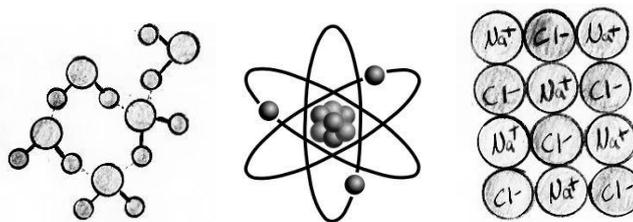
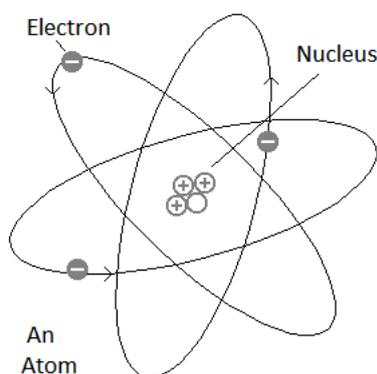


Atoms and Molecules



Chemistry is the study of chemicals. Chemicals are combinations of very basic elements, called atoms. They can be liquids, solids or gases. They can be mixed together or exist in a separate state.

Elements



All matter is made up of atoms. Atoms are made up of these three **subatomic** particles, protons, neutrons and electrons. The protons and neutrons are collectively called **nucleons**, because they join together to form **the nucleus** of an atom. The protons have **positive charge**, and the neutrons have **no charge**.

Around the outside, a large distance away, the much smaller particle, the electron, buzzes around. They have a negative charge and are bound to the positive nucleus.

| Particle | Charge | Mass | Where it is found |
|----------|---------------|-------|---------------------|
| Proton | Positive (+1) | Heavy | Nucleus |
| Neutron | Neutral (0) | Heavy | Nucleus |
| Electron | Negative (-1) | Light | Outside the nucleus |

Atoms differ by having different number of protons. An atom is defined by the number of protons it has. The different types of atoms that exist are present in the periodic table, and are **elements**.

Just to clarify...

Molecules are two or more atoms joined together.

- Elements consist of one atom.
- Compounds consist of one molecule, or two or more atoms.
- A mixture is two or more compounds or element.



Atomic Number and Mass Number

The number of protons an atom has is called the **atomic number** of the element. For example, Lithium has 3 protons, therefore the atomic number is 3. An atom with the same amount of positive and negative charge means that the atom is **neutral**. However, in chemical reactions, electrons are constantly being borrowed or stolen from other atoms. This means that atoms won't always be neutrally charged, but often will have a charge. If they do, they are called **ions**.

The number of neutrons an atom has, increases as the atom gets bigger. Usually there are many more neutrons than protons. Atoms also can come with different numbers of neutrons: these represent different species of the atom, known as **isotopes**.

The decimal number underneath the symbol on periodic tables is called the **mass number**. It represents the *average* number of *neutrons + protons* an atom has as we find it on earth. Chlorine, for instance, has a mass number of 35.5. This tells you about half of the time it is 35 and the other half you find it as 36. It is measured in atomic mass units, or amu.

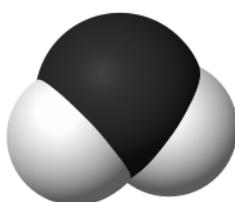
Molecules and Compounds

In chemical reactions, atoms join together to make things called molecules. A molecule is two or more atoms joined together.

Molecules have very different properties from the atoms that compose them. For example, water is made from two hydrogen atoms and one oxygen atom joined together. Hydrogen and oxygen are flammable, but water is not flammable and is a liquid.

Writing Molecular Formulas

We describe a molecule by writing down the number of each type of atom in the molecule. We always make the numbers that count the number of a type of molecule in subscript. For instance, H_2O has two hydrogen atoms and one oxygen atom in each molecule.



The 2 is a *subscript* telling us there are two hydrogen atoms in this molecule. We don't need to put the 1's in. So, one oxygen atom is just O, not O_1 .

Numbers in front of a chemical formula tell you how many of this type of molecule are present in whatever you are doing.

$2\text{H}_2\text{O} \rightarrow$ Two water molecules

$4\text{O}_2 \rightarrow$ Four oxygen gas molecules

If you have *an atom* with three nitrogen atoms and two aluminium atoms, **don't** write:

$2\text{Al}3\text{N}$

You must put the numbers underneath the symbols.

Al_2N_3

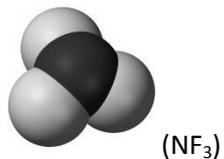
The place out the front of the number **is always reserved** for counting the number of molecules you have.

$5\text{Al}_2\text{N}_3$

This means 5 aluminium nitride molecules.

Which atom do you write first?

If we told you to write down the molecule you get when you join nitrogen and fluorine (1 N and 3 F's), how would you know which one to write first? Is it NF_3 or F_3N ? Generally, you **write the metal** first, then the metal atom. This means, most left, most highest on the periodic table is first. Therefore, it is NF_3 . This isn't always true though, especially where hydrogen is involved.



Also, the last atom in the molecule has its ending changed by the addition of an *-ide*. Fluorine becomes fluoride, iodine becomes iodide, oxygen becomes oxide. So, the above molecule is nitrogen fluoride.

How do you know how many?

More information on how to write them properly will be later on.

Compounds

An amount of the same type of molecule is called a **compound**. Compounds are sometimes defined as any substance that can be broken down by heat. Under heat, molecules break down into their individual atoms. For the above compound, it will separate into nitrogen and fluorine.