THE OPEN UNIVERSITY OF SRI LANKA

B. Sc. Degree Programme — Level 4

Assignment I (Test)— 2006/2007

(Part II/ 1-5and Part III/1-4)

CHU 2124/CHE 4124 — Physical Chemistry I

$\left(1\frac{1}{2}\text{ hours}\right)$

20th July 2006 3.30 a.m. — 5.00 a.m.

- This is a structured question paper consisting of two (2) questions. Answer both in the space provided. Attached sheets will not be marked.
- Please write your **Registration number, Name, and Address** clearly in the space provided; see **last page (page 6)** of this question paper.

Gas constant (R)	=	$8.314\ \text{J K}^{-1}\text{mol}^{-1}$
Avogadro constant (N_A)	=	$6.023\times10^{23}\ \text{mol}^{-1}$
Faraday constant (F)	=	$96,500\ \text{C mol}^{-1}$
Planck constant (h)	=	$6.63\times10^{-34}\ \text{J s}$
Velocity of light (c)	=	$3.0\times10^{8}\ \text{m s}^{-1}$
Standard atmospheric pressure	=	$10^{5}\ \text{Pa}\left(\text{N m}^{-2}\right)$
$\text{Log}_e(X)$	=	$2.303\ \text{Log}_{10}(X)$

1 (a) Liquids A and B form an ideal mixture, miscible at all compositions. When the mole fraction of A in the liquid phase is 0.4, the vapour pressure of the system is 2.0×10^5 Pa. The vapour pressure of pure A is $3.0 \times \times 10^5$ Pa.

(i) Write down the mathematical expressions for the following using the standard symbols; identify, clearly, all the symbols used.

(α) Raoults Law

(β) Daltons Law

(γ) Phase rule

(ii) Sketch the Pressure vs Composition phase diagram with appropriate labels for an ideal binary system

(iii) Calculate the vapour pressure of pure B.

(iv) Calculate the mole fraction of B in the liquid phase and the mole fraction of A in the vapour phase corresponding to the composition given above.

(60 marks)

(b) The normal boiling points of pure liquids, X and Y, respectively, are 160 °C and 190 °C. An equimolar molar mixture of X and Y forms an azeotrope whose normal boiling point is 130 °C.

(i) Sketch the Temperature vs Composition phase diagram for the above system and label it completely.

(ii) With the aid of the above sketch, briefly outline the result of carrying out fractional distillation corresponding to a composition of a mixture where the mole fraction of X = 0.3

(iii) What do you understand by the term "azeotrope"?

(40 marks)

2 (a) (i) Define the terms Absorbance (A) and Transmittance (T) and hence, derive the relationship between A and T.

(ii) Write down the mathematical expression for Beer -Lambert law and, clearly, identify, all the symbols in it.

(20 marks)

(b) (i) The intensity of a (parallel) beam of monochromatic radiation of wavelength 10 nm is 9.5×10^{-5} W m^{-2}. Calculate the number of photons crossing an area of 1.0 cm^2 (placed perpendicular to the beam) in 2 seconds.

(ii) The same incident radiation was used to carry out an absorption experiment involving a 0.01 M aqueous solution of a species X placed in a cell of length 10.0 mm. If the emergent radiation beam had 3.0×10^{12} photons crossing an area of 1.0 m^2 in 1 minute, calculate the absorbance of the sample and hence, the molar extinction coefficient

(60 marks)

(c) Indicating the assumption/s, if any, estimate the dipole moments of ortho-, meta-, and para – chlorotoluene if the dipole moments of toluene and chlorobenzene are 0.40 D and 1.57 D respectively. ($\cos(60^{o}) = ½$)

(20 marks)