1. For the reaction \( \text{N}_2 (g) \leftrightarrow 2\text{N} (g) \) at 4000 K, \( K^*_p = 3 \times 10^{-6} \). What will occur in a fixed volume reaction mixture where \( P_{\text{N}_2} = 361 \text{ torr}, P_{\text{He}} = 713 \text{ torr} \) and \( P_{\text{N}} = 0.012 \text{ torr} \)? (20 points)

2. How many independent components and degrees of freedom are found in a system consisting of a flask with both liquid and gaseous water, dissolved NaCl and both dissolved and solid AgCl (assume that NaCl is completely soluble)? (20 points)

3. For the gas phase reaction
   \[ \text{I}_2 (g) + \text{cyclopentene} (g) \leftrightarrow \text{cyclopentadiene} (g) + 2\text{HI} (g) \]
   Over the temperature range of 450 to 700 K, the measured data is described well by \( \ln(K^*_p) = 7.55 - (4.83 \times 10^3 \text{ K}) T^{-1} \). Calculate \( \Delta G^*, \Delta H^*, \Delta U^* \) and \( \Delta S^* \) at 500K assuming ideal gas behavior. (20 points)

4. The vapor pressure of water at 25°C is 23.76 torr and 760.0 torr at 100°C. Calculate the average \( \Delta H_m \) of vaporization for water over the temperature range from 25°C to 100°C. (20 points)

5. Given that an equation of state for a real gas is \( p = RT / (V_m - b) \). For a gas which has \( b = 40.0 \text{ cm}^3 \text{ mol}^{-1} \), calculate \( \alpha = V_m^{-1} (\partial V_m / \partial T)_p \) at 300K and 5.0 atm. Using \( \mu_T = (V_m / C_{p,m}) (\alpha T - 1) \), calculate the \( \Delta T \) for this gas if it expands from 5.0 atm to 4.8 atm at 300K, assuming \( C_{p,m} = 7 \text{ R} / 2 \). (20 points)