1. What is the vapor pressure of 450.0g of water when 68.0g of galactose (C₆H₁₂O₆) is added? Knowing vapor pressure of water at room temperature is 23.8 torr.

\[
n_{\text{water}} = \frac{450.0 \text{ g}}{18.015 \text{ g/mol}} = 24.98 \text{ mol}
\]

\[
n_{\text{water}} = \frac{68.0 \text{ g}}{180.156 \text{ g/mol}} = 0.377 \text{ mol}
\]

\[
P_{\text{solvent}} = X_{\text{solvent}} P_{\text{solvent}}^o
\]

\[
P_{\text{solvent}} = \left( \frac{24.98}{24.98 + 0.377} \right) 23.88 = 23.52 \text{ torr}
\]

2. About 10.56g Omeprazole (C₁₇H₁₉N₃O₃S) was added to 50.0g of ethyl acetate (C₄H₈O₂) for analysis. The vapor pressure of this solution is found to be 89.02 torr. Calculate the initial vapor pressure of ethyl acetate before adding in Omeprazole.

\[
n_{\text{ethyl acetate}} = \frac{50.0 \text{ g}}{88.105 \text{ g/mol}} = 0.568 \text{ mol}
\]

\[
n_{\text{Omeprazole}} = \frac{10.56 \text{ g}}{345.42 \text{ g/mol}} = 0.0306 \text{ mol}
\]

\[
X_{\text{solvent}} = \left( \frac{0.568}{0.568 + 0.0306} \right) = 0.948
\]

\[
P_{\text{solvent}} = X_{\text{solvent}} P_{\text{solvent}}^o
\]

\[
P_{\text{solvent}}^o = \frac{P_{\text{solvent}}}{X_{\text{solvent}}} = \frac{89.02}{0.948} = 93.81 \text{ torr}
\]
3. An unknown solid was added to 100.0g of acetonitrile and decreased the solvent’s vapor pressure to 89.05 torr. With the initial vapor pressure of acetonitrile is 97.51, calculate the number of mol for this unknown solid

\[
n_{\text{ethyl acetate}} = \frac{50.0 \text{ g}}{41.052 \text{ g/mol}} = 2.44 \text{ mol}
\]

\[
\[\]
\[
\]

\[
X_{\text{solvent}} = \frac{P_{\text{solvent}}}{P_{\text{solvent}}^0} = \frac{89.05}{97.51} = \frac{2.44 \text{ mol}}{2.44 \text{ mol} + n_{\text{unknown}}}
\]

\[
.9132 = \frac{2.44 \text{ mol}}{2.44 \text{ mol} + n_{\text{unknown}}}
\]

\[
.9132 (2.44 + n_{\text{unknown}}) = 2.44
\]

\[
.9132 n_{\text{unknown}} + 2.228 = 2.44
\]

\[
n_{\text{unknown}} = .232 \text{ mol}
\]

4. NaCl was added to water to increases water’s boiling point. After adding NaCl solution, boiling point of water increased to 102.5°C. With k_{bp} of water is .5121°C/m, what is the molality of this salt solution?

*Note: take in account of Van’t Hoff Factor, NaCl is soluble in water so it dissociates into Na⁺ and Cl⁻. Therefore, Van’t Hoff Factor is 2

\[
\Delta T = ik_{bp}m
\]

\[
(102.5 - 100.0) = 2(.5121°C/m)m
\]

\[
\frac{102.5 - 100.0}{2 (.5121°C/m)} = m = 2.441 m
\]
5. About 1.78g of CBD (C21H30O2) was added to 400.0g of benzene and raise benzene’s boiling point to 82.1°C. Calculate k_{bp} for benzene, knowing its normal boiling point is 80.1°C

\[
\text{mol of CBD} = \frac{1.78 \text{ g}}{314.464 \text{ g/mol}} = 0.00566 \text{ mol}
\]

\[
m = \frac{\text{mol of solute}}{\text{kg of solvent}} = \frac{0.00566 \text{ mol}}{0.4000 \text{ kg}} = 0.01415m
\]

\[
\Delta T = ik_{bp}m
\]

\[
\frac{\Delta T}{m} = k_{bp} = \frac{82.1 - 80.1}{1415} = 14.13 ^\circ \text{C/m}
\]

6. What is the change in freezing point for an aqueous solution of 4.00m of K₂SO₄? Given k_{f} for water is 1.86°C/m

\[
\text{K}_2\text{SO}_4 \rightarrow 2\text{K}^2+ + \text{SO}_4^{2-}
\]

Van’t Hoff Factor = 3

\[
\Delta T = ik_{fp}m
\]

\[
\Delta T = 3(1.86)(4.00) = 22.32
\]

7. The melting point of pure benzene is 278.70 K and k_{f} = 4.90 K/m. When 5.83 g of an unknown solute is added to 50.0g of benzene, the freezing point of the solution is 272.4 K. Determine the molecular weight of the unknown.

\[
\Delta T = ik_{fp}m
\]

\[
\frac{\Delta T}{ik_{fp}} = m = \frac{278.70 - 272.4}{4.90} = 1.3m
\]

\[
\frac{5.83 \text{ g solute}}{1.3 \text{ mol solute}} \left( \frac{0.05 \text{ kg solvent}}{1 \text{ kg solvent}} \right) = 89.69 \text{ g/mol}
\]
8. A solution prepared by dissolving .80g of cocaine ($C_{17}H_{21}NO_4$) in water to make 16mL of solution at 25°C. What is the osmotic pressure of this solution?

$$n \text{ cocaine} = \frac{.80 \text{ g cocaine}}{303.353 \text{ g/mol}} = .002637 \text{ mol}$$

$$\pi = MRT$$

$$\pi = \left(\frac{.002637 \text{ mol}}{.016L}\right)\left(0.0821 \frac{L \text{ atm}}{\text{mol} \text{ K}}\right)(25 + 273.15) = 4.034 \text{ atm}$$

9. About .260g of unknown solid was dissolved in 500g of water at 30.0°C resulting in osmotic pressure of 2.18 atm. What is the molar mass of this unknown

$$\pi = MRT$$

$$M = \frac{\pi}{RT} = \frac{2.18 \text{ atm}}{.0821 \frac{L \text{ atm}}{\text{mol} \text{ K}} (303.15 \text{ K})} = .0876 M$$

$$\frac{.260g \text{ solute}}{\frac{.0876 \text{ mol solute}}{L \text{ solution}} \frac{.05L \text{ solution}}{1}} = 59.36 g/\text{mol}$$