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# CHE 529/CHE 530/CHE 531

## M.Sc. IV$^{th}$ SEMESTER EXAMINATION, 2024-25

## (CBCS MODE)

## CHEMISTRY



Time : Three Hours] [Maximum Marks : 75

## CHE 529

## Statistical Mechanics

**Note:** There are **three** sections, (**A, B** and **C**) and Candidate has to attempt questions from all sections. Marks are indicated against each section.

### Section–A

1. Answer all questions. 3×5=15

   (a) What are important features of micro canonical ensemble ?

   (b) What are Fermions and Bosons ?

   (c) What do you mean by partition function ?

   (d) What is Phase Space ?

   (e) Derive relation between heat capacity $C_V$ and the partition function.

### Section–B

**Note :** Answer all questions of the following. 4×5=20

2. (a) Derive equilibrium constant from partition function for dissociation equilibrium $Na_2 \rightleftharpoons 2Na$ .

   Or

   (b) Derive equation for vibrational partition function.

3. (a) Derive relation between internal energy and partition function.

Or

(b) What are the limits of applicability of various distribution laws ?

4. (a) Derive expression for rotational partition function for linear molecule.

Or

(b) Derive equilibrium constant from partition function for Ionisation equilibrium.

5. (a) Describe basic postulates for the calculation of average properties.

Or

(b) Explain Boltzmann distribution law.

## Section-C

**Note :** Answer any <u>two</u> questions of the following. 20×2=40

6. Explain Liouville's theorem in detail. Describe quantisation of phase space.

7. What is canonical ensemble partition function ? Derive relation between :
   (i) Third law and partition function
   (ii) Equilibrium constant and partition function.

8. Derive an expression for translational partition function for particle moving in a rectangular box. Show that the total partition function for a monoatomic gas is same as translational partition function.

9. Write short note on :
   (i) Fermi-Dirac statistics
   (ii) Bose-Einstein statistics

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## CHE 530
## Organo Transition Metal Chemistry

**Note:** There are **three** sections, (**A, B** and **C**) and Candidate has to attempt questions from all sections. Marks are indicated against each section.

### Section–A

1. Answer all questions of the following. 5×3=15

   (a) Classify Alkyls and Aryls of Transition metals on the basis of nature of ligands and on the basis of number of metals present.

   (b) Write the preparation of $\pi$ metal ethylene complexes.

   (c) Write the factors affecting the stability of transition-metal $\pi$ complexes.

   (d) Briefly explain structure and bonding in carbynes.

   (e) What are low valent carbenes ? Differentiate between Fischer type and Schrock type carbene.

### Section–B

**Note :** Answer <u>all</u> question of the following. 4×5=20

2. (a) Explain briefly oxo-reactions of alkenes.

   Or

   (b) Give a detail account of hydrogenation reactions of alkenes using $CO_2(CO)_8$ as catalyst.

3. (a) What is Tropsch Process ? Explain.

   Or

   (b) Explain briefly catalytic cycle of Wacker process.

4. (a) What is fluxionality and dynamic equilibria in compound $\eta^3$- allyl.

Or

(b) Give a detail account of structural characteristic of low valent carbenes.

5. (a) Explain MO approach of bonding in ferrocene and bis-(benzene) chromium.

Or

(b) Explain thermal stability and decomposition pathway of alkyl and aryls of transition metals.

## Section-C

**Note :** Answer any <u>two</u> questions of the following : 2×20=40

6. Explain preparation properties and structure of transition metal acetylenes complexes.

7. Give an detail account of ligand behaviour of $C_3Ph_3^+$, $C_7H_7^+$ and $C_8H_8{}^{2-}$ in different organometallic compounds.

8. What is Ziegler-Natta catalyst ? Give an account of polymerisation reaction of olifins using Ziegler – Natta catalyst.

9. Explain substitution reaction in metal carbonyls using $\sigma$-donor, $\sigma$-donor and $\pi$-acceptor and $\pi$-donor ligands.

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## CHE 531

## Select Topics in Organic Chemistry

**Note:** There are **three** sections, (**A**, **B** and **C**) and Candidate has to attempt questions from all sections. Marks are indicated against each section.

### Section–A

1. Answer all parts of the following : 3×5=15

(a) What is a protecting group ? Name any four protecting groups.

(b) What is spin multiplicity ? Determine the spin multiplicity of methyl free radical.

(c) Although tropolone processes both keto and hydroxyl group but does not give some well known keto and hydroxyl reactions. Explain.

(d) Given product and mechanism of the following reaction :

$$CH_3 - \overset{\overset{O}{\|}}{C} - CH_3 \xrightarrow{h\nu}$$

(e) Why electrophilic substitution reaction in pyrazole at position C-4 is more favourable?

## Section–B

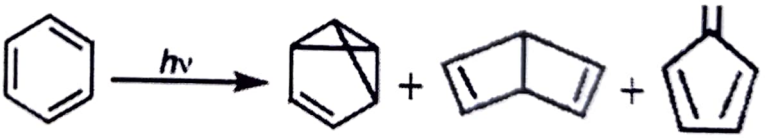
**Note** : Answer all question of the following. 5×4=20

2. (a) What are the criteria for aromaticity ? Select out aromatic, non-aromatic, anti-aromatic and homo-aromatic from the following with explanations :

Or

(b) Explain Norrish type-II reaction of carbonyl compounds with suitable examples.

3. (a) Irradiation of benzene yields a mixture of three products (A), (B) and (C) :




(A) (B) (C)

Propose a suitable mechanism for this transformation.

Or

(b) Give synthesis and importance of pyrimidine.

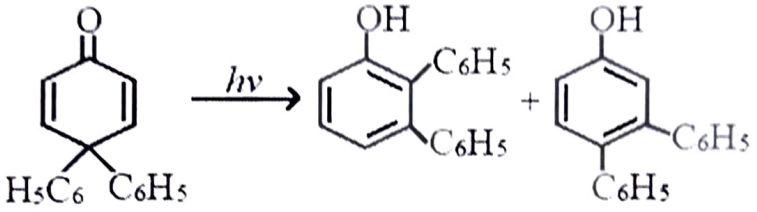
4. (a) Describe any one of the following terms :

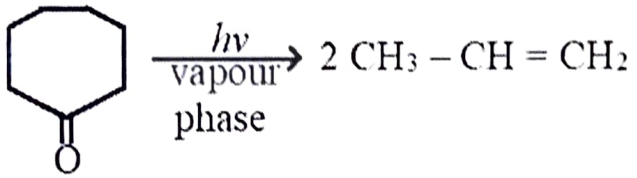
(i) Photo fries rearrangement

(ii) Alternant and non-alternant hydrocarbons

Or

(b) Rationalize the following transformation :

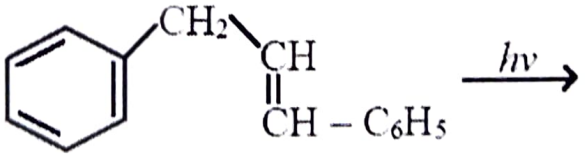
(i) 

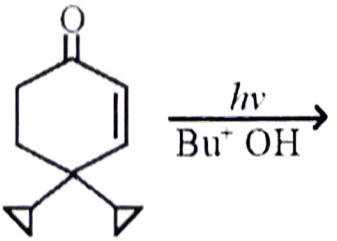

(ii) 


5. (a) Give two methods for the preparation of tropolone.

Or

(b) Give product and mechanism of the following reactions :

(i) 


(ii) 

## Section-C

**Note** : Answer any two questions of the following : 20×2=40

6. Describe two methods for the protection and deprotection of amine and alcohol with suitable examples.

7. Give two methods for the synthesis of Imidazole. Compare the electrophilic substitution of Imidazole and thiazole.

8. What is Paterno-Buchi reaction ? Discuss its mechanism along with its stereochemistry.

9. Write notes on any two of the following :

   (i) Di-Pi-methane rearrangement

   (ii) Photochemical cis/trans isomerization of alkenes

   (iii) Fullerene

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