

15



KIBABII UNIVERSITY

**UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR**

**SECOND YEAR SECOND SEMESTER
SPECIAL/SUPPLEMENTARY EXAMINATIONS**

FOR THE DEGREE OF BSC (CHEMISTRY)

COURSE CODE: SCH 224

COURSE TITLE: CHEMICAL KINETICS

DATE: 28/07/2022

TIME: 2:00PM-4:00PM

INSTRUCTIONS TO CANDIDATES:

TIME: 2 Hours

Answer **question ONE** and **any TWO** of the remaining

KIBU observes ZERO tolerance to examination cheating

Question one (30 Marks)

- (a) Define the following terms as used in this course (2Marks)
- Rate of reaction (2Marks)
 - Half-life (2Marks)
 - Molecularity (2Marks)
 - Complex reactions (3marks)
- (b) State the three types of complex reactions (5marks)
- (c) Explain why High Molecularity Reactions are Rare (4 marks)
- (d) State the four assumptions of collision theory (5marks)
- (e) State any five postulates of collision theory (1 mark)
- (f) i) Define heterogeneous catalysis (2 marks)
- (ii) State the two common characteristics of catalytic reactions (2 marks)
- (g) State any two methods of determining order of a reaction (2 marks)

Question Two (20 marks)

(a) The rate law for the decomposition of N_2O_5 (*l*) is: $\text{rate} = k [N_2O_5]$ where $k = 6.22 \times 10^{-4} \text{ sec}^{-1}$. Calculate half-life of N_2O_5 (*l*) and the number of seconds it will take for an initial concentration of N_2O_5 (*l*) of 0.100 M to drop to 0.0100 M. (8 marks)

(b) Show that the hydrolysis of ethyl acetate in the presence of a mineral acid as catalyst with data provided below is a first order reaction. (5marks)

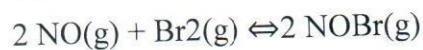
| t (secs) | 0 | 4500 | 7140 | ∞ |
|----------------|-------|-------|-------|----------|
| ml alkali used | 24.36 | 29.32 | 31.72 | 47.15 |

(c) Compound A decomposes to form B and C the reaction is first order. At 25°C the rate constant for the reaction is 0.450 s^{-1} . What is the half-life of A at 25°C? (4 marks)

(d) State the three types of elementary reactions (3 marks)

Question three (20 marks)

(a) Determine the rate law and evaluate the rate constant for the following reaction (8marks)



| Experiment | (NO) ₀ (M) | (Br ₂) ₀ (M) | Initial Rate of Reaction (M/min) |
|------------|--------------------------|--|-------------------------------------|
| 1 | 0.10 | 0.10 | 1.30×10^{-3} |
| 2 | 0.20 | 0.10 | 5.20×10^{-3} |
| 3 | 0.20 | 0.30 | 1.56×10^{-2} |

(b) i) Using Arrhenius equation $K = Ae^{-E_a/RT}$ show that $\ln k = \frac{-E_a}{R} \left(\frac{1}{T}\right) + \ln A$ (2 marks)

(ii) The values of the rate constant (*k*) for the reaction $2N_2O_5$ (*g*) \rightarrow $4NO_2$ (*g*) + O_2 (*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 $-1.2 \times 10^4 \text{ K}$. What is the activation energy of the reaction? (3 marks)

(R = gas constant (8.314 J/mol/K)) (4marks)

(c) Explain why high Molecularity reaction are rare (4marks)

(d) There are not many reactions showing third order kinetics. Write down chemical equations of any three of those reactions (3marks)

Question Four (20 marks)

(a) Describe the half-life method of determining order of reaction (10 marks)

(b) Show that the half-life of a second order reaction of the form $2A \rightarrow \text{Products}$ is

$$t_{1/2} = \frac{1}{k[A]_0} \quad (5 \text{ marks})$$

(c) (i) State the steady state approximation (1 mark).

ii) Using sequential reactions $A \xrightarrow{k_1} B \xrightarrow{k_2} C$, show that $\frac{d[C]}{dt} = k_1[A]$ (4 marks)

Question Five (20 marks)

(a) Describe the graphical method of determining order of a reaction of the type $A \rightarrow \text{products}$

(i) First order (5 marks)

(ii) Second order (5 marks)

(b) Explain the Michaelis-Menten mechanism (10 marks)