

[This question paper contains 4 printed pages.]

**Your Roll No.....**

**Sr. No. of Question Paper : 2904**

**L**

Unique Paper Code : 2172514801

Name of the Paper : DSC: CATALYSIS, PHOTOCATALYSIS,  
APPLICATION OF REAGENTS IN ORGANIC  
SYNTHESIS AND STATISTICAL  
THERMODYNAMICS

Name of the Course : **B.Sc. (Prog) Physical Science**

Semester : VIII

Duration : 3 Hours

Maximum Marks : 90

**Instructions for Candidates**

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. This question paper comprises **three** sections, each carrying **30** marks :
  - Section A : Inorganic Chemistry
  - Section B : Organic Chemistry
  - Section C : Physical Chemistry
3. Attempt each section on a separate answer sheet, clearly marking the section **(A/B/C)** at the top of each sheet.
4. Attempt **six** questions in total, selecting **two** questions from each section.
5. Scientific calculator is allowed.

**SECTION – A**  
**(INORGANIC CHEMISTRY)**

1. (a) Explain the general principles of catalysis and discuss the properties of catalysts.  
(b) Write short notes any two of the following:
  - (i) Promoter
  - (ii) Turnover frequency
  - (iii) Turnover number

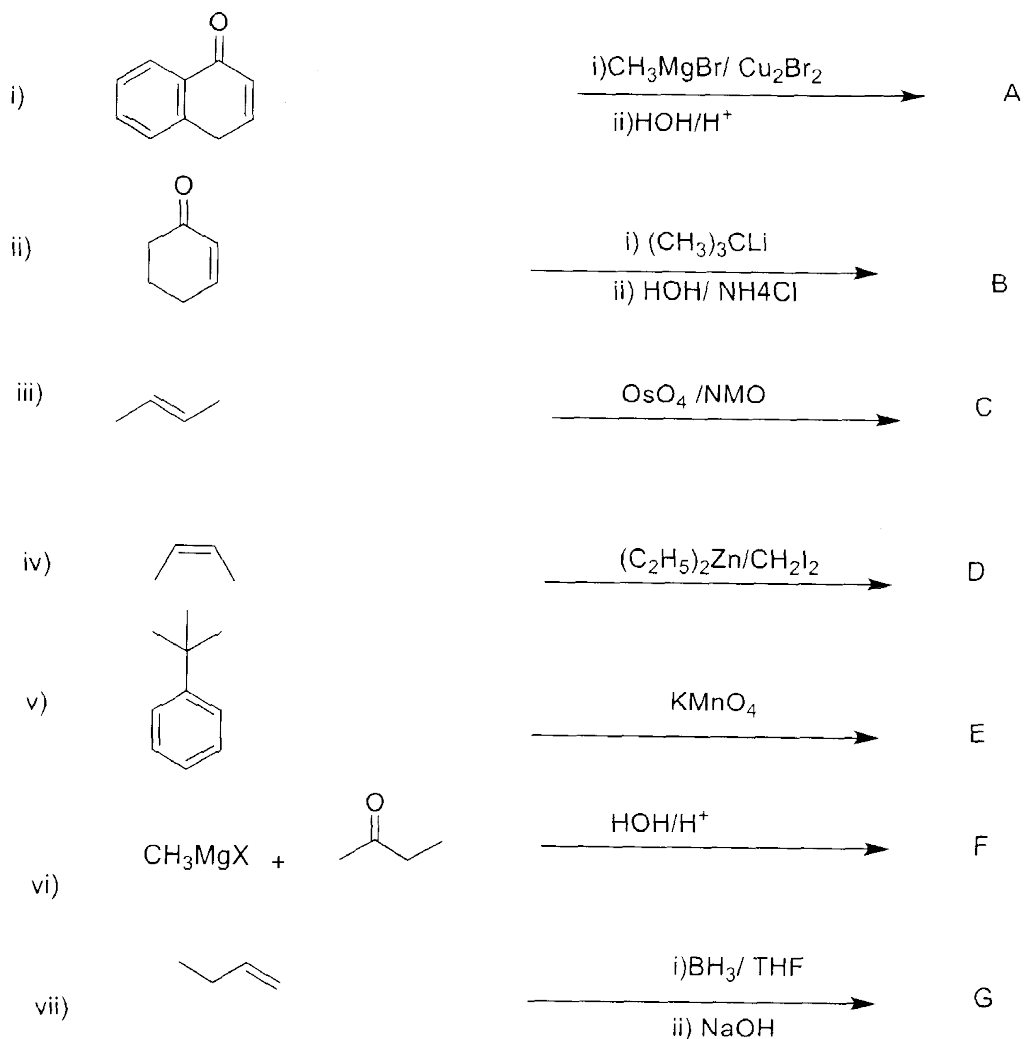
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- (c) What is band gap? Explain its significance in photocatalysis. (5,5,5)
2. (a) Explain the importance of catalysis in eco-friendly energy solutions.  
(b) Explain the catalytic cycle, and mechanism of alkene hydrogenation using Wilkinson's catalyst.  
(c) Explain the Wacker-Smith synthesis of aldehydes along with its catalytic cycle and mechanism.  
(d) Discuss the importance of UV-visible light filters in photocatalytic studies. (4,4,4,3)
3. (a) Discuss the role of photocatalysis in hydrogen production and CO<sub>2</sub> conversion.  
(b) Describe the polymerisation of ethene using Ziegler-Natta catalyst with suitable mechanism.  
(c) Differentiate between homogeneous and heterogeneous catalysis. (5,5,5)

**SECTION – B**  
**(ORGANIC CHEMISTRY)**

4. Write short notes on the following (**any five**) :
- (a) Discuss the synthesis and application of crown ethers.  
(b) Give the synthetic application of borane and alkylboranes in organic synthesis.  
(c) Discuss the following : KMNO<sub>4</sub> Oxidation ii) Barton Reaction. (5,5,5)
5. Write short notes on the following (**any five**) :
- (a) Tallium nitrate  
(b) Organo Zinc reagent  
(c) OsO<sub>4</sub>  
(d) PIDA  
(e) BuLi  
(f) Grignard reagent (3,3,3,3,3)

6. (a) Complete the following reactions (**any six**) : (1×1.5)



(b) Give the mechanism of the reactions : (**any two**)

(i)  $\text{SeO}_2$  (ii) DCC (iii) Lead acetate (3,3)

**SECTION – C**  
**(PHYSICAL CHEMISTRY)**

7. (a) Show that for a system of particles obeying Maxwell-Boltzmann Statistics, the most probable distribution is given by the expression:

$$n_i = \frac{g_i}{e^{-(\alpha + \beta \epsilon_i)}}$$

where symbols have their usual meaning.

- (b) Given a system of 5 weakly interacting distinguishable particles which can occupy any of the three energy levels of energy 0,  $\epsilon$  and  $2\epsilon$ . Let the total energy of the system be  $5\epsilon$ . Find out all possible macrostates and their corresponding number of microstates.
- (c) Starting from the definition of factorial, use an integral approximation to derive Stirling's formula for  $\ln N!$  (7,5,3)
8. (a) Using the quantum mechanical expression for the rotational energy of a diatomic molecule, derive the expression for the rotational partition function.
- (b) What are the assumptions of Conventional transition state theory? Show how equilibrium constant of a gas phase reaction can be expressed in terms of partition functions of the involved species.
- (c) What do you mean by an ensemble? Explain different types of ensembles. (7,5,3)
9. Attempt **ANY FIVE** of the followings :
- (a) The translational partition function of a molecule depends upon the dimensions of the container while rotational and vibrational partition functions do not. Comment.
- (b) Define the terms: macrostate, microstate and most probable macrostate.
- (c) Calculate the number of ways of arranging four bosons in seven available quantum states.
- (d) Differentiate between classical and quantum statistics.
- (e) In the activated complex theory, the number of degrees of freedom of the activated complex is always taken to be one less than that of the normal stable molecule of the same composition. Comment.
- (f) The partition function contains quantum mechanical as well as thermodynamic term. Comment.
- (g) The total partition function is multiplicative in nature. Justify.
- (h) What is the significance of Brownian dynamics in understanding microscopic systems? (3×5=15)