MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF APPLIED SCIENCES

UNIVERSITY ORDINARY EXAMINATION

2017/2018 ACADEMIC YEAR

FIRST YEAR **FIRST** SEMESTER EXAMINATION FOR THE BACHELOR OF ANALYTICAL CHEMISTRY AND EDUCATION SCIENCE

ACH 103 – PHYSICAL CHEMISTRY

DURATION: 2 HOURS

DATE: 18TH DECEMBER, 2017

TIME: 2.00 – 4.00 P.M.

Instructions to Candidates:

1. Answer **Question 1** and **Any Other Two** questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

Important Constants

Planks constant = 6.6226×10^{-34} mKg/s

R = 8.314J/mol K, 0.0821 L atm/mol K^{-1}

SECTION ONE - COMPULSORY

QUESTION ONE

(a) Define Charles Law and Rawlts Law (2 marks)

(b) List four types of electrodes (2 marks)

(c) 4.8L of chlorine gas at 6.5 atm pressure is used to fill a balloon with a final pressure of 1.15atm. Calculate the final volume (3 marks)

(d) A solution of non-electrolyte contains 30g of solute dissolving in 250g of water. The boiling point of the solution is observed at 101.04°C. calculate the molecular weight of the non-electrolyte substance ($K_{bwater} = 1.86°c/m$) (4 marks)

(e) The alkali metals react with halogens to form ionic metal halides. Calculate the amount of potassium chloride produced if 525L of chlorine gas at 0.950atm and 293K reacts completely with potassium (4 marks)

(f) Calculate the r.m.s velocity of

i) Water vapour molecules at 300°C (2 marks)

ii) Hydrogen gas molecules at 30°C (2 marks)

iii) Compare and comment on the speeds of $H_2O_{(g)}$ and $H_{2(g)}$ above (1 mark)

(g) The pH of some Grape juice at 25°C is found to be 3.45. Calculate

i) $[H_30^+]$ (2 marks)

ii) pOH (2 marks)

(h) Formation of phosgene $(COCl_2)$ from CO and Cl_2 at 600c follows the reaction below;

$CO_{(g)} + Cl_{2(g)} \rightleftarrows COCl_{2(g)}$

Suppose initial partial pressure of CO is 0.6 atm and 1.0 atm for Cl_2. At equilibrium, the partial pressure of $COCl_2$ is found to be 0.1 atm. Calculate;

i) Partial pressure of CO and Cl_2 at equilibrium (2 marks)

ii) Equilibrium constant (2 marks)

(i) Consider the following standard potentials

$Fe^{2+} + 2e \longrightarrow Fe_{(s)}\ E°/v = -0.44$

$Zn^{2+} + 2e \longrightarrow Zn_{(s)}\ E°/v = -0.76$

Deduce with reasons, the species reduced if the two (2) half cells are connected in a electrochemical cell (2 marks)

SECTION TWO – ANSWER ANY TWO QUESTIONS

QUESTION TWO

(a) Ammonia Perchlorate NH_4Cl0_4 decomposes to nitrogen gas, chlorine gas, oxygen gas and water vapour when heated

i) Write a balanced equation for the decomposition of NH_4Cl0_4 to products listed above (2 marks)

ii) State Dalton's Law (2 marks)

iii) What is the total pressure (P_T) of the gas mixture at 800°C when 7.00 x 10^5Kg of NH_4Cl0_4 is heated and allowed to fill a volume of 6400M^3 (6.4 x 10^6L). Using the ideal gas law (6 marks)

iv) The gas mixture from part (iii) cools to reach a temperature of 200°C and pressure of 3.20 atm. Calculate the volume occupied by the gas mixture at this temperature and pressure (Assume the gas behaves as an ideal gas) (4 marks)

(b) A solution of Nitric Acid with pH 2.32 at 25°C is diluted with water to twelve times its original volume. Calculate the pH of the solution after dilution (6 marks)

QUESTION THREE

(a) Consider reaction of 11.74ml of 0.071M of Na0H and 15.78ml of 0.094M of HCL (neutralization reaction)

i) Determine the pH of resulting solution at room temperature (8 marks)

ii) Calculate the concentration of $[0H^-]$ after neutralization (2 marks)

(b) Electrolytes of molten magnesium chloride in a large cell uses steel cathode and a graphite anode. The overall reaction is $Mg^{2+}_{(melt)} + 2Cl_{(melt)} \rightarrow Mg_{(i)} + Cl_{2(g)}$

i) Write equations for half-reactions occurring at the anode and cathode (2 marks)

ii) Draw a convertial cell diagram (2 marks)

(c) Complete and balance the following equation, which represent the dissolution of copper (ll) sulfide in aqueous nitric acid

$CuS_{(s)} + NO_3^- \rightarrow Cu^{2+} + SO_4^{2-} + NO_{(g)}$ (Acid Condition) (6 marks)

QUESTION FOUR

(a) A mixture of Nitrogen, hydrogen and Ammonia at room temperature have the following equilibrium constant as shown below $N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(ag)}$ $K_1 = 3.5\ x\ 10^8$

Find the equilibrium constants of the following equations

i) $\frac{1}{2}N_{2(g)} + \frac{3}{2}H_{2(g)} \rightleftarrows NH_{3(g)}$ $K_2 = ?$ (3 marks)

ii) $NH_{3(g)} \rightleftarrows \frac{1}{2}N_{2(g)} + \frac{3}{2}H_{2(g)}$ $K_3 = ?$ (3 marks)

(b) Complete and balance the following equation for a redox reaction that takes place in basic solution.

$ASO_{3(aq)}^{3-} + Br_{2(aq)} \rightarrow ASO_{4(aq)}^{3-} + Br_{(aq)}^{-}$ (6 marks)

(c) A galvanic cell is constructed in which $Ag_{(aq)}^{+}$ ions are reduced to silver at the cathode and zinc is oxidized to $Zn_{(aq)}^{2+}$ ions at the anode. A steady current of 0.500A passes through the cell for 101 minutes

i) Write the half cell reactions (2 marks)

ii) Calculate the mass of zinc dissolved (3 marks)

iii) Calculate the mass of silver deposited (3 marks)