BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION)

CLASS: BE **SEMESTER: V**
BRANCH: BIOTECH **SESSION : MO/2018**

SUBJECT : BT5027 REACTION ENGINEERING

TIME: 1.5 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The total marks of the questions are 30.
2. Candidates may attempt for all 30 marks.
3. In those cases where the marks obtained exceed 25 marks, the excess will be ignored.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. The missing data, if any, may be assumed suitably.

Q1 (a) i) What is activation energy of a reaction? [2]
ii) What increases activation energy?

(b) The decomposition of NO_2 follows a second order rate equation. Data at different temperatures are as follows: [3]

T (K)	592	603	627	651.5	656
k (cm^3/ gmol. sec)	522	755	1700	4020	5030

Compute the energy of activation Energy from the data.
The reaction is $2NO_2 \rightarrow 2NO + O_2$

Q2 (a) i) What are the units of the rate of reaction? [4x1/2=2]
ii) What are the units of rate constant for zero order reactions?
iii) What are the units of rate constant for first order reactions?
iv) What is rate determining step?

(b) The thermal decomposition of nitrous oxide (N_2O) in the gas phase at 1030°K is studied in a constant volume vessel at various initial pressures of N_2O. The half-life data so obtained are as follows: [3]

p_o (mm Hg)	52.5	139	290	360
$t_{1/2}$ (sec)	860	470	255	212

$2N_2O \rightarrow 2N_2 + O_2$. Determine the rate equation that fits the data.

Q3 (a) [2]

Reaction 1

[CA]	1.0	2.0	4.0	12.0
Rate	0.05	0.10	0.20	0.60

Reaction 2

[CA]	4.0	8.0	16.0	32.0
Rate	3.0	12.0	48.0	192.0

Reaction3

[CA]	6.0	12.0	24.0	48.0
Rate	5.0	4.8	5.1	4.9

The above tables 1 to 3 are data sets for various reactions. Guess the order of the reactions by examining data and justify your answer.

(b) Consider a feed C_{Ao} = 100, C_{B0} = 200, Cio = 100 to a steady-flow reactor. The isothermal gas-phase reaction is A 3B $\rightarrow$ 6R, if C_A = 40 at the reactor exit, what is C_B X_A, and X_B there? [3]

Q4 (a) Does $\frac{r_A}{-a} = \frac{r_B}{-b} = \frac{r_C}{c} = \frac{r_D}{d}$ (for aA + bB $\rightarrow$ cC + dD) only hold for first order reactions? [2]

PTO

(b) The gas phase decomposition of **A** takes place according to the irreversible reaction, $A \rightarrow 3P$. The kinetics of the reaction was studied by measuring the increase in pressure in a constant volume reaction vessel. At 504ºC and an initial pressure of 312 mm Hg, the following data were obtained: [3]

Time (Sec)	390	777	1195	3155
Total pressure (mm Hg)	488	562	779	931

Test for a first order reaction.
Calculate the value of the specific reaction rate at 504ºC

Q5 (a) What is difference between PFR, MFR and Batch reactor? [2]

(b) The liquid phase reaction [3]

$A + B \rightarrow C$

follows an elementary rate law and is carried out isothermally in a flow system. The concentrations of A & B feed streams are 2 M before mixing. The volumetric flow rate of each stream is $5dm^3/min$, and the entering temperature is 300 K. The streams are mixed immediately before entering. Two reactors are available. One is gray 200 dm^3 CSTR that can be heated to 77°C or cooled to 0°C, and the other is a white 800 dm^3 PFR operated at 300 K that cannot be heated or cooled but can be painted red or black. Note k = 0.07 dm^3/mol.min at 300 K and E = 20 kcal/mol.

i) Select type of reactor that could be used by showing appropriate calculations

Q6 (a) How will you determine the size of reactor required for a given duty and for a given temperature progression? [2]

(b) The reaction $A \rightarrow B$, $r = kC_A^2$ occurs in PFTR with 90% conversion. If k = 0.5 liter mole^{-1} min^{-1}, C_{A0} = 2 moles/ liter, and v = 4 liters /min, what residence time and reactor volume will be required? [3]

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