

Answer on Question #74597, Chemistry / General Chemistry :

A solution is prepared by dissolving 32.5 g of a nonvolatile solute in 200g of water. The vapor pressure above the solution is 21.85 torr and the vapour pressure of pure water is 23.76 Torr at this temperature. What is the molecular weight of the solute

Solution.

$$m = 32.5 \text{ g}$$

$$V(H_2O) = 200.0 \text{ ml}$$

$$m(H_2O) = 200.0 \text{ g} = 0.2 \text{ kg}$$

$$p_1 = 21.85 \text{ torr}$$

$$p_2 = 23.76 \text{ torr}$$

$$M = ?$$

Mathematically, Raoult's law for a single component in an ideal solution is stated as:

$$\frac{p_A^0 - p_A}{p_A^0} = x_B$$

And:

$$\frac{p_A^0 - p_A}{p_A^0} = \frac{\frac{m_B}{M_B}}{\frac{m_B}{M_B} + \frac{m(H_2O)}{M(H_2O)}}$$

Then:

$$\frac{23.76 - 21.85}{23.76} = \frac{\frac{32.5}{M_B}}{\frac{32.5}{M_B} + \frac{200}{18}}$$

$$\frac{\frac{32.5}{M_B}}{\frac{32.5}{M_B} + 11.1111} = 0.080387$$

$$\frac{32.5}{M_B} = 0.080387 \cdot \frac{32.5}{M_B} + 11.1111 \cdot 0.080387$$

$$0.919613 \frac{32.5}{M_B} = 0.89318$$

$$M_B = 33.46 \text{ g / mol}$$

Answer: $M_B = 33.46 \text{ g / mol}$.