Chemical reactions and balancing equations

Now we know what basic ionic compound formulas look like: cation/anion and the amount of each ion. The next step is to explore the actual reaction that takes place during the formation of the ionic compound. For example:

Mg^{2+} + S^{2-} = MgS magnesium sulfide

The two ions are known as the reactants of a chemical reaction, while the resulting compound is the product. We can write this combination in words:

Magnesium reacts with sulfur to produce magnesium sulfide

In order to properly represent the chemical reaction scientists **use chemical equations** that are a symbolic form of the word version above:

$$Mg + S \rightarrow MgS$$

	R	P
Mg	1	1
S	1	1

Once you have the basic equation you must make sure **the law of conservation of matter/mass** is not violated. You can do this by counting all the atoms of each element present on each side of the equation → → There is one atom of each element on each side of the equation so it is properly representing what is taking place during the reaction.

Hydrogen gas combusts with oxygen gas to produce water:

$$H_{2(g)} + O_{2(g)} \rightarrow H_2O_{(l)}$$

	R	P
H	~~2~~ 4	~~2~~ 4
O	2	~~1~~ 2

☑ $$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$$

In this case the equation violates the law of conservation of matter since one oxygen atom is lost in the reaction. This problem must be corrected by balancing the equation. This process is similar to forming ionic compounds because you can only balance by multiplying the number of each reactant or product without changing the actual chemical makeup of any of them. Instead of using subscripts as in a chemical formula we use **coefficients** placed before each substance as necessary. The coefficient multiplies all atoms located within the substance it proceeds. You cannot simply change H_2O to H_2O_2 since this changes the substance itself.

The coefficients can be worded into the reaction:

> 2 molecules of hydrogen gas combust with 1 molecule of oxygen gas to produce 2 molecules of water.

The coefficients can also be used to indicate a large number of particles called a **mole**:

> 2 moles of hydrogen gas combust with 1 mole of oxygen gas to produce 2 moles of water.

Remember that a mole is simply a unit representing **6.02×10^{23}** of anything. (e.g. a pair of shoes, a dozen donuts) One mole of water has a mass of about 18 g and a volume of 18 mL. This unit is equal to **Avagadro's number** and is very useful in "human scale" chemistry. Let's face it, we do not work with individual atoms but rather large collections of them.

There are five main types of chemical reactions which you should be able to identify (notice the balance of each equation):

1. **Synthesis** – multiple reactants producing *one* product.

$$2Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$$

2. **Decomposition** – *one* reactant producing multiple products.

$$2H_2O_{(l)} \rightarrow 2H_{2(g)} + O_{2(g)}$$

3. **Single displacement** – one element replaces another in a compound to produce an element and a compound.

$$Mg_{(s)} + 2AgNO_{3(aq)} \rightarrow Mg(NO_3)_{2(aq)} + 2Ag_{(s)}$$

4. **Double displacement** – two reacting compounds where one element from one compound will replace another element in the other compound.

$$2KI_{(aq)} + Pb(NO_3)_{2(aq)} \rightarrow 2KNO_{3(aq)} + PbI_{2(s)}$$

5. **Combusion -** the reaction of oxygen gas with an compound containing carbon and hydrogen (hydrocarbon). The products are always carbon dioxide and water

Written using generic symbols, it is usually shown as:

$$C_xH_y + O_2 \text{ ---> } CO_2 + H_2O$$

A common synonym for combustion is burn.