KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2019/2020

DIGITAL SCHOOL OF VIRTUAL AND OPEN LEARNING

SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE

SCH 401: ELECTROCHEMISTRY

DATE: WEDNESDAY 21ST OCTOBER 2020 **TIME: 2.00 P.M - 4.00 P.M**

INSTRUCTIONS:

Answer ALL the questions

$R = 8.314\ JK^{-1}\ mol^{-1} = 0.0821\ l\text{-}atm\ K^{-1}\ mol^{-1}$, 0°C =273 K F = 96500c, ln x = 2.303 log x, Atomic Mass Ag =108

Question One (20 marks)

(a). Define the following terms as used in electrochemistry.

i) Ampere (1 marks)

ii) Cathode (1 marks)

iii) Voltage (1 mark)

iv) Oxidation (1 mark)

(b).An anode of a galvanic cell is referred to as negative electrode. Explain. (2 marks)

(c). Design a galvanic cell that uses the redox reaction:

$$2Cr_{(s)} + 3\ Sn^{2+}_{(aq)} \rightarrow 2\ Cr^{3+}_{(aq)} + 3\ Sn_{(s)}$$

(i). Identify the anode and cathode half-reactions, and sketch the experimental setup. Label the anode and cathode, indicate the direction of electron and ion flow, and identify the sign of each electrode. (5 marks)

(ii). Given the standard reduction potentials (E°) for Sn^{2+} | Sn = -0.14 V and Cr^{3+} | Cr^{2+} = -0.74 V, and molar concentration of Sn^{2+} and Cr^{3+} as 3.0×10^{-4}M 1.1×10^{-3}M, respectively Calculate E°for the cell at 25 °C. (4 marks)

(d). Establish the difference between electroplating and electrowinning. (2 marks)

(e). A layer of silver is electroplated on a coffee server using a constant current of 100 mA. Calculate time required to deposit 2.99 g of silver. (3 marks)

Question Two (20 marks)

(a). Describe THREE mechanisms responsible for the motion of ions in a given electrolyte to and from an electrode surface (3 marks)

(b). State Kohlrausch's law and give the mathematical relationship between the limiting molar conductivity and concentration. (4 marks)

(c). The following table gives conductance data at infinite dilution at 298 K

Electrolyte	**Λ ($\Omega^{-1}cm^2mol^{-1}$)**
NaX	83
HX	413
NaX	127

Calculate the conductance of NaH at infinite dilution. (3 marks)

(d). Describe how conductometric titrations is applied in determining the end point in an acid-base reaction. List two conditions that afford reproducible data. (3 marks)

(e). Using appropriate examples rationalize the symmetrical conductometric titration curve for a strong acid against a strong base. (4 marks)

Question Three (20 marks)

a) Explain why molar conductivity of aqueous solution of sodium chloride will increase upon dilution. (3 marks)

b) Accidentally chewing on a stray fragment of Al foil can cause a sharp tooth pain if Al comes in contact with an amalgam filling. The filling, an alloy of silver, tin and mercury acts as a cathode of a tiny galvanic cell; Al behaves as an anode and saliva serves as an electrolyte. When Al and filling comes in contact; an electric current passes from Al to the filling which is sensed by a nerve in the tooth. Al is oxidised at the anode and O_2 is reduced to water at the cathode.

i) Write balanced equations for the anode, cathode and overall cell reaction. (3 marks)

ii) Write the Nernst equation in a form that applies at body temperature (approximately 37 °C) (4 marks)

c) State TWO functions of a salt bridge in a galvanic cell. (2 marks)

d)). Write the mathematical Heyrovsky-Ilkovic equation for the dropping mercury electrode (DME). Define the symbols used and graphically or otherwise, illustrate how half-wave potential and the number of moles are determined. (4 marks)

e) Draw the diagram of SHE electrode and describe its working principles using equations where necessary. (4 marks)

Question Four (10 marks)

a) In what ways are fuel cells and batteries similar, and in what ways are they different? (2 marks)

b) In the study of batteries, a mercury battery uses the following electrode half-reactions:

$HgO_{(s)} + H_2O_{(l)} + 2\,e^- \rightarrow Hg_{(l)} + 2\,OH^-_{(aq)}$ $\quad E^\circ = 0.098$ V

$ZnO_{(s)} + H_2O_{(l)} + 2\,e^- \rightarrow Zn_{(s)} + 2\,OH^-_{(aq)}$ $\quad E^\circ = -1.260$ V

i) Write a balanced equation for the overall cell reaction. (1mark)

ii) Calculate ΔG° (in kilojoules) and K at 25 °C for the cell. (3 marks)

c) "*Corrosion is considered as an electrochemical reaction*". Discuss this statement and explain how anodic prevention of corrosion is achieved. (4marks)