Balancing Chemical Equations

What goes in must come out!

Objectives

- Learn the steps to balancing chemical equations.
- Take notes to help you understand.
- Test yourself with a set of equations to balance.
- Enter your own equations to see if they balance.

Law of Conservation of Mass

You need to remember this law!

- The Law of Conservation of Mass states: ***that mass is neither created nor destroyed in any chemical reaction***. Therefore balancing of equations requires the same number of atoms on both sides of a chemical reaction.
- The number of atoms in the *Reactants* must equal the Number of atoms in the *Products*

Chemical Equations

Because of the principle of the *Conservation of Matter,*

an *equation must be balanced.*

It must have the same number of atoms of the same kind on both sides.

Lavoisier, 1788

Law of Conservation of Mass

- The mass of all the **reactants** (the substances going into a reaction) must equal the mass of the **products** (the substances produced by the reaction).

- Reactant + Reactant = Product

A simple equation, such as the synthesis of Iron (II) sulfide,

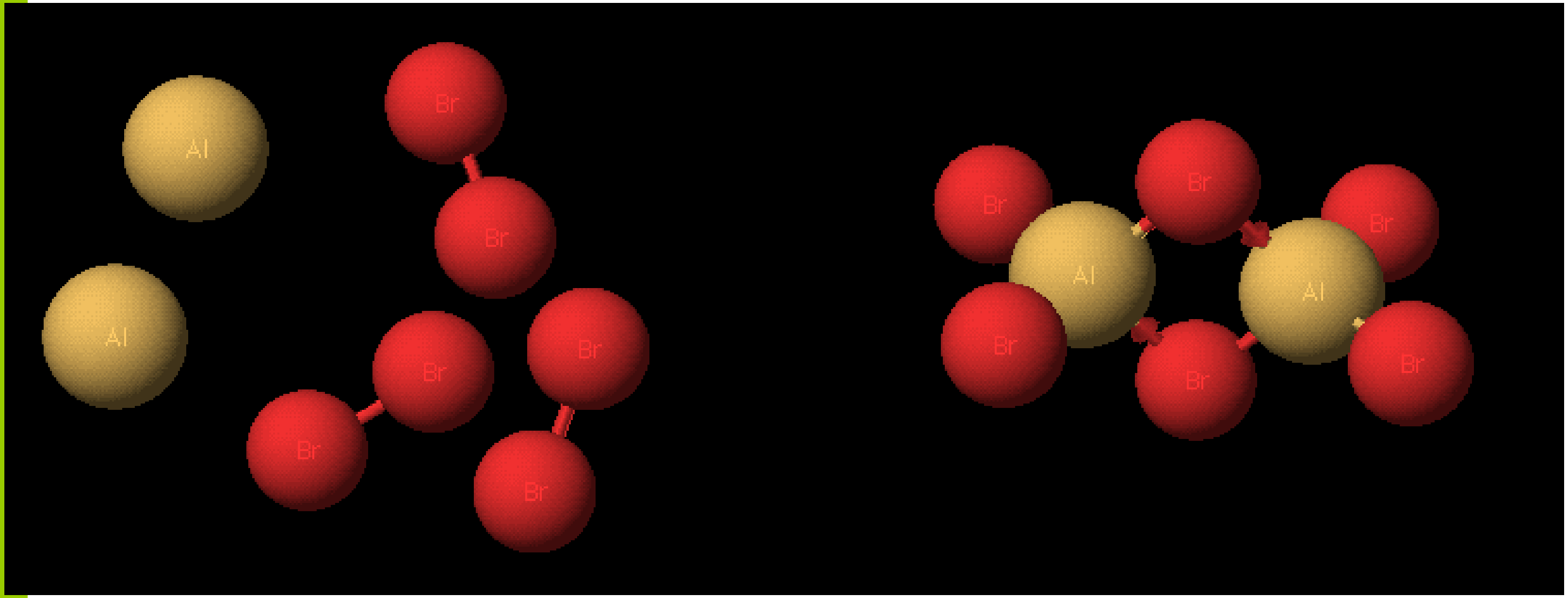
- iron + sulfur $\longrightarrow$ Iron (II) sulfide
- Fe + S $\longrightarrow$ FeS
- Note that in a chemical equation, by convention, we use the arrow " $\longrightarrow$ " instead of the equals " = ".

- The last stage is to put in state of matter symbols, (s, *l*, g, aq), as appropriate (solid, liquid, gas, aqueous or dissolved in water)

- $Fe_{(s)} + S_{(s)} \longrightarrow FeS_{(s)}$

Balancing Equations

$\underline{2}$ Al(s) + $\underline{3}$ Br_2(l) ---> ___ Al_2Br_6(s)

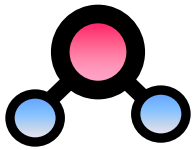


Steps to Balancing a Chemical Equation

1. Start balancing all elements except for H and O.
2. Balance the species that occur once on each side of the equation.
3. Balance polyatomic ions as one group.
4. (OH^-, SO_4^{2-}, SO_3^{2-}, PO_4^{3-}, CO_3^{2-}, ClO^-,
5. Balance Hydrogen
6. Balance O

Balancing Chemical Equations

An easier way



First you need an equation with the correct "formulae" ……. You'll probably be given this in the question

Just like this one

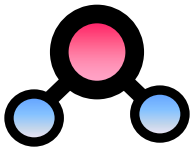
$$Mg + O_2 \rightarrow MgO$$

Then all you do is list the atoms that are involved on each side of the arrow

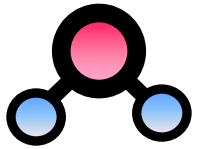
$$Mg + O_2 \rightarrow MgO$$

Mg ***Mg***

O ***O***



Then start balancing:



[1] Just count up the atoms on each side

$$Mg + O_2 \rightarrow MgO$$

1	Mg	1
2	O	1

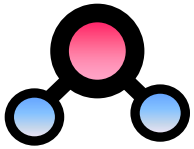
[2] The numbers aren't balanced so then add "BIG" numbers to make up for any shortages

$$Mg + O_2 \rightarrow 2\ MgO$$

1	Mg	~~1~~ 2
2	O	~~1~~ 2

And adjust totals

But the numbers still aren't equal, so add another "BIG" number



$$2\ Mg + O_2 \rightarrow 2\ MgO$$

2	~~1~~	Mg	2
	2	O	2

And adjust totals again

NOW BOTH SIDES HAVE EQUAL NUMBERS OF ATOMS

WE SAY THAT THE EQUATION IS BALANCED!!

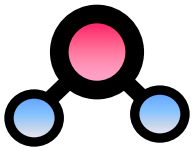
Try to balance these equations using the same method:

[1] $Na + Cl_2 \rightarrow NaCl$

[2] $CH_4 + O_2 \rightarrow CO_2 + H_2O$

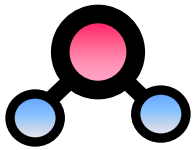
[3] $Li + HNO_3 \rightarrow LiNO_3 + H_2$

[4] $Al + O_2 \rightarrow Al_2O_3$



How did you get on??

Here are the answers:



[1] $2\ Na + Cl_2 \rightarrow 2\ NaCl$

[2] $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$

[3] $2\ Li + 2\ HNO_3 \rightarrow 2\ LiNO_3 + H_2$

[4] $4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$

Example

- $NH_3 + O_2 \longrightarrow NO + H_2O$

  Reactants *Products*

- N appears once on both sides in equal numbers, so the coefficient for NH_3 is the same as for NO.

Example: $NH_3 + O2 \longrightarrow NO + H_2O$

- Next look at H which appears only once on each side but has different numbers of atoms, 3 on the left and 2 on the right. The least common multiple of 3 and 2 is 6, so rewrite the equation to get 6 atoms of H on both sides:
- $2NH_3 + O_2 \longrightarrow NO + 3H_2O$

Example: $\mathbf{2NH_3 + O2 \longrightarrow NO + 3H_2O}$

- There are 2 oxygen atoms on the left and 5 on the right — the least common multiple of 2 and 5 is 10, so rewrite the equation as:

- $2NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$

Now count the atoms on each side:

- $2NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$
- Write them out keeping them on the appropriate side of the chemical equation
- 2 N **(nitrogen atoms)** 4 N **(nitrogen atoms)**
- 6 H **(hydrogen atoms)** 12 H **(hydrogen atoms)**
- 10 O **(oxygen atoms)** 10 O **(oxygen atoms)**
- This shows the equation not to be balanced ***"YET"***

Check the number again:

- If you double the N and H on the left the equation will be balanced:

- $4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$

Double-check:

- $4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$

4 N (nitrogen atoms)	4 N (nitrogen atoms)
12 H (hydrogen atoms)	12 H (hydrogen atoms)
10 O (oxygen atoms)	10 O (oxygen atoms)

- The equation is Balanced