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:

$$H_2\,(g) + Cl_2\,(g) \rightarrow HCl\,(g)$$

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: $H_2\,(g) + Cl_2\,(g) \rightarrow 2HCl\,(g)$

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 from 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:

____ Mg (s) + ____ O_2 (g) → ____ MgO (s)

Atoms	Reactants	Products
Mg		
O		

____ H_2 (g) + ____ O_2 (g) → ____ H_2O (g)

Atoms	Reactants	Products
H		
O		

____ Fe (s) + ____ O_2 (g) → ____ Fe_2O_3 (s)

Atoms	Reactants	Products
Fe		
O		

____ Al_2O_3 (s) + ____ H_2 (g) → ____ H_2O (l) + ____ Al (s)

Atoms	Reactants	Products
Al		
O		
H		

____ $Pb(NO_3)_2$ (aq) + ____ BF_3 (s) → ____ $B(NO_3)_3$ (aq) + ____ PbF_2 (s)

Atoms	Reactants	Products
Pb		
NO_3		
B		
F		

Sometimes to balance an equation, fractions must be used. Fractions are not to be left in the final balanced equation, as it 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 ½ as a coefficient, then multiply by 2).

____ NH_3 (l) + ____ O_2 (g) → ____ NO_2 (g) + ____ H_2O(s)

Atoms	Reactants	Products
N		
H		
O		

____ FeS_2 (s) + ____ O_2 (g) → ____ Fe_2O_3 (s) + ____ SO_2 (g)

Atoms	Reactants	Products
Fe		
S		
O		

Balancing chemical equations becomes increasing 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 you 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 _____

___Fe + ___O_2 →

___Mg + ___O_2 →

b) A _____ reacts with _____ to produce _____

___C + ___O_2 →

c) A _____ and _____ combine to form a _____

___K + ___Cl_2 →

d) _____ react with _____ to produce an _____

___SO_3 + ___H_2O →

e) _____ react with _____ to produce a _____

___CaO + ___H_2O →

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: ___H_2O_2 →

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: ___CH_4 + ___O_2 →

___C_8H_{16} + ___O_2 →

_____ 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: ___CH_4 + ___O_2 →

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?

$Ni + CdCl_2 \rightarrow$ No Reaction

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:

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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 — $I_2 + NaCl \rightarrow$
Bromine
Iodine — $F_2 + KBr \rightarrow$

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: $NaCl + AgNO_3 \rightarrow$

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: $Na_2CO_3 + HCl \rightarrow NaCl + H_2CO_3$ (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 _____.