UNIVERSITY OF GHANA

DEPARTMENT OF BIOMEDICAL ENGINEERING
END OF SECOND SEMESTER EXAMINATIONS: 2013/2014
LEVEL 300: BACHELOR OF SCIENCE IN BIOMEDICAL ENGINEERING
BMEN 304: Solution and Colloid Chemistry (3 Credits)

Total Marks: 100 Time allocation: 3 Hours

Answer all questions

Question 1 [25 Marks]

a. List the factors that influence solution formation. [4 marks]

b. State why solubility of gases in water increases with increasing mass? [4 marks]

c. Calculate the amount of water (in grams) that must be added to 5.00 g of urea in the preparation of a 16.2 percent by mass of a solution. [5 marks]

d. Differentiate between 1 molar solution and 1 molal solution. [4 marks]

e. A commonly purchased disinfectant is a 30% (by mass) solution of H_2O_2 in water. Assuming the density of the solution is 1.0g/cm^3, calculate the

i. Molarity [3 marks]

ii. Molality [3 marks]

iii. mole fraction of H_2O_2 [2 marks]

[H =1, O = 16]

Question 2 [25 Marks]

a. Using thermodynamic principles, deduce the most suitable conditions for an economic yield of SO_3

$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ ΔH = -ve [6 marks]

b. What is a Conjugate acid – base pair? [3 marks]

c. Explain why aqueous solutions of NH_3 and CH_3COOH are weak electrolytes but a mixture of the two forms a strong electrolyte. [6 marks]

d. What is the relationship between the value of pK_a and the strength of a weak acid? [4 marks]

e. The pH of a 0.10M solution of formic acid (HCOOH) is 2.39. What is the K_a of the acid? [6 marks]

Question 3 [25 Marks]

a. State the Raoult's Law. [3 marks]

b. In terms of intermolecular forces, what gives rise to positive and negative deviations from **Raoult's law**? Indicate the deviations with appropriate phase diagrams. [6 marks]

c. If a solution shows a positive deviation **from Raoult's law, would you** expect it to have a higher or lower boiling point than if it was ideal? Why? [4 marks]

d. The presence of a non volatile solute in solution reduces the tendency of the solvent molecule from escaping. Explain. [4 marks]

e. Calculate the vapour pressure of a solution made by dissolving 218g of glucose (mm =180.2g/mol) in 460ml of water at 30^0C. What is the vapour pressure lowering? [v.p of water at 30 ^{0}C = 31.82 mmHg; density of water = 1.0 g/ml]. [8 marks]

Question 4 [25 marks]

a. Explain why the following reaction is a REDOX reaction [2 marks]

$Mn^{2+} + H_2O_2 \rightarrow MnO_2 + H_2O$

b. The following reaction occurs in an alkali medium

$Pb(OH)_3^- + ClO^- \rightarrow \mathbf{PbO_4} + Cl^- + OH^- + H_2O$

(α) List the species that is reduced and the one that is oxidised. [2 marks]

(β) State the initial and final oxidation numbers of the species you have listed. [2 marks]

(γ) Separate the reaction into two half-reactions and balance each of them. [8 marks]

(δ) Write the overall balanced equation. [2 marks]

c. How is vapour pressure lowering related to a rise in boiling point of a solution? [2 marks]

d. Using intermolecular forces differentiate between an ideal solution and non-ideal solution. [2 marks]

e. (i) Differentiate between a galvanic cell and an electrolytic cell.
(ii) Draw a well labelled cell diagram represented by the equation A/A^{3+} $//B^{2+}$ / B and indicates the direction of flow of electrons. [5 marks]