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KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS 2022/2023 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER MAIN EXAMINATIONS

FOR THE DEGREE OF BED (Science)

COURSE CODE: SCH 215

COURSE TITLE: INTRODUCTION TO KINETICS AND
THERMODYNAMICS

DURATION: 2 HOURS

DATE: 13/12/2022

TIME: 2:00-4:00PM

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 3 printed pages. Please Turn Over



KIBU observes ZERO tolerance to examination cheating

QUESTION ONE (30 Marks)

(a) Define the following terms

(5Marks)

- i. Chemical kinetics
- ii. Molecularity
- iii. Order of reaction
- iv. State functions
- v. Isothermal process

(b) Derive and state the physical significance of gas constant R

(3Marks)

(c) Gases are divided into ideal and real gases. State the two conditions under which real gases tend to obey ideal gas laws

(2Marks)

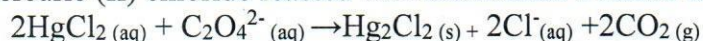
(d) (i) Define homogeneous catalysis

(1Mark)

(ii) Give any two examples of heterogeneous catalysis

(2Marks)

(e) Mercuric (II) chloride reacted with dichromate solution as shown in the equation below;



The table below shows the results involving different concentrations of reactants.

| Experiment number | $[\text{HgCl}_2](\text{M})$ | $[\text{C}_2\text{O}_4^{2-}](\text{M})$ | Initial rate (mol/S) |
|-------------------|-----------------------------|---|----------------------|
| 1 | 0.096 | 0.13 | 2.1×10^{-7} |
| 2 | 0.096 | 0.21 | 5.5×10^{-7} |
| 3 | 0.171 | 0.21 | 9.8×10^{-7} |

i. Determine the order of the reaction with respect to HgCl_2 and with respect to $\text{C}_2\text{O}_4^{2-}$ **(2Marks)**

ii. What is the overall order of the reaction?

(1marks)

iii. Calculate the rate constant

(2Marks)

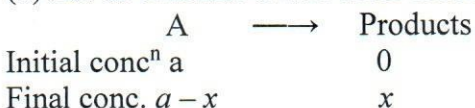
(f) (i) State the Hess's law

(2marks)

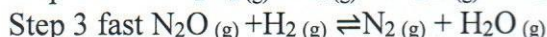
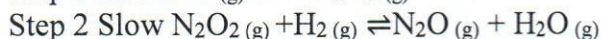
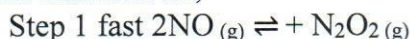
(ii) From the following enthalpies of reaction

Calculate the ΔH for the reaction of $\text{C}_2\text{H}_4(\text{g})$ with $\text{F}_2(\text{g})$ to make $\text{CF}_4(\text{g})$ and $\text{HF}(\text{g})$ **(3marks)**(g) State the first law of thermodynamics and write its mathematical expression **(3Marks)**

(h) Let us consider a first order reaction of the type

Show that its integrated rate law is given by $k = \frac{1}{t} \ln \left(\frac{a}{a-x} \right)$ **(4Marks)****QUESTION TWO (20 Marks)**

(a) Consider a three-step reaction mechanism suggested below and use it to answer the questions that follows;



- i) Define reaction mechanism (2Marks)
 iii) Derive the overall equation of reaction (2Marks)
 iv) Identify the rate determining step (2Marks)
 v) Derive the rate law for the above reaction (2Marks)
 vi) Identify the reaction intermediate (2marks)
 (b) Using the first law of thermodynamics ($dE = dq - dw$), show the specific heat capacity at constant pressure is given by $C_p = \left(\frac{dH}{dT}\right)$ (10Marks)

QUESTION THREE (20 Marks)

- (a) Describe the Graphical method of determining order of reaction (10Marks)
 (b) Using $\Delta E = q - W$, show that $\left(\frac{T_2}{T_1}\right) = \left(\frac{V_1}{V_2}\right)^{\alpha-1}$ for reversible adiabatic expansion (5Marks)
 (c) State the five common characteristics of catalytic reactions (5Marks)

QUESTION FOUR (20 Marks)

- (a) 2 moles of ideal gas 300K is compressed adiabatically to $\frac{1}{4}$ of the original volume. Find temperature of the gas after compression ($C_v = 12.5 \text{ J K}^{-1} \text{ mol}^{-1}$) (10Marks)
 (b) i) Define system (2Marks)
 (ii) State the three thermodynamic systems (3Marks)
 (c)) The decomposition of carbon disulfide, CS_2 , to carbon monosulfide, CS , and sulfur is first order with $k = 2.8 \times 10^{-7} \text{ s}^{-1}$ at 100°C . What is the half-life of this reaction at 100°C ? (5marks)

QUESTION FIVE (20 Marks)

- (a) The following results were obtained from a study of the isomerization of cyclopropane to propene in the gas phase at 433°C

| | | | | | | |
|-----------------------------|-----|----|----|----|----|----|
| Time(hours) | 0 | 2 | 5 | 10 | 20 | 30 |
| % of Cyclopropane remaining | 100 | 91 | 79 | 63 | 40 | 25 |

- (i) Show that the reaction is a first order with respect to cyclopropane (5Marks)
 (ii) Calculate the rate constant for the reaction (2Marks)
 (b) State the three types of elementary reactions (3Marks)
 (c) Describe the Michaelis-Menten mechanism (10Marks)