Make sure the chemical equation is balanced
Everything gets messed up if you don't pay attention to this little detail

Stoichiometry is a weird word. It sort of means "look at how the molecules must combine in the chemical reaction," like:

$$3\ A + 2\ B \rightarrow C + 4\ D$$

The stoichiometry is that three molecules of A react with two molecules of B to form a molecule of C and four molecules of D. Now, remember that molecules react with molecules That is why you have to use moles instead of mass. Moles are a unit of quantity. (1 mole = 6.02×10^{23} molecules)

We can't use grams because grams are a unit of mass and chemical equations aren't between masses, they are between molecules. You have to, have to, have to, HAVE TO be very good at converting between grams and moles.

$$\text{moles} = \frac{\text{grams}}{\text{molar mass}}$$

The central idea to chemical reaction stoichiometry is the mole ratio. If we know all the mole ratios and we know how much of one species gets used up or formed then you know how much of all species that get used up or formed.

Mole ratios are just the ratios of stoichiometric coefficients.

For example: $\frac{\text{moles A}}{\text{moles B}} = \frac{3}{2}$ etc.

Limiting Reactant Problems

Limiting reactant problems build on this idea of the mole ratio because the extent of the reaction is based upon the amount of one reactant that gets completely consumed (the limiting reactant). To find which reactant is limiting just look at the moles of all the reactants present (convert from grams if necessary), and use mole ratios to see which reactant is limiting (used up first) and which are in excess. Excess reactants aren't completely consumed, so you have to remember to include the unconsumed part in the products. For example:

40 grams of O_2 reacts with 20 grams of CH_4 according to the reaction

$$CH_4 + 2\ O_2 \text{ -----> } CO_2 + 2\ H_2O$$

What is the limiting reactant?

moles CH_4 = 20g/16g/mol = 1.25 mol ---> To fully react would require 1.25 (2 /1) = 2.5 moles O_2

moles O_2 = 40g/32g/mol = 1.125 mol <---- There's not enough O_2 so it's the limiting reactant.

You also need to know some terminology and definitions:

Theoretical yield = amount of products obtained if the reaction goes to completion

Actual yield = whatever you get from a specified extent of reaction

Percent yield = (actual yield/theoretical yield) x 100%

Stoichiometry: Student Review Notes

Percent composition problems are ever-present on the AP. You have to know how to do them. The idea behind them is that if you can break a molecule apart and look at the elements that compose it, you should be able to figure out, at the very least, the empirical formula. If you know how many moles your sample was or if you know the molecular weight of the molecule, you should also be able to determine the molecular formula.

Remember the difference between these two things: the empirical formula gives the lowest whole number ratio of all the elements in a molecule, and the molecular formula gives the actual makeup of the molecule. Okay, so this is how they usually proceed:

1. From some kind of a chemical analysis you will be given how much of each element there was in some molecule whose chemical formula you are supposed to figure out.
   (Be careful about the information you are given because you can also get extra stuff, like, if something was burned in the air, there will be N_2 present because air is a mixture of oxygen, 21%, and nitrogen, 79%.)

2. What you do is find the moles (sometimes grams then moles) of each element in the analysis and then find the lowest integer ratio between them (by dividing through by the smallest number of moles). That ratio for each element will be the subscripts for the empirical formula.

3. If you're given the molecular mass you can divide it by the empirical formula weight to find the molecular formula; that is, how many empirical formulas do you need to make up the molecular formula.

All this is easier to show in an example than to describe:

A compound contains carbon, hydrogen and zinc. When burned in oxygen the products are 21.88 g of ZnO, 47.52 g of CO_2 and 24.3 g H_2O.

(A) What is the empirical formula of the compound?

(B) If the molecular weight = 617, what is the molecular formula?

(A)

Element	Molecule	Mass of Molecule	Mass Fraction of Element	Mass Element	Moles Element	Lowest Integer Ratio	Emperical Formula
Zn	ZnO	21.98	.8	17.6	.27	1	
C	CO_2	47.52	.27	13	1.1	4	ZnC_4H_{10}
H	H_2O	24.3	.11	2.7	2.7	10	

1st key step. You have to figure out the mass of each element that was in the molecule

Convert to moles

Divide through by the smallest number of moles (.27)

(B)

$$\text{Molecular formula: } \frac{617}{123.39} = 5 \qquad \text{so it's } Zn_5C_{20}H_{50}$$