Answer guide for
CHU 2124 – Physical Chemistry I
2006/2007
Assignment Test I

(All references are to Part II and Part III of your study material)

1. (a) (i) (α) Raults law

$$P_A = X_A P^\circ_A$$

P_A = partial vapour pressure of A
X_A = mole fraction of A
P°_A = pure vapour pressure of A

(β) Daltons law

$$P = P_A + P_B$$
$$P_A = X'_A P$$

P = Total vapour pressure
X'_A = mole fraction in the vapour phase

(γ) Phase rule

$$F + P = C + 2$$

F = Number of degrees of freedom
P = Number of phases
C = Number of components

(ii) Refer Fig. 3.1(Page 36/ Part II)

(iii) $P_B = X_B P^\circ_B$, $P_A = X_A P^\circ_A$

$$P = X_A P^\circ_A + (1-X_A)P^\circ_B$$

$$2 \times 10^5 = 0.4 \times 3 \times 10^5 + 0.6 \times P^\circ_B$$

$$\frac{0.8 \times 10^5}{0.6} = P^\circ_B$$

$$P^\circ_B = 1.33 \times 10^5 \text{ Pa}$$

(iv) $X_B = 0.6$

Also $P_A = X'_A P$

$0.4 \times 3 \times 10^5 = X'_A \times 2 \times 10^5$

$X'_A = \frac{1.2}{2} = 0.6$

(b) (i) Similar to Fig. 2.9 (Page 33/Part II)

(ii) Fractional distillation : pure x and the azeotropic mixture (as the distillate) can be separated out

(iii) Constant boiling mixture, the composition of the vapour phase and liquid phase are the same on BOILING.

2. (a) (i) Refer Part III

(ii) $A = \varepsilon.C.l$

A = Absorbance

ε = Extinction coefficient

C = Concentration in moldm^{-3}

l = length in cm

(b) (i) $I_o = 9.5 \text{ X } 10^{-5}$ wm^{-2} , Area $= 1.0 \text{ cm}^2 = 1.0 \times 10^{-2} \times 10^{-2} \text{ m}^2$

$a = 10^{-4} \text{ m}^2$

$\lambda = 10 \text{ nm} = 10 \times 10^{-9} \text{ m}$

$= 10^{-8} \text{ m}$

$t = 2 \text{ s}$

$$\frac{Iat}{h\nu} = \text{No. of photons} = \frac{9.5 \times 10^{-5} \times 10^{-4} \times 2}{6.63 \times 10^{-34} \times \frac{3 \times 10^8}{10^{-8}}}$$

$$= \frac{19 \times 10^9}{20.89}$$

$$\approx 0.9 \times 10^9$$

$$\approx 9.0 \times 10^8$$

(ii) ℓ = 10.0 mm = 1.0 cm ; C = 0.01 mol dm^{-3}

I_0 = 9.5 x 10^{-5} w m^{-2} ; hv = 6.63 x 10^{-34} x 3 x 10^{16}

$$I = \frac{3 \times 10^{12} \times 6.63 \times 10^{-34} \times 3 \times 10^{16}}{1.0 \times 60}$$

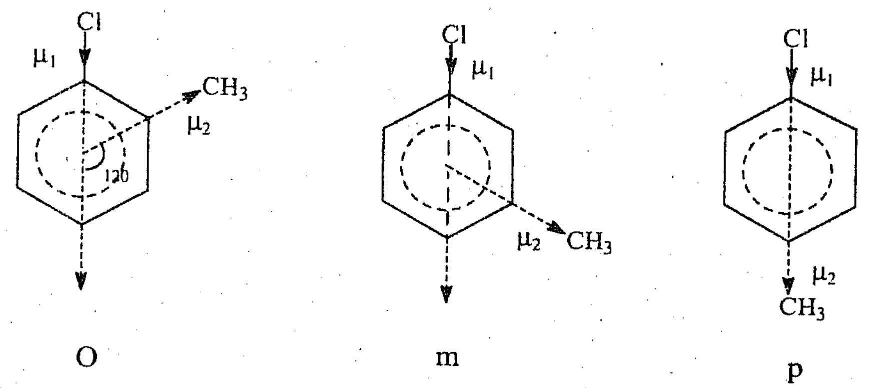
$$I = \frac{9 \times 6.63}{60} \times 10^{-6} \ wm^{-2}$$

$$A = -\log\frac{I}{I_o} = -\log\left[\frac{9 \times 6.63}{60} \times 10^{-6} \div 9.5 \times 10^{-5}\right]$$

$$A = 1.98$$

$$\therefore \varepsilon = \frac{A}{C\ell} = 198 dm^3 mol^{-1} cm^{-1}$$

(c)



<u>Assumption :</u>

The dipole moments are estimated based on the vectorial addition

$\mu^2 = \mu_1^2 + \mu_2^2 + 2\mu_1\mu_2 Cos\theta$

Ortho

$\mu^2 = (0.4)^2 + (1.57)^2 + 2(0.4)(1.57)$ Cos120°

$= 0.16 + 2.47 - 2 \times 0.63 \times ½$

$= 2.63 - 0.63 \approx 2.0$

$\mu = \sqrt{2.00} \approx 1.41D$

Similarly,

for meta, $\mu = \sqrt{2.63 + 0.63} = \sqrt{3.26} = 1.80\,D$

for para, $\mu = 0.4 + 1.57 = 1.97$ D