

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY  
DEPARTMENT OF APPLIED CHEMISTRY  
END OF SEMESTER EXAMINATIONS – DECEMBER 2001  
PHYSICAL CHEMISTRY FOR CHEMICAL ENGINEERS – SCH 1120  
TIME – (2 ½) TWO AND HALF HOURS

1220

INSTRUCTIONS TO CANDIDATES

Answer ALL questions from Section A and ANY THREE questions from Section B.

$$E_0 = 8.854 \times 10^{-12} \text{ J}^2 \text{ C}^2 \text{ m}^{-1}$$

$$N_A = 6.023 \times 10^{23}$$

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SECTION A

1. Calculate the polarisability volume of ethanol at the frequency corresponding to the Sodium D lines given that its refractive index is 1.360 at 20°C and its density is 0.789g/cm<sup>3</sup>. (6 marks)
2. Discuss entropy driven stabilization of micelle formation. (10 marks)
3. From the principle of light scattering, explain why the sky is blue during the day. (5 marks)
4. The molar conductivities at infinite dilution of aqueous CH<sub>3</sub>COONa, HCl and NaCl are 91.0, 425.0 and 128 S cm<sup>2</sup>mol<sup>-1</sup> respectively. What is the molar conductivity at infinite dilution of acetic acid? (5 marks)
5. (a) Compare and contrast *physisorption* and *chemisorption*. (5 marks)  
(b) What is an adsorption isotherm. (3 marks)
6. Define the symbols used in the BET isotherm.

$$\frac{P}{V_a} \frac{P^0}{P^0 - P} = \frac{1}{V_a^0} + \frac{P}{V_a^0 P^0}$$

And show that it reduces to the Langmuir Isotherm when  $P^0 \gg P$ . (6 marks)

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**SECTION B** (Answer Any Three Questions)

1. (a) Write concise notes on mobilities of ions and the Grotthus Mechanism. (12 marks)
- (b) What is the molar conductivity, the conductivity and the resistance (in the cell) of a 0.040M solution of acetic acid at 279K.  
 $\Lambda^{\circ}_M = 390.5 \text{ S cm}^2 \text{ mol}^{-1}$  (8 marks)

2. If the amount of nitrogen adsorbed on a mica film at 90K varies with pressure as given below:

$P_N/\text{atm}$	3.4	6.0	9.4	12.8	17.1	23.5	33.5
$V/\text{mm}^3$	13.4	19.0	23.9	25.5	28.2	30.8	33.0

Show that this data conform to a Langmuir Isotherm without dissociation and evaluate  $K_p$  and the amount of gas needed for a monolayer  $V_m$ . (20 marks)

3. (a) Define polarization and derive the equation for molar polarisability  $P_m$ . (12 marks)
- (b) Estimate the refractive index for ethanol for sodium D light ( $\rho = 0.789 \text{ g cm}^{-3}$ ). Use Table I for this equation. (8 marks)
4. (a) Evaluate the ionic strength of a solution which is  $0.2 \text{ mol kg}^{-1}$  NaCl and  $0.05 \text{ mol kg}^{-1}$   $\text{CuSO}_4$ . (5 marks)
- (b) What is the ionic strength and mean activity coefficient of a  $0.15 \text{ mol kg}^{-1}$  solution of  $\text{CaCl}_2$ ? (Debye-Huckel  $A = 0.509$ ) (10 marks)
- (c) State the functions affecting the Debye length  $r_D$  of an ion. (5 marks)

**END OF QUESTION PAPER!!!**

**TABLE I**

Molar refractivities at 589 $\mu\text{m}$ ,  $R_m/\text{cm}^3 \text{mol}^{-1}$

- C-H 1.65
- C-C 1.20
- C-O 1.41
- O-H 1.85