JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THEDEGREE OF BACHELOR OF EDUCATION (SCIENCE)

3RD YEAR 2ND SEMESTER 2016/17

MAIN REGULAR

COURSE CODE: SCH 308

COURSE TITLE: CHEMICAL KINETICS

EXAM VENUE: PHY LAB **STREAM: (BED SCI)**

DATE: 06/09/16 **EXAM SESSION: 2.00 – 4.00 PM**

TIME: 2:00HRS

Instructions:

1. **Answer question 1 (Compulsory) in Section A and ANY other 2 questions in Section B.**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room**

INSTRUCTIONS: Answer Question 1 and any TWO questions in this question paper

QUESTION ONE (30 marks)

1. (a) Define the following terms;

   (i) Rate equation
   (ii) Bimolecular reaction
   (iii) Activation energy
   (iv) Rate of a reaction [4 marks]

   (b) State the factors that affect the rate constant of a reaction. [4 marks]

   (c) Why are termolecular reactions rare? [2 marks]

   (d) The recombination of iodine atoms to form molecular iodine in the gas phase $I_{(g)} + I_{(g)} \rightarrow I_{2\,(g)}$ follows second order kinetics and has the high rate constant $7.9 \times 10^{9}\ M^{-1}s^{-1}$ at 23 °C.
   If the initial concentration of iodine atoms was 0.086 mol L^{-1}, calculate the concentration after 2 minutes. [5 marks]

   (e) Briefly explain how the collision theory explains increases in reaction rates constant with rises in temperature. [5 marks]

   (f) The gas phase decomposition of acetalhyde at elevated temperatures and represented by the chemical equation $CH_3CHO_{(g)} \rightarrow CH_{4\,(g)} + CO_{(g)}$ was found experimentally to follow the rate law; $R= [CH_3CHO]^{3/2}$. Determine the units of k. [3 marks]

QUESTION TWO (20 marks)

2. (a) Derive the integrated rate equation for a first order reaction. [8 marks]

   (b) The gas phase reaction between Methane (CH_4) and diatomic Sulphur (S_2) is given by the equation

   $$CH_4\,(g) + 2S\,(g) \rightarrow CS_2\,(g) + 2H_2S\,(g)$$

   At 550 °C, the rate constant for this reaction is 11 $Lmol^{-1}$ sec and at 625 °C the rate constant is 6.4 $Lmol^{-1}$ sec. Calculate E_a for this reaction. [6 marks]

   (c) Define the terms;
   (i) Frequency factor
   (ii) Boltzmann factor as used in the Arrhenius equation and in both cases state their significance and units. [6 marks]

QUESTION THREE (20 marks)

3. (a) The Arrhenius rate equation is given by the following expression;

$$k = Ae^{-Ea/RT}$$

Define all the terms in this equation. [5 marks]

(b) Define a zero order reaction and
(i) Derive its corresponding integrated rate law [6 marks]
(ii) Half life expression. [3 marks]

(c) The rate of decomposition of N_2O_3 to NO_2 and NO was studied and the following data of $[N_2O_3]$ with time was obtained.

Time (s)	0	500	1500	2800
$[N_2O_3]$ mol/L	0.910	0.775	0.563	0.408

Does the reaction follow first order kinetics? [6 marks]

QUESTION FOUR (20 marks)

4. (a) Reactions are classified as unimolecular, bimolecular and so on. Why are there no zero-molecular reactions? [2 marks]

(b) Consider the reaction

$$A \rightarrow P$$

If the concentration of A decreases from 0.40 $molL^{-1}$ to 0.20 mol L^{-1} in 100 seconds. What will the concentration of A be after another 50 seconds if the reaction is zero order for A? [4 marks]

(c) Sketch a graph showing the dependence of rate of a reaction on temperature. [5 marks]

(d) The rate constant of a first order reaction is 3.46×10^{-2} s^{-1} at 298 K. What is the rate constant at 350 K, if the activation energy for the reaction is 50.2 KJ/mole? [5 marks]

(e) The values of the rate constant (k) for the reaction $2N_2O_{5\,(g)} \rightarrow 4NO_{2\,(g)} + O_{2\,(g)}$ were determined at several temperatures. A plot of In k versus 1/T gave a straight line of which the slope was found to be -1.2×10^4 K. What is the activation energy of the reaction? [4 marks]