EXERCISE–01 CHECK YOUR GRASP

SELECT THE CORRECT ALTERNATIVE (ONLY ONE CORRECT ANSWER)

1. In the complex ion $[Fe(EDTA)]^-$ the co-ordination number and oxidation state of central metal ion is –
(A) C. N. = 6, O. N. = +3
(B) C. N. = 1, O. N. = –1
(C) C. N. = 4, O. N. = +2
(D) C. N. = 3, O. N. = +3

2. The IUPAC name of the complex $[CrCl_2(H_2O)_4]NO_3$ is –
(A) Dichlorotetraaquachromium(III) nitrate
(B) Tetraaquadichlorochromium(III) nitrate
(C) Chromiumtetraaquadichloro nitrate
(D) Dichlorotetraaquachromium nitrate

3. Amongst $TiF_6^{2-}, CoF_6^{3-}, Cu_2Cl_2$ and $NiCl_4^{2-}$ (At. No. of Ti = 22, Co = 27, Cu = 29, Ni = 28)
The colourless species are –
(A) CoF_6^{3-} and $NiCl_4^{2-}$
(B) TiF_6^{2-} and CoF_6^{3-}
(C) Cu_2Cl_2 and $NiCl_4^{2-}$
(D) TiF_6^{2-} and Cu_2Cl_2

4. Which of the following complex can not exhibit geometrical isomerism –
(A) $[Pt(NH_3)_2Cl\ NO_2]$
(B) $[Pt(gly)_2]$
(C) $[Cu(en)_2]^+$
(D) $[Pt(H_2O)(NH_3)BrCl]$

5. $[Cu(H_2O)_4]^{2+}$ absorbs orange light and the transmitted complementary colour will be –
(A) Green
(B) Yellow
(C) Blue
(D) Violet

6. AgCl precipitate dissolves in NH_3 due to the formation of –
(A) $[Ag(NH_3)_2]OH$
(B) $[Ag(NH_3)_2]Cl$
(C) $[Ag(NH_3)_2]Cl$
(D) $[Ag(NH_3)_2]OH$

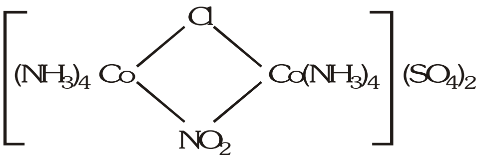
7. Which one of the following compounds will exhibit linkage isomerism –
(A) $[Pt\ (NH_3)_2\ Cl_2]$
(B) $[Co\ (NH_3)_2\ NO_2]Cl_2$
(C) $[Co\ (NH_3)_4\ Cl_2]Cl$
(D) $[Co\ (en)_2Cl_2]Cl$

8. A magnetic moment of 1.73 BM will be shown by one among of the following compounds –
(A) $[Cu(NH_3)_4]^{2+}$
(B) $[Ni(CN)_4]^{2-}$
(C) $TiCl_4$
(D) $[CoCl_6]^{-3}$

9. Give the name of the complex compound $K_3[Fe(C_2O_4)_3]$ according to IUPAC system –
(A) Potassium Ferric oxalate
(B) Potassium trioxalatoiron(III)
(C) Potassium trioxalatoferrate(III)
(D) Tripotassium trioxalatoferrate(III)

10. Give the IUPAC name of the complex compound $[Co(NH_3)_4(H_2O)Br](NO_3)_2$:–
(A) Bromoaquotetraaminecobalt(III) nitrate
(B) Bromoaquotetraaminocobalt(III) nitrate
(C) Bromoaquatetraamminecobalt(III) nitrate
(D) Tetraammineaquabromocobalt(III) nitrate

11. Name the following compound according to IUPAC system



(A) Octamine-μ-chloro-μ-nitrodicobalt(III) sulphate
(B) Octaammine-μ-chloro-μ-nitrodicobalt(III) sulphate
(C) Octaammine-μ-nitro-μ-chlorodicobalt(III) sulphate
(D) None of the above

12. Chemical Name of "Turn bull's blue" is –

(A) Ferrous ferricyanide (B) Ferri ferrocyanide (C) Potassium cyanide (D) Potassium ferricyanide

13. Hexafluorocobaltate(III) ion is found to be high spin complex, the probable hybrid state of cobalt in it, is–

(A) dsp^2 (B) d^2sp^3 (C) sp^3d^2 (D) sp^3d

14. In the complex $[Ni(H_2O)_2(NH_3)_4]^{+2}$ the magnetic moment (μ) of Ni is –

(A) Zero (B) 2.83 BM (C) 1.73 BM (D) 3.87 BM

15. Which of the following system has maximum number of unpaired electrones –

(A) d^5 (Octahedral, low spin) (B) d^8 (Tetrahedral)

(C) d^6 (Octahedral, low spin) (D) d^3 (Octahedral)

16. Nessler's reagent is –

(A) K_2HgI_4 (B) K_2HgI_4 + KOH (C) K_2HgI_2+ KOH (D) K_2HgI_4 + Hg

17. A blue colouration is not obtained when –

(A) NH_4OH is added to $CuSO_4$ (B) $CuSO_4$ solution reacts with $K_4[Fe(CN)_6]$

(C) $FeCl_3$ reacts with $K_4[Fe(CN)_6]$ (D) Anhydrous white $CuSO_4$ is dissolved in water

18. One among the following complex ions will not show optical activity –

(A) $[Pt\ (Br)(Cl)(I)(NO_2)(C_2H_5N)(NH_3)]$ (B) Cis-$[Co(en)_2Cl_2]^+$

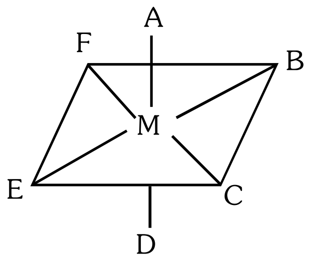
(C) $[Co(en)(NH_3)_2Cl_2]^+$ (D) $[Cr(NH_3)_4Cl_2]$

19. A Planar Complex (Mabcd) gives –

(A) Two Optical isomer (B) Two geometrical isomer

(C) Three optical isomer (D) Three geometrical isomers

20. A complex shown below can exhibit –



(A) Geometrical isomerism only

(B) Optical isomerism only

(C) Both Optical and geometrical isomerism

(D) None

21. $[Co(NH_3)_4Cl_2]NO_2$ and $[Co(NH_3)_4Cl\ NO_2]Cl$ are –

(A) Geometrical isomers (B) Optical isomers

(C) Linkage isomers (D) Ionisation isomers

22. Theoritically the No. of geometrical isomers expected for octahedral complex [Mabcdef] is –

(A) Zero (B) 30 (C) 15 (D) 9

23. Which of the following has two geometrical isomers, and is also a non ionisable complex –

(A) $PtCl_4$ $2NH_3$ (B) $PtCl_4$ $3NH_3$ (C) $PtCl_4$ $4NH_3$ (D) $PtCl_4$ $6NH_3$

24. $Na_2S_2O_3.5H_2O$ is used in photography to –

(A) Reduce AgBr to metallic Ag

(B) Remove reduced Ag

(C) Remove undecomposed AgBr as a soluble complex

(D) Converts metallic Ag to silver salt

25. Oxidation state of Ag in $Na_3[Ag(S_2O_3)_2]$ is –

(A) + 2 (B) – 2 (C) 0 (D) +1

26. Out of $[Fe(CN)_6]^{4-}$, $[Ni(CN)_4]^{-2}$ and $[Ni(CO)_4]$

(A) All have identical geometry.

(B) All are paramagnetic.

(C) All are dimagnetic.

(D) $[Fe(CN)_6]^{-4}$ is dimagnetic but $[Ni(CN)_4]^{-2}$ and $[(Ni(CO)_4]$ are paramagnetic

27. Which gives only 25% mole of cloride as AgCl, when reacts with excess $AgNO_3$ –

(A) $PtCl_2 . 4NH_3$ (B) $PtCl_4 . 5NH_3$ (C) $PtCl_4 . 4NH_3$ (D) $PtCl_4 . 3NH_3$

28. Which of the following compound is paramagnetic –

(A) Tetracyanonickelate(II) ion (B) Tetraamminezinc(II) ion

(C) Hexaamine chromium(III) ion (D) Diammine silver(I) ion

29. The complexes $[Co(NO_2) (NH_3)_5] Cl_2$ and $[Co(ONO) (NH_3)_5] Cl_2$ are the examples of

(A) Co-ordination isomerism (B) Ionisation isomerism

(C) Geometrical isomerism (D) Linkage isomerism

30. The complex $[Mn(CN)_6]^{4-}$ is –

(A) High spin complex (B) Diamagnetic ion

(C) Having magnetic moment 1.73 BM (D) Outer orbital complex

31. Amongst the following, identify the species with an atom in +6 oxidation state –

(A) MnO_4^- (B) $Cr(CN)_6^{3-}$ (C) NiF_6^{2-} (D) CrO_2Cl_2

32. Which of the following statement is incorrect about $[Fe(H_2O)_5NO]SO_4$ –

(A) It produce in brown ring test for nitrates (B) Oxidation state of Fe is +1

(C) It exhibits geometrical isomerism (D) Charge on NO is +1

33. Which is/are organometallic compound –

(I) Grignard reagent (II) Sodium methoxide (III) Sodium acetylide

(A) II (B) I, III (C) I, II (D) I

34. Which of the following is most likely formula of platinum complex, if 1/4 of total chlorine of the compound is precipitated by adding $AgNO_3$ to its aqueous solution

(A) $PtCl_4.6H_2O$ (B) $PtCl_4. 5H_2O$ (C) $PtCl_2.2H_2O$ (D) $PtCl_4.3H_2O$

35. A complex compound of cobalt has molecular formula containing five NH_3 molecules, one nitro group and two chlorine atom for one cobalt atom. One mole of this compound produces three moles of ion in aqueous solution. On reaction with excess of $AgNO_3$ solution two moles of AgCl get precipitated. The Ionic formula of the compound.

(A) $[Co(NH_3)_4 NO_2 Cl] NH_3Cl$ (B) $[Co(NH_3)_5Cl] ClNO_2$

(C) $[Co(NH_3)_5NO_2]Cl_2$ (D) None of these

36. Which of the following will give maximum number of isomers –

(A) $[Co(NH_3)_4Cl_2]^+$ (B) $[Ni(en)(NH_3)_4]^{+2}$ (C) $[Ni(C_2O_4)(en)_2]^0$ (D) $[Cr(SCN)_2(NH_3)_4]^+$

37. In the complexes $[Fe(H_2O)_6]^{3+}$, $[Fe(en)_3]^{3+}$, $[Fe(C_2O_4)_3]^{3-}$ and $[FeCl_6]^{3-}$, more stability is shown by

(A) $[Fe(H_2O)_6]^{3+}$ (B) $[Fe(en)_3]^{3+}$ (C) $[Fe(C_2O_4)_3]^{3-}$ (D) $[FeCl_6]^{3-}$

38. Both geometrical and optical isomerism are shown by –

(A) $[Co(en)_2Cl_2]^+$ (B) $[Co(NH_3)_5Cl]^{2+}$ (C) $[Co(C_2O_4)_3]^{-3}$ (D) $[Cr(ox)_3]^{3-}$

39. An example for a double salt is

(A) Cuprammonium sulphate (B) Mohr's salt

(C) Potassium ferricyanide (D) Cobalthexammine chloride

40. One mole of the complex compound $Co(NH_3)_5Cl_3$, gives 3 moles of ions on dissolution in water. One mole of the same complex reacts with two moles of $AgNO_3$ solution to yield two moles of AgCl (s). The structure of the complex is –

(A) $[Co(NH_3)_3Cl_3]. 2NH_3$ (B) $[Co(NH_3)_4Cl_2]$ $Cl.NH_3$

(C) $[Co(NH_3)_4Cl]$ $Cl_2.NH_3$ (D) $[Co(NH_3)_5Cl]Cl_2$

41. What are the geometric shape and the oxidation number of the copper atom, respectively, for the complex ion, $[Cu(NH_3)_4(OH_2)_2]^{2+}$

(A) Tetrahedral; + 2 (B) Square planar; – 2 (C) Linear; + 3 (D) Octahedral; + 2

42. What is the relationship between the following two linear complex ions ?

$[Cl - Ag - SCN]^{1-}$ $[SCN - Ag - Cl]^{1-}$

The complex ions are –

(A) Linkage isomers (B) Coordination isomers (C) Geometric isomers (D) Optical isomers

43. Which of the following common shapes (I–IV) can never exist as geometric isomers, regardless of the identity of the ligands –

(I) Linear (II) Square planar (III) Tetrahedral (IV) Octahedral

(A) I only (B) I and II (C) I and III (D) II and IV

44. Synergic bonding involves –

(A) The transference of electrons from ligands to metal

(B) The transference of electrons from filled metal orbitals to anti–bonding orbitals of ligands

(C) Both (A) and (B)

(D) None of these

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	A	B	D	C	C	C	B	A	C	D	D	A	C	B	D	B	B	D	D	C
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	D	C	A	C	D	C	D	C	D	C	D	C	D	D	C	D	B	A	B	D
Que.	41	42	43	44																
Ans.	D	A	C	C																

EXERCISE–02 BRAIN TEASERS

SELECT THE CORRECT ALTERNATIVES (ONE OR MORE THEN ONE CORRECT ANSWERS)

1. A complex cation is formed by Pt(in some oxidation state) with ligands (in proper number so that coordination number of Pt becomes six). Which of the following can be its correct IUPAC name –

(A) Diammineethylenediaminedithiocyanato-S-platinum(II)

(B) Diammineethylenediaminedithiocyanato-S-platinate(IV) ion

(C) Diammineethylenediaminedithiocyanato-S-platinum(IV) ion

(D) Diamminebis (ethylenediamine) dithiocyanato-S-platinum(IV) ion

2. In which of the following configuration (s) the value of 'spin only' magnetic moment is 2.84 BM for octahedral complex

(A) d^4 (in strong field ligand) (B) d^2 (in weak field ligand)

(C) d^3 (in weak as well as in strong field ligand) (D) d^5 (in strong field ligand)

(E) d^8 (in weak field ligand)

3. In the crystal field of the complex $[Fe(Cl)(CN)_4(O_2)]^{4-}$, the electronic configuration of metal is found to be t_{2g}^6, e_g^0 then which of the following is/are true about this complex ion –

(A) It is a paramagnetic complex

(B) O – O bond length will be more than found in O_2 molecule

(C) Its IUPAC name will be chlorotetracyanosuperoxidoferrate(II) ion.

(D) It will show geometrical as well as optical isomerism

4. The solubility of AgBr in hypo solution is due to the formation of –

(A) Ag_2SO_3 (B) $Ag_2S_2O_3$ (C) $[Ag(S_2O_3)]^-$ (D) $[Ag(S_2O_3)_2]^{3-}$

5. Photo graphic films or plates have...............as an essential ingredient –

(A) Silver oxide (B) Silver bromide (C) Silver thio sulphate (D) Silver nitrate

6. Silver halides are used in photography because they are –

(A) Photosensetive (B) Soluble in hypo solution

(C) Soluble in NH_4OH (D) Insoluble in acids

7. The compound which shows paramagnetism is –

(A) $[Cu(NH_3)_4]Cl_2$ (B) $Fe(CO)_5$ (C) NO (D) NO_2

8. Magnetic moment of x^{n+} is $\sqrt{24}$ B.M. Hence No. of unpaired electron and value of 'n' respectively. (Atomic number = 26)

(A) 4 , 3 (B) 3 , 5 (C) 4 , 2 (D) 4 , 1

9. Among the following compound that is both paramagnetic and coloured is –

(A) $K_2Cr_2O_7$ (B) $(NH_4)_2[TiCl_6]$ (C) $VOSO_4$ (D) $K_3[Cu(CN)_4]$

10. The total number of possible isomer for the complex compound : $[Cu(NH_3)_4]$ $[PtCl_4]$

(A) 3 (B) 6 (C) 5 (D) 4

11. The image on an exposed and developed photography film is due to –

(A) AgBr (B) $[Ag(S_2O_3)_2]^{3+}$ (C) Ag (D) Ag_2O

12. The chloro-bis (ethylenediamine) nitrocobalt(III) ion is –

(A) $[Co(NO_2)_2(en)_2Cl_2]^+$ (B) $[CoCl(NO_2)_2(en)_2]^+$

(C) $[Co(NO_2)Cl(en)_2]^+$ (D) $[Co(en)Cl_2(NO_2)_2]^-$

13. Zeigler natta catalyst is –

(A) Pt/PtO
(B) $Al(C_2H_5)_3 + TiCl_4$
(C) $K[PtCl_3(\eta^2 - C_2H_4)]$
(D) Pt/Rh

14. Which of the following set of isomer isomerism is/are correct –

(A) Cis–$[Co(gly)_2Cl_2]^-$ – optical isomerism
(B) $[Zn(NH_3)_3Cl]^+$ – Geometrical isomerism
(C) $[Fe(H_2O)_6]Cl_3$ – Hydrate isomerism
(D) $[Co(en)_2(NCS)_2]Cl$ – Linkage isomerism

15. In $Na_2 [Fe(CN)_5NO]$ sodium nitroprusside –

(A) Oxidation state of Fe is +2
(B) This has NO^+ as ligand
(C) It is paramagnetic
(D) None is correct

16. Which of the following statement is correct –

(A) $[Cu (NH_3)_6]^{2+}$ is a colourless ion
(B) $[Ni (CN)_4]^{2-}$ ion has tetrahedral shape
(C) $[Zn(H_2O)_6]^{2+}$ ion is blue coloured
(D) Nickel dimethylglyoxime is red in colour

17. Which of the following have square planar geometry –

(a) $[NiCl_4]^{-2}$
(b) $[Cu(NH_3)_4]^{+2}$
(c) $[Ni(CO)_4]$
(d) ClF_4^-

(A) b, c and d
(B) a, b and c
(C) b and d
(D) All

18. Pick up the incorrect statement –

(A) Cisplatin is a complex of platinum
(B) Vitamin B_{12} is a complex of cobalt
(C) Chlorophyll is a complex of Mangenese
(D) Haemoglobin is a complex of iron

19. Which of the following pair of molecule have identical shape –

(A) $[NiCl_4]^{-2}$ and XeF_4
(B) $[Zn(H_2O)_4]^{+2}$ and $SiCl_4$
(C) $[Fe(CO)_5]$ and $XeOF_4$
(D) $[Ag(NH_3)_2]^+$ and SF_2

20. Hypo is used in photography because it is –

(A) A strong reducing agent
(B) A strong oxidising agent
(C) A strong Complexing agent
(D) Photo sensitive Compound

21. The kind of isomerism exhibited by $[Rh(en)_2Cl_2][Ir(en)Cl_4]$ and $[Rh(en)_3][IrCl_6]$ is –

(A) Linkage
(B) Co-ordination
(C) Ligand
(D) Ionisation

22. Identify the complex which are expected to be colourless –

(A) $[Ti(NO_3)_4]^0$
(B) $[Cu(NCCH_3)_4]^+$
(C) $[Cr(NH_3)_6]Cl_3$
(D) K_3VF_6

23. Which of following organometallic compound is σ and π bonded –

(A) $[Fe(\eta^5 - C_5H_5)_2]$
(B) $K[PtCl_3(\eta^2 - C_2H_4)]$
(C) $[Co(CO)_5NH_3]^{+2}$
(D) $Fe(CH_3)_3$

24. Which statement is incorrect –

(A) $[Ni(CO)_4]$ - Tetrahedral, paramagnetic
(B) $[Ni(CN)_4]^{-2}$ - Square planar, diamagnetic
(C) $[Ni(CO)_4]$ - Tetrahedral, diamagnetic
(D) $[NiCl_4]^{-2}$ - Tetrahedral, paramagnetic

25. A complex $K_n [MnF_6]$ has magnetic moment 4.9 BM what will be the oxidation state of Mn and the value of n ?

(A) Mn(II), n = 4
(B) Mn(III) ; n = 3
(C) Mn(IV) ; n = 2
(D) Mn(V) ; n = 1

26. In $[Co(NH_3)_6]Cl_3$, the number of covalent bonds & coordinate bonds respectively –

(A) 3, 6
(B) 6, 6
(C) 8, 9
(D) 18, 6

27. $CuSO_4$ when reacts with KCN forms x, which is insoluble in water. x is soluble in excess of KCN, due to formation of –

(A) $K_2[Cu(CN)_4]$ (B) $K_3[Cu(CN)_4]$ (C) $CuCN_2$ (D) $Cu[KCu(CN)_4]$

28. A square planar complex is formed by hybridization of which atomic orbitals –

(A) s, p_x, p_y, d_{yz} (B) s, p_x, p_y, $d_{x^2-y^2}$ (C) s, p_x, p_y, d_{z^2} (D) s, p_x, p_y, d_{xy}

29. When $AgNO_3$ is added to a solution of $Co(NH_3)_5\,Cl_3$, the precipitate of AgCl shows two ionized chloride ions. This means –

(A) Only two chlorine atoms satisfy primary valency and one secondary valency

(B) One chlorine atom satisfies primary as well as secondary valency

(C) Three chlorine atoms satisfy primary valency

(D) Three chlorine atoms satisfy secondary valency.

30. Which of the following compound is not coloured ?

(A) $Na_2[CuCl_4]$ (B) $Na_2[CdCl_4]$ (C) $Fe_4[Fe(CN)_6]_3$ (D) $K_3[Fe(CN)_6]$

31. Colourless species is :

(A) VCl_3 (B) $VOSO_4$ (C) Na_3VO_4 (D) $[Ni(H_2O)_6]\,SO_4.H_2O$

32. The coordination number of a central metal atom in a complex is determined by –

(A) The number of ligands around a metal ion bonded by sigma and pi-bonds both

(B) The number of ligands around a metal ion bonded by pi-bonds

(C) The number of ligands around a metal ion bonded by sigma bonds

(D) The number of only anionic ligands bonded to the metal ion

33. The correct order of magnetic moments (spin only values in B.M.) among is –

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

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

34. Among the following series of transition metal ions, the one where all metal ions have $3d^2$ electronic configuration is –

(A) Ti^{2+}, V^{3+}, Cr^{4+}, Mn^{5+} (B) Ti^{2+}, V^{2+}, Cr^{3+}, Mn^{4+}

(C) Ti^{+}, V^{4+}, Cr^{6+}, Mn^{7+} (D) Ti^{4+}, V^{3+}, Cr^{2+}, Mn^{3+}

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

(A) It forms high spin complexes with metal species (B) It gives nagative charge

(C) It is a pseudohalide (D) It can accept electrons from metal species

36. Which of the following coordination compounds would not exhibit optical isomerism ?

(A) tris-(ethylenediamine)cobalt(III) bromide

(B) pentaamminenitrocobalt(III) iodide

(C) diamminedichloroplatinum(II)

(D) trans-dicyanobis (ethylenediamine) chromium(III) chloride

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

(A) dsp^2, sp^3, sp^3 (B) sp^3, dsp^2, dsp^2

(C) sp^3, dsp^2, sp^3 (D) sp^3, sp^3, dsp^2

38. Which one of the following is expected to not exhibit optical isomerism ?

(en = ethylenediamine)

(A) *cis* – $[Pt(NH_3)_2Cl_2]$ (B) *cis* – $[Co(en)_2Cl_2]$ (C) *trans* – $[Co(en)_2Cl_2]$ (D) *trans* – $[Pt(NH_3)_2Cl_2]$

39. An aqueous solution of $CoCl_2$ on addition of excess of concentrated HCl turns blue due to formations of :

(A) $[Co(H_2O)_4Cl_2]$ (B) $[Co(H_2O)_2Cl_4]^{2-}$ (C) $[CoCl_4]^{2-}$ (D) $[Co(H_2O)_2Cl_2]$

40. In which of the following pairs both the complexes show optical isomerism ?

(A) cis–$[Cr(C_2O_4)_2Cl_2]^{3-}$, cis–$[Co(NH_3)_4Cl_2]$

(B) $[Co(en)_3]Cl_3$,cis– $[Co(en)_2Cl_2]Cl$

(C) $[PtCl(dien)]Cl$,$[NiCl_2Br_2]^{2-}$

(D) $[Co(NO_3)_3(NH_3)_3]$, cis –$[Pt(en)_2Cl_2]$

41. The correct order for the wavelength of absorption in the visible resion is :

(A) $[Ni(NO_2)_6]^{4-} < [Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+}$ (B) $[Ni(NO_2)_6]^{4-} < [Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+}$

(C) $[Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+} < [Ni(NO_2)_6]^{4-}$ (D) $[Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+} < [Ni(NO_2)_6]^{4-}$

42. Which one of the following cyano complexes would exhibit the lowest value of magnetic moment ?

(A) $[Cr(CN)_6]^{3-}$ (B) $[Mn(CN)_6]^{3-}$ (C) $[Fe(CN)_6]^{3-}$ (D) $[Co(CN)_6]^{3-}$

43. The oxidation state of Mo in its oxo-complex species $[Mo_2O_4(C_2H_4)_2(H_2O)_2]^{2-}$ is –

(A) + 2 (B) + 3 (C) + 4 (D) + 5

44. The correct order of hybridisation of the central atom in the following species :

NH_3, $[PtCl_4]^{2-}$, PCl_5 and BCl_3 is

(A) dsp^2, dsp^3, sp^2, sp^3 (B) sp^3, dsp^2, dsp^3, sp^2

(C) dsp^2, sp^2, sp^3, dsp^3 (D) dsp^2, sp^3, sp^2, sp^3

45. $[Cr(H_2O)_6]Cl_3$ (at, no. of Cr=24) has a magnetic moment of 3.83 B.M. The correct distribution of 3d electrons in the Chromium of the complex is –

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

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

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

(A) linkage isomerism, geometrical isomerism and optical isomerism

(B) linkage isomerism, ionization isomerism and optical isomerism

(C) linkage isomerism, ionization isomerism and geometrical isomerism

(D) ionization isomerism, geometrical isomerism and optical isomerism

47. The pair in which both species have same magnetic moment (spin only value) is –

(A) $[Cr(H_2O)_6]^{2+}$, $[CoCl_4]^{2-}$ (B) $[Cr(H_2O)_6]^{2+}$, $[Fe(H_2O)_6]^{2+}$

(C) $[Mn(H_2O)_6]^{2+}$, $[Cr(H_2O)_6]^{2+}$ (D) $[CoCl_4]^{2-}$, $[Fe(H_2O)_6]^{2+}$

48. Among the following the species having same geometry for central atom are

(i) XeF_4 (ii) SF_4 (iii) $[NiCl_4]^{2-}$ (iv) $[PdCl_4]^{2-}$

(A) (i) and (iv) (B) (i), (iii) and (iv) (C) (ii) and (iii) (D) (iii) and (iv)

49. For $[FeF_6]^{3-}$ and $[Fe(CN)_6]^{3-}$ magnetic moment of the fluoride complex is expected to be–

(A) The same as the magnetic moment of the cyanide complex

(B) Larger than the magnetic moment of the cyanide complex because there are more unpaired electrons in the fluoride complex

(C) Smaller than the magnetic moment of the cyanide complex because there are more unpaired electrons in the fluoride complex

(D) Larger than the magnetic moment of the cyanide complex because there are few unpaired electrons in the fluoride complex

50. Coordination compounds which contain cyanide (CN^-) ligands tend to be yellow where as coordination compounds which contain water (H_2O) ligands tend to be blue or green because –

(A) The complexes diffract light at different angles

(B) Cyanide is a weak–field ligand and water is a strong–field ligand

(C) Cyanide is a strong–field ligand and water is a weak–field ligand

(D) Cyanide compounds absorb yellow light and water compounds absorb blue or green light

51. Which of the following complexes is not a chellate –

(A) bis (dimethylglyoximato) nickel(II)

(B) Potassium ethylenediaminetetrathiocyanato chromate (III)

(C) pantamminecarbonatocobalt (III) nitrate

(D) Trans–diglycinatoplatinum (II)

52. The stability constants of the complexes formed by a metal ion M^{2+} with NH_3, CN^-, H_2O are of the order of 10^{15}, 10^{27}, 10^{11} respectively. Then –

(A) NH_3 is the strongest ligand

(B) CN^- is the strongest ligand

(C) These values cannot predict the strength of the ligand

(D) All the ligands are equally strong

53. $Fe_4[Fe(CN)_6]_3$ a blue coloured complex. Average oxidation number of Fe in $Fe_4[Fe(CN)_6]_3$ is 'a' oxidation state of centeral iron atom 'b' oxidation state of counter iron atom 'c', a,b,c are respectively –

(A) $+\frac{5}{2}, +2, +3$ (B) $+\frac{5}{2}, +3, +2$ (C) $+\frac{18}{7}, +2, +3$ (D) $+\frac{18}{7}, +3, +2$

54. Which of the following is correct about

Tetraamminedithiocyanato-S-cobalt(III) tris(oxalato)cobaltate(III)?

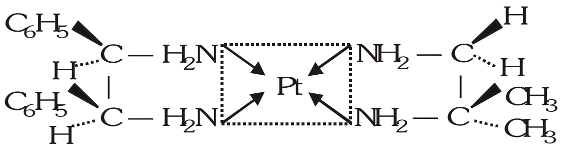
(A) Formula of the complex is $[Co(NH_3)_4(SCN)_2][Co(ox)_3]$

(B) It is a chelating complex and show linkage isomerism

(C) It shows optical isomerism

(D) It show geometrical isomerism

55. Select the correct statement about given square planar complex.



(A) It has no geometrical isomer

(B) It is optically active because it does not have plane of symmetry

(C) It is optically inactive because square planar complex have plane of symmetry

(D) It is optically active because it has symmetric carbon.

56. Total number of stereo isomers of $[Co(acac)_2BrCl]^-$ are:

(A) 4 (B) 3 (C) 6 (D) 2

57. Match list-I (Species) with List-II (Hybrid orbitals used by the central atom in their formation) and select the correct answer:

	Column-I		Column-II
(a)	$Ni(CN)_5^{3-}$	(1)	sp^3
(b)	$CuCl_5^{3-}$	(2)	dsp^2
(c)	$AuCl_4^-$	(3)	$sp^3d_{z^2}$
(d)	ClO_4^-	(4)	$d_{x^2-y^2}sp^3$

Codes :

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

58. Which of the following is correct IUPAC name of any complex compound?

(A) Tris (acetylacetonato)iron(III) chloride

(B) Hexachloroplatinum(IV) tetraamminedicyanoplatinate(IV)

(C) Amminebromochloromethylamineplatinum(II)

(D) Cis-dichloro(ethylenediamine)platinum(II)

59. Which of ther following statement(s) is (are) correct?

(A) The complexes $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ differ in the magnetic properties

(B) The complexes $[NiCl_4]^{2-}$ and $[NiCN_4]^{2-}$ differ in the geometry

(C) The complexes $[NiCl_4]^{2-}$ and $[NiCN_4]^{2-}$ differ in primary valencies of nickel

(D) The complexes $[NiCl_4]^{2-}$ and $[NiCN_4]^{2-}$ differ in the state of hybridization of nickel.

60. Which of the following statement(s) is/are correct with reference to Fe^{2+} and Fe^{3+} ions?

(1) Fe^{3+} gives brown colour with potassium ferricyanide

(2) Fe^{2+} gives blue colour with potassium ferricyanide

(3) Fe^{3+} gives red colour with potassium thiocyanate

(4) Fe^{2+} gives brown colour with ammonium thiocyanate

(A) 1, 2 (B) 1, 4 (C) 1, 2, 3 (D) All of these

61. 0.001 mol of $Co(NH_3)_5(NO_3)(SO_4)$ was passed through a cation exchanger and the acid coming out of its required 20 ml of 0.1 M NaOH for neutralisation. Hence, the complex is –

(A) $[CoSO_4(NH_3)_5]NO_3$ (B) $[CoNO_3(NH_3)_5]SO_4$

(C) $[Co(NH_3)_5]\ (SO_4)\ (NO_3)$ (D) None of these

62. The IUPAC name of the red coloured complex $[Fe(C_4H_7O_2N_2)_2]$ obtained from the reaction of Fe^{2+} and dimethyl glyoxime –

(A) bis(dimethyl glyoxime) ferrate(II)

(B) bis (dimethyl glyoximato) iron(II)

(C) bis (2, 3-butanediol dioximato) iron(II)

(D) bis (2, 3-butanedione dioximato) iron(II)

63. An ion M^{2+}, forms the complexes $[M(H_2O)_6]^{2+}$, $[M(en)_3]^{2+}$ and $[MBr_6]^{4-}$, Match the complex with the appropriate colour –

(A) Green, blue and red (B) Blue, red and green

(C) Green, red and blue (D) Red, blue and green

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	C	A,B,E	A,B,C	D	B	A	A,C,D	C	C	D	C	C	B	A,C,D	A,B	D	C	C	B	C
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	B	A,B	C	A	B	D	B	B	B,C	B	C	C	C	A	D	B,C,D	C	A,C,D	C	B
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	A	D	B	B	D	C	B	A	B	C	C	B	C	B,C,D	B	B	D	C	A,B,D	C
Que.	61	62	63																	
Ans.	B	B	B																	

EXERCISE–03 MISCELLANEOUS TYPE QUESTIONS

TRUE / FALSE

1. Coordination number and oxidation state of a metal means the same thing.
2. Stability of coordination compounds increases with increase in charge density of the metal ions.
3. $Fe(CO)_5$ has trigonal bipyramidal geometry.
4. $[NiCl_4]^{2-}$ is diamagnetic in nature.
5. Metal Carbonyls are organometallic compounds.
6. Both optical and geometrical isomerisms are shown by $[Co(en)_2\ Cl_2]^+$.
7. The complex $[Co(NH_3)_3Cl_3]$ is ionizable,
8. The complex ion trans-dichlorobis(ethylenediamine)rhodium(III) is optically active.

FILL IN THE BLANKS

1. A Solution of potassium ferrocyanide contains .... ions.
2. $EDTA^{-4}$ is a .... ligand.
3. The secondary valency of metal is equal to .... and is ....
4. The coordination number and oxidation number of cobalt in $[Co(edta)]^{-1}$ are .... and .... respectively.
5. The total number of electrons on the central metal atom/ion including those gained by bonding is called ....
6. $[Co(NH_3)_5\ SO_4]Br$ and $[Co(NH_3)_5\ Br]SO_4$ show .... isomerism.
7. One molecule of $[Pt(NH_3)_6]Cl_4$ gives .... ions in solution and requires .... of $AgNO_3$ for complete precipitation of chloride ions.
8. $[Pt(NH_3)(NH_2OH)(py)(NO_2)]NO_3$ has .... shape and has .... geometrical isomers.

MATCH THE COLUMN

1.

	Column-I		Column-II
(A)	$[Ni(CN)_4]^{2-}$	(p)	Paramegnatic
(B)	$[NiCl_4]^{2-}$	(q)	Diamegnatic
(C)	$[MnCl_4]^{2-}$	(r)	Tetrahedral
(D)	$[Cu(NH_3)_4]^{+2}$	(s)	SQ. planar

2.

	Column-I		Column-II
(A)	Sodium nitroprusside	(p)	μ = 0 BM
(B)	Brown ring complex	(q)	Octahedral
(C)	Complex of Ag formed during its extraction	(r)	$\mu = \sqrt{15}$ BM
(D)	Potassium ferrocyanide	(s)	NO^+ ligand
		(t)	cynide ligand is present

3.

	Column-I		Column-II
	Co-ordination compound		Type of isomerism
(A)	$[Co(NH_3)_4Cl_2]Br$	(p)	Optical isomerism
(B)	$[Co(en)_2Cl_2]Cl$	(q)	Ionization isomerism
(C)	$[Co(en)_2(NO_2)Cl]SCN$	(r)	Coordination isomerism
(D)	$[Co(NH_3)_6][Cr(F)_6]$	(s)	Geometrical isomerism
		(t)	Linkage isomerism

ASSERTION & REASON QUESTIONS

These questions contains, Statement-I (assertion) and Statement-II (reason).

(A) Statement-I is True, Statement-II is True ; Statement-II is a correct explanation for Statement-I

(B) Statement-I is True, Statement-II is True ; Statement-II is NOT a correct explanation for Statement-I

(C) Statement-I is True, Statement-II is False.

(D) Statement-I is False, Statement-II is True.

1. **Statement-I** : K_2SO_4. $Al_2(SO_4)_3$. $24H_2O$ is a double salt compound.
Because
Statement-II : It ionises to give a complex ion.

2. **Statement-I** : $[Fe(CO)_5]$ is dimagnetic complex.
Because
Statement-II : In the given complex oxidation state of Iron is zero.

3. **Statement-I** : $[Ni(CN)_4]^{-2}$ has zero unpaired electron while that of $[NiCl_4]^{-2}$ has two unpaired e^-
Because
Statement-II : $[Ni(CN)_4]^{-2}$ has strong crystal field while $[NiCl_4]^{-2}$ has weak crystal field

4. **Statement-I** : $K_2[PtCl_6]$ gives white ppt when reacts with $AgNO_3$
Because
Statement-II : Chloride ion in the complex is non-ionisable.

5. **Statement-I** : Trans $[CoCl_2(en)_2]^+$ is optically inactive.
Because
Statement-II : It has plane of symmetry.

6. **Statement-I** : Cis - $[Fe(en)_2Cl_2]^+$ can form recemic mixture.
Because
Statement-II : Cis - $[Fe(en)_2Cl_2]^+$ is optically active square planar complex .

7. **Statement-I** : Potassium ferrocyanide is diamagnetic whereas potassium ferricyanide is paramagnetic.
Because
Statement-II : Crystal field spliting in ferrocyanide ion is greater than that of ferricyanide ion.

8. **Statement-I** : $[Co(NO_2)_3(NH_3)_3]$ does not show optical isomerism.
Because
Statement-II : It has plane of symmetry.

9. **Statement-I** : C–C bond length in zeise's salt is same as ethylen.
Because
Statement-II : Double bond is shorter as compaire to single bond.

10. **Statement-I** : Hydrazine is a neutral ligand.
Because
Statement-II : It has two N as donor atoms and behaves as a chelating ligand.

11. **Statement-I** : $[Ti(H_2O)_6]^{4+}$ is coloured while $[Sc(H_2O)_6]^{3+}$ is colourless.
Because
Statement-II : d-d transition is not possible in $[Sc(H_2O)_6]^{3+}$.

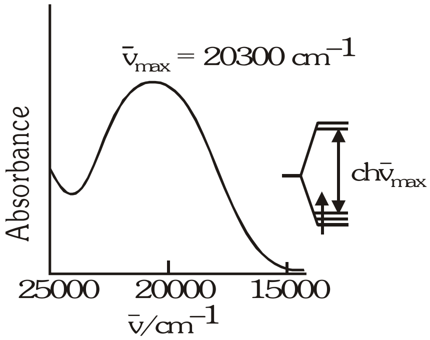
12. **Statement-I** : EAN of Fe in ferrocene is 36.
Because
Statement-II : 6π e^- are co-ordinated by each cyclo pentadien ring with central metal ion.

COMPREHENSION BASED QUESTIONS

Comprehension # 1

With the help of CFT number of unpaired electron in a compound can be calculated and we can calculate its paramagnetic moment (due to spin only), by the formula:

$\mu = \sqrt{n(n+2)}$ Bohr magneton (BM), where 'n' is the number of unpaired electron in the complex. For spectral analysis the separation between t_{2g} and e_g orbitals, called ligand field splitting parameter Δ_0 (for octahedral complexes) should be known to us, which can be easily calculated by observing the absorption spectrum of one e^- complex figure shows the optical absorption spectrum of the d^1 hexaaquatitanium (III) ion $[Ti(H_2O)_6]^{3+}$. The CFT assigns the first absorption maximum at 20,300 cm^{-1} to the transition $e_g \leftarrow t_{2g}$. For multielectronic (d^2 to d^{10}) system, the calculation of Δ_0 by absorption spectrum is not that easy as the absorption spectrum will also be affected by electron-electron repulsions.



1. The crystal field stabilization energy (CFSE) for complex given in the passage, $[Ti(H_2O)_6]^{3+}$ will be (in kJ/mol) –

(A) 243 kJ/mole (B) 97 kJ/mole (C) 194 kJ/mole (D) 143 kJ/mole

2. The complex for which the calculation of crystal field splitting can be most easily done, by knowing its absorption spectrum, will be –

(A) $[TiCl_6]^{2-}$ (B) $[Fe(H_2O)_6]^{2+}$ (C) $[Ti(CN)_6]^{3-}$ (D) $[CoF_6]^{3-}$

3. The magnetic moments of following, arranged in increasing order will be (atomic number of Co = 27)

(1) Co^{3+} (octahedral complex with a strong field ligand)

(2) Co^{3+} (octahedral complex with a weak field ligand)

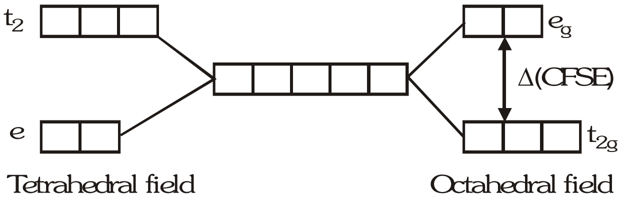
(3) Co^{2+} (tetrahedral complex)

(4) Co^{2+} (square planar complex)

(A) 1 > 2 > 3 > 4 (B) 2 > 3 > 4 > 1 (C) 3 > 2 > 4 > 1 (D) 2 > 4 > 3 > 1

Comprehension#2

When degenerate d-orbitals of an isolated atom/ion come under influence of magnetic field of ligands, the degeneracy is lost. The two set $t_{2g}(d_{xy}, d_{yz}, d_{xz})$ and eg $(d_{z^2}, d_{x^2-y^2})$ are either stabilized or destrabilized depending upon the nature of magnetic field. It can be expressed diagrammatically as:



Value of CFSE depends upon nature of ligand and a spectrochemical series has been made experimentally, for tetrahedral complexes, Δ is about 4/9 times to Δ_0 (CFSE for octahedral complex). This energy lies in visible region and i.e., why electronic transition are responsible for colour. Such transitions are not possible with d^0 and d^{10} configuration.

1. The CFSE for $[CoCl_6]^{4-}$ complex is 18000 cm^{-1}. The Δ for $[CoCl_4]^{2-}$ will be –

(A) 18000 cm^{-1} (B) 16000 cm^{-1} (C) 8000 cm^{-1} (D) 2000 cm^{-1}

2. The d-orbitals, which are stabilised in an octahedral magnetic field, are –

(A) d_{xy} and d_{z^2} (B) $d_{x^2-y^2}$ and d_{z^2} (C) d_{xy}, d_{xz} and d_{yz} (D) d_{z^2} only

3. For an octahedral complex, which of the following d-electron configuration will give maximum CFSE?

(A) High spin d^6 (B) Low spin d^4 (C) Low spin d^5 (D) High spin d^7

4. $Ti^{3+}_{(aq)}$ is purple while $Ti^{4+}_{(aq)}$ is colourless because –

(A) There is no crystal field effect in Ti^{4+}

(B) There energy difference between t_{2g} and e_g of Ti^{4+} is quite high and does not fall in the visible region
(C) Ti^{4+} has d^0 configuration.

(D) Ti^{4+} is very small in comparision to Ti^{3+} and hence does not absorb any radiation.

5. Crystal field stabilization energy for $[CoF_6]^{3-}$ in terms of parameter Dq is – (Δ = 10Dq)
(A) 4 (B) 6 (C) 12 (D) 24

MISCELLANEOUS TYPE QUESTION **ANSWER KEY** EXERCISE -3

- ***True / False***
  1.F 2.T 3.T 4.F 5.T 6.T 7.F 8.F
- ***Fill in the Blanks***
  1. Five **2.** hexadentate **3.**Co-ordination no. & satisfied by ligand **4.** Six &+3 **5.** EAN **6.** Ionization
  7. Five & Four **8.** Square planer, 3
- ***Match the Column***
  1. (A)-q,s (B) p,r (C)-p,r (d)-p,s **2.** (A)-p,q,s,t (B)-q,r,s (C)-p,t (D)-p,q,t
  3. (A)-q,s (B)-p,s (C)-p,q,s,t (D)-r
- ***Assertion - Reason Questions***
  1. C 2. B 3. A 4. D 5. A 6. C 7. C 8. A 9. D
  10. C 11. D 12. A
- ***Comprehension Based Quesions***
  Comprehension #1 : 1. B 2. C 3. B
  Comprehension #2 : 1. C 2. C 3. C 4. C 5. A

EXERCISE–04 [A] CONCEPTUAL SUBJECTIVE EXERCISE

1. Draw the structure of

(a) Cis-dichlorotetracyano-chromate(III),

(b) Mer-triamminetrichlorocobalt(III)

(c) Fac-triaquatrinitrito-N-cobalt(III)

2. Combination of Pt(IV), NH_3, Cl^- and K^+ results in the formation of seven complexes and one such complex is $[Pt(NH_3)_6]Cl_4$.

(i) Write the formula of the other six members of series.

(ii) Name these complexes according IUPAC system of nomenclature.

(iii) Which will have highest molar conductivity?

(iv) Which of these is non-ionic?

(v) What is the coordination number and oxidation state of Pt in these complexes.

3. What type of isomers are the following :

(i) $[(CO)_5MnSCN]$ and $[(CO)_5MnNCS]$, (ii) $[Co(en)_3][Cr(CN)_6]$ and $[Cr(en)_3][Co(CN)_6]$

(iii) $[Co(NH_3)_5NO_3]SO_4$ and $[Co(NH_3)_5SO_4]NO_3$

4. How many geometrical isomer are possible :

(a) $[Co(NH_3)_2Cl_4]^-$, octahedral? (b) $[AuCl_2Br_2]^-$, square planar?

(c) $[CoCl_2Br_2]^{2-}$, tetrahedral?

5. What are the types of hybridization involved in the following geometrical shapes of the complex?

(a) Square planar, (b) Tetrahedral, (c) Octahedral

6. On the basis of CFT, explain the following, giving appropriate reasons for your answer:

(1)The magnetic moment of $[Fe(H_2O)_6]^{3+}$ ion is 5.92 B.M. and that of $[Fe(CN)_6]^{3-}$ ion is 1.73 B.M.

(2) $[Fe(CN)_6]^{3-}$ ion is weakly paramagnetic while $[Fe(H_2O)_6]^{3+}$ ion strongly paramagnetic

(3) Complexes of Co(III) like $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$ and $[Co(NO_2)_6]^{3-}$ are diamagnetic while $[CoF_6]^{3-}$ and $[Co(H_2O)_3F_3]$ are paramagnetic.

(4) $[Co(CN)_6]^{4-}$ ion is paramagnetic while $[Co(CN)_6]^{3-}$ ion is diamagnetic, although both the ions have strong ligands.

7. Which of the following pairs of complex ions has higher value of Δ_0 and why?

(a) $[Co(NH_3)_6]^{3+}$ and $[Rh(NH_3)_6]^{3+}$ (b) $[Fe(C_2O_4)_3]^{4-}$ and $[Fe(C_2O_4)_3]^{3-}$

(c) $[Cr(en)_3]^{3+}$ and $[Cr(C_2O_4)_3]^{3-}$

8. Discuss the geometry of $[HgI_3]^-$ ion on the basis of valence bond theory.

9. Calculate CFSE of the following complexes: (i) $[CoF_6]^{3-}$ (ii) $[Fe(CN)_6]^{4-}$ (iii) $[Cu(NH_3)_6]^{2+}$

10. Calculate CFSE values for the following system:

(i) d^1 - octahedral (ii) d^1 - tetrahedral (iii) d^5 - low spin octahedral (iv) d^5 - high spin octahedral

11. Write the formula of the following compounds :

(i) di-μ-carbonyl octacarbonyl diiron(0)

(ii) Ammonium aquapentafluoronickelate(IV)

(iii) Tetrammineaquabromocobalt(III) chloride

(iv) Sodium dithiosulphatoargentate(I)

(v) Bromodichloroiodopalladate(II) ion

12. Explain how $[Pt(NH_3)_2Cl_2]$ and $[Pt(NH_3)_6]Cl_4$ will differ in their electrolytic conductance, Give the hybridisation state of Pt in these compounds. (At. No. of Pt is 78)

13. A coordination compound has the formula $CoCl_3 \cdot 4NH_3$. It does not liberate ammonia but precipitates Chloride ion as AgCl. Give the IUPAC name of the complex and write its structural formula.

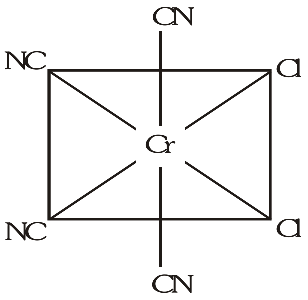
14. What is the coordination entity formed when excess of aqueous KCN is added to an aqueous solution of copper sulphate ? Why is it that no precipitate of copper sulphide is obtained when $H_2S(g)$ is passed through this solution ?

CONCEPTUAL SUBJECTIVE EXERCISE

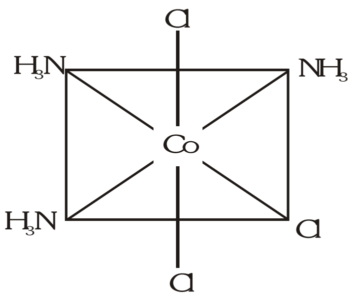
ANSWER KEY

EXERCISE -4(A)

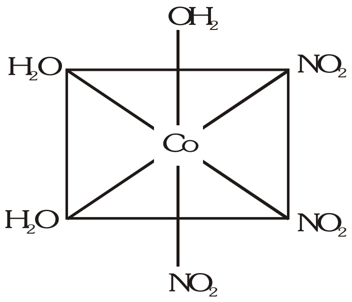
1.(a)



(b)



(c)



2. (i) $[Pt(NH_3)_5Cl]Cl_3$

$[Pt(NH_3)_4Cl_2]Cl_2$

$[Pt(NH_3)_3Cl_3]Cl^-$

$[Pt(NH_3)_2Cl_4]$

$K^+[Pt(NH_3)Cl_5]$

$K_2[PtCl_6]$

(iii) $[Pt(NH_3)_6]Cl_4$

(iv) $[Pt(NH_3)_2Cl_4]$

(v) 6 and 4

3. (i) Linkage (ii) coordination (iii) ionization

4. (a) two (b) two (c) 0

5. (a) dsp^2 (b) sp^3 (c) sp^3d^2 / d^2sp^3

EXERCISE–04 [B] BRAIN STORMING SUBJECTIVE EXERCISE

1. Draw all the possible isomers of the following complexes –

$[Pt(NH_3)_4Cl_2]^{2+}$, $[Pt(gly)_2]^0$, $[Pt\{P(C_2H_5)_3\}_2Cl_2]$, $[Cr(NH_3)(OH)_2Cl_3]^{2-}$, $[Pt(NH_3)(NH_2OH)(py)(NO_2)]^+$, $[Co(en)Cl_2Br_2]^-$, $[Rh(py)_3Cl_3]^0$, $[Co(en)Cl_3Br]^-$

2. Arrange the following pairs of complex ions on the basis of their crystal field splitting parameters (Δ_0) :

(a) $[V(H_2O)_6]^{2+}$ and $[V(H_2O)_6]^{3+}$ (b) $[Fe(CN)_6]^{4-}$ and $[Os(CN)_6]^{4-}$

3. A complex of the type $(M(AA)_2X_2]$ is known to be optically active. What does this indicate about the structure of the complex? Give one example of such complex.

4. A complex of the type $[M(AB)_2]$ is known to be opticall active. What does this indicate about the structure of the complex? Give one example of such complex.

5. $[Ni(Cl)_2(P(CH_3)_3)_2]$ is a paramagnetic complex of Ni(II). Analogous Pd(II) complex is diamagnetic. How many geometrical isomers will be possible for Ni(II) and Pd(II) complexes? Also explain their magnetic behaviour.

6. On the basis of CFT give the electronic configuration of Rh^{2+} ion in an octahedral complex for which $\Delta_0 > P$.

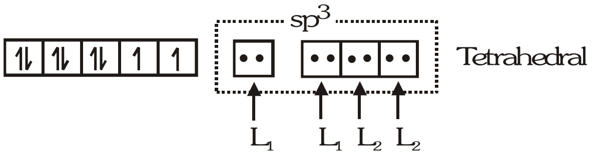
7. Two compounds have the empirical formula, $Co(NH_3)_3(NO_2)_3$. In aqueous solution one of these compounds does not conduct electricity while the other does. Write the possible structures of these two compounds.

8. Compute CFSE (in terms of Δ_0) values for d^7 (octahedral) and d^7 (tetrahedral) ions in strong field.

BRAIN STORMING SUBJECTIVE EXERCISE **ANSWER KEY** EXERCISE -4(B)

5. **(Hint)-** Ni(II) complex is paramagnetic, so it has unpaired electrons while complex of Pd(II) is diamagnetic without any unpaired electron. In both Ni(II) and Pd (II), there is d^8 configuration. In Ni(II), value of crystal field splitting energy (Δ) is less than in Pd(II). So in Ni(II) pairing is less favoured while in Pd(II), all electrons are paired because unpairing is unfavoured owing to high value of CFSE. Thus the geometry and hybridization in two complexes is explained as follows:

$[Ni(Cl)_2\{P(CH_3)_3\}_2]$ =

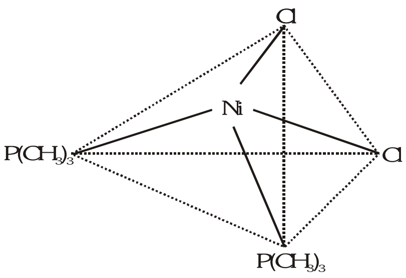


Cl^- = W.F.L. $P(CH_3)_3$=S.F.L. $L_1 = Cl^-$ $L_2 = P(CH_3)_3$

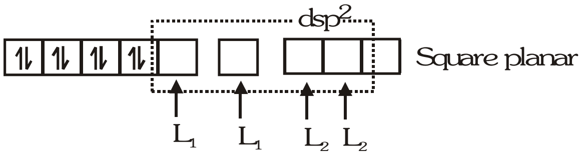
Pd(II) - C.F.S.E. > P.E. irrespective of ligand

Ni(II) - C.F.S.E < P.E. for W.F.L. & C.F.S.E. > P.E. for S.F.L.

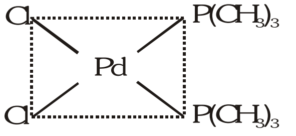
because complex is tetrahedral so only one structure will be possible



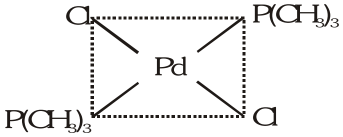
$[Pd(Cl)_2\{P(CH_3)_3\}_2]$ =



So it is complex of $M_{a_2b_2}$ type and will exist as cis and trans isomer. a,b = mondentate ligands.



Cis



Trans

EXERCISE–05 [A] (JEE-MAIN)

1. In $[Cr(C_2O_4)_3]^{3-}$, the isomerism shown is [AIEEE-2002]

(A) Ligand (B) Optical (C) Geometrical (D) Ionization

2. In the complexes $[Fe(H_2O)_6]^{3+}$, $[Fe(SCN)_6]^{3-}$, $[Fe(C_2O_4)_3]^{3-}$ and $[FeCl_6]^{3-}$, more stability is shown by [AIEEE-2002]

(A) $[Fe(H_2O)_6]^{3+}$ (B) $[Fe(SCN)_6]^{-3}$ (C) $[Fe(C_2O_4)_3]^{3-}$ (D) $[FeCl_6]^{3-}$

3. One mole of the complex compound $Co(NH_3)_5Cl_3$, gives 3 moles of ions on dissolution in water. One mole of the same complex reacts with two moles of $AgNO_3$ solution to yield two moles of AgCl (s). The structure of the complex is [AIEEE-2003]

(A) $[Co(NH_3)_3Cl_3]$. $2NH_3$ (B) $[Co(NH_3)_4Cl_2]$ $Cl.NH_3$

(C) $[Co(NH_3)_4Cl]$ $Cl_2.NH_3$ (D) $[Co(NH_3)_5Cl]Cl_2$

4. In the coordination compound $K_4[Ni(CN)_4]$, the oxidation state of nickel is – [AIEEE-2003]

(A) 0 (B) +1 (C) +2 (D) –1

5. The number of 3d-electrons remained in Fe^{2+} (At.no. of Fe = 26) ion is – [AIEEE-2003]

(A) 4 (B) 5 (C) 6 (D) 3

6. Ammonia forms the complex ion $[Cu(NH_3)_4]^{2+}$ with copper ions in alkaline solutions but not in acidic solution. What is the reason for it :- [AIEEE-2003]

(A) In acidic solutions hydration protects copper ions

(B) In acidic solutions protons coordinate with ammonia molecules forming NH_4^+ ions and NH_3 molecules are not available

(C) In alkaline solutions insoluble $Cu(OH)_2$ is precipitated which is soluble in excess of any alkali

(D) Copper hydroxide is an amphoteric substance

7. Among the properties (a) reducing (b) oxidising (c) complexing, the set of properties shown by CN^- ion towards metal species is :- [AIEEE-2004]

(A) c, a (B) b, c (C) a, b (D) a, b, c

8. The coordination number of a central metal atom in a complex is determined by :- [AIEEE–2004]

(A) The number of ligands around a metal ion bonded by sigma and pi-bonds both

(B) The number of ligands around a metal ion bonded by pi-bonds

(C) The number of ligands around a metal ion bonded by sigma bonds

(D) The number of only anionic ligands bonded to the metal ion

9. Which one of the following complexes is an outer orbital complex :- [AIEEE–2004]

(A) $[Co(NH_3)_6]^{3+}$ (B) $[Mn(CN)_6]^{4-}$ (C) $[Fe(CN)_6]^{4-}$ (D) $[Ni(NH_3)_6]^{2+}$

(Atomic nos.:Mn=25 ; Fe=26 ; Co=27 ; Ni = 28)

10. Coordination compounds have great importance in biological systems. In this contect which of the following statements is incorrect ? [AIEEE–2004]

(A) Cyanocobalamin is vitamin B_{12} and contains cobalt

(B) Haemoglobin is the red pigment of blood and contains iron

(C) Chlorophylls are green pigments in plants and contain calcium

(D) Carboxypeptidase - A is an enzyme and contains zinc

11. The correct order of magnetic moments (spin only values in B.M.) among is :-**[AIEEE–2004]**

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

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

(Atomic nos. : Mn = 25, Fe = 26, Co = 27)

12. For octahedral complex, the value of the 'spin only' magnetic moment for one of the following configurations is 2.84 BM. The correct one is **[AIEEE–2005]**

(A) d^4 (in strong ligand field) (B) d^4 (in weak ligand field)

(C) d^3 (in weak as well as in strong field) (D) d^5 (in strong ligand field)

13. The IUPAC name for the complex $[Co(NO_2)(NH_3)_5]Cl_2$ is **[AIEEE–2006]**

(A) pentaammine nitrito-N- cobalt (II) chloride (B) pentaammine nitrito-N- cobalt (III) chloride

(C) nitrito-N- pentaamminecobalt (III) chloride (D) nitrito-N- pentaamminecobalt (II) chloride

14. Nickel (Z=28) combines with a uninegative monodentate ligand X^- to form a paramagnetic complex $[NiX_4]^{2-}$. The number of unpaired electron in the nickel and geometry of this complex ion are, respectively. **[AIEEE–2006]**

(A) one, square planar (B) two, square planar (C) one, tetrahedral (D) two, tetrahedral

15. In $Fe(CO)_5$, the Fe–C bond possesses **[AIEEE–2006]**

(A) ionic character (B) σ – character only (C) π –character only (D) both σ and π character

16. How many EDTA (ethylenediaminetetraacetic acid) molecules are required to make an octahedral complex with a Ca^{2+} ion ? **[AIEEE–2006]**

(A) One (B) Two (C) Six (D) Three

17. The "spin-only" magnetic moment [in units of Bohr magneton, (μ_B)] of Ni^{2+} in aqueous solution would be (At. No. Ni= 28) **[AIEEE–2006]**

(A) 0 (B) 1.73 (C) 2.84 (D) 4.90

18. Which one of the following has a square planar geometry :- (Co = 27, Ni = 28, Fe=26, Pt = 78) **[AIEEE–2007]**

(A) $[CoCl_4]^{2-}$ (B) $[FeCl_4]^{2-}$ (C) $[NiCl_4]^{2-}$ (D) $[PtCl_4]^{2-}$

19. The coordination number and the oxidation state of the element 'E' in the complex $[E(en)_2(C_2O_4^{-2})]\ NO_2^{\ominus}$ (where (en) is ethylene diamine) are, respectively **[AIEEE–2008]**

(A) 6 and 2 (B) 4 and 2 (C) 4 and 3 (D) 6 and 3

20. In which of the following octahedral complexes of Co (at. no. 27), will the magnitude of Δ_0 be the highest ? **[AIEEE–2008]**

(A) $[Co(CN)_6]^{3-}$ (B) $[Co(C_2O_4)_3]^{3-}$ (C) $[Co(H_2O)_6]^{3+}$ (D) $[Co(NH_3)_6]^{3+}$

21. Which of the following pairs represents linkage isomers ? **[AIEEE–2009]**

(A) $[Co(NH_3)_5NO_3]SO_4$ and $[Co(NH_3)_5SO_4]NO_3$

(B) $[PtCl_2(NH_3)_4]Br_2$ and $[PtBr_2(NH_3)_4]Cl_2$

(C) $[Cu(NH_3)_4][PtCl_4]$ and $[Pt(NH_3)_4][CuCl_4]$

(D) $[Pd(PPh_3)_2(NCS)_2]$ and $[Pd(PPh_3)_2(SCN)_2]$

22. Which of the following has an optical isomer? **[AIEEE-2009]**

(A) $[Co(H_2O)_4(en)]^{3+}$ (B) $[Co(en)_2(NH_3)_2]^{3+}$

(C) $[Co(NH_3)_3Cl]^{+}$ (D) $[Co(en)(NH_3)_2]^{2+}$

23. Which one of the following has an optical isomer ? **[AIEEE-2010]**

(A) $[Zn(en)_2]^{2+}$ (B) $[Zn(en)(NH_3)_2]^{2+}$ (C) $[Co(en)_3]^{3+}$ (D) $[Co(H_2O)_4(en)]^{3+}$

(en = ethylenediamine)

24. A solution containing 2.675 g of $CoCl_3.6NH_3$ (molar mass = 267.5 g mol^{-1}) is passed through a cation exchanger. The chloride ions obtained in solution were treated with excess of $AgNO_3$ to give 4.78 g of AgCl (molar mass = 143.5 g mol^{-1}). The formula of the complex is :- **[AIEEE-2010]**

(At. mass of Ag = 108 u)

(A) $[CoCl(NH_3)_5]Cl_2$ (B) $[Co(NH_3)_6]Cl_3$ (C) $[CoCl_2(NH_3)_4]Cl$ (D) $[CoCl_3(NH_3)_3]$

25. Which of the following facts about the complex $[Cr(NH_3)_6]Cl_3$ is wrong ? **[AIEEE-2011]**

(A) The complex is an outer orbital complex

(B) The complex gives white precipitate with silver nitrate solution

(C) The complex involves d^2sp^3 hybridisation and is octahedral in shape

(D) The complex is paramagnetic

26. The magnetic moment (spin only) of $[NiCl_4]^{2-}$ is :- **[AIEEE-2011]**

(A) 2.82 BM (B) 1.41 BM (C) 1.82 BM (D) 5.46 BM

27. Among the ligands NH_3,en, CN^- and CO the correct order of their increasing field strength, is :- **[AIEEE-2011]**

(A) $CO < NH_3 < en < CN^-$ (B) $NH_3 < en < CN^- < CO$

(C) $CN^- < NH_3 < CO < en$ (D) $en < CN^- < NH_3 < CO$

28. Which one of the following complex ions has geometrical isomers ? **[AIEEE-2011]**

(A) $[Co\ (en)_3]^{3+}$ (B) $[Ni\ (NH_3)_5Br]^{+}$ (C) $[Co\ (NH_3)_2\ (en)_2]^{3+}$ (D) $[Cr\ (NH_3)_4(en)]^{3+}$

29. Which among the following will be named as dibromidobis (ethylene diamine) chromium (III) bromide ? **[AIEEE-2012]**

(A) $[Cr(en)Br_2]Br$ (B) $[Cr(en)_3]Br_3$ (C) $[Cr(en)_2Br_2]Br$ (D) $[Cr(en)Br_4]^{-}$

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

(A) $[Co(en)_3]^{3+}$ (B) $[Co(en)_2\ Cl_2]^{+}$ **[J-MAIN-2013]**

(C) $[Co(NH_3)_3\ Cl_3]$ (D) $[Co(en)\ (NH_3)_2Cl_2]^{+}$

JEE-MAIN **ANSWER KEY** EXERCISE -5[A]

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	B	C	D	A	C	B	A	C	D	C
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
	C	A	B	D	D	A	C	D	D	A
Que.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	D	B	C	B	A	A	B	C	C	C

EXERCISE–05 [B] JEE-ADVANCED

MCQ's WITH ONE CORRECT ANSWER

1. Which of the following is an organometallic compound? [1997; 1M]

(A) Lithium methoxide
(B) Lithium acetate
(C) Lithium dimethylamide
(D) Methyl lithium

2. The geometry of $Ni(CO)_4$ and $Ni(PPh_3)_2Cl_2$ are – [1999; 2M]

(A) Both square planar
(B) Tetrahedral and square planar, respectively
(C) Both tetrahedral
(D) Square planar and tetrahedral, respectively.

3. Amongst the following, identify the species with an atom in +6 oxidation state – [2000; 2M]

(A) MnO_4^- (B) $Cr(CN)_6^{3-}$ (C) NiF_6^{2-} (D) CrO_2Cl_2

4. The complex ion which has no 'd'-electrons in the central metal atom is – [2001; 2M]

(A) $[MnO_4]^-$ (B) $[Co(NH_3)_6]^{3+}$ (C) $[Fe(CN)_6]^{3-}$ (D) $[Cr(H_2O)_6]^{3+}$

5. Mixture of (X) = 0.02 mole of $[Co(NH_3)_5SO_4]Br$ and 0.02 mole of $[Co(NH_3)_5Br]SO_4$ was prepared in 2 litre of solution [IIT-2003]

1 litre of mixture [X] + excess $AgNO_3 \longrightarrow$ [Y]

1 litre of mixture [X] + excess $BaCl_2 \longrightarrow$ [Z]

Number of moles of [Y] and [Z] are –

(A) 0.01, 0.01 (B) 0.02, 0.01 (C) 0.01, 0.02 (D) 0.02, 0.02

6. The pair of compounds having metals in their highest oxidation state is – [IIT-2004]

(A) MnO_2, $FeCl_3$ (B) $[MnO_4]^-$, CrO_2Cl_2 (C) $[Fe(CN)_6]^{3-}$, $[Co(CN)_6]^{3-}$ (D) $[NiCl_4]^{2-}$, $[CoCl_4]^-$

7. The compound having tetrahedral geometry is – [IIT-2004]

(A) $[Ni(CN)_4]^{2-}$ (B) $[Pd(CN)_4]^{2-}$ (C) $[PdCl_4]^{2-}$ (D) $[NiCl_4]^{2-}$

8. Spin only magnetic moment of the compound $Hg[Co(SCN)_4]$ is – [IIT-2004]

(A) $\sqrt{3}$ (B) $\sqrt{15}$ (C) $\sqrt{24}$ (D) $\sqrt{8}$

9. Which kind of isomerism is exhibited by octahedral $Co(NH_3)_4Br_2Cl$? [IIT-2005]

(A) Geometrical and ionisation
(B) Geometrical and optical
(C) Optical and ionisation
(D) Geometrical only

10. Which pair of compounds is expeted to show similar colour in aqueous medium? [IIT-2005]

(A) $FeCl_3$ and $CuCl_2$ (B) $VOCl_2$ and $CuCl_2$ (C) $VOCl_2$ and $FeCl_2$ (D) $FeCl_2$ and $MnCl_2$

11. $CuSO_4$ decolourises on addition of excess KCN, the product is – [IIT-JEE-2006]

(A) $[Cu(CN)_4]^{2-}$ (B) $[Cu(CN)_4]^{3-}$ (C) $Cu(CN)_2$ (D) CuCN

COMPREHENSION (Q.12 to 14) **[IIT-JEE-2006]**

The co-ordination number of Ni^{+2} is = 4

$NiCl_2$ + KCN (excess) $\longrightarrow$ A (cyno complex)

$NiCl_2$ + Conc. HCl (excess) $\longrightarrow$ B (Chloro complex)

12. The IUPAC name of A and B are –

(A) Potassium tetracyanonickelate(II), potassium tetrachloronickelate(II),

(B) Tetracyanopotassiumnickelate(II), tetrachloro potassiumnickelate(II),

(C) Tetracyanonickel(II), tetrachloronickel(II)

(D) Potassiumtetracyanonickel(II), Potassiumtetrachloronickel(II)

13. Predict the magnetic nature of A and B –

(A) Both are diamagnetic

(B) A is diamagnetic and B is paramagnetic with one unpaired electron

(C) A is diiamagnetic and B is paramagnetic with two unpaired electrons

(D) both are paramagnetic

14. The hybridisation of A and B are –

(A) dsp^2, sp^3 (B) sp^3, sp^3 (C) dsp^2, dsp^2 (D) sp^3d^2, d^2sp^3

15. If the bond length of CO bond in carbon monoxide is 1.128 Å., then what is the value of CO bond length in $Fe(CO)_5$? **[IIT-2006]**

(A) 1.15 Å (B) 1.128 Å (C) 1.72 Å (D) 1.118 Å

16. Among the following metal carbonyls, the C – O bond order is lowest in – **[IIT-2007]**

(A) $[Mn(CO)_6]^+$ (B) $[Fe(CO)_5]$ (C) $[Cr(CO)_6]$ (D) $[V(CO)_6]^-$

17. Sodium-fusion extract, obtained from aniline, on treatment with iron(II) sulphate and H_2SO_4 in presence of air gives a Prussian blue precipitate. The blue colour is due to the formation of: **[IIT-2007]**

(A) $Fe_4[Fe(CN)_6]_3$ (B) $Fe_3[Fe(CN)_6]_2$ (C) $Fe_4[Fe(CN)_6]_2$ (D) $Fe_3[Fe(CN)_6]_3$

18. Match the complexes in Column-I with their properties listed in Column-II **(matrix match type) [IIT-2007]**

	Column-I		Column-II
(A)	$[Co(NH_3)_4(H_2O)_2]Cl_2$	**(p)**	geometrical isomers
(B)	$[Pt(NH_3)_2Cl_2]$	**(q)**	paramagnetic
(C)	$[Co(H_2O)_5Cl]Cl$	**(r)**	diamagnetic
(D)	$[Ni(H_2O)_6]Cl_2$	**(s)**	metal ion with +2 oxidation state

19. Among the following, the coloured compound is :- **[IIT-2008]**

(A) CuCl (B) $K_3[Cu(CN)_4]$ (C) CuF_2 (D) $[Cu(NCCH_3)_4]BF_4$

20. Both $[Ni(CO)_4]$ and $[Ni(CN)_4]^{2-}$ are diamagnetic. The hybridisations of nickel in these complexes, respectively, are

(A) sp^3, sp^3 (B) sp^3, dsp^2 (C) dsp^2, sp^3 (D) dsp^2, dsp^2 **[IIT-2008]**

21. The IUPAC name of $[Ni(NH_3)_4]$ $[NiCl_4]$ is – **[IIT-2008]**

(A) Tetrachloronickel(II) - tetraamminenickel(II) (B) Tetraamminenickel(II) - tetrachloronickel(II)

(C) Tetraamminenickel(II) - tetrachloronickelate(II) (D) Tetrachloronickel(II) - tetraamminenickelate(0)

22. The spin only magnetic moment value (in Bohr magneton units) of $Cr(CO)_6$ is : **[IIT 2009]**

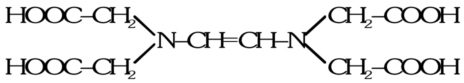
(A) 0 (B) 2.84 (C) 4.90 (D) 5.92

23. The compound(s) that exhibit(s) geometrical isomerism is (are) : **[IIT 2009]**

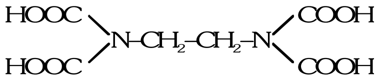
(A) $[Pt(en)Cl_2]$ (B) $[Pt(en)_2]Cl_2$ (C) $[Pt(en)_2Cl_2]Cl_2$ (D) $[Pt(NH_3)_2Cl_2]$

24. The correct structure of ethylenediaminetetraacetic acid (EDTA) is – **[IIT 2010]**

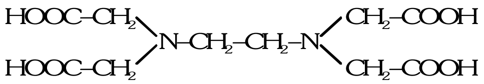
(A)



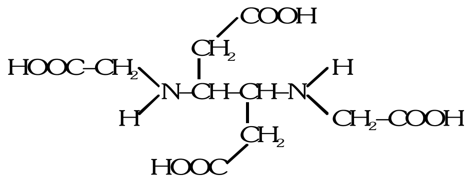
(B)



(C)



(D)



25. The ionization isomer of $[Cr(H_2O)_4Cl(NO_2)]Cl$ is – **[IIT 2010]**

(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) $[Cr(H_2O)_4Cl_2(NO_2)].H_2O$

26. The complex showing a spin-only magnetic moment of 2.82 B.M. is - **[IIT 2010]**

(A) $Ni(CO)_4$ (B) $[NiCl_4]^{2-}$ (C) $Ni(PPh_3)_4$ (D) $[Ni(CN)_4]^{2-}$

27. Geometrical shapes of the complexes formed by the reaction of Ni^{2+} with Cl^-, CN^- and H_2O respectively, are - **[JEE 2011]**

(A) octahedral, tetrahedral and square planar (B) tetrahedral, square planar and octahedral

(C) square planar, tetrahedral and octahedral (D) octahedral, square planar and octahedral

28. Among the following complexes (**K–P**) **[JEE 2011]**

$K_3[Fe(CN)_6]$ **(K)**, $[Co(NH_3)_6]Cl_3$ **(L)**, $Na_3[Co(oxalate)_3]$ **(M)**, $[Ni(H_2O)_6]Cl_2$ **(N),**
$K_2[Pt(CN)_4]$ **(O)** and $[Zn(H_2O)_6]$ $(NO_3)_2$ **(P)**
The diamagnetic complex are -

(A) K, L, M, N (B) K, M, O, P (C) L, M, O, P (D) L, M, N, O

29. The volume (in mL) of 0.1M $AgNO_3$ required for complete precipitation of chloride ions present in 30 mL of 0.01M solution of $[Cr(H_2O)_5Cl]Cl_2$, as silver chloride is close to. **[JEE 2011]**

30. As per IUPAC nomenclature, the name of the complex $[Co(H_2O)_4(NH_3)_2]Cl_3$ is : **[JEE 2012]**

(A) Tetraaquadiaminecobalt(III) chloride
(B) Tetraaquadiamminecobalt(III) chloride
(C) Diaminetetraaquacobalt(III) chloride
(D) Diamminetetraaquacobalt(III) chloride

31. The colour of light absorbed by an aqueous solution of $CuSO_4$ is - **[JEE 2012]**

(A) orange-red (B) blue-green (C) yellow (D) violet

32. $NiCl_2\{P(C_2H_5)_2(C_6H_5)\}_2$ exhibits temperature dependent magnetic behavior (paramagnetic/diamagnetic). The coordination geometries of Ni^{2+} in the paramagnetic and diamagnetic states are respectively : **[JEE 2012]**

(A) tetrahedral and tetrahedral (B) square planar and square planar

(C) tetrahedral and square planar (D) square planar and tetrahedral

33. Consider the following complex ions P, Q and R ,

P = $[FeF_6]^{3-}$, **Q** = $[V(H_2O)_6]^{2+}$ and **R** = $[Fe(H_2O)_6]^{2+}$

The correct order of the complex ions, according to their spin-only magnetic moment values (in B.M.) is - **[JEE 2013]**

(A) R < Q < P (B) Q < R < P (C) R < P < Q (D) Q < P < R

34. $EDTA^{4-}$ is ethylenediaminetetraacetate ion. The total number of N–Co–O bond angles in $[Co(EDTA)]^{-1}$ complex ion is **[JEE 2013]**

35. The pair(s) of coordination complex/ion exhibiting the same kind of isomerism is(are) - **[JEE 2013]**

(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

36. **Statement–I** : $[Fe(H_2O)_5NO]SO_4$ is paramagnetic. **[IIT-2008]**

Because

Statement–II : The Fe in $[Fe(H_2O)_5NO]SO_4$ has three unpaired electrons.

(A) Statement-I is True, Statement-II is True; Statement-II is a correct explanation for Statement-I

(B) Statement-I is True, Statement-II is True; Statement-II is **NOT** a correct explanation for Statement-I

(C) Statement-I is True, Statement-II is False

(D) Statement-I is False, Statement-II is True

37. **Statement–I** : The geometrical isomers of the complex $[M(NH_3)_4Cl_2]$ are optically inactive. **[IIT-2008]**

Because

Statement–II : Both geometrical isomers of the complex $[M(NH_3)_4Cl_2]$ possess axis of symmetry.

(A) Statement-I is True, Statement-II is True; Statement-II is a correct explanation for Statement-I

(B) Statement-I is True, Statement-II is True; Statement-II is **NOT** a correct explanation for Statement-I

(C) Statement-I is True, Statement-II is False

(D) Statement-I is False, Statement-II is True

38. **Statement–I** : Zn^{2+} is diamagnetic **[1998; 2M]**

Because

Statement–II : The electrons are lost from 4s-orbital to form Zn^{2+}.

(A) Statement-I is True, Statement-II is True; Statement-II is a correct explanation for Statement-I

(B) Statement-I is True, Statement-II is True; Statement-II is **NOT** a correct explanation for Statement-I

(C) Statement-I is True, Statement-II is False

(D) Statement-I is False, Statement-II is True

39. A, B and C are three complexes of chromium(III) with the empirical formula $H_{12}O_6Cl_3Cr$. All the three complexes have water and chloride ion as ligands. Complex A does not react with concentrated H_2SO_4, whereas complexs B and C lose 6.75% and 13.5% of their original mass, respectively , on treatment with concentrated H_2SO_4, identify A, B and C. **[1999; 6M]**

40. Draw the structures of $[Co(NH_3)_6]^{3+}$, $[Ni(CN)_4]^{2-}$ and $[Ni(CO)_4]$. Write the hybridisation of atomic orbital of the transition metal in each case. **[2000 main; 4M]**

41. A metal complex having composition $Cr(NH_3)_4Cl_2Br$ has been isolated in two forms A and B. The form A reacts with $AgNO_3$ to give a white precipitate readily soluble in dilute aqueous ammonia, whereas B gives a pale yellow precipitate soluble in concentrated ammonia. Write the formula of A and B and state the hybridization of chromium in each. Calculate their magnetic moments (spin-only value) **[2001 main; 5M]**

42. Deduce the structures of $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ considering the hybridization of the metal ion. Calculate the magnetic moment (spin only) of the species. **[2002 main; 5M]**

43. Write the IUPAC nomenclature of the given complex along with its hybridization and structure.

$K_2[Cr(NO)(NH_3)(CN)_4]$, (μ = 1.73 B.M. spin only) **[2003 main; 4M]**

Integer Type Question : [IIT-2010]

44. Total number of geometrical isomers for the complex $[RhCl(CO)(PPh_3)(NH_3)]$ is -

- *Objective Questions*

1.D 2.C 3.D 4.A 5.A 6.B 7.D 8.B 9.A 10.B
11.B 12.A 13.C 14.A 15.A 16.D 17.A 19.C 20.B 21.C
22. A 23. C,D 24. C 25.B 26.B 27.B 28.C 29.6 30.D 31.A
32. C 33.B 34.8 35.B,D

- *Match the Column*

18. (A) → p,q,s ; (B) → p,r,s ; (C) → q,s ; (D) → q,s

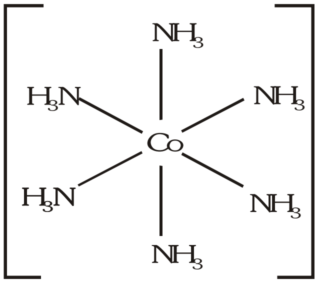
- *Assertion - Reason Questions*

36.A 37. B 38.B

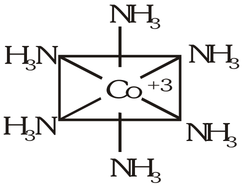
- *Subjective Questions*

39. A = $[Cr(H_2O)_6]Cl_3$
B = $[Cr(H_2O)_5Cl]\ Cl_2\quad H_2O$
C = $[Cr(H_2O)_4Cl_2]\ Cl\quad 2H_2O$

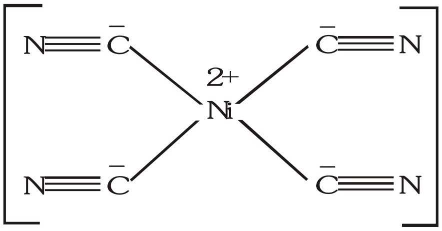
40.

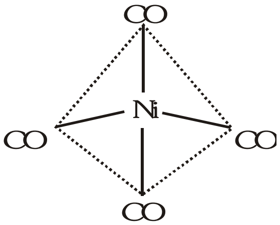


or



Structure of $[Co(NH_3)_6]^{3+}$ is octahedral, d^2sp^3 hybridization





Structure of $[Ni(CN)_4]^{2-}$ ion is square planar, dsp^2 hybridization Structure of $Ni(CO)_4$ is tetrahedral, sp^3 hybridization

41. $[Cr(NH_3)_4ClBr]Cl + AgNO_3 \rightarrow AgCl\downarrow + [Cr(NH_3)_4ClBr] + NO_3^-$
form 'A' white ppt.

These precipitates of AgCl are soluble in NH_4OH due to formation of complex salt.

$AgCl + 2NH_4OH \rightarrow [Ag(NH_3)_2Cl] + 2H_2O$
white ppt. complex salt

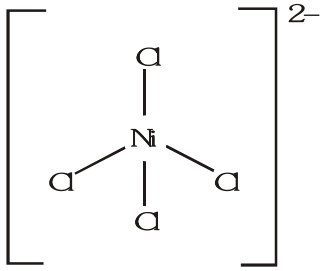
$AgNO_3 + (Cr(NH_3)_4Cl_2)\ Br \rightarrow AgBr\downarrow + (Cr(NH_3)_4Cl_2)^+ + NO_3^-$
pale yellow ppt

$AgBr + 2NH_4OH \rightarrow [Ag(NH_3)_2\ Br] + 2H_2O$

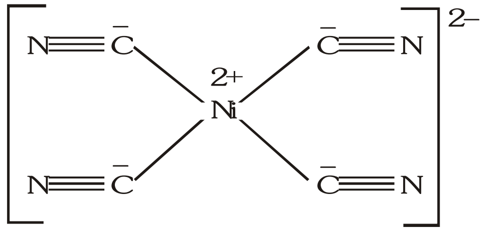
Pale yellow ppt.

Magnetic moment (μ) = 3.872 B.M.

42.

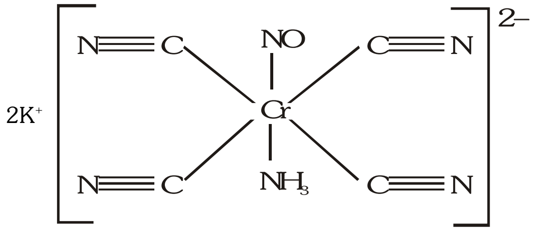


Structure of $[NiCl_4]^{2-}$ is tetrahedral, sp^3 hybridization, magnetic moment = 2.82 B.M.



Structure of $[Ni(CN)_4]^{2-}$ is square planar, dsp^2-hybridization, magnetic moment = 0

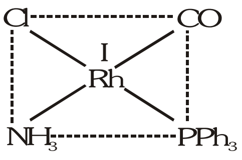
43. IUPAC name of $K_2[Cr(NO)(NH_3)(CN)_4]$ is potassium ammine tetra cyano nitrosylium chromate (I)



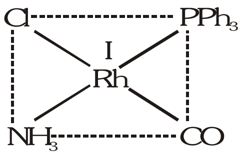
Structure of $K_2[Cr(NO)(NH_3)(CN)_4]$ is octahedral, d^2sp^3-hybridization

44. (3) $[RhCl(CO)(PPh_3)(NH_3)]$

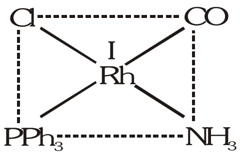
dsp^2, square planar, total 3 geometrical isomer.



(1)



(2)



(3)

HINTS :

Do Yourself I : 1. (a) co-ordination compound ; (b) Double salt ; (c) co-ordination compound

(d) Double salt ; (e) Double salt ; (f) co-ordination compound ; (g) Double salt

Do Yourself II : 1. (a) $[Pt(NH_3)_3Cl_2Br]^+$; (b) +1 ; (c) 6 ; (d) 6 ; (e) +4 ; (f) 2 ; (g) 1 ; (h) Yes ; (i) No;

(j) one mole of AgCl & No AgBr ; (k) No

Do Yourself III : (i) Potassium hexanitrito-Ncobaltate(III), (ii) Sodium pentacyanonitrosoniumferrate(I),

(iii) tetrachloronickelate(II) ion., (iv) pentaamminechlororuthenium(III) ion.,

(v) Tris(ethylenediamine)iron(III) ion, (vi) Bis(glycinato)nickel(II).

Do Yourself IV : 1. (i) $[Pt(NH_3)_6]Cl_6$; (ii) $[Pt(NH_3)_4Cl_2]Cl_2$; (iii) $[Pt(NH_3)_2Cl_2]$

Do Yourself V : 1. (i) 36 ; (ii) 34 ; (iii) 86 ; (iv) 50

Do Yourself VI : 1. (i) sp^3, tetrahedral, 5.92 ; (ii) d^2sp^3 octahedral,1.73 ; (iii) sp^3d^2 octahedral, 5.92

2. (i) inner orbital complex ; (ii) outer orbital complex ;

(iii) inner [exception : (i) incase of Co^{+3} ligand $C_2O_4^{2-}$ behave as a S.F.L. ;

(ii) in case of Fe^{+2}, Mn^{+2} ligand NH_3 behave like a W.F.L.] ; (iv) outer

Do Yourself VII : 1. (i) $t_{2g}^5e_g^0$, C.F.S.E = $-2.0\ \Delta_0 + 2P$; (ii) $t_{2g}^3e_g^2$, C.F.S.E = 0 ; (iii) $t_{2g}^3e_g^1$, C.F.S.E = $-0.6\ \Delta_0$;

(iv) $t_{2g}^6e_g^0$, C.F.S.E = $-2.4\ \Delta_0 + 3P$.

2. Less interaction between metal and ligands.

3. $t_{2g}^6e_g^0$ - octahedral, $t_{2g}^4e_g^2$ - octahedral, $t_{2g}^4e_g^2$ - octahedral, $t_{2g}^5e_g^0$ - octahedral.

Do Yourself VIII : 1. (i) 4.89BM ; (ii) 2.82BM ; (iii) 5.92BM ; (iv) 5.92BM ; (v) 4.89BM ; (vi) 2.82BM ;

(vii) 3.46 BM; (viii) 3.46 BM

Do Yourself IX : 1. Due to different crystal field splitting energy of complexes.

2. $[Ni(NO_2)_6]^{4-} > [Ni(NH_3)_6]^{2+} > [Ni(H_2O)_6]^{2+}$

Do Yourself X : 1. Both produce different ions in aquous soltuion.

2. (i) G.I. = None ; (ii) G.I. = 2

3. Draw the mirror image of the complexes.

4. See the chart given in theroy.

5. G.I. = 3, O.I. = 0

6. (i) G.I., O.I. ; (ii) O.I. ; (iii) Linkage ; (iv) G.I.