KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE AND BACHELOR OF EDUCATION

SCH 101: INTRODUCTION TO PHYSICAL CHEMISTRY

DATE: Thursday, 29th March, 2011 TIME: 8.00 a.m. – 10.00 a.m.

INSTRUCTIONS:

Answer **ALL** questions

Useful information:

$R = 8.314\ J\ mol^{-1}K^{-1} = 0.08206\ litre\text{-}atm\ mole^{-1}K^{-1}$

$0^0C = 273.15\ K$, 1 atm pressure = 760 mmHg = 101325 Nm^{-2}

He = 4, H = 1; C = 12; O = 16

Q.1. (a) State Charles' law [3 marks]

(b) A typical high pressure tyre has a volume of 365 cm^3 and a pressure of 7.8 atm , at 25^0C . If the tyre is to be filled with helium determine the mass required [3 marks]

(c) A sample of gas was found to contain 5.38g per litre at 15^0C and 736 mmHg pressure. Determine the molar mass of the gas [3 marks]

(d) Calculate the pressure in atmospheres exerted by 2.0 moles of chlorobenzene vapours confined to 10.0 liter vessel at 298 K using

(i) the ideal gas equation and [2 marks]

(ii) the van der Waals equation. [3 marks]

($a = 25.43\ L^2\ atm\ mol^{-2}$, $b = 0.1453\ L\ mol^{-1}$)

(e) A 0.50 L flask containing neon, Ne, at a pressure of 1.25 atm is connected to another 0.20 flask containing Argon gas at a pressure of 1.75 atm. What is the final pressure (in atm) after equilibrium is attained? [4 marks]

Q 2. **(a)** For the reaction $CO_2(g) + H_2(g) \rightleftharpoons CO(g) + H_2O(g)$ the equilibrium constant at 1000 K is 0.53.

i) Write the expression for the equilibrium constant K_c. [2 marks]

ii) Is a gaseous mixture containing 0.20 mole of CO, 0.25 mole of H_2O, 0.42 mole of CO_2 and 0.33 mole of H_2 in a 1 dm^3 vessel at equilibrium? Explain [2 marks]

iii) If a mixture at equilibrium in a 1 dm^3 vessel contains 0.25 mole of CO, 0.5 mole of CO_2 and 0.6 mole of H_2 , how many moles of H_2O are there in the vessel ? [4 marks]

iv) Suppose that 1.0 mole of H_2 and 1.0 mole of CO_2 are mixed in a 1 dm^3 vessel. How many moles of CO and H_2O will be produced when equilibrium is reached? [4 marks]

v) 0.5 mole of an inert gas is added to the equilibrium mixture in (iv) at (a) constant volume and (b) at constant pressure. Predict the equilibrium concentrations of CO_2 and H_2O. [4 marks]

b) The solubility product of AgCl is 1.56×10^{-10} at 298 K. Calculate the solubility of AgCl in

i) Pure water [2 marks]
ii) a solution of 0.1 M with respect to NaCl, and [2 marks]
iii) a solution 0.1 M with respect to $AgNO_3$ [2 marks]

Q3. a) For the cell Mn Mn^{2+} (0.5 M) $\|$ Pb^{2+} (1.5M) $|$ Pb and given that the standard reduction potentials for the half –cell Mn $|$ Mn^{2+} and Pb $|$ Pb^{2+} are – 1.180 V and – 0.126 V respectively:

(i) Write down the cell reaction [2 marks]

(ii) Calculate the emf at 25°C [4 marks]

(iii) Determine the cell equilibrium constant at 25°C. [3 marks]

(b) i) Calculate the pH of a solution that is both 1.00 M CH_3COOH and 1.00 M CH_3COONa. ($Ka = 1.8 \times 10^{-5}$) [4 marks]

ii) Saccharin, a sugar substitute, is a weak acid with pKa = 11.68 at 25°C. It ionises in aqueous solution as follows:

$$HNC_7H_4SO_3(aq) \rightleftharpoons H^+(aq) + NC_7H_4SO_3^-(aq)$$

What is the pH of a 0.10 M solution of the substance? [4 marks]

Q 4 a) i) Express Raoult's law in words. [2 marks]

(ii) Is Raoult's law valid for a solution of a volatile solute? Explain.[2 marks]

iii) Mixtures of water and methanol obey Raoult's vapour pressure law. If the vapour pressure of pure water at 298 K is 24 mmHg, calculate the partial vapour pressure of water in a mixture of 36 g water and 32 g methanol at this temperature. [4 marks]

b) One mole of N_2O_4 is confined in a vessel at 298 K under a pressure of 1 atm. When the equilibrium is attained, N_2O_4 is found to be 16.6% dissociated into NO_2. Calculate the pressure equilibrium constant, K_p ,for the dissociation of N_2O_4 into NO_2. [5 marks]