MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF APPLIED SCIENCES

UNIVERSITY ORDINARY EXAMINATION

2018/2019 ACADEMIC YEAR

…… YEAR **FIRST** SEMESTER EXAMINATION FOR, BACHELOR OF ……

ACH 204 – CHEMICAL KINETICS

DURATION: 2 HOURS

DATE:
TIME:

Instructions to candidates:

1. Answer question One and Any Other Two questions
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

a) Define the following terms. (4 Marks)

i. Rate law
ii. Molecularity
iii. Half –life
iv. Voltaic cell

b) In the reaction;

$$BrO_3^-{}_{(aq)} + 5Br^-{}_{(aq)} + 6H^+_{(aq)} \rightarrow 3Br_{2\ (aq)} + 3\ H_2O_{(l)}$$

It was established that the reaction order is 1, 1, 2 with respect to BrO_3^- , Br^- and H^+ respectively.

i. Write the rate expression in terms of reactants and products. (3 Marks)
ii. Write the rate law. (2 Marks)
iii. Find the units of K (4 Marks)

c) Write and discuss all the terms in the Arrhenius equation. (5 Marks)

d) State two (2) application of electrolysis. (2 Marks)

e) Complete and balance the following equation, which represent the dissolution of copper (II) Sulfide in aqueous nitric acid

$$CuS_{(s)} + NO_3^-{}_{(aq)} \rightarrow Cu^{2+}_{(aq)} + SO^{2-}_{(aq)} + NO_{(g)}$$ (5 Marks)

f) A battery delivers a steady current of 1.86A for a period of 2.5hours. Calculate the total charge (Q) in coulombs that pass through the circuit. (3 Marks)

g) Define the following terms: (3 Marks)

i. Specific conductance.
ii. Equivalent conductance.
iii. Molar conductance.

SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO (20 MARKS)

a) At high temperatures, HI reacts according to the equation.

At 443^0C, the initial rate of reaction increases with concentration of HI as shown in the following table.

Experiment No	HI ($molL^{-1}$)	Initial Rate ($MolL^{-1}S^{-1}$)
1	0.005	7.5×10^{-4}
2	0.01	3.0×10^{-3}
3	0.02	1.2×10^{-2}

i. Determine the order of reaction with respect to HI and write the rate law. (4 Marks)
ii. Calculate the rate constant and give its units. (4 Marks)
iii. Calculate the instantaneous rate of the reaction when the concentration of HI equal 0.002 $molL^{-2}$ (2 Marks)

b) The cell:
$Zn_{(s)} / Zn^{2+}_{n\,(aq)}$ // $MnO^{-}_{4\,(aq)},\ H^{+}_{(aq)}\ Mn^{2+}_{n\,(aq)} / Pt_{(s)}$
is set up at 298k with the following non-standard concentration: $[H^+]$=0.01M, $[M_nO_4]$ = 0.12M, $[Mn^{2+}]$ = 0.01 and $[Zn^{2+}]$ = 0.015M.
If the standard half cell equations are:

$MnO^{-}_{4\,(aq)} + 8H^+ + 5e^- \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$ $\mathcal{E}^0$=1.507v

$Zn^{2+}_{(aq)} + 2e^- \rightarrow Z_{n\ (s)}$ $\mathcal{E}^0$=-0.762v

Calculate the cell voltage. (8 Marks)

c) Define the term transference number. (2 Marks)

QUESTION THREE (20 MARKS)

a) Experimental values for the temperature dependence of the rate constant for the gas-phase reaction.

$NO + O_3 \rightarrow NO_2 + O_2$

are as follows;

Temperature (K)	K(L/mol.s)
195	1.08×10^9
230	2.95×10^9
260	5.42×10^9
298	12.0×10^9
369	35.5×10^9

Make an appropriate graph using these data and;
i. Determine the activation energy for this reaction. (8 Marks)
ii. Determine the value of A. (4 Marks)

i. Using suitable graphs explain the typical end-point of conductometric titration graphs of strong acid-strong base and strong acid-weak base are different. (5 Marks)

ii. Discuss at least three (3) applications conductance measurement. (3 Marks)

QUESTION FOUR (20 MARKS)

a) For a 3rd order kinetic with one reactant show that it's integrated rate equation is given by

$$\frac{1}{A_t^2} - \frac{1}{A0^2} = 2k_3t$$ (4 Marks)

b) The rate constant of the reaction.

$$NO_{3(g)} + O_{3\ (g)} \rightarrow NO_{3\ (g)} + O_{2\ (g)}$$

At 50^0C is found to be 2.10 x 10^5 (molL^{-1}) S^{-1}. The reaction occurs 1.90 times faster at 70^0c

i. Calculate the activation Energy. (4 Marks)

ii. Determine the rate constant of the reaction at 100^0c (4 Marks)

c) One half of a galvanic cell consists of a zinc anode immersed in a 1.00M solution of $Zn(NO_3)_2$. The other half consists of a platinum cathode that has gaseous hydrogen bubbling over it at a pressure of 1.00 atm.

The cathode is immersed in solution of unknown hydrogen-ion concentration $[H^+]$. The voltage of the cell is 0.473v at 298.15k

i. Draw a diagram of the cell. (2 Marks)

ii. Write an equation for reaction taking place in the cell &calculate quotient Q at 25^0c. (4 Marks)

iii. Calculate the unknown concentration of $[H^+]$ (2 Marks)