LAIKIPIA UNIVERSITY

UNIVERSITY EXAMINATIONS

1ST SEMESTER 2022/2023 ACADEMIC YEAR

FOURTH YEAR EXAMINATION FOR THE DEGREES OF BACHELOR OF SCIENCE (GEN), BACHELOR OF EDUCATION (SCIENCE)

CHEM 411: ELECTROCHEMISTRY

STREAM: R ***TIME: 2 HRS***

DAY: WED [11.30AM – 13.30] ***DATE: 14/11/2022***

THIS QUESTION PAPER CONSISTS OF FOUR (4) PAGES

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INSTRUCTIONS: - Answer ALL questions

QUESTION ONE

(a) Define the following terms

i) Specific resistance (1 mark)

ii) Molar conductance (1 mark)

(b) A conductance cell when filled with 0.001 M NaCl solution showed a resistance of 101.81 ohms. The specific conductance was 9.98 x 10^{-3} $ohm^{-1}M^{-1}$. The same cell containing 0.0001M KCl solution gave molar conductance 0f 0.247M^2 $ohm^{-1}mol^{-1}$. Calculate the specific resistance offered by the cell. (4marks)

(c) (i) Define equivalent conductance (1 mark)

(ii)A conductance cell when filled with 0.02 M KCl at 25^0C showed a resistance of 165 ohms. The specific conductance of KCl solution used is 2.77 x 10^{-3} $ohm^{-1}cm^{-1}$ The same cell containing 0.01M NaCl solution gave a resistance 384 ohms. Calculate the specific and equivalent conductance of the NaCl solution. (4 marks)

(d) (i) Define conductance (1 mark)

(ii) State Ohms law (1 mark)

(iii) A cell with electrodes that are $2\times10^{-4}m^2$ in areas and are 0.1m apart is filled with 100g-eqnt/m^3 of sodium chloride solution. Given that the equivalent conductance is 106.7×10^{-4} $ohm^{-1}eqnt^{-1}m^2$ at 298K. If the applied potential across the electrodes is 50V, calculate the current in amperes that go through the cell (3marks)

(e) Explain the following in relation to the Debye-Huckel theory of strong electrolytes

(i) Asymmetric or relaxation effect (3 mark)

(ii) Electrophoretic effect (2 marks)

(f) State and explain how conductance vary with

(i) Temperature ($1\frac{1}{2}$ mark)

(ii) Concentration (2 mark)

(g) (i) Define the terms activity and activity coefficient of a solution (2 marks)

(ii) Calculate the activity of 0.0992M solution of NaCl at 25^0C if the activity coefficient is 0.782 ($1\frac{1}{2}$ marks)

(iii) Using a diagram explain the difference between the value 0.0992M and the activity calculated in part (f (ii)) above (2 marks)

QUESTION TWO

(a) (i) State Hittorf's rule and give a mathematical expression (2 mark)

(ii) In an experiment, the increase in concentration of $AgNO_3$ around the silver anode was 5.6 mg of silver. 10.73 mg of silver were deposited by the same current in the silver coulometer placed in series. Find the speed ratio of Ag^+ and NO_3^- ions. (3marks)

(b) (i) Define transport number (1 mark)

(ii) Calculate the transport number of H+ ion from the following data obtained by moving boundary method: (3 marks)

Given; Concentration of HCl solution = 0.10 N
Weight of silver deposited in the coulometer = 0.12 g
Distance moved by the boundary = 7.5 cm
Cross-section of the tube = 1.25 sq cm
Equivalent weight of silver = 108

(c) (i) State the Kolrausch's law of independent migration of ions. (1 mark)

(ii) Calculate the equivalent conductance at 20^0 C of NH_4OH at infinite dilution. Given $\lambda_\infty(NH_4Cl) = 130 \quad \lambda(OH^-) = 174 \quad \lambda(Cl^-) = 66$ (3 marks)

(d) Explain the use of Kohlrausch's law to determine the.

(i) solubility of a sparingly soluble salt (2 marks)

(ii) Equivalent conductance at infinity for a weak electrolyte (2 marks)

(iii) At 25°C the transport number of H+ ion in HCl and CH_3COO^- ion in CH_3COONa are 0.81and 0.47 respectively. The equivalent conductances at infinite dilution of HCl and CH_3COONa are 426 ohm^{-1} cm^2 $eqvt^{-1}$ and 91.0 ohm^{-1} cm $eqvt^{-1}$ respectively. Calculate the equivalent conductance of acetic acid at infinite dilution. (3 marks)

QUESTION THREE

(a) (i) What is a reversible cell? (1 mark)

(ii) State the standard conditions under which the standard emf is determined. (2 marks)

(iii) What are secondary standard electrodes? Give two secondary standardelectrodes. (2 mark)

(b) The net reaction in a galvanic cell is $2Al + 3Cd^{2+} \rightarrow 2Al^{3+} + 3Cd$. The emf of the cell is 1.20V

(i) How many Faradays pass through the circuit? (1 marks)

(ii) How much work can the cell do in that process? (2 marks)

(iii) How much work can the cell do if 3.86g of Aluminium reacts? (R.A.M Al =27, F=96500C) (2 marks)

(c) (i) Define conductometric titration and explain how the end point is determined. (2 marks)

(ii) State three advantages of conductometric titrations (3 marks)

(iii) State two precautions to be taken when carrying out conductometric titrations. (2marks)

(d) (i) Define the term over-potential. (1 mark)

(ii) Account for occurrence of over-potential when hydrogen is liberated by discharge of H^+ ions (2 marks)