Molality

There are two basic ways to prepare solutions quantitatively. Keep in mind that solute takes up space. Even when the solute is completely dissolved, it affects the volume of the solution. Preparing solutions based on measuring the amount of solute per volume of solution is useful, because it is possible to measure out a sample of the solution and figure out how much solute you have. This is the type of measure that *molarity* is. Understanding how solute affects the solution, however, requires a different type of measure. To compare the solubility of different substances, it is necessary to know how much *solvent* is used compared to solute. To understand how dissolved solute affects the freezing point or boiling point of a liquid, it is necessary to know how much liquid solvent you have for a given amount of solute. *Molality* is very similar to molarity, except that it compares the moles of solute to kilograms of solvent instead of liters of solution. It is abbreviated by lower case *m*.

Competition among molar and molal solutions

$$m = \frac{mol(solute)}{kg(solvent)}$$

Sample Problem 1

Find the molality of a solution that contains 0.45 moles of solute dissolved in 300. g of water .

Step 1: Convert the amount of solvent to kilograms

$$300.\,g \times \frac{1kg}{1000g} = 0.300kg$$

Step 2: Substitute values into the definitional equation

$$m = \frac{0.45mol}{0.300kg} = 1.5m$$

Sample Problem 2

Find the molality of a solution that contains 25.57 g of sodium chloride dissolved in 250. g of water.

Step 1: Find the GFM

Na = 22.99 × 1 = 22.99
Cl = 35.45 × 1 = 35.45
58.44

Step 2: Convert the mass of solute to moles.

$$(25.57g)\left(\frac{1mol}{58.44g}\right) = 0.4375mol$$

Step 3: Convert the amount of solvent to kilograms.

$$250.\,g \times \frac{1kg}{1000g} = 0.250kg$$

Step 4: Substitute values into the definitional equation.

$$m = \frac{0.4375mol}{0.250kg} = 1.75m$$

Answer the questions below.

1. Find the molality of a solution that contains 225 g of $Ca(NO_3)_2$ dissolved in 400. g of water.
2. Find the molality of a solution that contains 0.663 mol of solute dissolved in 300. g of water.
3. Find the molality of a solution that contains 1.25 kg of KBr dissolved in 2.45 kg of water.