KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR

FIRST YEAR SECOND SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF BRB, BPH, BAB, BEE AND BCH

COURSE CODE: SCH 121*

COURSE TITLE: INTRODUCTION TO PHYSICAL CHEMISTRY

DATE: 9/05/2022   **TIME: 2:00PM-4:00PM**

INSTRUCTIONS TO CANDIDATES:

TIME: 2 HOURS

ANSWER QUESTION ONE AND ANY TWO OF THE REMAINING

CONSTANTS
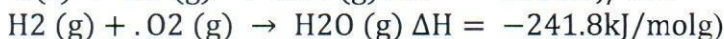$(R = 0.082 Latmmol^{-1}K^{-1})$
$a = 0.6780 litreatmmol^{-2}$
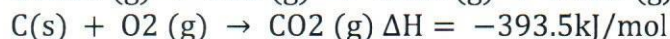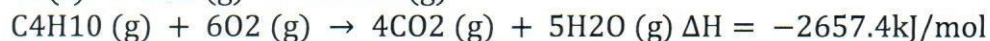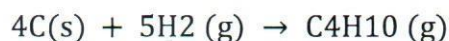$b = 0.0564 litremol^{-1}$
$1F = 96487$ C mole^{-1}

KIBU observes ZERO tolerance to examination cheating

Question One (30marks)
(a) State the following laws (3 marks)
  i.   Hess's law
  ii. Charles law
  iii. Boyles law
(b) Using $PV = nRT$ where R is gas constant derive the significance of gas constant R (3 marks)
(c) Gases are divided into ideal and real gases. State the two conditions under which real gases tend to obey ideal gas laws (2 marks)
(d) (i) State the law of mass action (1 mark)
(ii) The equilibrium constant K_c for the reaction $H_2 + Cl_2 \rightarrow 2HCl$ is 35 at 60°C. Calculate the number of moles of HCl in equilibrium with 0.5 moles of Hydrogen and 3 moles of chlorine at 60°C (2 marks)
(e) (i) Define colligative property (2 mark)
   (ii) State the four colligative properties (4 marks)
(f) Using the information given below calculate the enthalpy of the following equation (3 marks)

4C(s) + 5H2 (g) → C4H10 (g)
C4H10 (g) + 6O2 (g) → 4CO2 (g) + 5H2O (g) ΔH = −2657.4kJ/mol
C(s) + O2 (g) → CO2 (g) ΔH = −393.5kJ/mol
H2 (g) + .O2 (g) → H2O (g) ΔH = −241.8kJ/molg)

(g) State three differences between metallic and electrolytic conductors (3 marks)
(h) Is it possible to store nickel (II) Sulphate in a copper container? Explain ($Cu^{2+} + 2e \rightleftharpoons Cu (+.034v)$, $Ni^{+2} + 2e \rightleftharpoons Ni(-0.23V)$) (2marks)
(i) A 0.43 amp current flowed through a molten magnesium fluoride electrolytic cell for 1 hour, 35.0 minutes. What mass of magnesium was produced? (Mg=24) (2 marks)
(j) (i) In chromatography what is retention factor (1 mark)
   (ii) If a compound travels 1.3 cm and the solvent front travels 5.2 cm determine the retention factor (2 marks)
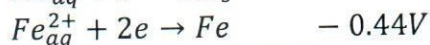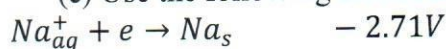
Question Two (20 marks)
(a) A sample of the black mineral hematite, an oxide of iron found in many iron ores, contains 34.97 g of iron and 15.03 g of oxygen. What is the empirical formula of the hematite? (5marks)
(b) The vapour pressure of pure benzene is 0.850 bars at room temperature. On addition of 0.6 g of non-volatile solute in 39 g of benzene solution, the vapour pressure of benzene reduces to 0.845 bars. What is the molar mass of the non-volatile solute? (Molar mass of benzene=78) (5 marks)
(c) Three moles of sulphur dioxide gas are confined in 5 litres vessel at 298 K. calculate the pressure in atm exerted by sulphur dioxide
(i) Assuming ideal gas behaviour (2 marks)
(ii) Assuming sulphur dioxide gas behaves as real gas (2marks)
(d) (i) State Lechatelier's principle (2 marks)
   ii) Briefly explain the effect of the following on equilibrium
   a) Concentration (2 marks)
   b) Temperature (2 marks)

Question Three (20 marks)

(a) Define acids using the following concepts
  i.   Arrhenius concept **(2 marks)**
  ii. Bronsted-Lowry concepts **(2marks)**
(b) (i) Define the term pH **(2 marks)**
  (ii)Calculate the pH value of a solution containing $2.0 \times 10^{-2} M$ of KOH **(5 marks)**
(c) (i) What is a buffer solution **(2 marks)**
  (ii) Using Henderson equation determine the pH of a buffer solution containing 0.2M $HCOOH$ and 0.02M Sodium methanoate. ($K_a = 1.85 \times 10^{-5}$) **(4 marks)**
(d) The solubility product (K_{SP}) of magnesium hydroxide ($Mg(OH)_2$) is 1.2×10^{-11}. Calculate the solubility of magnesium hydroxide **(3 marks)**

Question Four (20 marks)

(i) State the five assumptions of kinetic molecular theory. **(5 marks)**
(ii) Distinguish between Ebullioscopic constant and Cryoscopic constant **(3 marks)**
(iii) Copper (II) oxide reacts with hydrochloric acid to produce copper (II) chloride and water. How many liters of a 4.5 M HCl solution will react with 33.0 g of copper (II) oxide? $CuO_{(s)} + 2 HCl_{(aq)} \rightarrow CuCl_{2(aq)} + H_2O_{(l)}$ **(3 marks)**
(iv) A major textile dye manufacture developed a new yellow dye. The dye has a percent composition of 75.95%C, 17.72%N and 6.33%H by mass with molar mass of about 258g/mol. Determine the molecular formula of the of the dye **(3 marks)**
(v) (a) Define electrolysis **(2 marks)**
   (b) State the two types of electrochemical cells **(2 marks)**
   (c) Use the following electrode potentials to answer the question that follows
$Na^+_{aq} + e \rightarrow Na_s \qquad -2.71V$
$Fe^{2+}_{aq} + 2e \rightarrow Fe \qquad -0.44V$
Calculate the emf of Na/Fe cell **(2 marks)**

Question Five (20 marks)

(a) (i) State the two conditions required for real gases to obey ideal gas laws **(2 marks)**
   (ii) Using ideal gas equation ($PV=nRT$) deduce Vanderwaal equation **(3 marks)**
(b) Balance the following chemical equations **(4 marks)**
$Pb(NO_3)_{2(g)} + \rightarrow PbO_{(s)} + NO_{2(g)} + O_{2(g)}$
$Zn_{(s)} + HNO_{3(aq)} \rightarrow Zn(NO_3)_{2(aq)} + H_2O_{(l)} + NO_{(g)}$
$(NH_4)_2Cr_2O_{7(s)} \rightarrow Cr_2O_{3(s)} + N_{2(g)} + H_2O_{(g)}$
$Mg_3(PO_4)_{2(aq)} + H_3PO_{4(aq)} \rightarrow Mg(H_2PO_4)_{2(aq)}$
(c) State three types of chromatography commonly applied in the lab **(3 marks)**
(d) A given mass of a gas occupies a volume of 250ml at 21°C and a pressure of 1.4 atm. At what pressure would the volume be 300ml when the temperature rises to 49°C **(3 marks)**
(e) Show that the relationship between K_p and K_c is given by $K_P = K_c (RT)^{\Delta n}$ **(5 marks)**