SCHOOL OF APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PURE & APPLIED SCIENCES **UNIVERSITY**

EXAMINATION FOR:

DIPLOMA IN ANALYTICAL CHEMISTRY

ACH 2102: FUNDAMENTALS OF PHYSICAL CHEMISTRY

END OF SEMESTER EXAMINATION

SERIES: DECEMBER 2024

TIME: 2 HOURS

DATE: Pick Date Dec 2024

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **FIVE** questions. Attempt **Question one** and any other **TWO questions**.

Do not write on the question paper.

Question ONE

a) 4.26g of Na_2SO_4 was dissolved in water giving V cm3 of solution of concentration 0.075M Na_2SO_4. Find V. Na=23, S=32, O=16. **(4marks)**

b) Find the mass of solid K_2CO_3 required to prepare $500cm^3$ of 0.04M K_2CO_3 solution K=39, C=12, O=16. **(4 marks)**

c) i) Give the mathematical definition of the term pH. **(1 mark)**

ii) Give the equation that shows pKw is related to pH **(1 mark)**

iii) Find pKw and Ph in an aqueous solution of 0.02M HCl. Kw=1.0 x 10^{-14} at 25°C **(4 marks)**

d) State FIVE characteristics of acids **(5marks)**

e) In cold climate water gets frozen causing damage to radiator of a car. Ethylene glycol ($HOCH_2CH_2OH$) is used as an antifreezing agent. Calculate the amount of ethylene gly col to be added to 4Kg of water to prevent it from freeeezing at -6 °C. (C=12, O=16, H=1, Kf of water = 1.86. Normal freezing point of water = 0°C) **(7 marks)**

f) State four limitations of the cryoscopic method of determining the relative molecular mass of chemical compounds. **(2 marks)**

Question TWO

5.68g of sodium sulphate Na_2SO_4 was dissolved in water giving 400 cm^3 of solution. Express the concentration of this solution in:

a) g/l **(2 marks)**

b) g/100ml **(2 marks)**

c) %w/v **(2 marks)**

d) %w/w **(3 marks)**

e) Molarity M **(3 marks)**

f) Molality m **(3 marks)**

(Na=23, S=32, O=16 density of water = 1g/cm^3)

Question THREE

a. A solution is made by dissolving a non-volatile solute B in a volatile Solvent A. Using a clearly labelled sketch graph(in the same set of axes) indicate the following

i) Freezing point of pure solvent T_1

ii) Freezing point of solution T_2**.**

iii) Boiling point of pure solvent T_3.

iv) Boiling point of solution T_4.

(10 marks)

b. The equation $(P_o - P)/P_o = X_i$ is applicable to binary solutions where the solute is involatile while the solvent is volatile.

i) State what is represented by X_i , P_o and $(P_o - P)/P_o$ **(3marks)**

ii) Give the name of the law represented by the equation **(1mark)**

iii) State two conditions under which the equation is valid **(1mark)**

Question FOUR

a) The following table contains data of two types of solutions. Type A solutions were made by dissolving 20g of each compound in 500g of water while type B solution were made by dissolving different masses of each compound in 500g of water.

Compound	Formula	RMM	Solution	
			A Mass in 500g of water	B Mass in 500g of water
Sucrose	$C_{12}H_{22}O_{11}$	342	20	171
Ethanol	C_2H_5OH	46	20	23
Urea	NH_2CONH_2	60	20	30
Glucose	$C_6H_{12}O_6$	180	20	90

i) Compare the osmotic pressure of Type A solutions with that of Type B solutions and account for the difference. **(10marks)**

ii) Select the most effective compound in generating osmotic pressure. Expain your answer **(2 marks)**

b. i) Distinguish cryoscopy from cyroscopic constant. **(2 marks)**
ii) Define the term ebullioscopy **(1 mark)**

Question FIVE

Given solid slightly soluble and ionic compound $Mg(OH)_2$

a) Write the equation for the equilibrium established when the solid $Mg(OH)_2$ is placed in pure water **(2 marks)**

b) Give the K_{sp} expression for $Mg(OH)_2$ **(2 marks)**

c) If K_{sp} for $Mg(OH)_2 = 7.1 \times 10^{-12}$. Find the solubility of $Mg(OH)_2$ in:

i) Pure water **(5 marks)**

ii) In 0.01M NaOH **(5 marks)**

d) Give the name given to the cause of results observed in c above. **(1 mark)**