



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:

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

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

$$\text{He} = 4, \text{H} = 1; \text{C} = 12; \text{O} = 16$$

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- 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°C . 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°C 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]
- ($a = 25.43 \text{ L}^2 \text{ atm mol}^{-2}$, $b = 0.1453 \text{ L mol}^{-1}$)
- (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 $\text{CO}_2(\text{g}) + \text{H}_2(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + \text{H}_2\text{O}(\text{g})$ 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]

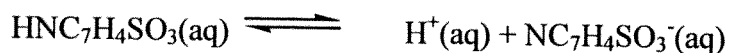
b) The solubility product of AgCl is 1.56×10^{-10} at 298 K. Calculate the solubility of AgCl in

- 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 $\text{Mn} | \text{Mn}^{2+} (0.5 \text{ M}) || \text{Pb}^{2+} (1.5 \text{ M}) | \text{Pb}$ and given that the standard reduction potentials for the half-cell $\text{Mn} | \text{Mn}^{2+}$ and $\text{Pb} | \text{Pb}^{2+}$ 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 . ($K_a = 1.8 \times 10^{-5}$) [4 marks]

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



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]