



NATIONAL OPEN UNIVERSITY OF NIGERIA
UNIVERSITY VILLAGE, PLOT 91 CADASTRAL ZONE, NNAMDI AZIKIWE
EXPRESS WAY,
JABI - ABUJA.
FACULTY OF SCIENCES
DEPARTMENT OF CHEMISTRY
2024 1 EXAMINATION

COURSE CODE: CHM 409
COURSE TITLE: Electrochemistry
COURSE UNIT: 2
TIME: 2 HOURS
INSTRUCTION: Answer question one and any other two questions.

Question 1

30 marks

- a. i. Present the IUPAC definition of electrode potential (3 marks)
(ii) In an electrochemical cell, what is the expected direction of flow of electron. (3 marks)
(iii) State one major difference between ionics and electrochemicals concerning electrochemistry (3 marks)
- b(i). State the meaning of Galvanic potential, Volta potential and Surface potential (6 marks)
b(ii) Given that an electrode potential is denoted by E and the equilibrium electrode potential by E^0 , define polarization and overpotential and show the expected values for the anodic and cathodic polarization (6 marks)
- c(i). State two differences between polarizable and non-polarizable interfaces. Hence state how a non-polarizable interface can be made polarizable (5 mark)
- c(ii) State Oswald Dilution Law (2 marks)
c(iii) What type of relationship does Butler Volmer equation describe? (2 marks)

Question 2

20 marks

- a. State four factors that are responsible for a complex distribution of charge within the interphase region of an electrochemical system. (4 marks)
- b Write the half cell reactions for the Daniel cell. Hence show that for the Daniel cell, the Nernst equation can be written as, $E_{cell} = E_{cell}^0 - \frac{0.059}{2} \log \left(\frac{[Zn^{2+}]}{[Cu^{2+}]} \right)$ (12 mark)
- c. Based on the derive equation (in a(ii)) above, calculate the emf of the Daniel cell if the concentration of zinc and copper ions are 0.04 and 0.004 M respectively. ($E_{cell}^0 = 2.0 V$). (4 marks)

Question 3

20 marks

- a. Write the general form of Tafel equation and split it to cathodic and anodic components. Define all the terms in the equation (8 marks)
- b. Calculate the Tafel constant for the anodic polarization when $\alpha = 0.7$, temperature = 300 K, $R = 8.314 \text{ J/K}$, $n = 2$ and $F = 9500 \text{ C}$ (7 marks)
- (c) State the two types of polarization and the major difference between them. Also, present an equation for expected total polarization (5 marks)

Question 4

20 marks

- a(i) State the Kohlrausch law and give its mathematical expression of the law (4 marks)
- ii. Define the term Activity coefficient (4 marks)
- b. Consider a 1:1 electrolyte consisting of a cation, A^+ and an anion, A^- where the Gibb function of these ions can be written as follows, $G_{A^+} = G_{A^+}^0 + RT \ln a_{A^+}$ and $G_{A^-} = G_{A^-}^0 + RT \ln a_{A^-}$, prove that the mean activity coefficient can be written as $\gamma_{\pm} = (\gamma_+^x \gamma_-^y)^{\frac{1}{x+y}}$. (9 marks)
- c. Highlight two applications of conductivity titration. (3 marks)

Question 5

- (a) Write the general form of the Ilkovic equation. Hence, given the following values for a dropping mercury electrode, calculate the diffusion current using the Ilkovic parameters $n = 2$, $D = 4.0$, $t = 64 \text{ s}$, $m = 8$ and $C = 2.3 \text{ M}$ (all in S.I unit). (7 marks)
- b. Write all possible electrochemical reactions that are possible in the hydrogen fuel cell and draw a block diagram of the cell (10 marks)
- c. Highlight causes of the three types of mass transport in an electrochemical cell (3 marks)