Convert Concentration Units

Consider a mesogenic polymer whose partial specific volume is 0.788 mL/g to be dissolved in a solvent with density 0.852 g/mL. You need to make solutions to a specific volume fraction for comparison to theory on liquid crystal phase formation, and desire a solution at \( \phi_2 = 0.35 \). You need about 10 mL of the solution. Write an experimental plan for your notebook showing how you will do this, starting from liquid solvent and solid polymer? (You can treat the partial specific volumes of both solute and solvent as constants—i.e., assume they do not vary with concentration, although in general these quantities do).

\[
V_2 = \phi_2 V = 0.35 \times 10 \text{ mL} = 3.5 \text{ mL} \quad V_1 = 0.65 \times 10 \text{ mL} = 6.5 \text{ mL}
\]

\[
m_2 = \frac{V_2 \rho}{7.88 \text{ mL/g}} = 0.494 \text{ g} \quad m_1 = V_1 \rho = 6.5 \text{ mL} \times 0.852 \text{ g/mL} = 5.54 \text{ g}
\]

For the same polymer-solvent system above, suppose now that you have pre-dissolved a large stock solution at \( c = 338 \text{ mg/mL} \). How would you dilute it down to make 5 mL of solution at \( \phi_2 = 0.043 \)?

\[
V_2 = \phi_2 V = 0.043 \times 5 \text{ mL} = 0.215 \text{ mL}
\]

\[
m_2 = \frac{V_2 \rho}{7.88 \text{ mL/g}} = 0.273 \text{ g} \quad V_{\text{stock}} = \frac{0.273 \text{ g}}{0.838 \text{ g/mL}} = 0.327 \text{ mL}
\]

Assuming the polymer in question has a molar mass of 1.23 x 10^3 g/mol, what is the molality of the solution with \( \phi_2 = 0.043 \)?

\[
c_1 = \phi_1 \rho = 0.957 \times 0.852 \text{ g/mL} = 0.815 \text{ g/mL}
\]

\[
m_1 = 5 \text{ mL} \times 0.815 \text{ g/mL} = 4.08 \text{ g} = 4.08 \times 10^3 \text{ kg}
\]

\[
c_2 = \phi_2 \rho = 0.043 \times 0.788 \text{ g/mL} = 0.055 \text{ g/mL}
\]

\[
m_2 = 5 \text{ mL} \times 0.055 \text{ g/mL} = 0.273 \text{ g} = 2.73 \times 10^{-3} \text{ kg}
\]

What is the molarity?

\[
c = 0.055 \text{ g/mL}
\]

\[
M = 0.055 \text{ g/mL} \left( \frac{\text{mol}}{1.23 \times 10^3 \text{ g}} \right) \left( \frac{1000 \text{ mL}}{1 \text{ L}} \right) = 4.47 \text{ M}
\]