



FreeExams.co.ke

**UNIVERSITY EXAMINATIONS  
2022/2023 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:** 19/04/2023

**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.

**SOME CONSTANTS**

R= 8.314J/mol/K or 0.082atmL/mol/K

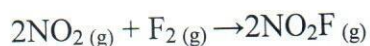
### QUESTION ONE (30 MARKS)

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

(4marks)

- i. Reaction intermediates
- ii. Reaction mechanism
- iii. Rate of a reaction
- iv. Molecularity

(b) Consider the following reaction;



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

| Experiment number | $[\text{NO}_2](\text{M})$ | $[\text{F}_2](\text{M})$ | Initial rate (M/S) |
|-------------------|---------------------------|--------------------------|--------------------|
| 1                 | 0.376                     | 0.196                    | 0.0549             |
| 2                 | 0.376                     | 0.413                    | 0.116              |
| 3                 | 0.685                     | 0.196                    | 0.100              |

- i. Determine the order of the reaction with respect to  $\text{NO}_2$  and with respect to  $\text{F}_2$  (2marks)
- ii. What is the overall order of the reaction? (1marks)
- iii. Calculate the rate constant. (2marks)

(c) (i) Explain why high Molecularity reactions are Rare (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 first order reaction of the type



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

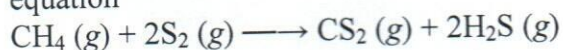
(f) Show that the half-life of a second order reaction of the form  $\text{A} \rightarrow \text{Products}$  is (5 marks)

$$t_{1/2} = \frac{1}{k[\text{A}]}$$

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

### QUESTION TWO (20 MARKS)

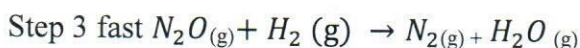
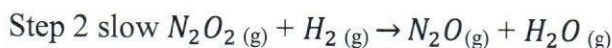
(a) The gas-phase reaction between methane ( $\text{CH}_4$ ) and diatomic sulphur ( $\text{S}_2$ ) is given by the equation





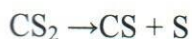
At 550°C the rate constant for this reaction is  $1.1 \text{ l mol}^{-1} \text{ sec}$  and at 625°C the rate constant is  $6.4 \text{ l mol}^{-1} \text{ sec}$ . Calculate  $E_a$  for this reaction **(7 marks)**

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



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

**(c)** The decomposition of carbon disulfide,  $\text{CS}_2$ , to carbon monosulfide,  $\text{CS}$ , 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)**

**(d)** Provide the reaction profile that shows the catalyzed and uncatalyzed patterns for a given reaction **(4marks)**

**QUESTION THREE (20 MARKS)**

- (a)** Describe the half-life method of determining order of reaction **(10 marks)**
- (b)** i) State any three assumptions of collision theory **(3marks)**
- ii) What are the draw backs of collision theory **(2marks)**
- (c)** (i) Define the term catalysis **(1 mark).**
- ii) State the four common characteristics of catalytic reactions **(4 marks)**

**QUESTION FOUR (20 MARKS)**

**(i)** From the following data for the decomposition of  $\text{N}_2\text{O}_5$  in  $\text{CCl}_4$  solution at 48°C, show that the reaction is of the first order **(5marks)**

|                             |       |       |       |          |
|-----------------------------|-------|-------|-------|----------|
| $t$ (minutes)               | 0     | 4500  | 7140  | $\infty$ |
| Vol of $\text{O}_2$ evolved | 24.36 | 29.32 | 31.72 | 47.15    |

**(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

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

(2 marks)

(iv) Explain the Michaelis-Menten mechanism

(10 marks)

#### QUESTION FIVE (20 MARKS)

(a) TST postulates three major factors that determine whether or not a reaction will occur. State these factors are: (3 marks)

(b) For a first order reaction of  $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$ , has a rate constant of  $1.06 \times 10^{-3} \text{ min}^{-1}$ . If the initial  $[H_2O_2] = 0.020 \text{ mol L}^{-1}$ , then what percentage of it remains after 100 minutes of reaction time? (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)