

THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

FACULTY OF ENGINEERING

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

DIPLOMA IN CHEMICAL ENGINEERING

ECH 2307: REACTOR ENGINEERING II

YEAR III SEMESTER II SUPPLEMENTARY EXAMINATION

SERIES: MARCH 2012

TIME: 2 HOURS

INSTRUCTIONS:

You should have the following for this examination:

- *Non-programmable Scientific calculator*
- *Answer booklet*
- *Writing material (Pen, Pencil, Rubber and Ruler) Only!*

This paper consists of TWO sections; **A** and **B**.

Answer **ALL** questions in section **A** and any **TWO** questions in section **B**.

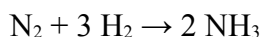
Section **A** carries **30 marks** while section **B** carries **40 marks**.

Each question in section **B** carries **20 marks**.

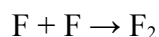
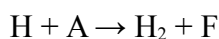
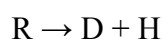
Maximum marks for each question / part of question are as indicated.

SECTION A

1. (a) Explain what is meant by an elementary reaction. [1 mark]
(b) Define molecularity and in relation to it, explain why the following reaction is not elementary. [4 marks]



2. (a) Define a chain reaction. [1 mark]
(b) The following mechanism has been proposed for a photochemical reaction of hydrocarbon A.



Identify the initiation, propagation and termination step(s). [4 marks]

3. (a) Explain what is meant by half life of a chemical reaction. [1 marks]
(b) In the Arrhenius law, the change of the reaction rate constant k , with temperature T , is
Given by;

$$\ln \frac{k}{k_0} = -\frac{E_a}{R} \left(\frac{1}{T} - \frac{1}{T_0} \right)$$

Where; k is reaction rate constant

T is temperature

R is universal gas constant

E_a is activation energy

Derive an expression of k for a change in temperature from T_1 to T_2 . [4 marks]

4. (a) Define the term catalysis. [1 mark]
(b) Distinguish between homogeneous and heterogeneous catalysis. [2 marks]
(c) Explain how a catalyst affects the rate of a chemical reaction. [2 marks]

SECTION B

5. Pure gaseous reactant A ($C_{A0} = 100$ millimol/litre) is fed at steady rate into a mixed reactor (CSTR), ($V = 0.1$ litre) where it dimerizes ($2A \rightarrow R$). For different gas feed rates the following data are obtained:

Run number	1	2	3	4
v_0 , litre/hr	30.0	9.0	3.6	1.5
$C_{A, out}$, millimol/litre	85.7	66.7	50	33.3

Find a rate equation for this reaction. [20 marks]

6. (a) The rate equation for a chemical reaction; $A \rightarrow$ products, is always expressed as;

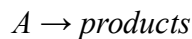
$$-r_A = kC_A^n$$

- (i) Define n and briefly explain how it affects the rate of a chemical reaction. [4 marks]
 (ii) With respect to the above expression of the rate equation, state two factors that affect the rate of a chemical reaction. [2 marks]
- (b) The following data were obtained for the reaction $A + B \rightarrow R + S$ from investigations carried out in a batch reactor at 298 °K.

$[A]_0$, (mole·L ⁻¹)	0.100	0.150	0.100
$[B]_0$, (mole·L ⁻¹)	0.100	0.100	0.200
Rate, (mole·L ⁻¹ ·sec ⁻¹)	2.73	6.14	2.71

Determine:

- (i) the order of the reaction. [12 marks]
 (ii) the true rate constant. [2 marks]
7. (a) After 8 minutes in a batch reactor, reactant ($C_{A0} = 1$ mol/ltr) is 80% converted; after 18 minutes, conversion is 90%. Find a rate equation to represent this reaction. [8 marks]
 (b) Consider the following experimental data in the table below obtained from a first order decomposition of organic substance A ;



Time (t) in minutes	Concentration of A in mol/dm ³
0.0	0.50
3.0	0.41
6.0	0.34
9.0	0.28
12.0	0.23
15.0	0.19
18.0	0.15

Using the integral method, determine the specific reaction rate constant, k , if the

analysis was carried out in a constant volume batch reactor.

[12 marks]

© March/2012