



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

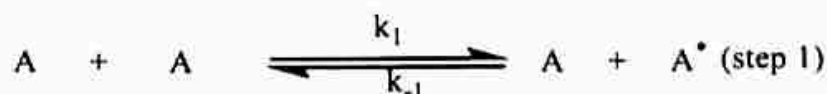
QUESTION ONE

- (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 : $\text{CH}_4 (g) + 2\text{S}_2 (g) \longrightarrow \text{CS}_2 (g) + 2\text{H}_2\text{S} (g)$. 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 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