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)

i. System

ii. Surrounding

iii. Open System

iv. State Function

v. Closed System

b) Write the rate expressions for each of the following reactions

i. $I^-_{(g)} + OCL^-_{(g)} \longrightarrow CL^-_{(g)} + OL^-_{(g)}$ (2 marks)

ii. $4NH_{3(g)} + 5O_{2(g)} \longrightarrow 4NO_{(g)} + 6H_2O_{(g)}$ (2 marks)

c) i. Define adiabatic change. (2 marks)

ii. 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) i. Explain the factors that affect chemical reactions (5 marks)

ii. Consider the reaction $4PH_3 \longrightarrow P4H_{(g)} + 6H_2O_{(g)}$ at a particular point during the reaction, molecular hydrogen is being formed at the rate 0.168m/s

iii. At what rate is P_4 being formed (3 marks)

iv. At what rate is PH_3 being consumed (2 marks)

e) i. Define isothermal change. (1 mark)

ii. 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

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

From the table below determine.

EXP	**$[NO]_o$(M)**	**$[H_2]_o$(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 4.8×10^{-3}M and $[H_2] = 6.2 \times 10^{-3}$M. (3 marks)

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

$A + B \longrightarrow 2C$

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

Exp	**$[A]_o$ M**	**$[B]_o$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)

$C_2H_{4(g)} + H_{2(g)} + C_2H_{6(g)}$

At 298K from the following data.

i. $C_2H_{4(g)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 2H_2O_{(g)}$ $\Delta H = -1395KJ$

ii. $C_2H_{6(g)} + {}^{7}/_{2}O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(g)}$ $\Delta H = -1550KJ$

iii. $H_{2(g)} + {}^{1}/_{2}O_{2(g)} \longrightarrow H_2O_{(g)}$ $\Delta H = -243KJ$

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

ii. For the reaction

$N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

The value of $\Delta H°$ 298 is -92.29kj at 25°c. The molar heat capacities at constant pressure of Nitrogen, hydrogen and ammonia are given as:

$CH_2 = (29.038 - 0.0836 \times 10^{-3}T + 20.097 \times 10^{-7}T^2)\ JK^{-1}$

$CN_2 = (26.957 + 5.906 \times 10^{-3}T - 3.373 \times 10^{-7}T^2)\ JK^{-1}$

$CNH_3 = (25.870 + 32.968 \times 10^{-3}T - 30.430 \times 10^{-7}T^2)\ JK^{-1}$

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 ΔH = -3250kj 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

$2H_2O_{2(aq)} \longrightarrow 2H_2O_{(L)} + O_{2(g)}$

The K is $1.8 \times 10^5\ s^{-1}$ at 20°c. If the starting concentration of H_20_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_20_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 x 10^{-4} 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)

$2C(g) + 2H_{2(g)} \longrightarrow 2C_2H_{4(g)}$

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

$C_{(graphite)}$	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 transmission 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_s in the gas phase was studied at constant temperature.

$2N_2O_{5(aq)} \longrightarrow 4NO_{2(g)} + O_{2(g)}$

The following results were collected.

$[N_2O_5]$ 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 (N_2O_5). (8 marks)

ii. Calculate the value of the rate constant where the rate. (4 marks)

$= \underline{-d\,[N_2O_5]}\,/dt$

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

$$Cl_{2(g)} + CHCl_{3(g)} \longrightarrow HCL_{(g)} + CCl_{4(g)}$$

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

$$\text{Rate} = K[Cl_2]^{1}/_{2}[CHCl_3]$$

A proposed mechanism for reaction follows: -

$$Cl_{2(g)} \underset{K^{-1}}{\overset{ki}{\rightleftharpoons}} 2Cl_{(g)}$$

$$Cl_{(g)} + CHCl_{3(g)} \longrightarrow HCl_{(g)} + CCl_{3(g)}$$

$$CCl_3 + Cl_{(g)} \longrightarrow CCl_4$$

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

c) Explain Collision Theory. (4 marks)