Boiling Pt. Elevation:

nonvolatile solute lowers vapor pressure as a result the boiling pt. of the solution increases

boiling pt of a pure liquid has a vapor pressure < 1 atm
∴ must have higher temp. to reach vapor pressure of 1 atm

molal boiling pt elevation constant, K_b, expresses how much ΔT_b changes with molality

$\Delta T_b = K_b m i$

T_b = change in boiling pt.
K_b = boiling pt constant
is specific for each liquid
K_b of water = $0.51^{\circ}C/m$
m = molality
i = ideal value = # of moles of ions in solution

Freezing point Depression:

when solution freezes crystals of almost pure solvent form first.

solute molecules are NOT soluble in solid phase of solvent.

∴triple point occurs at a lower temp. because of lower vapor pressure for the solution.

Melting pt. (freezing pt.) curve is a vertical line from the triple point.

Solution freezes at lower temp. than pure solvent.

Decrease in freezing pt. is directly proportional to molality

$$\Delta T_f = K_f m i$$

ΔT_f = change in freezing pt.

K_f = freezing pt. constant of liquid

changes for each liquid

K_f of water = $-1.86^{o}C/m$

m = molality of solution

i = van't Hoff factor = # moles of ions involved

Ex. 1
Automotive antifreeze consists of ethylene glycol ($C_2H_6O_2$), a nonvolatile nonelectrolyte. Calculate the boiling point elevation and freezing point depression of a 25.0 mass % solution of ethylene glycol in water.

Ex. 2
Calculate the freezing point of a solution containing 0.600 kg of $CHCl_3$ and 42.0 g of eucalyptol ($C_{10}H_{18}O$), a fragrant substance found in the leaves of eucalyptus trees.

Ex. 3

A solution of an unknown nonvolatile nonelectrolyte was prepared by dissolving 0.250 g of the substance in 40.0 g of CCl_4. The boiling point of the resultant solution was 0.357°C higher than that of the pure solvent. Calculate the molar mass of the solute.

$$\Delta T_b = K_b m i$$

$$0.357°C = (5.03°C/m)\, x$$

$$x = \frac{0.357°C}{5.03°C/m}$$

$$x = 0.071\, m$$

$$\text{molality} = \frac{\text{moles of solute}}{\text{kg of solvent}}$$

$$0.071\, m = \frac{x}{0.040\, kg}$$

$$x = 0.003 \text{ moles}$$

$$40.0\, g \left(\frac{1\, kg}{1000\, g}\right) = 0.040\, kg$$

Molar mass means g/mol

$$\frac{0.250\, g}{0.003 \text{ moles}} = 83.33\, g/mol$$