

Co-ordination Compounds

1. Ligand, Primary & Secondary Valency, Nomenclature

Q 1. State the denticity of the following type of ligands (if they are)?

- (a) CO (b) H₂O (c) NH₃ (d) NH₄⁺
 (e) N₂ (f) O₂ (g) CN⁻ (h) SCN⁻
 (i) Py (j) Bpy (k) phen (l) acac
 (m) terpy (n) EDTA (o) DMG (p) NO₃⁻
 (q) SO₄²⁻ (r) C₂O₄²⁻ (s) en (t) dien
 (u) trien (v) NH₂NH₃⁺ (w) PPh₃ (x) NO⁺
 (y) NO

- (z) (i) BAL (British anti lewisite)
 (ii) Glyme (CH₃OCH₂CH₂OCH₃)

Q 2. What is false about glycenato ion?
 (A) Its formula is H₂N – CH₂ – COO⁻
 (B) Its a symmetrical bidentate ligand
 (C) It is a chelating legand
 (D) It is an unsymmetrical bidentate ligand

Q 3. Indicate the oxidation state (Primary valancy) & Co-ordination number (Secondary valancy) of the following compounds.

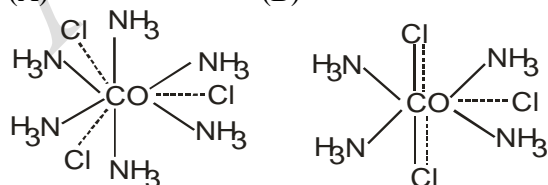
- (a) [Cu(NH₃)₄]²⁺ (b) [CuBr₄]²⁻
 (c) [Cu(CN)₂]⁻ (d) [Cr(NH₃)₄(CO₃)₊
 (e) [PtCl₄]²⁻ (f) [Co(NH₂NH₃)₂(NO₂)₄]⁺
 (g) [Co(en)₃]²⁺ (h) Fe(CO)₅
 (i) [CaEDTA]²⁻ (j) [Al(H₂O)₂(OH)₄]⁻
 (k) [Ni(DMG)₂]²⁺ (l) [Cr(NH₃)₂(H₂O)₂Cl₂]

Q 4. The sum of coordination number and oxidation number of the metal M in the complex [M(en)₂C₂O₄]Cl is [AIMPT 2015]
 (A) 9 (B) 6 (C) 7 (D) 8

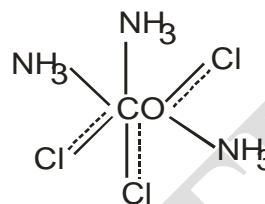
Q 5. The co-ordination number and the oxidation number of the element E in the complex [E(en)₂(C₂O₄)]NO₂ is [AIEEE 2008]
 (A) 6 & 2 (B) 4 & 2
 (C) 4 & 3 (D) 6 & 3

Q 6. The solution of which of the following will be non – conducting?

- (A) (B)



- (C) (D) None of these

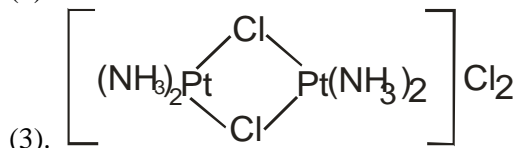
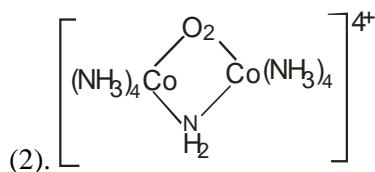


Q 7. Which of the following can be termed as mixed complex?

- (A) K₄[Fe(CN)₆]
 (B) [Cu(NH₃)₄]SO₄
 (C) [Co(NH₃)₄NO₂Cl]Cl
 (D) K₂FeO₄

Q 8. Write the name of the following compounds

- (a) [Co(NH₃)₅Br]SO₄
 (b) [Co(NH₂NH₃)₂(NO₂)₄]⁺
 (c) [Co(en)₃]²⁺ (d) Fe(CO)₅
 (e) [Cr(NH₃)₂(H₂O)₂Cl₂] (f) [Al(H₂O)₂(OH)₄]⁻
 (i) [Ni(DMG)₂]²⁺ (j) [CaEDTA]²⁺
 (k) (Au(CN)₄)⁻ (l) [Co(en)Cl₃(H₂O)]⁻
 (m) [Co(NH₃)₅CO₃]₂[CuCl₄]
 (n) [Cr(en)₂Cl₂]Cl
 (o) [Pt(Py)₄][PtCl₄]
 (p) K₃[Fe(CN)₅CO]
 (q) CsTeF₅
 (r) [Ni(NH₃)₆]₃[Co(NO₂)₆]₂
 (s) [PdBr₄]²⁻
 (t) [Cu(NH₃)₆][ZnCl₄]
 (u) [Co(NH₃)₆][Cr(NH₃)₂Cl₄]₃
 (v) Mn₃(CO)₁₂
 (w) [(CO)₃Fe(CO)₃Fe(CO)₃]
 (x) Mo(Ph₂PCH₂CH₂PPh₂)₂(N₂)₂
 (y) (1). K₂[OsCl₅N]
 (2). Co(NH₃)₂(Cl)(Br)(CH₃CO₃)
 (3). [Pt(en)₂](ClO₄)₂
 (4). Na[Co(OC₂H₅)₃]
 (5). [Ni(Phen)₃](ClO₄)₂
 (Z) (1) [NH₃]₅Co–NH₂–Co(NH₃)₄(H₂O)]Cl₅

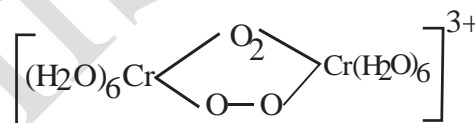


- (4). $[(en)_2Co(NH)(OH)Co(en)_2]^{3+}$
 (5). $[(C_6H_5)_3P(Cl)Pd(Cl)(Cl)Pd(Cl)(P(C_6H_5)_3)]$
- Q 9. Write the formula for the following compounds:
 (a) Bromotriammineplatinum(II) nitrite
 (b) Dichlorobis(ethylenediamine) cobalt(II) monohydrate
 (c) Sulfatopentaamminecobalt(III) bromide
 (d) Dibromotetraaquo chromium(III) chloride
 (e) Ammonium heptafluorozirconate (IV)
 (f) HexaammineChromium(III) hexanitrocobaltate(III)
 (g) Tetrachlorozincate(II) ion
 (h) Tetracarbonylnickel(0)
 (i) Potassium iron(III) hexaxynoferrate(II)
 (j) Sodium bis(thiosulphato) argentite(I)
 (k) Triamminechlorocyanonitrocobalt(III)
 (l) Tetrapyrindineplatinum(II) tetrachloroplatinate(II)
 (m) triamminetrithiosyanatochromium(III)
 (n) tetrathicyanato-N-Zinc(II)
 (o) bis(cyclopentadienyl) iron(II)
 (p) mer - trihydridotris(triphenylphosphene) ruthenium (III)
 (q) tetraammineaquacobalt(III) - μ - cyanobromotetracyanocobaltate (III)
- Q 10. Which of the following will be named as dibromidobis(ethylenediamine) chromium (III) bromide? [AIEEE 2012]
 (A) $[Cr(en)_3]Br_3$ (B) $[Cr(en)_2Br_2]Br$
 (C) $[Cr(en)Br_4]^-$ (D) $[Cr(en)Br_2]Br$
- Q 11. In octaqua - μ - dihydroxodiiron(III) sulphate, the number of bridging ligands is
 (A) 2 (B) 1
 (C) 3 (D) none
- Q 12. The number of bridging ligands and the number of bromine atoms per molecule in the compound

deca ammine - μ - hydroxodichromium (III) bromide are respectively

- (A) 1,5 (B) 2,6
 (C) 1,4 (D) 1,3

- Q 13. The IUPAC name of the complex compound $[(CO)_3Fe(CO)_3Fe(CO)_3]$ is
 (A) Nonacarbonyldiiron (0)
 (B) Tricarbonyliron(0) - μ - tricarbonyl iron(0)
 (C) Hexacarbonyliron(0) - μ - tricarbonyl iron(0)
 (D) Hexacarbonyl - μ - tricarbonyldiiron(0)
- Q 14. Write the formula of some of the important complex compounds which are used industrially:
 (a) Tollen's reagent (b) Switzer's reagent
 (c) Turnbull blue (d) Prussian blue
 (e) Sodium nitropruside
- Q 15. Oxidation number of Cr in the following complex is:



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

- Q 16. Which contains monovalent cationic complex?
 (A) $CoCl_3.6NH_3$ (B) $CoCl_3.5NH_3$
 (C) $CoCl_3.4H_2O$ (D) $CoCl_3.3NH_3$
- Q 17. Which complex gives three chloride ions per formula unit?
 (A) $CrCl_3.6H_2O$ (B) $CrCl_3.5H_2O$
 (C) $CrCl_3.4H_2O$ (D) All of these
- Q 18. In the complex $PtCl_4.4NH_3$
 (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 are correct
- Q 19. Which of the following is a polynuclear complex?
 (A) $[CrCl_4(H_2O)_2]^-$ (B) $[Co(NH_3)_4SO_4]^+$
 (C) $[(en)_2Co - (NH_2)(OH) - Co(en)_2]^{4+}$
 (D) $[Ni(CO)_4]$

2. Effective Atomic Number

- Q 1. Give the characteristic co-ordination number of the each of the central metal cations:
 (a) Cu^{+1} (b) Cu^{+2} (c) Co^{3+}
 (d) Al^{3+} (e) Zn^{2+} (f) Fe^{2+}
 (g) Fe^{3+} (h) Ag^{+1}
- Q 2. Which of the following compounds is satisfying EAN rule?
 (a) $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$
 (b) $[\text{Co}(\text{NH}_2\text{NH}_3)_2(\text{NO}_4)_4]^+$
 (c) $[\text{Co}(\text{en})_3]^{2+}$ (d) $\text{Fe}(\text{CO})_5$
 (e) $[\text{Cr}(\text{NH}_3)_2(\text{H}_2\text{O})_2\text{Cl}_2]$ (f) $(\text{Al}(\text{H}_2\text{O})_2(\text{OH})_4)$
 (i) $[\text{Ni}(\text{DMG})_2]^{2+}$ (j) $[\text{CaEDTA}]^{2+}$
 (k) $[\text{Au}(\text{CN})_4]^-$ (l) $[\text{Co}(\text{en})\text{Cl}_3(\text{H}_2\text{O})]$
 (m) $[\text{Co}(\text{NH}_3)_5\text{CO}_3]_2[\text{CuCl}_4]$
 Also find out the EAN value in each case.
- Q 3. The EAN of $[\text{Zn}(\text{OH})_4]^{2-}$ complex is
[AIIMS 2000]
 (A) 16 (B) 26 (C) 36 (D) 46
- Q 4. What are the effective atomic number of the metal atom in $\text{Fe}(\text{CO})_5$ and in $\text{Co}(\text{CO})_8$?
- Q 5. Determine the effective atomic number of iron in $\text{Fe}(\text{NO})_2(\text{CO})_2$ and in $\text{Fe}(\text{C}_5\text{H}_5)_2$.
- Q 6. Deduce the value of x in the formula $\text{Mo}(\text{CO})_x$.
- Q 7. Predict the value of x in each of the following compounds:
 (A) $\text{Co}(\text{CO})_x$ (B) $\text{HxCr}(\text{CO})_5$
 (C) $\text{HxCo}(\text{CO})_4$
- Q 8. What is the effective atomic number of Pd in tetrachloropalladium (II) ion?
 (A) 54 (B) 59 (C) 55 (D) 56
- Q 9. Which of the following is the correct value of x in $\text{Cr}(\text{CO})_x$?
 (A) 2 (B) 4
 (C) 6 (D) unpredictable
- Q 10. In which case EAN of Cr is maximum?
 (A) $[\text{Cr}(\text{CN})_6]^{3-}$ (B) $[\text{Cr}(\text{H}_2\text{O})_4(\text{NH}_3)_2]^{3+}$
 (C) $[\text{Cr}(\text{H}_2\text{O})_4(\text{C}_2\text{O}_4)]^+$ (D) Equal
- Q 11. Increasing order of EAN of the metals in $[\text{Ni}(\text{CN})_4]^{2-}$, $[\text{Fe}(\text{CN})_6]^{3-}$ and $[\text{Cu}(\text{CN})_4]^{3-}$ is:
 (A) $[\text{Ni}(\text{CN})_4]^{2-} < [\text{Fe}(\text{CN})_6]^{3-} < [\text{Cu}(\text{CN})_4]^{3-}$
 (B) $[\text{Ni}(\text{CN})_4]^{2-} < [\text{Fe}(\text{CN})_6]^{3-} = [\text{Cu}(\text{CN})_4]^{3-}$
 (C) $[\text{Ni}(\text{CN})_4]^{2-} < [\text{Cu}(\text{CN})_4]^{3-} < [\text{Fe}(\text{CN})_6]^{3-}$
 (D) $[\text{Cu}(\text{CN})_4]^{3-} < [\text{Fe}(\text{CN})_6]^{3-} < [\text{Ni}(\text{CN})_4]^{2-}$
- Q 12. EAN of cabalt is 36 in $[\text{Co}(\text{NH}_3)_2\text{O}_2(\text{en})\text{Cl}]$. Thus, O_2 is

- (A) dioxide (B) superoxide ion
 (C) peroxide ion (D) oxide

- Q 13. EAN of Mg is --- in $[\text{Mg}(\text{EDTA})]^{2-}$.
 (A) 16 (B) 20 (C) 22 (D) 18
- Q 14. The effective atomic number (EAN) of Pt in $[\text{Pt}(\text{NH}_3)_6]^{4+}$ is
 (A) 82 (B) 86 (C) 54 (D) 84

3. Valence Bond Theory in Complex Compounds

- Q 1. Which of the following ligands can be regarded as strong ligand & specify in which cases they can if they behaves somewhere strong and weak somewhere.
 (a) Py (b) NH_3 (c) Bipy
 (d) Phen (e) PPh_3 (f) CN^-
 (g) CO (h) CH_3CN (i) EDTA
- Q 2. The strength of ligand also depends on the atom for which lone pairs is being donated. Write the increasing order of the strength of sigma bond formed for the different type of
 (a) Halide donors (b) O donors
 (c) N donors (d) C donors
- Q 3. Draw the electronic configuration, hybridisation and structure of the following complexes.
 (a) $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$
 (b) $[\text{Co}(\text{NH}_2\text{NH}_3)_2(\text{NO}_4)_4]^+$
 (c) $[\text{Co}(\text{en})_3]^{2+}$
 (d) $\text{Fe}(\text{CO})_5$
 (e) $[\text{Cr}(\text{NH}_3)_2(\text{H}_2\text{O})_2\text{Cl}_2]$
 (f) $(\text{Al}(\text{H}_2\text{O})_2(\text{OH})_4)$
 (g) $(\text{Au}(\text{CN})_4)^-$
 (h) $[\text{Co}(\text{en})\text{Cl}_3(\text{H}_2\text{O})]$
 (i) $[\text{CoF}_6]^{3-}$
 (j) $[\text{Co}(\text{Phen})_6]^{3+}$
- Q 4. For the complexes $[\text{NiCl}_4]^{2-}$ and $[\text{Ni}(\text{CN})_4]^{2-}$
 (1) Deduce the structure of both the complexes
 (2) Hybridisation of the metal in both of the complexes.
 (3) Calculate the magnetic nature for both the complexes.
 (4) Calculate the μ -value [magnetic moment (spin only)] for both the complexes.

- Q 5. $[\text{Cu}(\text{NH}_3)_4]^{2+}$ is square planar complex? The number of unpaired electrons and hybrid state of copper are respectively
 (A) 4, dsp^2 (B) 1, sp^3
 (C) 1, dsp^3 (D) 4, sp^3
- Q 6. Which of the following pairs contains only tetrahedral complexes?
 (A) $[\text{ZnCl}_4]^{2-}$ and $[\text{MnCl}_4]^{2-}$
 (B) $[\text{Zn}(\text{NH}_3)_4]^{2+}$ and $[\text{Cu}(\text{NH}_3)_4]^{2+}$
 (C) $[\text{MnCl}_4]^{2-}$ and $[\text{Ni}(\text{CN})_4]^{2-}$
 (D) $[\text{ZnCl}_4]^{2-}$ and $[\text{Ni}(\text{CN})_4]^{2-}$
- Q 7. The geometry of $\text{Ni}(\text{CO})_4$ and $\text{Ni}(\text{PPh}_3)_2\text{Cl}_2$ are
[IIT JEE 1999]
 (A) Both square planar
 (B) Tetrahedral and square planar respectively
 (C) Both tetrahedral
 (D) Square planar and Tetrahedral respectively
- Q 8. $\text{NiCl}_2\{\text{P}(\text{C}_2\text{H}_5)_2(\text{C}_6\text{H}_5)_2\}$ exhibits temperature dependent magnetic behavior. The co-ordination geometries of Ni^{2+} in the paramagnetic and diamagnetic states are respectively
[IIT JEE 2012]
 (A) Tetrahedral and tetrahedral
 (B) Square planar & Square Planar
 (C) Tetrahedral & Square Planar
 (D) Square Planar & Tetrahedral
- Q 9. Among the complex ions given below which is/are outer – orbital complex?
 (I) $[\text{Co}(\text{CN})_6]^{4-}$ (II) $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$
 (III) $[\text{FeF}_6]^{3-}$ (IV) $[\text{CoF}_6]^{3-}$
 (A) III and IV (B) II and III
 (C) I and IV (D) I and II
- Q 10. The outer orbital hybridisation is involved in
 (A) $[\text{Zn}(\text{NH}_3)_4]^{2+}$ (B) $[\text{Co}(\text{NH}_3)_6]^{3+}$
 (C) $[\text{Cr}(\text{NH}_3)_6]^{3+}$ (D) $[\text{V}(\text{NH}_3)_6]^{3+}$
- Q 11. The one species which has a shape that is different from the rest
 (A) $[\text{Zn}(\text{NH}_3)_4]^{2+}$ (B) $[\text{Cu}(\text{NH}_3)_4]^{2+}$
 (C) $[\text{Cu}(\text{CN})_4]^{3-}$ (D) $\text{Ni}(\text{CO})_4$
- Q 12. In $\text{Fe}(\text{C}_5\text{H}_5)_2$, the number of unpaired electrons and hybrid state of iron are respectively
 (A) 5, sp^3d^2 (B) 0, d^2sp^3
 (C) 2, dsp^2 (D) 4, sp^3d^2
- Q 13. An octahedral complex of a metal ion has a magnetic moment of 5.92 BM and another octahedral complex of the same metal ion in the same oxidation state has a magnetic moment of 1.75 BM. Which of the following ion could be?
 (A) Fe^{+2} (B) Co^{+2}
 (C) Fe^{+3} (D) Co^{+3}
- Q 14. One mole of the complex compound $\text{Co}(\text{NH}_3)_5\text{Cl}_3$. Gives 3 moles of ions on dissolve 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 complex is
 (A) $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl} \cdot \text{NH}_3$
 (B) $[\text{Co}(\text{NH}_3)_4\text{Cl}]\text{Cl}_2 \cdot \text{NH}_3$
 (C) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$
 (D) $[\text{Co}(\text{NH}_3)_3\text{Cl}_3] \cdot 2\text{NH}_3$
- Q 15. When 0.1 mole of $\text{CoCl}_3(\text{NH}_3)_3$ is treated with excess of AgNO_3 , 0.2 mole of AgCl are obtained. The conductivity of solution will correspond to **[NCERT Exemplar]**
 (A) 1:3 electrolyte (B) 1:2 electrolyte
 (C) 1:1 electrolyte (D) 3:1 electrolyte
- Q 16. A coordination complex compound of cobalt has the molecular formula containing five ammonia molecules, one nitro group and two chlorine atoms for one cobalt atom. One mole of this compound produces three mole ions in an aqueous solution. On reacting this solution with excess of AgNO_3 solution, we get two moles of AgCl precipitate. The ionic formula for this complex would be **[AIPMT 1998]**
 (A) $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}_2$
 (B) $[\text{Co}(\text{NH}_3)\text{Cl}][\text{Cl}(\text{NO}_2)]$
 (C) $[\text{Co}(\text{NH}_3)_4(\text{NO}_2)\text{Cl}][(\text{NH}_3)\text{Cl}]$
 (D) $[\text{Co}(\text{NH}_3)_5][(\text{NO}_2)_2\text{Cl}_2]$
- Q 17. A, B & C are three complexes of chromium (III) with the empirical formula $\text{H}_{12}\text{O}_6\text{Cl}_3\text{Cr}$. All the three complexes have water and chloride ion as ligands. Complex A does not react with concentrated H_2SO_4 , whereas complexes B and C lose 6.75 % and 13.5 % of their original mass respectively. On treatment with concentrated H_2SO_4 , identify A, B, and C. **[IIT JEE 1996]**
- Q 18. A metal complex having composition $\text{Cr}(\text{NH}_3)_4\text{Cl}_2\text{Br}$ 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 formula of A and B and state the hybridization of chromium in each. Calculate the magnetic moments. [IIT JEE 2001]

Q 19. $[\text{Fe}(\text{H}_2\text{O})_6]^{+2}$ is paramagnetic whereas $[\text{Fe}(\text{CN})_6]^{-4}$ is diamagnetic because

- (A) $\text{Fe}[(\text{H}_2\text{O})_6]^{+2}$ has Fe^{2+} , $[\text{Fe}(\text{CN})_6]^{-4}$ has Fe^{3+}
 (B) $\text{Fe}[(\text{H}_2\text{O})_6]^{+2}$ is outer orbital complex, $[\text{Fe}(\text{CN})_6]^{-4}$ is inner orbital complex
 (C) H_2O is a strong field ligand, whereas CN^- is a weak field ligand
 (D) $\text{Fe}[(\text{H}_2\text{O})_6]^{+2}$ is inner orbital complex, $[\text{Fe}(\text{CN})_6]^{-4}$ is outer orbital complex

Q 20. Among the following complex [IIT JEE 2011]

- K:** $\text{K}_3[\text{Fe}(\text{CN})_6]$, **L:** $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$
M: $\text{Na}_3[\text{Co}(\text{C}_2\text{O}_4)_3]$ **N:** $[\text{Ni}(\text{H}_2\text{O})_6](\text{NO}_3)_2$
O: $\text{K}_2[\text{Pt}(\text{CN})_4]$ **P:** $[\text{Zn}(\text{H}_2\text{O})_6](\text{NO}_3)_2$

The diamagnetic complexes are

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

Q 21. Among $\text{Ni}(\text{CO})_4$, $[\text{Ni}(\text{CN})_4]^{2-}$ and $[\text{NiCl}_4]^{2-}$

[IIT JEE 1991]

- (A) $\text{Ni}(\text{CO})_4$ and $[\text{NiCl}_4]^{2-}$ are diamagnetic and $[\text{Ni}(\text{CN})_4]^{2-}$ is paramagnetic
 (B) $[\text{Ni}(\text{CN})_4]^{2-}$ and $[\text{NiCl}_4]^{2-}$ are diamagnetic and $\text{Ni}(\text{CO})_4$ is paramagnetic
 (C) $[\text{Ni}(\text{CN})_4]^{2-}$ and $\text{Ni}(\text{CO})_4$ are diamagnetic and $[\text{NiCl}_4]^{2-}$ is paramagnetic
 (D) $\text{Ni}(\text{CO})_4$ is diamagnetic and $[\text{Ni}(\text{CN})_4]^{2-}$ and $[\text{NiCl}_4]^{2-}$ are paramagnetic

Q 22. Nickel chloride, when treated with DMG in presence of ammonium hydroxide, a bright red precipitate is obtained. Answer the following

[IIT JEE 2004]

- (A) Draw the structure of the complex showing H bonds
 (B) Give oxidation state of Nickel and its hybridisation
 (C) Predict the magnetic behavior of the complex

Q 23. How many H-bonds are present in the complex formed by Ni^{2+} and DMG ligands?

- (A) 2 (B) 3
 (C) 4 (D) none of these

Q 24. What is the coordination number of Ni in nickel-DMG complex?

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

4. VBT & CFT in Complex Compounds

Q 1. Magnetic Moment in $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ is 2.83 B.M.

- when NH_3 is added in it, then magnetic moment
 (A) will remain same
 (B) increases
 (C) decreases
 (D) can't be predicted

Q 2. In which of the following, number of unpaired electrons is not same as in rest of the three?

- (A) $[\text{Cr}(\text{NH}_3)_6]^{3+}$ (B) $[\text{Cu}(\text{NH}_3)_6]^{2+}$
 (C) $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ (D) $\text{K}_3[\text{Fe}(\text{CN})_5\text{O}_2]$

Q 3. Hybridisation, Magnetic Moment (in B.M.) and oxidation state of Ni in $\text{Ni}(\text{DMG})_2$ complex respectively are

- (A) $d\text{sp}^2$, $\sqrt{8}$, +2 (B) $d\text{sp}^2$, 0, +2
 (C) sp^3 , $\sqrt{8}$, 0 (D) sp^3 , 0, +2

Q 4. Which of the following complexes are diamagnetic?

1. $[\text{Pt}(\text{NH}_3)_4]^{2+}$ 2. $[\text{Co}(\text{SCN})_4]^{2-}$
 3. $[\text{Cu}(\text{en})_2]^{2+}$ 4. $[\text{HgI}_4]^{2-}$
 (A) 1 & 2 (B) 2 & 3
 (C) 1 & 4 (D) 3 & 4

Q 5. Which of the following is correct about $[\text{Co}(\text{DMG})_2]$?

- (I) Tetrahedral (II) Square Planar
 (III) Paramagnetic (IV) +2 oxidation no. of Co
 (A) II, III & IV (B) I, II & IV
 (C) I, II & III (D) I, III & IV

Q 6. The correct order of energy level of d-orbitals of metal ion in octahedral complex is

- (A) $d_{xy} = d_{yz} = d_{zx} > d_{x^2-y^2} = d_{z^2}$
 (B) $d_{x^2-y^2} = d_{z^2} > d_{xy} = d_{yz} = d_{zx}$
 (C) $d_{x^2-y^2} > d_{z^2} > d_{xy} > d_{yz} = d_{zx}$
 (D) $d_{x^2-y^2} > d_{z^2} > d_{xy} > d_{yz} < d_{zx}$

Q 7. Assertion (A) :

After splitting of d-orbitals during the complex formation, the orbitals form two sets of orbitals t_{2g} and e_g in octahedral field.

Reason (R) : Splitting of d – orbitals occurs only in the case of strong field ligands such as CN^-

[AIIMS 2016]

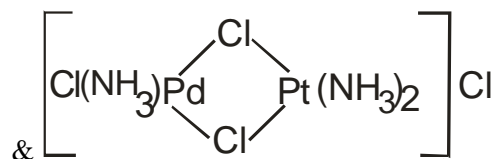
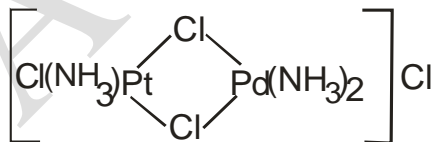
- (A) Both A & R are true and R is correct explanation of A
 (B) Both A & R are true but R is not correct explanation of A
 (C) A is true but R is false
 (D) A and R both are false
- Q 8. What will be the correct order of wavelengths of absorption in visible region for
 I. $[\text{Ni}(\text{NO}_2)_6]^{4-}$ II. $[\text{Ni}(\text{NH}_3)_6]^{2+}$
 III. $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$
 (A) I > II > III (B) I < II < III
 (C) II < I < III (D) II > I > III
- Q 9. Correct increasing order for the wavelengths of absorption in the visible region for the complexes of Co^{3+} is [NEET 2017]
 (A) $[\text{Co}(\text{en})_3]^{3+}$, $[\text{Co}(\text{NH}_3)_6]^{3+}$, $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$
 (B) $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$, $[\text{Co}(\text{en})_3]^{3+}$, $[\text{Co}(\text{NH}_3)_6]^{3+}$
 (C) $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$, $[\text{Co}(\text{NH}_3)_6]^{3+}$, $[\text{Co}(\text{en})_3]^{3+}$
 (D) $[\text{Co}(\text{NH}_3)_6]^{3+}$, $[\text{Co}(\text{en})_3]^{3+}$, $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$
- Q 10. Among the following complexes, the one with zero crystal field stabilisation energy (CFSE) is [AIMPT 2014]
 (A) $[\text{Mn}(\text{H}_2\text{O})_6]^{3+}$ (B) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$
 (C) $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ (D) $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$
- Q 11. Which of the following complex ion having zero values of CFSE?
 (A) $[\text{Co}(\text{NH}_3)_6]^{2+}$ (B) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$
 (C) $[\text{Fe}(\text{CN})_6]^{4-}$ (D) $[\text{Co}(\text{NH}_3)_6]^{3+}$
- Q 12. Which of the following co-ordination entity should be expected to absorb light of lowest frequency? [AIIMS 2009]
 (A) $[\text{Cr}(\text{en})_3]^{3+}$ (B) $[\text{CrCl}_6]^{3-}$
 (C) $[\text{Cr}(\text{NH}_3)_6]^{3+}$ (D) $[\text{Cr}(\text{CN})_6]^{3-}$
- Q 13. The octahedral complex of metal ion M^{3+} with four monodentate ligands L_1 , L_2 , L_3 & L_4 absorbs wavelengths in the region of red, green, yellow and blue respectively. The increasing order of ligand strength of the four ligands is

[JEE Main 2014]

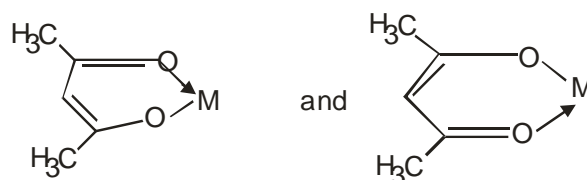
- (A) $\text{L}_4 < \text{L}_3 < \text{L}_2 < \text{L}_1$ (B) $\text{L}_1 < \text{L}_3 < \text{L}_2 < \text{L}_4$
 (C) $\text{L}_3 < \text{L}_2 < \text{L}_4 < \text{L}_1$ (D) $\text{L}_1 < \text{L}_2 < \text{L}_4 < \text{L}_3$
- Q 14. If $\Delta_o < P$, then electronic configuration of metal atom/ion in complex formation with d^4 configuration is
 (A) t_{2g}^4, e_g^0 (B) e_g^4, t_{2g}^0
 (C) e_g^2, t_{2g}^2 (D) t_{2g}^3, e_g^1
- Q 15. $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$ (At.Wt. 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 [AIMPT 2006]
 (A) $3d_{XY}^1, 3d_{YZ}^1, 3d_{z^2}^1$ (B) $3d_{x^2-y^2}^1, 3d_{XZ}^1, 3d_{z^2}^1$
 (C) $3d_{x^2-y^2}^1, 3d_{YZ}^1, 3d_{XY}^1$ (D) $3d_{ZX}^1, 3d_{YZ}^1, 3d_{XY}^1$
- Q 16. Crystal field stabilisation energy for high spin d^4 octahedral complex is [AIPMT 2010]
 (A) $-1.8\Delta_o$ (B) $-1.6\Delta_o + P$
 (C) $-1.2\Delta_o$ (D) $-0.6\Delta_o$
- Q 17. In which of the following complexes, order of energy level is $d_{x^2-y^2} < d_{xy}$
 (A) $[\text{Co}(\text{CN})_4]^{2-}$ (B) $[\text{Co}(\text{Cl})_4]^{2-}$
 (C) $[\text{CoF}_6]^{3-}$ (D) $[\text{Co}(\text{NH}_3)_6]^{3+}$
- Q 18. Draw the crystal field energy diagram for the following compounds:
 (A) $[\text{Pt}(\text{NH}_3)_4]^{2+}$ (B) $[\text{Cu}(\text{NH}_3)_4]^{2+}$
 (C) $[\text{Cr}(\text{NH}_3)_6]^{3+}$ (D) $[\text{Pd}(\text{en})_2]^{2+}$
- Q 19. If the value of CFSE in $[\text{CoCl}_6]^{4-}$ ion is 18000 cm^{-1} , then CFSE in $[\text{CoCl}_4]^{2-}$ ion is
 (A) 8000 (B) 10000
 (C) 12000 (D) 4000
- Q 20. For the complex $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$ it is found that electron pairing energy is equivalent to 23000 cm^{-1} and Δ_o is equivalent to 15000 cm^{-1} . Then predict for this complex. Calculate the CSFE for the above complex in KJ/mol.
- Q 21. Jahn Teller distortion is not observed in high orbital complexes of [NEET 2016, II]
 (A) d^7 (B) d^8 (C) d^4 (D) d^9

5. Isomerism in Complex Compounds

- Q 1. $[\text{Co}(\text{NH}_3)_4(\text{NO}_2)_2\text{Cl}]$ exhibits [AIMPT 2006]
 (A) Linkage isomerism, geometrical isomerism and optical isomerism
 (B) Linkage isomerism, ionisation isomerism and optical isomerism
 (C) Linkage isomerism, ionisation isomerism and geometrical isomerism
 (D) Ionisation isomerism, Geometrical isomerism and optical isomerism
- Q 2. Which of the following complex show ionization isomerism?
 (A) $[\text{Cr}(\text{NH}_3)_6]\text{Cl}_3$ (B) $[\text{Cr}(\text{en})_2\text{Cl}_2]$
 (C) $[\text{Cr}(\text{en})_3]\text{Cl}_3$ (D) $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$
- Q 3. Which is/are correct statement(s)?
 (A) $[\text{Co}(\text{en})_3][\text{Cr}(\text{CN})_6]$ will display coordination isomerism
 (B) $[\text{Mn}(\text{CO})_5(\text{SCN})]$ show linkage isomerism
 (C) $[\text{Co}(\text{NH}_3)_5(\text{NO}_3)\text{SO}_4]$ show ionisation isomerism
 (D) None is correct
- Q 4. $[\text{Fe}(\text{NO}_2)_3\text{Cl}_3]$ and $[\text{Fe}(\text{O}-\text{NO})_3\text{Cl}_3]$ shows [AIIMS 2008]
 (A) Linkage isomerism
 (B) Geometrical isomerism
 (C) Optical Isomerism
 (D) None of the above
- Q 5. The complexes $[\text{Pt}(\text{NH}_3)_4][\text{PtCl}_6]$ and $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2][\text{PtCl}_4]$ are
 (A) Linkage isomer (B) optical isomer
 (C) Co-ordination isomer (D) ionisation isomer
- Q 6. The total number of possible isomers of the compound $[\text{Cu}(\text{NH}_3)_4][\text{PtCl}_4]$ is
 (A) 3 (B) 6 (C) 5 (D) 4
- Q 7. The type of isomerism shown by given two molecules are



- (A) Ionisation isomerism
 (B) ligand isomerism
 (C) Valency isomerism
 (D) coordination position isomerism
- Q 8. In the complexes the pair that will give a total number of 5 and 3 ions respectively are
 (A) $[\text{Pt}(\text{NH}_3)_6]\text{Cl}_4$ and $[\text{PtCl}(\text{NH}_3)_5]\text{Cl}_3$
 (B) $[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}_2$ and $[\text{PtCl}(\text{NH}_3)_5]\text{Cl}_3$
 (C) $[\text{Pt}(\text{NH}_3)_6]\text{Cl}_4$ and $[\text{PtCl}_2(\text{NH}_3)_4]\text{Cl}_2$
 (D) $[\text{PtCl}_3(\text{NH}_3)_3]\text{Cl}$ and $[\text{PtCl}_4(\text{NH}_3)_2]$
- Q 9. Which one amongst the following isomerism is shown by $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$? [AIIMS 2015]
 (A) Structural (B) Geometrical
 (C) Optical (D) Conformational
- Q 10. The number of geometrical isomers that can exist for the square planar complex $[\text{PtClPy}(\text{NH}_3)(\text{NH}_2\text{OH})]^+$ is [JEE Main 2015]
 (A) 4 (B) 6 (C) 2 (D) 3
- Q 11. The possible number of isomers for the complex $[\text{MCl}_2\text{Br}_2]\text{SO}_4$ is
 (A) 1 (B) 2 (C) 4 (D) 5
- Q 12. Which of the following has largest number of Isomers? [AIEEE 2004]
 (A) $[\text{Ir}(\text{PR}_3)_2\text{H}(\text{CO})]^{2+}$ (B) $[\text{Co}(\text{NH}_3)_5\text{Cl}]^{2+}$
 (C) $[\text{Ru}(\text{NH}_3)_4\text{Cl}_2]^+$ (D) $[\text{Co}(\text{en})_2\text{Cl}_2]^+$
- Q 13. The compounds shown in the diagram are



- (A) Linkage isomers (B) Resonating forms
 (C) Tautomers (D) Co-ordination isomers
- Q 14. Which one of the following square planar complexes will be able to show geometrical isomerism?
 (A) MX_4 (B) Ma_3b
 (C) $\text{M}(\text{aa}')_2$ (D) $\text{M}(\text{aa})_2$
- Q 15. **Assertion (A):**
 Complexes of MX_6 and MX_5L type do not show geometrical isomerism

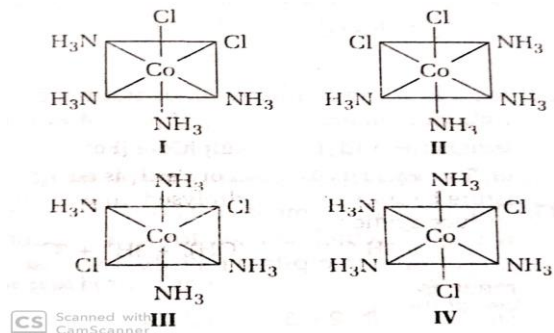
Reason (R): Geometrical isomerism is not shown by the complexes of co-ordination number 6.

[NCERT Exemplar]

- (A) Both A & R are true and R is correct explanation of A
 (B) Both A & R are true but R is not correct explanation of A
 (C) A is true but R is false
 (D) A and R both are false
- Q 16. The number of geometrical isomers for the complex compound $[\text{Co}(\text{NH}_3)_3(\text{NO}_2)_3]$ is
 (A) 2 (B) 3 (C) 4 (D) 0
- Q 17. How many geometrical isomers are possible in given coordination compounds? [NCERT]
 (A) $[\text{Cr}(\text{C}_2\text{O}_4)_3]^{3-}$ (B) $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$
- Q 18. Number of possible isomers for the complex $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$ will be [AIPMT 2015]
 (A) 2 (B) 1 (C) 3 (D) 4
- Q 19. The pair of coordination complexes/ions exhibiting the same kind of isomerism is/are [JEE Adv. 2013]
 (A) $[\text{Cr}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$ & $[\text{Cr}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$
 (B) $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$ & $[\text{Pt}(\text{NH}_3)_2(\text{H}_2\text{O})\text{Cl}]^+$
 (C) $[\text{CoBr}_2\text{Cl}_2]^{2-}$ & $[\text{PtBr}_2\text{Cl}_2]^{2-}$
 (D) $[\text{Pt}(\text{NH}_3)_3(\text{NO}_3)\text{Cl}]$ & $[\text{Pt}(\text{NH}_3)_3\text{Cl}]\text{Br}$

6. Stereoisomers in Complex Compounds

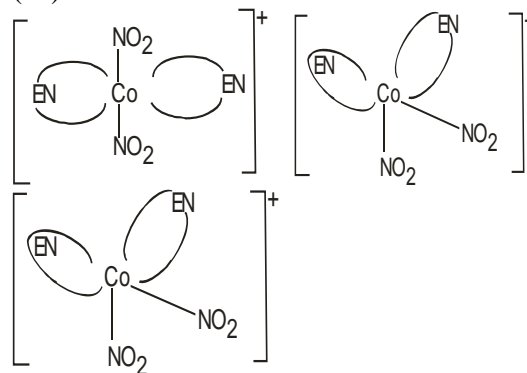
- Q 1. Dipole moment will be zero in complexes:
 I: $[\text{Ni}(\text{CN})_4]^{2-}$ II: cis- $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$
 III: trans- $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$
 (A) I and II (B) I and III
 (C) II and III (D) I, II and III
- Q 2. Fac and mer isomerism will be exhibited by
 (A) $[\text{Ni}(\text{CN})_4]^{2-}$
 (B) Trioxalatocobaltate (III) ion
 (C) Triglycinatocobalt (III) ion
 (D) $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$
- Q 3. Consider the following arrangements of the octahedral complex ion $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$?



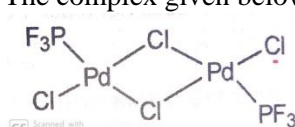
Which of the following statements is false?

- (A) II & III are cis and trans isomers respectively
 (B) III & IV are trans and cis isomers respectively
 (C) I and II are enantiomers
 (D) All are identical
- Q 4. $[\text{CoCl}_2(\text{NH}_3)_4] + \text{Cl}^- \rightarrow [\text{CoCl}_3(\text{NH}_3)_3] + \text{NH}_3$
 in above reaction, only one isomer of complex product is obtained. The initial complex is [AIIMS 2010]
 (A) Cis isomer (B) Trans Isomer
 (C) Not having stereoisomers (D) either cis or trans

- Q 5. Three arrangements have been shown for the complex cation bisethylenediaminedinitro cobalt (III). What is not correct?



- (A) I and III are geometrical isomers
 (B) II and III are geometrical isomers
 (C) I and II geometrical isomers
 (D) II and III are optical isomers
- Q 6. Select correct statement:
 (A) Geometrical isomer may differ in dipole moment and visible/UV spectra
 (B) Complexes of the type $[\text{Ma}_3\text{b}_3]$ can also have facial (fac) and meridional (mer) isomer

- (C) No optical isomer exists for the complex trans- $[\text{Co}(\text{en})_2\text{Cl}_2]^+$
 (D) All are correct
- Q 7. Which of the following compounds shows optical isomerism? [AIIMS 2011]
 (A) $[\text{Co}(\text{CN})_6]^{3-}$ (B) $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$
 (C) $[\text{ZnCl}_4]^{2-}$ (D) $[\text{Cu}(\text{NH}_3)_4]^{2+}$
- Q 8. Which of the following complexes is likely to show optical activity?
 (A) Trans - $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$
 (B) $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$
 (C) Cis - $[\text{Co}(\text{NH}_3)_2(\text{en})_2]^{3+}$
 (D) Trans - $[\text{Co}(\text{NH}_3)_2(\text{en})_2]^{3+}$
- Q 9. In which of the following pairs, both the complexes shows optical isomerism? [AIIMS 2005]
 (A) Cis $[\text{Cr}(\text{C}_2\text{O}_4)_2\text{Cl}_2]^{3-}$, Cis $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]$
 (B) $[\text{Co}(\text{en})_3]\text{Cl}_3$, Cis $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$
 (C) $[\text{PtCl}(\text{dien})]\text{Cl}$, $[\text{NiCl}_2\text{Br}_2]^{2-}$
 (D) $[\text{Co}(\text{NO}_3)_3(\text{NH}_3)_3]$, Cis $[\text{Pt}(\text{en})_2\text{Cl}_2]$
- Q 10. Which of the following will give maximum number of isomers?
 (A) $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]$ (B) $[\text{Ni}(\text{en})(\text{NH}_3)_4]^{2+}$
 (C) $[\text{Ni}(\text{C}_2\text{O}_4)(\text{en})_2]^{2-}$ (D) $[\text{Cr}(\text{SCN})_2(\text{NH}_3)_4]^+$
- Q 11. Which of the following give a pair of enantiomorphs ?
 (A) $[\text{Cr}(\text{NH}_3)_6][\text{Co}(\text{CN})_6]$ (B) $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$
 (C) $[\text{Pt}(\text{NH}_3)_4][\text{PtCl}_6]$ (D) $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{NO}_2$
- Q 12. The number of possible isomers of an octahedral Complex $[\text{Co}(\text{C}_2\text{O}_4)_2(\text{NH}_3)_2]^-$ is [AIIMS 2006]
 (A) 1 (B) 2 (C) 3 (D) 4
- Q 13. How many isomers are theroretically possible for a complex compound with formula $[\text{Pt}(\text{Py})(\text{NH}_3)(\text{NO}_2)\text{ClBrI}]$?
 (A) 3 (B) 4 (C) 8 (D) 15
- Q 14. Which of the following compounds shows optical isomerism? [AIEEE 2005]
 (A) $[\text{Co}(\text{CN})_6]^{3-}$ (B) $[\text{Cr}(\text{C}_2\text{O}_4)_3]^{3-}$
 (C) $[\text{ZnCl}_4]^{2-}$ (D) $[\text{Cu}(\text{NH}_3)_4]^{2+}$
- Q 15. The complex that is optically inactive is
 (A) $[\text{Cr}(\text{en})_3]^{3+}$ (B) $[\text{Co}(\text{Ox})_3]^{3-}$
 (C) trans $[\text{Cr}(\text{en})_2\text{Cl}_2]^+$ (D) cis $[\text{Cr}(\text{en})_2\text{Cl}_2]^+$
- Q 16. **Assertion (A):**
 $[\text{Co}(\text{NO}_2)_3(\text{NH}_3)_3]$ does not show optical
- Isomerism.
Reason (R): it has plane of symmetry [AIIMS 2006]
 (A) Both A & R are true and R is correct explanation of A
 (B) Both A & R are true but R is not correct explanation of A
 (C) A is true but R is false
 (D) A and R both are false
- Q 17. Which of the following coordination compounds Would exhibit optical isomerism? [AIPMT 2004]
 (A) Pentaamminenitrocobalt (III) Iodide
 (B) Diamminedichloroplatinum (II)
 (C) Trans - dicyanobisEthylenediammine chromium(III) chloride
 (D) Tris (ethylenediamine) Cobalt (III) Bromide
- Q 18. Draw the structure of optical isomers of [NCERT]
 (A) $[\text{Cr}(\text{C}_2\text{O}_4)_3]^{3-}$
 (B) $[\text{PtCl}_2(\text{en})_2]^{2+}$
 (C) $[\text{Cr}(\text{NH}_3)_2\text{Cl}_2(\text{en})]^+$
- Q 19. Draw all the isomers (Geometrical & Optical) of [NCERT]
 (A) $[\text{CoCl}_2(\text{en})_2]^+$ (B) $[\text{Co}(\text{NH}_3)\text{Cl}(\text{en})_2]^{2+}$
 (C) $[\text{Co}(\text{NH}_3)_2\text{Cl}_2(\text{en})]^+$
- Q 20. The complex given below show

 (A) Optical Isomerism
 (B) Co-ordination isomerism
 (C) Geometrical Isomerism
 (D) Bridged Isomerism

7. Organometallic Compounds

- Q 1. The ligand is called π acid is [AIIMS 2003]
 (A) CO (B) NH_3
 (C) $\text{C}_2\text{O}_4^{2-}$ (D) $\text{C}_2\text{H}_8\text{N}_2$
- Q 2. In the complex $\text{Fe}(\text{CO})_x$, the value of x is
 (A) 3 (B) 4 (C) 5 (D) 6

- Q 3. Which of the following is the correct value of x in $\text{Cr}(\text{CO})_x$?
 (A) 2 (B) 4 (C) 6 (D) unpredictable
- Q 4. Which is NOT true for metal carbonyl?
 (A) CO acts as lewis base as well as lewis acid
 (B) Metal acts as lewis acid as well as lewis base
 (C) $d\pi - d\pi$ back bonding takes place
 (D) $p\pi - p\pi$ back bonding takes place
- Q 5. In the isoelectronic series for Metal carbonyl, the CO bond strength is expected to increase in the order
 (A) $[\text{Mn}(\text{CO})_6]^+ < [\text{Cr}(\text{CO})_6] < [\text{V}(\text{CO})_6]^-$
 (B) $[\text{V}(\text{CO})_6]^- < [\text{Cr}(\text{CO})_6] < [\text{Mn}(\text{CO})_6]^+$
 (C) $[\text{V}(\text{CO})_6]^- < [\text{Mn}(\text{CO})_6]^+ < [\text{Cr}(\text{CO})_6]$
 (D) $[\text{Cr}(\text{CO})_6] < [\text{Mn}(\text{CO})_6]^+ < [\text{V}(\text{CO})_6]^-$
- Q 6. What is wrong about $\text{Al}_2(\text{CH}_3)_6$?
 (A) it is a electron deficient organometallic compound
 (B) It contains two $3\text{C}-2\text{e}$ bonds
 (C) It is a π -bonded organometallic
 (D) It does not contain any Al-Al bond
- Q 7. Among the following which is not the π -bonded organometallic compound?
 (A) $\text{K}[\text{PtCl}_3(\eta^2-\text{C}_2\text{H}_4)]$ (B) $\text{Fe}(\eta^5-\text{C}_5\text{H}_5)_2$
 (C) $\text{Cr}(\eta^6-\text{C}_6\text{H}_6)_2$ (D) $(\text{CH}_3)_4\text{Sn}$
- Q 8. If the bond length of CO bond in carbon monoxide is 1.128 \AA , then what is the value of CO bond length in $\text{Fe}(\text{CO})_5$?
 (A) 1.15 \AA (B) 1.128 \AA
 (C) 1.72 \AA (D) 1.118 \AA
- Q 9. Which of the following is an oxidising agent?
 (A) $\text{Mn}(\text{CO})_5$ (B) $\text{Fe}(\text{CO})_5$
 (C) $\text{Mn}_2(\text{CO})_{10}$ (D) $\text{Fe}_2(\text{CO})_9$
- Q 10. Among the following metal carbonyls, the C - O bond order is lowest in [IIT JEE 2007]
 (A) $[\text{Mn}(\text{CO})_6]^+$ (B) $[\text{Fe}(\text{CO})_5]$
 (C) $[\text{Cr}(\text{CO})_6]$ (D) $[\text{V}(\text{CO})_6]^-$
- Q 11. In which of the following compound the bond order of C-O is minimum.
 (A) $[\text{Mn}(\text{CO})_5]^+$ (B) $\text{Fe}(\text{CO})_5$
 (C) $[\text{Ni}(\text{CO})_4]^{2+}$ (D) all have same length
- Q 12. Which of the following can't have a metal carbon bond?
 (A) $\text{Al}(\text{OC}_2\text{H}_5)_3$ (B) $\text{C}_2\text{H}_5\text{MgBr}$
 (C) $\text{K}[\text{Pt}(\text{C}_2\text{H}_4)\text{Cl}_3]$ (D) $\text{Ni}(\text{CO})_4$
- Q 13. In metal carbonyl the bond length of CO as compared to that in carbon monoxide is due to
 (A) the donation of lone pair of electrons on the carbon into a vacant orbital of the metal atom
 (B) due to the donation of a pair of electrons from a filled d-orbital of metal into the vacant antibonding π orbital of carbon monoxide.
 (C) A & B both
 (D) None
- Q 14. Which of the following statement is false for Nickel Carbonyl $[\text{Ni}(\text{CO})_4]$?
 (A) it is a colourless compound
 (B) it shows optical isomerism
 (C) the four carbonyl group are lying at the corners of a regular tetrahedron
 (D) The metal - carbon bond length does alter
- Q 15. Consider the following complexes.
 (I) $[\text{Mn}(\text{CO})_5]$ (II) $[\text{Mn}(\text{en})(\text{CO})_3]$
 (III) $[\text{Mn}(\text{en})_2(\text{CO})]$
 (A) $\text{I} > \text{II} > \text{III}$ (B) $\text{II} > \text{I} > \text{III}$
 (C) $\text{III} > \text{II} > \text{I}$ (D) $\text{II} > \text{III} > \text{I}$

8. Stability & Use of Complex Compounds

- Q 1. Which of the following complexes formed by Cu^{2+} ions is most stable? [NCERT Exemplar]
 (A) $\text{Cu}^{2+} + 4\text{NH}_3 \rightleftharpoons [\text{Cu}(\text{NH}_3)_4]^{2+}$; $\log K = 11.6$
 (B) $\text{Cu}^{2+} + 4\text{CN}^- \rightleftharpoons [\text{Cu}(\text{CN})_4]^{2-}$; $\log K = 27.3$
 (C) $\text{Cu}^{2+} + 2\text{en} \rightleftharpoons [\text{Cu}(\text{en})_2]^{2+}$; $\log K = 15.4$
 (D) $\text{Cu}^{2+} + 4\text{H}_2\text{O} \rightleftharpoons [\text{Cu}(\text{H}_2\text{O})_4]^{2+}$; $\log K = 8.9$
- Q 2. The stabilisation of coordination compounds due to chelation is called chelating effect. Which of the following is the most stable complex species? [NCERT Exemplar]
 (A) $[\text{Fe}(\text{CO})_5]$ (B) $[\text{Fe}(\text{CN})_6]^{3-}$
 (C) $[\text{Fe}(\text{C}_2\text{O}_4)_3]^{3-}$ (D) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$
- Q 3. **Assertion (A):** Toxic metals ions are removed by the chelating ligands
Reason (R): Chelate complexes tend to be more stable. [NCERT Exemplar]
 (A) Both A & R are true and R is correct explanation of A

- (B) Both A & R are true but R is not correct explanation of A
 (C) A is true but R is false
 (D) A and R both are false
- Q 4. Among the following the most stable complex is [NCERT]
 (A) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ (B) $[\text{Fe}(\text{NH}_3)_6]^{3+}$
 (C) $[\text{Fe}(\text{C}_2\text{O}_4)_3]^{3-}$ (D) $[\text{Fe}(\text{Cl})_6]^{3-}$
- Q 5. $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is blue in colour while CuSO_4 is colorless, because [AIIMS 2017]
 (A) H_2O is a strong field ligand than SO_4^{2-}
 (B) SO_4^{2-} is a strong field ligand
 (C) CuSO_4 can not form the complex
 (D) no d – d transition are possible in CuSO_4
- Q 6. $[\text{Fe}(\text{H}_2\text{O})_5\text{NO}]^+$ is a complex formed during brown ring test for NO_3^- ion. In this complex [AIIMS 2015]
 (A) There are three unpaired electrons so that its Magnetic moment is 3.87 B.M.
 (B) NO transfer its electrons to Fe^{2+} so that iron become Fe(I) and NO as NO^+
 (C) The colour is because of charge transfer
 (D) All of the above statements are correct
- Q 7. The limiting radius ration of the complex $[\text{Ni}(\text{CN})_4]^{2-}$ is [AIIMS 2010]
 (A) 0.225 – 0.414 (B) 0.414 – 0.732
 (C) 0.155 – 0.225 (D) None of these
- Q 8. An aqueous solution of CoCl_2 on addition of excess of concentrated HCl turns blue due to the formation of [AIIMS 2005]
 (A) $[\text{Co}(\text{H}_2\text{O})_4\text{Cl}_2]$ (B) $[\text{Co}(\text{H}_2\text{O})_2\text{Cl}_4]^{2-}$
 (C) $[\text{CoCl}_4]^{2-}$ (D) $[\text{Co}(\text{H}_2\text{O})_2\text{Cl}_2]$
- Q 9. **Assertion (A) :**
 $[\text{Co}(\text{NH}_3)_6]^{3+} \longrightarrow [\text{Co}(\text{NH}_3)_5\text{H}_2\text{O}]^{3+}$, the colour continuously changes
Reason (R) : Light of larger wavelength will be absorbed in $[\text{Co}(\text{NH}_3)_5\text{H}_2\text{O}]^{3+}$ than $[\text{Co}(\text{NH}_3)_6]^{3+}$ [AIIMS 2018]
 (A) Both A & R are true and R is correct explanation of A
 (B) Both A & R are true but R is not correct explanation of A
 (C) A is true but R is false
 (D) A and R both are false
- Q 10. Which of the following complex is used as an anticancer agent? [AIPMT 2013]
 (A) Mer – $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$
 (B) Cis – $[\text{PtCl}_2(\text{NH}_3)_2]$
 (C) Cis – $\text{K}_2[\text{PtCl}_2\text{Br}_2]$ (D) Na_2CoCl_4
- Q 11. In the separation of Cu^{2+} and Cd^{2+} of IInd group in qualitative analysis of cations, tetramine copper (II) Sulphate and tetramine Cadmium (II) Sulphate reacts with KCN to form the corresponding cyano complexes, which one of the following and their relative stability enables the separation of Cu^{2+} & Cd^{2+} [AIPMT 2000]
 (A) $\text{K}_3[\text{Cu}(\text{CN})_4]$: less stable and $\text{K}_2[\text{Cd}(\text{CN})_4]$ More stable
 (B) $\text{K}_3[\text{Cu}(\text{CN})_4]$: more stable and $\text{K}_2[\text{Cd}(\text{CN})_4]$ less stable
 (C) $\text{K}_2[\text{Cu}(\text{CN})_4]$: less stable and $\text{K}_2[\text{Cd}(\text{CN})_4]$ More stable
 (D) $\text{K}_2[\text{Cu}(\text{CN})_4]$: More stable and $\text{K}_2[\text{Cd}(\text{CN})_4]$ less stable
- Q 12. Ammonia forms complex ion $[\text{Cr}(\text{NH}_3)_4]^{2+}$ with copper ions in alkaline solutions but not in acidic solutions. What is the reason for it? [AIEEE 2003]
 (A) In acidic solution, protons coordinate with ammonia to form NH_4^+ ions and NH_3 molecules are not available
 (B) In alkaline solution insoluble $\text{Cu}(\text{OH})_2$ is precipitated which is soluble in excess of alkali
 (C) Copper hydroxide is an Amphoteric substance
 (D) In acidic solutions, hydration protects copper ion
- Q 13. Co-ordination compounds have great importance in biological systems. In this context, which of the following statements is INCORRECT? [AIEEE 2004]
 (A) Cyanocobalamin is B12 and contains cobalt
 (B) Haemoglobin is the red pigment of blood and contains Iron
 (C) Chlorophylls are green pigments in plants and contains Calcium

(D) Carboxypeptidase – A is an enzyme and

contains Zn

Answer Key

1. Ligand, Primary & Secondary Valency, Nomenclature

- (1).
 (a) 1 (b) 1 (c) 1 (d) No
 (e) 1 (f) 1 (g) 1 (h) 1
 (i) 1 (j) 2 (k) 1 (l) 2
 (m) 3 (n) 4 (o) 2 (p) 1
 (q) 2 (r) 2 (s) 2 (t) 3
 (u) 4 (v) 1 (w) 1 (x) 1
 (y) 1
 (z) (i) 2 (ii) 2
 (2). D
 (3).
 (a) 2, 4 (b) 2, 4
 (c) 1, 2 (d) 3, 6
 (e) 2, 4 (f) 3, 6
 (g) 2, 6 (h) 0, 5
 (i) 2, 6 (j) 3, 6
 (k) 2, 4 (l) 2, 6
 (4). B (5). D (6). C
 (7). C
 (8).
 (a) Pentaamminebromocobalt(III) Sulphate
 (b) dihydraziniumtetranitrocobalt(III)
 (c) bisethylenediaminecobalt(II)
 (d) PentaCarbonylcobalt(0)
 (e) Diamminediaquadichlorochromium(II)
 (f) Diaquatetrahydroxoaluminium(III)
 (i) BisdimethylglyoximeNickel(II)
 (j) EthylenediamminetetraacetateCalcium(II)
 (k) TetracyanoGold(III)
 (l) Aquatrichloroethylenediamminecobalt(III)
 (m) Pentamminecarbonatocobalt(III)
 TetrachloroCopper(II)
 (n) DichlorobisethylenediammineChromium(III)
 chloride
 (o) Tetrapyridineplatinum(II)
 TetrachloroPlatinum(II)
 (p) Potassium CarbonylPentacyanoFerrate(II)
 (q) Cesium PentafluoroTerlluriumate(IV)
 (r) HexamineNickel(II) HexaNitrocobaltate(III)
 (s) TetrabromoPalladium(II)
 (t) TetrammineCopper(II) TetrachloroZincate(II)

- (u) HexammineCobalt(III)
 DiamminetetraChloroChromate(III)
 (v) TriManganese Dodecacarbonyl
 (w) μ - tricarbonyl Hexacarbonyl Diiron(0)
 (x) bisdiNitrodibisdiphenylphospheneethylene
 Molybdenum(0)
 (y) (1). Potassium
 PentachloroNitridoOsmiumate(VI)
 (2). DiammineBromoChloroMethylcarbanato
 Cobalt(II)
 (3). BisethylenediamminePlatinum(II)
 perchlorate
 (4). Sodium Triethoxycobalate(II)
 (5). TriphenylNickel(II) Perchlorate
 (Z) (1) μ - ammine Pentaamminecobalt(III)
 TetraammineaquaCobalt(III)
 (2). μ - amido - μ - dioxygen
 Tetraamminecobalt(II) TetraammineCobalt(II)
 (3). μ - dichloro TetraamminediPlatinum(II)
 Chloride
 (4). μ - amido μ - hydroxo
 TetrakisEthylenediammineDicobalt(III)
 (5). μ - dichloro
 dichlorobistriphenylphosphenedipalladium(II)
 (9).
 (a) $[\text{Pt}(\text{NH}_3)_3\text{Br}]\text{NO}_3$
 (b) $[\text{CoCl}_2(\text{en})_2] \cdot \text{H}_2\text{O}$
 (c) $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$
 (d) $[\text{CrBr}_2(\text{H}_2\text{O})_4]\text{Cl}$
 (e) $(\text{NH}_4)_3[\text{ZrF}_7]$
 (f) $[\text{Cr}(\text{NH}_3)_6] [\text{Co}(\text{NO}_3)_6]$
 (g) $[\text{ZnCl}_4]^{2-}$
 (h) $\text{Ni}(\text{CO})_4$
 (i) $\text{KFe}[\text{Fe}(\text{CN})_6]$
 (j) $\text{Na}_3[\text{Ag}(\text{S}_2\text{O}_3)_2]$
 (k) $[\text{Co}(\text{NH}_3)_3\text{Cl}(\text{CN})\text{NO}_3]$
 (l) $[\text{Pt}(\text{Py})_4][\text{PtCl}_4]$
 (m) $[\text{Cr}(\text{NH}_3)_3(\text{SCN})_3]$
 (n) $[\text{Zn}(\text{NCS})_4]^{2-}$
 (o) $\text{Fe}(\text{C}_5\text{H}_5)_2$
 (p) $\text{RuH}_3(\text{PPh}_3)_3$ Mer represents Isomeric position
 (q) $[(\text{NH}_3)_4\text{H}_2\text{OCo}-\text{CN}-\text{CoBr}(\text{CN})_4]$
 (10). B (11). A (12). A
 (13). D

- (14).
 (a) $[\text{Ag}(\text{NH}_3)_2]\text{Cl}$
 (b) $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2](\text{OH})_2$
 (c) $\text{K}[\text{Fe}_2(\text{CN})_5]\text{CN}$ (d) $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$
 (e) $\text{Na}_2[\text{Fe}(\text{CN})_5\text{NO}]$
 (15). A (16). C (17). A
 (18). D (19). C

2. Effective Atomic Number

- (1).
 (a) 4 (b) 4 (c) 6
 (d) 4 (e) 4 (f) 6
 (g) 6 (h) 4
 (2).
 (a) Yes (b) Yes (c) No
 (d) Yes (e) No (f) No
 (i) No (j) No (k) No
 (l) Yes (m) No
 (3). C (4). 36, 43
 (5). 34, 36
 (6). 6
 (7). 6, 2, 4
 (8). B (9). C (10). D
 (11). A (12). C (13). C
 (14). B

3. Valence Bond Theory in Complex Compounds

- (1).
 (a) Weak
 (b) Weak, Strong with Cu^{2+} & Co^{3+}
 (c) Weak
 (d) Strong (e) Strong (f) Strong
 (g) Strong (h) Weak (i) Strong
 (2). $\text{C} > \text{N} > \text{O} > \text{X}$
 (3).
 (a) $[\text{Ar}]3d^6, d^2sp^3$, Octahedral
 (b) $[\text{Ar}]3d^6, d^2sp^3$, Octahedral
 (c) $[\text{Ar}]3d^7, sp^3d^2$, Octahedral
 (d) $[\text{Ar}]3d^8, dsp^3$, Trigonal Pyramidal
 (e) $[\text{Ar}]3d^4, sp^3d^2$, Octahedral
 (f) $[\text{Ne}]$, sp^3d^2 , Octahedral
 (g) $[\text{Xe}]5d^8, dsp^2$, Square Planar
 (h) $[\text{Ar}]3d^6, d^2sp^3$, Octahedral
 (i) $[\text{Ar}]3d^6, sp^3d^2$, Octahedral

- (j) $[\text{Ar}]3d^6, d^2sp^3$, Octahedral
 (4).
 (1) Tetrahedral & Square Planar
 (2) sp^3 & dsp^2
 (3) Paramagnetic, Diamagnetic
 (4) 2.828 B.M. & 0
 (5). C (6). A (7). C
 (8). C
 (9). A
 (10). D (11). B (12). C
 (13). C (14). C (15). B
 (16). A
 (17). $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3, [\text{Cr}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2, \text{H}_2\text{O}$
 $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl}, 2\text{H}_2\text{O}$
 (18). $[\text{Cr}(\text{NH}_3)_4\text{BrCl}]\text{Cl}, d^2sp^3$
 $[\text{Cr}(\text{NH}_3)_4\text{Cl}_2]\text{Br}, d^2sp^3, 3.87 \text{ B.M.}$
 (19). B (20). C (21). C
 (22). +2, dsp^2 , diamagnetic
 (23). A (24). D

4. VBT & CFT in Complex Compounds

- (1). A (2). A (3). B
 (4). C (5). A (6). B
 (7). C (8). B (9). A
 (10). B (11). B (12). B
 (13). B (14). D (15). D
 (16). D (17). B
 (18). See the Notes
 (19). A
 (20). $18000 \text{ cm}^{-1}, 215.07 \text{ KJ/mol}$
 (21). B

5. Isomerism in Complex Compounds

- (1). C (2). D (3). A, B, C
 (4). A (5). C (6). D
 (7). D (8). C (9). B
 (10). D (11). D (12). D
 (13). B (14). C (15). B
 (16). A
 (17). SUBJ.
 (18). C (19). B, D

6. Stereoisomers in Complex Compounds

- (1). B (2). C (3). D

- (4). B (5). B (6). D
(7). B (8). C (9). B
(10). D (11). B (12). C
(13). D (14). B (15). C
(16). A (17). D
(18). SUBJ.
(19). SUBJ.
(20). C

7. Organometallic Compounds

- (1). A (2). C (3). C
(4). D (5). B (6). C
(7). D (8). A (9). A
(10). D (11). B (12). A
(13). B (14). D (15). C

8. Stability & Use of Complex Compounds

- (1). B (2). C (3). C
(4). C (5). D (6). D
(7). B (8). C (9). A
(10). B (11). B (12). A
(13). C