

系所組別： 化學工程學系乙組

考試科目： 物理化學

考試日期： 0307，節次： 3

※ 考生請注意：本試題 可 不可 使用計算機

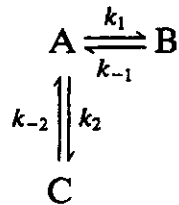
1. (a) For a van der Waals gas (i.e.,  $(P + \frac{a}{V_m^2})(V_m - b) = RT$ ),

show that  $(\frac{\partial U}{\partial V})_T = \frac{a}{V_m^2}$  ( $U$ : internal energy;  $V$ : volume) (8%)

(b) Assuming  $N_2$  gas could be considered as a van der Waals gas (i.e.,  $a=0.1408 \text{ Pa m}^6 \text{ mol}^{-2}$ ,  $b=0.0391 \times 10^{-3} \text{ m}^3 \text{ mol}^{-1}$ ), calculate  $q$ ,  $w$ ,  $\Delta U$  for the isothermal compression of 1.0 mol of  $N_2$  gas at 300 K from  $10 \text{ m}^3$  to  $1 \text{ m}^3$ . (12%)

2. Prove that  $\Delta_{\text{mix}}H = 0$  for an ideal solution and explain why from the viewpoint of molecular interaction. (10%)

3. For the two reversible first-order parallel reactions



if only A is present ( $[A]_0=0.1 \text{ mol dm}^{-3}$ ) initially and the values of  $k_1$ ,  $k_{-1}$ ,  $k_2$ ,  $k_{-2}$  are 1, 0.01, 0.1,  $0.005 \text{ s}^{-1}$ , respectively, (a) estimate the selectivity ( $[B]/[C]$ ) in the early period and (b) calculate the concentrations of A, B, and C at equilibrium. (12%)

4. Show that the competitive adsorption of  $N$  types of molecules on the same surface:

$$\theta_i = \frac{K_i C_i}{1 + \sum_{i=1}^N K_i C_i}$$

where  $\theta_i$  indicates the fraction of the surface covered by species  $i$ , and  $K_i$  and  $C_i$  are the equilibrium constant and the bulk concentration of species  $i$ , respectively. (12%)

5. Describe the Joule-Thomson experiment and show the Joule-Thomson expansion is an isenthalpic process. (10%)

6. An aqueous solution contains 1.0 g of sodium chloride in 100 g water and the freezing point is  $-0.636^\circ\text{C}$ . Calculate the freezing point depression constant of water and the osmotic pressure at 300 K. (10%)

(背面仍有題目,請繼續作答)

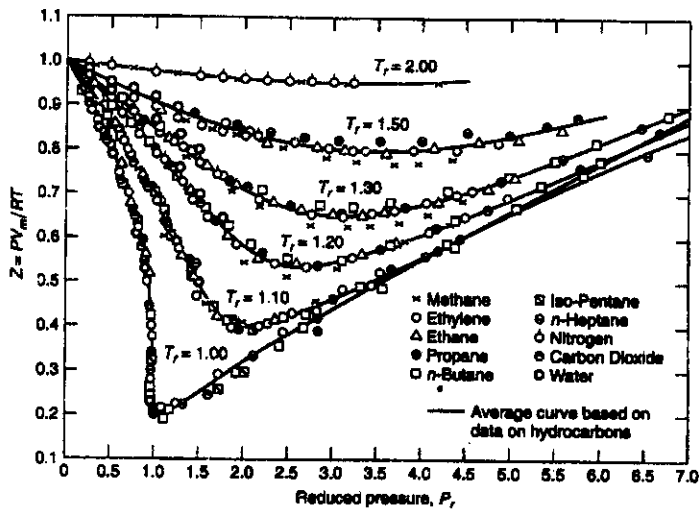
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7. A gas has a critical pressure of 60 bar and a critical temperature of 300K. Calculate the molar volume of the gas at 120 bar and 360K from the below figure. (8%)



8. The molar conductivities of  $Li^+$  and  $Cl^-$  at infinite dilution of  $25^\circ C$  38.66 and  $76.31 S cm^2 mol^{-1}$ , respectively.

(a) Calculate the transport numbers of  $Li^+$  and  $Cl^-$  ions. (4%)

(b) What are the speeds of  $Li^+$  and  $Cl^-$  ions under a potential gradient of  $100 V cm^{-1}$ . (6%)

9. (a) For the phase transitions:  $\Delta_{trans} S = \Delta_{trans} H / T_{trans}$ . Why? (4%)

(b) Give an example which approaches the reversible process. (4%)