



THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

A. M. E. C. E. A

MAIN EXAMINATION

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JANUARY - APRIL 2017 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

REGULAR PROGRAMME

CHEM 102: PHYSICAL CHEMISTRY I

Date: APRIL 2017

Duration: 2 Hours

INSTRUCTIONS: Answer Question ONE and any other Two Questions

$R = 0.08206 \text{ l atm mol}^{-1} \text{ K}^{-1}$
 $= 8.3145 \text{ Jmol}^{-1}\text{K}^{-1}$
 $1 \text{ atm} = 760\text{mmHg}$
 $0^\circ\text{C} = 273\text{K}$

Q1.

- a) Given the reaction $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ express K_p in terms of K_c .
(5 marks)
- b) the average kinetic energy of $\text{NH}_3(\text{g})$ at 70°C is $7.5 \times 10^{-21} \text{ J/molecule}$. Calculate the mean square speed of Ne gas in m^2/s^2 at the same temperature and pressure $\text{NH}_3 = 17$, Ne = 20.
(7 marks)
- c) The vapour pressure of water at 17.55mmHg at 20.0°C is 17.5 mmHg. What is the vapour pressure of water above a solution of 1.50m urea $\text{CO}(\text{NH}_2)_2$ at 20.0°C ?
(6 marks)

- d) The equilibrium constant for the reaction $\text{H}_{2(g)} + \text{I}_{2(g)} \rightleftharpoons 2\text{HI}_{(g)}$ is 54.2 at 698K. If 0.500mol $\text{H}_{2(g)}$ and 0.500mol I_2 in a 2.0L vessel are mixed at 698K. How many moles of each gas will be present at equilibrium? **(6 marks)**
- e) Calculate the molar mass of a compound whose vapour density at 260°C is 0.480g/1L at 103mmHg pressure. **(6 marks)**

Q2.

- a) State five basic assumptions of the kinetic theory of gasses. **(5 marks)**
- b) Using the kinetic theory of gases explain
- i) Charles law **(3 marks)**
 - ii) Dalton's law **(3 marks)**
 - iii) Boyles' law **(3 marks)**
- c) A certain hydrate $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$ was heated to drive off the water of crystallization. 54.2g of the hydrate gave off a steam that exerted 24.80 atm in a 2.0L flask at 120°C. Calculate x. (Mg = 24, S = 32, O = 16, H = 1). **(6 marks)**

Q3.

- a) Given that 3.50 moles of NH_3 occupy 5.20L at 47°C, calculate the pressure of the gas (in atm) using
- i) The ideal gas equation **(4 marks)**
 - ii) The vander Waals equation **(4 marks)**
 $a = 4.17\text{atm L}^2/\text{mol}^2$, $b = 0.037\text{L/mol}$
- b) The solubility of nitrogen gas at 298K and 1 atm is 6.8×10^{-4} mol/L. What is the concentration (in molarity) of nitrogen dissolved in water under atmospheric conditions? The partial pressure of nitrogen gas in the atmosphere is 0.78 atm. **(5 marks)**

Q4.

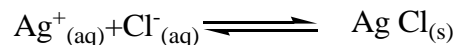
- a) Explain in details how you would prepare 500g of an aqueous solution that is 2.0% NaOH by mass. **(5 marks)**
- b) An aqueous solution of urea $\text{CO}(\text{NH}_2)_2$ is 30% by mass and has a density of 1.02g/ml. Calculate the following:
- i) mole fraction **(3 marks)**
 - ii) molarity **(3 marks)**
 - iii) Molality **(3 marks)**
- c) Use a phase diagram to show the difference in melting point and boiling point of

a pure solvent and an aqueous solution of sucrose. **(6 marks)**

Q5.

a) i) State Le Chatelier's principle. **(3 marks)**

ii) Consider the following equilibrium

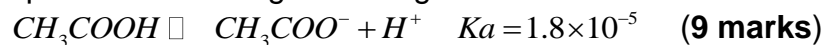


Predict how the amount of solid silver chloride will change when the equilibrium is disturbed by:

- I) adding Na Cl
- II) adding Ag NO₃
- III) adding NH₃ which reacts with Ag⁺ to form the complex ion Ag(NH₃)₂⁺. **(6 marks)**

b) i) Define a buffer. **(2 marks)**

ii) 25.0ml of 0.200M acetic acid was reacted with 10.0ml of 0.100M NaOH. Determine the pH of the resulting solution given that



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