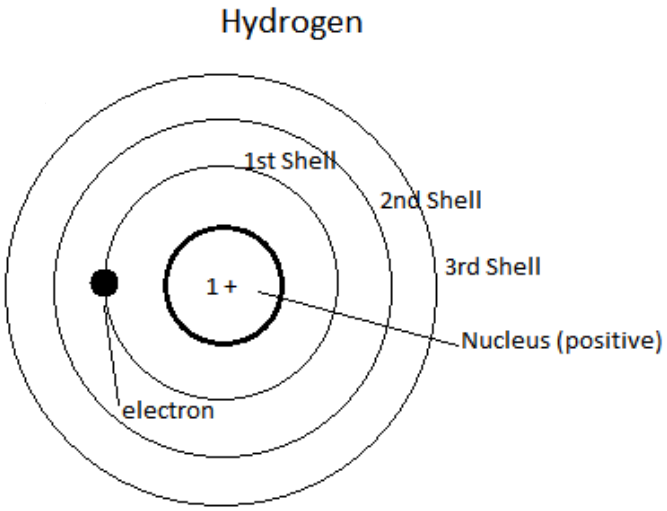
Electron Shells and Ions

We have known something about what's inside an atom, earlier in the booklet (Atoms, Molecules and Compounds section). If we take out a magnifying glass, however, and watch the electrons closely, we will see that the electron behaves in certain patterns.

Electron Shells

It has long been known that electrons arrange themselves in patterns of orbits, called **shells**. You can think of a shell as a barrier, or a shield. An electron orbiting a nucleus can't orbit where it feels like, it must fit itself into one of these shells.



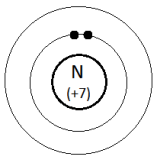
The way they work isn't too difficult to work out. Around any group of nuclei, there is a collection of shells into which electrons fit themselves.

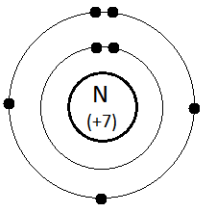
The closest shell to the nucleus, shell one, can carry up to **two electrons** before coming full. Once full, it becomes a shield that prevents any other electrons. Further electrons must fill up shell 2. Shell 2 and 3 can carry **up to 8 electrons**. The electrons are also attracted to the nucleus, so the inner circles must be filled up first.

After these three shells, things get more complicated, so for the meantime it is easiest to deal with elements up to 18 electrons in size.

So, how do these shells work? Let's look at the first nitrogen on the periodic table, 7th in the list. Let's assemble it from scratch, but let's not worry about neutrons, they don't affect how shells form.

Nitrogen has 7 protons, meaning there are 7 electrons. We need to arrange them into shells. We first plot the first two electrons in. They immediately jump to the first shell, as they want to fill up the inner shell.





The next electron is locked out of the first shell and must be content with the second shell. The last four continue adding to the first shell.

The diagram on the right is the finished nitrogen atom.

Electron Rules

There are several rules of electrons.

Rule One

An element has always the same number of electrons as it has protons. This is simply because positive charge must balance negative charges.

Rule Two

Electrons form shells, or orbital paths, around the nucleus. The first shell can have no more than two electrons, the second and third, no more than eight. This rule comes from quantum physics. Think of a filled shell as a barrier preventing other electrons getting close to the nucleus.

Rule Three

Electrons always fill the lower shells first. This is simply a fact of forces. If there is a 'hole' in a shell, an electron will be pulled by the force between the positive nucleus and the electron into that hole. It wants to be as close as possible to the nucleus.

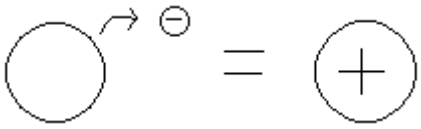
Rule Four

Electrons like to go in pairs. The first two electrons in every shell will form a pair. Electrons after the first pair will not form pairs, until there are at least 5 electrons in that shell. As I have done with the nitrogen atom, there is one pair at the top and three leftover electrons by themselves. If there were one more, to form oxygen, then it would pair up with one of the leftovers.

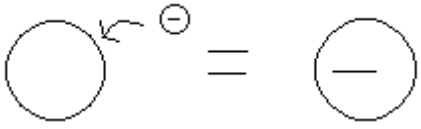
Ions

Ions are elements that have **too many or too few electrons**. Such particles no longer have balanced charge, because the number of electrons no longer balances the number of protons. They are **charged atoms**.

If you have a neutrally charged atom and you **remove an electron**, it becomes **positively charged**.



If you have a neutrally charged atom and you **add an electron**, it becomes **negatively charged**.



There is a special way of writing symbols if an atom is or has become an ion. We use superscripts.

If Sodium loses an electron, it becomes Na^{+}.
If Magnesium loses two electrons, it becomes Mg^{2+}.

Cations are positive ions, while **anions** are negative ions.