1. In an experiment, the vapor pressure of a liquid is measured as 5 kPa at 300K, and as 120 kPa at 400 K. Calculate from these data the enthalpy of vaporization $\Delta_{vap}H$ of the liquid.

$$\ln \frac{p_2}{p_1} = \frac{\Delta_{vap} H}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right) = \frac{\Delta_{vap} H}{R} \cdot \frac{T_2 - T_1}{T_1 T_2}$$

$$\Rightarrow \Delta_{vap} H = R \cdot \ln \frac{p_2}{p_1} \cdot \frac{T_1 \cdot T_2}{T_2 - T_1} = 8.3145 \cdot \ln \frac{120}{5} \cdot \frac{300 \cdot 400}{100} \; J/mol$$

$$= 31.21 \; kJ/mol$$

2. The ratio of a component A to that of water collected in a steam distillation is 6, when the mixture was boiled at 344 K and 80 kPa. If the vapor pressure of water at this temperature is 43.2 kPa, calculate the molar mass of A. (Molar mass of water: 18.02 g/mol)

$m = n M$

$$\frac{m_A}{m_{H_2O}} = \frac{n_A \cdot M_A}{n_{H_2O} \cdot M_{H_2O}} = \frac{p_A^*}{p_{H_2O}^*} \cdot \frac{M_A}{M_{H_2O}} \Rightarrow M_A = \frac{p_{H_2O}^*}{p_A^*} \cdot \frac{m_A}{m_{H_2O}} M_{H_2O} \quad \left| \; p_A^* = p - p_{H_2O}^* \right.$$

$$\Rightarrow M_A = \frac{p_{H_2O}^*}{p - p_{H_2O}} \cdot \frac{m_A}{m_{H_2O}} \cdot M_{H_2O} = \frac{43.2}{80 - 43.2} \cdot 6 \cdot 18.02 \; g/mol = 126.92 \; g/mol$$

3. How many different phases can at most co-exist in a two-component system? Why?

$$f = c - p + 2 \qquad f \geq 0 \Rightarrow p \leq 4$$

4. The molar entropy of vaporization is 108.72 j/K at 1 bar. The corresponding densities of liquid water and water vapor are 0.958kg/dm³ and 5.98 x 10^{-4} kg/dm³ respectively. Calculate the change of pressure for a one-degree change in temperature.

$$\frac{\Delta p}{\Delta T} = \frac{\Delta S_{vap}}{V_v - V_l} \; ; \quad V_l = \frac{18.02 \; g/mol}{0.958 \; kg/dm^3} = 18.80 \cdot 10^{-3} \; \frac{dm^3}{mol}$$

$$V_v = \frac{18.02 \; g/mol}{5.98 \cdot 10^{-4} \; kg/dm^3} = 30.12 \; \frac{dm^3}{mol}$$

$$\Rightarrow \frac{\Delta p}{\Delta T} = 3.612 \; \frac{J}{dm^3 \, K}$$

$$\Rightarrow \Delta p = \frac{\Delta p}{\Delta T} \cdot 1K = 3.612 \cdot 10^3 \; \frac{J}{m^3}$$