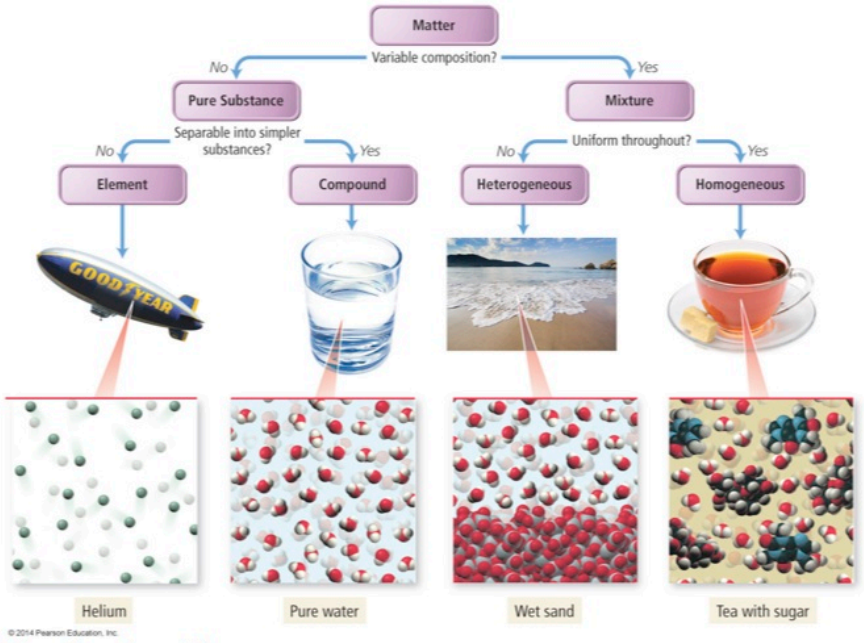
4.4: Solution Concentration and Solution Stoichiometry



(Textbook p.7)

Solutions are **homogenous mixtures**, consisting of a **solute** dissolved in a **solvent** (water).

The **concentration** of a solution is the amount of solute dissolved in a certain volume of solution.

One unit of concentration is **molarity**:

$$\text{Molarity} = \frac{\text{Moles of Solute}}{\text{Liters of Solution}} \qquad 1\,M = 1\ \text{mol/L}$$

1M = 1 molar

So, solving for moles of solute:

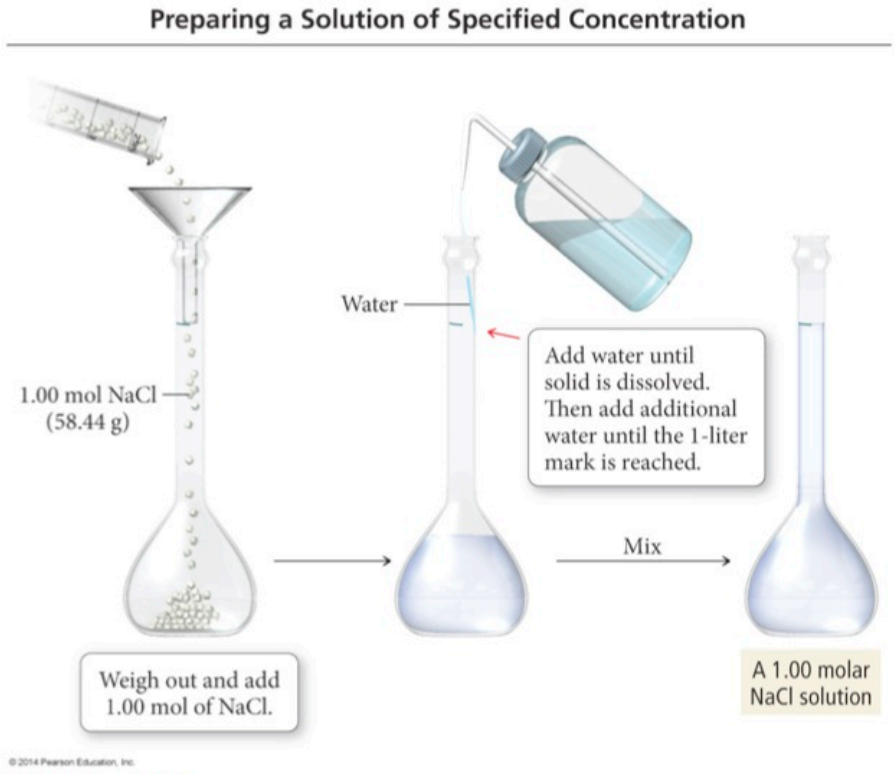
Moles solute = molarity × volume (in liters) = MV

Example: 250.0 mL of a solution of NaCl contains 1.461 g of salt. What is the molarity of this solution?

$$\frac{1.461\ \text{g NaCl}}{58.44\ \text{g/mol}} = 0.02500\ \text{mol NaCl}$$

$$250.0\ \text{mL} \times \frac{1\ \text{L}}{1000\ \text{mL}} = 0.2500\ \text{L}$$

$$\text{Molarity} = \frac{0.02500\ \text{mol}}{0.2500\ \text{L}} = 0.1000\ M$$



(Figure 4.5)

So to make the solution from the previous example, add 1.461 g NaCl to a 250 mL volumetric flask partially filled with water. Mix until dissolved, then add enough water to give 250 mL total of solution.

Dilutions:

When a solution is diluted, more solvent is added, lowering the concentration of the solution.

The amount (moles) of solute *does not change*.

Moles solute (before) = Moles solute (after)

Since moles solute = MV: $M_1V_1 = M_2V_2$

Example:

How would you prepare 250.0 mL of a 0.1000 M solution of NaCl starting with a 1.25 M solution?

$$1.25\ M \times V_1 = 0.1000\ M \times 250.0\ mL$$

$$V_1 = \frac{0.1000\ M \times 250.0\ mL}{1.25\ M} = 20.0\ mL$$

So, Take 20.0 mL of the 1.25 M solution, and dilute with water until the final volume is 250.0 mL.

Solution Stoichiometry:

Use the solution concentration and volume to calculate moles (instead of mass and molar mass).

moles solute = molarity × volume (in liters)

Example: What mass (in grams) of aluminum would react with 25 mL of 6.0 *M* sulfuric acid?

Balanced equation:

$$2\,Al\,(s) + 3\,H_2SO_4\,(aq) \rightarrow 3\,H_2\,(g) + Al_2(SO_4)_3\,(aq)$$

$$6.0\ \frac{mol}{L} \times 25\ mL \times \frac{1\ L}{1000\ mL}$$

$$= 0.15\ mol\ H_2SO_4$$

$$0.15\ mol\ H_2SO_4 \times \frac{2\ mol\ Al}{3\ mol\ H_2SO_4} \times 0.10\ mol\ Al$$

$$0.10\ mol\ Al \times \frac{26.98\ g}{1\ mol\ Al} = 2.7\ g$$