



THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

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MAIN EXAMINATION

MAY – JULY 2015 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

CHEM 309: ELECTROCHEMISTRY

SCHOOL FOCUSED PROGRAMME

Date: JULY 2015

Duration: 2 Hours

INSTRUCTIONS: Answer Question ONE and ANY OTHER TWO Questions

Q1. Useful Information

$$O^0_c = 273 \text{ k} \quad \frac{RT}{F} \ln x = 0.0591 \log_{10} x \text{ at } 298\text{k}$$

$$1 \text{ F} = 96500 \text{ c mol}^{-1} \quad R = 8.314 \text{ J MOL}^{-1} \text{ K}^{-1}$$

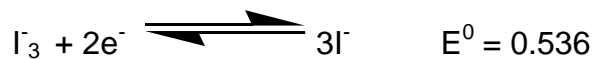
a) A conductivity cell has a resistance of 845.5Ω when filled with a 0.015 M KCl solution and a resistance of 876Ω when filled with a 0.005 M CaCl_2 solution both at 25°C . Given that the specific conductivity of KCl solution at 25°C is $0.14114 \text{ SE } \Omega^{-1} \text{ M}^{-1}$ calculate:

- i The cell constant. **(3 marks)**
- ii The specific conductance of CaCl_2 solution. **(3 marks)**

b) i By means of a Hirtoff's cell describe how the transport numbers of H^+ and Cl^- may be determined. **(8 marks)**

- ii Perform the analysis of the anode and cathode compartments of the above cell when 1 F of electricity is passed through the electrolyte. **(6 marks)**

c) Calculate the equilibrium constant for the reaction $2\text{Fe}^{3+} + 3\text{I}^- \rightleftharpoons 2\text{Fe}^{2+} + \text{I}_3$ at 298k .



- d) Calculate the ionic strength of a 0.15m solution of $\text{Ca}_3(\text{PO}_4)_2$ **(4 marks)**
- Q2. a) Consider the cell $\text{Ag}^-/\text{Ag}_{(a+)_1}\text{NO}_3 // \text{Ag}_{(a+)_2}/\text{Ag}$ Suppose the activities of the silver ions in the right and left hand electrodes are $(a+)_2$ and $(a+)_1$ and the corresponding potentials being E_2 and E_1 respectively. Derive an equation for the emf of the cell. **(12 marks)**
- b) Describe how the emf of an electrochemical cell is measured. **(8 marks)**
- Q3. a) The resistance R of an electrical conductor is proportional to its length (l) and inversely proportional to its cross section area (A) Show that $k=J/E$ and define all the terms. **(8 marks)**
- b) For the cell $\text{pb}/\text{pbCl}_{2(s)}/\text{kcl}/\text{Agcl}/\text{Ag}$ The emf and its temperature coefficients at 25°C are 0.49002v and a 0.000186vK^{-1} respectively.
- i Write down the cell reaction. **(3 marks)**
- ii Calculate ΔG , ΔH and ΔS for the reaction at 25°C . **(9 marks)**
- Q4. a) Briefly discuss the arrhenius theory of ionization and by using HAC show how the results were expressed in the ostwald dilution law. **(10 marks)**
- b) i Describe how iodine coulometer works. **(6 marks)**
- ii Differentiate between electronic and electrolytic conductors. **(4 marks)**
- Q5. a) Explain the origin of electrochemistry. **(6 marks)**
- b) Using the Debye Huckel limiting equation calculate the mean activity coefficient and the mean activity of a 0.015m solution of $\text{ZnCl}_{2(aq)}$ ($A = 0.51\text{mol}^{-1/2}$ for aqueous solution). **(6 marks)**
- c) Using appropriate plots describe how the end points may be determined using conductivity measurement for a titration between

- i HCl and NaOH
- ii CH₃COOH and NaOH.

(8 marks)

END