

Please mark your answers clearly and provide derivation and calculations.

1. The van der Waals equation of state:  $(P + \frac{a}{\bar{V}^2})(\bar{V} - b) = RT$ 
  - A. Find expressions for the temperature, molar volume ( $\bar{V}$ ), pressure, and compression factor for a van der Waals gas at the critical point (20%).
  - B. For reversible isothermal expansion, find expressions for work, heat, internal energy, and enthalpy (20%).
2. If 2 moles of supercooled liquid water at  $-15^\circ\text{C}$  freezes irreversibly at a constant pressure of 1 atm to ice, calculate the entropy change of the system, the surroundings, and the universe. Assume the surroundings remain at equilibrium at  $-15^\circ\text{C}$  and the molar heat capacity of liquid water to be constant and equal to  $76.1 \text{ J/mol}\cdot\text{K}$  and that of ice to be constant and equal to  $37.15 \text{ J/mol}\cdot\text{K}$ , the latent heat of water fusion is  $-333.5 \text{ J/g}$  (30%).
3. The vapor pressure of water at  $100^\circ\text{C}$  is 760 torr and 23.756 torr at  $25^\circ\text{C}$ . Find the average enthalpy change of vaporization of water between 25 and  $100^\circ\text{C}$  (10%).
4. Calculate the Gibbs energy change of mixing, the entropy change of mixing, and the enthalpy change of mixing for a solution of 1.2 mole of benzene and 1.3 mole of toluene at  $20^\circ\text{C}$ . Also find the proportion of toluene vapor at equilibrium. The vapor pressure of pure benzene is 74.9 torr at  $20^\circ\text{C}$  and that of toluene is 74.9 torr (20%).

試題隨卷繳回