淡江大學八十八學年度碩士班招生考試試題

系別：化學工程學系　　科目：物理化學　　本試題共 1 頁

1. Nitrogen is expanded reversibly and adiabatically from a volume of 5 liter at 3 bar and 25°C, until the volume is 20 liter. The C_p of nitrogen can be taken to be 29.12 J K^{-1} mol^{-1}. (a) Calculate the final pressure and temperaturre on assuming ideal gas behavior during the expansion process. (b) Calculate ΔU_{therm} (= - q), ΔU_{mech} (= - w) for the thermal and mechanical surroundings, and ΔU, ΔH for the nitrogen gas. 20%

2. (a) Explain the two correction terms in van der Waals' equation with respect to the ideal gas equation. (b) Calculate, to a precision of about 1 %, the molar volume of methane, given the constants of van der Waals' equation as a = 2.29 bar liter^2 mol^{-2} and b = 0.0428 liter mol^{-1}. 20% (R = 8.314 J K^{-1} mol^{-1})

3. What are the half-life of a first-order reaction and a second-order reaction? 10%

4. (a) Explain the phenomenum of freezing-point depression and deduce the mathematical relationship between ΔT_{fp} and the activity of solvent $a_{solvent}$ in a certain solution. (b) What is the requirement as the previous relation may be approximated into $\Delta T_{fp} = - K_{fp} m_{solute}$. (c) Deduce the expression of K_{fp} as a function of solvent's properties, where K_{fp} is the freezing-point depression constant and m_{solute} is the molality of solute in the solution. 30%

Note that $\mu_i = \mu_i^* + RT \ln a_i$ and $dG = Vdp - SdT$ and that the Taylor series of $\ln (1 + x) = x - x^2/2 + x^3/3 - x^4/4 + \ldots$

5. (a) Derive the capillary-rise equation as $\gamma = r\rho gh / 2$. (b) At 20°C the surface tensions of water and carbon tetrachloride, respectively, are 0.0727 and 0.0268 N m^{-1}, and their densities are 0.998 and 1.595 g mL^{-1}. Compare the heights to which water and carbon tetrachloride will rise as a result of capillary action in a tube with an internal diameter of 0.1 mm. 20% (g = 9.8 m s^{-2})