

1. What is the osmotic pressure Π_1 ? Please derive that the partial molar free energy change of mixing with respect to the solvent in solution is equal to $\Pi_1 \bar{V}_1$, where \bar{V}_1 is the molar volume of pure solvent. (15%)
2. What is the second law of thermodynamics? Please describe it in detail! (10%)
3. When a gas, that has the equation of state $PV = nRT - n^2a/V$, expands reversibly from V_i to V_f at constant temperature, please derive the work, W , done on the surroundings would be

$$W = nRT \ln \frac{V_f}{V_i} + n^2 a \left(\frac{1}{V_f} - \frac{1}{V_i} \right) \quad (15\%)$$

4. What is the electromotive force (emf) of a system when all concentrations are unity? (15%)
5. Please explain the cleansing action of soap. (15%)
6. What is the ideal solution? Please explain it in detail! (15%)
7. Given that solid A does not float on liquid A, explain whether the melting point of the solid will be raised or lowered by pressure. You may explain it according to Clapeyron equation. (15%)