RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. Honours in Chemistry

Fourth Year – Semester II Examination – January / February 2023

CHE 4203 – SURFACE AND COLLOIDAL CHEMISTRY

Time: Two (2) hours

Answer all the questions

R = 8.314 J $K^{-1}mol^{-1}$ g = 9.8 m S^{-2} c = 3.0 x 10^8 m s^{-1} Boltzmann constant k = 1.381 x 10^{-23} J K^{-1}

1.

a) Elaborate the impact of temperature on the surface tension. (20 marks)

b) For a clean glass the contact angle of water is approximately zero. In a clean glass capillary tube with the diameter 0.40 diameter, water raised to 4.96 cm at 20 °C. Density of water at 20 °C is 998.2 kg m^{-3}. Calculate the surface tension of water at the same temperature. (20 marks)

c) Account for the reverse micelles. Discuss the potential applications of reverse micelles in drug delivery. (20 marks)

d) A needle weighing 1g is floated on water at 25 °C. Calculate the minimum length of the needle. Given that the surface tension of water at 25 °C is 72 mN m^{-1}. Assume the only acceleration act on the needle is the gravity. (20 marks)

2.

a) Obtain Gibb's adsorption isotherm for the system where Na_2SO_4 is dissolved in water. Given that the general expression of Gibb's adsorption isotherm as $d\gamma = -RT\ \Sigma\ \Gamma_i d(\ln a_i)$. (25 marks)

b) Explain how to use Langmuir trough method to estimate the cross-sectional area of a surfactant molecule. (25 marks)

c) A soap bubble holds excess pressure inside. Derive an equation for the excess pressure. Given that for a surface, $dG = -SdT + Vdp + \gamma dA + \Sigma\mu_i dn_i$. (25 marks)

d) Consider the two surfactant molecules $(C_2H_5)_2CHCH_2(OC_2H_4)_6OH$ and $(C_4H_9)_2CHCH_2(OC_2H_4)_6OH$. Discuss their effect on surface tension when the same amounts of each solute is dissolved in water. Which of the molecules would have higher CMC value? (25 marks)

3.

a) There are two immiscible liquids in a vessel, aquas solution (30 mL) and oil (500 mL).

i. Explain how to make a permanent dispersion out of these liquids.

ii. Describe a technique to identify the dispersion.

iii. What type of dye needed to be useed to colour the dispersion prepared above.

(30 marks)

b) Starting from

$$dU = TdS - pdV + \gamma dA + \Sigma \mu_i dn_i$$

derive general expression of Gibbs adsorption isotherm

$$d\gamma = -RT\ \Sigma\ \Gamma_i d(\ln a_i)$$ and identify all the terms. (34 marks)

c) Write short notes on

i. Foam

ii. Capillary active solutes

iii. Super cooling of a vapour (36 marks)

4.

a) Use the following data is given for the adsorption of CO on charcoal at 273 K.

P/ Nm^{-2}	13300	26700	40000	53300	66700	80000	933000
V/ cm^3	10.3	19.3	27.3	34.1	40.0	45.5	48.0

Langmuir adsorption isotherm is given below.

$\theta = \frac{Kp}{1+Kp}$ where $\theta = \frac{V}{V_m}$

i) Define the terms and obtain a linear relationship from the isotherm. (10 Marks)

ii) Show the data given above fit to the Langmuir isotherm using the linear relationship obtained. (30 Marks)

iii) Find the value of K and the number of adsorption sites present in charcoal. (30 Marks)

b) Discuss the need of BET isotherm in gas adsorption studies. Include the hypothesis used in BET isotherm in your answer. (30 marks)

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