

Molality

Molality is the concentration of a solution expressed in moles of solute per kilogram of solvent. A solution that contains 1 mol of solute, sodium hydroxide, NaOH, for example, dissolved in exactly 1 kg of solvent is a “one molal” solution. The symbol for molality is m , and the concentration of this solution is written as 1 m NaOH.

One mole of NaOH has a molar mass of 40.0 g, so 40.0 g of NaOH dissolved in 1 kg of water results in a one molal NaOH solution. If 20.0 g of NaOH, which is 0.500 mol of NaOH, is dissolved in exactly 1 kg of water, the concentration of the solution is 0.500 m NaOH.

$$\text{molality} = \frac{\text{moles solute}}{\text{mass of solvent (kg)}}$$

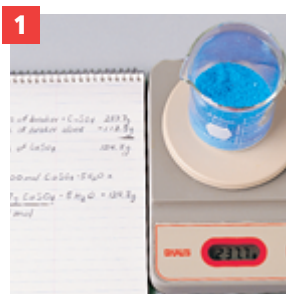
$$\frac{0.500 \text{ mol NaOH}}{1 \text{ kg H}_2\text{O}} = 0.500 \text{ } m \text{ NaOH}$$

If 80.0 g of sodium hydroxide, which is 2 mol, is dissolved in 1 kg of water, a 2.00 m solution of NaOH is produced. The molality of any solution can be found by dividing the number of moles of solute by the mass in kilograms of the solvent in which it is dissolved. Note that if the amount of solvent is expressed in grams, the mass of solvent must be converted to kilograms by multiplying by the following conversion factor.

$$1 \text{ kg}/1000 \text{ g}$$

FIGURE 18 The preparation of a 0.5000 m solution of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ also starts with the calculation of the mass of solute needed.

Figure 18 shows how a 0.5000 m solution of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is prepared, in contrast with the 0.5000 M solution in **Figure 17**.



Calculate the mass of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ needed. Making this solution will require 0.5000 mol of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ per kilogram of solvent (1000 g). This mass is calculated to be 124.8 g.



Add 1.000 kg of solvent to the solute in the beaker. Because the solvent is water, 1.000 kg will equal 1000 mL.



Mix thoroughly.



The resulting solution has 0.5000 mol of solute dissolved in 1.000 kg of solvent.