

國立高雄大學 107 學年度研究所碩士班招生考試試題

科目：化工動力學  
 考試時間：100 分鐘

系所：化學工程及材料工程學系  
 (無組別)  
 本科原始成績：100 分

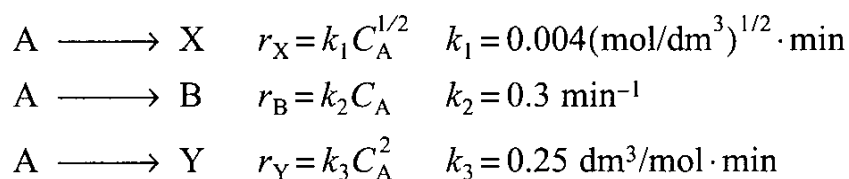
是否使用計算機：是

**I. Single choice (4 points each, 48 points total)**

- Liquid A decomposes by first-order kinetics, and in a batch reactor 50% of A is converted to product in a 5-minute run. How much longer would it take to reach 75% conversion? (A) 5 min, (B) 10 min, (C) 15 min, (D) 20 min, (E) can not determine.
- Repeat the above question for second-order kinetics. (A) 5 min, (B) 10 min, (C) 15 min, (D) 20 min, (E) can not determine.
- If  $-r_A = 0.2$  mol/liter-sec when  $C_A = 1$  mol/liter, what is the rate of reaction ( $-r_A$ ) when  $C_A = 10$  mol/l? (A) 1 mol/liter-sec, (B) 2 mol/liter-sec, (C) 20 mol/liter-sec, (D) 0.2 mol/liter-sec, (E) can not determine.
- What is the half-life for a third-order reaction of reactant A? (A)  $0.693/k$ , (B)  $k$ , (C)  $1/(kC_{A0})$ , (D)  $C_{A0}/2k$ , (E)  $3/(2kC_{A0}^2)$ . ( $k$  is the rate constant and  $C_{A0}$  is the initial concentration of A)
- What is the half-life for a zero-order reaction of reactant A? (A)  $0.693/k$ , (B)  $k$ , (C)  $1/(kC_{A0})$ , (D)  $C_{A0}/2k$ , (E)  $3/(2kC_{A0}^2)$ . ( $k$  is the rate constant and  $C_{A0}$  is the initial concentration of A)
- A reaction  $2A \rightarrow 2B + C$  with the rate law  $-r_A = k C_A^2$ . What is the rate law for the reaction  $A \rightarrow B + 1/2 C$ ? (A)  $-r_A = k C_A$ , (B)  $-r_A = k C_A^2$ , (C)  $-r_A = k C_A^3$ , (D)  $-r_A = k C_A^{1/2}$ .
- For the reaction  $A \rightarrow$  products, if the plot of  $1/C_A^2$  vs  $t$  is linear. What is the reaction order for the reaction? (A) 0, (B) 1, (C) 2, (D) 3, (E) 1/2.
- For parallel reactions
 
$$\begin{array}{lll} A + B \longrightarrow D, & \text{desired,} & r_D = C_A^{0.4} C_B^{1.6} \\ A + B \longrightarrow U, & \text{undesired,} & r_U = C_A^{1.0} C_B^{0.2} \end{array}$$
 Which of the following reactor types (or schemes) is the best for reducing  $C_U$ ? (A) CSTR, (B) PFR, (C) Batch, (D) Semi-batch
- For parallel reactions
 
$$\begin{array}{lll} A \longrightarrow D, & \text{desired,} & r_D = k_D C_A \\ A \longrightarrow U, & \text{undesired,} & r_U = k_U C_A^2 \end{array}$$
 Which of the following reactor types is the best for maximizing  $C_D$ ? (A) CSTR, (B) PFR, (C) Batch.
- An irreversible second-order liquid-phase reaction gave 80% conversion in a batch reactor in 200 min. What would be the conversion of this reaction in a CSTR with a 200 min space time? (A) 50%, (B) 61%, (C) 85%, (D) 90%, (E) can not determine.
- Repeat the above question. What space time would be required for 80% conversion in a CSTR? (A) 100 min, (B) 200 min, (C) 500 min, (D) 1000 min, (E) can not determine.
- An irreversible second order reaction  $A \rightarrow B$  is to be carried out isothermally in a plug-flow reactor (PFR). Calculate PFR reactor volumes necessary to consume 99 % of A (i.e.,  $C_A = 0.01 C_{A0}$ ) when the entering molar flow rate ( $F_{A0}$ ) is 5 mol/h and  $k$  is 3 dm<sup>3</sup>/mol h. (A) 99 dm<sup>3</sup>, (B) 128 dm<sup>3</sup>, (C) 500 dm<sup>3</sup>, (D) 660 dm<sup>3</sup>, (E) 2750 dm<sup>3</sup>.

**II. (17 points)**

Consider the following system of gas-phase reactions:



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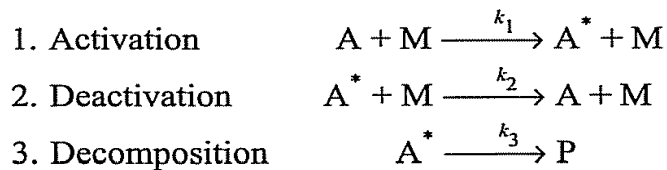
B is the desired product, and X and Y are undesired products. The rate constants are at 27 °C. The reaction system is to be operated at 27 °C and 4 atm. Pure A enters the system at a volumetric flow rate of 10 dm<sup>3</sup>/min.

- What is the instantaneous selectivity  $S_{B/XY}$ ? (3 points)
- Determine the maximum  $S_{B/XY}$ ? At which  $C_A$ ,  $S_{B/XY}$  is maximum? (6 points)
- If CSTR is used to carry out this reaction at this  $C_A$  as determined in (b), what is the volume of CSTR? (8 points)

**III. (15 points)**

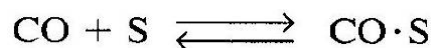
- What is active intermediate? (3 points)
- What is pseudo-steady-state hypothesis (PSSH)? (2 points)
- Use the PSSH to derive the rate law for the reaction  $A \longrightarrow P$  for the rate of the disappearance of A (i.e.,  $-r_A$ ). The reaction proceeds by first forming an active intermediate,  $A^*$ , from the collision of the reactant molecule and an inert molecule of M. (10 points)

The mechanism consists of the three elementary reactions:



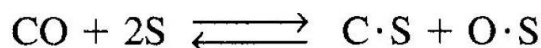
**IV. (20 points)**

- The mechanism for carbon monoxide (CO) adsorption as molecules on the surface of the catalyst is



where  $S$  represents an active (vacant) site,  $CO \cdot S$  represents that CO molecule is adsorbed on the site  $S$ . Derive the equilibrium isotherm equation (i.e.,  $C_{CO \cdot S}$  as a function of  $P_{CO}$ ) for this adsorption. ( $C_{CO \cdot S}$  is the concentration of the adsorbed CO on  $S$  and  $P_{CO}$  is the partial pressure of CO.)

- The mechanism for dissociative carbon monoxide (CO) adsorption on the surface of the catalyst is



Derive the equilibrium isotherm equation (i.e.,  $C_{C \cdot S}$  (or  $C_{O \cdot S}$ ) as a function of  $P_{CO}$ ) for this adsorption. ( $C_{C \cdot S}$  is the concentration of the adsorbed C on  $S$  and  $P_{CO}$  is the partial pressure of CO.)