UNIVERSITY OF JOHANNESBURG

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 (Kc) for the reaction below.

$$aA(g) + bB(g) \rightleftharpoons gG(s) + hH(s)$$

(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 25^0C. Will the reaction occur spontaneously? ΔH = -176.0 kJ, ΔS = -284.8 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 °C? ***Note:*** $E^0_{Fe2+/Fe} = -0.447$ V, $E^0_{Ag+/Ag} = 0.7996$ V

$$2Ag^+_{(aq)} + Fe_{(s)} \rightleftharpoons 2Ag_{(s)} + Fe^{2+}_{(aq)}$$

QUESTION 5 (20 marks)

5.1 Write briefly on Arrhenuis 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 $m^{-2}s^{-1}$.

5.4 Use the following data to calculate I_0, and hence i_0. These data refer to a voltammetry solution containing $[Fe^{II}CN)6]^{4-}$ = $[Fe^{111}(CN)6]^{3-}$= **20** m mol dm^{-3} and [KCl] = **0.1** mol dm^{-3} at T = **298 K** at an electrode of area A = **0.60** 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