TECHNICAL UNIVERSITY OF MOMBASA

School of Applied and Health Sciences

DEPARTMENT OF PURE AND APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN BIOCHEMISTRY

BACHELOR OF TECHNOLOGY IN INDUSTRIAL MICROBIOLOGY

BACHELOR OF SCIENCE IN FOOD AND QUALITY ASSURANCE

BSB 24S, BTMB 24S AND BSFQ 23S.

ACH 4109: FUNDAMENTALS OF PHYSICAL CHEMISTRY

SPECIAL/SUPPLIMENTARY EXAMINATION

SERIES: JULY 2025 SERIES

TIME: 2 HOURS

DATE: JULY 2025

Instructions to Candidates

You should have the following for this examination

Answer Booklet, examination pass and student ID

This paper consists of **FIVE** questions. Attemptquestion ONE (Compulsory) and any other TWO questions.

Do not write on the question paper.

Question One (30 Marks)

a) Outline two causes of deviation of gases from the ideal behavior. **(2 marks)**

b) Define mixture **(2 marks)**

c) With the help of graph, state Boyle's and Charles law of gases **(4 marks)**

d) 0.18398 moles of CO and 0.22046 moles of H_2 were feed into 1L flask. Reaction proceed to equilibrium where 0.051716 moles of CH_3OH were formed. Determine the value of equilibrium constant (K_C)

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$ **(5 marks)**

e) The boiling point elevation of a solution prepared by dissolving 3.1 grams of urethane in 68.44 grams of methanol CH_3OH is 0.32 °C. Calculate

i Molar mass of urethane given ebuliscopic constant as 0.88^oCm^{-1}

ii Mole fraction of urethane **(5 marks)**

f) Discuss the effect of adding HCL on dissociation and PH of the equilibrium of sodium acetate $CH_3COOH + H_20 \rightleftharpoons CH_3COO^- + H_30^+$ **(4 marks)**

g) Calculate the pH of a saturated solution of $Cu(OH)_2$, with $K_{sp} = 1.6 \times 10^{-19}$ **(5 marks)**

h) The equilibrium pressure of Ammonia, Nitrogen and Hydrogen as 2.9×10^{-4} atm, 8.9×10^{-1} atm 2.9×10^{-3} atm respectively alculate (i) kp (ii) k_c at $35\ ^0$c **(5 marks)**

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

Question Two (20 Marks)

a) Define

i. Arrhenius, Bronsted and Lewis concept of acids **(4 marks)**

ii. Acidic salt and Acidic Buffer **(2 marks)**

b) Using examples explain the term conjugate acid base pair. **(4 marks)**.

c) 1.00 kg of Compound Y of molar mass 62 was added to a solution containing 5.00 kg of water. What is the boiling point of the solution obtained? Data: The molal elevation boiling point constant Kb= 1.86 °C kg mol–1 . **(4 marks)**

d) 453 mL of hydrogen at 18° C exert 780. mm Hg. Calculate the volume it will occupies at STP **(4 marks)**

e) Define homogeneous mixture **(2 marks)**

Question Three (20 Marks)

a) Dinitrogen tetraoxide exist in equilibrium with nitrogen dioxide At temperature above its boiling point, using le chatelier principle explain how the equilibrium will readjust itself if

i. Pressure is decrease

ii. Temperature is increase

iii. Concentration of $N0_2(g)$ withdrawn

$N_20_4(g) \rightleftharpoons 2N0_2(g)$ DH 57 KJ/MOL^{-1} **(3 marks)**

b) A buffer solution was prepared by mixing 2.5 moles of Weak acid (Ka= 1.8 X 10^{-5}) and 2.5 moles of its salt to give 1 L of solution, Find the pH of the buffer solution and PH change when 2 mL of 6M NaOH is added to this buffer **(4 marks)**

c) Differentiate between Boiling point and Boiling **(3 marks)**

a) Define partial pressure **(2 marks)**

b) 1.24 moles of hydrogen gas was blended with 2.91 moles of oxygen gas. Calculate respective partial pressure if the total pressure is 104 kilopascals. **(4 marks)**

c) State and explain four assumptions maze in Kinetic molecular theory **(4 marks)**

Question Four (20 Marks)

a) Calculate the pressure exerted by 0.8 moles of nitrogen dioxide (NO_2) which occupies 20 m^3 at 300K, using Van der Waals equation. **(4 marks)**

[Data a = 0.535 Nm^2 mol^{-1}, b = 4.42 x $10^{-5}m^3$ mol^{-1}, R = 8.314 $JK^{-1}mol^{-1}$]

Van der Waals equation $(P + a(n^2/v^2)(V- n b) = n RT$

b) Calculate Enthalpy of combustion per mole when 3 g of glucose (molar mass 180g/mol) was burn in constant volume colorimeter containing 1.2 kg of water. During experiment temperature of water rose from 19ºC to 25.5ºC. [Heat capacity of colorimeter = 2.21 KJ /ºC,Specific heat of water = 4.184J/ºC.g **]** **(4 marks)**

c) Determine the amount of heat release per mole during combustion of 1 g of butane (C_4H_10). **[**$\Delta H°_f$ of C_4H_{10}, CO_2 and H_2O as –147.6,-393.5 and -285.5 kJ mol^{-1} respectively] **(4 marks)**

d) Air at 1 atmospheric and 25°C (V = 0.02479 m^3) was compressed to 5 bar, Apply Boyles and Charles law to calculate final volume and final temperature **(5 marks)**

e) Litmus indicator is and acidic indicator and its dissociation is represented below. Using le Chateliers principle explain its colour change in alkaline media. **(3 marks)**

$$HLit_{(aq)} \rightleftharpoons H^+_{(aq)} + Lit^-_{(aq)}$$

Red Blue

Question Five (20 Marks)

a) 20 g of nitrogen gas and 10 g of helium gas are placed together in a 5 L container at 25°C. Calculate the partial pressure of each gas and the total pressure of the gas mixture. **(5 marks)**

b) With the help of equation State Dalton and Raoults law **(4 marks)**.

c) Differentiate between Amphiprotic and amphoteric substance **(3 marks)**

d) Calculate the concentration of hydroxyl and hydrogen ions for a solution witH pH of 6.8 at 25 ^{0}C calculate **(4 marks)**

e) Determine equilibrium constant Kp for the following reaction **(4 marks)**

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

K_c at 500°C .is at 69