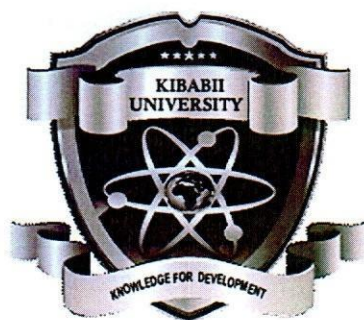


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KIBABII UNIVERSITY

**UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR**

**SECOND YEAR SECOND SEMESTER
MAIN EXAMINATIONS**

FOR THE DEGREE OF B.Sc. (CHEMISTRY)

COURSE CODE: SCH 224

COURSE TITLE: CHEMICAL KINETICS

DATE: 12/05/2022

TIME: 2:00PM-4:00PM

INSTRUCTIONS TO CANDIDATES:

TIME: 2 Hours

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

Gas constant(R) = (8.314j/mol/k)

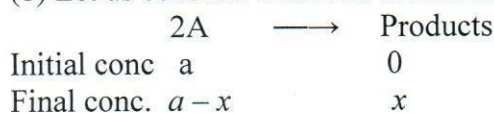
KIBU observes ZERO tolerance to examination cheating

Question One (30 marks)

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

- i. Order of reaction (1Mark)
- ii. Rate of reaction (1Mark)
- iii. Elementary reaction (1Mark)
- iv. Complex reaction (1Mark)

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

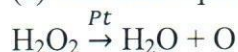


Show that its integrated rate law is given by $k = \frac{1}{at} \cdot \frac{x}{a(a-x)}$ (5 marks)

(c) State any three postulates of collision theory (3marks)

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

(e) The decomposition of H_2O_2 in the presence of Pt as catalyst is a first order reaction.



The progress of the reaction is followed by titrating equal volumes of the reaction mixture against standard KMnO_4 solution at different time intervals. A solution of H_2O_2 when titrated against KMnO_4 solution at different time intervals gave the following results:

t (minutes)	0	10	20
Vol KMnO_4 (ml) used for 10 ml H_2SO_4	23.8	14.7	9.1

Show that the decomposition of H_2O_2 is a first order reaction (4 marks)

(f) i) Define homogeneous catalysis (1 mark)

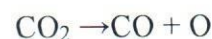
(ii) Give any one example of homogeneous catalysis (2 marks)

(g) State the four common characteristics of catalytic reactions (4 marks)

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

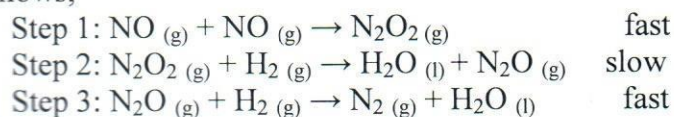
Question Two (20 marks)

(a) The decomposition of carbon dioxide, CO_2 , to carbon monoxide, CO , and Oxygen is first order with $k = 1.4 \times 10^{-5} \text{ s}^{-1}$ at 500°C .



What is the half-life of this reaction at 500°C ? (4 marks)

(b) Consider a three-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)

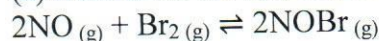
(c) The gas-phase reaction between methane (CH₄) and diatomic sulphur (S₂) is given by the equation



At 550°C the rate constant for this reaction is 1.1 l mol⁻¹ sec and at 625°C the rate constant is 6.4 l mol⁻¹ sec. Calculate E_a for this reaction **(8 marks)**

Question Three (20 marks)

(a) Determine the rate law and evaluate the rate constant for the following reaction:



Experiment	(NO) ₀ (M)	(Br ₂) ₀ (M)	Initial Rate of Reaction (M/min)
1	0.10	0.10	1.30 × 10 ⁻³
2	0.20	0.10	5.20 × 10 ⁻³
3	0.20	0.30	1.56 × 10 ⁻²

(i) Determine the order of the reaction with respect to NO and with respect to Br₂ **(4 marks)**

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

(iii) Write the rate law for this reaction **(2 mark)**

(b) i) Using Arrhenius equation $K = Ae^{-E_a/RT}$ show that $\text{Ln}k = \frac{-E_a}{R} \left(\frac{1}{T}\right) + \text{Ln}A$ **(3 marks)**

(ii) The values of the rate constant (k) for the reaction $2\text{N}_2\text{O}_5(\text{g}) \longrightarrow 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$ were determined at several temperatures. A plot of $\text{Ln}k$ versus $1/T$ gave a straight line of which the slope was found to be $-1.5 \times 10^3 \text{ K}$. What is the activation energy of the reaction? **(3 marks)**

(c) Write down chemical equations of any three third order reactions **(3marks)**

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

Question four (20 marks)

(a)(i) Show that the order of reaction (n) is given by $n = 1 + \frac{\log[t_1/t_2]}{\log[A_2/A_1]}$ using half-life method **(5 marks)**

(ii) 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).**

(b) Describe the Michaelis-Menten mechanism **(10 marks)**

Question five (20 marks)

(a) 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? **(3 marks)**

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

(c) (i) Define the term catalyst **(1 mark).**

ii) State the three examples of heterogeneous catalysis **(3 marks)**

(d) Describe the Differential method of determining order of reaction **(10 marks)**