NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF APPLIED CHEMISTRY
END OF SEMESTER EXAMINATIONS – JULY 2002
PHYSICAL CHEMISTRY FOR CHEMICAL ENGINEERS – SCH 1120
TIME – (3) THREE HOURS

INSTRUCTIONS TO CANDIDATES

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

$R = 8.314 Jmol^{-1}K^{-1}$

$N_A = 6.022 \times 10^{23}$

SECTION A

1. The limiting molar conductivities at infinite dilution of aqueous sodium acetate, hydrochloric acid, and sodium chloride are 91.0 Scm^2mol^{-1}, 425.0 Scm^2mol^{-1} and 128.1 Scm^2mol^{-1} respectively. What is the molar conductivity at infinite dilution of acetic acid?

   (5 marks)

2. (a) Distinguish between polarisability and polarisability volume.

   (4 marks)

   (b) At 0°C the molar polarisability of $ClF_3(l)$ is 27.18 cm^3mol^{-1} and its density is 1.89gcm^{-3}. Find its relative permittivity at 0°C given that M_m = 92.45g/mol.

   (6 marks)

3. At a relative pressure (P/P_o) of 0.20 a 1.25g sample of alumina adsorbs 52.5cm^3 (corrected to s.t.p) of nitrogen at 77K. Assume the BET equation to be valid and taking the molecular area of nitrogen to be 16.2 x $10^{-20}m^2$, Calculate the specific surface area of the alumina.

   (5 marks)

4. Derive the Kelvin Equation. (10 marks)

5. For a 0.001mol/kg of $CaCl_2(aq)$ at 298K, Calculate:

   (a) ionic strength

   (b) the activity coefficients of the Ca^{2+} and Cl^- ions

   (c) the mean ionic activity coefficient.

   (10 marks)

SECTION B

1. The volume of butane adsorbed on one gram sample activated carbon at 0°C varies with pressure as follows:

P/kPa	14.0	28.6	42.6	57.2	73.1	94.4
V/cm^3 (s.t.p.)	15.4	19.6	21.0	21.9	22.7	23.2

Show that the data fit Langmuir equation and evaluate the constants.

(20 marks)

2. (a) From the Sedimentation theory of Colloids, show that:

$$\mathbf{Mm} = \frac{\mathbf{SRT}}{\mathbf{(1-\rho v)D}}$$

(8 marks)

(b) Sedimentation studies on the haemoglobin in water gave sedimentation constant S = 4.5x10^{-13} S at 20°C. The diffusion coefficient is 6.3 x 10^{-7} cm^{2}s^{-1} at the same temperature. Calculate the relative molecular mass of haemoglobin using Vs = 0.75 cm^{3}g^{-1} for its partial specific volume and ρ = 0.998gcm^{-3} for the density of the solution.

(6 marks)

(d) If the viscosity of the above solution is 1.00 x 10^{-3} kgm^{-1}s^{-1}, What is the effective radius of haemoglobin?

(6 marks)

3. (a) State Ostwald's Dilution Law Equation. (6 marks)

(b) The molar conductivity of ethanoic acid (aq 0.0025 mol dm^{-3}) is 0.003165 Sm^2 mol^{-1} at 298K and the limiting molar conductivity at infinite dilution is 0.03907 Sm^2 mol^{-1}. From the data, determine at 298K:

(i) the dissociation constant and the pH of the ethanoic acid.

(7 marks)

(ii) the molar conductivity and pH of ethanoic acid when the concentration is 0.01 mol dm^{-3}. (7 marks)

4. (a) Give a brief classification of colloids. (12 marks)

(b) Using the Rayleigh Equation, explain why the sky appears blue during the day? (8 marks)

END OF QUESTION PAPER!!!