

MACHAKOS UNIVERSITY COLLEGE

(A Constituent College of Kenyatta University)
University Examinations for 2015/2016 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST SEMESTER EXAMINATION FOR DIPLOMA IN EDUCATION (SCIENCE)

SCH 0201: CHEMICAL KINETICS AND THERMODYNAMICS

DATE:

TIME:

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

SECTION A - COMPULSORY.

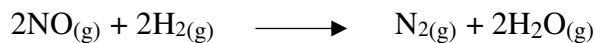
QUESTION ONE

- a) Define each of the following terms used in Thermodynamics. (5 marks)
- System
 - Surrounding
 - Open System
 - State Function
 - Closed System
- b) Write the rate expressions for each of the following reactions
- $\text{I}_{(g)} + \text{OCl}_{(g)} \longrightarrow \text{Cl}_{(g)} + \text{OI}_{(g)}$ (2 marks)
 - $4\text{NH}_{3(g)} + 5\text{O}_{2(g)} \longrightarrow 4\text{NO}_{(g)} + 6\text{H}_2\text{O}_{(g)}$ (2 marks)
- c)
- Define adiabatic change. (2 marks)
 - Two Moles of an ideal monatomic gas at 300k are compressed adiabatically to one quarter of the original volume. What is the temperature of the gas after compression? (4 marks)
- d)
- Explain the factors that affect chemical reactions (5 marks)
 - Consider the reaction $4\text{PH}_3 \longrightarrow \text{P}_4 + 6\text{H}_2$ at a particular point during the reaction, molecular hydrogen is being formed at the rate 0.168m/s
 - At what rate is P_4 being formed (3 marks)
 - At what rate is PH_3 being consumed (2 marks)
- e)
- Define isothermal change. (1 mark)
 - 0.1 mole of an ideal gas is expanded isothermally at a temperature of 273k from 3dm^3 to 5dm^3 . Determine the energy (q) absorbed from the surrounding. (4 marks)

SECTION B: (ANSWER ANY 2 (TWO) QUESTIONS)

QUESTION TWO

- a) The gas reaction of NO with H_2 at 1280 °C is

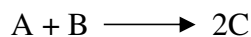


From the table below determine.

EXP	[NO] ₀ (M)	[H ₂] ₀ (M)	Initial Rate M/Min
1	5.0×10^{-3}	2×10^{-3}	1.3×10^{-5}
2	1.0×10^{-2}	2×10^{-3}	5×10^{-5}
3	1.0×10^{-2}	4×10^{-3}	1×10^{-4}

- i. Rate Law. (2 marks)
- ii. Rate constant. (3 marks)
- iii. Overall order of the reaction. (2 marks)
- iv. Rate of reaction when [NO] is $4.8 \times 10^{-3}\text{M}$ and [H₂] = $6.2 \times 10^{-3}\text{M}$. (3 marks)

- b) For the following reaction, Rate = $K[\text{A}]^2$ and $K = 1.3 \times 10^{-2} \text{M}^{-1} \text{S}^{-1}$



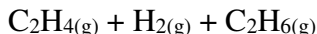
Use this information to fill in the missing table entries. (7 marks)

Exp	[A] ₀ M	[B] ₀ M	Initial Rate M/Min
1	0.013	0.25	2.2×10^{-6}
2	0.026	0.25	_____
3	_____	0.5	2.2×10^{-6}

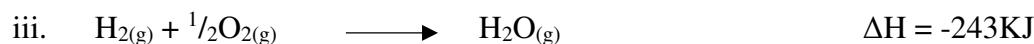
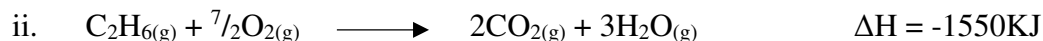
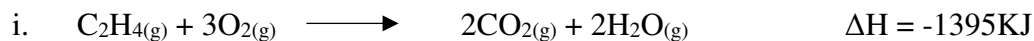
- c) Name three major orders of chemical reactions. (3 marks)
 - i. State Hess's law of constant heat summation (2 marks)

QUESTION THREE

- a) Calculate the enthalpy of the reaction (4 marks)

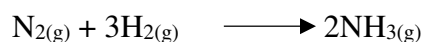


At 298K from the following data.



- b) i. Derive the Kirchoff's equation (5 marks)

ii. For the reaction



The value of $\Delta\text{H}^\circ_{298}$ is -92.29kJ at 25°C . The molar heat capacities at constant pressure of Nitrogen, hydrogen and ammonia are given as:

$$\text{CH}_2 = (29.038 - 0.0836 \times 10^{-3}\text{T} + 20.097 \times 10^{-7}\text{T}^2) \text{JK}^{-1}$$

$$\text{CN}_2 = (26.957 + 5.906 \times 10^{-3}\text{T} - 3.373 \times 10^{-7}\text{T}^2) \text{JK}^{-1}$$

$$\text{CNH}_3 = (25.870 + 32.968 \times 10^{-3}\text{T} - 30.430 \times 10^{-7}\text{T}^2) \text{JK}^{-1}$$

Calculate the standard enthalpy of reaction at 125°C . (5 marks)

- c) When one mole of liquid benzene was completely burnt in oxygen to form liquid water and CO_2 gas $\Delta\text{H} = -3250\text{kJ}$ at 298K . Calculate the enthalpy of reaction at constant volume at the same temperature. (4 marks)

4. QUESTION FOUR

- a) The decomposition of hydrogen peroxide is 1st Order



The K is $1.8 \times 10^5 \text{ s}^{-1}$ at 20°C . If the starting concentration of H_2O_2 is 0.75M determine.

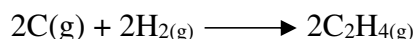
- i. The concentration of H_2O_2 remaining after 2hrs 30mins. (5 marks)
- ii. How long will it take for H_2O_2 concentration to drop to 0.1 M . (5 marks)
- b) Define the term half-life. (2 marks)

- i. The decomposition of Ethane to Methyl radicals is a 1st Order reaction with rate constant of $5.36 \times 10^{-4} \text{ s}^{-1}$ at 700°C. Calculate the half-life of the reactions in seconds. (5 marks)
- ii. State the methods of determining rate law from experimental data. (3 marks)

QUESTION FIVE

a) Define entropy of a system. (1 mark)

i. Calculate the entropy change for the reaction. (5 marks)



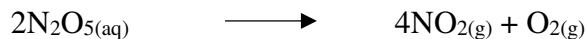
Given the following standard entropies at 25°C in units $\text{JK}^{-1} \text{ mole}^{-1}$

$\text{C}_{(\text{graphite})}$	5.7
H_2	131.2
C_2H_4	221.0

- ii. One mole of an ideal monoatomic gas at standard temperature and pressure was heated at constant volume to a temperature of 353K. Determine the change in entropy. (4 marks)
- b) The enthalpy of transition from rhombic to monoclinic Sulphur at the transition temperature of 95.6°C is 0.361 KJ/mole. Determine the entropy of transition. (4 marks)
- c) 2 moles of an ideal gas at 10 atmospheres and 23°C are expanded isothermally to a pressure of 1 atmosphere. Determine the work done. (4 marks)
- d) Differentiate between extensive properties and intensive properties. (2 marks)

QUESTION SIX

a) The decomposition of N_2O_5 in the gas phase was studied at constant temperature.



The following results were collected.

[N ₂ O ₅] Mol/L	Time
0.1000	0
0.0707	50
0.0500	100
0.0250	200
0.0125	300
0.00625	400

- i. Using the data above verify that the rate is First Order in (N₂O₅). (8 marks)
- ii. Calculate the value of the rate constant where the rate. (4 marks)

$$= -\frac{d[\text{N}_2\text{O}_5]}{dt}$$

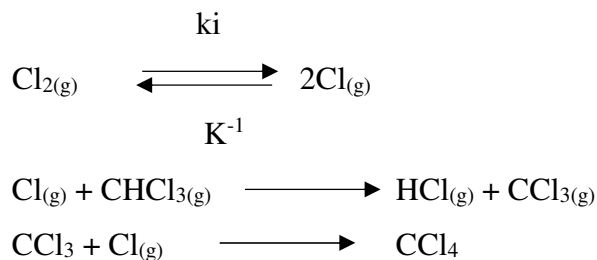
The gas phase reaction of chlorine with chloroform is described by the equation.



The rate law determined from experiment has a non-integer order.

$$\text{Rate} = K[\text{Cl}_2]^{1/2}[\text{CHCl}_3]$$

A proposed mechanism for reaction follows: -



Is this an acceptable mechanism for the reaction? (4 marks)

- c) Explain Collision Theory. (4 marks)