 **CHUKA UNIVERSITY**

 **COLLEGE**

**UNIVERSITY EXAMINATIONS**

**FIRST YEAR EXAMINATION FOR THE AWARD OF DEGREE OF**

**BACHELOR OF SCIENCE & BACHELOR OF EDUCATION (SCIENCE)**

**CHEM 120: PHYSICAL CHEMISTRY I**

**STREAMS: B.SC & B.ED (SCIENCE) Y1S1 TIME: 2 HOURS**

**DAY/DATE: THURSDAY 13/12/2012 11.30 A.M– 1.30 P.M**

**INSTRUCTIONS:**

Answer Question ONE and any other TWO Questions.

USEFUL DATA:

IF = 96500 C

1 Cal = 4.184J

1 atm = 101325 N M-2 = 760mmHg

R = 8.314 N mmol-1K-1

In x = 2.303 Logx

**QUESTION ONE (30 MARKS)**

1. (a) Comment on the following observation: “A real gas in a container starts behaving

 ideally as temperature is raised”. [5 marks]

(b) When nitrogen and hydrogen gases are mixed in the proportion 1:3 at 50 atm and 650 ̊ C, the equilibrium concentration of ammonia is 25% by wt. Calculate the equilibrium constant. [5 marks]

(c) At 1100 K the following data were obtained on the homogeneous reaction given by the following overall equation:

 2 NO(g) + 2H2(g) N2(g) + 2H2O(g)

|  |  |  |  |
| --- | --- | --- | --- |
| ExpNO | [NO] | [H2] | Rate |
|  | mol dm-3 | mol dm-3 | mol dm-3 sec-1 |
| 1 | 5.0 x 10-3 | 2.5 x 10-3 | 3.0 x 10-5 |
| 2 | 15.0 x 10-3 | 2.5 x 10-3 | 9.0 x 10-5 |
| 3 | 15.0 x 10-3 | 10.0 x 10-3 | 36.0 x 10-5 |

1. Calculate the order of the reaction with respect to NO, with respect to H2 and the overall order. [3 marks]
2. Write the rate law expression for the reaction {H = 1, 0 = 16, N = 14}.

[½ mark]

1. Calculate the rate constant for the reaction. [1 mark]
2. What will be initial rate of the reaction when [NO] = [H2] = 8.0 x 10-3 mol dm-3. [½ mark]

(d) “The Neutralization of all bases by acids do not necessarily occur at pH 7”.

 Explain. [5 marks]

(e) Given the following heats of reaction at 25̊ C:

 C2H4(g) + 3O2(g)$ \rightarrow $ 2CO2(g) + 2H2O(l) $∆$H = -337.3 kcal

 2H2(g) + O2(g) $ \rightarrow $ 2H2O(l) $∆$H = -136.6 k Cal

 2C2H6 + 7O2(g) $\rightarrow $ 4 CO2(g) + 6 H2O(1): $∆$H = -745.6 k Cal

 Calculate the $∆$H for the reaction.

 C2H4(g) + H2(g) $\rightarrow $ C2H6(g) at 25̊ C. [5 marks]

(f) A current of 0.452 A is passed through an electrolytic cell containing molten

Cacl2 for 1.50 hours. Write the electrode reactions and calculate the quantity of products (in grams) formed at the electrodes

Given: Ca = 40.08

 Cl = 35.45 [5 marks]

**QUESTION TWO (20 MARKS)**

1. (a) (i) Two separate bulbs are filled with an ideal gas A and a non-ideal gas B

respectively in such a way that the PV remains same. B is below its Boyle temperature. Which gas has higher temperature? Explain. [2 marks]

 (ii) A faulty barometer reads 740 torr when the pressure is 750 torr. The

barometric tube is 790 mm long. What pressure will the barometer read when the real pressure is 760 mmHg? [4 marks]

 (iii) “The compressibility factor of a real gas is greater than unity at high

 pressure and temperature”. Comment. [5 marks]

 (b) (i) Discuss the effects of temperature and pressure on the rate and rate

 constant in a reversible reaction. [6 marks]

 (ii) Determine the rate law for the reaction A + B + C $\rightarrow $ products.

 From the following information when the initial rate concentration of A

Is doubled, the initial rate of reaction doubles. Doubling the initial concentration of B doubles the rate twice and doubling the initial concentration of C cuts the reaction rate by half. [3 marks]

**QUESTION THREE (20 MARKS)**

1. (a) For the reaction

CO2(g) + H2(g) $⇌$ CO(g) + H2O(g)

 The value of k at 552 ̊ C is 0.137. If 5 moles of CO2, 5.0 moles of H2, 1.0 mole

of CO and 1.0 mole of H2O are initially present, what are the actual concentration of CO2, H2, CO and H2O at equilibrium? [4½ marks]

 (b) Use Le Chatelier’s principle to predict the effect of

1. increased pressure [2½ marks]
2. decreased temperature on the formation of ammonia from Nitrogen and hydrogen

N2 + 3H2 $\rightarrow $ 2NH3 [2 marks]

(c) (i) Describe the preparation of acidic buffer with a given pH in Chemistry

 laboratory. [7½ marks]

1. The pH of a buffer solution containing 0.5 mole/lite of CH3COOH and 0.5 mole/litre CH3COONa has been found to be 4.76. What will be th pH of this solution after 0.1 mole/litre HCl has been added to the buffer? Assume that the volume is unchanged Ka = 1.75 x 10-5. [3½ marks]

**QUESTION FOUR (20 MARKS)**

1. (a) (i) State Hess’s law of constant heat summation and describe its application.

[6 marks]

 (ii) Calculate the bond energy of HCl, given that H-H bond energy is

433KJ mol-1, Cl-Cl bond energy is 242 KJ mol-1 and $∆$Hf for

HCl is – 91 KJ mol-1. [6 marks]

 (b) (i) The standard potentials of Cu2+/Cu and Zn2+/Zn systems are reported with

different signs. Why? Which one is positive according to your convention? [5 marks]

1. Predict whether the reaction 2Ag(s) + Zn2+(aq) $\rightarrow $ Ag+aq + Zn(s) is

feasible or not. Explain.

Given: Zn2+(aq) + 2e- $\rightarrow $ Zn(s), E̊ = -0.763 V

 Ag+(aq) + e- $\rightarrow $ Ag(s) . E̊ = -0.90V [3 marks]

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