NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
END OF SEMESTER TWO EXAMINATIONS – MAY 2005
PHYSICAL CHEMISTRY FOR CHEMICAL ENGINEERS – SCH 1211
TIME: 3 HOURS

INSTRUCTION TO CANDIDATES

Answer **five** questions only. Total marks are 100.

SECTION A

1. (a) At 273.16K the enthalpy change of fusion of water is 6.50kJ/mol and the corresponding volume change of -1.65×10^{-6} m^3/mol. Estimate the temperature at which ice will melt at 1000atm pressure.
(take 1 atm $= 10^5$ Nm^{-2}) (8marks)

   (b) Calculate the osmotic pressure of a sucrose solution of concentration 0.0950dm^{-3} mol at 303K. The molecular weight of sucrose is 342.3g/mol (6 marks)

   (c) Compare and contrast physisorption and chemsorption. (8marks)

2. (a) Determine the vapor pressure of n-heptane at 58.7°C and 98.4°C using Clausius-Clapeyron equation. In the literature it is reported that its vapor pressure is 40mmHg at 22.3°C and that the latent heat of vaporization at 25°C is 364.94kJ/kg. The molecular weight of n-heptane is 100kg/mol and R = 8.314kJ/Kmol. (13 marks)

   (b) If the refractive index of water at 20°C is 1.3404 for light of wavelength 434nm, calculate the polarizability volume of the molecule at this frequency.
$N_A = 6.022 \times 10^{23}$ mol^{-1} $\rho = 0.9983$g/cm^3 (7marks)

3. (a) From the following information show that:
$U(r) = 4 \varepsilon \{(\sigma/r)^{12} - (\sigma/r)^6\}$ Lennard-Jones 6-12 Potential equation.
$F_L = -k_L r^{-7}$; $F_R = k_R r^{-13}$; $F = -dU/dr$. also draw a sketch diagram and label it fully. (15marks)

   (b) State Ostwald's dilution law expression. (5marks)

4. (a) The molecular conductivity of 0.100M KCl(aq) at 298K is 129Scm^{2}mol^{-1}. The measured resistance in a conductivity cell was 28.33Ω. The resistance was 28.50Ω when the same cell contained 0.100M NH$_4$Cl(aq). Calculate the molar conductivity of NH$_4$Cl(aq) at this concentration (8 marks)

(b) The resistance of an 0.0250M HCOOH(aq) solution was measured at 298K in the same cell as in (a) and found to be 555Ω. Find the degree of ionization of the acid at this concentration and its pK_a. (12marks)

5. (a) Calculate the polarisability volume of ethanol at the frequency corresponding to the Sodium D lines given that its refractive index is 1.360 at $20^{\circ}C$ and its density is $0.789g/cm^3$. (6marks)

(b) Estimate the refractive index of ethanol for Sodium-D light.
$\rho = 0.789gcm^{-3}$. $n_r = (Vm+2Rm/Vm-Rm)^{1/2}$

Molar refractivities at 589nm, Rm/cm^3mol^{-1}

C-H	1.65
C-C	1.20
C=C	2.79
C=O	3.34
O-H	1.85
C-O	1.41

(12marks)

6. The data below relate to the adsorption of N_2 on rutile (TiO_2) at 85K Confirm that they fit a BET isotherm in the range of pressures reported, and find V_{mon} and c.

P/Torr	1.20	14.0	45.8	87.5	127.7	164.4	204.7
V/cm^3	235	559	649	719	790	860	950

At 85K P* = 570Torr. The volumes have been corrected to 1atm and 273K and refer to 1g of substrate. (20marks)

End of question Paper!!!