



# MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

DECEMBER SESSION EXAMINATION FOR

BACHELOR OF EDUCATION

SCH 401: ELECTROCHEMISTRY

DATE: 25/4/2019

TIME: 11.00-1.00 PM

---

## INSTRUCTIONS TO CANDIDATES

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

### Useful data

$$F = 96,485 \text{ C mol}^{-1}$$

### Standard reduction potentials

Copper +0.34 V

Zinc -0.76 V

## SECTION A: COMPULSORY (30 MARKS)

### QUESTION ONE (30 MARKS)

- a) Define the following terms in electrochemistry;
- Standard electrode potential
  - Redox reaction
  - Faradaic process
  - Cell potential
  - Reducing agent
  - Overvoltage (12 marks)
- b) With the help of a labelled diagram, explain the set up and the use of a standard hydrogen electrode. (6 marks)
- c) Briefly differentiate between glass, hydrogen and calomel electrodes as used in electrochemistry. (6 marks)
- d) A cell is constructed as follows;  $\text{Zn}/\text{ZnSO}_4 (\text{soln}) // \text{CuSO}_4 (\text{soln})/\text{Cu}$
- Write the two half-cell equations and the net cell reaction equation (3 marks)
  - Calculate the standard cell potential and determine if the reaction is spontaneous. (3 marks)

## SECTION B (ANSWER ANY TWO QUESTIONS (20 MARKS EACH))

### QUESTION TWO (20 MARKS)

- a) Using a cyclic voltammogram, describe the peak potentials and currents. (5 marks)
- b) Calculate the total charge passing through a TV set that uses 2.0 A of current in one hour. Given that 96500 Coulombs is the amount of charge per mole of electrons, calculate the number of moles of electrons that pass through the TV set in one hour. (5 marks)
- c) Describe an electrode in terms of an anode or cathode. (2 marks)
- d) Calculate EMF of the following cell at 298 K.  $\text{Cd (Hg)} (a = 0.1) | \text{CdSO}_4 (\text{soln}) | \text{Cd (Hg)} (a = 0.01)$  (4 marks)
- e) Briefly describe any **TWO** roles of a supporting electrolyte in an electrochemical cell. (4 marks)

### QUESTION THREE (20 MARKS)

- a) Explain the use of cyclic voltammetry for estimating the values of  $E^0$  and  $n$  for a reversible system. (4 marks)
- b) Using a diagram, differentiate between reversible and irreversible system in cyclic voltammetry in terms of their features. (4 marks)
- c) Write the cell reaction for the following electrochemical cell:  $\text{Cd} \mid \text{Cd}^{2+} \parallel \text{KCl} \parallel \text{Hg}_2\text{Cl}_2(\text{s}) \mid \text{Hg}$ . (2 marks)
- d) Distinguish between galvanic and electrolytic cells. (4 marks)
- e) Describe the **THREE** modes of mass transport-controlled reactions in an electrochemical cell. (6 marks)

### QUESTION FOUR (20 MARKS)

- a) Distinguish between potentiostatic and potentiometric techniques as used in electroanalysis. (3 marks)
- b) State the Nernst equation and define all the terms in it. (5 marks)
- c) Briefly discuss any **THREE** applications of electrochemistry (6 marks)
- d) Write the cell reaction for the cell  $\text{Zn} \mid \text{ZnSO}_4(\text{aq}) \parallel \text{CuSO}_4(\text{aq}) \mid \text{Cu}$  and calculate the equilibrium constant at  $25^\circ\text{C}$ . (6 marks)

### QUESTIONS FIVE (20 MARKS)

- a) Using a well labelled diagram, show how the direction of electrons and current flow compare in an electrochemical cell. (5 marks)
- b) A cell reaction has the following cell potentials  $+1.4\text{ V}$  and  $-1.2\text{ V}$ . Which cell potential qualifies the reaction to be spontaneous, explain? (3 marks)
- c) Define the roles of the following electrodes;
  - i) Reference electrode
  - ii) Counter electrode
  - iii) Working electrode (6 marks)
- d) Determine the potential of a Pt indicating electrode if dipped in a solution containing  $0.1\text{ M Sn}^{4+}$  and  $0.01\text{ M Sn}^{2+}$ . (3 marks)
- e) Distinguish between a strong electrolyte and a weak electrolyte. (3 marks)