



NATIONAL OPEN UNIVERSITY OF NIGERIA
UNIVERSITY VILLAGE, PLOT 91 CADASTRAL ZONE, NNAMDI AZIKIWE
EXPRESS WAY, JABI - ABUJA.
FACULTY OF SCIENCES
DEPARTMENT OF CHEMISTRY
2024 1 EXAMINATION

COURSE CODE: CHM 407
COURSE TITLE: REACTION KINETICS
COURSE UNIT: 2
TIME: 2 HOURS
INSTRUCTION: ANSWER QUESTION NO. ONE (1) AND ANY OTHER TWO (2) QUESTIONS

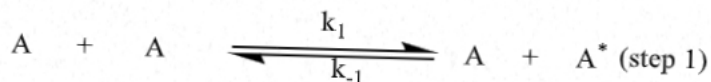
QUESTION ONE

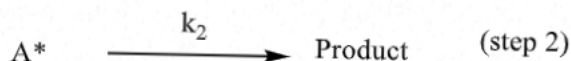
- (a)(i) What do you understand by the terms: rate, rate law, order and molecularity of reaction (8 marks)
- (ii) What is the major condition required for a zero-order reaction to occur? (2 marks)
- (iii) State (with example), if a fractional order reaction is possible for a normal reaction or otherwise. (4 marks)
- (b) 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 $1.1 \text{ litres mol}^{-1} \text{ sec}$ and at 625°C the rate constant is $6.4 \text{ litres mol}^{-1}\text{sec}$. Calculate the activation energy (E_a) for this reaction. (9 marks)
- (c)(i) State the Frank-Condon (mirror image) rule (2 marks)
- (ii) Highlight the major implications of the Frank Condon rules in photochemistry (3 marks)
- (iii) State the condition under which a singlet state can become a triplet state in phosphorescence (2 marks)

Total mark Question 1 = 30 marks

QUESTION TWO

- (a) State the law of mass action (3 marks)
- (b) Given that a reaction occurs as shown in the equations below,





Derive the Linderman mechanism and use the law of mass action to derive an expression for the integrated rate law (I) if $k_{-1}[A] \gg k_2$ and (II) if $k_2 \gg k_{-1}[A]$ **(17 marks)**

Total mark Question 2 = 20 marks

QUESTION THREE

- (a) Define the term, "activity of a catalyst" **(2 marks)**
- (b) Use the adsorption theory to outline the five (5) steps involved in the mechanism of catalysis. **(10 marks)**
- (c) Highlight four (4) industrial processes that uses catalyst. **(8 marks)**

Total mark Question 3 = 20 marks

QUESTION FOUR

- (a) A reactant "A" undergoes second-order kinetics.
- (i) Show that the time variation of the reactant concentration a_t at any time t is given by $\frac{1}{a_t} = \frac{1}{a_0} + k_2 t$ where a_0 is the initial concentration of the reactant and k_2 is the second-order rate constant. **(5 marks)**
- (ii) Derive also an expression for the half-life of the reaction. **(5 marks)**
- (b) A first-order reaction takes 40 min for 30 % decomposition. Calculate the half - life for the reaction **(10 marks)**

Total mark Question 4 = 20 marks

QUESTION FIVE

- (a) Write short notes on the following terms in photochemistry
- (i) Intra-molecular energy transfer **(3 marks)**
- (ii) Inter-molecular energy transfer **(3 marks)**
- (iii) Quenching **(3 marks)**
- (iv) photolysis **(3 marks)**
- (b) Highlight any four (4) reasons that may be responsible for low values of quantum yield in some photochemical reactions. **(8 marks)**

Total mark Question 5 = 20 marks