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

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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 $Mg(NO_3)_2$ solution and a Ag electrode in a 1.0 M $AgNO_3$ solution. Calculate the standard emf of this cell at 25 °C. (3 Marks)

$$Ag^+(1.0\ M) + e^- \longrightarrow Ag(s) \qquad E^\circ = 0.80\ V$$
$$Mg^{2+}(1.0\ M) + 2e^- \longrightarrow Mg(s) \qquad E^\circ = -2.36\ V$$

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:

$$Sn(s) + 2Cu^{2+}(aq) \rightleftharpoons Sn^{2+}(aq) + 2Cu^{+}(aq)$$ (3 Marks)

$$2Cu^{2+}(aq) + 2e^- \longrightarrow 2Cu^{+}(aq) \quad E^\circ = 0.15v$$

$Sn(s) \longrightarrow Sn^{2+}(aq) + 2e \quad E^\circ = -0.14v$

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 $\Omega^{-1} cm^2$ and 198 $\Omega^{-1} cm^2$ 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 Kohlransch law and identify one practical application of the law (2 Marks)

Question Three (15 Marks)

a) Calculate the limiting molar conductivity, $\Lambda^\circ m$, of $FeCl_3$ solution given the following information: ($\lambda_{+} = 0.0204$ and $\lambda_{-} = 0.00704$) (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 $\gamma \pm$ 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 $(\delta E^\circ)/(\delta t)p = -4.02 \times 10^{-4}$ v K^{-}

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)

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