl]^{4-}$ is named as

a) Chlorotetracyanodioxoferrate (II) ion b) Chlorotetracyanoperoxoferrate (II) ion

c) Chlorotetracyanosuperoxoferrate (II) ion d) None of the above is correct

70. When concentrated HClis added to a, solution of $[Co(H_2O)_6]^{2+}$ ion, an intense blue colour develops due to the formation which one of the following

a) $[CoCl_6]^{4-}$ b) $[CoCl_4]^{2-}$ c) $[CoCl_2(H_2O)_4]$ d) $[CoCl(H_2O)_5]^+$

71. In the complex $[Pt(O_2)(en)_2(Br)]^{2+}$ coordination number and oxidation number of platinum are

a) 4,3 b) 4,5 c) 4,6 d) 6,4

72. Which of the following types of bonds are present in $CuSO_4 \cdot 5H_2O$

I. Electrovalent II. Covalent III. Coordinate

Select the correct answer out of

a) I,II b) II,III c) I,III d) I,II,III

73. EAN of the elements (*) are equal in

a) $Ni(CO)_4, [Fe(CN)_6]^{4-}$ b) $[Ni(en)_2]^{2+}, [Fe(H_2O)_6]^{2+}$

c) $[Co(CN)_6]^{3-}, [Fe(CN)_6]^{3-}$ d) $[Ni(en)_2]^{2+}, [Sc(H_2O)_6]^{3+}$

74. Match the geometry (given in Column I) with the complexes (in Column II) in

Column I	Column II
A. Octahedral	$[Ni(CN)_4]^{2-}$
B. Square planar	$Ni(CO)_4$
C. Tetrahedral	$[Fe(CN)_6]^{4-}$

A B C

a) 1 2 3 b) 3 1 2

c) 3 2 1 d) 2 1 3

75. The compound(s) that exhibit (s) geometrical isomerism is (are)

a) $[Pt(en)Cl_2]$ b) $[Pt(en)_2Cl_2$ c) $[Pt(en)_2Cl_2]Cl_2$ d) $[Pt(NH_3)_4Cl_2$

76. What is the ratio of uncomplexed to complexed Zn^{2+} ion in a solution that is 10 M in , in NH_3if the stability constant of is $[Zn(NH_3)_4]^{2+}$ is 3×10^9

a) 3.3×10^{-9} b) 3.3×10^{-11} c) 3.3×10^{-14} d) 3×10^{-13}

77. Complexes of which ions are not kinetically labile

a) Cu^{2+}, Ni^{2+} b) Cr^{3+}, Co^{3+}

c) V^{3+}, Ti^{4+} d) None of the above is correct

78. In which case racemic mixture is obtained on mixing its mirror images in 1:1 molar ratio

a) $[Cr(en)_3]^{3+}$ b) $[Ni(DMG)_2]$ c) Cis – $[Cu(Gly)_2]$ d) In all cases

79. Which of the following an example of coordination compound

a) $CoCl_3 \cdot 6NH_3$ b) $KCl \cdot MgCl_2 \cdot 6H_2O$

c) $FeSO_4 \cdot 6H_2O$ d) $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$

80. Which is the incorrect observation

a) For the complex , $[CoF_6]^{3-}$,F is a weak-field ligand, so that $\Delta_{oct} < P$ (electron –pairing energy) and is thus high spin complex

b) For the complex , $[Co(NH_3)_6]^{3+}$, $NH_3$is a strong-field ligand, so that $\Delta_{oct} > P$ and thus low spin complex

c) $\Delta_t = +\frac{4}{9}\Delta_{oct}$

d) Greater the ionic charge on the central metal ion the greater the value of Δ

81. In Which case geometrical isomers is possible with M as metal ion?

a) MX_2Y_2 b) MX_2Y_4 c) $MX_2Y_2Z_2$ d) In all cases

82. While Ti^{3+}, V^{3+}, Fe^{3+} and Co^{2+}afford a large number of tetrahedral complexes, Cr^{3+} never does this, the reason being

a) Cr^{3+} forces high crystal field splitting with a verieties of ligands

b) Crystal field stabilization energy in octahedral vis-à-vis tetrahedral Cr^{3+} system plays the Deciding role

c) The ionic radius of Cr^{3+} is the largest among the other M^{3+} ions mentioned

d) Electronegativity of Cr^{3+} is the largest among these trivalent 3d- metals and so chromium prefers to be associated with as many ligands as its ionic radius permits

83. In an octahedral complex , if ligands on one axis are displaced little away from their ideal positions the crystal field splitting of d-orbitals for this complex is as given below

$d_{x^2-y^2} d_{z^2} d_{xy} d_{yz} d_{xz}$

The ligands are displaced on which axis/axes

a) x-and y
b) y-only
c) x-only
d) z-only

84. Of the following complex ions, one exhibits isomerism. That is

a) $[Ag(NH_3)_2]^+$
b) $[Co(NH_3)_5NO_2]^{2+}$
c) $[Pt(en)Cl_2]$
d) $[Co(NH_3)_5Cl]^{2+}$

85. A compound has the empirical formula $CoCl_3 \cdot 5NH_3$, When an aqueous solution of this compound is mixed with excess silver nitrate, 2 moles ofAgCl precipitate per mol of compound. On reaction with excess HClno NH_4^+ is detected. Hence, it is

a) $[Co(NH_3)_5Cl_2]Cl$
b) $[Co(NH_3)_5Cl]Cl_2$
c) $[Co(NH_3)_5Cl_3]$
d) $[Co(NH_3)_4Cl_2]Cl \cdot NH_3$

86. Hexammine platinum (IV) tetrachloroplatinate (II) is

a) $[Pt(NH_3)_6][PtCl_4)_3]$
b) $[Pt(NH_3)_6[PtCl_4]$
c) $[Pt(NH_3)_6][PtCl_4]_2$
d) $[Pt(NH_3)_6][PtCl_4]_2$

87. The crystal field-splitting for Cr^{3+} , ion in octahedral field increases for ligands I^-, H_2O, NH_3, CN^- and the order is

a) $I^- < H_2O < NH_3 < CN^-$
b) $CN^- < I^- < H_2O < NH_3$
c) $CN^- < NH_3 < H_2O < I^-$
d) $NH_3 < H_2O < I^- < CN^-$

88. For the complex ML_2, stepwise formation constants for

$M + L \rightleftharpoons ML$

$ML + L \rightleftharpoons ML_2$

are 4 and 3. Hence, overall stability constant for

$M + 2L \rightleftharpoons ML_2$ is

a) 12
b) 7
c) 1.33
d) 0.75

89. The formula of a carbonyl complex of cobalt,$(CO)_nCo - Co(CO)_n$,in which there a single covalent Co − Cobond is

a) $Co_2(CO)_4$
b) $Co_2(CO)_6$
c) $Co_2(CO)_8$
d) $Co_2(CO)_{10}$

90. The spin only magnetic moment value (in Bohr magneton units) of $Cr(CO)_6$is

a) 0
b) 2.84
c) 4.90
d) 5.92

91. Select the correct statement

a) $[Fe(CN)_6]^{4-}]$and $[Fe(H_2O)_6]^{2+}$ can be distinguished by magnetic moment
b) $[Ni(CN)_6]^{2-}$ and $[Ni(CO)_4]$both are diamagnetic
c) $[Fe(CN)_6]^{3-}$ and $[Co(NH_3)_6]^{2+}$ have equal magnetic moment
d) All the above are correct statements

92. Which is true for ,$[Ni(en)_2]^{2+}$, Z(Ni)=28

a) Paramagnetism, dsp^2, square planar, CN of Ni =2
b) Diamagnetism, dsp^2 square planar, CN of Ni =4
c) Diamagnetism, sp^3 tetrahedral, CN of Ni =4
d) Paramagnetism , sp^3 square planar, CN of Ni =4

93. Among the following complexes $(K-P)K_3[Fe(CN)_6](K)$, $(Co(NH_3)_6Cl_3(L)$, $Na_3[Co(ox)_3](M)$, $[Ni(H_2O)_6]Cl_2(N)$, $K_2[Pt(CN)_4](O)$ and $[Zn(H_2O)_6](NO_3)_2(P)$ The diamagnetic complexes are

a) K, L, M, N
b) K, M, O, P
c) L,M, O, P
d) L, M, N, O

94. Extraction of Ag from sulphide ore and removal of unreacted silver from photographic plate involve complexes

a) $[Ag(S_2O_3)_2]^{3-}$ in both
b) $[Ag(CN)_2]^-$in both
c) $[Ag(S_2O_3)_2]^{3-}, [Ag(CN)_2]^-$
d) $[Ag(CN)_2]^-, [Ag(S_2O_3)_2]^{3-}$

95. $FeSO_4$ on treatment with excess of KCN gives a product that does not give test of Fe^{2+},the product formed is
a) $[Fe(CN)_2]SO_4$ b) $K_3[Fe(CN)_6]$ c) $K_4[Fe(CN)_6]$ d) $KFe[Fe(CN)_6]$

96. $[Fe(H_2O)_6]^{2+}$ and $[Fe(CN)_6]^{4-}$ differ in
a) geometry, magnetic moment b) Magnetic moment and colour
c) Geometry and hybridization d) None of the above

97. Select the correct statement
a) The $d_{x^2-y^2}$andd_{z^2} orbitals are directed alon a set of mutually perpendicular x, y and z-axes. As a group these orbitals are called, e_g orbitals
b) Thed_{xy}, d_{yz}andd_{xy} orbitals lie between the axes and collectively called t_{2g} orbitals
c) Both (a) & (b) are correct
d) None of the above is correct

98. $[Pt\,(NH_3)(NO_2)Py\,(NH_2OH)]^+$will form geometrical isomers
a) 2 b) 3 c) 4 d) 5

99. The number of water molecule(s) directly bonded to the metal centre in $CuSO_4\,.5H_2O$ is
a) 1 b) 2 c) 3 d) 4

100. Extraction of metals or other processes is through the complex formation
I. Cyanide process
II. Monds process
III. Photographic fixing process
Complexes formed in these methods are
I II III
a) $[Ag(NH_3)_2]$ $ClNi(CO)_4$ $[Ag(CN)_2]^-$ b) $[Ag(CN)_2]^-$ $Ni(CO)_4$ $[A(S_2O_3)_2]^{3-}$
c) $[Ag(CN)_2]^-$ $[Ag(S_2O_3)_2]^{3-}$ $Ni(CO)_4$ d) $[Cd(CN)_4]^{2-}$ $Ni(CO)_4$ $[Ag(S_2O_3)_2]^{3-}$

101. The intense blue colour of Prussian blue salts arises from which one of the following?
a) d-d transition b) Inter valence electron transfer
c) Ligand to metal charge transfer d) Metal to ligand chare transfer

102. $NiCl_2\{P(C_2H_5)_2(C_6H_5)\}_2$ exhibits temperature dependent magnetic behavior (paramagnetic/diamagnetic) the coordination geometries of Ni^{2+} in the paramagnetic and diamagnetic states are respectively
a) Tetrahedral and tetrahedral b) Square planar and square planar
c) Tetrahedral and square planar d) Square planar and tetrahedral

103. The reaction between metallic silver and aqueous NaCN forming a soluble complex occurs in the presence of
a) Nitrogen b) Helium c) Argon d) Oxygen

104. Which complex gives three chloride ions per formula unit?
a) $CrCl_3 \cdot 6H_2O$ b) $CrCl_3 \cdot 5H_2O$ c) $CrCl_3 \cdot 4H_2O$ d) All of these

105. The spin only magnetic moment value (in Bohrmagneton units) of $Cr(CO)_6$ is
a) 0 b) 2.84 c) 4.90 d) 5.92

106. The crystal field splitting energy for octahedral (Δ_0) and tetrahedral (Δ_t) complexes is related as
a) $\Delta_t = -\frac{4}{9}\Delta_o$ b) $\Delta_t = \frac{1}{2}\Delta_o$ c) $\Delta_o = -2\Delta_t$ d) $\Delta_o = -\frac{4}{9}\Delta_t$

107. Which one of the following compounds has tetrahedral geometry
a) $[Ni(CN)_4]^{2-}$ b) $[NiCl_4]^{2-}$ c) $[PdCl_4]^{2-}$ d) $[Pd(CN)_4]^{2-}$

108. If there is 100% ionisation of this complex A compound has the empirical formula $CoCl_3 \cdot 5NH_3$, When an aqueous solution of this compound is mixed with excess silver nitrate, 2 moles ofAgCl precipitate per mol of compound. On reaction with excess HClno NH_4^+ is detected, its 1 M solution at 300 k will have osmotic pressure equal to
a) 8.21 atm
b) 24.63 atm
c) 49.28 atm
d) 73.89 atm

109. Which of the following compounds show optical isomerism?
I. $Cis-[Co(NH_3)_4Cl_2]^+$II.$Trans-[Co(en)_2Cl_2]^+$III.$Cis-[Co(en)_2Cl_2]^+$IV.$[Co(en)_3]^{3+}$
Select the correct answer using the codes given below
a) I and IV b) II and III c) III and IV d) I,III and IV

110. Which kind of isomerism is exhibited by octahedral $Co(NH_3)_4Br_2Cl$?
a) Geometrical and ionisation b) Geometrical and optical
c) Optical and ionisation d) Geometrical only

111. Which contains monovalent cationic complex
a) $CoCl_3 \cdot 6NH_3$ b) $[CoCl_3 \cdot 5NH_3$ c) $CoCl_3 \cdot 4NH_3$ d) $CoCl_3 \cdot 3NH_3$

112. As per IUPAC nomenclature, the name of the complex $[Co(H_2O)_4(NH_3)_2]Cl_3$ is
a) Tetraaquadiaminecobalt (III) chloride b) Tetraaquadiaminecobalt (III) chloride
c) Diaminetetraquacobalt (III) chloride d) Diamminetetraaquacobalt (III) chloride

113. The compound having tetrahedral geometry is
a) $[Ni(CN)_4]^{2-}$ b) $[Pd(CN_4)]^{2-}$ c) $[PdCl_4]^{2-}$ d) $[NiCl_4]^{2-}$

114. The IUPAC name of $[Ni(NH_3)_4][NiCl_4]$ is
a) Tetrachloro nickel (II) – tetraammine nickel (II)
b) Tetraammine nickel (II) –tetrachloro nickel(II)
c) Tetraammine nickel (II) –tetrachloro nickelate(II)
d) Tetrachloro nickel (II) –tetraammine nickelate(0)

115. What are the spin-only magnetic moments (in BM) for ion in square-planar and octahedral geometry respectively
a) 0,2,83 b) 2.83,2.83 c) 2.83,0 d) 0,0

116. Which one of the following is the correct order of the wavelengths of absorption for complexes?
I. $[Ni(H_2O)_6]^{2+}$II. $[Ni(NH_3)_6]^{2+}$III. $[Ni(NO_2)_6]^{4-}$
a) I>II>III b) II>I>III c) III>II>I d) III>I>I

117. The coordination number of Pt in the complex ion $[Pt(en)_2Cl_2]^{2+}$ is
a) 3 b) 4 c) 5 d) 6

118. Which has maximum EAN of the underlined atoms
$(Cr = 24, Co = 27, Fe = 26, Ni = 28)$
a) $[Cr(EDTA)]^-$ b) $[Co(en)_3]^{3+}$ c) $[Fe(C_2O_4)_3]^{3-}$ d) $[Ni(CN)_4]^{2-}$

119. The ionization isomer of $[Cr(H_2O)_4Cl(NO_2)]Cl$ is
a) $[Cr(H_2O)_4(O_2N)]Cl_2$ b) $[Cr(H_2O)_4Cl_2](NO_2)$
c) $[Cr(H_2O)_4Cl(ONO)]Cl$ d) $[Cr(H_2O)_4Cl_2(NO_2)] \cdot H_2O$

120. Which one of the following complexes is expected to have lowest Δ_0 values?
a) $[Co(NH_3)_6]^{3+}$ b) $[CoF_6]^{3-}$ c) $[Rh(NH_3)_5]^{3+}$ d) $[Ir(NH_3)_6]^{3+}$

121. Primary and secondary valency of Pt in $[Pt(en)_2Cl_2]Cl_2$are
a) 4,4 b) 4,6 c) 6,6 d) 4,2

122. Which is Prussian blue
a) $KF_e^{III}[Fe^{II}(CN)_6]$ b) $KFe^{III}[Fe^{III}(CN)_6]$ c) $K_2[Fe^{II}(CN)_6]$ d) $K_3[Fe(CN)_6]$

123. In the complex $PtCl_4 \cdot 5NH_3$
a) Two Cl^- ligands satisfy primary as well as secondary valencies
b) Four NH_3 ligands satisfy secondary valency
c) Ions are $[Pt(NH_3)_4Cl_2]^{2+}$ and $2Cl^-$
d) All the above are correct statements

124. Select the correct statement about the complex $[Co(NH_3)_5SO_4]Br$
a) Its ionization isomer is $[Co(NH_3)_5Br]SO_4$
b) It gives yellow precipitate with $AgNO_3$
c) Its ionization isomer give white precipitate with $BaBl_2$
d) All the above are correct statements

125. In the complex $[Fe(NH_3)_6]^{3+}$
a) Fe^{3+} is a Lewis acid b) $NH_3$is a Lewis base

c) Both (a) & (b) correct
d) None is Correct

126. Following ligands can show linkage isomerism
a) CNS
b) NO_2
c) CN
d) All of these

127. Among the following complexes (*K-P*),
$K_3[Fe(CN)_6](K)$, $[Co(NH_3)_6]Cl_3(L)$,
$Na_3[Co(ox)_3](M)$
$[Ni(H_2O)_6]Cl_2$ (N) , and
$[Zn(H_2O)_6](NO_3)_2(P)$ the diamagnetic complexes
a) *K, L, M, N*
b) *K, M, O, P*
c) *L, M, O, P*
d) *L, M, N, O*

128. Which one of the following is an example of coordination isomerism
a) $[Co(NH_3)_5Br]SO_4$and $[Co(NH_3)_5SO_4]Br$
b) $[Co(NH_3)_5NO_2]Cl_2$ and $[Co(NH_3)_5ONO]Cl_2$
c) $[Cr(H_2O)_6Cl_3$and $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$
d) $[Cr(NH_3)_6][Co(CN)_6]$and $[Co(NH_3)_6][Cr(CN)_6$

129. Which of the following complexes is diamagnetic?
a) $[Fe(CN)_6]^{4-}$
b) $[Cu(NH_3)_4]^{2+}$
c) $[Ti(H_2O)_6]^{3+}$
d) $[Ni(en)_2]^{2+}$

130. Which is used in cancer-chemotherapy?
a) Cis-platin
b) Zeise's salt
c) Both (a) and (b)
d) None of these

131. The complex $[Fe(H_2O)_5NO]^{2+}$ is formed in the brown ring test nitrates when freshly prepared $FeSO_4$ solution is added to aqueous solution of NO_3^- followed by addition of conc. H_2SO_4 Select correct statement about this complex
a) Colour change is due to charge transfer
b) It has iron in $+1$ oxidate state and nitrosyl as NO^+
c) It has magnetic moment of 3.87 BM confirming three unpaired electrons in Fe
d) All the above are correct statements

132. Optical isomers are
1. enantiomers
2. non-superimposable
3. have the property of chirality
4. form racemic mixture if present in 1:1 ratio

Select the correct alternate
a) I,II, Iv are correct
b) I,II III are correct
c) All are correct
d) All are incorrect

133. In the ring compounds formed by bidentate ligands ,on binding to a metal or metal ions, are called
a) Ligands
b) Chelates
c) Complexes
d) Ambident

134. Select the correct statement
a) Geometrical isomer may differ in dipole moment and visible/UV spectra
b) Complexes of the type $[Ma_3b_3]$can also have facial (fac) and meridional (mer) isomer
c) No optical isomer exists for the complex $trans - [Co(en)_2Cl_2]^+$
d) All the above are correct

Multiple Correct Answers Type

135. The effective atomic number of$Co(CO)_4$ is 35 and hence ,is less stable, It attains stability by
a) Oxidation of Co
b) Reduction of Co
c) Dimerization
d) Tetramerization

136. Which of the following complexes will have four different isomers
a) $[Co(en)_2Cl_2]Cl$
b) $[Co(en)(NH_3)_2Cl_2]Cl$
c) $[Co(PPh_3)_2(NH_3)Cl_2]Cl$
d) $[Co(en)_3]Cl_3$

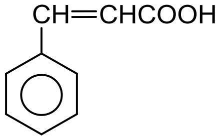
137. Which of the following coordination compounds would exhibit optical isomerism
a) Pentaamminenitrocobalt (III) iodide
b) Diamminedichloroplatinum (II)
c) *Trans*-dicyanobis (ethylenediamine) chromium (III) chloride
d) *Tris*-(ethylenediamine) cobalt (III) bromide

138. Which of the following can show coordination isomerism
a) $[Cu(NH_3)_4][PtCl_4]$
b) $[Fe(NH_3)_6]_2[Pt(CN)_6]_3$

c) $[Co(NH_3)_6][Cr(C_2O_4)_3]$ d) $[Pt(en_3)](SO_4)_2$

139. Which of the following statement is/are false?
    a) $[Ni(CO)_4]$ is high spin complex
    b) Weak ligands like F^-, Cl^- and OH^- usually form low spin complexes
    c) $[FeF_6]^{3-}$ is high spin complex
    d) Strong ligand like CN^- and NO_2^-, generally form high spin complexes

140. The pair (s) of coordination complexes/ions exhibiting the same kind of isomerism is/are
    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$[Pt(NH_3)_3Cl]Br$

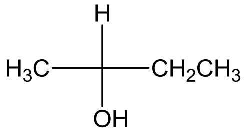
141. The compound  may be called as

    a) Cinnamic acid b) Mandelic acid
    c) Citric acid d) 3-phenylprop-2-ene-1-oic acid

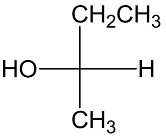
142. Nitroprusside ion is
    A: $[Fe^{II}(CN)_5NO^+]^{2-}$and not
    B:$[Fe^{III}(CN)_5NO]^{2-}A.$ and Bcan be differentiated by
    a) Estimating the concentration of iron b) Measuring the concentration of CN^-
    c) Measuring the magnetic moment d) Thermally decomposing the compound

143. $K_4[Fe(CN)_6]$ is used in the identification of
    a) Cu^{2+} ions b) Fe^{3+} ions c) Cd^{2+} ions d) Fe^{2+} ions

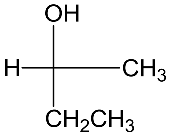
144. Consider the following compounds and choose the correct statement



(I)



(II)



(III)

    a) Structure (I) and (II) are identical b) All are identical
    c) Structure (I) and (III) are identical d) Structure (I) and (II) are different

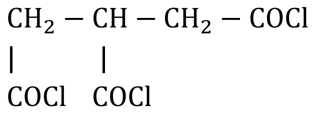
145. Bidentate ligands are
    a) $C_2O_4^{2-}$ (oxalate) b) En (ethylenediamine)
    c) DMG (dimethyl glyoxime) d) Gly (glycine)

146. In which of the following, the chemical formula and the name correctly matched?
    a) $K_3[Cr(C_2O_4)_3]$ – Potassium trioxalatochromate (III)
    b) $K[Pt(NH_3)Cl_5]$ – Potassium amminepentachloro palatinate (IV)
    c) $Na_2[Ni(EDTA)]$ – Sodium ethylenediaminetetra Acetonickel (I)
    d) $[Ag(CN)_2]^-$ – Dicyanoargentate (I)

147. Which of the following can exist in syn and anti forms?
    a) $(C_6H_5)C = NOH$ b) $C_6H_5 - N = N - OH$
    c) $C_6H_5 - N = N - C_6H_5$ d) $C_6H_5 - N = NOH$

148. $CN^-$is a strong field ligand .This is due to the fact that
    a) It carries negative charge
    b) It is a conjugate base of weak acid
    c) It can accept electrons from metal species
    d) It forms high spin complexes with metal species

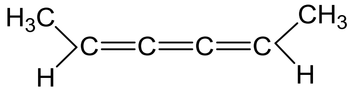
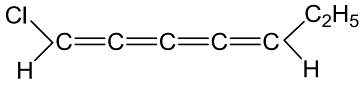
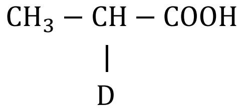
149. Which of the following name is/are correct for compound is/are



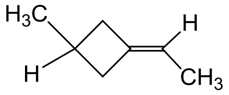
$$\begin{array}{l} CH_2 - CH - CH_2 - COCl \\ | \qquad\quad | \\ COCl \quad COCl \end{array}$$

a) Pentanedinoyl chloride b) Alkanedinoyl chloride
c) 3-chloroformyl pentane dinoylchloride d) None of the above

150. The compound $CH_3 - C \equiv C - CH_3$ can be named as
a) Allylene b) But-2-yne
c) Dimethyl acetylene d) crotonylene

151. Which is optically active?
a) 
b) 
c) 

$$\begin{array}{l} CH_3 - CH - COOH \\ \qquad\quad | \\ \qquad\quad D \end{array}$$

d) 

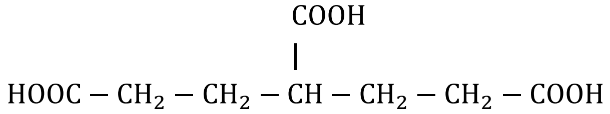
152. Which of the following statements are not correct?
a) A *meso* compound is optically active because the rotation caused by any molecule is cancelled by an equal and opposite rotation caused by another molecules that is the mirror image of the first
b) A *meso* compound has chiral centres and but exhibits no optical activity
c) A *meso* compound has no chiral centres and thus exhibits no optical activity
d) A *meso* compound has molecules which are superimposable on their mirror image a even through they contain chiral centres

153. For which of the following d^n configuration of octahedral complexes, can't exist in both high spin and low spin forms
a) d^5 b) d^6 c) d^8 d) d^3

154. Which of the following complexes are chelates
a) *bis*-(dimethyl glyoximato)nickel (III)
b) Potassium ethylenediaminetetracyanato chromate (III)
c) Tetraamminedicyanocobalt (III) nitrate
d) Trans-diglycinatopalladium (II)

155. Which of the following are paramagnetic
a) $[Ni(CN)_4]^{2-}$ b) $[NiCl_4]^{2-}$ c) $[CoF_6]^{3-}$ d) $[Co(NH_3)_6]^{3+}$

156. Which of the following name are correct for the compound?



$$\begin{array}{l} \qquad\qquad\qquad\qquad COOH \\ \qquad\qquad\qquad\qquad | \\ HOOC - CH_2 - CH_2 - CH - CH_2 - CH_2 - COOH \end{array}$$

a) Heptane-1,4,7-trioic acid b) 4-carboxy heptane-1,7-dioic acid
c) Pentan-1,3,5-tricarboxylic acid d) All of the above

157. 0.0012 mol of $CrCl_3 \cdot 6H_2O$ was passed through a cation exchange resin and acid coming out of it required 28.5 mL of 0.125 M NaOH. Hence, complex is
a) $[Cr(H_2O)_5Cl_2 \cdot H_2O$ b) $[Cr(H_2O)_4Cl_2] \cdot 2H_2O$ c) $[Cr(H_2O)_6]Cl_3$ d) $[Cr(H_2O)_3Cl_3] \cdot 3H_2O$

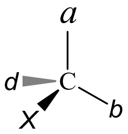
158. Which of the following are cyclic compounds?
a) Borazole b) Pyrrole c) Anthracene d) Isobutylene

159. Which are correct statements?
a) $[Ag(NH_3)_2]^+$is linear with *sp* hybridized Ag^+ ion
b) $NiCl_4^{2-}$, Vo_4^{3-} and MnO_4^{3-}have tetralhedral geometry
c) $[Cu(NH_3)_4]^{2+}$, $[Pt(NH_3)_4]^{2+}$ and $[Ni(CN)_4]^{2-}$ have dsp^2hybridisation of the metal ion
d) $Fe(CO)_5$have bipyramidal structure with hybridised iron

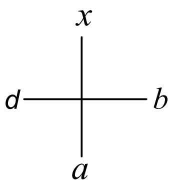
160. Using anhydrous $AlCl_3$ as catalyst, which one of the reaction produces ethyl benzene?
a) $CH_3CH_2OH + C_6H_6$ b) $CH_3CH{=}CH_2 + C_6H_6$ c) $CH_2{=}CH_2C_6H_6$ d) $CH_3—CH_3 + C_6H_6$

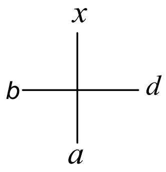
161. In which of the following compounds transition metal may have zero oxidation state
a) $[Fe(CO)_5]$ b) $[Ni(CN)_4]^{2-}$ c) Fe_2O_3 d) CrO_5

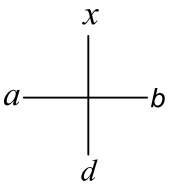
162. The Fischer-projection of the molecule as represented in the wedge

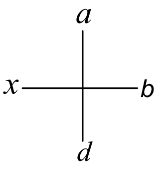
eg, 

is/are not

a) 

b) 

c) 

d) 

163. In which of the following complexes metal atoms have zero oxidation state?
a) $[Fe_2(CO)_9]$ b) $[Ni(CO)_4]$ c) $Na[Co(CO)_4]$ d) Cu

164. Identify the complexes which is/are eapected to be coloured
a) $Ti(NO_3)_4$ b) $[Cu(NCCH_3)]^+BF_4^-$ c) $[Cr(NH_3)_6]Cl_3$ d) $K_3[VF_6]$

165. Which is/are correct statement(s)
a) $[Co(en)_3][Cr(CN)_6]$will display coordination isomerism
b) $[Mn(CO)_5(SCN)]$will display linkage isomerism
c) $[Co(NH_3)_5(NO_3)]SO_4$ will display ionization isomerism
d) None of the above is correct

Assertion - Reasoning Type

This section contain(s) 0 questions numbered 166 to 165. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

166

Statement 1: The IUPAC name for the compound, $NCCH_2CH_2COOH$ is 3-cyano propanoic acid

Statement 2: $-COOH$ is considered as substituent group while – CN is considered as the principal functional group

167

Statement 1: $CH_3 - CH(Cl)OH$ is a optically active compound

Statement 2: Dissymetry arises in a chemical compound owing to the presence of chiral centre

168

Statement 1: F^- ion is weak ligand and forms outer orbital complex.

Statement 2: F^- ion can not force the electrons of d_{z^2} and $d_{x^2-y^2}$ orbitals to occupy d_{xy} d_{yz} and d_{zx} orbitals of the same shell.

169

Statement 1: Highly charged cations are expected to form most strongly acidic hydrated cations

Statement 2: The acidity of a hydrated metal ion depends on the strength of the bond between cation and oxygen

170

Statement 1: A compound whose molecule has D configuration will always be dextrorotatory

Statement 2: Compounds having D configuration may be dextrorotatory or levorotatory

171

Statement 1: The IUPAC name of the $CH_3 - CH = CH - C \equiv CH$ is pent-3-en-1-yne and not pent-2-ene-4-yne

Statement 2: Lowest locant rule for multiple bond is preferred

172

Statement 1: EDTA forms complexes with a large number of metal ions

Statement 2: It coordinates with 6 points of attachement to the metal, 4 O-atoms and two N atoms

173

Statement 1: Ions with more than five $3d$ electrons have usually slightly larger magnetic moment than calculated on the basis of $\mu = \sqrt{n(n+2)}$

Statement 2: The maximum number of unpaired d-electrons is five as in $Mn^{2+}$and Fe^{3+} and so, $\mu = 5.92$ for 5 unpaired electrons

174

Statement 1: The conversion of an optically active compound into its enantiomer is called Walden inversion

Statement 2: A racemic mixture is optically inactive due to internal compensation

175

Statement 1: Staggered form is less stable than the eclipsed form

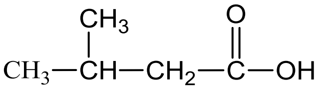
Statement 2: The conformation in which the bond pairs of two central atoms are very far from one another is called staggered form

176

Statement 1: d-d transition is not possible in $[Sc(H_2O)_6]^{3+}$

Statement 2: $[Ti(H_2O)_6]^{4+}$ is coloured while $[Sc(H_2O)_6]^{3+}$ is colourless

177

Statement 1: 
$CH_3-CH(CH_3)-CH_2-C(=O)-OH$ is 3-methyl butanoic acid

Statement 2: In poly functional group, the substituent should be given lower number than the principal functional group

178

Statement 1: Geometrical isomerism is also called C is- trans isomerism.

Statement 2: Tetrahedral complexes shows geometrical isomerism.

179

Statement 1: In keto-enol tautomerism of dicarbonyl compounds, the enol form is preferred in contrast to the keto-form

Statement 2: The enol form is more stable due to resonance

180

Statement 1: $[Ti(H_2O)_6]^{3+}$ is coloured while $[Sc(H_2O)_6]^{3+}$ is colourless.

Statement 2: *d-d* transition is not possible in $[Sc(H_2O)_6]^{3+}$.

181

Statement 1: A hydroxy group directly attached to a carbonyl group constitutes a carboxyl group

Statement 2: Ester is a family of carboxylic acid derivatives in which – OH group is altered by other group

182

Statement 1: $[Cr(NH_3)_6]^{3+}$ is paramagnetic.

Statement 2: $[Cr(NH_3)_6]^{3+}$ shows d^2sp^3 hybridisation.

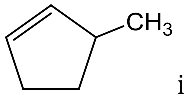
183

Statement 1: Hydrazine has two N as donor atoms and behaves as a chelating ligand

Statement 2: Hydrazine is a neutral ligand

184

Statement 1:



is 3-methyl cyclopentene

Statement 2: In the numbering, double bonded carbon atom gets preference to the alkyl group in cycloalkenes

Matrix-Match Type

This section contain(s) 0 question(s). Each question contains Statements given in 2 columns which have to be matched. Statements (A, B, C, D) in **columns I** have to be matched with Statements (p, q, r, s) in **columns II**.

185. Match the complex (in Column I) with the equivalent conductance (in Column II)

	Column-I		Column- II
(A)	$[Pt(NH_3)_5Cl]Cl_3$	(1)	229
(B)	$[Pt(NH_3)_4Cl_2]Cl_2$	(2)	97
(C)	$[Pt(NH_3)_3Cl_3]Cl$	(3)	404

(D) $[Pt(NH_3)_6]Cl_4$	(4) 523

CODES :

	A	B	C	D
a)	2	3	4	1
b)	1	4	3	2
c)	3	1	2	4
d)	4	2	1	3

186. Match the complex (in Column I) with its corresponding (ies) (given in Column II)

Column-I	**Column- II**
(A) [Ni(DMG)2]	(1) Chelation
(B) $Na_3[Fe(C_2O_4)_3]$	(2) Paramagnetic
(C) $[Ni(en)_2]Cl_2$	(3) Diamagnetic
(D) $Ni(Co)_4$	(4) Conducting
	(5) H-bonding

CODES :

	A	B	C	D
a)	1,2,4	3	1,3,5	1,3,4
b)	1,3,5	1,2,4	1,3,4	3
c)	3	1,3,4	1,2,4	1,3,5
d)	1,2,4	1,3,5	3	1,2,4

187. Match the complex (in Column I) with the hybridization of the central ion (in Column II)

Column-I	**Column- II**
(A) $Ni(CO)_4$	(1) sp^3d^2
(B) $[Ni(CN)_4]^{2-}$	(2) sp^3
(C) $[Fe(CN)_6]^{4-}$	(3) d^2sp^3
(D) $[MnF_6]^{4-}$	(4) dsp^2

CODES :

	A	B	C	D
a)	2	4	3	1
b)	4	2	1	3

c)	1	3	4	2
d)	3	1	2	4

188. Match list I and list II and choose the correct matching codes

	Column-I		**Column- II**
(A)	$[Ni(CN)_4]^{2-}$	(1)	Ti^{4+}
(B)	Chlorophyll	(2)	sp^3 ;paramagnetic
(C)	Ziegler-Natta catalyst	(3)	non-planar
(D)	$[NiCl_4]^{2-}$	(4)	Mg^{2+}
(E)	Deoxyhaemoglobin	(5)	Planar
		(6)	dsp^3;diamagnetic

CODES :

	A	**B**	**C**	**D**	**E**
a)	6	4	1	2	3
b)	2	4	1	6	3
c)	2	4	1	6	3
d)	6	4	1	2	3
e)	2	4	3	6	3

189. Match the complex (in Column I) with the geometry (in Column II)

	Column-I		**Column- II**
(A)	$[Ni(CN)_4]^{2-}$	(1)	Tetrahedral
(B)	$[ZnCl_4]^{2-}$	(2)	Trigonal bipyramidal
(C)	$[Fe(CO)_5]$	(3)	Square planar
(D)	$[Co(NO_2)_6]^{4-}$	(4)	Square pyramid
		(5)	Octahedral

CODES :

	A	**B**	**C**	**D**
a)	2	3	1	4
b)	3	1	2	5
c)	5	2	3	1
d)	1	4	5	2

190. Match the following

	Column-I		**Column- II**
(A)	Cyclohexane carboxylic acid	(1)	$CH_3 - CH(CH_3)CH_2 - CH(CH_3) - CH(CH_3) - CH_3$
(B)	2,3,5-trimethyl hexane	(2)	$CH_3 - CH(CH_3)CH_2 - CH(CH_3) - CH(CH_3) - CH_3$
(C)	Trimethyl bismuthane	(3)	$CH_3 - CH(CH_3)CH_2 - CH(CH_3) - CH(CH_3) - CH_3$
(D)	Bicyclo [4.2.0] octane 1-ol	(4)	$CH_3 - CH(CH_3)CH_2 - CH(CH_3) - CH(CH_3) - CH_3$

CODES :

	A	**B**	**C**	**D**
a)	4	1	2	3
b)	1	2	4	3
c)	2	1	4	3
d)	3	2	4	1

191. Match the complex (in Column I) with its coprresponding property (ies) (in Column II)

	Column-I		**Column- II**
(A)	$[Cr(NO_2)_2(NH_3)_2Cl_2]$	(1)	Geometrical isomerism
(B)	$[Cr(NH_3)_4Cl_2]Br$	(2)	Ionisation isomerism
(C)	$[Cr(en)_3]^{3+}$	(3)	Optical isomerism
(D)	$[Pt(NH_3)_2Cl_2][Cu(CN)_4]$	(4)	Linkage isomerism
		(5)	Coordinate isomerism

CODES :

	A	**B**	**C**	**D**
a)	1,4	1,2	3	1,4,5
b)	1,2	3	1,4,5	1,4
c)	3	1,4,5	1,4	1,2
d)	1,4,5	1,4	1,2	3

192. Match the complex (in Column I) with the oxidation number of Co (in Column II)

	Column-I		**Column- II**
(A)	$[Co(NCS)(NH_3)_5]SO_3$	(1)	-1
(B)	$Na[Co(CO_4)]$	(2)	0

(C)	$Na_4[Co(S_2O_3)_3]$	(3)	+1
(D)	$Co_2(CO)_5$	(4)	+2
		(5)	+3

CODES :

	A	**B**	**C**	**D**
a)	1	2	3	4
b)	5	3	2	1
c)	3	4	5	3
d)	5	1	4	2

193. Match the complex (in Column I) with the type of isomerism (in Column II)

	Column-I		**Column- II**
(A)	$[Co(NH_3)_4Cl_2]$	(1)	Optical
(B)	$cis - [Co(en)_2Cl_2]$	(2)	Ionisation
(C)	$[Co(en)_2(NO_2)Cl]SCN$	(3)	Coordination
(D)	$[Co(NH_3)_6]Cr(CN)_6]$	(4)	Geometrical

CODES :

	A	**B**	**C**	**D**
a)	4	1	2	3
b)	1	2	3	4
c)	2	3	4	1
d)	3	4	1	2

194. Match the compounds given in List-I with their characteristic reactions given in List-II. Select the correct option.

	Column-I		**Column- II**
(A)	$CH_3(CH_2)_3NH_2$	(p)	Alkaline hydrolysis
(B)	$CH_3C \equiv CH$	(q)	With KOH(alcohol) and $CHCl_3$ produces bad smell
(C)	$CH_3CH_2COOCH_3$	(r)	Gives white ppt. with ammoniacal $AgNO_3$.
(D)	$CH_3CH(OH)CH_3$	(s)	With Lucas reagent cloudiness appears after 5 minutes

CODES :

	A	**B**	**C**	**D**

a)	ii	i	iv	iii
b)	iii	ii	i	iv
c)	ii	iii	i	iv
d)	iv	ii	iii	i

Linked Comprehension Type

This section contain(s) 28 paragraph(s) and based upon each paragraph, multiple choice questions have to be answered. Each question has atleast 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 195 to -195

Splitting energy (Δ_o)can usually be measured from the absorption spectra of the complex ions. In simple cases when light is absorbed by a complex ion, an electron in one of the lower energy orbitals is excited to one of the higher energy orbital. The energy corresponding to the frequency of absorbed light is equal to Δ_o. If value of Δ_o for the complex is in visible region, the complex is coloured and the value of Δ_o lies in ultraviolet or infrared region, the complex is colourless. For octahedral complexes the crystal field stabilization energy is given by $\mathrm{CFSE} = [-0.4t_{2\mathrm{g}}N + 0.6e_{\mathrm{g}}N']\Delta_o$,where N and N' are number of electrons in $t_{2\mathrm{g}}$ and e_{g} orbitals respectively

195. Among the following pairs of complexes, in which case the Δ_0 value is higher for the first one?
    a) $[\mathrm{CoF_6}]^{3-}$and $[\mathrm{Co(NH_3)_6}]^{3+}$
    b) $[\mathrm{Co(H_2O)_6}]^{2+}$ and $[\mathrm{Co(H_2O)_6}]^{3+}$
    c) $[\mathrm{Rh(H_2O)_6}]^{3+}$and $[\mathrm{Co(H_2O)_6}]^{3+}$
    d) $[\mathrm{Co(NH_3)_6}]^{3+}$and $[\mathrm{Co(CN)_6}]^{3-}$

Paragraph for Question Nos. 196 to - 196

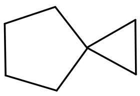
Complex compounds are molecular compounds which retain their identities even when dissolved in water. They do not give all the simple ions in solution but instead furnish complex ions. The complex compounds are often called coordination compounds because certain groups called ligands are attached to the central metal ion by coordinate or dative bonds. Coordination compounds exhibit isomerism, both structural and stereoisomerism. The structure, magnetic property, colour and electrical properties of complexes are explained are explained by various theories

196. Generally, a group of atoms can function as a ligand if
    a) They are free radicals
    b) They are either neutral molecules or negatively charged ions
    c) They are positively charged ions
    d) None of the above

Paragraph for Question Nos. 197 to - 197

Compounds in which one carbon atom is common to two different rings are known as "spiro" compounds. The name for a spiro compounds begins with the word spiro followed by the square brackets containing the number of carbon atoms, in ascending order, in each ring connected to the common carbon atom and then by the name of the parent hydrocarbon corresponding to the total number of C-atoms in the rings. The positions of substituents are indicated by numbers, the numbering beginning with the carbon atom adjacent to the common carbon and proceeding first around the smaller ring and then around the larger ring and finally ending on the common carbon atom

197.

The IUPAC name of compound  is

a) spiro (2,4) heptane b) spiro (1,5) heptane

c) spiro (1,4) heptane d) spiro (2,5) heptane

Paragraph for Question Nos. 198 to - 198

The organic compound contains more than two similar terminal groups and all such groups are directly attached to the principal chain, then none of these groups forms a part of the principal chain. To name such compounds special suffixes are used and when using these suffixes, the carbon atoms of these terminal groups are not counted in the principal chain. The special suffixes used in these cases are as

Functional group	**suffix**
$-\mathrm{COOH}$	−carboxylic acid
$-\mathrm{CHO}$	−carbaldehyde
$-\mathrm{CN}$	−carbonitrile
$-\mathrm{CO}X$	−carbonyl halide
$-\mathrm{COO}R$	−R-carboxylate
$-\mathrm{CONH_2}$	−carboxamide

198. IUPAC name of $\mathrm{CH_3CH(OH)COOH}$ is

a) Carboxypropanol b) α-hydroxy propanoic acid

c) 2-hydroxypropanoic acid d) Lactic acid

Paragraph for Question Nos. 199 to - 199

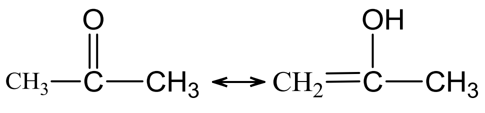
Stability of cycloalkanes can be explained on the basis of Baeyer strain theory. This theory is applicable only for cyclopropane, cyclobutane and cyclopentane. Stability of cyclohexane and its derivative can be explained by Mohr's theory. According to this theory cyclohexane exists in two forms chair and boat. The chair form is more stable than the boat form. Every carbon of chair form has an axial and equatorial bonds. Bulky groups are generally present at equatorial position. The preferred conformation of cyclohexane ring is the chain form, but when intramolecular hydrogen bonding is possible between the group 1 and 4 positions the molecule assume a boat form

199. According to Baeyer strain theory which cycloalkane is the most stable?

a) Cyclohexane b) Cyclopentane c) Cyclopropane d) Cyclobutane

Paragraph for Question Nos. 200 to - 200

Tautomerism is the phenomenon in which two structural isomers differing in the relative positions of their atoms are spontaneously interconvertable and can exist in dynamic equilibrium. The two forms in tautomeric equilibrium are called tautomers of each other. The interconvertibility of tautomers is a chemical reaction which involves making and braking of bonds. Tautomers are true isomers, and either of the individual tautomeric forms may be isolated



$$\mathrm{CH_3{-}\overset{\overset{\displaystyle O}{\|}}{C}{-}CH_3} \longleftrightarrow \mathrm{CH_2{=}\overset{\overset{\displaystyle OH}{|}}{C}{-}CH_3}$$

200. In the keto-enol tautomerism of dicarbonyl compounds the enol form is preferred in contrast to the keto form, this is due to

a) Rapid chemical exchange
b) Group rearrangement
c) Presence of carbonyl group on each side of the chain
d) Resonance stabilization of enol form

Paragraph for Question Nos. 201 to - 202

The octahedral complex ions$[FeCl_6]^{3-}$and $[Fe(CN)_6]^{3-}$are both paramagnetic but the former is high spin and the latter is low spin
Based on the above study, answer the following questions

201. High spin complex $[FeCl_6]^{3-}$ has the d-configuration as

a) $t_{2g}^3 e_g^2$ b) t_{2g}^5 c) $t_{2g}^2\, e_g^3$ d) e_g^5

Paragraph for Question Nos. 202 to - 202

The Alsatian-Swiss chemist Alfred Werner pioneered the field of coordination chemistry in the late nineenth century. At that time, a number of compounds of cobalt (III) chloride with ammonia were known, with with gneral formulae
$CoCl_3 \cdot xNH_3 x = 3$ to 6
Treatment of these compounds with aqueous HCl acid did not remove the ammonia.However treatment of the compounds with excess of $AgNO_3$at 273 K gave white precipitate AgCl in varying ratio depending on the structure. Also each complex had electrical conductivity of varying nature. Based on the above study, answer the following questions

202. Which complex has the maximum electrical conductivity

a) $CoCl_3 \cdot 3NH_3$ b) $CoCl_3 \cdot 4NH_3$ c) $CoCl_3 \cdot 5NH_3$ d) $CoCl_3 \cdot 6NH_3$

Paragraph for Question Nos. 203 to - 203

Consider the following reactions
I. $[Co(NH_3)_6]^{3+}(aq) + 6H_3O^+(aq) \rightleftharpoons [Co(H_2O)_6]^{3+}(aq) + 6NH_4^+(aq)$
The products are favoured in the above reaction
II. $[Co(NH_3)_6]^{2+}(aq) + 6H_3O^+(aq) \longrightarrow [Co(H_2O)_6]^{2+}(aq) + 6NH_4^+(aq)$
This, reactions (II) takes place withH_2Oin a matter of seconds Based on the above reactions, answer the following questions

203. Select the correct statements

a) $[Co(NH_3)_6]^{3+}$thermodynamically and kinetically stable relative to $[Co(H_2O)_6]^{3+}$
b) $[Co(NH_3)_6]^{3+}$ is thermodynamically unstable but kinetically stable relative to $[Co(H_2O)_6]^{3+}$
c) $[Co(NH_3)_6]^{3+}$is thermodynamically and kinetically unstable relative to $[Co(H_2O)_6]^{3+}$
d) $[Co(NH_3)_6]^{3+}$is thermodynamically stable but kinetically unstable relative to $[Co(H_2O)_6]^{3+}$

Paragraph for Question Nos. 204 to - 204

The octahedral complex ion $[FeCl_6]^{3-}$ and $[Fe(CN)_6]^{3-}$are both paramagnetic
Answer the following questions

204. Select the correct statements
   a) $[FeCl_6]^{3-}$ and$[Fe(CN)_6]^{3-}$ both are high-spin complex
   b) $[FeCl_6]^{3-}$ is high-spin and$[Fe(CN)_6]^{3-}$ is low-spin complex
   c) $[FeCl_6]^{3-}$ is low-spin and $[Fe(CN)_6]^{3-}$ is high-spin complex
   d) $[FeCl_6]^{3-}$ and$[Fe(CN)_6]^{3-}$ both are low-spin complexes

Paragraph for Question Nos. 205 to - 205

Read the following experiment and answer the questions at the end of it
"A student in 1895 prepared three coordination compounds containing chromium with the following properties

Formula	**Colour**	**Cl^-ions in solution Per formula units**
A. $CrCl_3 \cdot 6H_2O$	Violet	3
B. $CrCl_3 \cdot 6H_2O$	Light green	2
C. $CrCl_3 \cdot 6H_2O$	Dark green	1

205. Which complex has maximum molecules of hydration
   a) A b) B c) C d) Equally

Paragraph for Question Nos. 206 to - 206

Read the following experimental method and answer the questions at the end of it.
A rose-coloured compound has the empirical formula $CoCl_3 \cdot 5NH_3 \cdot H_2O$. Two moles of this compound react with concentrated sulphuric acid to formHCl(g) and one mole of a new compound with empirical formula $Co_2(SO_4)_3 \cdot 10NH_3 \cdot 5H_2O$
When this new compound is dried at room temperature, it loses three moles of water per mol of $Co_2(SO_4)_3 \cdot 10NH_3 \cdot 5H_2O$

206. What is the formula rose-coloured compound
   a) $[Co(NH_3)_4Cl]Cl_2 \cdot H_2O$ b) $[Co(NH_3)_5H_2O]Cl_2$
   c) $[Co(NH_3)_3(H_2O) \cdot Cl_2]Cl$ d) None of these

Paragraph for Question Nos. 207 to - 207

Mr. William isolated two complexes and in chemical abstract, he reported.
"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, where (B) gives a pale yellow precipitate soluble in concentrated ammonia
Read the above report from chemical abstract and answer the questions at the end of it

207. Complex A and B are respectively
   a) $[Cr(NH_3)_4Cl_2]Br, [Cr(NH_3)_4Br]Cl_2$ b) $[Cr(NH_3)_4Br]Cl_2, [Cr(NH_3)_4Cl_2]Br$
   c) $[Cr(NH_3)_4ClBr]Cl, [Cr(NH_3)_4Cl_2]Br$ d) $[Cr(NH_3)_4Cl_2]Br, [Cr(NH_3)_4ClBr]Cl$

Paragraph for Question Nos. 208 to - 208

Study the following short write up and answer the questions at the end of it
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 ions as ligands complex A does not react with concentrated H_2SO_4,whereas complexes $B$and Close 6.75% and 13.5% of their original weight respectively , on treatment with concentrated H_2SO_4

208. Complex A is

a) $[Cr(H_2O)_6]Cl_3$
b) $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$
c) $[Cr(H_2O)_4Cl_2]Cl \cdot 2H_2O$
d) None of these

Paragraph for Question Nos. 209 to - 209

Consider the following experiments and answer the questions at the end of it
(A) When $Fe(CN)_2$ solution is treated with KCN solution , species formed , no longer , gives tests ofFe^{2+} and CN^-
(B) When K_2SO_4 solution is treated with$Al_2(SO_4)_3$ solution, species formed give tests of K^+, Al^{3+} and SO_4^{2-}

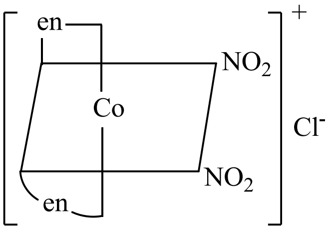
209. Species formed in experiment A does not give test ofFe^{2+} andCN^-. It is due to formation of

a) $K_2[Fe(CN)_4]$
b) $K_2[Fe(CN)_5]$
c) $K_3[Fe(CN)_6]$
d) $K_4[Fe(CN)_6]$

Paragraph for Question Nos. 210 to - 210

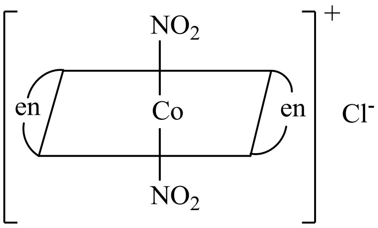
Following experiment has been given to identify isomer. Read the Experiment and answer the questions
A compound$Co(en)_2(NO_2)_2Cl$ has been prepared in a number of isomeric forms. One form undergoes no reaction with $AgNO_3$ or (en) and is optically inactive .A second form reacts with $AgNO_3$but not with (en) and is optically active and reacts with both$AgNO_3$ and (en), complexes are

(A)



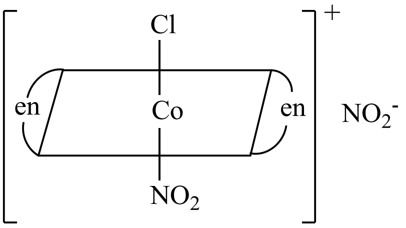
cis-bis (ethylenediamine)dinitrocobalt (III) chloride

(B)



trans-bis (ethylenediamine)dinitrocobalt (III) chloride

(C)



trans-chloronitrobis(ethylenediamine)cobalt (III) nitrite

210. First form of the complex is

a) A b) B c) C d) None of these

Paragraph for Question Nos. 211 to - 211

A research-guide instructed his two students to synthesize complex
$[Co(NH_3)_5(NO_2)]Cl_2$
They synthsised complex with identical molecular formula. molar mass, geometry and spin, but they differed in colour Based on the above facts answer the following questions.

211. The difference in colour is due to

a) Optical isomerism
b) Geometrical isomerism
c) Linkage isomerism
d) Nuclear isomerism

Paragraph for Question Nos. 212 to - 212

Read the following short write-up and answer the questions at the end of it.
One cationic complex has two isomers.A and .Each has oneCo^{3+}, fiveNH_3one$Br^-$and SO_4^{2-} stoichiometrically. A given white ppt with$BaCl_2$while Bgive yellow ppt with $AgNO_3$

212. A can be

a) $[Co(NH_3)_5]BrSO_4$
b) $[Co(NH_3)_5SO_4]Br$
c) $[Co(NH_3)_5Br]SO_4$
d) $[Co(NH_3)_4SO_4]Br \cdot NH_3$

Integer Answer Type

213. Total number of orbitals used in hybridization of octahedral complex $[Fe(CN)_6]^{3-}$ is……
214. Number of aromatic rings in ferrocene is…….
215. $[Co(NH_3)_6]^{3+}$ has…… unpaired electron (s) in t_{2g} orbitals
216. Ambidentate ligands out of Py, en, CNS, CN, CNO, $C_2O_4^{2-}$, NO_2, are
217. $CrCl_3H_{12}O_6$ loses 13.5% water on treatment with conc. H_2SO_4. Number of water molecule lost is…….
218. Effective atomic number of Ni in $Ni(CO)_x$ is 36. Thus, $x =$…
219. Ionisable chloride ions in $CoCl_5 \cdot 4NH_3$ are……
220. In the high spin complexes of Cr^3number of unpaired electron in t_{2g} orbitals is…….
221. Magnetic moment of a complex is 4.9 BM. Thus, unpaired electron(s) may be…..
222. Nickel dimethylglyoximate is stable due to chelation. Chelate ring(s) is/are…..
223. EDTA is a multidentate ligand. Its deniticity (multicity) is…….
224. B in question (4) is…….
225. The volume (in mL) of 0.1 M $AgNO_3$ 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……
226. Ethylenediamine displaces H_2O in the complex $[Fe(H_2O)_6]^{3+}$ in three steps
$[Fe(H_2O)_6]^{3+} + 3\text{ en} \rightarrow [Fe(en)_3]^{3+} + 6H_2O$
Stepwise formation constants are
$\log k_1 = 4.34$
$\log k_2 = 3.31$
$\log k_3 = 2.05$
Overall formation constant is $A \times 10^B A$ is……

227. There are ..... electron in e_g orbitals is $[CoF_6]^{3-}$
228. Square-planar $[Ni(CN)_4]^{2-}$ uses..... d-orbital(s) in hybridisation
229. Total number of geometrical isomers for the complex $[RhCl(CO)(PPh_3)(NH_3)]$ is......
230. CFSE of high-spin d^5-Mn^{2+} complex is.....
231. $EDTA^{4-}$ is ethylenediamine tetraacetate ion. The total number of $N - Co - O$ bond angles in $[CO(EDTA)]^-$ complex ion is.......
232. There are...... electron in t_{2g} orbitals in $[CoF_6]^{3-}$
233. Total number of ions due to ionization of the complex $CoCl_3 \cdot 6H_2O$ is......

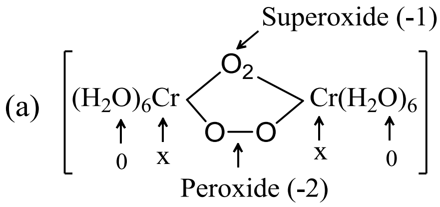
: ANSWER KEY :

1)	**a**	**2)**	**c**	**3)**	**d**	**4)**	**a**
5)	**c**	**6)**	**b**	**7)**	**b**	**8)**	**b**
9)	**d**	**10)**	**c**	**11)**	**c**	**12)**	**d**
13)	**a**	**14)**	**d**	**15)**	**b**	**16)**	**a**
17)	**a**	**18)**	**a**	**19)**	**a**	**20)**	**b**
21)	**a**	**22)**	**b**	**23)**	**d**	**24)**	**b**
25)	**b**	**26)**	**c**	**27)**	**c**	**28)**	**c**
29)	**c**	**30)**	**c**	**31)**	**a**	**32)**	**b**
33)	**c**	**34)**	**c**	**35)**	**b**	**36)**	**c**
37)	**c**	**38)**	**b**	**39)**	**c**	**40)**	**b**
41)	**b**	**42)**	**b**	**43)**	**c**	**44)**	**b**
45)	**c**	**46)**	**d**	**47)**	**b**	**48)**	**c**
49)	**b**	**50)**	**c**	**51)**	**a**	**52)**	**a**
53)	**c**	**54)**	**b**	**55)**	**b**	**56)**	**a**
57)	**a**	**58)**	**c**	**59)**	**a**	**60)**	**b**
61)	**c**	**62)**	**d**	**63)**	**a**	**64)**	**a**
65)	**b**	**66)**	**b**	**67)**	**b**	**68)**	**c**
69)	**c**	**70)**	**a**	**71)**	**c**	**72)**	**d**
73)	**a**	**74)**	**b**	**75)**	**c**	**76)**	**c**
77)	**b**	**78)**	**a**	**79)**	**a**	**80)**	**c**
81)	**d**	**82)**	**b**	**83)**	**a**	**84)**	**b**
85)	**b**	**86)**	**c**	**87)**	**a**	**88)**	**a**
89)	**c**	**90)**	**a**	**91)**	**d**	**92)**	**b**
93)	**c**	**94)**	**d**	**95)**	**c**	**96)**	**b**
97)	**c**	**98)**	**b**	**99)**	**d**	**100)**	**b**
101)	**b**	**102)**	**c**	**103)**	**d**	**104)**	**a**
105)	**a**	**106)**	**a**	**107)**	**b**	**108)**	**d**
109)	**d**	**110)**	**a**	**111)**	**c**	**112)**	**c**
113)	**d**	**114)**	**c**	**115)**	**a**	**116)**	**a**
117)	**d**	**118)**	**b**	**119)**	**b**	**120)**	**d**
121)	**b**	**122)**	**a**	**123)**	**d**	**124)**	**d**
125)	**c**	**126)**	**d**	**127)**	**c**	**128)**	**d**
129)	**a**	**130)**	**a**	**131)**	**d**	**132)**	**c**
133)	**b**	**134)**	**d**	**1)**	**c**	**2)**	**b**
	3)	**d**	**4)**	**a,c**			
5)	**a,b,d**	**6)**	**b,d**	**7)**	**a,d**	**8)**	**c**
9)	**a,d**	**10)**	**a,d**	**11)**	**a,b,c,d**	**12)**	
	a,b,d						
13)	**b,c,d**	**14)**	**b**	**15)**	**a,b,c**	**16)**	
	b,c,d						
17)	**b,c,d**	**18)**	**b,c**	**19)**	**c,d**	**20)**	
	a,b,d						
21)	**b,c**	**22)**	**b,c**	**23)**	**c**	**24)**	
	a,b,c						
25)	**a,b,c,d**	**26)**	**a, b**	**27)**	**a**	**28)**	
	a,b,c						
29)	**a,b,d**	**30)**	**c**	**31)**	**a,b,c,**	**1)**	**c**

	2)	**a**	**3)**	**a**	**4)**	**b**	
5)	**d**	**6)**	**a**	**7)**	**a**	**8)**	**b**
9)	**c**	**10)**	**d**	**11)**	**c**	**12)**	**c**
13)	**c**	**14)**	**a**	**15)**	**a**	**16)**	**b**
17)	**b**	**18)**	**d**	**19)**	**a**	**1)**	**c**
	2)	**b**	**3)**	**a**	**4)**	**a**	
5)	**b**	**6)**	**c**	**7)**	**a**	**8)**	**d**
9)	**a**	**10)**	**c**	**1)**	**c**	**2)**	**b**
	3)	**a**	**4)**	**c**			
5)	**b**	**6)**	**d**	**7)**	**a**	**8)**	**d**
9)	**b**	**10)**	**b**	**11)**	**c**	**12)**	**b**
13)	**c**	**14)**	**a**	**15)**	**d**	**16)**	**c**
17)	**c**	**18)**	**c**	**1)**	**6**	**2)**	**2**
	3)	**0**	**4)**	**4**			
5)	**2**	**6)**	**4**	**7)**	**3**	**8)**	**3**
9)	**4**	**10)**	**4**	**11)**	**6**	**12)**	**9**
13)	**6**	**14)**	**5**	**15)**	**2**	**16)**	**1**
17)	**3**	**18)**	**0**	**19)**	**8**	**20)**	**2**
21)	**4**						

: HINTS AND SOLUTIONS :

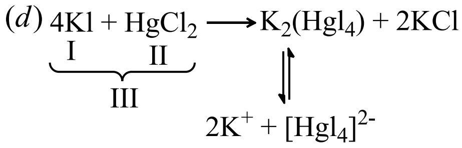
1 **(a)**



Thus, $2x + (-) + (-2) = +3$

$x = +3$

3 **(d)**



I gives test of K^+ and I^-

II gives test of Hg^{2+} and Cl^-

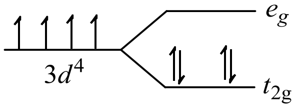
III gives testing of K^+ and $[HgI_4]^{2-}$

4 **(a)**

Cr: $[Ar]3d^5 4s^1$

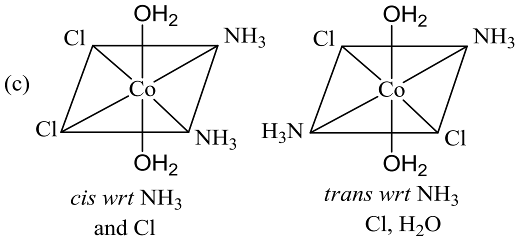
Cr^{2+}: $[Ar]3d^4$

NH_3 is a strong ligand thus, by (CFSE),



two unpaired electrons

5 **(c)**



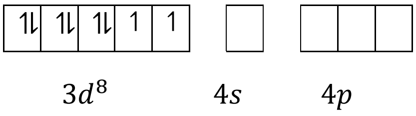
Enatiomer are non-superimposable

Thus, geometrical and optical isomer

6 **(b)**

$Ni : 3d^8 4s^2 \quad Ni^{2+} : 3d^8$

Since, Cl is a weak field ligand, it doesn't cause paring of electron.



Number of unpaired electrons, n=2

$\mu = \sqrt{n(n+2)} = \sqrt{2(2+2)\text{BM}} = \sqrt{8}$ BM = 2.82 BM

9 **(d)**

$[Ni(CN)_4]^{2-} dsp^2$ square planar diamagnetic

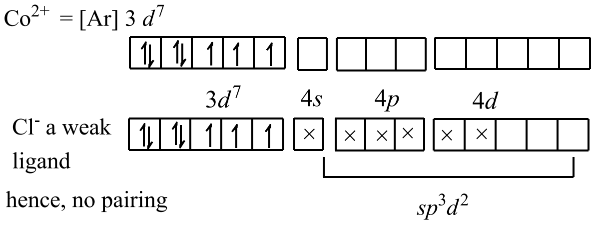
$[NiCl_4]^{2-} sp^3$ tetrahedral paramagnetic

10 **(c)**

$[CoCl_6]^{4-}$

Oxidation number of cobalt = +2

CN of cobalt = 6



Hence, no pairing

It is thus paramagnetic and high spin complex

Thus, (I) and (IV) are correct

11 **(c)**

$[Ni(CN)_4]^{2-}$: dsp^2 square planar

$Ni(CO)_4$: sp^3 tetrahedral

12 **(d)**

Ligand strength is in order

Py < Br^- < NH_3

Thus, replacement of Cl^- ligands by above ligands is in same order

13 **(a)**

(a) $K_2[PtCl_6] \rightleftharpoons \underbrace{2K^+ + [PtCl_6]^{2-}}_{\text{Three ions}}$

(b) $PtCl_4 \cdot 2NH_3 \equiv [PtCl_4(NH_3)_2] \rightleftharpoons$ no ionization One molecule

(c) $PtCl_4 \cdot 3NH_3 \equiv [Pt(NH_3)_3Cl_3]Cl \rightleftharpoons \underbrace{[Pt(NH_3)_3Cl_3]^+ + Cl^-}_{\text{two ions}}$

(d) $PtCl_4 \cdot 5NH_3 \equiv [Pt(NH_3)_5Cl]Cl_3 \rightleftharpoons \underbrace{[Pt(NH_3)_5Cl]^{3+} + 3Cl^-}_{\text{four ions}}$

Conductance ∝ number of ions

Maximum conductance is of (d) and least that of (b)

14 **(d)**

$[Co(en)_3]^{3+}$ is most stable due to chelate formation

Thus, highest K_f value

15 **(b)**

It does not lack symmetry

17 **(a)**

Due to different n linkage, of NO_2 (metal linked to Co) and ONO (metal linked to Co) they differ in colour

18 **(a)**

Anion is $[Pt(NH_3)_2(CN)_2(SO_4)(O_2)]$

$\uparrow \quad \uparrow \qquad \uparrow \qquad \uparrow \qquad \uparrow$

$+4 \;\; +0 \qquad -2-2-1=-1$

Cation is K^+

$K[Pt(CN)_2(O_2)(SO_4)(NH_3)_2]$

19 **(a)**

Complex	**ligand**	**Unpaired Electrons**
I. $[Fe(H_2O)_6]^{2+}$	H_2O —weak	4
II. $[Fe(CN)_6]^{3-}$	CN^- – strong	1
III. $[Fe(CN)_6]^{4-}$	CN^- – strong	0
IV. $[Fe(H_2O)_6]^{3+}$	H_2O – weak	5

Thus, IV $> I > II > III$

20 **(b)**

5. $Mn^+ =$ $3d^5, 4s^1$. In presence of CO effective configu $3d^6, 4s^0$.

Three lone pair of back bonding with vacant orbital of C in CO.

6. $Fe^0 =$ $3d^6, 4s^2$. In presence of CO effective configu $3d^8$.

Four lone pair for back bonding with CO.

7. $Cr^0 = 3d^4, 4s^2$. Effective configuration $=$ $3d^6$.

Three lone pair for back bonding with CO.

8. $V^- = 3d^4, 4s^2$. Effective configuration $=$ $3d^6$.

Three lone pair for back bonding with CO.

Maximum back bonding in $Fe(CO)_5$, therefore CO bond order is lowest here.

22 **(b)**

When ligands are arranged in ascending order of crystal field splitting energy, Δ, they produce a spectrochemical series.

In comparison to H_2O, Cl is strong σ-donor and good π-acceptor, therefore it is a strong ligand than H_2O. Hence, in the spectrochemical series Cl is above than water.

23 **(d)**

Complementary colour of red is green

25 **(b)**

	Unpaired electron
(a) $[Cr(NH_3)_6]^{3+}(d^2sp^3)$	3
(b) $[CoF_6]^{3-}(sp^3d^2)$	4
(c) $[Co(NH_3)_6]^{3+} d^2sp^3$	0
(d) $Ni(CO)_4 sp^3$	0

26 **(c)**

$[Pt(NH_3)_5Cl]^{3+}Cl^-$

$+4 \qquad -1$

Thus, complex is

$[Pt(NH_3)_5Cl]Cl_3 \rightleftharpoons \underbrace{[Pt(NH_3)_5Cl]^{3+} + 3Cl^-}_{\text{four ions}}$

27 **(c)**

$[Co^{III}(en)_2Cl_2]Cl$

It has one ionisable Cl^-

$Cl^- + Ag^+ \rightarrow AgCl$

100 mL of 0.024 M complex

$\equiv 2.4 \times 10^{-3}$mol complex

$\equiv 2.4 \times 10^{-3}$ mol AgCl $= 0.0024$

30 **(c)**

$[Cr(H_2O)_3Cl_3] \cdot H_2O$

$[Cr(H_2O)_4Cl_2]$

Oxidation number $= +3$

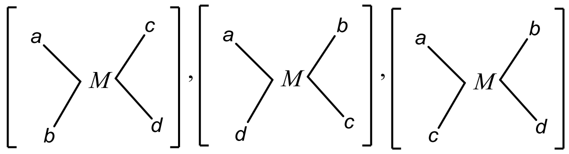
and CN $= 6$ of Cr is satisfied by both

31 **(a)**

EDTA is hexadentate

34 **(c)**

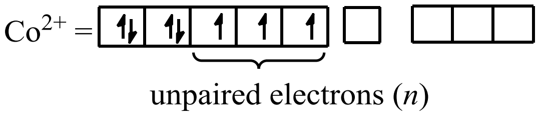
$[M(abcd)]$ complex is square planar so will have three geometrical isomers.



35 **(b)**

In $Hg[Co(SCN)_4]$, Co is present as Co^{2+}. The configuration of Co^{2+} is given as following

$[Ar]3d^7\ 4s^0$



∴ Magnetic moment $(\mu)=\sqrt{n(n+2)}$

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

36 **(c)**

$[Fe(H_2O)_6]^{3+} \rightleftharpoons [Fe(H_2O)_6(OH^-)]^{2+} + H^+$

H^+ ion donor thus, Bronsted-Lowry acid

37 **(c)**

Cl^- is a weak ligand hence

$[MoCl_6]^{3-} sp^3d^2$hybridisation and with unpaired electrons is paramagnetic (en) is a strong ligand hence $[Co(en)_3]^{3+} - d^2sp^3$ hybridization and with all paired electrons is diamagnetic

38 **(b)**

Complexes differ in nature of lonisation

$[Cr(NH_3)_5Br]Cl \xrightarrow{Ag^+} AgCl \downarrow$

White ppt.

$[Cr(NH_3)_5Cl]Br \xrightarrow{Ag^+} AgBr \downarrow$

Yellow ppt.

39 **(c)**

Complex is

$[Co(NH_3)_4Cl_2]Cl \rightleftharpoons [Co(NH_3)_4Cl_2]^+ + Cl^-$

40 **(b)**

(a) In MnO_2, $FeCl_3$oxidation states of Mn and Fe are +4 and +3 respectively.

(b) In $(MnO_4)^-$, CrO_2Cl_2 oxidation states of Mn and Cr are +7 and +6 respectively.

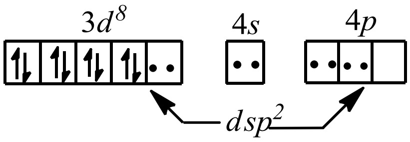
(c) In $[Fe(CN)_6]^{3-}$, $[Co(CN)_3]$ oxidation states of Fe and Co are +3 and +3 respectively.

(d) $[NiCl_4]^{2-}$, $[CoCl_4]^-$ oxidation states of Ni and Co are +2 and +3 respectively.

41 **(b)**

$Ni^{2+} + 4CN^- \rightarrow [Ni(CN)_4]^{2-}$

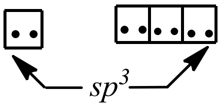
Here Ni^{2+} has d^8-configuration with CN^- as strong ligand.



d^8-configuration in strong ligand field gives dsp^2 hybridisation, hence square planar geometry.

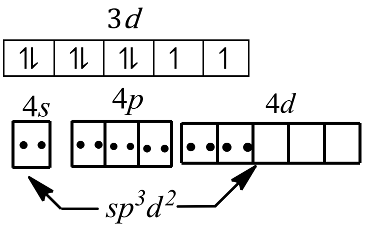
$Ni^{2+} + 4Cl^- \rightarrow [NiCl_4]^{2-}$

Here Ni^{2+} has d^8-configuration with CN^- as weak ligand.



d^8-configuration in weak ligand field gives sp^3hybridisation, hence tetrahedral geometry.

Ni^{2+} with H_2O forms $[Ni(H_2O)_6]^{2+}$ complex and H_2O is a weak ligand.



Therefore, $[Ni(H_2O)_6]^{2+}$has octahedral geometry.

44 **(b)**

DMG, en: Bidentate

EDTA : Hexadentate

py : Unidentate

46 **(d)**

mmol of complex =30×0.01 =0.3 Also, 1 mole of complex $[Cr(H_2O)_5Cl]Cl_2$ gives only two moles of chloride ion when dissolved in solution.

$[Cr(H_2O)_5Cl]Cl_2 \longrightarrow [Cr(H_2O)_5Cl]^{2+} + 2\ Cl^-$

⇒mmol of Cl^- ion produced from its 0.3 mmol =0.6

Hence, 0.6 mmol of Ag^+ would be required for precipitation.

⇒ 0.60 mmol of Ag^+=0.1 M × V (in mL)

⇒ V=6 mL

47 **(b)**

The ionisation isomer of $[Cr(H_2O)_4Cl\ (NO_2)]Cl$ is $[Cr(H_2O)_4Cl_2](NO_2)$ because of exchanging of ligand and counter ions.

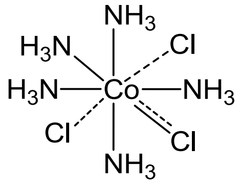
48 **(c)**

$[Co(NH_3)_4(CO_3)\ ]NO_3$

No chelation

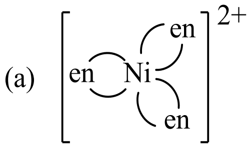
50 **(c)**

Given complex is shown as



----- PV, —SV, ===== dual

52 **(a)**



Chelate complex thus more stable than $[Ni(NH_3)_6]^{2+}$

54 **(b)**

Ligands are

$-NO_2$, metal linked to N

−ONO, metal linked to O

55 **(b)**

$Fe^{3+} + 3C_2O_4^{2-} \rightarrow [Fe(C_2O_4)_3]^{3-}$

soluble

56 **(a)**

$[Co(NH_3)_3Cl_3] \rightleftharpoons$ no ionization

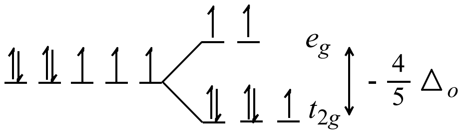
Thus, is the molecular complex

57 **(a)**

EDTA (in the form of dihydrogen salt) forms insoluble compound with $Pb^{2+}$and is thus drained out

58 **(c)**

$Co^{2+} = [Ar]3d^7$

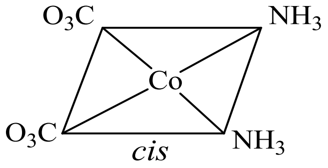


59 **(a)**

$Cr^{3+} + 3(C_2O_4)^{2-} \rightarrow K^+[Cr(C_2O_4)_3]^{3-}$

Thus, complex is $K_3[Cr(C_3O_4)_3]$

60 **(b)**



Mirror –images are not superimposable

62 **(d)**

+2

↓

$K_4 \quad [Fe(CN)_6]$

Cation anion

63 **(a)**

$Ni(CO)_4 \quad sp^3$ diamagnetic

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

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

64 **(a)**

$[Cu(CN)_4]^{3-}$ is stable, does not ionize

$[Cd(CN)_4]^{2-}$ is unstable, ionizes to form Cd^{2+}, thus CdS is precipitated

65 **(b)**

EAN rule is not followed in which EAN of metal ≠ EC of nearest inert gas

In this case Kr

Complex	$\boldsymbol{Z}$	**ON**	**Electrode from ligand ($\boldsymbol{L}$)**	**EAN $= \boldsymbol{Z} - (\mathbf{ON}) + \boldsymbol{L}$**
(a)	29	+1	8	36
(b)	24	+3	12	33
(c)	26	+2	12	36
(d)	28	0	8	36

$[Cr(NH_3)_6]^{3+}$ does not follow EAN rule

69 **(c)**

$[Fe(O_2)(CN)_4(Cl)]^{4-}$

↑ ↓ ↓ ↓

$+2 \quad 2x \quad -4 \quad -1 = -4$

Thus, oxygen is as superoxo

70 **(a)**

$[Co(H_2O)_6]^{2+} + 6Cl^- \rightarrow [CoCl_6]^{4+} + 6H_2O$

Cl^- replaces H_2Oligands and intense blue colour is developed

71 **(c)**

Superoxide (−1)

↓

$[Pt(O_2)(en)_2(Br)]^{2+}$

↑

Bidentate

Thus, ON = +4

CN = 6

72 **(d)**

$CuSO_4 \cdot 5H_2O$exists as$[Cu(H_2O)_4]SO_4 \cdot H_2O$

Ionic bonding between $[Cu(H_2O)_4]^{2+}$ and SO_4^{2-}

Covalent bonding in SO_4^{2-} and H_2Ocoordinate bonding in complex between Cu^{2+} and H_2O

73 **(a)**

	$\boldsymbol{Z}$	**ON**	**Electron from ligand ($\boldsymbol{L}$)**	**EAN $\boldsymbol{Z} - (\mathbf{ON}) + \boldsymbol{L}$**
$Ni(CO)_4$	28	0	8	36
$[Fe(CN)_6]^{4-}$	26	2	12	36
$[Ni(en)_2]^{2+}$	28	2	8	34
$[Fe(H_2O)_6]^{2+}$	26	2	12	36
$[Co(CN)_6]^{3-}$	27	3	12	36
$[Fe(CN)_6^{3-}]$	26	3	12	35
$[Sc(H_2O)_6]^{3+}$	21	3	12	30

74 **(b)**

(A) octanehedral (3) $[Fe(CN)_6]^{4-} d^2sp^3$

(B) square planar (1) $[Ni(CN)_4]^{2-} \quad dsp^2$

(C) Tetrahedral (2) $Ni(CO)_4 \quad sp^3$

76 **(c)**

$Zn^{2+} + 4NH_3 \rightleftharpoons [Zn(NH_3)_4]^{2+}$

$$K = \frac{[Zn(NH_3)_4]^{2+}}{[Zn^{2+}][NH_3]^4}$$

$$\frac{[Zn^{2+}]}{[Zn(NH_3)_4]^{2+}} = \frac{\text{uncomplexed zinc ion}}{\text{complexed zinc ion}}$$

$$= \frac{1}{K[NH_3]^4} = \frac{1}{3 \times 10^9 \times (10)^4}$$

$= 3.33 \times 10^{-14}$

78 **(a)**

$[Cr(en)_3]^{3+}$ exists as enantiomer and thus 1 : 1mixture of two optically active forms results in the formation of recemic mixture

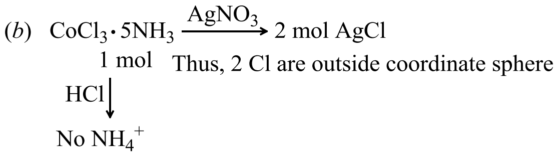
79 **(a)**

1. $[CO(NH_3)_6]Cl_3$
2. Double salt
3. Simple salt
4. Double salt

84 **(b)**

It shows linkage isomerism

85 **(b)**



(*b*) $CoCl_3\cdot 5NH_3 \xrightarrow{AgNO_3} 2$ mol AgCl

1 mol Thus, 2 Cl are outside coordinate sphere

$\downarrow HCl$

No NH_4^+

Thus, are inside coordinate sphere

Thus, complex is $[Co(NH_3)_5Cl]Cl_2$

86 **(c)**

IV II

$[Pt(NH_3)_6]^{4+}[Pt\,Cl_4]^{2-}$

Thus, complex is $[Pt(NH_3)_6][PtCl_4]_2$

87 **(a)**

It acid is weak, its conjugate base is strong ligand

$HI > HCN$ acid strength

$I^- < CN^-$ ligand strength

$NH_3 > H_2O$ ligand strength

88 **(a)**

$$M + L \rightleftharpoons ML,\ K_1 = \frac{[ML]}{[M][L]} = 4$$

$$M + L \rightleftharpoons ML_2,\ K_2 = \frac{[ML_2]}{[ML][L]} = 3$$

$$M + 2L \rightleftharpoons ML_2 K_3 = \frac{[ML_2]}{[M][L]^2}$$

$K_1 = K_1K_2 = 12$

90 **(a)**

CO is a strong ligand, all the six electrons of the valence shell of Cr is paired and spin only magnetic moment=0

91 **(d)**

	Unpaired electrons
(a) $[Fe(CN)_6]^{4-}$	0
$[Fe(H_2O)_6]^{2+}$	4

Thus, they differ in magnetic moment

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

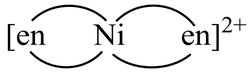
$Ni(CO)_4 sp^3$ diamagnetic

Thus, true

(c)	Unpaired electron	
$[Fe(CN)_6]^{4-}$	4	d^2sp^3
$[Co(NH_3)_6]^{3+}$	4	d^2sp^3

Thus, true

92 **(b)**



$[en\ \ Ni\ \ en]^{2+}$

dsp^2, CN of Ni = 4

94 **(d)**

$Ag_2S + CN^- \rightarrow [Ag(CN)_2]^-$

$AgBr + 2S_2O_3^{2-} \rightarrow [Ag(S_2O_3)_2]^{3-} + Br^-$

In photographic plate

95 **(c)**

$FeSO_4 + 6KCN \rightarrow K_2SO_4 + K_4[Fe(CN)_6]$

96 **(b)**

$[Fe(H_2O)_6]^{3+}$ sp^3d^2 (H_2O being weak ligand)

Four unpaired electrons

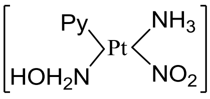
$[Fe(CN)_6]^4 d^2sp^3 CN^-$ being strong ligand

no unpaired electron

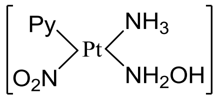
both have octahedral geometrical but differ in colour

98 **(b)**

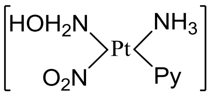
(*b*)



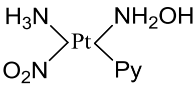
I



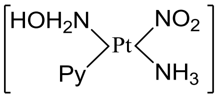
II



III



IV



V

II and III, IV and V are identical

99 **(d)**

$[Cu(H_2O_4)]SO_4.H_2O$ coordination number of Cu is 4.

100 **(b)**

I. $Ag_2S + CN^- \longrightarrow [Ag(CN)_2]^-$

II. $Ni + 4CO \longrightarrow [Ni(CO)_4]$

III. $AgBr + 2S_2O_3^{2-} \longrightarrow [Ag(S_2O_3)_2]^{3-}$

101 **(b)**

$Fe^{3+} + [Fe^{II}(CN)_6]^{4-} \rightarrow Fe^{2+} + [Fe^{III}(CN)_6]^{3-}$

104 **(a)**

$[Cr(H_2O)_6]Cl_3 \rightleftharpoons [Cr(H_2O)_6]^{3+} + 3Cl^-$

107 **(b)**

$[NiCl_4]^{2-}$ sp^3 – tetrahedral

Cl^- being a weak ligand

108 **(d)**

$[Co(NH_3)_5Cl]Cl_2 \rightleftharpoons \underbrace{[Co(NH_3)_5Cl]^{2+} + 2Cl^-}_{y=3}$

Van't Hoff factor (number of ions per mole complex)

$i = i + (y-1)x = 1 + 2x = 3 (x = 1)$

Thus, osmotic pressure

$\pi = MSTi = 1 \times 0.0821 \times 300 \times 3 = 73.89$ atm

109 **(d)**

II does not form enantionmers

110 **(a)**

Octahedral $Co(NH_3)_4Br_2Cl$ shows ionisation and geometrical isomerism.

In ionisation isomerism ligands show different coordination sphere and the anions present outside the coordination sphere.

These are exchanged with each other as follows

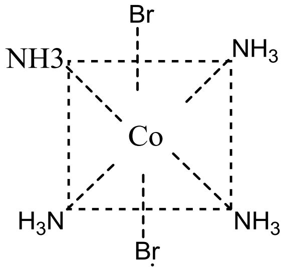
$Co(NH_3)_4Br_2Cl \rightleftharpoons [Co(NH_3)_4Br_2]^+ + Cl^-$

I

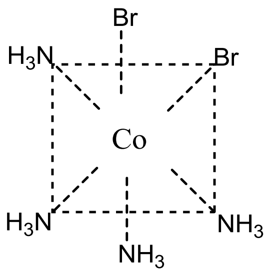
$[Co(NH_3)_4BrCl]Br \rightleftharpoons [Co(NH_3)_4Br\,Cl]^+ + Br^-$

II

In geometrical isomerism, coordination number of central atom (cobalt) is six and shape is octahedral, so it shows following geometrical isomers.



trans-isomer



cis-isomer

111 **(c)**

ON of Co = +3 and CN of Co = 6

(a) $[Co(NH_3)_6]Cl_3 \rightleftharpoons [Co(NH_3)_6]^{3+} + 3Cl^-$

(b) $[Co(NH_3)_5Cl]Cl_2 \rightleftharpoons [Co(NH_3)_5Cl]^{2+} + 2Cl^-$

(c) $[Co(NH_3)_4Cl_2]Cl \rightleftharpoons \underset{\text{Monovalent cation}}{[Co(NH_3)_4Cl_2]^+} + Cl^-$

(d) $[Co(NH_3)_3Cl_3] \rightleftharpoons$ no ionisation

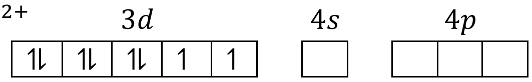
113 **(d)**

$[Ni(Cl)_4]^{2-}$ oxidation state of Ni is +2

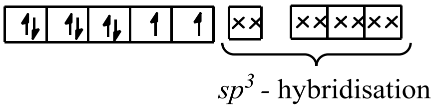
So, configuration of

$Ni^{2+} = 1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^8$

In Ni^{2+}



In $[NiCl_4]^{2-}$



Thus, due to sp^3-hybridisation of Ni^{2+} in $[NiCl_4]^{2-}$, the shape of $[NiCl_4]^{2-}$is tetrahedral.

114 **(c)**

IUPAC name is tetraammine nickel (II) – tetrachloronickelate (II).

115 **(a)**

$H_2O < NH_3 < NO_2$ ligand strength and energy. In square planar as in $[Ni(CN)_4^{2-}]$, hybridisation is dsp^2 thus all electrons are paired

Magnetic moment = 0

In octahedral geometry as in $[NiCl_6]^{4-}$, hybridization is sp^3d^2

Unpaired electrons $(N) = 2$

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

$= \sqrt{8}$

= 2.83 BM

116 **(a)**

$$E = h\nu = \frac{hc}{\lambda}$$

$$\therefore\ \lambda = \frac{hc}{E}$$

Weaker the ligands, smaller the energy difference, hence larger the value of λ

117 **(d)**

en is bidentate ligand

$[Pt(en)_2Cl_2]$

↑↑

4 2

Thus, six

118 **(b)**

$[Cr(EDTA)]^-$

EDTA = Hexadentate

$Z = 24$

ONof Cr = +3

Thus, (EAN) of Cr = 24 − 3 + 2 × 6 = 33

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

en = bidenate

$Z = 27$

ON of Co = +3

EAN of Co = 27 − 3 + 12 = 36

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

$C_2O_4^{2-}$ = bidentate

$Z = 26$

ON of Fe = +3

EAN of Fe = 26 − 3 + 12 = 35

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

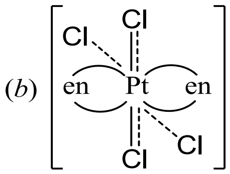
CN^- = monodentate

$Z = 28$

ON of Ni = +2

EAN of Ni = 28 − 2 + 8 = 34

121 **(b)**



Two chlorine satisfy (PV)

Two chlorine satisfy (PV) and (SV)

Two en satisfy (SV)

Since,(en) is bidentate,

Thus, PV = 4, SV = 6

Note C.N. = SV

O.N. = PV

122 **(a)**

$Fe^{3+} + [Fe^{II}(CN)_4]^{4-} \rightarrow Fe^{III}[Fe^{II}(CN)_6]^-$

Prussian blue

124 **(d)**

$[Co(NH_3)_5SO_4]Br \rightleftharpoons [Co(NH_3)_5SO_4]^+ + Br^-$

Yellow ppt.
With $AgNO_3$

$[Co(NH_3)_5Br]SO_4 \rightleftharpoons [Co(NH_3)_5Br]^{2+} + SO_4^{2-}$

↑ White ppt.
With $BaCl_2$

125 **(c)**

$Fe^{3+} + 6NH_3 \rightarrow [Fe(NH_3)_6]^{3+}$

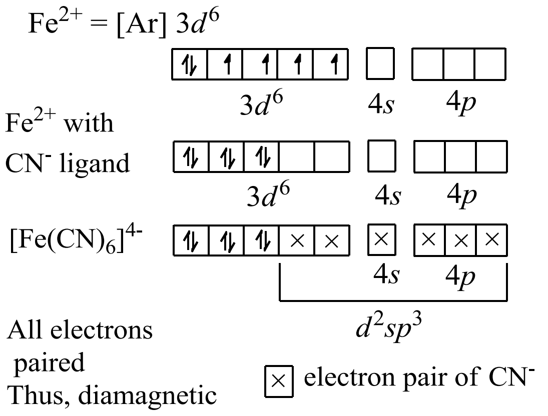
Lewis acid Lewis base

128 **(d)**

In which cation and anion both are complexes

129 **(a)**

Species with all paired electrons is diamagnetic

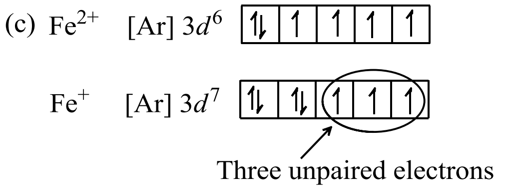


131 **(d)**

Fe^{2+}changes to brown-coloured ring complex

(b) $NO \rightarrow NO^+ + e^-$

$Fe^{2+} + e^- \rightarrow Fe^+$



Magnetic moment $= \sqrt{N(N+2)} = \sqrt{15} =$ 3.87 BM

Thus, (a),(b) and (c) are true

139 **(a,b,d)**

F^-, Cl^- and OH^- are weak field ligands usually form high spin complexes. CN_2^- and NO_2^- are strong field ligands usually form low spin complexes, $[Ni(CO)_4]$ is low spin complex

143 **(a,d)**

$K_4[Fe(CN)_6]$ gives blue colour with Fe^{2+} ions due to $Fe_2[Fe(CN)_6]$ and also gives chocolate precipitate with Cu^{2+} due to copper ferrocyanide formation

146 **(a,b,d)**

Three names and formulas are correctly matched

$K_3[Cr(C_2O_4)_3]$ – Potassium trioxalatochormate (III)

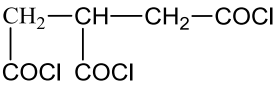
$K[Pt(NH_3)Cl_5]$ – Potassium amminepentachloroplantinate (IV)

$[Ag(CN)_2]^-$ – Dicyanoargentate (I) ion

147 **(b,c,d)**

$(C_6H_5)_2C = NOH$ can't exist in syn and anti forms due to molecular symmetry because of the presence of two identical C_6H_5 groups

149 **(a,b,c)**



$\underset{\displaystyle COCl}{CH_2}-\underset{\displaystyle COCl}{CH}-CH_2-COCl$

Alkanedinitrile ⇒ pentanedinitrile

⇒ 3-cyanopentanedinitrile

150 **(b,c,d)**

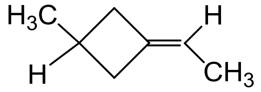
$CH_3 - C \equiv C - CH_3$ can be named as but-2-yne dimethyl acetylene or crotonylene

151 **(b,c,d)**

(b) Alkene with even number of carbon atoms are non-polar so, these are optically active

(c) $CH_3 - CH(D) - COOH$ molecule contains one chiral carbon atom thus, it is optically active

(d)



is non-polar and does not contain any symmetric element thus, optically active

152 **(b,c)**

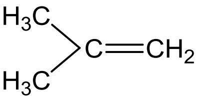
A *meso* compound has minimum two chiral centres and it has a plane of symmetry and it is optically inactive

153 **(c,d)**

The octahedral complexes having electronic configuration d^1 to d^3 are inner orbital complexes, while, those which having electronic configuration d^8 to d^{10} are outer orbital complex

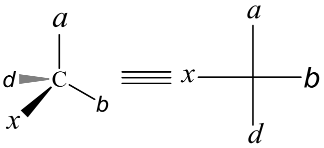
158 **(a,b,c)**

Isobutylene is not a cyclic compound



162 **(a,b,c)**

For Fischer's projection to be drawn bring the wedge-edge in correct visual point. The compound can also be represented as



163 **(a,b,d)**

Metals in carbonyl complexes and metal atoms as such have zero oxidation state

166 **(c)**

−COOH is the principal group while – CN is the substituent group

167 **(a)**
In chiral centre, chiral axis and chiral plane, if any one is present, the molecule will be optically active

168 **(a)**
F^- ion is weak field ligand and it forms outer orbital complex as it cannot force the electrons to pair up.

169 **(b)**
Trivalent cations, as a group are more acidic than divalent cations and most monovalent cations have negligible acidic character

When cation-oxygen bond is strong, the bond between oxygen and hydrogen is weakened and the proton can be donated to a base

170 **(d)**
The configuration in a compound is independent of its physical properties like optical activity

171 **(a)**
If however, there is a choice in numbering, the double bond is always given preference over the triple bond

172 **(a)**
EDTA binds to both $Ca^{2+}$and Mg^{2+},*ie*, cations with noble gas configuration as well as to transition metal ions. It is so efficient in binding metal ions that it is used to remove traces of metal from distilled water

173 **(b)**
The slightly larger value of μ than expected from the formula $\mu = \sqrt{n(n+2)}$ is due to a small contribution from the orbital anguler momentum of the electrons to the magnetic moment

174 **(c)**
Racemic mixture is optically inactive because the two enantiomers rotate the plane polarised light equally in opposite directions and cancel each others rotation. This phenomenon is called external compensation

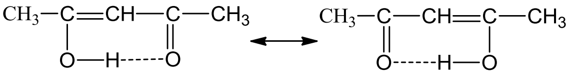
175 **(d)**
The staggered form is more stable than the eclipsed form because the potential energy of staggered form in which the bond pairs of two carbons are far away from each other is minimum

176 **(c)**
Both $[Ti(H_2O)_6]^{4+}$and $[Sc(H_2O)_6]^{3+}$ are colourless due to absence of free electrons in $3d$ subshell

177 **(c)**
The functional group is – COOH, the numbering is done from RHS to give minimum number to carbon atom bearing the functional group. The given compound is a derivative of butane. The substituent is the methyl group. So, the above compound is 3-methyl butanoic acid

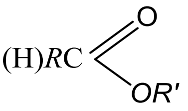
178 **(c)**
Square planar complexes having dsp^2 hybridisation shows geometrical isomerism.

179 **(a)**
Resonance stabilisation of enol form can be shown as



180 **(a)**
$[Sc[H_2O_6]^{3+}]$ has no unpaired electrons in its *d*-subshell and thus *d*-*d* transition is not possible whereas $[Ti(H_2O_6)]^{3+}$ has one unpaired electron in its d-subshell which gives rise to *d*-*d* transition to impart colour.

181 **(b)**
If the acidic hydrogen of carboxylic acid is replaced by an aryl or alkyl group, the resulting structure is a carboxylate ester



or $(H)RCO_2R'$

182 **(b)**
The Cr^{3+} ions has three unpaired electrons. It has $d^2\ sp^3$ hybridisation and it is paramagnetic.

183 **(d)**
$NH_2 - NH_2$ is neutral ligand. It does not act as bidentate because when it acts as bidentate, a three membered ring will be formed, that will highly strained

184 **(a)**

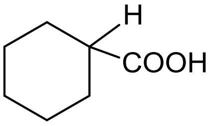
In naming cycloalkanes, number the ring to give the double bonded carbons 1 and 2 choose the direction of numbering. So, that the substituents get the lowest numbers. The position of the double bond is not indicated because it is known to bond between C-1 and C-2

190 **(c)**

(A) $CH_3-CH(CH_3)-CH_2-CH(CH_3)-CH(CH_3)-CH_3$

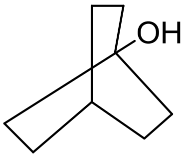
2,3,5-trimethyl hexane

(B)



cyclohexane carboxylic acid

(C)



bicyclo [4.2.0] octane-1-ol

(D) $(CH_3)_3Bi$

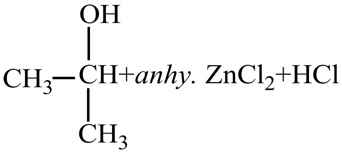
Trimethyl bismuthane

194 **(c)**

$CH_3(CH_2)_3\cdot NH_2 \xrightarrow[CHCl_3]{KOH\ alc.} CH_3(CH_2)_3NC + 3KCl + 3$

$CH_3—C\equiv CH + Amm\cdot AgNO_3 \longrightarrow CH_3C\equiv C\cdot Ag + HNO_3$

$CH_3\cdot CH_2COOCH_3 + NaOH \overset{\Delta}{\rightarrow} CH_3CH_2COONa + CH_3OH$



$CH_3-\underset{CH_3}{\overset{OH}{CH}}+anhy.\ ZnCl_2+HCl$

2°alcohol

⟶Cloudiness appears within 5 minute.

195 **(c)**

In complexes $[Rh(H_2O)_6]^{3+}$and $[Co(H_2O)_6]^{3+}$,central metal cations have same oxidation state as well as same ligands and they fall in same group, but Δ_0 of $[Rh(H_2O)_6]^{3+} > \Delta_o$ of $[Co(H_2O)_6]^{3+}$ because Rh^{3+} has high Z_{eff} value then Co^{3+}

196 **(b)**

Ligand must have capacity to donate lone pair of electrons to form coordinate bond

199 **(b)**

Baeyer predicted that a five membered ring compound would be the most stable. It has angle of deviation = 0.44°

And we know that stability $\propto \frac{1}{d}$

200 **(d)**

Due to hydrogen bonding and resonance enol form is preferred in contrast