

115CH03

國立臺北科技大學 115 學年度碩士班招生考試

系所組別：3510 化學工程與生物科技系化學工程碩士班甲組

第二節 化工熱力學與反應工程 試題

第 1 頁 共 1 頁

注意事項：

1. 本試題共 4 題，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

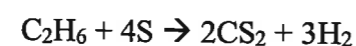
1. A thermodynamic system is designed to convert thermal energy released during a phase-change process into mechanical work. In this system, 8 kg of ice initially at 0 °C is placed in thermal contact with 80 kg of liquid water initially at 45 °C inside a rigid, well-insulated container. The C_p value is $4.2 \text{ kJ}\cdot\text{kg}^{-1}\cdot\text{K}^{-1}$ and heat of fusion is $330 \text{ kJ}\cdot\text{kg}^{-1}$. Thermal energy released during this process is used to drive a piston-cylinder device containing 1 mol of an ideal gas. The gas is compressed under a constant pressure of 2.5 bar, and its temperature decreases from 420 K to 320 K. The molar heat capacity of this gas at constant pressure is $34 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$. The compression process is irreversible, and the actual work required is 40% greater than the work required for a reversible compression between the same initial and final states. Any heat rejected by the gas is transferred to a thermal reservoir maintained at 320 K. Ideal gas behavior may be assumed throughout.

- (1) Determine final equilibrium temperature of ice-water mixture if no work extracted (5%).
- (2) Calculate the total entropy change associated with the thermal equilibration process (5%).
- (3) Evaluate the reversible and irreversible compression work of the gas (10%).
- (4) Determine the entropy changes of the gas, the heat reservoir, and the overall combined system (15%).

2. A certain compound has a triple-point temperature of $-82 \text{ }^\circ\text{C}$ with a corresponding vapor pressure of 6.5 Pa. Its normal boiling point is $68 \text{ }^\circ\text{C}$.

- (1) Determine the enthalpy of vaporization of this compound (10%).
- (2) Under isothermal conditions at $30 \text{ }^\circ\text{C}$, determine the maximum temperature (in $^\circ\text{C}$) at which this compound can exist in the gaseous state under atmospheric pressure (5%).

3. A tubular reactor was carried out at $500 \text{ }^\circ\text{C}$ and 1 atm with the following reaction:



The feeding rates of C_2H_6 and S are 0.12 and 0.62 gmol/hr, respectively. The production rate of CS_2 is 0.0085 gmol/hr. The reaction is first order with respect to C_2H_6 and first order with respect to S. The rate constant is $0.0042 \text{ L}/(\text{gmol}\cdot\text{hr})$. Find the volume of the tubular reactor (25%).

4. Consider the reaction: $2\text{A} \rightarrow 2\text{B} + \text{C}$. Experimental studies show the following kinetic behavior. The initial rate exhibits first-order dependence on the concentration of A; the reaction rate is not influenced by the concentration of C; increasing the concentration of B results in a decrease in the reaction rate; under conditions of very low A concentration and very high B concentration, the initial rate displays second-order dependence on A. Using these observations to derive the rate expression ($-\tau_{\text{A}}$) and propose a reaction mechanism and verify that it is consistent with the derived rate law ($-\tau_{\text{A}}$) (25%).