Stoichiometry

Chemical reactions

- Whenever we do a chemical reaction, we want to have the ability to predict how much we need to use and how much we expect to produce.
- From the mole conversions we can calculate how much we have.
- From a balanced equation we know how much we need in relation to other pieces.
- Ex. $2Fe + 3CuCl_2 \rightarrow 2FeCl_3 + 3Cu$
- 2 atoms of iron plus 3 formula units of copper(II)chloride yields 2 formula units of Iron (III) chloride and 3 atoms of copper.

Putting it together.

- Looking at the same equation we know that the number of atoms in a mole is 6.02×10^{23}, and the number of formula units in a mole is also 6.02×10^{23}.
- Therefore the equation can be reread as 2 moles of iron plus 3 moles of copper (II) chloride yields 2 moles of iron (III) chloride and 3 moles of copper.
- This means that all substances in a balance equation are related to each other through moles.
- The coefficients in the balanced equation represent the numbers of moles, and comparing the coefficients gives a mole ratio.

Steps

1) Whatever I give you for an amount of one substance, convert to moles of that substance.

2) Once in moles of that substance, convert to moles of the other substance (the one that is being asked for in the question) using the coefficients in the balanced equation.

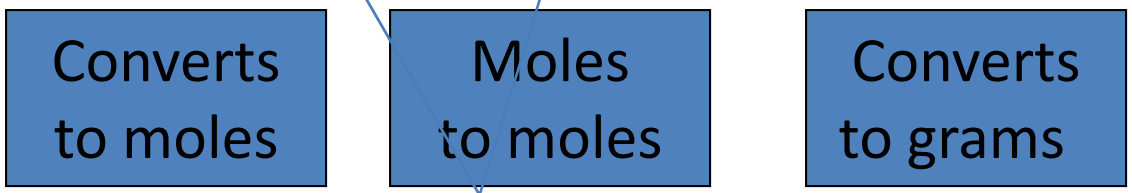
3) Convert you answer to whatever units are asked for.

Reminders: a balanced equation is necessary, if one is not provided, you must come up with it on your own.

All stoichiometry problems require mole conversions, some require two!

$$2H_2 + O_2 \rightarrow 2H_2O$$

- 15.0g of water is produced in the combustion of hydrogen. How many grams of hydrogen are required?



- 15.0g x $\frac{1 \text{ mole}}{18.0 \text{ g}} \times \frac{2 \text{ mol } H_2}{2 \text{ mol } H_2O} \times \frac{2.0 \text{ g}}{1 \text{ mol}} =$

1.67 g hydrogen

Limiting reactants

- In every reaction it is impossible to have the perfect number of reactants necessary to use both of them up.
- Therefore one reactant will run out before the other.
- Once that reactant runs out, the reaction stops and you can't make any more product.
- The first reactant you run out of is called the limiting reactant because it limits how much product you can make.

Determining the limiting reactant

- Some problems give an amount of one reactant and tell you that the other is excess. That's great because then you know the limiter is the amount you are given.
- If you are given two quantities of reactants, then you need to determine which one the limiter is.
- This is important because the limiting reactant determines the maximum amount of each product that can be formed as well as how much of the other reactant will be used.
- You can never make more than what the limiter allows.

Two methods

- Method one: I have vs. I need
  - Figure out how many moles of each reactant you have.
  - Do stoichiometry from the amount of moles in one reactant to the amount of the other to find out how much you need.
  - Compare what you have with what you need. If you don't have enough, that's the limiter, if you have more, the other is the limiter.
- Method two: How much can you make
  - Do stoichiometry from each reactant to find out the amount of the same product you can make.
  - The smaller amount of product is the right answer.

Percent Yield

- The stoichiometry tells you how much product you should get from the lab.
- That is the theoretical yield (in theory you should get it!)
- When you do the lab you don't always get what you want due to error. What you do get is your experiemental yield.

$$\frac{\text{Experimental yield}}{\text{Theoretical yield}} \times 100 = \%\ \text{yield}$$

Allowed percents

- Percent yield can be done in any unit. It can be grams, moles, liters, particles etc.
- What ever unit you experimental yield is in is what your theoretical yield should be found in.
- If your percent is below 100, it means you lost some of your sample.
- If it is above 100, it means you have something unwanted mixed with your sample.
- Both can happen, so all percents are allowed!

Recognizing problem types

- If you are given an amount of a substance and asked to find a different unit for the same substance = mole conversion.
- If you want to find an amount of one piece of a substance in the whole substance = % composition or mole conversion.
- If you are given an amount of 1 reactant and want an amount of 1 product with the other reactant in excess = simple stoichiometry.
- If you are given two amounts of reactants = limiting reactant.
- If you are given an amount of a reactant and an amount of product = % yield (usually says it anyway)