

八十五學年度國立台灣工業技術學院研究所碩士班招生考試

所別：化學工程技術研究所

組別：

科目：化工熱力學與動力學

1. (15%) Please answer concisely and briefly:

- a. What are the advantages to express the thermodynamic properties (e.g., U,H,G..) with independent variables, such as V, T, and P.
- b. Use the first law to show why leaving the refrigerator door open will not cool the kitchen.
- c. differences between a steady-state and an equilibrium state
- d. In 1845 Joule presented before the British Association that water at the bottom of a waterfall should be warmer than at the top. Why?
- e. Define the Damkohler number for first-order and second-order reaction systems conducted in a CSTR and explains its significance.

2. (10%) The isolated system consists of two subsystems I and II. The only component originally contained in subsystem I is called Y. Please discuss the equilibrium criteria of the system under the following conditions:

- a. The partition is adiabatic, movable, and permeable to Y.
- b. The partition is adiabatic, fixed, and impermeable to Y.
- c. The partition is a heat-conductor, movable, and permeable to Y

3. (10%) Adsorption isotherm for single substance, $A(g) + S(s) \rightleftharpoons A.S(s)$, is relatively easy to derive. When more than one substance is present, the adsorption isotherm equation is more complex. Please show that the adsorption isotherm of $A(g)$ in the presence of another adsorbate $B(g)$ is expressed by the equation

$$C_{A.S} = \frac{K_A P_A C_t}{1 + K_A P_A + K_B P_B}$$

where K_i stands for equilibrium adsorption constant, C_t for total site on the adsorbent, $C_{A.S}$ for the amount of A adsorbed, and P_i for the partial pressure.



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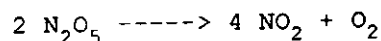
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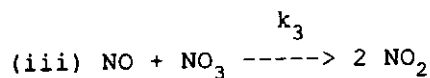
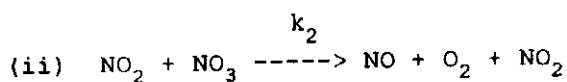
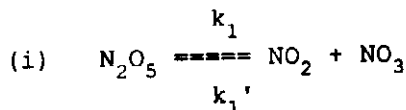
4. (15%) Chemical reaction of A and B over a solid catalyst, $A(g) + B(g) \rightarrow C(g) + D(g)$, is studied. Experimental results are shown in Table 1. Please **step by step** deduce (推導) a qualitative (定性) rate law based on these data.

Run	$\gamma_c \times 10^6$	P_A	P_B	P_C	P_D
1	42	1	1	1	0
2	41	1	1	3	0
3	30	1	1	0	1
4	15	1	1	0	3
5	12	1	1	0	4
6	42	1	1	0	0
7	164	1	2	0	0
8	262	1	2.5	0	0
10	20	0.5	1	0	0
11	38	1	1	0	0
12	68	2	1	0	0
13	96	2.5	1	0	0
14	140	4	1	0	0
15	146	8	1	0	0

5. Consider the decomposition of N_2O_5 :



The reaction occurs by the following three-step mechanism:



If both NO_3 and NO rapidly disappear immediately after the formation of these species, please derive a rate equation for the production of O_2 (i.e., $r = dC_{O_2}/dt = ?$). The parameter r is the reaction rate, C_{O_2} is the concentration of O_2 , and t is the reaction time. (20%)

6. Gas X enters a reversible, isothermal compressor at T_1 and P_1 and it is continuously compressed to P_2 . Please calculate the work per mole of X required to run the compressor if X follows the equation of state $PV = RT + BP$, where V is the molar volume of X and B is a constant. (20%)

7. At vapor-liquid equilibrium, please derive the Clapeyron equation. (10%).

