

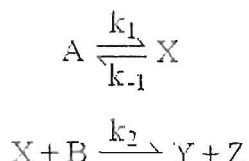
系所組別： 化學工程學系乙組

考試科目： 物理化學

考試日期： 0219，節次： 3

※ 考生請注意：本試題 可，不可 使用計算機

- Judge the following statements are correct (O) or incorrect (X): (10%)
 - All spontaneous (natural) processes are irreversible.
 - Considering the universe as an isolated system, its entropy remained constant because no heat was input or released.
 - It is impossible to convert heat to work completely for any cyclic processes.
 - Entropy (S) is a state function, so $\oint dS = 0$ for all reversible and irreversible processes.
 - At 1 atm and 120°C, the Gibbs energy of liquid water is smaller than the Gibbs energy of water vapor.
- Calculate the most probable speed, root-mean-square speed, mean free path, collision frequency, and collision density of nitrogen molecules at 300K and 1 bar based on the assumption of ideal gas. (*i.e.* collision diameter of $N_2 = 3.74 \times 10^{-10}$ m) (15%)
- Suppose that the reaction $A + B = Y + Z$ is believed to occur according to the mechanism



Apply the steady-state treatment to obtain an expression for the reaction rate. (15%)

- The pH may be measured with a hydrogen electrode connected with a calomel electrode through a salt bridge. If the cell expression is

$$\text{Pt, H}_2(1\text{bar}) \mid \text{H}^+(a_{\text{H}^+}) \mid \text{Cl}^-(\text{saturated}) \mid \text{Hg}_2\text{Cl}_2(\text{s}) \mid \text{Hg}$$
 and $E^\circ = 0.2412 \text{ V}$ for the calomel electrode $\text{Cl}^-(\text{saturated}) \mid \text{Hg}_2\text{Cl}_2(\text{s}) \mid \text{Hg}$ at 25°C (a) Write the half-cell reactions and cell reaction. (b) Derive the relationship between pH and E , ignoring the liquid junction potential. (15%)
- One mole of ideal gas was compressed isothermally at 300 K from 1 bar to 10 bar against a constant pressure of 10 bar. Calculate the q_m , w_m , ΔS_m , ΔA_m , ΔG_m . (15%)
- Determine the number of degrees of freedom for the following systems?
 - $\text{CaCO}_3(\text{s})$ in equilibrium with $\text{CaO}(\text{s})$ and $\text{CO}_2(\text{g})$. (3%)
 - $\text{NH}_4\text{Cl}(\text{s})$ is allowed to dissociate to $\text{NH}_3(\text{g})$ and $\text{HCl}(\text{g})$ until equilibrium is reached. (3%)
 - A solution of potassium chloride and sodium chloride at 298 K and 1 atm. (3%)
 - The region between the bubble point surface and the dew point surface in the P-T-composition diagram for a two-component system. (3%)
 - $\text{CO}(\text{g})$, $\text{CO}_2(\text{g})$, $\text{H}_2(\text{g})$, and $\text{CH}_4(\text{g})$ in equilibrium in the gas phase. (5%)
- Describe the following terms or answer the questions:
 - Is the vapor pressure of a spherical droplet larger or smaller than that of a planar liquid? Why? (3%)
 - The molar conductivity of hydrogen ions in water is much higher than other ions. Why? (3%)
 - Retrograde condensation (3%)
 - When the pressure is reduced, the b.p. and m.p. of water increase or decrease? Explain them according to a plot of Gibbs energy vs. temperature. (4%)