

2025

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** from the rest.1. Answer **any ten** questions :

2×10

- (a) Write two postulates of Werner's theory.
- (b) Identify the complex with larger 10Dq value and justify $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$ or $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$.
- (c) Name the origin of colour for the following compounds :
 $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ and KMnO_4 .
- (d) Give examples of one molecule each which shows hydrogen bonding and halogen bonding. Show their interactions.
- (e) MnO_4^- is reduced to Mn^{2+} in acid medium. Write down the half cell reaction and the corresponding Nernst equation at 25°C.
- (f) Find the potential at the equivalence point for the titration of Fe^{2+} with KMnO_4 in presence of 1(M) H_2SO_4 .

$$E_{\text{Fe}^{3+}/\text{Fe}^{2+}}^{\circ} = +0.77 \text{ V and } E_{\text{MnO}_4^-/\text{Mn}^{2+}}^{\circ} = +1.51 \text{ V}$$

- (g) Draw the crystal field splitting diagram of d^n configuration for square pyramidal geometry and label the d orbitals.
- (h) Predict the geometry of the following complex on the basis of its magnetic moment value –
 $[\text{MnBr}_4]^{2-}$ (5.90 BM)
- (i) Which force is responsible for the condensation of the inert gases into liquid? Find the order of liquefaction temperature of He, Ne and Ar.
- (j) Give one example each for disproportionation and comproportionation reaction.
- (k) Predict the hybridization involved in the complex $[\text{Fe}(\text{CN})_6]^{4-}$ and classify it as inner orbital or outer orbital complex according to VB theory.

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- (l) Give one example each for molecules showing antiferromagnetic and super exchange interactions.
2. (a) Write short note on the crystal field splitting pattern for Ni^{2+} based on the following points –
- Diagrams in octahedral, square planar and tetrahedral geometrics.
 - Preferences for ligands for tetrahedral and square planar geometrics. 3+2

Or

- (b) Write short note on selection rules for electronic spectral transitions based on the following points :
- Selection rules and ways of relaxation of any one selection rule.
 - Justification of the observation that *cis*- $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$ is more intensely coloured than its trans-isomer. 3+2
3. (a) Write short note on Π -interaction based on the following points :
- Cation – Π
 - Anion – Π
 - Edge to face and face to face $\Pi - \Pi$
 - NH – Π . 1+1+2+1

Or

- (b) Write short note on Redox titrations and Redox indicators based on the following points :
- Indicator range and conditions for a suitable redox indicator
 - Explanation of the fact that addition of H_3PO_4 or F^- ion is essential in the titration of Fe^{2+} by $\text{K}_2\text{Cr}_2\text{O}_7$ in acid medium using BDS as redox indicator.

$$\left[E^\circ_{\text{Cr}_2\text{O}_7^{2-}/2\text{Cr}^{3+}} = 1.33\text{V}, E^\circ_{\text{Fe}^{3+}/\text{Fe}^{2+}} = 0.77\text{V}, E^\circ_{\text{Ind(ox)}/\text{Ind(red)}} = 0.76\text{V} \right] \quad 2+3$$

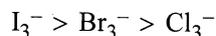
4. (a) Write short note on Jahn Teller distortion based on the following points :
- Statement
 - Conditions for distortion in octahedral complexes
 - Types of distortion with examples. 1+1+3

Or

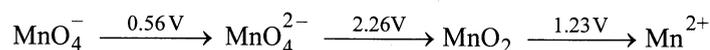
- (b) Write short note on spin only moments of d^n ions and their correlation with μ_{eff} based on the following points :
- Expression of $\mu_{\text{spin only}}$.
 - Causes of deviation of μ_{eff} from $\mu_{\text{spin only}}$.
 - Comparison of μ_{eff} values of Co^{2+} (HS, Oct) and Co^{2+} (Td) complexes. 1+1+3

5. (a) Define geometrical isomerism. sketch all the possible isomers of $[\text{Co}(\text{NH}_3)_2(\text{py})_2\text{Cl}_2]^+$. Among them identify the pair of optical isomers.

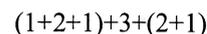
- (b) Justify the stability sequence of the following polyhalide ions :



- (c) Calculate the E° for reduction of MnO_4^- to Mn^{2+} in acid solution from the following Latimer diagram—

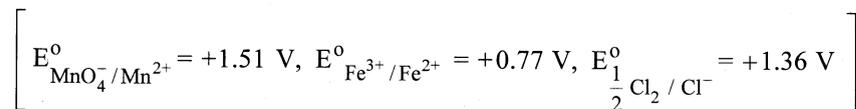


Identify the species that will undergo disproportionation.

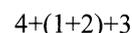


6. (a) Electronic absorption spectra of $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ exhibits bands at 8100, 16000 and 19400 cm^{-1} . Assign the bands to electronic transitions using Orgel diagram and calculate the 10 Dq value.

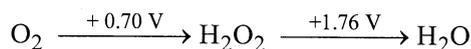
- (b) What is Zimmermann-Reinhardt solution? Why it is used in the titration of Fe^{2+} ion by KMnO_4 in presence of hydrochloric acid?



- (c) Both $[\text{Ni}(\text{CN})_4]^{2-}$ and $[\text{Ni}(\text{CO})_4]$ are diamagnetic but they have different geometries. — Explain.



7. (a) Predict the thermodynamic redox stability of H_2O_2 and construct the Fröst diagram from the following data :



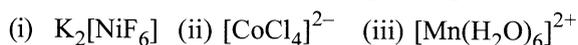
- (b) The electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ shows a peak at 490 nm and a broad shoulder at 580 nm. Assign the transitions and explain the reason for the appearance of the shoulder.

- (c) Give IUPAC name for $[\text{Co}(\text{en})_2(\text{CO}_3)]\text{Cl}$ and write the formula of $[\mu\text{-oxo-bis pentaammine-chromium(III)}]\text{chloride}$.

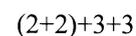


8. (a) What do you mean by ion-dipole and dipole-induced dipole interactions? Explain with suitable examples.

- (b) Calculate the CFSE for the complexes given below :



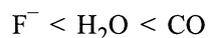
- (c) Wavelength of LMCT transition bands for isoelectronic ions runs in the sequence :



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9. (a) The order of ligand field strength in the spectrochemical series is :



Explain the order on the basis of M.O. approach.

- (b) Which non-covalent interaction is strongest : hydrogen bonding, van der Waals forces or ionic interactions? Justify.
- (c) Explain how does the formal potential affect the oxidation of potassium iodide to iodine by cupric ion.

$$\left(E_{Cu^{2+}/Cu^+}^{\circ} = 0.15 \text{ V}, E_{\frac{1}{2}I_2/I^-}^{\circ} = 0.54 \text{ V} \right)$$

4+3+3

10. (a) What do you mean by charge transfer transition? Write down the conditions for different kinds of the transitions.
- (b) Calculate the OSSE value for Ni(II) ion. State the significance of the result.
- (c) Fe(III) cannot be estimated iodometrically with high accuracy. Justify this statement.

$$\left[E_{Fe^{3+}/Fe^{2+}}^{\circ} = 0.77 \text{ V}, E_{\frac{1}{2}I_2/I^-}^{\circ} = 0.54 \text{ V} \right]$$

4+3+3