CHEMISTRY (CODE – 043)

Chapter-wise Test: Coordination Compounds

(NCERT Class XII Chemistry, Unit 5: Coordination Compounds)

PRACTICE QUESTION PAPER

CLASS XII (2026-27)

Time: 1½ hours **Max. Marks: 35**

GENERAL INSTRUCTIONS: Read the following instructions carefully.

1. There are 17 questions in this question paper with internal choice. All questions are based on Unit 5: Coordination Compounds.
2. SECTION A consists of 8 multiple-choice questions carrying 1 mark each.
3. SECTION B consists of 3 very short answer questions carrying 2 marks each.
4. SECTION C consists of 4 short answer questions carrying 3 marks each.
5. SECTION D consists of 1 case-based question carrying 4 marks.
6. SECTION E consists of 1 long answer question carrying 5 marks.
7. All questions are compulsory. Internal choice is provided in Questions 9 to 15, 16(iii) and 17.
8. Questions 2, 3, 9, 12, 13, 14 and 16 are based on figures, structures or data tables given in the paper.
9. Use of log tables and calculators is not allowed.

SECTION A

Questions 1 to 8 are multiple choice questions. Only one of the choices is correct. Select and write the correct choice as well as the answer to these questions. Each question carries 1 mark.

1 The correct IUPAC name of the complex $[Cr(NH_3)_3(H_2O)_3]Cl_3$ is: — 1

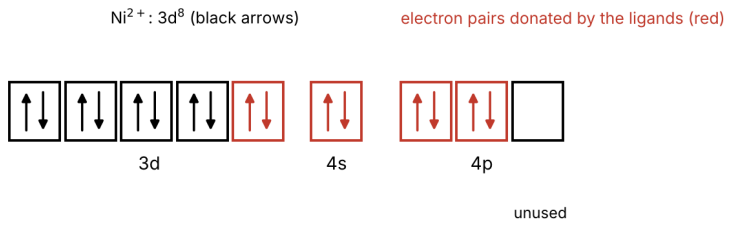
A. triaquatriamminechromium(III) chloride
B. triamminetriaquachromium(III) chloride
C. triamminetriaquachromium(III) trichloride
D. triamminetriaquachromium(0) chloride

2 The table gives the data obtained for the cobalt(III) chloride–ammonia complexes when excess $AgNO_3$ solution was added to one mole of each. — 1

Colour	Composition	Moles of AgCl precipitated
Yellow	$CoCl_3 \cdot 6NH_3$	3
Purple	$CoCl_3 \cdot 5NH_3$	2
Green	$CoCl_3 \cdot 4NH_3$	1

The correct formulation of the **purple** compound is:

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

3	Fig. 1 shows the distribution of electrons in the valence orbitals of the central metal ion in a complex. The electron pairs donated by the ligands are shown in red.  **Fig. 1** Fig. 1 represents the bonding in: A. $[Ni(CN)_4]^{2-}$ B. $[NiCl_4]^{2-}$ C. $[Ni(H_2O)_6]^{2+}$ D. $[Ni(CO)_4]$	1
4	The spin-only magnetic moment (in BM) of the complex ion $[CoF_6]^{3-}$ (atomic number of Co = 27; F^- is a weak field ligand; $\sqrt{24} = 4.90$) is: A. 0 B. 2.83 C. 4.90 D. 5.92	1
5	Which of the following is an ambidentate ligand? A. Ethane-1,2-diamine (en) B. Thiocyanate ion (SCN^-) C. Ammonia (NH_3) D. Oxalate ion ($C_2O_4^{2-}$)	1
6	In the spectrochemical series, the ligand that causes the **maximum** crystal field splitting among the following is: A. Cl^- B. H_2O C. NH_3 D. CN^-	1
7	Which of the following complexes can show **optical isomerism**? A. $[Co(en)_3]^{3+}$ B. $[Co(NH_3)_6]^{3+}$ C. $[PtCl_2(NH_3)_2]$ (square planar) D. $[Ni(CO)_4]$	1
8	**Assertion (A):** Tetrahedral complexes of metal ions are generally high spin complexes. **Reason (R):** For the same metal and ligand, the tetrahedral splitting Δ_t is greater than the octahedral splitting Δ_o. A. Both A and R are true and R is the correct explanation of A. B. Both A and R are true but R is not the correct explanation of A. C. A is true but R is false. D. A is false but R is true.	1

SECTION B

Question Nos. 9 to 11 are very short answer questions carrying 2 marks each.

9 **Attempt either A or B.** — 2

(A) The table gives the amount of AgCl precipitated when an excess of $AgNO_3$ solution was added to one mole of each compound (all are coordination compounds with coordination number 4 or 6).

Compound	Composition	Moles of AgCl precipitated
A	$PdCl_2 \cdot 4NH_3$	2
B	$CoCl_3 \cdot 4NH_3$	1
C	$PtCl_2 \cdot 2NH_3$	0

(i) Write the formula of the coordination entity for A, B and C.
(ii) Which one of them is a non-electrolyte?

OR

(B) Write the IUPAC names of (i) $[Pt(NH_3)_2Cl(NH_2CH_3)]Cl$ and (ii) $K_3[Fe(CN)_6]$.

10 **Attempt either A or B.** — 2

(A) Explain *ionisation isomerism* and *coordination isomerism* with one example each.

OR

(B) Differentiate between a double salt and a coordination compound, giving one example of each.

11 **Attempt either A or B.** — 2

(A) Calculate the spin-only magnetic moment of (i) $[NiCl_4]^{2-}$ (tetrahedral) and (ii) $[Ni(CN)_4]^{2-}$ (square planar). (Atomic number of Ni = 28; $\sqrt{8} = 2.83$)

OR

(B) Write the formula of (i) tetraammineaquachloridocobalt(III) chloride and (ii) potassium tetrahydroxidozincate(II).

SECTION C

Question Nos. 12 to 15 are short answer questions carrying 3 marks each.

12 **Attempt either A or B.** 1+1+1

(A) The table gives the wavelength of light absorbed by some complexes.

Complex	Wavelength absorbed (nm)	Colour of light absorbed
$[CoCl(NH_3)_5]^{2+}$	535	Yellow
$[Co(NH_3)_6]^{3+}$	475	Blue
$[Co(CN)_6]^{3-}$	310	Ultraviolet
$[Cu(H_2O)_4]^{2+}$	600	Red

(i) Arrange the three cobalt complexes in increasing order of the crystal field splitting Δ_o. Give the reason.
(ii) What is the colour of $[Cu(H_2O)_4]^{2+}$ as seen by the eye? Why?
(iii) Why is $[Co(CN)_6]^{3-}$ pale yellow although it is a d^6 complex?

OR

(B) (i) Anhydrous $CuSO_4$ is white whereas $CuSO_4 \cdot 5H_2O$ is blue. Explain.
(ii) The colour changes from green to violet as the ligand H_2O in $[Ni(H_2O)_6]^{2+}$ is replaced stepwise by ethane-1,2-diamine (en), finally giving $[Ni(en)_3]^{2+}$. Explain.
(iii) What is the spectrochemical series?

13 **Attempt either A or B.** 1+1+1

(A) Fig. 2 shows the splitting of the five d orbitals of a metal ion in an octahedral and in a tetrahedral crystal field. P, Q, R and S are the sets of d orbitals; Δ_1 and Δ_2 are the energy gaps.

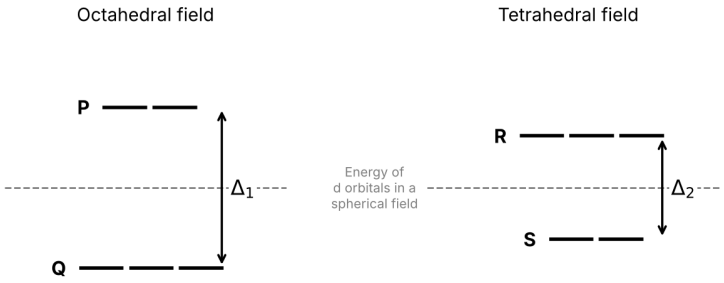
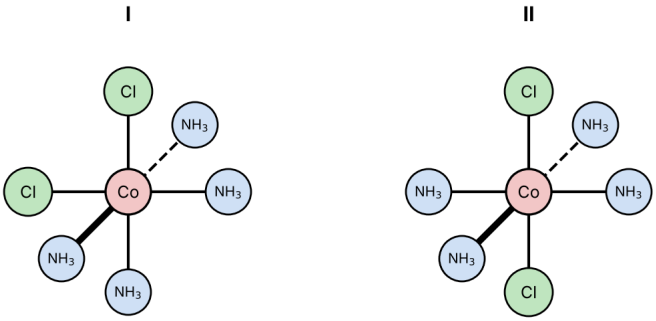


Fig. 2

(i) Name the sets of orbitals P, Q, R and S.
(ii) What is the relation between Δ_1 and Δ_2?
(iii) Why are tetrahedral complexes always high spin?

OR

(B) Using crystal field theory, write the electronic configuration of the d orbitals, the number of unpaired electrons and the magnetic behaviour of (i) $[Co(NH_3)_6]^{3+}$ ($\Delta_o > P$) and (ii) $[CoF_6]^{3-}$ ($\Delta_o < P$). Name the type of complex in each case.

14	**Attempt either A or B.** **(A)** Fig. 3 shows two isomers, I and II, of the complex ion $[CoCl_2(NH_3)_4]^+$.  **Fig. 3** (i) Name the type of isomerism shown. Which of the two is *cis* and which is *trans*? (ii) Which isomer has a net dipole moment? Give a reason. (iii) Do the isomers show optical isomerism? Give a reason. **OR** **(B)** (i) What is linkage isomerism? (ii) Give the formulas of a pair of linkage isomers of $[Co(NH_3)_5(NO_2)]Cl_2$. (iii) Name the ligand responsible and write its two donor atoms.	1+1+1
15	**Attempt either A or B.** **(A)** Explain the importance of coordination compounds in (i) the estimation of hardness of water, (ii) the extraction of gold, (iii) black and white photography. **OR** **(B)** (i) Explain the synergic bonding in metal carbonyls. (ii) Write the shapes of $Ni(CO)_4$, $Fe(CO)_5$ and $Cr(CO)_6$.	1+1+1

SECTION D

Question No. 16 is a case-based/data-based question carrying 4 marks.

16 **Valence bond theory and the shapes of complexes** 1+1+2

Valence bond theory (VBT) explains the geometry and the magnetic behaviour of coordination compounds in terms of the hybridisation of the metal orbitals. The table gives the data obtained for four complexes of nickel(II) and cobalt(III).

Complex	Hybridisation	Shape	Number of unpaired electrons
$[Ni(CN)_4]^{2-}$	dsp^2	Square planar	0
$[NiCl_4]^{2-}$	sp^3	Tetrahedral	2
$[Co(NH_3)_6]^{3+}$	d^2sp^3	Octahedral	0
$[CoF_6]^{3-}$	sp^3d^2	Octahedral	4

Answer the following questions ($\sqrt{8} = 2.83$, $\sqrt{24} = 4.90$, $\sqrt{3} = 1.73$):

(i) Calculate the spin-only magnetic moment of $[NiCl_4]^{2-}$ and $[CoF_6]^{3-}$.

(ii) Classify $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$ as inner orbital or outer orbital complexes. Give a reason.

(iii) **Attempt either A or B.**

(A) $[Ni(CO)_4]$ is tetrahedral and diamagnetic although nickel has the configuration $3d^84s^2$. Explain.

OR

(B) $[Fe(CN)_6]^{3-}$ is an inner orbital complex with a magnetic moment of 1.73 BM. Explain with the hybridisation involved.

SECTION E

Question No. 17 is a long answer question carrying 5 marks.

17 **Attempt either A or B.** 5

(A) (i) State the postulates of Werner's theory of coordination compounds (any three).

(ii) Two complexes have the formulas $[Co(NH_3)_5SO_4]Br$ and $[Co(NH_3)_5Br]SO_4$. Name the type of isomerism shown and describe a chemical test that distinguishes the two.

OR

(B) Define each of the following terms with one example:

(i) coordination entity

(ii) ligand

(iii) coordination number

(iv) coordination sphere

(v) homoleptic complex

— End of Question Paper —