LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – **CHEMISTRY**

SECOND SEMESTER – **APRIL 2023**

PCH2ME02 – SURFACE CHEMISTRY AND CATALYSIS

Date: 10-05-2023 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 Fetizon's reagent?	
b)	Which type of adsorption isotherms explain the behaviour of capillary condensation of gas?	
c)	Write the chemical structure of one of the hydrophilic groups for amphoteric amphiphiles.	
d)	Define degrees of inhibition.	
e)	Write de Boer equation.	
	SECTION A – K2 (CO1)	
	Answer ALL the questions	**(5 x 1 = 5)**
2.	**Fill in the blanks**	
a)	In a homogeneous catalytic reaction, 1.0 M of a substrate in the presence of 1.0 μM of a catalyst yields 1.0 mM of a product in 10 s. The turnover frequency of the reaction is_____.	
b)	Adsorption is invariably accompanied by _____ in enthalpy of the system.	
c)	Micellar colloids represent _____ equilibria.	
d)	_____ is a measure of catalytic efficiency.	
e)	Mesopore size calculations are made assuming cylindrical pore geometry using the _____equation.	
	SECTION B – K3 (CO2)	
	Answer any THREE of the following	**(3 x 10 = 30)**
3.	How are kinetic theories used to interpret catalysis thermodynamically?	(10 Marks)
4.	Derive Brunauer – Emmett – Teller equation.	(10 Marks)
5.	Explain the theories used in identifying the type of an emulsion.	(10 Marks)
6.	a) Discuss the mechanism of photoelectrolysis of water using TiO_2. (5 Marks) b) Hexokinase catalyzes the reaction of D-glucose to D-glucose 6-phosphate. Under the conditions of pH 7 at 25°C and a hexokinase concentration of 3.0 nmol/mL, the K_M for Hexokinase for the substrate glucose was determined to be 3.0 x 10^{-4} M. When the glucose concentration was set to 160 μM, the initial rate of the reaction was found to be 65.0 μmol/(mL.s). Calculate V_{max} and turnover number for hexokinase under these conditions. (5 Marks)	
7.	How is pore size distribution calculated using Barrett-Joyner-Halenda?	(10 Marks)
	SECTION C – K4 (CO3)	
	Answer any TWO of the following	**(2 x 12.5 = 25)**
8.	a) Discuss the general catalytic mechanism involving Arrhenius intermediate. (9 Marks) b) The noncatalytic reaction occurs at 500 ºC and has an activation energy of 50 kJ/mol. By using a	

	catalyst, the activation energy can be reduced to 35 kJ/mol. What is the difference in the reaction rate at this temperature? (3.5 Marks)
9.	a) Explain the role of heterogeneous catalysts on the mechanism of Fischer-Tropsch process. (6 Marks) b) How are temperature and nature of the adsorbent influence the adsorption? (6.5 Marks)
10.	a) Mention the significances of Hydrophilic – Lipophilic Balance of a surfactants. (4 Marks) b) Explain the desirable properties of emulsifying agents. (8.5 Marks)
11.	a) Account for the importance of TiO_2 in degradation of dyes and isomerization reactions. (7.5 Marks) b) Explain the kinetics of noncompetitive enzyme inhibition. (5 Marks)
	SECTION D – K5 (CO4)
	Answer any ONE of the following **(1 x 15 = 15)**
12.	a) Derive the Bronsted equations from Hammett equation. (8 Marks) b) Differentiate chemisorption from physisorption. The time for which the oxygen atom remains adsorbed on a tungsten surface is 0.36 s at 2550 K and 3.49 s at 2360 K. Calculate the activation energy of desorption of oxygen atom and assume that the oxygen atom is tightly chemisorbed. Calculate the pre-exponential factor τ_0 in the Arrhenius expression. (7 Marks)
13.	a) How are mesoporous materials synthesized using liquid crystal template (LCT) mechanism? (8 Marks) b) How is the specific surface area of solid adsorbents determined? Write the significance of BET constant. (7 Marks)
	SECTION E – K6 (CO5)
	Answer any ONE of the following **(1 x 20 = 20)**
14.	a) Derive the equation of Hammett acidity function. (5 Marks) b) For a weak base, 2-nitroaniline B, in 0.02 M $HClO_4$, the ratio of $[BH^+]$ to [B] is found to be 0.01. Calculate i) the pK_{BH^+} for the 2-nitroanilinium ion and ii) the ratio of $[BH^+]$ to [B] in 0.05 M $HClO_4$ using the same indicator. (5 Marks) c) Derive thermodynamically Gibb's adsorption isotherm for the adsorption of a solute on the surface of a liquid. (10 Marks)
15.	a) Differentiate elastic gels from inelastic gels. (5 Marks) b) Compare reversible and irreversible enzyme inhibition. (5 Marks) c) Discuss the principle of XPS. How is an XPS spectrum analyzed? (10 Marks)

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