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

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. Attemptquestion ONE (Compulsory) and any other TWO questions.

Do not write on the question paper.

Question One (30 Marks)

a) A buffer solution was prepared by mixing 2.5 moles per litre of weak acid (Ka= 1.8 X 10^{-5}) and 2.5 moles per litre of its salt. Find

   i. the pH of this buffer solution

   ii. PH change when 2 mL of 6M NaOH is added to it **(4 marks)**

b) Define indicators **(2 marks)**

c) Distinguish between

i. Arrhenius, Bronsted and Lewis concept of acids **(3 marks)**

ii. Homogeneous from heterogeneous equilibria **(2 marks)**

d) Discuss deviation of gases from the ideal behavior. **(3 marks)**

e) With the help of graph and equations, state Boyle's and Charles law of gases **(4mks)**

f) Calculate vapor pressure lowering of water when 10 mL glycerol ($C_3H_8O_3$) was added to 500 mL water at 50°c. [vapour pressure of water is 92.5 mmHg, Density of glycerol and water as 1.26 g/ml and 0.988 g/ml respectively]. **(4 marks)**

g) Discuss the effect of adding HCL on dissociation of sodium acetate

$CH_3COOH + H_20 \rightleftharpoons CH_3COO^- + H_30^+$ **(3 marks)**

h) Given the equilibrium partial pressure of Ammonia, Nitrogen and Hydrogen as 2.9 X 10 -4 atm, 8.9 X 10 - 1 atm 2.9 X 10 -3 atm respectively, calculate

i. Equilibrium constant kp

ii. Equilibrium constant kC at 35 ^{0} c (R= 0821 atmp.L $mol^{-1}.K^{-1}$

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

(**5 marks**

Question Two (20 Marks)

a) Calculate the pH of a saturated solution of AgOH, $K_{sp} = 2.0 \times 10^{-8}$ **(4 marks)**

b) Using examples explain the term conjugate acid base pair. **(3 marks)**.

c) 31.150 dm^3 of H_2 gas initially at 30°C and 745 mmHg was cooled to – 30 °C and 312 mmHg, Calculate the Contraction final volume. **(3 marks)**

d) Differentiate between

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

ii. Boiling point and Boiling **(3 marks)**

e) One Kg of ethylene glycol ($C_2H_60_2$) was added to car radiator containing 4.450 g of water. Calculate the boiling point of solution (k_b= 0.512 °c Kg / moles) **(3 marks)**.

f) Define dynamic **(2 marks)**

Question Three (20 Marks)

a) A gas mixture was prepared by blending 1.24 moles of hydrogen gas with 2.91 moles of oxygen gas under a total pressure of 104 kilopascals. Determine respective partial pressure in atmospheric. **(4 marks)**

b) State Le Chatelier principle and used it to explain the effect of increasing temperature and pressure on the following equilibrium **(4 marks)**

$$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g) \qquad DH = 57\ KJ/MOL^{-1}$$

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

d) State and explain four assumptions made in Kinetic molecular theory **(4 marks)**

e) State the law of equilibrium **(2 marks)**

f) A solution was prepared by dissolving 86.8 g of a nonvolatile solute in 350. g of water. Calculate the molar mass of a nonvolatile solute given vapor pressure of pure water at 29.6 °C as 31.1 mmHg and that of resulting solution as 28.6 mmHg **(4 marks)**

Question Four (20 Marks)

a) Calculate

i. 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] **(5 marks)**

ii. 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)**

b) Distinguish between an electrolytic cell and a voltaic cell. **(3 marks)**

c) Calculate the equilibrium constant at 25ºC for the cell: $Cu \mid Cu^{2+}(1\ M) \parallel Ag^{+}(1\ M) \mid Ag$ Given $Cu^{2+}/Cu(s)$ $E° = 0.518$ V and Ag+/ Ag(s) $E° = +0.799$ V. **(5 marks)**

b) 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)**

Question Five (20 Marks)

a) With the help of equation state Raoults law **(2 marks)**.

b) Calculate the pH of a buffer solution containing 0.25mol/litre NH_3 ($kb=1.8X10^{-5}$) and 0.40mol/ litre ammonium chloride. **(4 marks)**

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

d) Define common ion effect **(2 marks)**

e) A given household detergent has a pOH of 6.165 at 25 ^{0}C calculate the concentration of hydroxyl and hydrogen ions **(4 marks)**

f) Compare and Comment on the pressure predicted for 536 mL of 1 mole Carbon dioxide gas at 373 Kelvin. using the;

   a. Ideal gas equation **(2 marks)**

   b. Van der waals equation **(3 marks)**

Given **a = 3.61 L^2 atm mol^{-2}, b = 0.0428 L** and

van der waals equation $\boldsymbol{(P + an^2/v^2)(V - nb) = nRT}$.