KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2020/2021 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER
SPECIAL/SUPPLEMENTARY EXAMINATIONS

FOR THE DEGREE OF B.SC. (CHEMISTRY)

COURSE CODE: **SCH 224**

COURSE TITLE: **CHEMICAL KINETICS**

DATE: 20/1/2022 **TIME:** 11-1PM

INSTRUCTIONS TO CANDIDATES:

TIME: 2 Hours

Answer **question ONE** and **any TWO** of the remaining

Question one (30 Marks)

(a) Define the following terms as used in this course

i. Chemical kinetics **(2Marks)**
ii. Activation energy **(2Marks)**
iii. Molecularity **(2Marks)**
iv. Half-life **(2Marks)**

(b) State the three types of elementary reactions **(3marks)**

(c) Explain why High Molecularity Reactions are Rare **(5marks)**

(d) State the four assumptions of collision theory **(4 marks)**

(e) From the following data for the decomposition of N_2O_5 in CCl_4 solution at 48°C, show that the reaction is of the first order **(5marks)**

t (minutes)	10	15	20	∞
Vol of O_2 evolved	6.30	8.95	11.40	34.75.

(f) i) Define heterogeneous catalysis **(1 mark)**
(ii) Give any two examples of heterogeneous catalysis **(2 marks)**
(g) State any two methods of determining order of a reaction **(2 marks)**

Question Two (20 marks)

(a) The rate constants for the isomerization of methyl isocyanide are listed in the table below.

$H_3N^+{\equiv}C^-: \rightarrow H_3\text{-}C{\equiv}N$
(Methyl isocyanide) (acetonitrile)

T (K)	k ($M^{-1}\cdot s^{-1}$)	Ln K	1/T
592	522		
603	755		
627	1700		
652	4020		
656	5030		

(a) Complete the table for the values of In K and 1/T and using an appropriate graph in the form of Arrhenius equation, find the value of activation energy E_a **(10 marks)**
(b) What is steady state approximation **(2 marks)**
(c) State the elementary steps in a chain reaction **(4 marks)**
(d) Explain the two different mechanisms that may lead to an explosion **(4 marks)**

Question three (20 marks)

(a) For the following reaction:

$$2\ HgCl_{2\ (aq)} + C_2O_4{}^{2-}{}_{(aq)} \rightleftharpoons Hg2Cl_{2(s)} + 2\ Cl^-_{(aq)} + 2\ CO_{2\ (g)}$$

Experiment	Initial Concentration of $HgCl_2$ (M)	Initial Concentration of $C_2O_4^{2-}$ (M)	Initial Rate of Reaction (M /sec)
1	0.096	0.13	2.1×10^{-7}
2	0.096	0.21	5.5×10^{-7}
3	0.171	0.21	9.8×10^{-7}

(i) Determine the order of the reaction with respect to $HgCl_2$ and with respect to $C_2O_4^{2-}$. **(6 marks)**

(ii) Write the rate law for this reaction **(1 mark)**

(iii) Calculate the rate constant and give its units **(2 marks)**

(b) i)Using Arrhenius equation $K = Ae^{-E_a/RT}$ show that $Lnk = \frac{-E_a}{R}\left(\frac{1}{T}\right) + \ln A$ **(2 marks)**

(ii) The values of the rate constant (k) for the reaction $2N_2O_5\ (g) \longrightarrow 4NO_2\ (g) + O_2\ (g)$ were determined at several temperatures. A plot of ln k *versus* $1/T$ gave a straight line of which the slope was found to be -1.2×10^4 K. What is the activation energy of the reaction? **(3 marks)**

(Where K =rate constant, E_a =activation energy, R= gas constant (8.314j/mol/k) and T= temperature in Kelvin)

(d) There are not many reactions showing third order kinetics. Write down chemical equations of any three of those reactions **(3marks)**

Question Four (20 marks)

(a) Describe the graphical method of determining order of a reaction of the type A → products **(5 marks)**

(i) First order **(5 marks)**

(ii) Second order **(10 marks)**

(b) Explain the Michaelis-Menten mechanism

Question Five (20 marks)

(a) The rate law for the decomposition of N_2O_5 (l) is: rate = k [N_2O_5] where $k = 6.22 \times 10^{-4}$ sec^{-1}. Calculate half-life of N_2O_5 (l) and the number of seconds it will take for an initial concentration of N_2O_5 (l) of 0.100 M to drop to 0.0100 M. **(8 marks)**

b) State any five postulates of collision theory **(5marks)**

(c) Compound A decomposes to form B and C the reaction is first order. At 25°C the rate constant for the reaction is 0.450 s^{-1}. What is the half-life of A at 25°C? **(4 marks)**

(d) State the three types of complex reactions **(3 marks)**