KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2019/2020 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER
SUPPLEMENTARY EXAMINATIONS

FOR THE DEGREE (SCIENCE)

COURSE CODE: SCH 215

COURSE TITLE: INTRODUCTION TO KINETICS AND THERMODYNAMICS
DURATION: **2 HOURS**

DATE: 1/02/2021 **TIME:** 8 - 10 Am

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

KIBU observes ZERO tolerance to examination cheating

QUESTION ONE (30 marks)

i. Define each of the following terms as used in thermodynamics; (5 marks)
   I. System
   II. Surrounding
   III. State function
   IV. Intensive property
   V. Closed system

ii.
   I. Define an isothermal change. (2 marks)
   II. 0.2 moles of an ideal gas was expanded isothermally at 273 K from 8L to 10L. Determine the energy (q) absorbed from the surroundings. (R = 8.314 $J.K^{-1}.mol^{-1}$) (4 marks)

iii. Under what conditions would a gas depart from: (2 marks)
   I. Boyles' law
   II. Charles' law

iv. Carbon (II) oxide reacts with nitrogen (IV) oxide according to the equation below.
$CO_{(g)} + NO_{2(g)} \rightarrow CO_{2(g)} + NO_{(g)}$
The concentration of CO was found experimentally every 10 seconds and recorded in the table below.

Concentration of CO	0.100	0.067	0.050	0.040	0.033
Time (seconds)	0	10	20	30	40

   I. Determine the average rate of reaction between the 10^{th} and 30^{th} second. (2 marks)
   II. Explain how the rate of this reaction at the 25^{th} second would be determined. (3 marks)

v. State any three postulates of the kinetic molecular theory. (3 marks)

vi. $PV = \frac{1}{3}mnu^2$ is the kinetic gas equation where m is the mass of one gas molecule, n is the number of gas molecules and u^2 is mean square velocity. Show that in terms of kinetic energy, this equation is given as $PV = \frac{2}{3}E$ where E is the total kinetic energy of all the n molecules. (3 marks)

vii.
   I. Explain how the graphical method can be used to show that a given reaction obeys the first order kinetics. (3 marks)
   II. Other than the graphical method, name other three methods used to determine the order of a reaction. (3 marks)

QUESTION TWO (20 marks)

i. What is an ideal gas? (1 mark)

ii. Calculate the pressure exerted by 64g of oxygen at 27^0C in a 10 litre flask using: ((R = 0.0821 $atm.litre.mol^{-1}K^{-1}$)
   I. The ideal gas equation. (3 marks)
   II. The van der Waals equation. (3 marks)

iii. Give the difference between an elementary and a complex reaction (2 marks)

iv. State the: (2 marks)
   I. Molecularity of the following reaction.

$CH_3COOC_2H_5 + H_2O \rightarrow CH_3COOH + C_2H_5OH$

II. Order of a reaction whose rate law is given as: rate = $k[H_2]^a[NO]^b$

v. The following data was obtained for the reaction between hydrogen and nitrogen (II) oxide at 700^0C. $2H_{2\,(g)} + 2NO_{(g)} \rightarrow 2H_2O_{\,(g)} + N_{2\,(g)}$

Experiment	$[H_2]$	[NO]	Initial rate (M/s)
1	0.10	0.010	1.2×10^{-3}
2	0.10	0.040	4.8×10^{-3}
3	0.20	0.010	2.4×10^{-3}

Determine the:

I. Rate law for the overall reaction. (5 marks)

II. Overall order of the reaction. (1 mark)

III. The rate constant for the overall reaction. (3 marks)

QUESTION THREE (20 marks)

i. Define the following: (3 marks)

I. Enthalpy

II. Enthalpy of formation

III. Enthalpy of combustion

ii. Explain the following: (2 marks)

I. Enthalpy is an extensive property

II. Enthalpy is a state function

iii. State Hess's law. (2 marks)

iv. Calculate the enthalpy change accompanying the transformation of C (graphite) to C (diamond) given that the enthalpies of combustion of graphite and diamond are 393.5 $kJmol^{-1}$ and 395.4 $kJmol^{-1}$ respectively. (Note that combustion is an exothermic process) (4 marks)

v. Show that for a first order reaction, the half life is independent of the initial concentration. (4 marks)

vi. Show that for a first order reaction, the time required for 99.9% completion of the reaction is 10 times that required for 50% completion. (5 marks)

QUESTION FOUR (20 marks)

i. The equation below represents Saponification of ethyl acetate using sodium hydroxide.

$CH_3COOC_2H_5 + NaOH \rightarrow CH_3COONa + C_2H_5OH$

In the study of reaction kinetics of such a reaction equal concentrations and volume of ethyl acetate and sodium hydroxide were mixed. Small amounts of the reaction mixture was withdrawn at different time intervals and titrated against dilute hydrochloric acid. The data obtained is shown in the table below.

Time in minutes	0	4.89	10.07	23.6	∞
Volume of HCl used (ml)	47.65	38.92	32.62	22.58	11.84

Show that the above reaction is second order. (8 marks)

ii. What is the importance of an integrated rate law? (2 marks)

iii. At a certain temperature, the half lives for the catalytic decomposition of ammonia were found to be as follows.

Pressure (mmHg)	50	100	200
Half life (hours)			

Determine the order of the reaction. (5 marks)

iv. State any five factors that affect the rate of a chemical reaction. (5 marks)