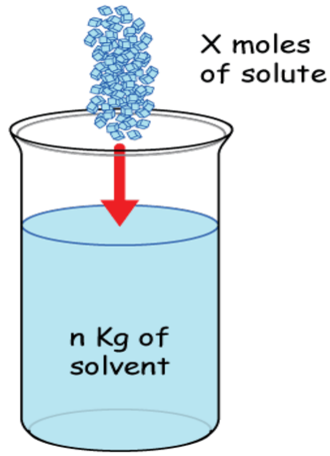
MOLALITY (m) AND MOLE FRACTION (Xi)

Molality*, abbreviated by lower-case **m**, is the number of moles of solute divided by the number of **Kilograms** of solvent. We say a solution is, for example, a "3.0 **molal** solution."

This figure (→) shows how to make an X-molal (X m) solution, where **X** is the number of moles of solute and **n** is the number of Kilograms of solvent.

The volume of the solvent can be used instead of the mass if its density is known. For example, at 4˚C, 1 liter of H_2O has a mass of 1 Kg. This measure of concentration has a couple of advantages: (1) only a balance is required to prepare a solution of known concentration and (2) variations of the density of the solvent with temperature (some can be significant) are irrelevant. Nevertheless, molality isn't used that often.

***Note: In modern chemistry the term molality has fallen out of use in favor of just using the units: mol/Kg**



Molality (m) is the number of moles of solute divided by the number of Kilograms of solvent. A 1 m solution contains 1 mole of solute for every 1 Kg of solvent. Use of the unit mol/Kg is now preferred over molality.

Mole Fraction (X_i)

The **mole fraction** is used in some calculations because it is massless. The mole fraction of one constituent of a solution is the number of moles of that constituent divided by the total number of moles of all components of the solution. The sum of the mole fractions of all components is one.

Mole fraction calculations work with any property that is proportional to the number of molecules (therefore moles) present, including partial pressure for gases.

The mole fraction (Xi) of the ith component of a mixture is the number of moles of that component divided by the total number of moles of all components.

Example 3

Find the mole fraction of both components of a mixture of water (H_2O) and ethanol (C_2H_5OH) that is 50% by mass in each component.

The density of ethanol is 789 g/L, so there are $789\text{ g}\left(\frac{1\text{ mole}}{46.07\text{ g}}\right) = 17.13$ moles in 1 L.

The density of water is 1000 g/L, so there are $1000\text{ g}\left(\frac{1\text{ mole}}{18.0\text{ g}}\right) = 55.55$ moles in 1 L.

I looked these up on Wikipedia.

Water is smaller and has a higher density.

Note that $X_{ethanol} + X_{water} = 1$

$$\boxed{X_{ethanol} = \frac{17.13}{17.13 + 55.55} = 0.236}$$

$$\boxed{X_{H_2O} = \frac{55.55}{17.13 + 55.55} = 0.764}$$

Source: http://www.drcruzan.com/Concentration.html