

所 別： 化學工程技術研究所
學程別：

組別：

科目： 化工熱力學與動力學

1. $-R_A = 1/(10 X)$ mol/(liter-s)

where $-R_A$ = rate of disappearance of A, mol/(liter-s)

X = conversion = 0.5

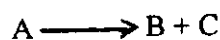
F_{A0} = molar flow rate of A fed to a system operated at steady
state = 10 mol/s

V = reactor volume, liter

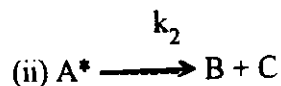
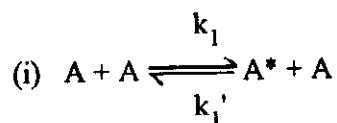
(A) calculate the value of V for a CSTR (10%)

(B) calculate the value of V for a PFR (10%)

2. Suppose that the stoichiometry of a reaction is:



The reaction occurs by the following mechanism:



If the life-time of A^* is extremely short and the concentration of A^* at any time is negligible, please derive an expression for the net rate of disappearance of A (i.e., $-R_A = -dC_A/dt = ?$ where C_A is the concentration of A and t is the reaction time). (10%)

3. An ideal gas undergoes an isothermal, reversible compression in a frictionless piston-cylinder from 1 to 10 atm. Calculate the initial and final molar volumes of the gas and the work necessary to perform the compression if the gas is initially at 100°F. ($R = 0.73 \text{ atm-ft}^3/(\text{lb-mol} \cdot ^\circ\text{R}) = 1.987 \text{ Btu}/(\text{lb-mol} \cdot ^\circ\text{R})$) (20%)

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4. a) Define the general characteristics of an equilibrium state. (5%)
b) Define excess mixing fugacity. (5%)
c) Define van der Waals equation of state and the physical meaning of parameters a and b in the equation. (5%)

5. The activity coefficient (γ_1) of component 1 in a binary mixture can be expressed in terms of the mole fraction (X_1):

$$\ln \gamma_1 = aX_2^2 + bX_2^3 + cX_2^4$$

a , b , and c are constants independent of concentration. Please express d , e , f , and g in terms of constants (a , b , c) if the activity coefficient of component 2 (γ_2) is:

$$\ln \gamma_2 = dX_1^2 + eX_1^3 + fX_1^4 + gX_1^5 \quad (15\%)$$

6. For the irreversible aqueous-phase reaction



The initial concentration of A is 0.2 M, and the volumetric flow rate is $50 \text{ dm}^3\text{s}^{-1}$. The reaction rate follows:

$$\text{For } X \leq 0.5 : -r_A^{-1} = 4.0 \text{ sM}^{-1}$$

$$\text{For } X > 0.5 : -r_A^{-1} = 4.0 + 10(X - 0.5) \text{ sM}^{-1}$$

- a) What conversion will be achieved in a CSTR that has a volume of 20 dm^3 ? (5%)
b) What conversion will be achieved in a CSTR that has a volume of 32 dm^3 ? (5%)
c) What plug-flow reactor volume is required to achieve 70% conversion? (5%)
d) What CSTR reactor volume is required if the effluent from the PFR in part (c) is fed to a CSTR to raise the conversion to 90%? (5%)