

2026/FYUG/EVEN/SEM/
CHMDSC 252T/121

FYUG Even Semester Exam., 2026

CHEMISTRY
(4th Semester)

Paper Code : CHMDSC 252T

(Organometallic and Analytical Chemistry)

Full Marks : 70

Pass Marks : 28

Time : 3 hours

*The figures in the margin indicate full marks
for the questions.*

UNIT—I

1. Answer any *two* questions from the following : 2×2=4

(a) Define hapticity of a ligand. Give an example where the same ligand shows varying hapticities. 1+1=2

(b) Are all sandwich compounds metallocenes? Justify your answer with example. $\frac{1}{2}+1\frac{1}{2}=2$

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(Turn Over)



(2)

(c) Give one example of each of the following : $\frac{1}{2} \times 4 = 2$

- (i) Sigma bonded covalent organo-metallic compound
- (ii) π -complex
- (iii) Ionic organometallic compound
- (iv) Organometallic compound with bridging alkyl group

2. Answer any one question from the following : 10

(a) (i) What is EAN rule? Using $18e^-$ rule as a guide, find—

(1) the number of metal-metal bonds in $\text{Co}_4(\text{CO})_{12}$;

(2) the $3d$ metal in $[(\eta^6\text{-C}_6\text{H}_6) \text{M}(\text{C}_2\text{H}_4)_2]$;

(3) the number of metal-metal bonds in



$$1 + (1 \times 3) = 4$$

(ii) Draw the structures of ferrocene in solid and gaseous states. 2

(iii) Why is direct nitration of ferrocene not possible? How can you get the nitro derivative of ferrocene? 1+1=2

(iv) Why is CO a π -acid ligand? Through which atom does CO act as an electron pair donor and why? 1+1=2

(b) (i) Draw and explain the structure of Zeise's salt. How do you rationalize the increase in C—C bond length from 133.7 pm in ethene to 137.5 pm in Zeise's salt, accompanied by a decrease in C—C stretching frequency from 1623 cm^{-1} to 1526 cm^{-1} ? 2+3=5

(ii) What happens when ferrocene reacts with—

(1) HCHO and HNMe_2 in presence of base;

(2) acetyl chloride in excess in presence of aluminium chloride? 1+1=2

(iii) Give one example of a metal carbonyl which is thermally unstable. Write the limitations of EAN rule. 1+1=2

(iv) Explain aromaticity in ferrocene. 1

(Turn Over)

UNIT—II

3. Answer any *two* questions from the following : $2 \times 2 = 4$

- (a) What is meant by three-centre two-electron bonding? Why does multi-centre bonding occur in electron-deficient molecules? $1+1=2$
- (b) Why are metal-carbon bonds in metal alkyls highly reactive? How many Li-C interactions are present in the tetrameric structure of methyl lithium? $1+1=2$
- (c) Write the composition of Ziegler-Natta catalyst. Mention its use. $1+1=2$

4. Answer any *one* question from the following : 10

- (a) (i) What is the general formula of tri-alkylaluminium compounds? Draw its structure and explain how electron-deficiency influences its structure. $1+3=4$
- (ii) Discuss the factors affecting the position of Schlenk equilibrium. 3
- (iii) What type of polymer is formed in Ziegler-Natta catalysis? Mention its characteristics. Why do Ziegler-Natta catalysts produce such polymers? $1+1+1=3$

- (b) (i) What is Schlenk equilibrium?
Explain. Predict the effect of removing ether from Grignard solution. 2+1=3
- (ii) Write one method for the preparation of Ziegler-Natta catalyst. Discuss the mechanism of Ziegler-Natta catalysis. 1+3=4
- (iii) Discuss the structural features of methyl lithium. 2
- (iv) Write one limitation of Grignard reagent. 1

UNIT—III

5. Answer any *two* questions from the following : 2×2=4

- (a) Predict whether $[\text{Co}(\text{NH}_3)_6]^{3+}$ is labile or inert. Give reasons supporting your answer. 1+1=2
- (b) Define electrophilic ^{type} substitution reaction in octahedral complexes. Give a suitable example. 1+1=2
- (c) Define thermodynamic and kinetic stability of complexes.

6. Answer any one question from the following : 10

(a) (i) What is *trans*-effect? Explain *trans*-effect in the light of electrostatic polarization theory. 1+3=4

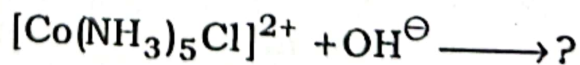
(ii) Discuss the mechanism and kinetics of nucleophilic substitution reaction in octahedral complexes. 4

(iii) Define transition state. What does a large activation energy indicate about a complex? 1+1=2

(b) (i) Use the *trans*-effect series to suggest synthetic routes to *cis*- and *trans*- $[\text{PtCl}_2(\text{NH}_3)_2]$ from $[\text{Pt}(\text{NH}_3)_4]^{2+}$ and $[\text{PtCl}_4]^{2-}$ respectively. 3

(ii) Discuss the factors which affect ligand exchange rates in octahedral complexes. 3

(iii) Predict the product and suggest a plausible mechanism for the following reaction : 3



(iv) What do you mean by aquation reactions? Give a suitable example. $\frac{1}{2} + \frac{1}{2} = 1$

UNIT—IV

7. Answer any *two* questions from the following : $2 \times 2 = 4$

(a) Draw the structure of Wilkinson catalyst. Mention the oxidation state and the coordination number of the central metal atom in Wilkinson catalyst. $1+1=2$

(b) What is synthesis gas? Write the equation for steam reforming. $1+1=2$

(c) What is meant by migratory insertion? Give a suitable example. $1+1=2$

8. Answer any *one* question from the following : 10

(a) (i) What is hydroformylation reaction? Explain the catalytic pathway involved in hydroformylation. $1+3=4$

(ii) Discuss the mechanistic pathway involved in the production of synthesis gas using metal carbonyl complexes. 4

(iii) Is catalytic hydrogenation of alkenes using Wilkinson catalyst a syn- or anti-addition? What happens to the oxidation state of metal after reductive elimination? $1+1=2$

- (b) (i) Outline the mechanism of homogeneous hydrogenation reaction using Wilkinson catalyst. Write two advantages of using Wilkinson catalyst in hydrogenation reaction. 3+1=4
- (ii) Write the limitations of cobalt catalyst mediated hydroformylation reaction. 2
- (iii) What is Fischer-Tropsch process? Explain a plausible mechanism for this process. 1+3=4

UNIT—V

9. Answer any *two* questions from the following : 2×2=4
- (a) Write the chemistry involved in the detection of PO_4^{3-} radical during qualitative analysis of a salt mixture.
- (b) When NaCl solution is added to a saturated AgCl solution, the precipitate increases. Explain.
- (c) Define solubility product. What is the effect of temperature on solubility product? 1+1=2

10. Answer any one question from the following : 10

- (a) (i) Explain how a buffer solution resists change in pH. 3
- (ii) What are interfering acid radicals? Discuss the cause of interference of some acid radicals in inorganic qualitative analysis. 1+2=3
- (iii) Account for the selective precipitation of Group-II cations when H_2S gas is passed through an acidified solution. 3
- (iv) The ionic product of AgCl in a solution is 2.0×10^{-10} while its K_{sp} is 1.8×10^{-10} . State whether AgCl precipitation will occur or not. 1
- (b) (i) Discuss, in detail, giving chemical reactions, the method used to detect and remove BO_3^{3-} radical from an inorganic salt mixture. 5
- (ii) Explain the role of group reagents in qualitative analysis. 2
- (iii) Why is sodium carbonate extract prepared for confirmatory tests of anions in qualitative analysis? Why is the extract acidified before adding any reagent? 2+1=3

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