2026

CHEMISTRY — HONOURS

Paper : DSCC-8

(Inorganic Chemistry - II)

Full Marks : 75

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer ***question nos.* 1, 2, 3 & 4 *(Compulsory)*** and ***any four*** questions from the rest.

1. Answer ***any ten*** questions : 2×10

(a) Assign the geometries for $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$.

(b) Write down the primary and secondary valencies of the metal in $[Co(NH_3)_5Cl]Cl_2$.

(c) Identify the spin-allowed and spin-forbidden transition between

(i) $t_{2g}^3 e_g^2 \rightarrow t_{2g}^2 e_g^3$

(ii) $t_{2g}^2 e_g^0 \rightarrow t_{2g}^1 e_g^1$.

(d) $Cr_2O_7^{2-}$ is reduced to Cr^{3+} in acid medium. Write down the half-cell equation and the corresponding Nernst equation.

(e) Write down the full name and formula of one redox indicator.

(f) Write down the IUPAC names of the compounds : $Na_2[Fe(CN)_5NO]$, $[Co(NH_3)_5N_3]Cl_2$.

(g) Which of the following complexes are expected to show Jahn-Teller distortion?

$[CrCl_6]^{4-}$, $[Co(CN)_6]^{3-}$, $[Fe(CN)_6]^{3-}$, $[Mn(H_2O)_6]^{2+}$.

(h) Write any two roles of sulphur-pi interaction in supramolecular chemistry.

(i) From the following Latimer diagram, identify the higher E^o-value between E_1^o and E_2^o

$$M^{2+}(aq.) \xrightarrow{E_1^o} M^{+}(aq.) \xrightarrow{E_2^o} M(s),$$

The reaction : $2M^+(aq.) \rightarrow M(s) + M^{2+}(aq.)$. Name the type of reaction.

(j) Give one example each of $\pi - \pi$ interaction and $\pi - \pi$ stacking interaction.

(k) Calculate the spin-only magnetic moment value of $[FeBr_4]^-$.

(l) Give one example of ambidentate ligand and draw the structures of its complexes showing ambidentate nature.

Please Turn Over

2. (a) Write short note on : Crystal Field Stabilization Energy (CFSE) based on the following points :

(i) Difference between CFSE and Crystal Field Splitting Energy.

(ii) Calculation of CFSE for low spin and high spin Fe^{2+} complexes.

(iii) Explanation of the fact that $[Fe(H_2O)_6]^{3+}$ has greater crystal field splitting energy than $[Fe(H_2O)_6]^{2+}$. 2+2+1

Or

(b) Write short note on spectrochemical series based on the following points :

(i) Definition

(ii) Explanation of the fact that position of H_2O in the series is higher compared to OH^-.

(iii) Arrangement of the following ions in increasing order of ligand field strength in the series : CN^-, NH_3, CO, F^-. 2+2+1

3. (a) Write short note on hydrogen bonding based on the following points :

(i) Definition of symmetrical and unsymmetrical hydrogen bonding.

(ii) Factors controlling hydrogen bond energy.

(iii) Comparison of boiling points of HF and H_2O. 1+2+2

Or

(b) Write short note on formal potential based on the following points :

(i) Definition.

(ii) Difference between standard electrode potential and formal potential.

(iii) Calculation of formal potential of MnO_4^-/Mn^{2+} system at pH = 3 and pH = 6. 1+1+3

4. (a) Write short note on octahedral site stabilisation energy (OSSE) based on the following points :

(i) Definition.

(ii) Calculation of the values for Co^{2+}(H.S.) and Ni^{2+}. 1+4

Or

(b) Write short note on Orgel diagram based on the following points :

(i) Construction of the diagram for Ni^{2+} (Oct. and Td complexes).

(ii) Assignments of electronic transitions.

(iii) Limitation.

5. (a) Define optical isomerism. Draw all possible stereoisomers of $[Pt(en)Cl_2Br_2]$. Among them, identify the optical isomers. (1+1)+(1+1)+1

(b) Define halogen bonding. "CF_3I is better candidate for halogen bonding compared to CH_3I" — Explain.

(c) Latimer diagram of silver in acid medium is

$$Ag^{2+} \xrightarrow{1.99\ V} Ag^{+} \xrightarrow{0.80\ V} Ag$$

Construct a Frost diagram of silver.

What does the diagram suggest? 4+3+3

6. (a) μ_{eff} value of Co^{2+}(H.S. oct.) is higher than Co^{2+}(Td) while that of Ni^{2+}(oct.) is lower than Ni^{2+}(Td). Justify.

(b) In 1(N) H_2SO_4 medium, calculate the redox potential values at the following three stages of titration of 0.1(N)Fe^{2+} with 0.1(N)$KMnO_4$

(i) 25 ml Fe^{2+} + 24.95 ml $KMnO_4$

(ii) 25 ml Fe^{2+} + 25 ml $KMnO_4$

(iii) 25 ml Fe^{2+} + 25.05 ml $KMnO_4$.

[Given : $E^{o}_{MnO_4^-/Mn^{2+}}$ =1.51 volt, $E^{o}_{Fe^{3+}/Fe^{2+}}$ =0.77 volt]

(c) "Pd(II) and Pt(II) from square-planar complexes exclusively but Ni(II) forms square-planar complexes under certain conditions"— Explain. 4+3+3

7. (a) Based on the following Latimer diagram

$$Sn^{4+} \xrightarrow{0.15\ V} Sn^{2+} \xrightarrow{-0.136\ V} Sn$$

answer the following :

(i) Calculate $E^{o}_{Sn^{4+}/Sn}$ value.

(ii) Comment on the ease of reduction of $Sn^{2+} \rightarrow Sn$ and $Sn^{4+} \rightarrow Sn$.

(b) Explain which one of each pair is comparatively more intense coloured :

(i) *cis*- and *trans*- $[Cr(H_2O)_4Cl_2]^+$

(ii) $[CoCl_4]^{2-}$ and $[Co(H_2O)_6]^{2+}$

(c) What is Chelate effect? Explain. 4+3+3

8. (a) What do you mean by non-covalent interactions? Mention their different types with one example in each case.

(b) Write down three limitations of valence bond theory in coordination chemistry.

(c) Arrange the followng in increasing order of energy for ligand to metal charge transfer bands and explain :

$[CoCl_4]^{2-}$, $[CoBr_4]^{2-}$, $[CoI_4]^{2-}$. 4+3+3

9. (a) "Metal ions having d^9 configuration preferably forms octahedral complexes, whereas d^{10} configuration preferebly forms tetrahedral complexes." Why?

(b) "KHF_2 exists but $KHCl_2$ does not." —Explain.

(c) "A solution of potassium ferricyanide cannot oxidise iodide to iodine but it can do so in presence of zinc ion"— Explain.

[Given : $E^{o}_{[Fe(CN)_6]^{3-}/[Fe(CN)_6]^{4-}} = 0.36$ volt, $E^{o}_{I_2/I^-} = 0.54$ volt at $25°C$]. 4+3+3

10. (a) Both the metal ions in $K_3[CuF_6]$ and $K[AgF_4]$ possess d^8 electronic configuration, but one is paramagnetic and the other is diamagnetic. Identify them with justification.

(b) 10 Dq for $[Mn(H_2O)_6]^{3+}$ is known from electronic spectrum as 21000 cm^{-1}. The pairing energy of Mn(II) is 28000 cm^{-1}. Predict whether the complex is high-spin or low-spin and also calculate the CFSE value.

(c) Cu^{2+} will oxidise I^- to I_2 during iodometric estimation of Cu^{2+}. Justify the statement from the relevant redox potential and solubility product values given below :

$E^{o}_{Cu^{2+}/Cu^{+}} = 0.15$ volt, $E^{o}_{I_2/2I^-} = 0.54$ volt, $K_{sp}(CuI) \sim 1\times10^{-12}$ at $25°C$. 4+3+3
