Answer on Question # 73566 - Chemistry - Physical Chemistry

The vapor pressure of a pure water at 50°C is 0.1217 atm. The vapor pressure of a solution containing 90 g of a non-volatile organic compound in 1000g of water at the same temperature is 0.1184 atm. Calculate the molar mass of the organic compound by assuming the solution is dilute.

Solution

The vapor pressure of water solution is proportional to its mole fraction (Rauolt's law):

$P = X \cdot P^0$,

Where P^0 is the vapor pressure of the pure solvent.

Therefore, the mole fraction of water in the solution is:

$X = P/P^0 = 0.1184 \text{ atm} / 0.1217 \text{ atm} = 0.973$.

Then the mole fraction of the non-volatile organic compound is $1 – 0.973 = 0.027$.

Converting the mass of water to moles:

$1000 \text{ g } H_2O \text{ (1 mol H2O/18 g } H_2O) = 55.56 \text{ mol } H_2O$.

Amounts of substances are proportional to its mole fraction, therefore the amount of the non-volatile organic compound (n) is:

$55.66/0.973 = n/0.027$,

$n = 0.027 \cdot 55.66 / 0.973 = 1.545$ (moles).

The molar mass of the non-volatile organic compound is:

$90 \text{ g} / 1.545 \text{ mol} = 58 \text{ g/mol}$.

Answer: 58 g/mol.