



JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY
SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES
UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF
EDUCATION (SCIENCE)
3RD YEAR 2ND SEMESTER 2017/18
MAIN REGULAR

COURSE CODE: SCH 308

COURSE TITLE: CHEMICAL KINETICS

EXAM VENUE:

STREAM: (BED SCI)

DATE:

EXAM SESSION:

TIME: 2:00HRS

Instructions:

- 1. Answer question 1 (Compulsory) in Section A and ANY other 2 questions in Section B.**
- 2. Candidates are advised not to write on the question paper.**
- 3. Candidates must hand in their answer booklets to the invigilator while in the examination room**

INSTRUCTIONS: Answer Question 1 and any TWO questions in this question paper

QUESTION ONE (30 marks)

1. (a) Define the following terms;

- (i) Elementary steps
- (ii) Termolecular reaction
- (iii) Activation energy
- (iv) Molecularity
- (v) Order of a reaction
- (vi) Half life [12 marks]

(b) State the assumption made in the initial rate method of determining rate law. [2 marks]

(c) The recombination of iodine atoms to form molecular iodine in the gas phase $I_{(g)} + I_{(g)} \rightarrow I_{2(g)}$ follows second order kinetics and has the high rate constant $9.7 \times 10^9 \text{ M}^{-1}\text{s}^{-1}$ at 23°C . If the initial concentration of iodine atoms was 0.068 mol L^{-1} .

- (i) Calculate the concentration after 2 minutes. [5 marks]
- (ii) Calculate the half life of the reaction if the initial concentration of I is 0.42 M . [3 marks]

(d) The reaction $(\text{CH}_3)_3\text{CBr}_{(l)} + \text{H}_2\text{O}_{(l)} \longrightarrow (\text{CH}_3)_3\text{COH}_{(l)} + \text{HBr}_{(aq)}$ proceeds sufficiently slowly that its rate can be measured by determining the HBr content of successive samples by titration. The following table summarizes some of the data obtained at 25°C expressed as concentration of $(\text{CH}_3)_3\text{CBr}$ as a function of time.

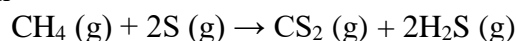
Time (hours)	$[(\text{CH}_3)_3\text{CBr}] \text{ mol L}^{-1}$
0.00	0.104
3.15	0.0896
10.00	0.0648

- (i) Does the reaction follow first order kinetics. [2 marks]
- (ii) If so, determine the value of the rate constant and the half life. [6 marks]

QUESTION TWO (20 marks)

2. (a) Derive the integrated rate equation for a second order reaction with one reactant. [6 marks]

(b) The gas phase reaction between Methane (CH_4) and diatomic Sulphur (S_2) is given by the equation



At 550 °C, the rate constant for this reaction is 11 Lmol⁻¹ sec and at 655 °C the rate constant is 4.6 Lmol⁻¹ sec. Calculate E_a for this reaction. [6 marks]

(c) Define the terms;

(i) Frequency factor

(ii) Boltzmann factor as used in the Arrhenius equation and in both cases state their significance and units. [6 marks]

(d) Reactions are classified as unimolecular, bimolecular and so on. Why are there no zero-molecular reactions? [2 marks]

QUESTION THREE (20 marks)

3. (a) The Arrhenius rate equation is given by the following expression;

$$k = Ae^{-E_a/RT}$$

Define all the terms in this equation. [5 marks]

(b) The rate of decomposition of N₂O₃ to NO₂ and NO was studied and the following data of [N₂O₃] with time was obtained.

Time (s)	0	500	1500	2800
[N ₂ O ₃] mol/L	0.910	0.775	0.563	0.408

Does the reaction follow first order kinetics? [6 marks]

(c) Define a third order reaction and

(i) Derive its corresponding integrated rate law with one reactant [6 marks]

(ii) Half life expression. [3 marks]

QUESTION FOUR (20 marks)

4. (a) Briefly discuss how the collision theory explains increases in reaction rates constant with rises in temperature. [5 marks]

(b) State any **FOUR** factors that affect the rate of a reaction. [4 marks]

(c) The gas phase decomposition of acetaldehyde at elevated temperatures and represented by the chemical equation CH₃CHO (g) → CH₄ (g) + CO (g) was found experimentally to follow the rate law; R = [CH₃CHO]^{3/2}. Determine the units of k. [2 marks]

(d) The rate constant of a first order reaction is 3.56 x 10⁻² s⁻¹ at 288 K. What is the rate constant at 340 K, if the activation energy for the reaction is 50.2 KJ/mole? [5 marks]

(e) The values of the rate constant (k) for the reaction 2N₂O₅ (g) → 4NO₂ (g) + O₂ (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 -1.4 x 10⁴ K. What is the activation energy of the reaction? [4 marks]

QUESTION FIVE (20 marks)

5. (a) In derivation of rate law for third order reactions there are **THREE** possibilities that exist. Name them. [3 marks]

(b) The decomposition of dinitrogen pentoxide (N_2O_5) dissolved in carbon tetrachloride is a first order reaction. The chemical change for the reaction is given by



At 45°C , the reaction began with an initial N_2O_5 concentration of 1.00 M. After 3 hours, the N_2O_5 concentration had decreased to 1.21×10^{-3} M. What is the half life of N_2O_5 expressed in minutes at 45°C ? [5 marks]

- (c) Discuss how the initial rate method is used to determine rate laws. [12 marks]