KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR
SECOND YEAR SECOND SEMESTER
SUPPLIMENTARY EXAMINATIONS

FOR THE DEGREE OF B.ED (SCIENCE)

COURSE CODE: SCH 241

COURSE TITLE: CHEMICAL KINETICS

DURATION: 2 HOURS

DATE: 15/10/2018 **TIME:** 11:30-1:30PM

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.
- You are provided with graph papers where necessary.

This paper consists of 4 printed pages. Please Turn Over

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QUESTION ONE (30 MARKS)

1. a) Define the following terms as used in chemical kinetics. (4marks)
   i. Activation energy
   ii. Activated complex
   iii. Enzymes
   iv. Catalytic poisoning

b) Nitric oxide reacted with hydrogen gas and was reduced at 1280°C in the equation below;

$2NO_{(g)} + 2N_{2(g)} \longrightarrow N_{2(g)} + 2H_2O_{(g)}$ (1280°C)

The table 1 below was obtained for the results involving different concentrations of reactants.

Experiment	[NO](in mols/liter)	[H_2](in mols/liter)	Initial rate (in mols/S)
1	0.0050	0.0020	1.25×10^{-5}
2	0.0100	0.0020	5.00×10^{-5}
3	0.0100	0.0040	1.00×10^{-5}

Use the values in the table to answer questions (b) (i) – (b) (iv) that follow.

i. Determine the rate law. (4marks)
ii. What is the overall order of the reaction? (2marks)
iii. Calculate the rate constant. (3marks)
iv. What is the rate constant when the concentration of nitric oxide is 0.012M and that of hydrogen is 0.0060M?. (3marks)

c) The data in table below was obtained for the conversion of cyclopropane into propene which is a 1st order reaction at 100°C.

Time (in seconds)	0	300	600	900
[C_3H_6](in mols/liter)	0.099	0.079	0.065	0.054
In[C_3H_6]				

Use the values in the table to answer questions © (i) – © (vi) that follow.

i. Complete the table 2 for values of In[C_3H_6] for the different concentration values of cyclopropane. (2marks)
ii. Plot the graph for In[C_3H_6] against time (S), hence show that the conversion of cyclopropane is a first order reaction at that temperature. (4marks)
iii. Use the graph to calculate the value of the rate constant for the reaction. (2marks)
iv. If the initial concentration for cyclopropane was 0.500M, what is the concentration of cyclopropane after 30minutes? (2marks)
v. How long does it take for the concentration of C_3H_6 to reach 0.0100M? (2marks)
vi. Calculate the half-life for the conversion of cyclopropane into propene. (2marks)

QUESTION TWO (20 MARKS)

2 a) Discuss briefly the limitation of collision theory reactions. (4marks)

b) Explain examples of autocatalysis. (6marks)

c) Derive mathematical expression for the rate constant of a reaction

(A + B →Products) of the second order. (5marks)

ii) The rate constants for the isomerization of methyl isocyanide are listed in the table3 below.

$H_3N^+{\equiv}C^-$: ⟶ H_3-C≡N

(Methyl isocyanide) (acetonitrile)

Temperature (K)	Rate constant K (S^-)	In K	1/T
470	5.79×10^{-5}		
480	1.36×10^{-4}		
490	3.10×10^{-4}		
500	6.81×10^{-4}		
510	1.45×10^{-3}		

Complete the table for the values of In K and 1/T and using an appropriate graph in the form of Arrhenius equation, find the value of activation energy E_a (5marks)

QUESTION THREE (20 MARKS)

a) Define the following terms; (6marks)

i. Molecularity
ii. Zero order reaction
iii. First order reaction

b) In the reaction;

$$NO_2(g) + CO(g) \longrightarrow NO(g) + CO_2$$

Propose a possible mechanism, clearly identifying the reaction intermediate and the rate determining step. (3marks)

c)

i. What is the difference between homogenous and heterogeneous catalysts. (4marks)

ii. State four examples of heterogeneous catalysis reaction (4marks)

d) Draw a potential energy profile for the reaction showing how activation energy

changes in each step. (3marks)

QUESTION FOUR (20 MARKS)

a) State TWO factors which affect the molecular speed of a gas particle in a system. (2marks)

b) Define the following with respect to the distribution of molecular speeds of a gas sample. (3marks)

i. Most probable speed
ii. Root mean square speed
iii. Average speed

c) Using Maxwell and Boltzman's postulates about the distribution of molecular speeds, explain how the kinetic energy and rate of reaction are affected by the following;

i. Temperature of the gas sample. (5marks)
ii. Molecular mass of the particle. (5marks)
iii. Use of a catalyst. (5marks)

(Use distribution function diagrams to show how each property affects the fraction of molecules with kinetic energy above activation energy.)

QUESTION FIVE (20 MARKS)

a) The reaction below 2 NOBr (g) $\rightarrow$2 NO (g) + Br_2(g) is a second order reaction with respect to NOBr. k= 0.810 $M^{-1}\cdot s^{-1}$at 10^{oC}. If [NOBr]o= 7.5 ×10-3M, how much NOBr will be left after a reaction time of 10 minutes? Determine the half-life of this reaction. (4marks)

b) The gas-phase reaction between methane (CH4) and diatomic sulphur (S2) is given by the equation CH4(g) + 2S2(g) $\longrightarrow$ CS2(g) + 2H2S (g). At 550°C the rate constant for this reaction is 1.1 lmol–1sec and at 625°C the rate constant is 6.4 1 mol^{-1}sec. Calculate Ea for this reaction. (7marks)

c) Derive an expression for the half-life period of the following reaction:
A $\rightarrow$B, rate $\propto$[A (4marks)

d) Why is the study of chemical kinetics quite important in the application chemistry. (5marks)