



LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – CHEMISTRY

SECOND SEMESTER – APRIL 2024

PCH2ME02 – SURFACE CHEMISTRY AND CATALYSIS

Date: 15-04-2024

Dept. No.

Max. : 100 Marks

Time: 01:00 PM - 04:00 PM

SECTION A – K1 (CO1)

Answer ALL the questions

(5 x 1 = 5)

1 Answer the following

- a) What is the catalyst used in hydroformylation?
- b) Write the Harkins-Jura equation.
- c) What are elastic gels?
- d) Define degrees of inhibition.
- e) What is the significance of the BET constant?

SECTION A – K2 (CO1)

Answer ALL the questions

(5 x 1 = 5)

2 Fill in the blanks

- a) Silver carbonate precipitated on celite is called _____.
- b) According to BET theory, the energy of adsorption in the first layer is _____.
- c) _____ part of the stearate ion is hydrophilic in nature.
- d) The bandgap of TiO_2 is _____.
- e) A Mercury porosimeter is used to measure _____.

SECTION B – K3 (CO2)

Answer any THREE of the following

(3 x 10 = 30)

- 3 Explain the thermodynamic interpretation of catalysis using the activated complex theory.
- 4
 - a) Explain the role of heterogeneous catalysts in Fischer-Tropsch process. (7)
 - b) Show that BET equation reduces to Langmuir isotherm when $p_0 \gg p$. (3)
- 5
 - a) Give the classification of surfactants with an example. (6)
 - b) Calculate the packing parameter of sodium dodecyl sulfate micelle in water if the aggregation number of SDS is 80. (4)
- 6
 - a) Outline the working of solar energy conversion devices and explain the storage. (5+5)
 - b) Consider an enzymatic reaction where the enzyme concentration was determined to be 3.0×10^{-4} M. When the substrate concentration was set to 160 μM , the initial rate of the reaction was found to be 65.0 $\mu\text{mol}/(\text{mL.s})$. Calculate the V_{max} and turnover number for the enzyme under these conditions.
- 7 How is pore size distribution calculated using Barrett-Joyner-Halenda?

SECTION C – K4 (CO3)

	Answer any TWO of the following	(2 x 12.5 = 25)
8	a) Discuss the general catalytic mechanism involving the Arrhenius intermediate. (10) b) The energy of activation for homogeneous decomposition of H_2O_2 into H_2O and O_2 is 18 kcal/mol. If the reaction is catalyzed by <i>catalase</i> , the energy of activation is 6 kcal/mol. Calculate the increase in the rate at 27 °C due to the catalyst. (2.5)	
9	a) How are heterogeneous catalysts prepared by precipitation and impregnation methods? (9) b) Calculate the surface excess of a solute per unit area at 25 °C, if the concentration of the solution is 10×10^{-2} mol and $(dy/dc)_T = 8.35 \text{ N m}^{-1} \text{ mol}^{-1}$. (3.5)	
10	a) Discuss the shape and structure of micelles in aqueous media. (8.5) b) How are total pore volume and average pore radius calculated? (4)	
11	a) What is a photocatalyst? Describe the mechanism of photocatalytic degradation of dyes using ZnO. (7.5) b) How will you modify the Michaelis-Menten equation to get a Lineweaver-Burk plot? (5)	

SECTION D – K5 (CO4)

	Answer any ONE of the following	(1 x 15 = 15)
12	a) Derive the Bronsted equations from the Hammett equation. (7.5) b) The adsorption of CH_4 on charcoal surface at 273K confirms the Langmuir isotherm. The slope and intercept of the graph between P/V and P are 0.02 g cm^{-3} and $2.05 \text{ torr cm}^{-3} \text{ g}$ respectively. Calculate the fraction of charcoal surface that is covered by CH_4 molecules at $P = 150 \text{ torr}$. (7.5)	
13	a) How is surfactant selected as emulsifying agents by phase inversion temperature method? b) Describe the construction and working of the Honda-Fujishima cell for the electrolysis of water. c) How is the specific surface area of solid adsorbents determined? (5+5+5)	

SECTION E – K6 (CO5)

	Answer any ONE of the following	(1 x 20 = 20)
14	a) Derive the equation of Hammett acidity function. (5) b) The pK_{BH^+} of the base, 4-chloro-2-nitroaniline, has been determined to be -3.30 . In 1M HClO_4 , the $\frac{[BH^+]}{[B]}$ data obtained for the bases 4-chloro-2-nitroaniline and 2,4-dinitroaniline are 7.94×10^{-4} and 4.47×10^{-5} , respectively. Calculate the pK_{BH^+} and H_0 of 2,4-dinitroaniline. (5) c) Deduce Gibbs adsorption isotherm for the adsorption of a solute on the surface of a liquid. (10)	
15	a) Explain the LCT mechanism for the formation of mesoporous materials. (5) b) Explain the kinetics of competitive enzyme inhibition. (5) c) How is X-ray photoelectron spectroscopy performed for chemical analysis? (10)	
