

1. Prove that, for any substance,

$$C_{p,m} - C_{v,m} = \left[p + \left(\frac{\partial U}{\partial V} \right)_T \right] \left(\frac{\partial V}{\partial T} \right)_p \quad (15\%)$$

2. (a) Estimate the Boyle temperature for a certain non-ideal gas whose equation of state is

$$P\bar{V} = RT + APT - BP$$

where \bar{V} is the molar volume and A and B are constants.

(b) Determine whether this gas has a critical point.

(15%)

3. Give an explanation of why the heat capacity of a solid or a liquid is usually greater than that of the same substance as a gas at the same temperature. (5%)

4. Derive the expression

$$\ln K = \frac{-\Delta H^\circ}{RT} + C$$

starting with the equation $\Delta G^\circ = -RT \ln K$, where C is an integration constant.

(15%)

5. Please explain non ideal solutions in detail. (10%)

6. What is the electromotive force (emf) of a system when all concentrations are unity? (10%)

7. What is the osmotic pressure? How to measure it? Why can it be used to measure the molecular weight of polymers? Please explain in detail. (20%)

8. What is the Maxwell's relations. (10%)