**Quiz 11**

# Directions: Answer each of the following questions. Be sure to use complete sentences where appropriate. For full credit be sure to show all of your work. Where appropriate answers should be boxed for clarity, written to the correct number of significant figures, and, include the proper units.

1. A solution of 1.50 g of solute dissolved in 25.0 mL of water at 25 °C has a boiling point of 100.45 °C (12 points).
	1. What is the molar mass of the solute if it is a nonvolatile nonelectrolyte and the solution behaves ideally (Dwater = 0.997 g/mL, and kB water = 0.512 °C/$ m$ at 25 °C)?

$$∆T\_{B}=ik\_{B}m ⟹∆T\_{B}=ik\_{B}\frac{n\_{solute}}{kg\_{solvent}} and MM=\frac{m\_{solute}}{n\_{solute}}, so MM=\frac{ik\_{B}m\_{solute}}{kg\_{solvent}∆T\_{B}}$$

$$MM=\frac{\left(1\right)\left(0.512\frac{℃ mol}{kg\_{solvent} }\right)(1.50 g)}{\left(25.0 mL×\frac{0.997 g}{mL}\right)(100.45℃-100.00℃)}$$

$$MM=\frac{\left(1\right)\left(0.512\frac{℃ mol}{kg\_{solvent} }\right)(1.50 g)}{\left(25.0 mL\_{solvent}×\frac{0.997 g\_{solvent}}{mL\_{solvent}}×\frac{1 kg\_{solvent}}{1000 g\_{solvent}}\right)(0.45℃)}$$

$$MM=68.47208292\frac{g}{mol}≈68\frac{g}{mol}$$

* 1. Conductivity measurements how that the solute is ionic with a general formula AB2 or A2B. What is the molar mass if the solution behaves ideally?

$$MM=\frac{ik\_{B}m\_{solute}}{kg\_{solvent}∆T\_{B}}$$

$$MM=\frac{\left(3\right)\left(0.512\frac{℃ mol}{kg\_{solvent} }\right)(1.50 g)}{\left(25.0 mL×\frac{0.997 g}{mL}\right)(100.45℃-100.00℃)}$$

$$MM=\frac{\left(3\right)\left(0.512\frac{℃ mol}{kg\_{solvent} }\right)(1.50 g)}{\left(25.0 mL\_{solvent}×\frac{0.997 g\_{solvent}}{mL\_{solvent}}×\frac{1 kg\_{solvent}}{1000 g\_{solvent}}\right)(0.45℃)}$$

$$MM=205.4162487\frac{g}{mol}≈210\frac{g}{mol}$$

* 1. Analysis indicates an empirical formula of CaN2O6. Explain the difference between the actual formula mass and that calculated from the boiling point elevation.

The molar mass of CaN2O6 is 164.10 g/mol. This value is less than 210 g/mol calculated when the compound is assumed to be a strong electrolyte and is greater than 68 g/mol calculated when the compound is assume to be a nonelectrolyte. Thus, the compound form a nonideal solution because the ions interact but do not dissociate completely in solution.

* 1. Find the van’t Hoff factor for this solution.

$$MM=\frac{ik\_{B}m\_{solute}}{kg\_{solvent}∆T\_{B}}⇒i=\frac{(MM)kg\_{solvent}∆T\_{B}}{k\_{B}m\_{solute}}$$

$$i=\frac{\left(164.10\frac{g}{mol}\right)\left(25.0 mL\_{solvent}×\frac{0.997 g\_{solvent}}{mL\_{solvent}}×\frac{1 kg\_{solvent}}{1000 g\_{solvent}}\right)(0.45℃)}{\left(0.512\frac{℃ mol}{kg\_{solvent} }\right)(1.50 g)}$$

$$i=2.396597168≈2.4$$

1. What is a semipermeable membrane (3 points)?

A semipermeable membrane is a boundary between two solutions through which some molecules may pass but others cannot. Usually, small molecules may pass through but large molecules are excluded.