國立臺灣大學 105 學年度碩士班招生考試試題

1. A gas obeys the van der Waals equation. Derive the relation for work done if the gas expands isothermally and reversibly from volume V_1 to V_2. (10%)

2. Prove that, for any substance,

$$C_p - C_v = \left[p + \left(\frac{\partial U}{\partial V}\right)_T\right]\left(\frac{\partial V}{\partial T}\right)_p \qquad (10\%)$$

3. Please derive an expression of $\alpha = 1/T$ where α is the thermal expansion coefficient of perfect gas and T is the temperature. (10%)

4. Suppose you have a weight on a rubber band so as to keep it under constant tension. If you then heat the rubber band, will the weight rise or fall? Give a thermodynamic answer. (10%)

5. The chemical reaction in a "lead storage" cell of a car battery during charging involves the reduction of $PbSO_4$(s) to Pb(s) and the oxidation of $PbSO_4$(s) to PbO_2(s), both reactions occurring in the presence of H_2SO_4(aq). Please write the balanced reaction. (10%)

6. For an experiment to determine the Osmotic pressure of a solution, at equilibrium the solvent molecules pass through the membrane raising the level of the solution to height, h. At this height, the Osmotic pressure of the solution is equal to the hydrostatic pressure. If the solution is ideal, show that

$$\mathrm{RT}\ln(P/P^o) = -Mgh$$

where P and P^o are the vapor pressure of the solution and the pure solvent respectively. M is the molecular weight of the solvent. (15%)

7. A certain liquid solution contains two components 1 and 2. Component 1 follows Henry's law for the mole fraction range $0 \leqq x_1 \leqq a$ at constant temperature and at low pressure. Show that component 2 must follow Raoult's law for the mole fraction range $(1-a) \leqq x_2 \leqq 1$. (10%)

8. (a) A solution contains n_1 moles of component 1 and n_2 moles of component 2. Their molecular weights are M_1 and M_2, respectively. Please provide the expression for the partial molar volume $\overline{V}_2$ of component 2 in terms of n_1, n_2, the density ρ with respect to n_2 at constant n_1, and the molecular weights.
(b) Let x_1 and x_2 be the mole fractions of 1 and 2 in the solution. Show that

$$\overline{V}_2 = \frac{M_2}{\rho} - (M_1x_1 + M_2x_2)\frac{x_1}{\rho^2}\frac{d\rho}{dx_2} \qquad (15\%)$$

9. Please define the following terms: (10%)

(a) Fugacity
(b) Gibbs-Duhem equation
(c) Maxwell relations
(d) Nernst equation
(e) Thermodynamic Second Law

試題隨卷繳回