



**NATIONAL OPEN UNIVERSITY OF NIGERIA**  
**University Village, Nnamdi Azikiwe Expressway, Plot 91, Cadastral Zone, Jabi, Abuja**  
**FACULTY OF SCIENCE**

**JULY 2017 EXAMINATION**

**COURSE CODE: CHM 407**

**COURSE TITLE: Reaction Kinetics**

**COURSE UNIT: 2 units**

**TIME: 2 hours**

**INSTRUCTION: Answer Question 1 and any other three (3) questions**

**Question 1**

- (a) Define the term, molecularity of a reaction (2 marks)
- (b) Given a reaction characterized by four consecutive steps, A, B., C and D and the time taken for the completion of the reaction are 10, 20, 30 and 40 minutes for steps A, B, C abd D respectively. Also, the number of molecules associated with the steps are 1,2 ,3 and 4 respectively. Use this explanation to answer the following questions,
- (i) Define the term, rate determining step and state the step that is associated with your definition. Give reason for your answer (2 marks)
- (ii) Calculate the molecularity of the reaction. Give reason for your answer (2 marks)
- (c) Define the term, rate law, order of reaction and rate constant (3 marks)
- (d) What is the basic requirement for photochemical reactions? (2 marks)
- (e) State three applications of photochemical reactions (3 marks)
- (f) Highlight four methods that can be used to study the rate of chemical reaction (4 marks)
- (g) Write equations for the half life of a first and second order reaction (2 marks)
- (h) What is a pseudo first order reaction/ (2 marks)
- (i) What are catalyst poison, promoters and inhibitors (3 marks)

### **Question 2**

(a) Given the reaction,  $2\text{N}_2\text{O}_5 = 4\text{NO}_2 + \text{O}_2$ , write an expression for the theoretical rate equation with respect to the reactant and the products. (3 marks)

(b) In writing theoretical rate equation in 'a' above, positive and negative signs were involved. Give reason for the choice of the sign (2 marks)

(c) Derive an integrated rate law for a zero order reaction (5 marks)

(d) The decomposition of hydrogen iodide on gold at 323K is zeroth order reaction and the rate constant is  $1.20 \times 10^{-4} \text{ Ms}^{-1}$  a) If the initial concentration of hydrogen iodide is 0.500M. Answer the following questions

i. calculate its concentration after  $3.00 \times 10^3 \text{ s}$ . (2 marks)

ii. How long will it take for all of the hydrogen iodide to decompose? (3 marks)

### **Question 3**

(a) Given the reaction,  $\text{ClO}_3^- + \text{H}_2\text{O} \rightarrow \text{ClO}_4^- + \text{H}_2\text{O}_2$ . If the values of rate constant and temperature are as presented in the Table below,

K(/s)	T (°C)
$2 \times 10^{-3}$	25
$4 \times 10^{-3}$	35
$6 \times 10^{-3}$	45
$8 \times 10^{-3}$	55
$1.0 \times 10^{-2}$	65

Complete the Table missing values in the Table given below.

k(/s)	T (°C)	1/T x 1000 (K)	lnk
$2 \times 10^{-3}$	298		
$4 \times 10^{-3}$	308		
$6 \times 10^{-3}$	318		
$8 \times 10^{-3}$	328		
$1.0 \times 10^{-2}$	338		

(0.5 mark for each = 5 marks)

If the expected Arrhenius plot is linear according to the equation,  $Y = 456X + 7.1795$ . Answer the following question,

- i. The activation energy for the reaction (3 marks)
- ii. The value of the Arrhenius constant for the reaction (2 marks)
- (b) What is the significant of collision in chemical reaction (2 marks)
- (d) Define the term activation energy and state how molecules can be activated prior to reaction (3 marks)

#### **Question 4**

- (a) What are the factors that influence the adsorption of gases on a solid surface (3 marks)
- (b) State three basic assumption of the Langmuir adsorption isotherm (3 marks)
- (c) Write the Langmuir and Freundlich adsorption equation and highlight the nature of graph expected for each of them. (6 marks)
- (d) Highlight three differences between physical and chemical adsorption (3 marks)

#### **Question 5**

- (a) State the following laws of photochemistry
  - i. Draper-Grothus law (1 marks)
  - ii. Stark-Einstein law (1 marks)
- (b) Define the under listed types of catalysis and give one example (equations are required) for each
  - i. Heterogeneous catalysis (2 marks)
  - ii. Homogenous catalysis (2 marks)
  - iii. Enzyme catalysis (2 marks)

(c) In photochemical decomposition of acetone using 313 nm light,  $7.57 \times 10^{-6}$  mol of carbon monoxide is formed in 20 minutes. If the light absorbed corresponds to  $2.41 \times 10^{-3}$  Js<sup>-1</sup>, calculate the energy absorbed per quantum of the photon . (3 marks)

(d) The decomposition of HI is a second order reaction. At 700 K, the rate constant for the reaction is  $1.8 \times 10^{-3}$  M/s. If the initial concentration of HI is 0.002 M. Answer the following,

(i) Write a balance equation for the decomposition (1 marks)

(ii) Write an expression for the rate law showing the relationship between rate and order of reaction (1 mark)

(iii) Calculate the rate of the reaction and express your answer in appropriate unit (2 marks)

