



MACHAKOS UNIVERSITY

University Examinations 2021/2022 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FOURTH YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR
BACHELOR OF EDUCATION (SPECIAL NEEDS)

SCH 401: ELECTROCHEMISTRY

DATE: 17/3/2022

TIME: 2.00-4.00 PM

INSTRUCTIONS:

1. Answer question 1 (Compulsory) in Section A and ANY other 2 questions in Section B.
2. Candidates are advised not to write on the question paper.
3. Candidates must hand in their answer booklets to the invigilator while in the examination room

Useful data

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

Standard reduction potentials

$$\text{Cu}^{2+}/\text{Cu}, E^{\circ} = +0.34 \text{ V}$$

$$\text{Ag}^{+}/\text{Ag}, E^{\circ} = 0.80 \text{ V}$$

$$\text{Zn}^{2+}/\text{Zn}, E^{\circ} = -0.763 \text{ V}$$

SECTION A: COMPULSORY (30 MARKS)

QUESTION ONE

- a) Define the following terms in electrochemistry;
- Transference numbers
 - Cell potential
 - Qualitative electrolysis
 - Voltaic cells
 - Concentration cells (10 marks)
- b) Derive the Nernst equation for emf of a cell. (4 marks)
- c) Consider the following reaction;
- $$2 \text{Ag}(s) + \text{Zn}^{2+}(aq) \longrightarrow 2\text{Ag}^{+}(aq) + \text{Zn}(s)$$
- Calculate the standard cell potential (2 marks)
 - Predict whether the reaction is feasible or not (2 mark)
- d) Briefly differentiate between redox and metal-metal ion electrodes as used in electrochemistry. (4 marks)
- e) The emf of the cell
- $$\text{Ag} \mid \text{AgI in } 0.045 \text{ M KI} \parallel 0.045 \text{ M AgNO}_3 \mid \text{Ag}$$
- is 0.678 at 25 °C. Calculate the solubility product of AgI in water at 25 °C. (4 marks)
- f) Using an electrochemical cell diagram, show the direction of electron flow (4 marks)

SECTION B Any TWO QUESTIONS (20 marks EACH)

QUESTION TWO (20 MARKS)

- a) Consider an audio speaker plugged onto a socket.
- Calculate the total charge passing through an audio speaker that uses 2.5 A of current in 2 hours. (2 marks)
 - Calculate the moles of electrons that pass through the TV set in 180 mins. (3 marks)
- b) Briefly state the second Faraday's law of electrolysis. (2 marks)
- c) Briefly describe any **TWO** roles of a supporting electrolyte in an electrochemical cell. (3 marks)
- d) Briefly discuss the **THREE** types of liquid junctions. (6 marks)
- e) Given the cell $\text{Zn}(s)/\text{Zn}^{2+}(0.001 \text{ M})//\text{Cu}^{2+}(0.01 \text{ M})/\text{Cu}(s)$. $E^0_{\text{cell}} = 1.1 \text{ V}$
- Write the cell potential expression at standard state conditions. (2 marks)
 - Write the cell potential expression at non-standard state conditions. (2 marks)

QUESTION THREE (20 MARKS)

- a) Differentiate between faradaic and non-faradaic processes. (3 marks)
- b) Calculate the emf of the cell. $\text{Zn} \mid \text{Zn}^{2+} (0.01 \text{ M}) \parallel \text{Ag}^+ (0.1 \text{ M}) \mid \text{Ag}$. The standard reduction potential of Ag/Ag^+ half cells is 0.80 V and Zn/Zn^{2+} is -0.76 V. (5 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 a specific conductance and equivalent conductance. (4 marks)
- e) Differentiate between reversible and irreversible cells. (6 marks)

QUESTION FOUR (20 MARKS)

- a) Distinguish between a weak and a strong electrolyte, include examples in each case. (4 marks)
- b) Describe the **THREE** modes of mass transport-controlled reactions in an electrochemical cell. (6 marks)
- c) Briefly discuss the mechanism of electrolysis (4 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 °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. (4 marks)
- b) A cell reaction has the following cell potentials +1.4 V and -1.2 V. Which of the cell potentials qualifies the reaction to be spontaneous, explain? (3 marks)
- c) What is the potential of a half cell consisting of Zinc electrode in 0.001 M ZnSO_4 solution at 52 °C, $E^\circ = 0.763 \text{ V}$. (6 marks)
- d) Distinguish between a supporting electrolyte and an electrolyte. (3 marks)
- e) Briefly differentiate between a battery and a fuel cell. (4 marks)