

**W1-2-60-1-6**

**JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY**

**UNIVERSITY EXAMINATIONS 2018/2019**

**YEAR II SEMESTER I EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN INDUSTRIAL BIOTECHNOLOGY AND BIOENGINEERING**

**HBB 2204: CHEMICAL REACTIONS IN BIOENGINEERING**

**DATE: DECEMBER 2018 TIME: 2 HOURS**

**INSTRUCTIONS: Answer question one and any other two questions.**

**Useful information**

ln x=2.303 log x

00=273k

R=8.314 JK-1 mol-1

=0.0821 L atm K-1 mol-1

=1.98 cal k-1 mol-1

F =96500 C

1 atm=101, 325 Nm-2

At 250C, =0.0591V

QUESTION ONE (30 MARKS)

a. i. Explain what is meant by rate of chemical reaction? How is it expressed?

(2 marks)

ii. Discuss the effect of a catalyst on the rate of a chemical reaction. (2 marks)

iii. What are the factors that affect the rate of reaction? (4 marks)

b. For the following reaction, the initial rate of formation of I2 (aq) was found to be

2.5x10-3 mol dm-3 s-1



What was

i. The initial rate of formation of 

ii. The initial rate of consumption of  (4 marks)

c. When cyclopropane is heated to 750K in a closed container, it isomerizes to form propene.



The reaction was monitored using infrared spectroscopy and the following data obtained.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| t/min | 0 | 5.0 | 10 | 20 | 30 | 40 | 50 | 60 |
| Cyclopropane/10-3 moldm-3 | 1.50 | 1.23 | 1.01 | 0.68 | 0.46 | 1.31 | 0.21 | 0.14 |

Show that the reaction is first order and find a value for the rate constant, k at 750k.

(10 marks)

d. The following elementary reaction between ozone and oxygen.

O3+O→O2

i. Write down an expression for the rate of reaction. (2 marks)

ii. What is the order of the reaction with respect to

i. O3 and

ii. O? (2 marks)

ii. What is the overall order of the reaction? (3 marks)

QUESTION TWO (20 MARKS)

a. What is meant by half life of a chemical process? (1 mark)

b. Sucrose decomposes in acid solution into glucose and fructose according to first order rate law, with half- life of 3.33h at 250C. What fraction of a sample of sucrose remains after 9.00 hour. (5 marks)

c. The reaction of nitric oxide with hydrogen at 12800C is 2NO(g)+2H2(g)→N2(g)+2H2O(g)

From the following data collected at this temperature, determine

i. The rate law (5 marks)

ii. The rate constant (5 marks)

iii. The rate of reaction when [NO] =13.0 x 10-3 M and [H2]=6.0 x10-3

(4 marks)

|  |  |  |  |
| --- | --- | --- | --- |
| Experiment | [NO]/M | [H2]/M | Initial rate (MS-1) |
| 1 | 10.0 x 10-3 | 2.0x10-3 | 5.0x10-5 |
| 2. | 10.0 x 10-3 | 4.0 x 10-3 | 10.0 x 10-5 |
| 3. | 14.0 x 10-3 | 2.0 x 10-3 | 9.8 x 10-5 |

QUESTION THREE (20 MARKS)

a. A reaction between A and B is second order. Write three different rate law expressions which might possibly apply to the reaction. (3 marks)

b. If the rate of a reaction obeyed the rate law K[A] [B] what would be the units of K if the concentration are expressed in moles per litre and time in seconds. (3 marks)

c. For a reaction A→B, the rate law is



i. Integrate the rate equation. (4 marks)

ii. How would a plot of against t vary? (2 marks)

iii. Derive an expression of the half life period in terms of K and (3 marks)

QUESTION FOUR (20 MARKS)

a. What is meant by mechanism of a reaction? (1 mark)

b. What are the advantages of transition state theory over collision theory? (3 marks)

c. Calculate the activation energy of a reaction whose reaction rate at 270C gets doubled for 100C rise in temperature. (4 marks)

d. The reaction A+B→C+D is e second order reaction. Assuming the initial concentration of both the reactants to be equal to ‘a’ derive the expression for specific rate constant of the reaction. (5 marks)

ii. Find the expression for the half life of this reaction. (2 marks)

e. The thermal decomposition of acetaldehyde was studied by Hinshelwood and Hutchison at 5180C. Starting with an initial pressure of 363mm of Hg, the following results were obtained at different intervals of time.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| T(sec) | 42 | 73 | 105 | 190 |
| Increase in pressure | 34 | 54 | 74 | 114 |

Show that the reaction is of the second order. (5 marks)