Stoichiometry 4

Reactants, Products, and the Mole Ratio – Perfect Together

INFORMATION

Consider the following balanced chemical equation representing an acid-base neutralization reaction:

$$H_2SO_{4\,(aq)} + 2\ NaOH_{\,(aq)} \rightarrow Na_2SO_{4\,(aq)} + 2\ H_2O_{\,(l)}$$

The coefficients in the reaction denote the integer molar quantities required for this reaction to go to **completion** (all reactants are consumed and converted to products). In this reaction, for each mole of acid put into the reaction, 2 moles of base are required consume it all. The resulting products will be 1 mole of salt and 2 moles of water.

The ratio of how much of one substance in a reaction is required to produce or consume another substance in the reaction is called the **mole ratio**. For example, the mole ratio of sodium hydroxide to sodium sulfate is 2:1. or 2/1.

The mole ratio can be used to "convert" one substance in an equation to another using dimensional analysis (sometimes called "factor-label" – see the POGIL entitled **Basic Skills Supplement – Converting Units**).

Typically, a quantity of substance is given in grams, with the intention of determining the quantity of one of the other reactants or products in the reaction. The given quantity of substance can then be converted from grams to moles, then to moles of the other substance, and then to grams (or any other appropriate unit of measure).

For example, for the acid-base neutralization above, imagine that a quantity of 20.0 grams of NaOH is given, and it is desired to determine how much sodium sulfate can be produced it all of the NaOH is consumed. The setup for the conversion would appear like this:

$$\left(\frac{20.0\text{g NaOH}}{1}\right)\left(\frac{1\text{ mol NaOH}}{40.0\text{g NaOH}}\right)\left(\frac{1\text{ mol } Na_2SO_4}{2\text{ mol NaOH}}\right)\left(\frac{142.0\text{g } Na_2SO_4}{1\text{ mol } Na_2SO_4}\right) = 35.5\text{ g } Na_2SO_4$$

This technique can be used for conversion from any substance in an equation to any other substance in an equation – the third term, the mole ratio term, is the critical component of this technique.

A properly written, balanced equation is required for the mole ratio to be correct.

The starting and ending units of measure can be arbitrary, as long as it is possible to convert those units to moles for the purpose of converting around the mole ratio term. Particles, liters of gas at STP, and moles are all viable as starting or ending units.