

III B.Tech II Semester Supplementary Examinations, Apr/May 2006
CHEMICAL REACTION ENGINEERING-I
(Chemical Engineering)

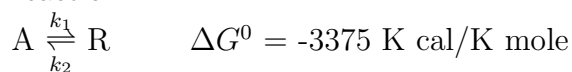
Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
 All Questions carry equal marks

1. (a) Define reaction rate constant. Develop an expression that facilitates calculation of units of rate constant for any order. [6]

- (b) Determine equilibrium conversion of A at 373⁰K for the following aqueous reaction.



$$\Delta H_r^0 = -18,000 \text{ K cal/K mole}$$

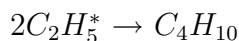
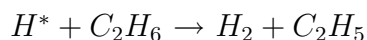
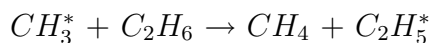
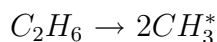
Assume specific heats of all solutions are equal to that of water. [10]

2. The gas reaction $2A \rightarrow R + 2S$ is approximately second order with respect to A. When pure A is introduced at 1 atm. into a constant volume batch reactor, the pressure rises 40% in 3 minutes. For a constant pressure batch reactor find

- (a) the time required for the same conversion [8]

- (b) the fractional increase in volume at that time. [8]

3. Thermal decomposition of ethane to ethylene, butane and hydrogen is believed to follow the sequence given below.



Derive the rate law for formation of ethylene. [16]

4. An aqueous reaction is being studied in a mixed flow reactor of 5 lit. volume. The stoichiometry of the reaction is $A \rightarrow 2R$ and the reactant A is introduced at a concentration of one mole/liter. Using following data, determine a rate expression for this reaction. [16]

Feed rate <i>cm³/sec.</i>	Temperature <i>°C</i>	Concentration of R in effluent, <i>mole/liter</i>
2	13	1.8
15	13	1.5
15	84	1.8

5. A liquid reactant stream (1 mol/liter) passes through two mixed flow reactors in a series. The concentration of A in the exit of the first reactor is 0.5 mol/liter. Find the concentration in the exit stream of the second reactor. The reaction is second-order with respect to A and $V_2/V_1 = 2$. [16]
6. A 20 lit. mixed reactor is to treat a reactant which decomposes as follows:
 $A \rightarrow R \quad r_R = K_1 C_A = (4/\text{hr}) C_A$
 $A \rightarrow S \quad r_S = K_2 C_A = (1/\text{hr}) C_A$
 Find the feed rate and conversion of reactant so as to maximize profits. What are there on hourly basis? Data: Feed material A cost Rs. 100/mol at $C_{AO} = 1$ mol/lit. Product R sells for Rs.500/mol and S has no value. The total operating cost is Rs.2500/hr + Rs.125/mol A fed to the reactor unconverted A is not recycled. [16]
7. The decomposition of Phosphine is irreversible and first order at 650°C.
 $4PH_3(g) \rightarrow P_4(g) + 6H_2(g)$
 The rate constant s^{-1} is reported as:
 $\log K = -\frac{18963}{T} + 2 \log T + 12.130$ where T is in °K.
 In a closed vessel (constant volume) initially containing Phosphine at 1 atm. pressure, what will be the pressure after 50, 100 and 500s. The temperature is maintained at 650°C. [16]
8. Write brief notes on:
 (a) Series and parallel reactions
 (b) Multiple reactor network. [8+8]
