

**III B.Tech II Semester Supplementary Examinations, April/May 2005**  
**CHEMICAL REACTION ENGINEERING-I**  
**(Chemical Engineering)**

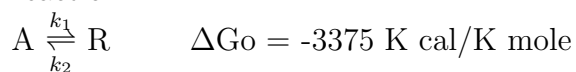
Time: 3 hours

Max Marks: 80

Answer any FIVE Questions  
 All Questions carry equal marks

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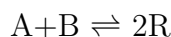
- (a) Define reaction rate constant. Develop an expression that facilitates calculation of units of rate constant for any order.  
 (b) Determine equilibrium conversion of A at 373oK for the following aqueous reaction.



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

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

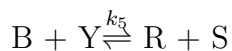
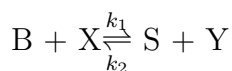
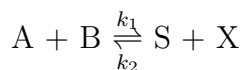
- The following initial rate data were reported for two gas phase reversible reaction of diborene (A) and acetone (B) at 114°C.



Run	initial	Pressure(torr)	Initial $\times 10^3$ (torr/sec)
	A	B	
1	60.	20.0	0.5
2	8.0	20.0	0.63
3	10.0	20.0	0.83
4	12.0	20.0	1.0
5	16.0	20.0	1.28
6	10.0	10.0	0.33
7	10.0	20.0	0.80
8	10.0	40.0	1.5
9	10.0	60.0	2.211
10	10.0	100.0	3.33

Determine order with respect to A and B and find the rate constant. Be sure to express K in appropriate units.

- Consider the reaction  $A + 3B \rightarrow R + 3S$  for which the mechanism suggested is



- Derive the rate law

- (b) Show how the rate law transforms when each of the mechanism steps controls the rate.
4. The reaction  $A + B \rightarrow R$  is first order with respect to each of the reactants when conducted in liquid phase in a  $1.5 m^3$  plug flow reactor using a mole ratio  $M = C_{Bo}/C_{Ao} = 2$ , a 90% conversion is obtained. What mole ratio  $M$  will provide the same amount of product, if the reaction is conducted in a  $7.5 m^3$  backmix reactor.
5. Acetic anhydride is to be hydrolyzed in three stirred tank reactors operated in series. The reaction is first order with  $k = 0.0806 min^{-1}$ . Each reactor has a volume of 1.8 *liters* and the feed rate to the first is 35 *liters/hr*. Compute the percent of hydrolysis accomplished in the three reactors.
6. For the first order series reactions,
- $$A \xrightarrow{K_1} R \xrightarrow{K_2} S$$
- Derive  $\frac{C_{Rmax}}{C_{Ao}}$  and  $P_{opt}$  in a PFR.
7. The decomposition of Phosphine is irreversible and first order at  $650^{\circ}C$ .  $4PH_3(g) \rightarrow P_4(g) + 6H_2(g)$
- The rate constant ( $s^{-1}$ ) is reported as:
- $$\log K = -\frac{18963}{T} + 2 \log T + 12.130 \text{ where } T \text{ is in } O_k.$$
- 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  $650^{\circ}C$ .
8. Write detailed notes on:
- Integral and differential methods
  - Total volume and total pressure methods.

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