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Describing Chemical Reactions

When chemicals form _____ substances, a chemical reaction has occurred. E.g., the gases hydrogen and oxygen mix and are ignited, which produces a new compound – _____.

We call the original chemicals, in this case the hydrogen and oxygen _____, while the chemicals that we end up with (in this example, water) are called _____.

Chemical Equations:

To save time (and ink), chemists have a quick way to _____ a chemical reaction. These summaries are called _____ _____. They follow a specific format:

Reactants → Products

The reactants are always found on the _____ side of the equation, while the products are always on the _____. The arrow in the equation is like an equal sign in math and means '_____ _____' or '_____'. Sometimes there will be more than one reactant combining, in this situation the reactants are separated by a _____ sign which means 'reacting with':

Reactant + Reactant → Product

In some reactions, one reactant may break down into multiple _____, in this situation the products are separated by a plus sign which means '_____':

Reactant → Product + Product

In many cases, there are multiple _____ and _____ in the same reaction. These are written using the same symbols as described above:

Reactant + Reactant → Product + Product

Word Equations

Chemical reactions can be represented using a word equation, where the _____ _____ of the chemicals involved are written out. For example:

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Magnesium reacts with oxygen to form magnesium oxide is written as:

Magnesium + Oxygen → Magnesium oxide

Activity 1:

Rewrite each of the following reactions as word equations:

1. Hydrogen reacts with oxygen to form water

2. Sodium reacts with hydrochloric acid to form sodium chloride and hydrogen.

3. Copper oxide reacts with carbon to form copper and carbon dioxide.

Chemical Equations using Formula

Chemical formula equations are an even shorter way to summarize a reaction. Some of the common formulae for chemicals you will use in this class are given in the table below:

Name	Chemical Formula
Water	H_20
Hydrochloric acid	HCl
Carbon dioxide	CO_2
Sodium Chloride	NaCl
Sodium hydroxide	NaOH
Hydrogen peroxide	H_2O_2
Methane	CH_4

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Activity 2:

Write the following reactions as chemical formula equations.

1. Hydrochloric acid and Sodium hydroxide give Sodium chloride and Water.

2. Coal (carbon) reacts with oxygen gas to produce carbon dioxide.

The Law of Conservation of Mass

Nearly 2500 years ago early scientists stated that "everything must come from something". This theory has been further developed by modern scientists into what is referred to today as "The Law of Conservation of _____". It tells us that matter cannot be _____ nor _____".

This theory is proven each time you bake a cake. If you were to weigh the _____ of the cake before baking it, and then reweigh it after it was cooked, the mass would be the _____. This is because nothing is lost during the baking process and the ingredients recombine to become the cake.

The same is true for chemical reactions, the number of _____ in the reactants (the _____ side of the equation) will always _____ the number of atoms in the products (the _____ side of the equation). Scientists show this by 'balancing' their chemical equations. They do this by adjusting the _____ for the chemicals involved so that the numbers of _____ and _____ are equal. An example of this is shown below.

Example: Hydrogen gas reacting with oxygen gas to make water.

The word equation for this reaction is:

Hydrogen + Oxygen → Water

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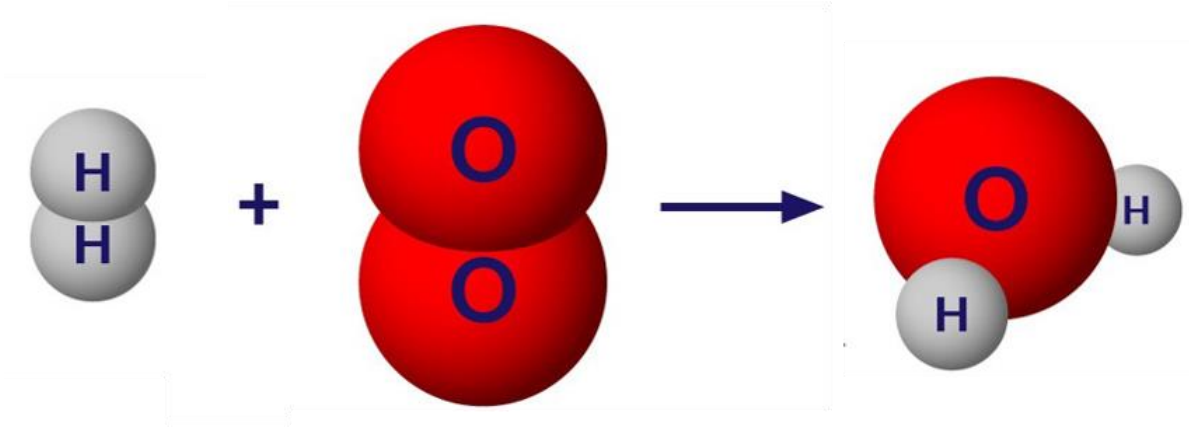
If we were to draw the compounds out, it would look like this:



As a chemical equation it would therefore be:

H_2 + O_2 → H_2O

___ atoms of hydrogen

____ atoms of oxygen

____ atoms of hydrogen and ____ atom of oxygen

This equation is _____ as it has a total of _____ atoms on the reacting side and only _____ on the product side of the equation - the product side is missing _____ oxygen atom! The steps of how to balance chemical equations are outlined in the next section.

Balancing Chemical Equations

To balance a chemical equation there are two rules that must be obeyed.

1. The number of _____ on one side of the equation must _____ the number of atoms on the other side.
2. Only ever adjust the _____ (large numbers in front of a chemical), not the _____ (small numbers in a chemical). See the diagram below to see which is which!

Coefficient

$2H_2O$

Subscript

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To fix the water example from above we need to:

1. Count the number of atoms of each type on both sides of the equation and identify which atoms are balanced and which are not. The easiest way to do this is using a grid:

$$H_2 + O_2 \rightarrow H_2O$$

	Reactants (left side)	Products (right side)	Balanced?
Hydrogen (H)			
Oxygen (O)			
Total:			

2. Start by adding coefficients to the compounds in the equation which are not balanced.
   In this example, oxygen is not balanced. There are two atoms of oxygen on the reactant side and only one on the product side. Therefore, we need to add another oxygen to the product side. We do this by adding a 2 in front of the water molecule, to give two water molecules.

$$H_2 + O_2 \rightarrow \_\_\_\_H_2O$$

3. Review the numbers of atoms on each side of the reaction using the adjusted equation and the grid from step 1:

	Reactants (left side)	Products (right side)	Balanced?
Hydrogen (H)			
Oxygen (O)			
Total:			

4. If both sides of the reaction are still unbalanced, continue to add coefficients to the equation.
   In this example, the hydrogen gas on the reactant side is now unbalanced and therefore requires a 2 to be added in front of it to give us two molecules of hydrogen gas.

$$\_\_\_\_H_2 + O_2 \rightarrow \_\_\_\_H_2O$$

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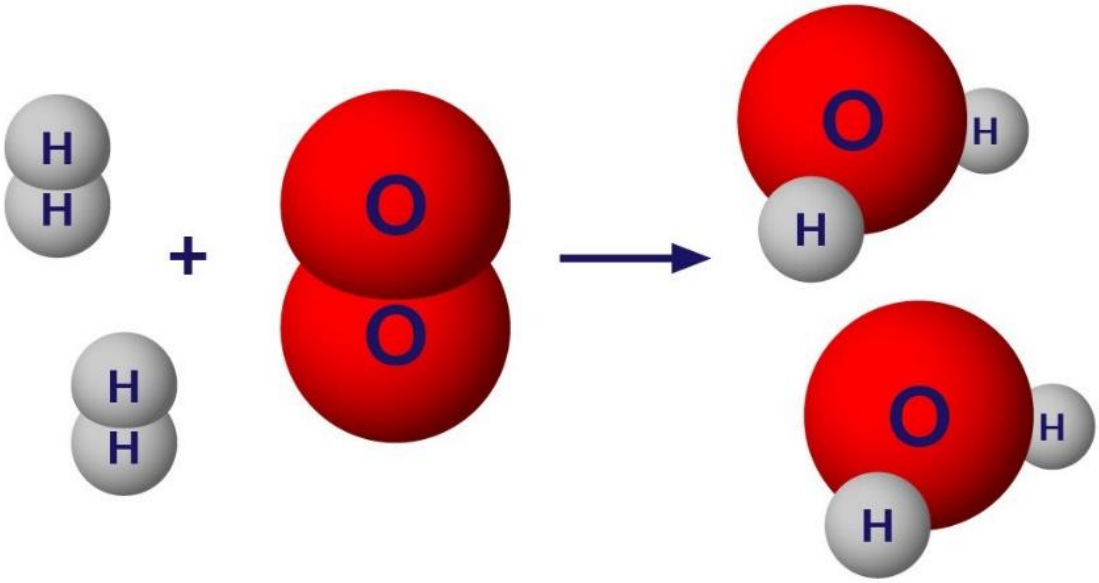
5. Review the grid to check each side of the equation is balanced using the amended equation:

$$\_\_\_H_2 + O_2 \rightarrow \_\_\_ H_2O$$

	Reactants (left side)	Products (right side)	Balanced?
Hydrogen (H)			
Oxygen (O)			
Total:			

As a correctly balanced chemical equation, the reaction to form water will look like this:



$2H_2$ + O_2 → $2H_2O$

2 x 2 atoms of hydrogen = ___ in total.

____ atoms of oxygen in total.

____ atoms of hydrogen and ____ atoms of oxygen

_____ atoms in total

_____ atoms in total

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Activity 3:

Balance the following chemical equations:

1. $C + H_2 \rightarrow CH_4$

   C = ___ ___

   H= ___ ___

   Balanced equation:

2. $Zn + O_2 \rightarrow ZnO$

   Zn = ____ ___

   O = ___ ___

   Balanced equation:

3. $H_2 + Cl_2 \rightarrow HCl$

   H =___ ___

   Cl = ___ ___

   Balanced equation:

4. $Mg + Cl_2 \rightarrow MgCl_2$

   Mg = __ ___

   Cl = ___ ___

   Balanced equation:

5. $K + I_2 \rightarrow KI$

   K = ___ ___

   I = ___ ___

   Balanced equation: