**NATIONAL OPEN UNIVERSITY OF NIGERIA**
**UNIVERSITY VILLAGE, PLOT 91 CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESS WAY,**
**JABI - ABUJA.**
**FACULTY OF SCIENCES**
**DEPARTMENT OF CHEMISTRY**
**2024_2 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) Outline the composition of the Daniel's cell and how the redox reaction occurs in the cell (8 marks)

a(ii) Provide the half cell and overall cell reaction for the Daniel cell described above. Also explain the mechanism of the flow of electrons and current (5 marks)

b(i) Consider a cell in which the electrode potential of the cathode and the anode are 0.45 and 0.76 V. Show by calculation if the cell reaction is spontaneous. (n = 2) (5 marks)

b(ii) Calculate the free energy change of the cell described above and also make a remark on the spontaneity of the cell reaction (1F = 96500 C) (4 marks)

c(i) Draw two label diagrams to show a typical assembly for galvanic and electrolytic cells (6 marks)

c(ii) Based on the cell presented above, state which of the cells is associated with a spontaneous or non-spontaneous reaction (2 marks)

**Question 2** **20 marks**

a . With the aid of suitable diagrams, highlight the basic properties of the three basic types of ion pairs. (11 marks)

b. Calculate the mass of lead deposited at the cathode during electrolysis when a current of 2.50A flows through molten lead (II) bromide for 20.0 min. (*A*r value: [Pb] = 207; $F$ = 96500Cmol$^{-1}$) 7 marks

c . State the major application of the electric double layer (2 marks)

**Question 3** 20 marks

(a) Given the cathodic and anodic Tafel equations, written as, $i = i_0 exp\left(\frac{-\alpha F\eta}{RT}\right)$ and $i = i_0 exp\left(\frac{\beta F\eta}{RT}\right)$, respectively. Show that the cathodic and anodic Tafel equation can be written as $\eta = a - blogi$ and $\eta = a + blogi$ respectively. (11 marks)

b. The conductivity of the aqueous solution of KCl (0.0005 mol/dm$^3$) at 298 K is 7.22 x $10^{-3}$ $Sm^{-1}$ while that of the solvent (water) is 0.007 x $10^{-3}$ $Sm^{-1}$. Calculate the molar conductivity of KCl in the solution. 5 marks

(c) The resistance of a conductivity cell containing 0.1 mol/L KCl solution is 1000 ohms. The resistance of the same cell when filled with 0.02 mol/L KCl solution is 500 ohms. Calculate the conductivity and molar conductivity of 0.02 mol/L KCl solution. Given that the conductivity of 0.1 mol/L KCl solution is 1.29 S/m. (4 marks)

**Question 4** 20 marks

i. Give four examples of physical parameters that most electrochemical instruments Rely upon (4 marks)

ii. Calculate the force between two charges of magnitude, 2.4 and 1.6 C separated by a distant of 0.8 m in a medium whose relative permittivity is 78.54 at 298 K (4 marks)

(b) Briefly describe the processes that leads to the formation of electric double layer (6 marks)

(c) Write the Tafel equation for anodic, cathodic and explain how the Tafel constants can be obtained from a polarization plot. (6 marks)

**Question 5** 20 marks

a(i). Use a label diagram to explain the electrolytic process for the extraction of aluminum. (12 marks)

a(ii) Outline one major challenge that is faced by industries extracting aluminium by electrolysis (3 marks)

b. Sketch a label block diagram of the a potentiostat that can be used for polarization study (5 marks)