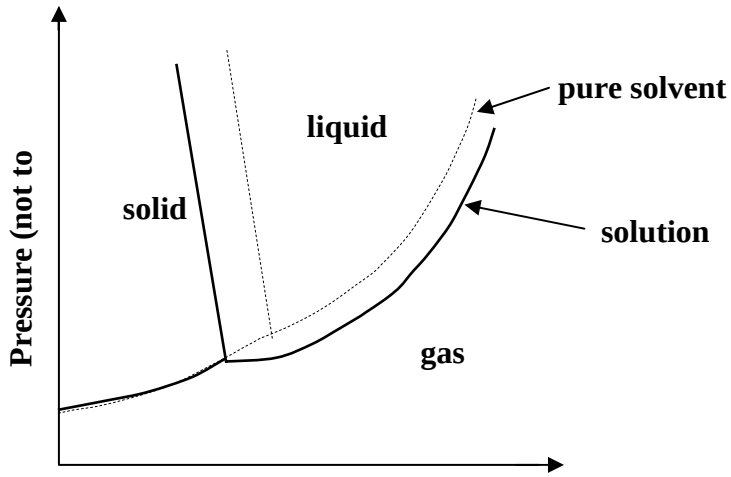
Marks 3

- Explain why the freezing temperature of an aqueous salt solution is lower than that of pure water.

The presence of solute particles lowers the vapour pressure of the solution compared to that of the pure solvent. This results in a lowering of the freezing point as shown in the phase diagram.



What mass of sugar (sucrose, MW 342 g mol^{-1}) would have to be dissolved in 1.0 L of water to lower the freezing point as much as a water solution containing 11.1 g L^{-1} of $CaCl_2$?

The molar mass of $CaCl_2$ is (40.08 (Ca) + 2 × 35.45 (Cl)) g mol^{-1} = 110.98 g mol^{-1}. The number of moles in 11.1 g of $CaCl_2$ is therefore:

$$\text{number of moles} = \frac{\text{mass}}{\text{molar mass}} = \frac{11.1\ \text{g}}{110.98\ \text{g mol}^{-1}} = 0.100\ \text{mol}$$

As $CaCl_2$ dissolves to give 3 particles per mole (Ca^{2+} + $2Cl^-$), the number of moles of sucrose required is (3 × 0.100 mol) = 0.300 mol. The corresponds to a mass of:

$$\text{mass} = \text{number of moles} \times \text{molar mass} = (0.300\ \text{mol}) \times (342\ \text{g mol}^{-1}) = 103\ \text{g}$$

Answer: **103 g**

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.