TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES

Department of Pure and Applied Sciences

BACHELOR OF TECHNOLOGY IN MICROBIOLOGY (BTMB16S) &

BACHELOR OF SCIENCE IN MOLECULAR BIOLOGY AND FORENSIC TECHNOLOGY (BSMF16S)

ACH 4109: FUNDAMENTALS OF PHYSICAL CHEMISTRY

(PAPER 2)

SEMESTER EXAMINATION

SEPT. 2017

TIME: 2 HOURS

This paper consists of **FIVE** questions

Answer question **ONE (Compulsory)** and any other **TWO** questions

Question one

a) (i) Define a base according to the Brownsted-Lowry theory. **(2 marks)**

(ii) With reasons, state whether the following solutions are acidic or basic.

I) A solution of sodium in liquid ammonia **(1 mark)**

II) A solution of hydrogen chloride in liquid ammonia. **(1 mark)**

III) A solution of methyl benzene in water. **(1 mark)**

b) (i) State the osmotic pressure law. **(2 marks)**

(ii) The average osmotic pressure of human blood at 37^{o}C is 7.6 atm.

What will be the:

I) Total concentration of the various solutes in blood? **(2 marks)**

II) Freezing point of blood if the molarity is taken to be equal to molality?

(kf = 1.86 K/mol.kg, R = 0.0821 L.atm./Kmol). **(3 marks)**

c) A sample of a gas occupies 300 dm^3 at 27^{o}C and 750 Torr pressure. Calculate the:

(i) Contraction in volume when the gas is cooled to – 33 ^{o}C at 750 Torr pressure.

(3 marks)

(ii) Change in volume when the pressure is reduced by 150 Torr at the same temperature.

(3 marks)

d) At temperatures above its boiling point, dinitrogen tetraoxide exists in equilibrium with nitrogen dioxide as shown:

$$N_2O_4 \rightleftharpoons 2NO_2; \Delta H = +57\ kJmol^{-1}$$

Derive an expression relating kp and kc for this reaction. **(4 marks)**

e) (i) State qualitatively, the pH of CH_3COONa. **(1 mark)**

(ii) Give a reason for the answer in (i) above. **(1 mark)**

(iii) Calculate the pH of 0.15 M CH_3COONa (K_a = 1.8 x 10^{-5}, K_b = 5.56 x 10^{-10})

(2 marks)

f) The density of an unknown gas is 1.23 gL^{-1} at S.T.P. Calculate its molecular mass (R = 0.082057 $L.atm.K^{-1}mol^{-1}$). **(4 marks)**

Question Two

a) Define buffer capacity. **(2 marks)**

b) Give an example of a buffer solution with:

(i) A pH less than 7 **(1 mark)**

(ii) A pH greater than 7 **(1 mark)**

c) Describe how the buffer capacity of a buffer is determined. **(7 marks)**

d) Calculate the pH of a buffer solution containing 0.04 M Na_2HPO_4 and 0.08 M KH_2PO_4 at 25^{o}C.

$$H_2PO_4^- + H_2O \rightleftharpoons HPO_4^{2-} + H_3O^+ \quad PK_a = 7.21$$

(4 marks)

e) Estimate the volume of 0.1 M HCl that may be added to 25 cm^3 of the phosphate buffer in (d) above before it stops acting as a buffer. **(5 marks)**

Question Three

a) (i) Define the term "colligative property of matter". **(2 marks)**

(ii) List the colligative properties of matter. **(4 marks)**

b) Differentiate between molarity and molality of a solution as used in concentration measurements. **(4 marks)**

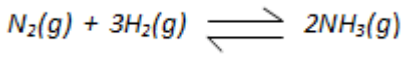
c) The addition of 0.24 g of sulphur to 100 g carbon tetrachloride lowered its freezing point by 0.28 K. Determine the molecular formula of sulphur. (S = 32). The molal freezing point depression constant is 29.8 K) **(10 marks)**

Question Four

a) (i) Define the term reaction quotient as used in chemical equilibria. **(2 marks)**

(ii) Explain the importance of the reaction quotient. **(4 marks)**

b) K_c for the reaction given below is 69 at 500^{o}C.



Analysis of a 10 litre container of the equilibrium mixture at 500^{o}C revealed the presence of 4.0 moles of H_2 and 5.0 moles of NH_3.

(i) Calculate the number of moles of N_2 in the container. **(4 marks)**

(ii) Calculate Kp for the reaction mixture. **(3 marks)**

c) K_c for the reaction given below is 9.00 at 973K.

If 1.00 mole of SO_3 and 1 mole of NO are injected into a 1.00 litre flask at 973K:

(i) Predict the direction in which the reaction would proceed. **(2 marks)**

(ii) Determine the concentration of all the species in the equilibrium mixture. **(5 marks)**

Question Five

a) State Boyle's law. **(1 mark)**

b) State the application of Boyle's law. **(2 marks)**

c) The table below shows the variation of pressure with volume for one mole of ammonia gas at 0^oC.

Experiment	P (atm)	Volume, V, (Litres)
1	0.1300	172.10
2	0.2500	89.28
3	0.3000	74.35
4	0.5000	44.49
5	0.7500	29.55
6	1.000	22.08

(i) Plot a graph of P against $\frac{1}{V}$. **(12 marks)**

(ii) Use the graph to determine the value of the gas constant R and give its units.

(5 marks)