



EXAMINATION

Program : B.ENG TECH. METALLURGY
Subject : ELECTROCHEMISTRY 2B
Subject Code : ECMMTB2
Date : January 2020
Duration : 3 Hours
Total Marks : 100
Examiner : Mr Samuel Akinwamide
Moderator : Prof M.E. Makhatha
No. of Pages : 4

Instructions:

Number each question accordingly. You may answer the questions in your preferred order

Calculators are allowed (only one per student)

Show all units in calculations

This is a closed book test

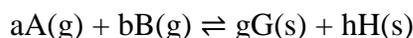
All workings are to be shown clearly

QUESTION 1 (10 marks)

- 1.1 Differentiate between an electrolytic and galvanic process
- 1.2 Describe the activities that takes place in an electrochemical cell
- 1.3 When is an electrochemical reaction said to be (i) spontaneous (ii) non-spontaneous?
- 1.4 What is meant by electric current in solution?

QUESTION 2 (10 marks)

- 2.1 (i) Write the equilibrium constant (K_c) for the reaction below.



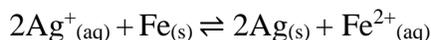
- (ii) When is forward and backward reaction said to be favoured in an equilibrium reaction?
- 2.2 Calculate the equilibrium constant for the reaction below, given that 0.231 moles of N_2O , 0.035 moles of N_2 and 0.007 moles of O_2 are present in the system.
$$2N_2O(g) \rightleftharpoons 2N_2(g) + O_2(g)$$
- 2.3 Describe the conditions for endergonic and exergonic conditions
- 2.4 Calculate ΔG for the following reaction at $25^\circ C$. Will the reaction occur spontaneously?
 $\Delta H = -176.0 \text{ kJ}$, $\Delta S = -284.8 \text{ J/K}$

QUESTION 3 (20 marks)

- 3.1 Give a brief explanation on how ions are conducted in an electrochemical circuit.
- 3.2 How does current flow between semi-conductors?
- 3.3 State Faraday's laws (first and second) of electrolysis
- 3.4 Discuss any 3 forms of corrosion

QUESTION 4 (10 marks)

- 4.1 Write briefly on Gibbs **free energy**
- 4.2 What is the standard Gibbs free energy change and equilibrium constant for the following reaction at $25^\circ C$? **Note: $E^0_{Fe^{2+}/Fe} = -0.447 \text{ V}$, $E^0_{Ag^+/Ag} = 0.7996 \text{ V}$**



QUESTION 5 (20 marks)

- 5.1 Write briefly on Arrhenius Theory.
- 5.2 With the aid of a well labelled diagram, explain the significance of activation energy in a chemical reaction
- 5.3 Find the new rate constant if the temperature is 298K, activation energy is 200 kJ.mol and pre-exponential factor is $9 \text{ m}^{-2}\text{s}^{-1}$.
- 5.4 Use the following data to calculate I_0 , and hence i_0 . These data refer to a voltammetry solution containing $[\text{Fe}^{\text{II}}\text{CN}]\text{6}]^{4-} = [\text{Fe}^{\text{III}}(\text{CN})\text{6}]^{3-} = 20 \text{ m mol dm}^{-3}$ and $[\text{KCl}] = 0.1 \text{ mol dm}^{-3}$ at $T = 298 \text{ K}$ at an electrode of area $A = 0.60 \text{ cm}^2$. For simplicity, only those data corresponding to kinetic control are included, i.e. I obtained at intermediate overpotentials (both anodic and cathodic η).

η/V	-150	-120	-90	-60	60	90	120	150
I/mA	18.66	10.3	5.77	3.21	-3.21	-5.77	-10.3	-18.6

QUESTION 6 (15 marks)

- 6.1 Define the following terms.
- (i) Hydrometallurgy
 - (iii) Electrometallurgy
 - (iii) Pyrometallurgy
- 6.2 List **three (3)** mechanisms that determines the leaching rate
- 6.3 List **three (3)** advantages and **two (2)** disadvantages of leaching operation
- 6.4 Explain (i) Vat leaching (ii) Heap leaching (iii) Bioleaching

QUESTION 7 (15 marks)

- 7.1 Define corrosion and mention four consequences of corrosion
- 7.2 Write briefly on electrowinning and electrorefining in the extraction and purification of metals.
- 7.3 Write briefly on the following (i) Primary battery (ii) Secondary battery (iii) Fuel cells