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MAIN EXAMINATION

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 l atm mol^{-1} K^{-1}
= 8.3145 $Jmol^{-1}K^{-1}$
1 atm = 760mmHg
0^oC = 273K

Q1.

a) Given the reaction $N2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$ express K_p in terms of K_c. (**5 marks**)

b) the average kinetic energy of $NH_{3(g)}$ at 70^oC is 7.5 x 10^{-21}J/molecule. Calculate the mean square speed of Ne gas in m^2/s^2 at the same temperature and pressure NH_3 = 17, Ne = 20. (**7 marks**)

c) The vapour pressure of water at 17.55mmHg at 20.0^oC is 17.5 mmHg. What is the vapour pressure of water above a solution of 1.50m urea $CO(NH_2)_2$ at 20.0^oC?

(6 marks)

d) The equilibrium constant for the reaction $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$ is 54.2 of 698K. If 0.500mol $H_{2(g)}$ 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^oC 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 $MgSO_4.xH_2O$ 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^oC. Calculate x. (Mg = 24, S = 32,) = 16, H = 1). **(6 marks**)

Q3.

a) Given that 3.50 moles of NH_3 occupy 5.20L at 47^oC, calculate the pressure of the gas (in atm) using

i) The ideal gas equation (**4 marks)**
ii) The vander Waals equation (**4 marks**)

a = 4.17atm L^2/mol^2, b = 0.037.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 $CO(NH_2)_2$ 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

$$Ag^{+}_{(aq)} + Cl^{-}_{(aq)} \rightleftharpoons Ag\,Cl_{(s)}$$

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

I) adding Na Cl
II) adding Ag NO_3
III) adding NH_3 which reacts with Ag^+ to form the complex ion $Ag(NH_3)_2^{+}$. **(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

$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+ \quad Ka = 1.8\times10^{-5}$$ (**9 marks**)

END