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Second Semester Examination: 2010/2011

BACHELOR OF SCIENCE IN ENGINEERING

BIEN 304 Solution and Colloid Chemistry

## INSTRUCTION: ANSWER ALL QUESTION IN SECTION A AND THREE QUESTIONS FROM SECTION B

## TIME: TWO (2) HOURS.

## SECTION A: ANSWER ALL QUESTIONS FROM THIS SECTION

**Question 1**
a) Differentiate between a galvanic cell and an electrolytic cell.      [8 Marks]
b) Explain why aqueous solution of $NH_4Cl$ is acidic but that of $NaCl$ is neutral to litmus.
                                                                         [8 Marks]
c) How does common ion effect influence solubility?                      [8 Marks]
d) Differentiate between **Molality** and **Molarity** of a solution.    [8 Marks]
e) 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 were ideal? Why?        [8 Marks]

## SECTION B: ANSWER Three QUESTIONS FROM THIS SECTION

**Question 2**
a) Define the following concentration terms and give their units:      [5 Marks]
   i.   Percent by mass
   ii.  Molarity
   iii. Molality
b) The concentrated sulphuric acid used in the laboratory is 98% $H_2SO_4$ by mass. Calculate the molality and molarity of the acid solution.
   [H=1, O=16, S=32, density of solution = 1.83 g/ml].                  [10 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]

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## Question 3
a) State the factors that influence solution formation [5 Marks]
b) Describe how you will prepare 50 g of a 30 % (w/w) solution of $CaCl_2$ in water. [5 Marks]
c) (i) Distinguish between the strength of an acid and the concentration of an acid. [5 Marks]

(ii) Explain the following observation: Ethanoic acid ($CH_3COOH$) and aqueous Ammonia ($NH_4OH$) are weak electrolytes but a mixture of the two solutions is a strong electrolyte. [5 Marks]

## Question 4
a) (i) What is an ideal solution? [2 Marks]

(ii) State 3 characteristics of a buffer solution [3 Marks]
b) A 0.04M $(CH_3COO)_2Ca$ salt was dissolved in 0.02M $CH_3COOH$ acid at 25°C to form a buffer solution. Calculate the pH and hydrogen ion concentration of the solution.(Ka = $1.84 \times 10^{-5}$). [5 marks]
c) Calculate the vapour pressure of a solution made by dissolving 218g of glucose in 460ml of water at 30°C. [ Vapour pressure of water at 30°C = 31.82mmHg, density of water = 1.0 g/ml, Molar mass of glucose = 180.2 g/mol.] [10 Marks]

## Question 5
a) (i) What is a conjugate acid-base pair? [2 marks]

(ii) Calculate the hydrogen ion concentration and pH of a 0.02M solution of methylamine ($CH_3NH_2$) with a Kb of $4.38 \times 10^{-4}$ [3 Marks]

$$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^-$$
b) Consider the following reaction

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)} \quad \Delta = \text{-ve}$$
State and explain what happens to $SO_2$, $O_2$, and $SO_3$ when volume of containing vessel is reduced and temperature is increased. [10 Marks]
c) Calculate the Ksp value for bismuth sulphide ($Bi_2S_3$) which has a solubility of $1.0 \times 10^{-15}$ moldm$^{-3}$ at 25°C. [5 Marks]

## Question 6
a) Outline the differences between solutions, suspensions and colloids. [6 Marks]
b) Explain, using electrochemical principles, why: [4 Marks]

(i) Aluminum metal does not corrode as rapidly as a less active metal such as iron.

(ii) Many new cars have galvanized body parts
c) Derive Beer-Lambert's equation for spectroscopic analysis of a dilute solution with concentration c contained in a cell of length l. Assuming an electromagnetic radiation of intensity Io passes through this solution (which absorbs a fraction of it) and leaves the cell with intensity I (< Io). [2 Marks]
d) Copper content of tea was measured by AAS as follows. A series of copper standard solutions was prepared and aspirated into the AAS set at optimum conditions for copper determination. The following results were obtained:

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| Standard Copper (ppm) | Absorbance |
|---|---|
| 0 | 0.00 |
| 1 | 0.18 |
| 2 | 0.32 |
| 3 | 0.46 |
| 4 | 0.62 |
| 5 | 0.75 |

Duplicate tea samples were ashed at 550 °C for one hour and the resulting ash redissolved and made up to 50 mL in a volumetric flask. After filtering, the solutions were used for aspiration into the AAS with the following results:

| Sample | Sample Wt (g) | Absorbance |
|---|---|---|
| #1 | 5.07 | 0.25 |
| #2 | 5.12 | 0.24 |

(i) Calculate the copper content of the tea in mg/kg.
(ii) If 10 g of this tea was infused with boiling water to make 1000 ml of tea, compare the theoretical maximum copper concentration possible in the tea drink with the legal maximum of 5 ppm.                **[8 Marks]**