CHAPTER 5

Coordination Compounds

1. NOMENCLATURE & ISOMERISM OF COORDINATION COMPOUNDS

Objective Qs [1 mark]

1. The formula of the complex dichloridobis (ethane-1, 2-diamine) platinum (IV) nitrate is:

   (a) $[PtCl_2(en)_2(NO_3)_2]$

   (b) $[PtCl_2(en)_2](NO_3)_2$

   (c) $[PtCl_2(en)_2(NO_3)]NO_3$

   (d) $[Pt(en)_2(NO_3)_2]Cl_2$

   [CBSE 2023]

2. What is the secondary valency of Cobalt in $[(Co(en_2)Cl_2]^+$?
   (a) 6
   (b) 4
   (c) 2
   (d) 8

   [CBSE 2023]

3. The number of ions formed on dissolving one molecule of $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$ in water is:
   (a) 3
   (b) 4
   (c) 5

   (d) 6 [CBSE SQP 2022]

4. One mole of $CrCl_3 \cdot 6H_2O$ compound reacts with excess $AgNO_3$ solution to yield two moles of $AgCl_{(s)}$. The structural formula of the compound is:

   (a) $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$

   (b) $[Cr(H_2O)_5Cl_3] \cdot 3H_2 \cdot O$

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

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

   [CBSE 2020]

5. The coordination number of Co in the complex $[Co(en)_3]^{3+}$ is:
   (a) 3
   (b) 6
   (c) 4
   (d) 5

   [CBSE 2020]

6. The oxidation number of Ni in $[Ni(CO)_4]$ is:
   (a) 0
   (b) 2
   (c) 3
   (d) 4

   [CBSE 2020]

7. Predict the number of ions produced per formula unit in an aqueous solution of $[Co(en)_3]Cl_3$:
   (a) 4
   (b) 3
   (c) 6
   (d) 2

   [CBSE 2019]

8. Ambidentate ligands like NO_2^- and SCN^- are:

   (a) unidentate

   (b) didentate

   (c) polydentate

   (d) has variable denticity

   [CBSE SQP 2019]

   In the following question (Q. No. 9-10) a statement of assertion (A) followed by a statement of reason (R) is given. Choose the correct answer out of the following choices.

   (a) Both (A) and (R) are true and R is the correct explanation of A.

   (b) Both (A) and (R) are true and R is not the correct explanation of A.

   (c) (A) is true but (R) is false.

   (d) (A) is false but (R) is true.

9. Assertion (A): $[Pt(en)_2Cl_2]^{2+}$ complex is less stable than $[Pt(NH_3)_4Cl_2]^{2+}$ complex.
   Reason (R): $[Pt(en)_2Cl_2]^{2+}$ complex shows chelate effect.

[CBSE 2020]

10. Assertion (A): Linkage isomerism arises in coordination compounds because of ambidentate ligand.

    Reason (R): Ambidentate ligand like NO_2 has two different donor atoms i.e., N and O.

    [CBSE 2020]

Very Short & Short Qs [1 - 3 marks]

11. (A) Write the formula for the following coordination compound Bis(ethane-1, 2-diamine) dihydroxidochromium(III) chloride.

    (B) Does ionization isomer for the following compound exist? Justify your answer. $Hg[Co(SCN)_4]$

    (C) Is the central metal atom in coordination complexes a Lewis acid or a Lewis base? Explain.

    [CBSE SQP 2023]

12. Write the IUPAC names of the following:

    (A) $[Co(NH_3)_5(ONO)]^{2+}$

    (B) $K_2[NiCl_4]$

    OR

    (A) What is a chelate complex? Give one example.

    (B) What are heteroleptic complexes? Give one example.

    [CBSE 2023]

13. The formula $Co(NH_3)_5CO_3Cl$ could represent a carbonate or a chloride. Write the structures and names of possible isomers.

    [CBSE SQP 2022]

14. (A) Write the IUPAC name of:

    $[Co(NH_3)Cl(en)_2]^{2+}$.

    (B) Discuss bonding, geometry and magnetic property of $[Ni(CN)_4]^{2-}$.

    [Delhi Gov. SQP Term-2 2022]

15. Explain the following giving examples:

    (A) Ambidentate ligand

    (B) Coordination number

(C) Chelate complex

[Delhi Gov. SQP Term-2 2022]

16. Give the formulae of the following compounds:

(A) Potassium tetrahydroxidozincate (II)

(B) Hexaammineplatinum (IV) chloride

[CBSE 2020]

17. What is the difference between a complex and a double salt?

[CBSE 2019]

18. Using IUPAC norms write the formulae for the following:

(A) Pentaamminenitrito-o-cobalt (III) chloride

(B) Potassium tetracyanidonickelate (II)

[CBSE 2019]

19. Write IUPAC name of the complex $[Cr(NH_3)_4Cl_2]^+$. Draw structures of geometrical isomers for this complexes.

[CBSE 2019]

20. Write the coordination number and oxidation state of Platinum in the complex $[Pt(en)_2Cl_2]$.

[CBSE 2018]

21. Write the formula of the following coordination compound:

Iron (III) hexacyano ferrate (II)

[CBSE 2018]

22. Write the IUPAC name of the following complex:

$[Cr(NH_3)_3Cl_3]$

[CBSE 2018]

23. What type of isomerism is exhibited by the complex $[Co(NH_3)_5Cl]SO_4$?

[CBSE 2018]

24. What type of isomerism is shown by the complex $[Co(en)_3Cl_3]$?

[CBSE 2017]

25. What type of isomerism is shown by the complex $[Co(NH_3)_5(SCN)]^{2+}$?

[CBSE 2017]

26. Write the IUPAC name of the following complex:
$[Co(NH_3)_5(CO_3)]Cl$.

[CBSE 2017]

27. What type of isomerism is shown by the complex $[Co(NH_3)_6][Cr(CN)_6]$?
[CBSE 2017]

28. Using IUPAC norms write the formulae for the following:
(A) Sodium dicyanidoaurate (I)

(B) Tetraamminechloridonitrito-N-platinum (IV) sulphate

[CBSE 2017]

29. Using IUPAC norms write the formulas for the following:
(A) Tris (ethane- 1, 2, diamine) chromium (III) chloride

(B) Potassium tetrahydroxozincate (II)

[CBSE 2017]

30. When a coordination compound $CoCl_3.6NH_3$ is mixed with $AgNO_3$, 3 moles of $AgCl$ are precipitated per mole of the compound. Write structural formula of the complex.
[CBSE 2016]

31. Draw one of the geometrical isomers of the complex $[Pt(en)_2Cl_2]^{2+}$ which is optically active.
[CBSE 2016]

32. (A) Write down the IUPAC name of the following complex:
$[Cr(NH_3)_2Cl_2(en)]Cl$ (en = ethylene-diamine)

(B) Write the formula for the following complex:

Pentaamminenitrito-o-cobalt (III)

[CBSE 2015]

33. (A) Write down the IUPAC name of the following complex: $[Cr(en)_3]Cl_3$
(B) Write the formula for the following complex:

Potassium trioxalatochromate (III)

[CBSE 2015]

34. Write the IUPAC name of the following:

(A) $[Co(NH_3)_6]Cl_3$

(B) $[NiCl_4]^{2-}$

(C) $K_3[Fe(CN)_6]$

[CBSE 2015]

35. Which of the following is more stable complex and why?

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

[CBSE 2014]

36. What type of isomerism is exhibited by the complex $[Co(NH_3)_5(NO_2)]^{2+}$?

[CBSE 2014]

37. Write the IUPAC name and draw the structure of each of the following complex entities:

(A) $[Co(ox)_3]^{-3}$

(B) $[Cr(CO)_6]$

(C) $[PtCl_3(C_2H_4)]^-$

(At. nos. $Cr = 24, Co = 27, Pt = 78$)

[CBSE 2014]

2. BONDING IN COORDINATION COMPOUNDS

Objective Qs [1 mark]

38. The CFSE for octahedral $[CoCl_6]^{4-}$ is 18,000 cm^{-1}. The CFSE for tetrahedral $[CoCl_4]^{2-}$ will be:

(a) 18,000 cm^{-1}

(b) 16,000 cm^{-1}

(c) 8,000 cm^{-1}

(d) 20,000 cm^{-1}

[CBSE SQP 2022]

39. The crystal field splitting energy for octahedral (Δ_0) and tetrahedral (Δ_t) complexes are related as:
(a) $\Delta_t = \frac{4}{9}\Delta_0$
(b) $\Delta_t = \frac{1}{2}\Delta_0$
(c) $\Delta_0 = 2\Delta_t$
(d) $\Delta_0 = \frac{4}{9}\Delta_t$

[CBSE 2020]

Case Based CBQ [4 - 5 marks]

Read the following passage and answer the questions that follow:

40. Crystal field splitting by various ligands

Metal complexes show different colours due to d-d transitions. The complex absorbs light of specific wavelength to promote the electron from t_{2g} to e_g level. The colour of the complex is due to the transmitted light, which is complementary of the colour absorbed.

The wave number of light absorbed by different complexes of Cr ion are given below:

Complex	Wavenumber of light absorbed (cm^{-1})	Energy of light absorbed (kJ/mol)
$[CrA_6]^{3-}$	13640	163
$[CrB_6]^{3+}$	17830	213
$[CrC_6]^{3+}$	21680	259
$[CrD_6]^{3-}$	26280	314

Answer the following questions:

(A) Out of the ligands " X ", " Y ", " Z " and " W ", which ligand causes maximum crystal field splitting? Why? [1]

OR

Which of the two, " W " or " W " will be a weak field ligand? Why?

(B) Which of the complexes will be violet in colour? $[CrA_6]^{3-}$ or $[CrB_6]^{3+}$ and why? (Given: If $560 - 570$ nm of light is absorbed, the colour of the complex observed is violet.) [1]

(C) If the ligands attached to Cr^{3+} ion in the complexes given in the table above are water, cyanide ion, chloride ion, and ammonia (not in this order)

Identify the ligand, write the formula and IUPAC name of the following:
(i) $[CrA_6]^{3-}$
(ii) $[CrC_6]^{3+}$

[CBSE SQP 2023]

Very Short & Short Qs [1-3 marks]

41. In a coordination entity, the electronic configuration of the central metal ion is $t_{2\,g}^3 e_g^1$.

(A) Is the coordination compound a high spin or low spin complex?

(B) Draw the crystal field splitting diagram for the above complex.

[CBSE SQP Term-2 2022]

42. Answer the following questions:

(A) $[Ni(H_2O)_6]^{2+}{}_{(aq)}$ is green in colour whereas $[Ni(H_2O)_4(en)]^{2+}{}_{(aq)}$ is blue in colour. Give reason in support of your answer.

(B) Write the formula and hybridization of the following compound: tris(ethane-1,2-diamine) cobalt(III) sulphate

[CBSE SQP Term-2 2022]

43. Using Valence Bond Theory, explain the following in relation to the paramagnetic complex $[Mn(CN)_6]^{3-}$:

(A) Type of hybridisation

(B) Magnetic moment value

(C) Type of complex.

[CBSE SQP 2022]

44. (A) Write the IUPAC name of the following complex: $K_2[PdCl_4]$

(B) Using crystal field theory, write the electronic configuration of d^5 ion, if $\Delta_0 > P$.

(C) What are Homoleptic complexes?

[CBSE Term-2 2022]

45. (A) Why chelate complexes are more stable than complexes with unidentate ligands?

    (B) What is "spectrochemical series"? What is the difference between a weak field ligand and a strong field ligand?

    [CBSE Term-2 2022]

46. (A) Write the IUPAC name of:

    $[Co(NH_3)Cl(en)_2]^{2+}$.

    (B) Discuss bonding, geometry and magnetic property of $[Ni(CN)_4]^{2-}$.

    [Delhi Gov. SQP Term-2 2022]

47. Write the IUPAC name and hybridisation of the complex $[CoF_6]^{3-}$

    [Given: Atomic number of $Co = 27$]

    [CBSE 2020]

48. Give the formula of each of the following coordination entities:
    (A) Co^{3+} ion is bound to one Cl^-, one NH_3 molecule and two bidentate ethylene diamine (en) molecules.

    (B) Ni^{2+} ion is bound to two water molecules and two oxalate ions.

    Write the name and magnetic behaviour is each of the above coordination entities.

    [At. nos. $Co = 27, Ni = 28$]

    [CBSE 2019]

49. Two complex is given as $[CoF_6]^{3-}$ and $[Co(C_2O_4)_3]^{3-}$, which one complex is:

    (A) diamagnetic

    (B) more stable

    (C) outer orbital complex and

    (D) low spin complex?

    [Atomic no. of $Co = 27$]

    [CBSE 2019]

50. Write the hybridisation and magnetic character of $[Co(C_2O_4)_3]^{3-}$.

    [At. No. of $Co = 27$]

[CBSE 2017]

51. Why a solution of $\left[\mathrm{Ni}^{(}(\mathrm{H_2O})_6\right]^{2+}$ is green while a solution of $[\mathrm{Ni(CN)_4}]^{2-}$ is colourless?

[CBSE 2017]

52. (A) Why is $[\mathrm{NiCl_4}]^{2-}$ paramagnetic while $[\mathrm{Ni(CN)_4}]^{2-}$ is diamagnetic?

[Atomic number of $\mathrm{Ni} = 28$]

(B) Why are low spin tetrahedral complex rarely observed?

[CBSE 2017]

53. For the complex $[\mathrm{Fe(H_2O)_6}]^{3+}$, write the hybridization, magnetic character and spin of the complex. [At. number of $\mathrm{Fe} = 26$]

[CBSE 2016]

54. Why is $[\mathrm{NiCl_4}]^{2-}$ is paramagnetic but $[\mathrm{Ni(CO)_4}]$ is diamagnetic?

[CBSE 2014]

55. Write the state of hybridisation, shape and IUPAC name of the complex $[\mathrm{Co(NH_3)_6}]^{3+}$. [Atomic no. of $\mathrm{Co} = 27$].

[CBSE 2014]

56. Write the state of hybridisation, shape and IUPAC name of the following complex:

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

[CBSE 2014]

57. Write the name, stereochemistry and magnetic behaviour of the following:

[At. nos. $\mathrm{Mn} = 25, \mathrm{Co} = 27, \mathrm{Ni} = 28$]

(A) $\mathrm{K_4[Mn(CN)_6]}$

(B) $\mathrm{[Co(NH_3)_5Cl]Cl_2}$

[CBSE 2014]