國立臺北科技大學 113 學年度碩士班招生考試

系所組別：3520 化學工程與生物科技系化學工程碩士班乙組

第一節　物理化學　試題

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1. At 0°C 25 g of ice are added to 60 g of water at 30°C in a vessel that has a water equivalent of 20 g. Calculate the entropy changes in the system and in the surroundings. The heat of fusion of ice at 0°C is 6.02 kJ mol^{-1}, and specific heat capacities of water and ice may be taken as constant at 4.184 and 2.094 J K^{-1} g^{-1}, respectively, and independent of temperature. (H = 1.0079 g mol^{-1}, O = 15.9994 g mol^{-1}). (20%)

2. In the gas-phase reaction:

 $$2\,A + B \rightleftharpoons 3\,C + 2\,D$$

    It was found that, when 1.00 mol A, 2.00 mol B, and 1.00 mol D were mixed and allowed to come to equilibrium at 25°C, the resulting mixture contained 0.87 mol C at a total pressure of 1.10 bar. Calculate

    (a) the mole fractions of each species at equilibrium. (8%)

    (b) the equilibrium constant in terms of mole fractions, K_X. (3%)

    (c) the equilibrium constant in terms of partial pressure, K_P. (3%)

    (d) the equilibrium constant in terms of concentration, K_C. (3%)

    (e) the standard reaction Gibbs energy in terms of partial pressure, $\Delta_r G_P^\ominus$. (3%)

3. Naphthalene, $C_{10}H_8$, melts at 80.2°C. If the vapor pressure of the liquid is 1.3 kPa at 85.8°C and 5.3 kPa at 119.3°C, use the Clausius-Clapeyron equation to calculate

    (a) the enthalpy of vaporization. (8%)

    (b) the normal boiling point. (6%)

    (c) the entropy of vaporization at the boiling point. (6%)

4. The second-order reaction:

    $$\text{ester(aq)} + \text{B(aq)} \rightarrow \text{Y(aq)} + \text{Z(aq)}$$
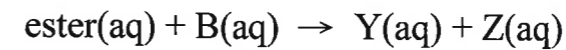
    The rate constant is 0.12 dm^3 mol^{-1} s^{-1}. When ester is added to B so that the initial concentrations are [ester]$_0$ = 0.110 mol dm^{-3} and [B]$_0$ = 0.060 mol dm^{-3}. What is the concentration of ester after

    (a) 20 seconds. (10%)

    (b) 15 minutes. (10%)

5. The limiting molar conductivities of NaI, NaNO$_3$, and AgNO$_3$, are 12.69 mS m^2 mol^{-1}, 12.16 mS m^2 mol^{-1} and 13.34 mS m^2 mol^{-1}, respectively (all at 25°C).

    (a) What is the limiting molar conductivity of AgI? (8%)

    (b) The molar ionic conductivities of Na$^+$ is 5.01 mS m^2 mol^{-1} at 25°C. What are the mobilities and diffusion coefficients of Na$^+$? (6%)

    (c) At 25°C, the mobility of a NO$_3^-$ ion in aqueous solution is 7.40×10^{-8} m^2 s^{-1} V^{-1}. Calculate its diffusion coefficient in water at 25°C. (6%)