- Ethylene glycol antifreeze, $C_2H_6O_2$, (1.00 kg) is added to a car radiator that contains 5.00 kg of water. What is the freezing point of the solution obtained?
  Data: The molal freezing point depression constant for water K_f = 1.86 °C kg mol^{-1}.

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The molar mass of ethylene glycol is ((2 × 12.01 (C)) + (6 × 1.008 (H)) + (2 × 16.00 (O))) g mol^{-1}) = 62.068 g mol^{-1}. The number of moles in 1.00 kg is therefore:

$$\text{number of moles} = \frac{\text{mass}}{\text{molar mass}} = \frac{1.00 \times 10^3 \text{ g}}{62.068 \text{ g mol}^{-1}} = 16.1 \text{ mol}$$

The molality is:

$$\text{molality} = \frac{\text{number of moles of solute (mol)}}{\text{mass of solvent (kg)}} = \frac{16.1 \text{ mol}}{5.00 \text{ kg}} = 3.22 \text{ mol kg}^{-1}$$

The freezing point depression, ΔT_f, is given by:

$$\Delta T_f = K_f m$$

where K_f is the molal freezing point depression constant. Hence,

$$\Delta T_f = K_f m = (1.86 \text{ °C kg mol}^{-1}) \times (3.22 \text{ mol kg}^{-1}) = 5.99 \text{ °C}$$

At atmospheric pressure, the water freezes at 0 °C. The solution will freeze at -5.99 °C.