Introduction

You're now ready to solve practical chemistry problems. A good example of the type of problem we are going to discuss would be a pharmaceutical company that desires to make a certain amount of a drug. They don't want to waste money buying too much of any raw materials, so they use stoichiometric calculations to calculate the amount of each reagent to buy. They'll want the amount in terms of a mass because bulk chemicals are sold by mass.

What we've done so far

We've discussed the pieces of the stoichiometry puzzle:

1. **Formula weights** (molar masses) can be used to **relate moles of a chemical to mass**.
2. **Balanced chemical equations** can be used to **relate moles of one substance to moles of another**.

A sample problem illustrating the process

The best way to learn the process of relating reagents and products is to simply try and do an actual stoichiometry problem. We will then sum up the steps you need to go through to solve a stoichiometry problem in a more general fashion.

The problem:

What mass of water (g) is produced when 50.0 g of ethane (C_2H_6) are burned in oxygen? How many grams of oxygen are required for the combustion? The reaction is:

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + \mathbf{6}H_2O$$

How do we solve this? What are some possible first steps?

We can calculate formula weights of any compound that we have (or need) **mass information** on:

Compound	Formula weight (g/mol)	Notes
C_2H_6	**30.06904**	Common name: ethane
H_2O	**18.01529**	Common name: water
O_2	**31.9988**	
CO_2	Not Needed	We aren't asked about CO_2 in the problem, so we don't need its formula weight.

(Getting these weights to four significant figures - one more than the number of sig figs in 50.0 g - would be sufficient to solve this problem.)

Using the **formula weights**, convert any given **mass to moles**.

$$50.0\,\text{g}\,C_2H_6 \times \frac{1\,\text{mol}\,C_2H_6}{30.06904\,\text{g}\,C_2H_6} = 1.663\ \text{mol}\,C_2H_6$$

(Wait to round to three significant figures until the end of the calculation. This will minimize roundoff errors in the final answer.)

At this point, we need to take a look at the **balanced chemical equation** to proceed farther.

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

The problem asks us two things:

1. How much water is produced?
2. How much oxygen is required?

We can figure out both of these using the **balanced equation**. How? Remember that the chemical equation is really a **ratio of moles of chemicals**.

- Every 2 mol C_2H_6 form 6 mol H_2O (2:6 ratio , 2 mol C_2H_6 = 6 mol H_2O)
- Every 2 mol C_2H_6 requires 7 mol O_2 (2:7 ratio , 2 mol C_2H_6 = 7 mol O_2)

Remembering that these ratios can be used as conversion factors, we can convert from moles of C_2H_6 (which we have already calculated) to moles of H_2O and O_2 (which we **want**).

$$1.663\,\text{mol}\,C_2H_6 \times \frac{6\,\text{mol}\,H_2O}{2\,\text{mol}\,C_2H_6} = 4.989\ \text{mol}\ H_2O\,\text{produced}$$

$$1.663\,\text{mol}\,C_2H_6 \times \frac{7\,\text{mol}\,O_2}{2\,\text{mol}\,C_2H_6} = 5.820\ \text{mol}\,O_2\,\text{required}$$

We're almost done! We were asked for the mass (not moles), but the mass is easy to find since we know the formula weights of each substance.

$$4.989\ \text{mol}\ H_2O \times \frac{18.01528\,\text{g}\,H_2O}{\text{mol}\ H_2O} = \mathbf{89.9\,g\,H_2O\,produced}$$

$$5.820\ \text{mol}\ O_2 \times \frac{31.9988\ \text{g}\ O_2}{\text{mol}\ O_2} = \mathbf{186\ g\ O_2\ required}$$

We could have answered each one of the problem's two questions using one dimensional analysis setup. The example was split up so we could talk about each individual step. For example:

$$50.0\ \text{g}\ C_2H_6 \times \frac{\text{mol}}{30.07\ \text{g}} \times \frac{6\ \text{mol}\ H_2O}{2\ \text{mol}\ C_2H_6} \times \frac{18.02\ \text{g}}{\text{mol}} = \mathbf{89.9\ g\ H_2O}$$

$$50.0\ \text{g}\ C_2H_6 \times \frac{\text{mol}}{30.07\ \text{g}} \times \frac{7\ \text{mol}\ O_2}{2\ \text{mol}\ C_2H_6} \times \frac{32.00\ \text{g}}{\text{mol}} = \mathbf{186\ g\ O_2}$$

So the problem's really shorter than it looks!

Summary

In this note pack, we discussed how to solve basic stoichiometry problems.

To solve a basic stoichiometry problem (one where you have been given the amount of **one chemical** and been asked about the amounts of other chemicals required or produced), you can follow this procedure to solve the problem:

1. **Convert** the given compound from **mass to moles** using its **formula weight**. (Find the formula weight using a periodic table if necessary.)
2. **Relate** moles of given compound to moles of desired compound using the **balanced chemical equation**.
3. **Convert** the desired compound from **moles to mass** using its **formula weight**.