



# THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

**A. M. E. C. E. A**

**MAIN EXAMINATION**

**JANUARY – APRIL 2014 TRIMESTER**

**FACULTY OF SCIENCE**

**DEPARTMENT OF NATURAL SCIENCE**

**SCHOOL FOCUSED PROGRAMME**

**CHEM 309: ELECTROCHEMISTRY**

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

**Date: APRIL 2014**

**Duration: 2 Hours**

**INSTRUCTIONS: Answer Question ONE and ANY OTHER TWO Questions**

## Useful information

$$\ln x = 2.303 \log_{10} x$$

$$0^{\circ}\text{C} = 273\text{K}$$

$$R = 8.314 \text{ Jmol}^{-1}\text{K}^{-1}$$

$$F = 96485 \text{ Cmol}^{-1}$$

$$\frac{RT}{F} \ln x = 0.0591 \log_{10} x \text{ at } 298\text{K}$$

- Q1. a) The electrode potential for the electrode  $\text{Cl}^{-} / \text{Cl}_{2(g)} / \text{Pt}$  is given by  $E^{\circ} / \text{V} = 1.484867 + 3.959492 \times 10^{-4} T - 2.750639 \times 10^{-6} T^2$ . In the temperature range 273 – 373K. Calculate:
- i)  $E^{\circ}$  (3 marks)
  - ii)  $\Delta G^{\circ}$  (3 marks)
  - iii)  $\Delta H^{\circ}$  (3 marks)
  - iv)  $\Delta S^{\circ}$  (3 marks)
- at 298.15K.
- b) The transport numbers for HCl at infinite dilutions are estimated to be  $t_{+} = 0.821$  and  $t_{-} = 0.179$  and the molar conductivity is 426.16

$\Omega^{-1}cm^2mol^{-1}$ . Calculate the mobilities of the hydrogen and chloride ions. **(8 marks)**

- c) Describe how the transport number are determined using the Hirtoff's method. **(10 marks)**
- Q2. a) Using the Debye-Huckel limiting equation calculate the mean activity coefficient and the mean activity of a 0.002M  $CuCl_{2(aq)}$  solution. ( $A = 0.51 \text{ mol}^{-1/2}dm^{3/2}$  at 25°C for aqueous solution). **(8 marks)**
- b) Explain briefly how the conductance of electrolytes are measured. **(6 marks)**
- c) Calculate the liquid junction potential at 25°C between two solutions of HCl of mean ionic activities of 0.1 and 0.01 given that  $E_{H^+} = 0.828$  and that the electrodes are reversible to  $H^+$  ions. **(6 marks)**
- Q3. a) Explain **FIVE** factors that affect the conductance of an electrolyte solution. **(10 marks)**
- b) Discuss the Arrhenius theory of ionization for  $CH_3COOH$  and show how these ideas were expressed by Ostwald. **(10 marks)**
- Q4. a) Explain **FIVE** types of electrodes used in electrochemistry giving an example for each. **(10 marks)**
- b) For the cell  $Zn/Zn^{2+} // Fe^{3+}, Fe^{2+} / pt$
- Write the cell reaction. **(2 marks)**
  - Determine the equilibrium constant given that  $E^0$  for the reaction is 1.534V at 25°C. **(3 marks)**
- Q5. a) Explain how a pH glass electrode work. **(10 marks)**
- b) Calculate the  $E_{cell}$  at 25°C for the cell  
 $Cu / Cu^{2+} (0.50m) // Fe^{3+} (0.40m), Fe^{2+} / 0.20m / pt$ . Assume that the activity = concentration  $E^0 Fe^{3+} / Fe^{2+} = 0.771V$   $E^0_{cu^{2+}/cu} = 0.340V$ . **(8 marks)**
- c) In the conductimetric titration of a weak acid with a strong base, the transition of the end point is not sharp. Explain. **(2 marks)**

**\*END\***