3.1: Prelude to Chemical Equations

The following sections are concerned with the amounts of substances which participate in chemical reactions(opens in new window), the quantities of heat given off or absorbed when reactions occur(opens in new window), and the volumes of solutions which react exactly with one another(opens in new window). These seemingly unrelated subjects are discussed together because many of the calculations involving them are almost identical in form. The same is true of the density calculations(opens in new window) and of the calculations involving molar mass and the Avogadro constant(opens in new window). In each case one quantity is defined as the ratio of two others.

Table 3.1.1: Summary of Related Quantities and Conversion Factors.

Related Quantities	Conversion Factor	Definition	Road Map
Volume ↔ mass	Density, ρ	$\rho = \frac{m}{V}$	$V \overset{\rho}{\longleftrightarrow} m$
Amount of substance ↔ mass	Molar Mass, *M*	$M = \frac{m}{n}$	$n \overset{M}{\longleftrightarrow} m$
Amount of substance ↔ number of particles	Avogadro constant, N_A	$N_{\text{A}} = \frac{N}{n}$	$n \overset{N_{\text{A}}}{\longleftrightarrow} N$
Amount of X consumed or produced ↔ amount of Y consumed or produced	Stoichiometric ratio, S(Y/X)	$S(\text{Y}/\text{X}) = \frac{n_{\text{Y}}}{n_{\text{X}}}$	$n_{\text{X}} \overset{S(\text{Y}/\text{X})}{\longleftrightarrow} n_{\text{Y}}$
Amount of X consumed or produced ↔ quantity of heat absorbed during reaction	ΔH_{m} for thermochemical equation	$\Delta H_{\text{m}} = \frac{q}{n_{\text{X}}}$	$n_{\text{X}} \overset{\Delta H_m}{\longleftrightarrow} q$
Volume of solution ↔ amount of solute	Concentration of solute, c_X	$c_{\text{X}} = \frac{n_{\text{X}}}{V}$	$V \overset{c_{\text{X}}}{\longleftrightarrow} n_{\text{X}}$

The first quantity serves as a conversion factor relating the other two. A summary of the relationships and conversion factors we have encountered so far is given in Table $3.1.1$.

An incredible variety of problems can be solved using the conversion factors in Table $3.1.1$. Sometimes only one factor is needed, but quite often several are applied in sequence, as in Example 3 in Titrations(opens in new window). In solving such problems, it is necessary first to think your way through, perhaps by writing down a road map showing the relationships among the quantities given in the problem. Then you can apply conversion factors, making sure that the units cancel, and calculate the result.

The examples in these sections should give you some indication of the broad applications of the problem-solving techniques we have developed here. Once you have mastered these techniques, you will be able to do a great many useful computations which are related to problems in the chemical laboratory, in everyday life, and in the general environment. You will find that the same type of calculations, or more complicated problems based on them, will be encountered again and again throughout your study of chemistry and other sciences.

$$\underset{\text{Gasoline}}{2\text{C}_8\text{H}_{12}} + \underset{\text{Air}}{25\text{O}_2} \rightarrow \underset{\begin{array}{c}\text{Carbon}\\\text{dioxide}\end{array}}{16\text{CO}_2} + \underset{\text{Water}}{18\text{H}_2\text{O}}$$

There are a great many circumstances in which you may need to use a balanced equation. For example, you might want to know how much air pollution would occur when 100 metric tons of coal were burned in an electric power plant, how much heat could be obtained from a kilogram of natural gas, or how much vitamin C is really present in a 300-mg tablet. In each instance someone else would probably have determined what reaction takes place, but you would need to use the balanced equation to get the desired information.