Answer on Question #49788 - Chemistry – Other

Question

Calculate the boiling point and freezing point of a 20% aqueous sucrose $C_{12}H_{22}O_{11}$ (MM=342) solution.

Answer:

The boiling point elevation is proportional to the molality of the solute particles:

$$\Delta T_b = K_b m$$

ΔT_b = the amount by which the boiling point is raised, m = molality (moles solute particles per kg of solution), K_b = molal boiling-point elevation constant (solvent dependent), for water K_b = 0.512 $^oC m^{-1}$. Boiling Point of solution = normal boiling point of solvent + ΔT_b. The freezing point depression is proportional to the molality of the solute particles:

$$\Delta T_f = -K_f m$$

ΔT_f = the amount by which the freezing point is lowered, m = molality (moles solute particles per kg of solution), K_f = molal freezing-point depression constant (solvent dependent), for water K_f = 1.855 $^oC m^{-1}$

Freezing Point of solution = normal freezing point of solvent + ΔT_f

Assume we have 100 g of 20% aqueous sucrose $C_{12}H_{22}O_{11}$ solution, then the mass of sucrose is 20 g and the mass of water is 80 g. Molality of this solution is:

$$m = \frac{m(sucrose)}{M(sucrose)m(water)} = \frac{20}{342 \cdot 80} = 0.000731\ mol/g\ = 0.731 mol/kg$$

The boiling point elevation is:

$$\Delta T_b = 0.512 \cdot 0.731 = 0.374$$

Boiling Point of solution = normal boiling point of solvent + ΔT_b = 100.0 + 0.374 = 100.374 °C

The freezing point depression is:

$$\Delta T_f = -1.855 \cdot 0.731 = -1.356$$

Freezing Point of solution = normal freezing point of solvent + ΔT_f = 0.0 + (-1.356) = -1.356 °C

Answer: T_b = 100.374 °C, T_f = -1.356 °C.