

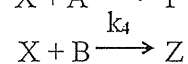
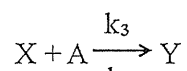
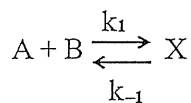
※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Answer the following questions: (32%)
- (a) The work required for the isothermal compression of an ideal gas via an irreversible process is larger than that via a reversible process. Explain why (4%).
- (b) Plot the dependence of  $Z$  (compression factor) on  $P$  for a real gas at a constant temperature below its Boyle temperature, and give the reason(s) causing the different tendencies at low  $P$  and high  $P$ . (4%)
- (c) Judge the following statement is right or wrong, and explain why: Langmuir isotherm belongs to the chemical adsorption because only a monolayer is adsorbed. (4%)
- (d) Explain what is the stripping mechanism, and illustrate its potential-energy surfaces for a reaction  $A + B - C \rightarrow A - B + C$  (showing contour lines connecting positions of equal energy). (4%)
- (e) What is the main trouble caused by azeotropes in distillation and how to overcome this problem? (4%)
- (f) May a process with  $\Delta S < 0$  occur spontaneously? If it is possible, give an example. (4%)
- (g) Explain why  $\text{Na}^+$  ion has a lower molar conductivity than  $\text{K}^+$  ion, but why the molar conductivity of  $\text{H}^+$  ion in water is much higher than other ions. (4%)
- (h) Is the vapor pressure of a spherical droplet larger or smaller than that of a planar liquid? Why? (4%)
2. One mole of nitrogen gas at 300 K and 5 bar is considered as an ideal gas. (15%)
- (a) Calculate  $\Delta U$  while heating to 400 K at a constant pressure of 5 bar (5%);
- (b) Calculate  $\Delta S$  while expanding to 1 bar reversibly and adiabatically (5%);
- (c) Calculate  $\Delta G$  while expanding to 1 bar isothermally against a constant pressure of 1 bar (5%).
3. An aqueous solution contains 1.0 g of NaCl in 100 g water and the freezing point is  $-0.636^\circ\text{C}$ . (a) Calculate the freezing point depression constant of water (4%) and the osmotic pressure of this solution (4%) at 300 K. (b) For an aqueous solution containing 1.0 g unknown solute in 100 g water without the occurrence of dissociation or association, its freezing point is  $-0.12^\circ\text{C}$ . Calculate the molar mass of the unknown solute (4%). (12%)
4. Consider the cell  $\text{Pt}, \text{H}_2(1 \text{ bar}) \mid \text{HCl}(m_2) :: \text{HCl}(m_1) \mid \text{Pt}, \text{H}_2(1 \text{ bar})$  in which the solutions are separated by a partition. Assuming zero junction potential for the partition and the activity coefficients are unity, derive the expression for the emf of this cell under the following three conditions: (a) the partition is permeable to only to  $\text{Cl}^-$  ions (4%); (b) the partition is permeable to only to  $\text{H}^+$  ions (4%); (c) the partition is permeable to both  $\text{H}^+$  and  $\text{Cl}^-$  ions and the ratio of the speeds with which these ions pass through the partition is the ratio of their transport numbers ( $t_+$  and  $t_-$ ) (6%). (14%)

5. Show the partial molar properties obey the equations: (a)  $dU_i = TdS_i - PdV_i$  (10%) and

$$(b) \left( \frac{\partial T}{\partial V_i} \right)_{S_i} = - \left( \frac{\partial P}{\partial S_i} \right)_{V_i} \quad (5\%) \quad \underline{(15\%)}$$

6. Y and Z are produced from A and B by the following mechanism, in which X is an unstable intermediate:



(a) Drive the expression for rate of production of Z by the steady-state treatment (6%); (b) What rate equations are obtained if A is present in great excess (3%)? (c) What is the product selectivity (i.e.,  $[Y]/[Z]$ ) (3%)? (12%)