

國立臺北科技大學 114 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

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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 30 kg piece of metal is dropped into a large pool of water until reaching thermal equilibrium. The average specific heat of metal is $0.40 \text{ kJ/kg}\cdot\text{K}$. The initial temperatures of metal and water are respectively 450 K and 290 K. Find the entropy change of metal and water, and the entropy generated during the heat transfer process (18%).

2. A gas follows van der Waals equation, $p = \frac{RT}{v-b} - \frac{a}{v^2}$, where a is $0.1350 \text{ J}\cdot\text{dm}^3\cdot\text{mol}^{-2}$ and b is $0.0289 \text{ dm}^3\cdot\text{mol}^{-1}$. At 25°C , 1 mol gas is compressed from 3 dm^3 to 0.2 dm^3 . Calculate Q , W , ΔU and ΔH . The whole process is isothermal and reversible (27%).

3. A liquid phase reaction ($A \rightarrow B + C$) occurred in a batch reactor. Consider the following data and calculate the rate constant (k) and the order of reaction (20%).

Time (s)	0	500	1000	1500	2000
C_A (mol/L)	0.62	0.46	0.31	0.25	0.14

4. For a catalytic reaction $A + B \rightarrow C + D$. The molar feed rate of A to the reactor is 40 mol/min. The reaction is operated at 32 atm and 500°C . The feed is composed of 35% A, 40% B and 25% inerts. Assuming only A and C are adsorbed on the catalyst. B is reacted and D is formed without adsorbing on the catalyst.

(1) Derive the rate law in the form of $-r'_A = \frac{k P_A P_B}{1 + K_A P_A + K_C P_C}$ (20%)

- (2) Determine the catalyst weight (kg) in CSTR and the volume (m^3) of the CSTR. The bulk density of the catalyst in CSTR is 20 kg/m^3 . The conversion (X) of A is 30%. In rate law, $k = 1.8 \text{ mol/kg cat}\cdot\text{atm}^{-2}\cdot\text{min}^{-1}$, $K_A = 2.5 \text{ atm}^{-1}$, $K_C = 3.2 \text{ atm}^{-1}$. (15%)