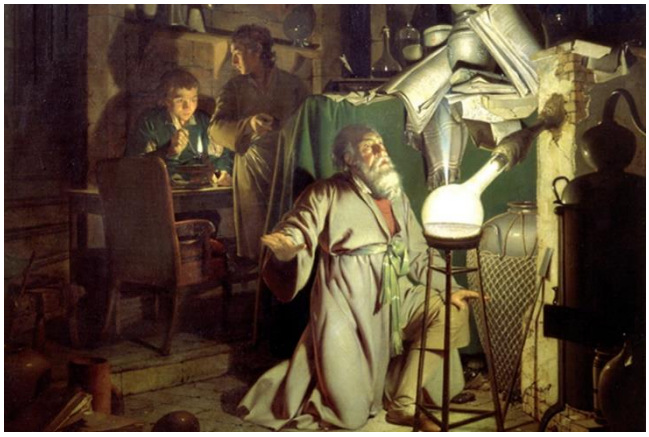
MAGICAL CHEMISTRY!

THE ALCHEMY

Harry Potter, in one of his adventures, is searching for the Philosopher's Stone… a magical substance that can transform metals, such as copper or lead, into gold.

From Egyptian age to the 18th century (1700), untiring researchers of the natural matters tried to mix, cook, melt different liquid and solid substances, to obtain something special or magic…

These **alchemists** (this is the name they were called) were trying to find a way to make the Philosopher's Stone, useful to create immortality elixir.

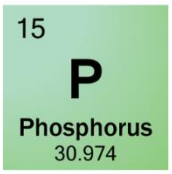


The German alchemist Hennig Brand collected buckets of human urine and heated it with sand and water. He was amazed to see the substance burst into a bright white light.

He had accidentally found phosphorus!

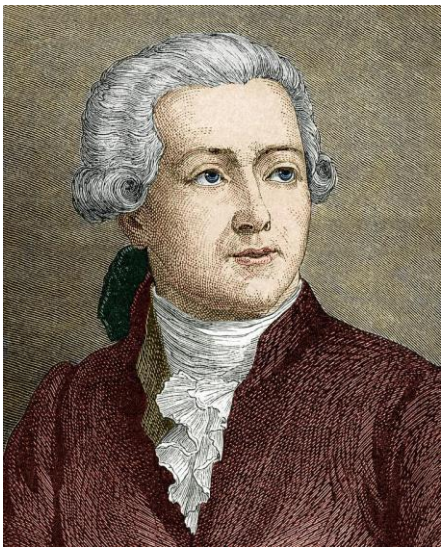
https://www.youtube.com/watch?v=GIGOF_In9BM

("How phosphorus was discovered", a strange story– 1:37)



In 1700 the age of alchemy finishes… it's time to start the real chemistry!

ANTOINE LAVOISIER



He grew up in an aristocratic and wealthy French family. His father was a lawyer and his mother died when he was only five years old.
Lavoisier, who initially was going to follow in his father's footsteps, got a law degree.
Lavoisier didn't ever practice law because he found science much more interesting. In 1775, Lavoisier set up a laboratory in Paris where he could run experiments.

After several experiments, he discovered the famous law of conservation of mass (we'll see it in the next lessons). He also named the element hydrogen. During his experiments, Lavoisier discovered that water was a compound made of hydrogen and oxygen.

In 1789, Lavoisier wrote the Elementary Treatise of Chemistry. This was the first chemistry textbook. The book contained a list of elements and the most recent theories and laws of chemistry.

His wife, Marie, played an important role in his research helping him to translate a lot of documents from English into French so he could study them. She also drew illustrations for his scientific papers.

The French Revolution began in 1789. Lavoisier was branded as traitor, because he had been a tax collector for the government.

On 8th May 1794, he was executed by guillotine.

THE LAW OF CONSERVATION OF MASS

We've already seen that Lavoisier discovered the famous law of conservation of mass. He demonstrated that…

in a reaction, the mass of the products

is equal to the mass of the reactants.

But what are the products and what are the reactants?

And what is a chemical reaction?

Chemists use symbolic sentences called **chemical equations** to describe how elements and compounds react when mixed.

The substances combined in a chemical reaction are called the **reactants**.

The substances produced in a chemical reaction are called the **products**.

Between the reactants and the products there must be an horizontal arrow pointing to the right.

For example: $2H_2 + O_2 \longrightarrow 2H_2O$

In every chemical reaction we have the same number of atoms at the beginning and at the end of the reaction.

Nothing is created, nothing is destroyed.

For example, in this chemical reaction, iron oxide reacts with aluminium to make aluminium oxide and iron.

iron oxide + aluminium ⟹ aluminium oxide + iron




160 g 54 g 102 g 112 g

160 + 54 = **214 g** 102 + 112 = **214 g**

…the mass of the reactants in a reaction is equal to the mass of the products…

for example, in a reaction I've got…

4g + 7g ⟶ 5g + x x=?

THE LAW OF CONSERVATION OF MASS

Read the lecture notes about these experiments.

CHEMICAL REACTIONS AND THEIR BALANCING

Write this reaction:

- The first **reactant** is hydrogen gas (H_2)
- The second **reactant** is oxygen gas (O_2)
- The **product** is water (H_2O).

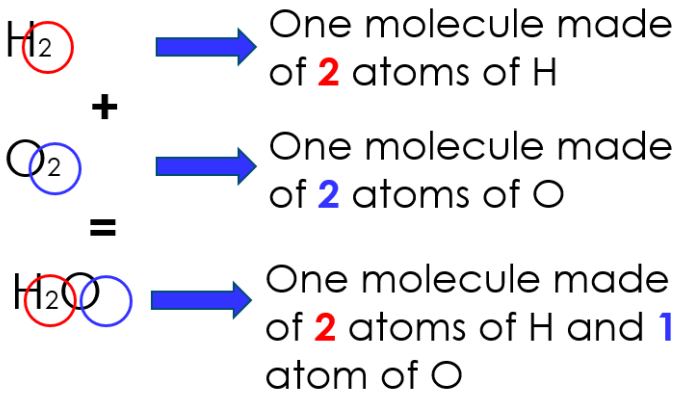
$$H_2 + O_2 \longrightarrow H_2O$$

Is this chemical equation correct?

Is the law of conservation of mass satisfied?

Are the number of atoms in the reactants the same as in the products??

Let's count the atoms:

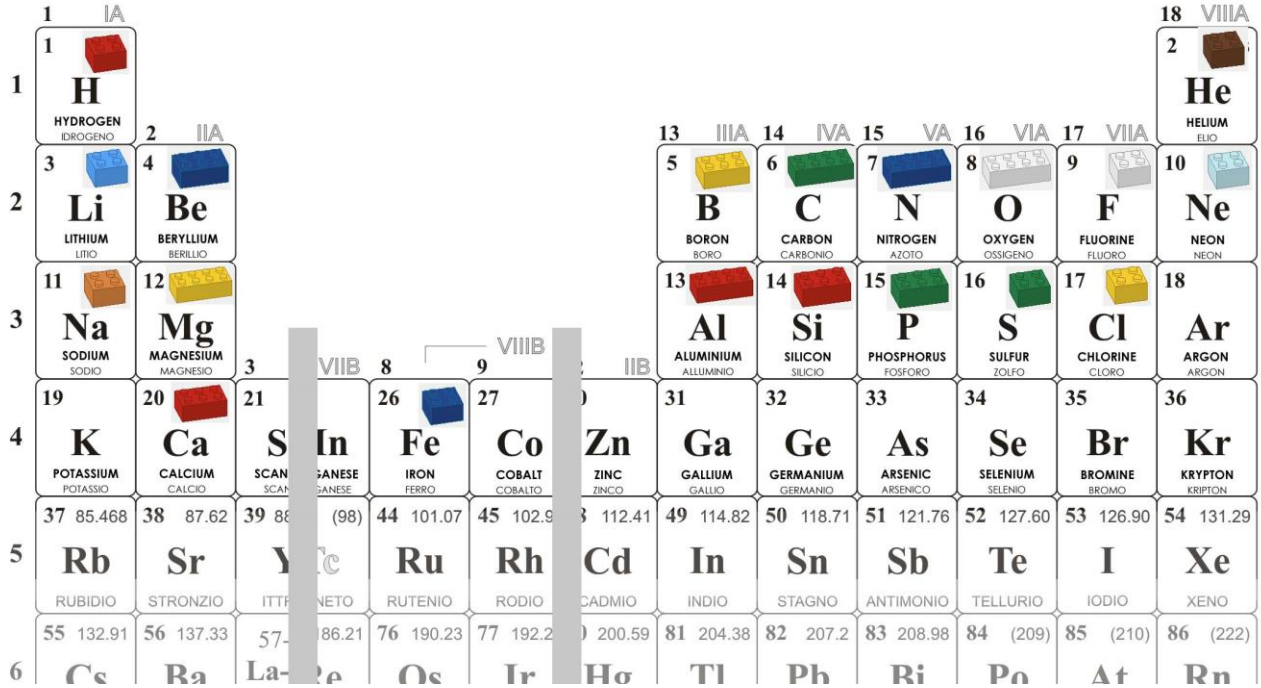


There's an Oxygen atom missing…

How can I balance this equation??

We can use the Lego bricks!

LEGO - PERIODIC TABLE



First, some examples…

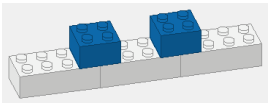
Cl  1 atom

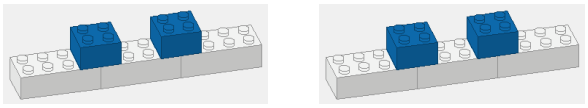
2Cl  2 atoms

3Cl  3 atoms

Cl_2  1 molecule (made of two atoms)

2Cl_2  2 molecules

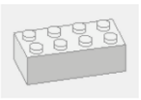
Fe_2O_3  1 molecule (made of 5 atoms)

2Fe_2O_3  2 molecules

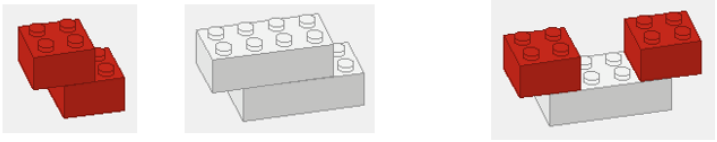
Try to build the reaction

$H_2 + O_2 \longrightarrow H_2O$

H 

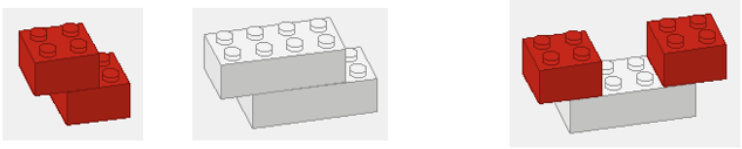
O 

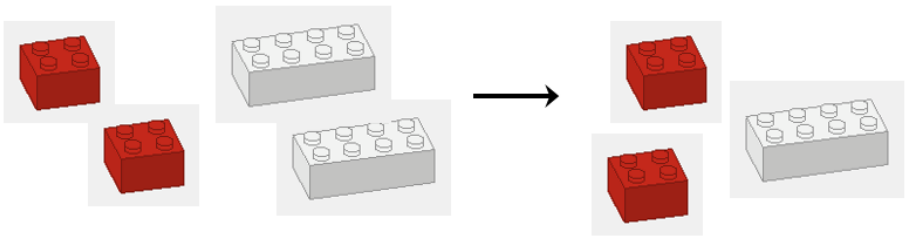
H_2 + O_2 $\longrightarrow$ H_2O



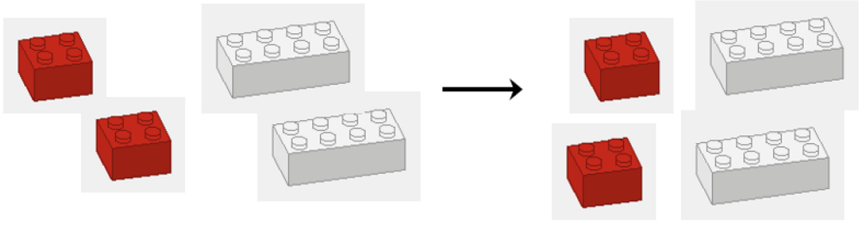
Let's count the bricks:

H_2 + O_2 $\longrightarrow$ H_2O





How can I do to balance this equation??
Can we add one white brick on the right??



So…

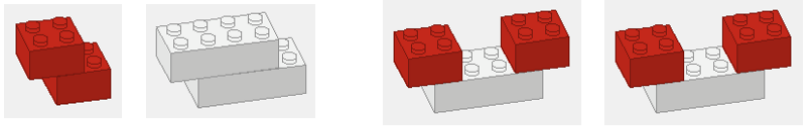
H_2 + O_2 ⟶ H_2O_2

But H_2O_2 isn't water!!!!

The only thing we can do is to <u>increase</u> the number of each type of **molecule** we have!

So **I can't** add only one Oxygen atom (one white brick) but I must add one complete molecule of water on the right…

H_2 + O_2 ⟶ H_2O + H_2O

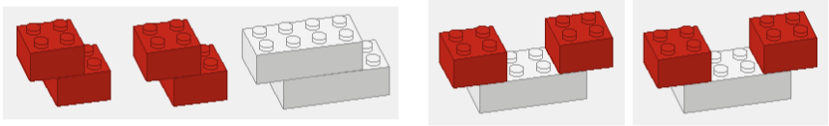


Let's count the bricks…

We have four red bricks on the right and only two on the left…
What can we do now?

We add another H_2 molecule (two red bricks) on the left.

H_2 + H_2 + O_2 ⟶ H_2O + H_2O



$2H_2 + O_2 \longrightarrow 2H_2O$

The reaction is balanced!!

The large "**2**" in front of the chemical formulas for hydrogen gas and water is called **coefficient**. A coefficient tells the chemist how many molecules of each substance are involved in a chemical reaction.

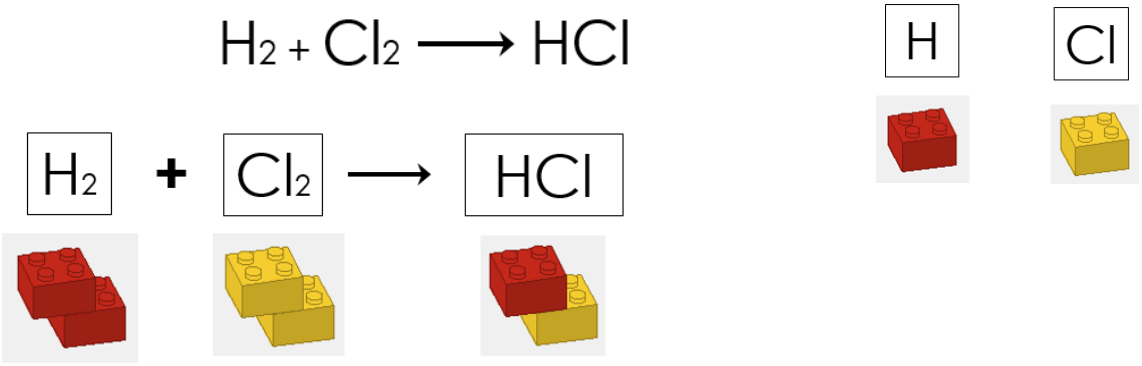
Since no new matter is ever created or destroyed, according to the law of conservation of mass, the number of atoms in the reactants must be the same of the number of atoms in the products.

In this chemical equation, 2 molecules of "H_2" react with 1 molecule of "O_2" to form 2 molecules of "H_2O." A total of 4 hydrogen atoms and 2 oxygen atoms are rearranged to form 2 molecules of water containing a total of 6 atoms.

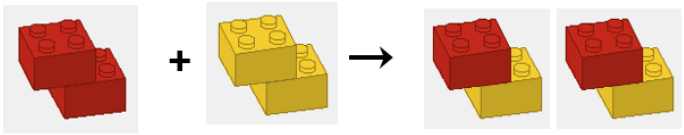
It is not necessary to use the number "1" to indicate one molecule.

Try to build and balance this reaction:

$$H_2 + Cl_2 \longrightarrow HCl$$



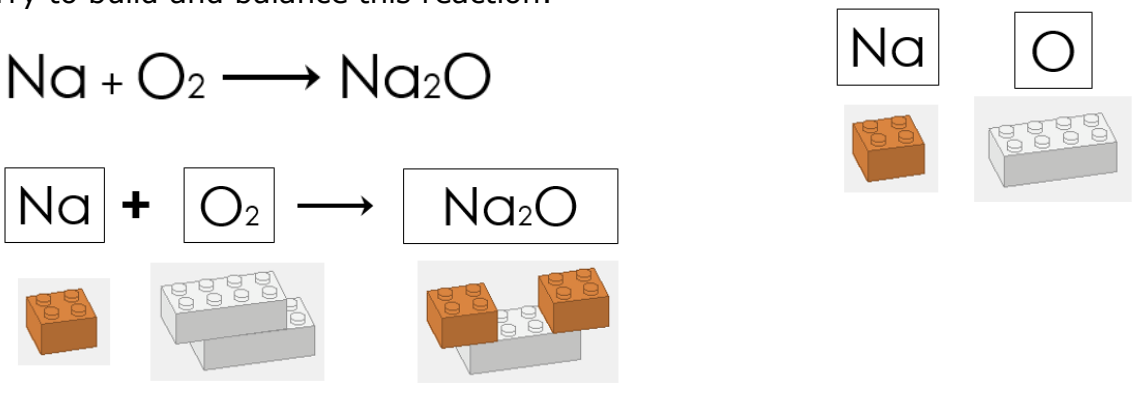
Is the equation balanced?

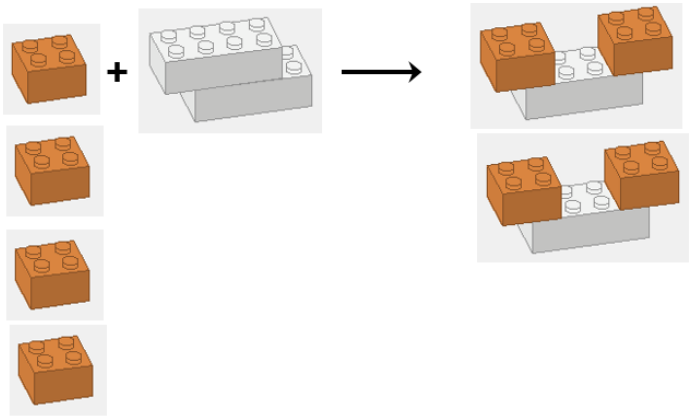


$$H_2 + Cl_2 \longrightarrow 2HCl$$ **The reaction is balanced!!**

Try to build and balance this reaction:

$$Na + O_2 \longrightarrow Na_2O$$





$4Na + O_2 \longrightarrow 2Na_2O$ **The reaction is balanced!!**

Another examples…

$Na + Cl_2 \longrightarrow NaCl$ $2Na + Cl_2 \longrightarrow 2NaCl$

$Al + O_2 \longrightarrow Al_2O_3$ $4Al + 3O_2 \longrightarrow 2Al_2O_3$

And now let's go to the science lab!

CANDLE COMBUSTION

Read the lecture notes about this experiment.

MAGICAL FLAME

Read the lecture notes about this experiment.

SINGLE DISPLACEMENT REACTION

Read the lecture notes about this experiment.

RUST

Read the lecture notes about this experiment.

BOUNCING EGG

Read the lecture notes about this experiment.