

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

KIBU observes ZERO tolerance to examination cheating

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)

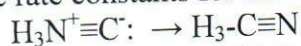
(e) From the following data for the decomposition of N_2O_5 in CCl_4 solution at $48^\circ C$, show that the reaction is of the first order (5marks)

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.



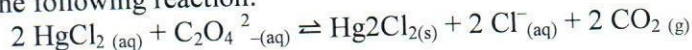
(Methyl isocyanide) (acetonitrile)

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 $\ln K$ 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:



Experiment	Initial Concentration of HgCl_2 (M)	Initial Concentration of $\text{C}_2\text{O}_4^{2-}$ (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 $\text{C}_2\text{O}_4^{2-}$. (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 $\ln k = \frac{-E_a}{R} \left(\frac{1}{T}\right) + \ln A$ (2 marks)

(ii) The values of the rate constant (k) for the reaction $2\text{N}_2\text{O}_5(\text{g}) \rightarrow 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$ 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 $-1.2 \times 10^4 \text{ K}$. What is the activation energy of the reaction? (3 marks)

(Where K = rate constant, E_a = activation energy, R = gas constant (8.314 J/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 (3 marks)

Question Four (20 marks)

(a) Describe the graphical method of determining order of a reaction of the type $A \rightarrow \text{products}$ (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: $\text{rate} = k [\text{N}_2\text{O}_5]$ where $k = 6.22 \times 10^{-4} \text{ sec}^{-1}$. 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 (5 marks)

(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)