Answer on Question # 72642 - Chemistry - Physical Chemistry

How would the freezing point depression of a 0.05m cacl2 solution compare with that of a nacl solution?

Solution

The freezing point depression (ΔT_f) of a solution depends on the total molal concentration of solute particles (m) according to the following equation:

$$\Delta T_f = K_f m i,$$

where K_f is the cryoscopic constant (for water K_f = 1.86 °C/m) and i is van't Hoff factor (depends on the nature of the solute). The compound NaCl present in solution as $Na^+ + Cl^-$, two ions, therefore its van't Hoff factor is i=2, whereas $CaCl_2$ gives Ca^{2+} and $2Cl^-$, three ions, the van't Hoff factor is i=3.

The freezing point depression of NaCl is:

$$\Delta T_f = 1.86\ ^\circ\text{C/m}\ (0.05\ \text{m})(2) = 0.186\ ^\circ\text{C}.$$

The freezing point depression of $CaCl_2$ is:

$$\Delta T_f = 1.86\ ^\circ\text{C/m}\ (0.05\ \text{m})(3) = 0.279\ ^\circ\text{C}.$$

The difference is 0.279-0.186 = **0.093 °C.**

Answer: the freezing point depression of $CaCl_2$ is higher than that of NaCl by 0.093 °C.

Sources:

www1.lsbu.ac.uk/water/colligative_properties.html (Colligative properties of water)