# UNIVERSITY OF EMBU

**2017/2018 ACADEMIC YEAR**

**SECOND SEMESTER EXAMINATIONS**

**SECOND YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION, BACHELOR OF SCIENCE, BACHELOR OF SCIENCE IN ANALYTICAL CHEMISTRYAND BACHELOR OF SCIENCE IN INDUSTRIAL CHEMISTRY**

**SCH 204: INTRODUCTION TO REACTION KINETICS AND ELECTROCHEMISTRY**

**DATE: APRIL 9, 2018** **TIME: 8:30-10:30AM**

**INSTRUCTIONS:**

**Answer Question ONE and any other TWO Questions**
**The following constants may be useful: R=8.314 J/K/Mol, F=96485c/Mol and T=298.15 K**

## QUESTION ONE (30 MARKS)

a) Explain the following terms used in chemical kinetics. (2 marks)

i) Order of reaction (2 marks)

ii) Rate of reaction (2 marks)

iii) Molecularity (2 marks)

iv) Elementary reaction (2 marks)

b) Explain the concept of half life used in chemical kinetics (2 marks)

c) Account for the effect of temperature on the rate of a chemical reaction (3 marks)

d) The reaction $\dot{Cl}_{(g)} + \dot{Cl}_{(g)} \rightarrow Cl_{2(g)}$ follows second order kinetics with

a rate constant of $7.0 \times 10^9$ $mol^{-1}s^{-1}$ if the initial concentration of $\dot{Cl}_{(g)}$ is

0.086M determine the half life of the reaction. (2 marks)

Consider the equation $A_{(g)} + B_{(g)} \rightarrow C_{g)}$

e) Briefly explain how the order of the reaction with respect to the reactants can be obtained (2 marks)

f) Differentiate between conductance and conductivity (2 marks)

g) Briefly explain what is meant by limiting molar conductivity (2 marks)

h) Distinguish between ionic mobility and ionic velocity (2 marks)

i) Using specific examples, sketch a graph that would be obtained in conductometric titration of a strong acid with a strong base. Explain the shape of the graph (2 marks).

j) Explain the terms used in Arrhenius equation (3 marks)

**QUESTION TWO (20 MARKS)**

a) The rate law for a first order reaction is given by Rate = k [A].

i) Derive the integrated rate law for this reaction. (6 marks)

ii) Show that the $t_{\frac{1}{2}} = \frac{0.693}{k}$ (4 marks)

b) Using specific examples explain the factors that affect molar conductance (10 marks)

**QUESTION THREE (20 MARKS)**

a) The first order rate constant for the decomposition of a certain insecticide in water at 12 °C is 45 $yr^{-1}$. A quantity of this insecticide is washed into the lake in June, leading to a concentration of $5.0 \times 10^{-7}$ $g/cm^3$ of water. Assume that the effective temperature of the lake is 12° C.

i) What is the concentration of the insecticide in june the following year? (5 marks)

ii) How long will it take for the concentration of the insecticide to drop to $3.0 \times 10^{-7}$ $g/cm^3$. (5 marks)

b) At 25°C, the standard Emf of the cell $Zn_{(s)} \mid ZnSO4_{(aq)} \parallel PbSO4_{(aq)} \mid Pb_{(s)}$

is 0.4085V. When the cell contains 0.005M ZnSO4, its Emf is 0.6114V

i) Write down the electrode reactions and the cell reaction (3 marks)

ii) Write the Nernst equation for the cell (2 marks)

iii) Calculate the activity of the $ZnSO_4$ (5 marks)

**QUESTION FOUR (20 MARKS)**

a) The following data was obtained for the gas phase decomposition of $NO_2$ at 300°C.

$2NO_{2(g)} \rightarrow 2NO_{(g)} + O_{2(g)}$

| Time | $[NO_2]$ M |
|---|---|
| 0.0 | 0.0100 |
| 50.0 | 0.0079 |
| 100.0 | 0.0065 |
| 200.0 | 0.0048 |
| 300.0 | 0.0038 |

i) Use graphical method to determine whether the reaction is a first or a second order reaction and its slope, hence deduce the rate equation. (12 marks)

b) If $\Delta G = -nFE_{cell}$ and $\Delta G^\circ = -nFE^\circ_{cell}$. Use this information to derive the Nernst equation. (4 marks)

c) An electrochemical cell is based on the following two half reactions.

Anode reaction: $Cu_{(s)} \rightarrow Cu^{2+}_{(aq,0.010M)} + 2e^-$

Cathode reaction : $MnO^-_{4(aq,2M)} + 4H^+_{(aq,1M)} + 3e^- \rightarrow MnO_{2(s)} + 2H_2O_{(l)}$

If $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$ $E^\circ = +0.34V$ and

$MnO^-_{4(aq)} + 4H^+_{(aq)} + 3e^- \rightarrow MnO_{2(s)} + 2H_2O_{(l)}$ $E^\circ = +1.68V$ calculate the cell potential.(4 marks)

**QUESTION FIVE (20 MARKS)**

a) An electrochemical cell is created using Gold amd Magnesium half- cells.

Given that $E^{\circ}_{Mg^{2+}/Mg} = -2.37V$ and $E^{\circ}_{Au^{3+}/Au} = +1.50V$ and atomic mass (Au) =197 while that of (Mg) =24

i) Determine which half cell will undergo oxidation and which will undergo reduction, identify anode and cathode and calculate the voltage of the cell (6 marks)

ii) If the mass of the magnesium electrode changes by 5.0 g, what will be the change in mass of the gold electrode, and will its mass increase or decrease? (4 marks)

b) The kinetics of decomposition of ozone $O_{3(g)} \rightarrow O_{2(g)} + O^{\bullet}_{(g)}$ was studied and the data below was obtained.

| Temp (K) | Rate constant $M^{-1}S^{-1}$ | T (K) | Rate constant $M^{-1}S^{-1}$ |
|---|---|---|---|
| 600 | $3.37 \times 10^{3}$ | 1300 | $7.83 \times 10^{7}$ |
| 700 | $4.85 \times 10^{4}$ | 1400 | $1.45 \times 10^{8}$ |
| 800 | $3.58 \times 10^{5}$ | 1500 | $2.46 \times 10^{8}$ |
| 900 | $1.70 \times 10^{6}$ | 1600 | $3.93 \times 10^{8}$ |
| 1000 | $5.90 \times 10^{6}$ | 1700 | $5.93 \times 10^{8}$ |
| 1100 | $1.63 \times 10^{7}$ | 1800 | $8.55 \times 10^{8}$ |
| 1200 | $3.81 \times 10^{7}$ | 1900 | $1.19 \times 10^{9}$ |

Determine the value of the frequency factor and the activation energy for the reaction. (10 marks)

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