

## Writing Chemical Formulas

Chemical formulas are a useful way to convey information about a compound such as:

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- 

When writing chemical formula, they must be ordered such that:

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- 

**Example:**

Elements that make up the compound →

Ratio of each atom →

Total number of atoms →

A number in front of the compound ( ) represents the number of compounds.

**Example:**

The chemical formula has different meanings depending on the type of forces holding together the compound:

**Covalent Compounds -**

**Ionic Compounds -**

Every element has a certain capacity to combine with other atoms. A number is assigned to each element to describe its bonding capacity. This number is called the , or .

**Group 1A** - the alkali metals have \_\_\_ valence electron. Generally they will \_\_\_ this electron to become a \_\_\_ with a charge of \_\_\_. Their oxidation state is \_\_\_.

**Group 2A** - the alkaline earth metals have \_\_\_ valence electrons. Generally they will \_\_\_ both of these electrons to become a \_\_\_ with a charge of \_\_\_. Their oxidation state is \_\_\_.

**Group 7A** - the halogens have \_\_\_ valence electrons. Generally they will \_\_\_ this electron and become an \_\_\_ with a charge of \_\_\_. Their oxidation state is \_\_\_.

*Instead of drawing Lewis structures, we can use the oxidation states of atoms to determine the chemical formula. Oxidation states can be determined by looking at your Periodic Tables.*

## Chemical Reactions

A chemical reaction can be written in a number of different forms:

Chemical Equation

A description of a chemical reaction using \_\_\_\_\_, not \_\_\_\_\_, where:

- The \_\_\_\_\_ are written first
- The \_\_\_\_\_ are written second
- The state for each element or compound is indicated in brackets - \_\_\_\_\_ (s), \_\_\_\_\_ (l), \_\_\_\_\_ (g), \_\_\_\_\_ (aq)
- Reactants and products are separated by an arrow (→) - read as "\_\_\_\_\_"

*Example:*

Word Equation

The elements and compounds that are reacting are written first followed by the products. States are included in the description.

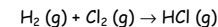
*Example:*

### Skeleton Equation

The Law of Conservation of Mass states that matter cannot be \_\_\_\_\_ or \_\_\_\_\_; it can only be \_\_\_\_\_ from one form to another. Therefore the \_\_\_\_\_ in the reactants must \_\_\_\_\_ the number of atoms in the products.

A skeleton equation is an unbalanced equation that \_\_\_\_\_ follow the Conservation of Mass. The number of atoms on the left side (reactants) of the chemical equation \_\_\_\_\_ equal the number of atoms on the right side (products).

*Example:*



On the reactant side there is a total of \_\_\_ atoms (\_\_\_ hydrogen and \_\_\_ chlorine)

On the product side there is a total of \_\_\_ atoms (\_\_\_ hydrogen and \_\_\_ chlorine)

### Balanced Chemical Equation

An equation that follows the Law of Conservation of Mass. The number of atoms on the reactant side equals the atoms on the product side. In most chemical equations, numbers placed in front of the elements or compounds ( ) are required to balance the equation.

*Example:*

On the reactant side there is a total of \_\_\_ atoms (\_\_\_ hydrogen and \_\_\_ chlorine)

On the product side there is a total of \_\_\_ atoms (\_\_\_ hydrogen and \_\_\_ chlorine)

When there is a coefficient of "\_\_\_", it is typically not written:  $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$

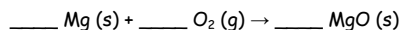
# Balancing Equations

All chemical equations must be balanced so that they are consistent with the Law of Conservation of Mass.

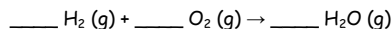
Here are some suggestions for balancing equations:

1. When balancing equations, always start with the "ugliest" molecule first (polyatomics).
2. To balance, place the desired number (coefficient) in front of the element or compound. Never split-up a compound and never change the subscripts in the chemical formula.
3. It is often useful to balance the diatomic molecules, if they are present, last.
4. Creating a chart to keep track of the type and number of each atom on the reactant and product side of the equation can make balancing easier.
5. Make sure to always recheck the final balanced equation.

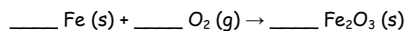
**Examples:**



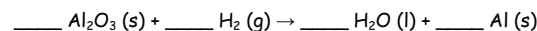
Atoms	Reactants	Products
Mg		
O		



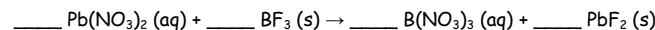
Atoms	Reactants	Products
H		
O		



Atoms	Reactants	Products
Fe		
O		

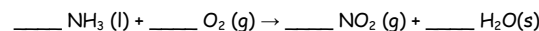


Atoms	Reactants	Products
Al		
O		
H		

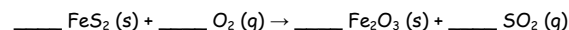


Atoms	Reactants	Products
Pb		
NO <sub>3</sub>		
B		
F		

*Sometimes to balance an equation, fractions must be used. Fractions are not to be left in the final balanced equation, as it is impossible to have part of an atom. To get rid of the fraction, multiply every element or compound in the equation by the denominator of the fraction (i.e. If you use  $\frac{1}{2}$  as a coefficient, then multiply by 2).*



Atoms	Reactants	Products
N		
H		
O		



Atoms	Reactants	Products
Fe		
S		
O		

*Balancing chemical equations becomes increasingly more difficult when you are given the reaction as a word equation. To balance the equation, you must first convert the elements and/or compounds into their correct chemical formula. Even the slightest mistake will make your equation incorrect and could possibly create an equation that is impossible to balance. Be careful, and make sure to always check your work.*

*Write out a balanced chemical equation for the following:*

Oxygen gas reacts with solid aluminum sulfide to produce solid aluminum oxide and sulfur dioxide gas.

# Types of Chemical Reactions

It is important to be able to classify chemical reactions as it enables scientists to predict possible products or outcomes. For example, think of appropriate storage of chemicals...

Why are some chemicals stored in dark glass jars?

Why is it inappropriate to store propane tanks in areas that are not air-conditioned?

Below are 5 major categories of chemical reactions:

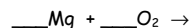
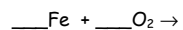
## 1. Synthesis

A synthesis reaction occurs when 2 or more \_\_\_\_\_ combine to form a new \_\_\_\_\_ or \_\_\_\_\_.

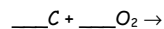
The general equation for a synthesis reaction is:

*Specific types of synthesis reactions:*

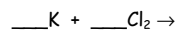
a) \_\_\_\_\_ react with \_\_\_\_\_ to produce a \_\_\_\_\_



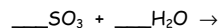
b) A \_\_\_\_\_ reacts with \_\_\_\_\_ to produce \_\_\_\_\_



c) A \_\_\_\_\_ and \_\_\_\_\_ combine to form a \_\_\_\_\_



d) \_\_\_\_\_ react with \_\_\_\_\_ to produce an \_\_\_\_\_



e) \_\_\_\_\_ react with \_\_\_\_\_ to produce a \_\_\_\_\_



## 2. Decomposition

A decomposition reaction is the reverse to a synthesis reaction; a compound \_\_\_\_\_ into \_\_\_\_\_ or other \_\_\_\_\_

The general equation for a decomposition reaction is:

Example:  $\text{___H}_2\text{O}_2 \rightarrow$

Typically, some form of \_\_\_\_\_ or type of \_\_\_\_\_ is needed to initiate a decomposition reaction.

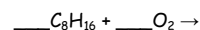
A catalyst is a substance that controls the \_\_\_\_\_ of a reaction, without being \_\_\_\_\_ during the reaction or affecting the overall \_\_\_\_\_.

## 3. Combustion Reactions

Combustion reactions typically involve a \_\_\_\_\_ or \_\_\_\_\_ reacting with \_\_\_\_\_ to form the most common \_\_\_\_\_ of the elements that make up that compound. There are 2 types of combustion reactions; \_\_\_\_\_ and \_\_\_\_\_.

\_\_\_\_\_ combustion occurs in the presence of \_\_\_\_\_. The reaction is very "\_\_\_\_\_" with \_\_\_\_\_ and \_\_\_\_\_ being the only products.

Example:  $\text{___CH}_4 + \text{___O}_2 \rightarrow$



\_\_\_\_\_ combustion occurs in the presence of an \_\_\_\_\_ of \_\_\_\_\_ such as the \_\_\_\_\_. The reaction is very "\_\_\_\_\_" with various products, which can include \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_ (solid carbon).

Example:  $\text{___CH}_4 + \text{___O}_2 \rightarrow$

*Note: \_\_\_\_\_ and \_\_\_\_\_ are also produced in both of these types of reactions*

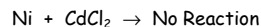
## 4. Single Displacement Reaction

A single Displacement reaction occurs when one \_\_\_\_\_ in a compound is \_\_\_\_\_ by another \_\_\_\_\_. This can occur in 2 ways, a \_\_\_\_\_ can replace a \_\_\_\_\_ or a \_\_\_\_\_ can replace a \_\_\_\_\_.

The general equation for a single displacement reaction is:

Examples:

**Question:** How do you know that a single displacement reaction can occur or do they always occur? For example, explain why the two above reactions occur but the following reaction does not?



In order to determine if an element will displace another element in a single displacement reaction you must refer to an \_\_\_\_\_. Conveniently there is an activity series on **page 130** of your text.

If one element is \_\_\_\_\_ another element in the compound, it can be \_\_\_\_\_ and a single displacement reaction will occur.

Using the activity series below, we can explain the previous examples:

Magnesium	
Zinc	In example 1 Mg is _____ Zn, therefore Zn _____ be bumped out
Cadmium	
Cobalt	In example 3 Ni is _____ Cd, therefore Cd _____ be bumped out
Nickel	
Copper	In example 2 Cu is _____ Ag, therefore Ag _____ be bumped out
Silver	

Some helpful hints when solving single displacement reactions:

- >
- >
- >

**Non-metals, typically \_\_\_\_\_ are involved in Single Displacement Reactions. To determine who can bump out whom, you must refer to the \_\_\_\_\_ on page 131 of your text.**

Predict if the following reactions will occur and what the products are:

Fluorine	
Chlorine	$\text{I}_2 + \text{NaCl} \rightarrow$
Bromine	
Iodine	$\text{F}_2 + \text{KBr} \rightarrow$

## 5. Double Displacement Reactions

A double displacement reaction occurs when there is an \_\_\_\_\_ of \_\_\_\_\_ between two \_\_\_\_\_ compounds.

The general equation for a double displacement reaction is:

In the general equation, A and C are \_\_\_\_\_ (written first) and B and D are \_\_\_\_\_.

Evidence that a double displacement reaction has occurred:

- A)
- B)
- C)

### A) Precipitate

- > A precipitate is an \_\_\_\_\_ that obviously will not \_\_\_\_\_ in solution
- > It looks like a \_\_\_\_\_ that won't go away
- > You can determine if a precipitate will form by looking at a \_\_\_\_\_

The following symbols are found in a solubility chart:

S -

SS -

I -

Example:  $\text{NaCl} + \text{AgNO}_3 \rightarrow$

*Note: if both products are \_\_\_\_\_ (ie. neither one forms a ppt), the result is \_\_\_\_\_ (NR). The solution produces \_\_\_\_\_ that float around.*

### B) Gas is Produced

When a gas is produced due to a double displacement reaction it is mainly due to the fact that one of the products created has \_\_\_\_\_.

Example:  $\text{Na}_2\text{CO}_3 + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{CO}_3$  (this compound will decompose)

Overall Rx:

### C) Molecular Compound is Produced

This is referring to the fact that \_\_\_\_\_ may be produced. Water is evidence of an \_\_\_\_\_ reaction (\_\_\_\_\_), which is a type of double displacement reactions. Since water is a clear, colourless, liquid, it typically cannot be seen by looking at the reaction. To determine if water is present, it has to be tested using \_\_\_\_\_ or \_\_\_\_\_.