*(University of Choice)*
**MASINDE MULIRO UNIVERSITY OF
SCIENCE AND TECHNOLOGY
(MMUST)
MAIN CAMPUS**

**UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR**

**FIRST YEAR FIRST SEMESTER EXAMINATIONS**

**FOR THE DEGREE
OF
BACHELOR OF EDUCATION AND BACHELOR OF SCIENCE
(SUPPLEMENTARY EXAM)**

**COURSE CODE:    SCH 140**

**COURSE TITLE:  PHYSICAL CHEMISTRY**

**DATE:  27.07.2022**                    **TIME: 8.00-10.00 AM**

**INSTRUCTIONS TO CANDIDATES**
  ➢  Answer **ALL** questions

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 12 Printed Pages. Please Turn Over.

**Question one (18 marks)**

a) Give the Van der Walls equation defining all the terms **(3 marks)**

b) State any two postulates of kinetic theory of gases and why it may not be applicable in real gas situation **(4 marks)**

c) Briefly explain the terms;

i) Avogadros Law **(2marks)**

ii)Maxwell-Boltzmann distribution **(2marks)**

d) The volume of a gas at 1 atm pressure is 390 $cm^3$. Calculate the volume that the gas will occupy if the pressure is increased to 1.5 atms at constant temperature **(2 marks)**

e)i) What is common ion effect **(1mark)**

ii) The solubility of AgCl is 1.67 x $10^{-5}$ moles per litre at 25 °C. Calculate the solubility product of AgCl **(2marks)**

f) How does increase in pressure affect solubility of gases in water **(2marks)**


**Question two (17 marks)**

a) A mixture of 0.1 mol NO, 0.05 mol $H_2$ and 0.1 mol $H_2O$ are placed in a 1.0 litre flask. The mixture established the equilibrium;

$2NO_{(g)} + 2H_{2(g)} \longleftrightarrow N_{2(g)} + 2H_2O_{(g)}$ at equilibrium, [NO] = 0.07 M.

    i)      Calculate the equilibrium concentrations of $H_2$, $N_2$ and $H_2O$ **(4marks)**
    ii)     Write the expression for $K_C$ for this reaction **(2marks)**
    iii)    Calculate $K_c$ for this reaction **(2marks)**

b) The pH of a solution of acetic acid ($C_2H_4O_2$) is found to be 2.68. What is the $K_a$ for this solution **(3marks)**

c) Methanol ($CH_3OH$) is prepared by a reaction of carbon monoxide and hydrogen gases. In a laboratory test, a vessel was filled with 35.4g CO and 10.2 $H_2$

$CO_{(g)} + H_{2(g)} \longrightarrow CH_3OH_{(l)}$

    i)     How many grams of methanol would be prepared in a complete reaction **(3marks)**
    ii)    How many grams of the unconsumed reagent remained at the end of the reaction **(3marks)**

**Question three (18marks)**

a)Pure benzene freezes at 5.6 $^0C$. A solution prepared by dissolving 0.45g of an unknown substance in 27.3g benzene is found to freeze at 4.18 $^0C$. Determine the molecular weight of the unknown substance. The freezing point constant for benzene is 5.12 $^0C$/mol.        **(4marks)**

b) Use examples to discuss any two colligative properties        **(4marks)**

c) A voltaic cell is represented by the short notation;

$Mg_{(s)} \mid Mg^{2+}_{(aq)} \parallel Ni^{2+}_{(aq)} \mid Ni_{(s)}$

    i)        Draw this conventional cell indicating flow of electrons and flow of ions    **(4 marks)**

    ii)       Calculate the EMF of the cell given that; $E_{Mg^{2+}(aq)/Mg(s)}$ = -2.38 V and $E_{Ni^{2+}(aq)/Ni(s)}$ = - 0.23V    **(2marks)**

    iii)     Explain what you would observe if a nickel based emulsion paint would be kept in a magnesium vessel    **(2marks)**

d) Describe a solid–vapour equilibrium giving an example.        **(2marks)**


**Question four (17 marks)**

a) A balanced equation for the industrial synthesis of ammonia using the Haber-Bosch process yields only 17-21% ammonia. The process is represented by the equation below;

$3H_{2(g)} + N_{2(g)} \longrightarrow 2NH_{3(g)}$ + heat. Discuss how the yield of ammonia can be increased from the 17-21%.        **(6 marks)**

b) At 88$^0C$, saturated vapour pressure of benzene and toluene are 953 and 378 mmHg respectively. Calculate the vapour pressure of a benzene-toluene mixture containing 2 mol of benzene per mol of toluene, assuming Rauolts law is obeyed        **(3marks)**

c) Consider the composition-temperature curve for water and ethanol at sea level;
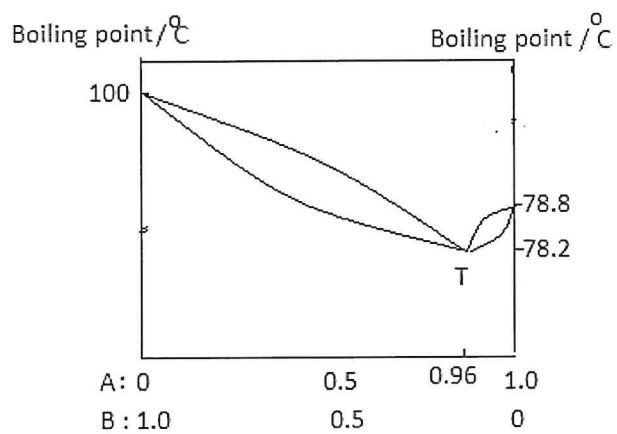
i)   Identify A and B giving a reason                                      (2marks)
ii)  Describe the effect of point T to distillation of the mixture         (2marks)
iii) Discuss negative and positive deviations to Raoults Law               (4marks)