THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

A. M. E. C. E. A

P.O. Box 62157
00200 Nairobi - KENYA
Telephone: 891601-6
Fax: 254-20-891084
E-mail:academics@cuea.edu

MAIN EXAMINATION

MAY – JULY 2015 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

CHEM 102: PHYSICAL CHEMISTRY I

SCHOOL FOCUSED PROGRAMME

Date: JULY 2015	**Duration: 2 Hours**
INSTRUCTIONS: Answer Question ONE and ANY OTHER TWO Questions	

Useful information
R = 0.0821, L atm mol^{-1} or 8.314J mol^{-1} k^{-1}
O^0C = 273K
1 atm = 760 mmHg

Q1. a) State the Boyle's and Charles law of gases and use them to derive the ideal gas equation. **(6 marks)**

b) State FOUR basic assumptions of the kinetic theory of gases. **(4 marks)**

c) How many litres of chlorine gas, Cl_2 can be obtained at 40^0c and 787 mmHg from 9.41g of hydrogen chloride Hcl, according to the following equation.

$$2KM_nO_{4(s)} + 16HCl_{(aq)} \longrightarrow 2KCl_{(aq)} + Mncl_{(aq)} + 5Cl_{2(g)} + 8H_2O_{(l)}$$

(6 marks)

d) 100ml of oxygen at 1.75 atm and 200 ml nitrogen at 0.6 atm are passed into a vessel whose capacity is 500ml. Calculate the total pressure in the vessel at the same temperature. **(4 marks)**

e) 0.250 mol SO_2 and 0.300 mol $O_{2(g)}$ react at 500K in a 2.0l vessel to form 0.08M $SO_{3(g)}$ at equilibrium. Determine K_c at 500 K for the reaction.

$2S0_{2(g)} + 3O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ **(6 marks)**

f) State the Graham's law of diffusion and give a relation between the times (t_1 and t_2) of diffusion of two gases of masses M_1 and M_2 respectively to diffuse through a hole of a given temperature. **(4 marks)**

Q2. a) i Differentiate between real gases and ideal gases. **(2 marks)**

ii Briefly explain the pressure and volume with regard to modification of ideal gas reaction. **(6 marks)**

b) i Using ideal gas equation (PV = nRT) derive the real gas equation. **(6 marks)**

ii Determine the difference between ideal pressure and real pressure of a sample of 1.00 mol ethane, C_2H_6 that has a volume of 22.4l at 0^0c given that the van der waals constants a and b for C_2H_6 are $5.570l^2$ atm $(mol^{-1})^2$ and 0.0650 l mol^{-1} respectively. **(6 marks)**

Q3. a) i Define chemical equilibrium **(2 marks)**

ii Define Le Chatelier's principle. **(2 marks)**

b) Using examples, explain THREE factors that affect a chemical equilibrium. **(9 marks)**

c) The following equilibrium process has been studied at 230^0c

$2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$ in one experiment the concentrations of the reating species at equilibrium, are found to be [NO] = 0.0542M [O_2] = 0.127M and [NO_2] = 15.5M. Calculate the equilibrium constant (K_C) of the reaction at 230^0c. **(3 marks)**

d) For the equilibrium $2S0_{\mathbf{3(g)}} \rightleftharpoons 2SO_{2(g)} + O_{2(g)}$ at 1000Ktemperature Kc has the value of 4.07×10^{-3}. Calculate the value of Kp. **(4 marks)**

Q4. a) i Define a buffer. **(2 marks)**

ii List TWO importance of a buffered solution. **(2 marks)**

iii Calculate the pH of a buffer made from 0.24M NH_3 and 0.20M NH_4Cl K_b = 1.8×10^{-5} **(5 marks)**

iv Suppose 0.001 mol NaOH is added to 1.0L of the solution in (ii) above what will be the pH of the resulting solution? **(5 marks)**

b) i Differentiate between a strong base and a weak base. **(2 marks)**

ii Calculate pH of 0.01M Ba $(OH)_2$ (Ba. $(OH)_2$ is a strong base. **(4 marks)**

Q5. a) Consider the reaction for the manufacture of methanol (CH_3OH) by reaction of carbon monoxide with hydrogen in presence of Z_nO/ Cr_2O_3 catalyst as shown below:

$$CO_{(g)} + 2H_{2(g)} \xrightleftharpoons{Z_nO/Cr_2O_3} CH_3OH_{(g)} \quad \Delta H^0 = -91kj$$

Explain how the changes in the following parameters affects the yield of methanol:

i Temperature is increased **(2 marks)**

ii Volume is deceased for CH_3OH **(2 marks)**

iii Helium is added **(2 marks)**

iv CO is added. **(2 marks)**

v Catalyst is removed. **(2 marks)**

b) i Write the equilibrium constant expression the equation in (a) above. **(2 marks)**

ii Briefly explain the common ion effect. **(2 marks)**

iii Given that K_{sp} for AgCL is 2.8×10^{-1} M^2 determine the solubility of $AgCl_{(s)}$ in 0.1M $AgNO_3$ **(3 marks)**

c) The solubility of $CuBr_2$ is 2.0×10^{-4} M at 25^0c. Calculate the K_{sp} value of $CuBr_2$ **(3 marks)**

END