



OFFICE OF THE DEPUTY VICE CHANCELLOR
ACADEMICS, STUDENT AFFAIRS AND RESEARCH

UNIVERSITY EXAMINATIONS

2023/2024 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER REGULAR EXAMINATION

**FOR THE DEGREE OF BACHELOR OF
EDUCATION SCIENCE**

COURSE CODE: CHE 317

COURSE TITLE: ELECTROCHEMISTRY

DATE:

TIME:

INSTRUCTION TO CANDIDATES

- SEE INSIDE

THIS PAPER CONSISTS OF 4 PRINTED PAGES

PLEASE TURN OVER

REGULAR – MAIN EXAM

CHE 317: ELECTROCHEMISTRY

STREAM: BED (Science)

DURATION: 3 Hours

INSTRUCTIONS TO CANDIDATES

- i. Answer **ALL** questions.
- ii. Diagrams may be used whenever they serve to illustrate the answer

Question One (17 Marks)

a) Define the following terms

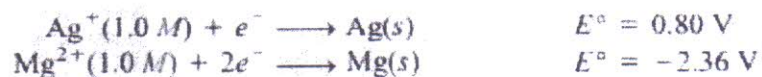
- | | |
|-----------------------------|-----------|
| i) Electrochemistry | (2 Marks) |
| ii) Electrolysis | (1 Mark) |
| iii) Electrolyte | (1 Mark) |
| iv) Electrical conductivity | (1 Mark) |
| v) Ohm's law | (1 Mark) |
| vi) Conductivity cell | (1 Mark) |

b) Explain the following observations:

- | | |
|---|-----------|
| i) Electrical conductivity decreases with decrease in concentration | (1 Mark) |
| ii) Molar conductivity increases with decrease in concentration | (2 Marks) |

c) A galvanic cell consists of a Mg electrode in a 1.0 M Mg(NO₃)₂ solution and a Ag electrode in a 1.0 M AgNO₃ solution. Calculate the standard emf of this cell at 25 °C.

(3 Marks)



d) What is a reference electrode?

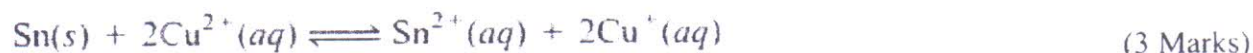
(1 Mark)

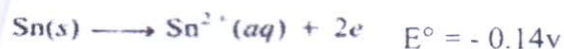
e) State any three properties which a reference electrode should exhibit

(3 Marks)

Question Two (13 Marks)

a) Calculate the equilibrium constant for the following reaction at 25 °C:





A conducting cell has a resistance of 5×10^4 ohms when filled with 6×10^{-5} M ammonium hydroxide. The equivalence conductance of NH_4^+ and OH^- at infinite dilution are $73.4 \Omega^{-1}\text{cm}^2$ and $198 \Omega^{-1}\text{cm}^2$ respectively. Calculate:

- a) The degree of dissociation of ammonium hydroxide in the 6×10^{-5} M solution (3 Marks)
(cell constant = 0.34625 cm^{-1})
- ii) The dissociation constant of ammonium hydroxide (2 Marks)
- c) Define the term limiting molar conductivity (1 Mark)
- d) Explain why it is difficult to determine the molar conductivity of a weak electrolyte at infinite dilution (2 Marks)
- e) State Kohlrausch law and identify one practical application of the law (2 Marks)

Question Three (15 Marks)

- a) Calculate the limiting molar conductivity, Λ°_m , of FeCl_3 solution given the following information: ($\lambda_{+}^\circ = 0.0204$ and $\lambda_{-}^\circ = 0.00704$) (3 Marks)
- b) State four factors that determine the movement of ions in an electrolyte (4 Marks)
- c) Define the term transport number (1 Mark)
- d) The velocity of a boundary HCl with LiCl is followed in aqueous solution. It moves 15 cm in a tube 1 cm in diameter in 22 minutes when the current is 11.54 mA. If the concentration of HCl is 0.01065 moles per litre, what is transport number of
 - i) Hydronium ions? (3 Marks)
 - ii) Chloride ions? (2 Marks)
- e) State two methods that can be used to determine transport numbers (2 Marks)

Question Four (14 Marks)

- a) For a 0.1 M solution of MX_2 at 25°C γ_{\pm} was found to be 0.265. Determine:
 - i) The mean activity (2 Marks)
 - ii) Activity (1 Mark)
- b) Define the term conductometric titration (1 Mark)

- c) State Faraday's first law of electrolysis (1 Mark)
- d) Calculate the quantity of electricity in Faradays required to deposit 1 mole of lead if a current of 2.0 A is passed for 15 minutes through molten lead II Bromide deposits 1.95 g of lead. (3 Marks)
- e) The electromotive force (emf) of a cell with liquid junction is given by:
 $E = -0.1184 t - \log (a_{\pm})_1 / (a_{\pm})_2$. Determine:
- i) The emf of the cell given that: (2 Marks)
 $t_{+} = 0.40$
 for cell 2: $\gamma_{\pm} = 0.25$, $C = 0.0025$
 for cell 1: $\gamma_{\pm} = 0.125$, $C = 0.00025$
- ii) The emf of the cell without liquid junction (2 Marks)
- iii) The liquid junction potential (2 Marks)

Question Five (11 Marks)

- a) What is a battery? (1 Mark)
- b) Give the electrode reactions as well as the overall reaction that occurs in a dry cell battery (2 Marks)
- c) Consider the following cell:
 $Zn_{(s)} + 2AgCl_{(s)} \leftrightarrow ZnCl_{2(aq)} + Ag_{(s)}$
 The value of E at 0 °C is 1.015v while $(\delta E^{\circ})/(\delta t)_p = -4.02 \times 10^{-4} \text{ v K}^{-1}$
 Calculate the following thermodynamic measurements:
- i) Gibbs free energy (ΔG) (2 Marks)
- ii) Entropy change (ΔS) (2 Marks)
- iii) Enthalpy change (ΔH) (2 Marks)
- d) Show both the electrode and overall reactions for the lead – acid accumulator battery (2 Marks)
