Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fifth Semester B.Tech Degree Regular and Supplementary Examination December 2020

Course Code: CH305

Course Name: CHEMICAL REACTION ENGINEERING-I

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Define reaction rate, rate constant, molecularity and order of a reaction. (4)

b) Derive the temperature dependency of rate constant using collision theory. (6)

c) The activation energy of a bimolecular reaction is about 10,000 cal/mol. How much faster this reaction takes place at 50 °C than at 30 °C? (5)

2 a) Describe the types of mechanism involved and the intermediates formed in the progress of non-elementary reactions. (6)

b) Differentiate between elementary and non-elementary reactions. (2)

c) For the gas phase decomposition of azomethane (7)

$(CH_3)_2N_2 \rightarrow C_2H_6 + N_2$

The rate expression is

$r_{N_2} = \frac{k_1 C_{AM}^{\ 2}}{1 + k' C_{AM}}$, where C_{AM} represents the concentration of azomethane.

Suggest a mechanism to explain this rate.

3 a) Derive the temperature dependency of rate constant using transition state theory. (7)

Compare Arrhenius theory and collision theory with transition state theory for relating temperature and rate constant.

b) For the hydrogen bromide reaction (8)

$H_2 + Br_2 \rightarrow 2HBr$

The experimental rate law is:

$r_{HBr} = \frac{k_a [H_2][Br_2]^{\frac{1}{2}}}{k_b + k_c \frac{[HBr]}{[Br_2]}}$, suggest a reaction mechanism to explain this rate.

PART B

Answer any two full questions, each carries 15 marks.

4 a) Derive the rate equation for the irreversible second order reaction 2A → Products using integral method (5)

b) Explain the method of half-lives to find the kinetics of elementary reactions. (5)

c) For the reaction A → Products, the following data were obtained at 25 °C. (5)

Time (minutes)	0	10	20	30	40
Concentration of A (mol/l)	0.860	0.740	0.635	0.546	0.405

Find the order, rate constant and half-life of the reaction.

5 a) Write short notes on stirred contained solid reactor and stirred through transport reactor. (6)

b) Derive the performance equation of isothermal batch reactor. (4)

c) In an isothermal batch reactor, for a first order reaction 75% conversion of liquid reactant 'A' is achieved in 30 minutes. Find the space time and space velocity necessary to effect this conversion in a mixed flow reactor and in a plug flow reactor. (5)

6 a) For the series reaction A → R → S, derive expressions for the concentration of compounds A, R, and S vary with time. Find out the time at which the maximum concentration of R occurs. (8)

b) In an isothermal batch reactor, a liquid phase reaction with stoichiometry A →R is achieved. Find the time needed to lower the concentration of 'A' from 8 mol/l to 4 mol/l. The rate versus concentration data are as follows: (7)

C_A, mol/l	1	2	4	6	7	9	12
$-r_A$, mol/(l. min)	0.06	0.1	0.25	1	2	1	0.5

PART C

Answer any two full questions, each carries 20 marks.

7 a) Derive the performance equation for recycle reactor and the expression for optimum recycle ratio. (10)

b) The elementary liquid phase reaction A + B → Products, is conducted in a setup consisting of a mixed flow reactor, into which two reactant solutions are introduced, followed by a plug flow reactor. The component 'B' is used in (10)

excess so that the reaction is first order with respect to 'A'. What will be the change in conversion if the reactor order is reversed?

8	a)	Develop the kinetic expressions for competitive and non-competitive inhibition.	(10)
	b)	With a neat sketch, explain the principle of membrane reactor.	(5)
	c)	Write the features of bioreactors and give their classification.	(5)
9	a)	Evaluate the performance of two equal sized mixed flow reactors in series for carrying out a first order reaction.	(8)
	b)	With a neat sketch explain the principle of reactive distillation.	(5)
	c)	Explain the phases of bacterial cell growth.	(7)

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