Introduction

While the interpretation of chemical equations is mainly of use to a chemist (or to a student who intends to pass general chemistry), most people have dealt with a very similar concept in everyday life. Chemical equations are equivalent to recipes.

For example,

2 pkg angel hair pasta+ **½** lb cooked shrimp + **¾** cup chopped green onions + **1½** cup ranch dressing → **6** servings pasta salad

... is similar to

$$\mathbf{4}Fe + \mathbf{3}O_2 \rightarrow \mathbf{2}Fe_2O_3$$

In fact, the chemical equation is easier, since it's more consistent! We don't have to worry about things like what exactly a "package" or a "cup" is.

Interpretation

From balancing equations, we already know one way to interpret the chemical formula, the "molecular" interpretation. This simply means that the coefficients (called **stoichiometric coefficients**) represent formula units - atoms, **molecules**, etc.

$$\mathbf{4}Fe + \mathbf{3}O_2 \rightarrow \mathbf{2}Fe_2O_3$$

... means that 4 atoms of iron react with 3 molecules of O_2 to form 2 formula units of Fe_2O_3.

However, single atoms, molecules, or formula units are far too small to deal with on a real-world scale. This is why we use the mole scale. Anything that's true for 1 atom is true for a dozen of them, and for 6.022×10^{23} of them! This leads us to the "molar" interpretation. **Four moles** of iron react with **three moles** of O_2 to form **two moles** of Fe_2O_3. This interpretation is more useful to us, because four moles of iron is 223 grams of iron - a quantity which we can easily deal with in the lab.

Scaling the chemical "recipe"

You can also think of the coefficients as ratios. Using our example reaction with iron, we can write the ratio:

$$4 \text{ moles Fe} : 3 \text{ moles } O_2 : 2 \text{ moles } Fe_2O_3$$

You can modify to your taste the same way you'd scale a recipe. For example, we can express the ratio above as "1 mole Fe : ¾ mole O_2 : ½ mole Fe_2O_3". We've divided the ratio by four and put it in terms of one mole of iron.

We can actually scale the chemical "recipe" to any arbitrary amount of reagent. For example, let's say we have 0.345 moles of iron and plenty of O_2. We can figure out how much Fe_2O_3 we can make by realizing that for every **four moles** of iron, we can produce **two moles** of Fe_2O_3. This ratio is a conversion factor, and we can use it for dimensional analysis.

$$\mathbf{4\ mol\ Fe = 2\ mol\ Fe_2O_3}$$

$$0.345\ \text{mol Fe} \times \frac{2\ \text{mol}\ Fe_2O_3}{4\ \text{mol Fe}} = 0.173\ \text{mol}\ Fe_2O_3$$

Thus, for every **0.345 moles of iron**, you can produce **0.173 moles of Fe_2O_3**.

You've just learned the heart of **stoichiometry**. By putting this together with your knowledge of the way to relate mass and moles (via the formula weight), you can solve more complex stoichiometry problems.

<u>Summary</u>

In this note pack, you have learned how to take the coefficients from a chemical equation and use them as conversion factors for dimensional analysis. This enables you to convert from moles of one substance in the equation to moles of another substance. You can now calculate how much product you can produce from a given amount of reactant, or you can calculate the amount of reactant you need to produce a given amount of product. It's even possible for you to calculate how much of one reactant you need to completely use up another reactant in a chemical reaction.