

**KABARAK**



**UNIVERSITY**

**UNIVERSITY EXAMINATIONS**

**2008/2009 ACADEMIC YEAR**

**FOR THE DEGREE OF BACHELOR OF EDUCATION**

**SCIENCE**

**COURSE CODE: CHEM 411**

**COURSE TITLE: ELECTROCHEMISTRY**

**STREAM: SESSION VI & VII**

**DAY: WEDNESDAY**

**TIME: 2.00 – 4.00 P.M.**

**DATE: 12/08/2009**

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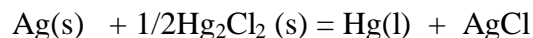
**INSTRUCTIONS TO CANDIDATES:**

F= 96500 C  
Answer ALL QUESTIONS

**PLEASE TURN OVER**

- Q1. a) Define the following terms:
- i) An electrochemical cell (2mks)
  - ii) Ionic mobility (2mks)
  - i) Molar conductivity. (2mks)
- b) A conductivity cell has a resistance of 250 ohms when filled with  $2 \times 10^{-2}$  mol/L KCl solution at 298K and resistance of  $10^5$  ohms when filled with  $6 \times 10^{-5}$  M  $\text{NH}_4\text{OH}$  solution. The specific conductivity of  $2 \times 10^{-2}$  M KCl is  $2.77 \times 10^{-3} \text{ ohm}^{-1} \text{ cm}^{-1}$  and the ionic molar conductivities of  $\text{NH}_4^+$  and  $\text{OH}^-$  are 73.4 and  $198 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$  respectively. Calculate
- i) the cell constant [2mks]
  - ii) the dissociation constant ( $K_b$ ) of  $\text{NH}_4\text{OH}$  [7mks]
- c) The specific conductivity of a saturated solution of silver chloride ( $\text{AgCl}$ ) is  $3.6 \times 10^{-6} \text{ ohm}^{-1} \text{ cm}^{-1}$  and that of water used in preparing the solution is  $0.6 \times 10^{-6} \text{ ohm}^{-1} \text{ cm}^{-1}$ . If the molar conductivities at infinite dilution of  $\text{Ag}^+$  and  $\text{Cl}^-$  are 61.92 and  $76 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$
- Calculate,
- i) The solubility of  $\text{AgCl}$
  - ii) The solubility product,  $K_{sp}$ , of  $\text{AgCl}$ . [6mks]
- Q2. a) Give the differences between electronic and electrolytic conductors [4mks]
- b) State
- (i) Kohlrausch's law of ionic mobility at infinite dilution [2mks]
  - (ii) Ohm's law [2mks]
- c) State the distinction between a galvanic cell and an electrolytic cell [4mks]
- d) Calculate the equilibrium constant at  $25^\circ$  for the reaction
- $$\text{Zn(s)} + \text{Cu}^{2+}_{(\text{aq})} (1\text{M}) = \text{Cu(s)} + \text{Zn}^{2+}_{(\text{aq})} (1\text{M}) \quad E^\circ = 1.1\text{V} \quad [4\text{mks}]$$
- e) Calculate the transport number of  $\text{H}^+$  ions and  $\text{Cl}^-$  ions from the following data obtained by a moving boundary method using silver chloride as an indicator electrolyte. Atomic weight  $\text{Ag}=108$
- Concentration of  $\text{HCl}=0.1\text{M}$
  - Weight of  $\text{Ag}$  deposited in the coulometer = 0.13g
  - Boundary movement = 4.5 cm
  - Cross-section area = 1.25 sq. cm [4mks]

- Q3 a) When a silver- silver chloride and calomel electrode are incorporated in the same cell the reaction taking place as the cell supplies current is



The EMF of the cell is 0.0455V at 998K and the temperature coefficient ( $\frac{\delta E}{\delta T}$ ) is  $5.0 \times 10^{-5} \text{ VK}^{-1}$ . Calculate  $\Delta G$ ,  $\Delta S$  and  $\Delta H$  for the reaction. [7mks]

- b) Give a suitable explanation as to why the resistance of a metal increases and that of an electrolyte solution decreases on raising the temperature. [3mks]

- 4 a) The respective standard electrode potentials and the reaction taking place in the electrochemical cell is given as follows;



Write down the cathode, anode and the net cell reaction of the cell and predict whether the reaction is spontaneous. [5mks]

- b) In a Hittorf experiment a student electrolyzed aqueous  $\text{AgNO}_3$  using silver electrodes. The amount of  $\text{AgNO}_3$  in the anode compartment before electrolysis was 0.228 g and after electrolysis it was 0.282 g. During electrolysis it was found that 0.019 g of Cu was deposited on copper coulometer connected in series to Hittorf cell. Calculate the transport number of  $\text{Ag}^+$  and  $\text{NO}_3^-$ . Atomic masses; N= 14, Cu = 63.5, O= 16 and Ag =108 [6mks]

- c) Explain briefly three factors that affect ionic mobility [6mks]  
d) Write brief notes on electrophoretic effect [2 mks]