KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER
SUPPLEMENTARY EXAMINATIONS

FOR THE DEGREE OF B.ED (SCIENCE)

COURSE CODE: SCH 241

COURSE TITLE: Chemical Kinetics

DURATION: 2 HOURS

DATE: 25TH SEPTEMBER 2017 TIME: 11:30AM – 1:30PM

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.

This paper consists of **3** printed pages. Please Turn Over

Question one

(a) Define the following examples using appropriate examples and illustrations...... (6)

(i) Molecularity of a reaction

(ii) Order of a reaction

(iii) Activated complex

(b) Consider the stoichiometric reaction; $H_{2(g)} + Cl_{2(g)} \longrightarrow 2HCl_{(g)}$

(i) Determine the rate of consumption of Cl_2 given that the rate of formation of HCl is $2.5x10^{-3}$mol/l/sec .... (3)

(ii) If the rate of consumption of $H_{2(g)}$ is doubled, determine the rate of consumption of $Cl_{2(g)}$ and the formation of $HCl_{(g)}$ .... (2)

(c) The following data were measured for the reaction of nitric oxide with hydrogen:

$2NO_{(g)} + 2H_{2(g)} \longrightarrow N_{2(g)} + 2H_2O_{(g)}$

Experiment	[NO](M)	$[H_2]$(M)	Initial rate(M/sec)
1	0.10	0.10	$1.23x10^{-3}$
2	0.10	0.20	$2.46x10^{-3}$
3	0.20	0.10	$4.92x10^{-3}$

(i) Determine the rate law for this reaction......... (4)

(ii) Calculate the rate constant ....(1)

(iii) Calculate the rate law when [NO] =0.050M and $[H_2]$ = 0.150M .... (2)

(d) Carbon – 14 (^{14}C) is a radioactive isotope with a half life of 5.73 x 10^3yrs. The amount of ^{14}C present in an object can be used to determine its age. Calculate the rate constant for decay of ^{14}C and determine how long is required for 90% of the ^{14}C in a sample to decompose. .....(8)

(e) The half life of a radioactive ^{14}C is 5730yrs. An archaeological sample contains 72% of the ^{14}C normally found in nature. Calculate the age of the archaeological sample.....(5)

Question 2

(a) Derive the integrated rate law for a first order reaction $A \longrightarrow P$ with initial concentration$[A]_o$ and concentration at time, t, is $[A]_t$.........(4)

(b) The decomposition of A is first order, and A is monitored. The following data was recorded

t/min	0	1	2	4
[A]/(M)	0.100	0.0905	0.0819	0.0670

(i) Calculate the rate constant, k. .... (2)

(ii) What is the half life?................(2)

(iii) Calculate [A] when t = 5 min ....(2)

(iv) Calculate t when [A] = 0.0100. ....(2)

(v) Estimate the time required for 90% of A to decompose. ....(2)

(c) Outline any three applications of half – life. ......(3)

(d) The reactions of NO_2 have been studied as a function of temperature. For the following decomposition reaction, the rate constant is $2.7 \times 10^{-2}\ m^{-1}s^{-1}$ at 227°C and $2.4 \times 10^{-1} m^{-1}s^{-1}$ at 277°C.

$$2NO_2 \longrightarrow 2NO + O_2$$

Studies of the conversion of NO_2 to N_2O_4 give k = 5.2 x 10^9m-1s-1 at both 298 and 350K

$$2NO_2 \longrightarrow N_2O_4$$

Calculate the activation energies of these two reactions........(3)

Question three

(a) Suppose the following sequence of reactions were proposed for a certain reaction

Step 1 $\quad 2A \xrightarrow{k1} A2$

Step 2 $\quad A2 + B \xrightarrow{k2} C + 2D$

(i) Identify any intermediate species in the above mechanism. Explain your answer. ....(2)

(ii) What would be the rate law if step 1 was slow and step 2 was fast? ....(1)

(iii) What would be the rate law if step 2 was slow and step 1 was fast? ....(2)

(iv) Determine the rate law expression if step 2 is slow with the first reaction being a rapidly established dynamic equilibrium. ....(3)

(v) Explain why the slowest step is considered to be the rate determining step? ....(2)

(b) For the reaction: $H_{2(g)} + I_{2(g)} \longrightarrow 2HI_{(g)}$, what mechanism might be appropriate? Derive a rate law from the proposed mechanism. ......(4)

(c) The decomposition of hydrogen iodide has the rate constant of 9.51 x 10^{-9}mol/l/sec at 500K and 1.10x 10^{-5}mol/l/sec at 600K. Find the activation energy for this reaction. ......(4)

(d) Explain the following terms

(a) Homogenous catalysis......................(1)

(b) Heterogeneous catalysis ....(1)

Question four

(a) Two main theoretical approaches applied to the theory of reaction rates are the collision theory and transition state theory

(i) Briefly discuss what the collision theory is based on .....(4)

(ii) Outline the limitations of the collision theory ......(3)

(b) Using appropriate examplesto differentiate between homogeneous and heterogeneous catalysis. ....(2)

(c) Outline any three characteristics of a catalyst. ....(3)

(d) The rate of the reaction

$H_2O_{2(aq)} + 2I^-_{(aq)} + H^+_{(aq)}\ I_{2(aq)} + 2H_2O_{(l)}$

May be calculated by measuring the time for the first appearance of I^2 in the solution.i.e the time required for the concentration of I_2 to reach 10^{-5} moles/dm^3.

(a) For a particular experiment in which initially

$[H_2O_2] = 0.010M$

$[I^-] = 0.010M$

$[H^+] = 0.10M$

Calculate the reaction rate if I_2 first appear after 6 seconds........(2)

(b) In a second experiment in which initially,

$[H_2O_2] = 0.005M$

$[I^-] = 0.010M$

$[H^+] = 0.10M$

Calculate the reaction rate if I_2 first appear after 12 seconds......(2)

(c) From these calculations, show that the reaction is first order with respect to H_2O_2......(2)

(d) Given further information that the rate law is

Reaction rate = $k[H_2O_2][H^+][I^-]$, calculate the rate constant k........(2)