



KIBABII UNIVERSITY

**UNIVERSITY EXAMINATIONS
2020/2021 ACADEMIC YEAR**

**SECOND YEAR SECOND SEMESTER
MAIN EXAMINATIONS**

FOR THE DEGREE OF B.Sc. (Chemistry)

COURSE CODE: SCH 224

COURSE TITLE: CHEMICAL KINETICS

DURATION: 2 HOURS

DATE: 7/10/2021

TIME: 2:00-4:00PM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.
- You are provided with graph papers where necessary.

This paper consists of 4 printed pages. Please Turn Over



KIBU observes ZERO tolerance to examination cheating

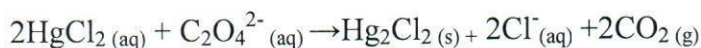
Question ONE (30 marks)

(a) Define the following terms as used in chemical kinetics.

(4marks)

- i. Molecularity
- ii. Catalyst
- iii. Rate of a reaction
- iv. Elementary reaction

(b) Mercuric (II) chloride reacted with dichromate solution as shown in the equation below;



The table below shows the results involving different concentrations of reactants.

Experiment number	$[\text{HgCl}_2](\text{M})$	$[\text{C}_2\text{O}_4^{2-}](\text{M})$	Initial rate (mol/S)
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}

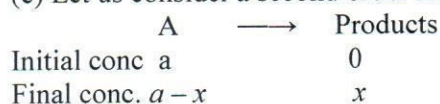
- i. Determine the order of the reaction with respect to HgCl_2 and with respect to $\text{C}_2\text{O}_4^{2-}$ (4marks)
- ii. What is the overall order of the reaction? (1marks)
- iii. Calculate the rate constant. (2marks)

(c) (i) State any three differences between Molecularity and order of reactions (3marks)

(ii) State the three types of elementary reactions (3marks)

(d) Discuss briefly the main postulates of collision theory and how it explains chemical reactions. (3marks)

(e) Let us consider a second order reaction of the type



Show that its integrated rate law is given by $K = \frac{1}{t} \ln \left(\frac{a}{a-x} \right)$ (4 marks)

(f) i) Define the term complex reactions (1 marks)

ii) State the three types of complex reactions (3 marks)

(g) Give any two examples of heterogeneous catalysis (2 marks)

Question Two (20 marks)

(a) The gas-phase reaction between methane (CH_4) and diatomic sulphur (S_2) is given by the equation $\text{CH}_4(\text{g}) + 2\text{S}_2(\text{g}) \longrightarrow \text{CS}_2(\text{g}) + 2\text{H}_2\text{S}(\text{g})$

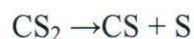
At 550°C the rate constant for this reaction is $1.1 \text{ l mol}^{-1} \text{ sec}$ and at 625°C the rate constant is $6.4 \text{ l mol}^{-1} \text{ sec}$. Calculate E_a for this reaction (8 marks)

(b) Consider a two-step reaction mechanism suggested below and use it to answer the questions that follows;



- i) Derive the overall reaction (2 marks).
- ii) Identifying the reaction intermediate (1 mark)
- iii) Define the term reaction intermediate (2 marks)
- iv) Identify the rate determining step (2 marks)
- v) Derive the rate law of the above reaction (1 mark)

(c) The decomposition of carbon disulfide, CS_2 , to carbon monosulfide, CS, and sulfur is first order with $k = 2.8 \times 10^{-7} \text{ s}^{-1}$ at 1000°C .



What is the half-life of this reaction at 1000°C ? (4 marks)

Question Three (20 marks)

- (a) Describe the half-life method of determining order of reaction (10 marks)
- (b) Show that the half-life of a first order reaction of the form $\text{A} \rightarrow \text{Products}$ is (5 marks)

$$t_{1/2} = \frac{0.693}{k}$$
- (c) (i) Define the term catalysis (1 mark).
- ii) State the four common characteristics of catalytic reactions (4 marks)

Question Four (20 marks)

- (a) TST postulates three major factors that determine whether or not a reaction will occur. State these factors are: (3 marks)
- (b) Briefly explain the application of TST in biochemistry (5 marks)
- (c) In the reduction of nitric oxide, 50% of reaction was completed in 108 seconds when initial pressure was 336 mm Hg and in 147 seconds initial pressure was 288 mm Hg. Find the order of the reaction (5 marks).
- (d) Briefly explain the Ostwald's Isolation method of determining order of reaction (5 marks)
- (e) Why does the rate constant depend on temperature (2 marks)

Question Five (20 marks)

Q5) (i) Hydrolysis of ethyl acetate by NaOH using equal concentration of the reactants was studied by titrating 25ml of the reaction mixture at different time intervals against standard acid. From the data given below, establish that this is a second order reaction (4 marks).

t (minutes)	0	5	15	25
ml acid used	16.00	10.24	6.13	4.32

- (ii) State the three types of complex reactions (3 marks)

(iii) In the case of sequential reactions, $A \xrightarrow{k_1} B \xrightarrow{k_2} C$ applying steady state approximation show that

$$\frac{d[c]}{dt} = k_1[A]$$

(3 marks)

(iv) Explain the Michaelis-Menten mechanism

(10 marks)

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