JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION (SCIENCES)

3RD YEAR SECOND SEMESTER 2019/2020 ACADEMIC YEAR

MAIN REGULAR

COURSE CODE:

COURSE TITLE: CHEMICAL KINETICS

EXAM VENUE: **DATE:1/12/20**

TIME: 3 HRS **EXAM SESSION:3-6 PM**

STREAM:

INSTRUCTIONS:

1. **Answer question 1 (Compulsory) in section A and ANY other 2 questions in Section B.**
2. **Candidates are advised to write on the text editor provided, or to write on a foolscap, scan and upload alongside the question.**
3. **Candidates must ensure that they submit their work by clicking 'FINISH AND SUBMIT ATTEMPT' button at the end.**

SECTION A (30 MARKS)

Question 1.

a) Briefly discuss the following terms: (6 marks)

i. Rate of reaction
ii. Order of a reaction
iii. Molecularity of a reaction
iv. Rate constant
v. Half-life of a reaction
vi. Arrhenius equation

b) Derive mathematical expressions for the rate constants of the following reactions

i. Zero order (3 marks)
ii. First order (3 marks)
iii. Second order (3 marks)
iv. Third order (3 marks)

c) How is the order of the reaction determined by Differential method and Half-life method (2 marks)

d) 50% of a first order reaction is complete in 23 minutes. Calculate the time required to complete 90% of the reaction (3 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 1n k *versus* 1/*T* gave a straight line of which the slope was found to be –1.2 × 104 K. What is the activation energy of the reaction? (2 marks)

f) The gas-phase reaction between methane (CH_4) and diatomic sulphur (S_2) is given by the equation
$CH_4\ (g) + 2S_2\ (g) \rightarrow CS_2\ (g) + 2H_2S\ (g)$
At 550°C the rate constant for this reaction is 1.1 *l* mol^{-1} sec and at 625°C the rate constant is 6.4 1 mol^{-1} sec. Calculate E*a* for this reaction. (3 marks)

g) Briefly Explain what are rate laws (2 marks)

SECTION B (20 marks)

Question 2

(a) Discuss the collision theory of reactions (5 marks).
(b) What are the limitations of the collision theory (5 marks)
(c) Sometimes there are some side reactions accompanying the main chemical reaction. Generally, following types of complications occur:
    i) Consecutive reactions

ii) Parallel reactions
iii) Reversible or opposing reactions

Discuss these concepts (10 marks)

Question 3

a) Discuss the transition state theory (10 marks)
b) The variation in the partial pressure of azomethane with time was followed at 600 K, with the results given below. Confirm that the decomposition
$CH_3N_2CH_3(g) \rightarrow CH_3CH_3(g) + N_2(g)$
is first-order in azomethane, and find the rate constant at 600 K. (10 marks)

t/s	0	1000	2000	3000	4000
p/Pa	10.9	7.63	5.32	3.71	2.59

Question 4

a) Explain, with examples, the functions of catalytic promoters and poisons in chemical reactions (5 marks).
b) The rates of chemical reactions are measured by using techniques that monitor the concentrations of species present in the reaction mixture. Discuss in detail the various examples of these techniques. (10 marks)
c) The decomposition of H_2O_2 in the presence of Pt as catalyst is a first order reaction

$$H_2O_2 \xrightarrow{Pt} H_2O + O$$

The progress of the reaction is followed by titrating equal volumes of the reaction mixture against standard $KMnO_4$ solution at different time intervals.

t (minutes)	0	10	20
Vol $KMnO_4$ used for 10 ml H_2SO_4	23.8 ml	14.7 ml	9.1 ml

Show that the decomposition of H_2O_2 is a first order reaction (5 marks)

Question 5

a) The rate law for the decomposition of N_2O_5 (l) is: rate = k [N_2O_5] where $k = 6.22 \times 10^{-4}$ sec^{-1}. Calculate half-life of N_2O_5 (l) and the number of seconds it will take for an initial concentration of N_2O_5 (l) of 0.100 M to drop to 0.0100 M. (5 marks)

b) In the reduction of nitric oxide, 50% of reaction was completed in 108 seconds when initial pressure was 336 mm Hg and in 147 seconds initial pressure was 288 mm Hg. Find the order of the reaction. (5 marks)

c) Explain how the acid catalysed hydrolysis of an ester is followed experimentally to show it to follow first order kinetics. (5 marks)

c) Discuss the Lindeman's theory of unimolecular reactions (5 marks)