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) = 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.

國立台灣工業技術學院 圖書館 LIBRARY NATIONAL TAIWAN INSTITUTE OF TECHNOLOGY

命題請勿超出線外

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

4. (15%) Chemical reaction of A and B over a solid catalyst, A(g) + B(g) = 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	$r_c \times 10^6$	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:

$$2\ N_2O_5 \text{ -----> } 4\ NO_2 + O_2$$

The reaction occurs by the following three-step mechanism:

(i) $N_2O_5 \underset{k_1'}{\overset{k_1}{=====}} NO_2 + NO_3$

(ii) $NO_2 + NO_3 \xrightarrow{k_2} NO + O_2 + NO_2$

(iii) $NO + NO_3 \xrightarrow{k_3} 2\ NO_2$

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%)

國立台灣工業技術學院 圖書館 LIBRARY NATIONAL TAIWAN INSTITUTE OF TECHNOLOGY

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 $P\bar{V} = RT + BP$, where $\bar{V}$ is the molar volume of X and B is a constant. (20%)

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

命題請勿超出線外