



TECHNICAL UNIVERSITY OF MOMBASA

School of Applied and Health Sciences
DEPARTMENT OF PURE AND APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN APPLIED CHEMISTRY

(ANALYTICAL AND INDUSTRIAL OPTION)

BTAC 2024S.

ACH 4106: PHYSICAL CHEMISTRY 1

ORDINARY EXAMINATION

SERIES: DECEMBER 2024 SERIES

TIME: 2 HOURS

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 (Compulsory) and any other TWO questions.

Do not write on the question paper.

Question One (30 Marks)

- a) 26.9 g CO and 2.32 g H₂ was initial feed into 5.22 L where reaction was allowed to proceed till it reaches equilibrium. At equilibrium there were 8.65 g CH₃OH. Using ICE table determine the value of equilibrium constant (K_c)

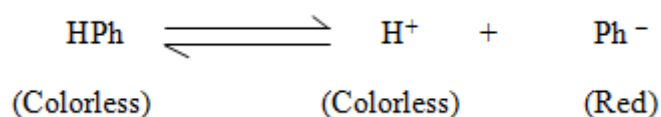


- b) Using an example, explain what is meant by common ion effect **(4 Marks)**

- c) Distinguish between
- Arrhenius, Bronsted and Lewis concept of Bases **(3 Marks)**
 - Homogeneous from heterogeneous equilibria **(2 Marks)**
- d) A buffer solution was prepared by mixing 0.20M in ethanoic acid and 0.10M in sodium ethanoate. Given dissociation constant of ethanoic acid as 1.74×10^{-5} M, calculate
- pH of buffer solution. **(3 Marks)**
 - PH change when 1ml of 1M NaOH was added to 1L of this buffer **(2 Marks)**
- e) Calculate vapour pressure lowering, when 10.0mL of glycerol ($C_3H_8O_3$, 1.26g/ml) was added to 500mL of water at 50°C. Given vapour pressure of water At this temperature as 92.5mmHg and its density as 0.988g/ml. **(4 Marks)**
- f) By the help of graph and equations, state Boyle's and Charles law of gases **(4 Marks)**
- g) State the postulate made in kinetic theory of gases **(3 Marks)**

Question Two (20 Marks)

- a) 0.25 moles of A was mixed with 0.45 moles of B in 1 liter vessel and allowed to react to form C. At equilibrium there were 0.16 moles of C. Calculate Equilibrium constant K_x
- $$A(g) + 2B(g) \rightleftharpoons C(g) \quad \text{(4 Marks)}$$
- b) Using examples, explain the term conjugate acid base pair. **(4 Marks).**
- c) When 16 g of an organic compound was dissolved in 225g of carbon tetrachloride, boiling point rose to 85.36°C, Calculate RMM of an organic compound. Given ebullioscopic constant and boiling point of CCl_4 as $5.03 \text{ }^\circ\text{C kg mol}^{-1}$ and $76.72 \text{ }^\circ\text{C}$ respectively. **(4 Marks)**
- d) Calculate the pH of a saturated solution of AgOH, $K_{sp} = 2.0 \times 10^{-8}$ **(4 Marks)**
- e) The dissociation of phenolphthalein may be represented as follows, with reasons, state the color of the indicator in:
- Alkaline solution.
 - Acidic solution. **(4 Marks)**

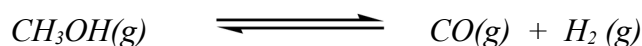


Question Three (20 Marks)

- a) State the success of
- (i) Arrhenius theory
 - (ii) Bronsted theory **(4 Marks)**
- b) The following equilibrium exist at 35 °C, given equilibrium partial pressure of Ammonia, Nitrogen and Hydrogen as 2.9×10^{-4} atm, 8.9×10^{-1} atm 2.9×10^{-3} atm respectively Calculate;
- (i) Equilibrium constant K_p
 - (ii) Equilibrium constant K_c ($R = 8.314 \text{ J}$) **(5 Marks)**
- $$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$$
- c) Compare and Comment on the pressure predicted for 536 mL of 1 mole Carbon dioxide gas at 373 Kelvin. using the;
- (i) Ideal gas equation **(2 Marks)**
 - (ii) Van der waals equation **(3 Marks)**
- Given $a = 3.61 \text{ L}^2 \text{ atm mol}^{-2}$, $b = 0.0428 \text{ L}$ and
van der waals equation $(P + \frac{an^2}{v^2})(V - nb) = nRT$.
- d) 0.64 g of adrenaline in 36.0 g of CCl_4 produces a Bp elevation of 0.49 °C. Calculate molecular weight of adrenaline. **(4 Marks)**
- e) Define Indicators **(2 Marks)**

Question Four (20 Marks)

- a) Calculate the equilibrium constant K_p for the following reaction at 25°C . Given standard free energy ΔG° of $\text{CH}_3\text{OH}(\text{g})$, $\text{CO}(\text{g})$ and $\text{H}_2(\text{g})$ as 161.9, -110.5 and 130.6 Kilojoules per mole respectively. **(4 Marks)**



- b) Outline the characteristic of
- i. ideal solution **(3 Marks)**
 - ii. Reversible reaction **(3 Marks)**
 - iii. Double salt **(2 Marks)**
- c) An air sample containing nitrogen and oxygen gases has a density of 1.3393 g / L at STP. Find the mass and mole percentages of nitrogen in the sample. **(4 Marks)**
- A. Calculate the pH of A saturated solution of $\text{Mg}(\text{OH})_2$ solution is 10.17. Calculate the K_{sp} for this compound. **(4 Marks)**

Question Five (20 Marks)

- a) Differentiate between positive and negative deviation in non -ideal solution **(4 mks)**
- b) Calculate the concentration of OH^- in a solution of $2.0 \times 10^{-3} \text{ M HCl}$ **(4 Marks)**
- c) 1.00 g of nonvolatile sulfanilamide, $\text{C}_6\text{H}_8\text{O}_2\text{N}_2\text{S}$, is dissolved in 10.0 g of acetone, $\text{C}_3\text{H}_6\text{O}$. The vapor pressure of pure acetone at the same temperature is 400mmHg. Calculate the vapor pressure of the solution. **(4 Marks)**
- d) Show the relationship between K_p and K_c for reaction **(4 Marks)**
- $$3\text{A} \rightleftharpoons \text{1B} + \text{1D}$$
- e) A Buffer was prepared by mixing acetic acid and sodium acetate. Explain how this buffer will behave when small amount of Acid is added **(4 Marks)**