2026

CHEMISTRY — HONOURS

Paper : DSCC-15

(Inorganic Chemistry - IV)

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 (***question nos.* 5-10**).

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

(a) Identify the first-row transition metal for the following 18-electron species :

$[(\eta^5 - C_5H_5)M(CO)_3]_2$ (assume single M – M bond)

(b) Name one 'essential' and one 'beneficial' elements in living system.

(c) Write down any two factors on which associative mechanism depend in ligand substitution reaction.

(d) Mention any two organometallic complexes which do not obey $18e^-$ rule.

(e) Write one advantage and one disadvantage of homogeneous catalysis over heterogeneous one.

(f) Write down the order of σ-donor and π-acceptor behaviour of CO, NO^+ and CN^-.

(g) Give examples of one triply bridging and one semi-bridging metal carbonyl complexes.

(h) What happens when Fe(II) of haemoglobin is oxidised to Fe(III)?

(i) Give one example of inert and one example of labile complexes.

(j) Name the active catalyst involved in Ziegler-Natta polymerization process. Write one advantage of the Ziegler-Natta catalyst in polymer production.

(k) The compound, $[W(CO)_2(\eta^x - C_5H_5)(\eta^y - C_5H_5)]$ obeys 18-electron rule. Find x and y.

(l) Mention the biological role of Zn^{2+} and Mg^{2+} (one in each case).

2. Write a short note on :

(a) Zeise's Salt based on the following points :

(i) Structure

(ii) Bonding. 2+3

Or

(b) Oxidative addition based on the following points :

(i) Definition and example.

(ii) Characteristic features. (1+1)+3

3. Write a short note on :

(a) Ferrocene based on the following points :

(i) Structure and IUPAC name

(ii) Monoacetylation reaction

(iii) Metallation reaction. (1+1)+(1½+1½)

Or

(b) 4Fe – 4S ferredoxin based on the following points :

(i) Cubane unit structure

(ii) Magnetic properties in the oxidized and the reduced forms. 2+(1½+1½)

4. Write a short note on :

(a) Wilkinson's catalyst based on the following points :

(i) Chemical formula and use.

(ii) Catalytic cycle taking one compound of your choice. (1+1)+3

Or

(b) Trans effect based on the following points :

(i) Definition.

(ii) Difference with trans-influence.

(iii) Comparison of the effect between I^- and Cl^-. 1+2+2

5. (a) What are the different modes of binding of CO in polynuclear metal carbonyls? How are these differentiated experimentally?

(b) Explain the term 'Bohr effect' in connection to release of O_2 from haemoglobin.

(c) Fe^{3+} (aq) reacts rapidly with EDTA at room temperature while Cr^{3+} (aq) reacts slowly. Comment. 4+3+3

6. (a) Discuss the active site structure and functions of Hemerythrin emphasizing the role(s) of metal ion(s) therein.

(b) Compare the acidity of the following compounds : $H_2Fe(CO)_4$, $HMn(CO)_5$ and $HCo(CO)_4$.

(c) $[Fe(H_2O)_5NO]^{2+}$ shows N-O stretching frequency 1748 cm^{-1} and $\mu_{eff} = 3.92$ B.M. On this basis, how will you infer on the bonding character of NO? 4+3+3

7. (a) Arrange the ligands H_2O, NH_3, NO_2^- and Cl^- in order of increasing trans effect and hence design two step syntheses of the *cis*- and *trans*- isomers of $[Pt(NH_3)_2(NO_2)_2]$ starting from $K_2[PtCl_4]$.

(b) Explain the carbonyl stretching frequencies $[\bar{\nu}(CO), cm^{-1}]$ in the following compounds :

	$[Cr(CO)_6]$	$[Mo(CO)_6]$	$[W(CO)_6]$
$\bar{\nu}(CO), cm^{-1}$	2000	1984	1960

(c) Discuss the change in the active site structural features of haemoglobin during oxygen transport. 4+3+3

8. (a) Applying 18 e^- rule, find out the member of metal – metal bonds in

(i) $[Fe_4(CO)_{14}]$

(ii) $[(\eta^5 - C_5H_5)_2Fe_2(CO)_3]$.

(b) The V–C bond distances in $[V(CO)_6]^-$ and $[V(CO)_6]$ are 1.93 Å and 2.00 Å respectively. Justify.

(c) When the two isomers of $[Pt(NH_3)_2Cl_2]$ react with thiourea (tu), one product is $[Pt(tu)_4]^{2+}$ and the other is $[Pt(NH_3)_2(tu)_2]^{2+}$. Identify the initial isomers and explain the result. 4+3+3

9. (a) Which of the following complexes is expected to have a shorter Ru – N bond?

$[(\eta^3 - allyl)Ru(CO)_2NO]$, $[(\eta^5 - C_5H_5)Ru(CO)_2NO]$ Give reason(s).

(b) How many redox centres are present in cytochrome C oxidase? What are the metal ions present in the respective centres?

(c) Thermodynamically stable complexes are not always kinetically stable and vice versa. Justify with examples. 4+3+3

10. (a) Define insertion reaction. Explain with an example. Compare the reaction with oxidative addition.

(b) Haemoglobin shows cooperative effect but myoglobin does not. Justify.

(c) Predict whether the reaction between $[Co(NH_3)_6]^{3+}$ and $[Cr(H_2O)_6]^{2+}$ follows inner-sphere or outer-sphere mechanism. Explain your answer. 4+3+3
