1. When 12.5 g of the nonvolatile component B is dissolved in 520.8 g of A, the vapor pressure of the pure solvent, 7.47 kPa, is reduced to 7.35 kPa. Calculate the molar mass of compound B if that of compound A is 46.1 g/mol. Hint: assume that $n_A >> n_B$.

$$P_A = \chi_A P_A^* \Rightarrow \frac{P_A}{P_A^*} = \chi_A \Rightarrow 1 - \frac{P_A}{P_A^*} = 1 - \chi_A \Rightarrow \frac{P_A^* - P_A}{P_A^*} = \chi_B$$

$$\Rightarrow \frac{P_A^* - P_A}{P_A^*} = \frac{n_B}{n_A + n_B} \approx \frac{n_B}{n_A} \Rightarrow \frac{P_A^* - P_A}{P_A^*} = \frac{m_B}{M_B} \cdot \frac{M_A}{m_A}$$

$$\Rightarrow M_B = m_B \cdot \frac{M_A}{m_A} \cdot \frac{P_A^*}{P_A^* - P_A} = 12.5\,g \cdot \frac{46.1}{520.8} \cdot \frac{7.47}{7.47 - 7.35}$$

$$= 12.5\,g \cdot \frac{46.1}{520.8} \cdot \frac{7.47}{0.12} = 68.9\ g/mol$$

2. Components 1 and 2 form an ideal solution. The pressure of pure component 1 is 13.3 kPa at 298 K. If addition of 1.00 g of component 2 to 10.00 g of component 1 reduces the total vapor pressure to 12.6 kPa, what is the ratio of the molar mass of component 2 to that of component 1.

$$\frac{P_1}{P_1^*} = \chi_1 \Rightarrow 1 - \frac{P_1}{P_1^*} = 1 - \chi_1 \Rightarrow \chi_2 = \frac{P_1^* - P_1}{P_1^*} = \underline{0.053}$$

$$\chi_2 = \frac{\frac{m_2}{M_2}}{\frac{m_1}{M_1} + \frac{m_2}{M_2}} = \frac{1}{\frac{m_1}{M_1}\frac{M_2}{m_2} + 1}$$

$$\Rightarrow \frac{1}{\chi_2} = \frac{m_1}{M_1}\frac{M_2}{m_2} + 1$$

$$\Rightarrow \frac{1}{\chi_2} - 1 = \frac{M_2}{M_1}\frac{m_1}{m_2}$$

$$\Rightarrow \frac{M_2}{M_1} = \frac{m_2}{m_1}\left(\frac{1}{\chi_2} - 1\right) = \frac{1.00}{10.00}\left(\frac{1}{0.053} - 1\right) = 0.1 \cdot 18.0 = 1.8$$