THE ELEMENTS

The number of protons that an atom has, determines which chemical ***element*** it is. (And since a normal atom is electrically neutral, it has the same number of electrons as it has protons.) The simplest element is **hydrogen:** an atom of one proton and one electron. The next simplest is **helium:** two electrons, two protons. The third is **lithium:** three electrons, three protons ...... and so on. The heaviest element which occurs in nature is uranium, with 92 electrons or protons. Still heavier ones have been made in nuclear physics laboratories.

Other common elements, with familiar names, are:
carbon (6 protons)
nitrogen (7 protons)
oxygen (8 protons)
silicon (14 protons)
iron (26 protons)
The two most common elements in the universe as a whole (including stars, planets, and all the interstellar gas in space) are the two simplest: hydrogen and helium. Elements heavier than iron are rare, in relative terms. The course material on the origin of the elements explains why!

The study of chemistry is all about the exchanges of electrons between atoms, whereas nuclear physics is about the alterations in the nucleus.

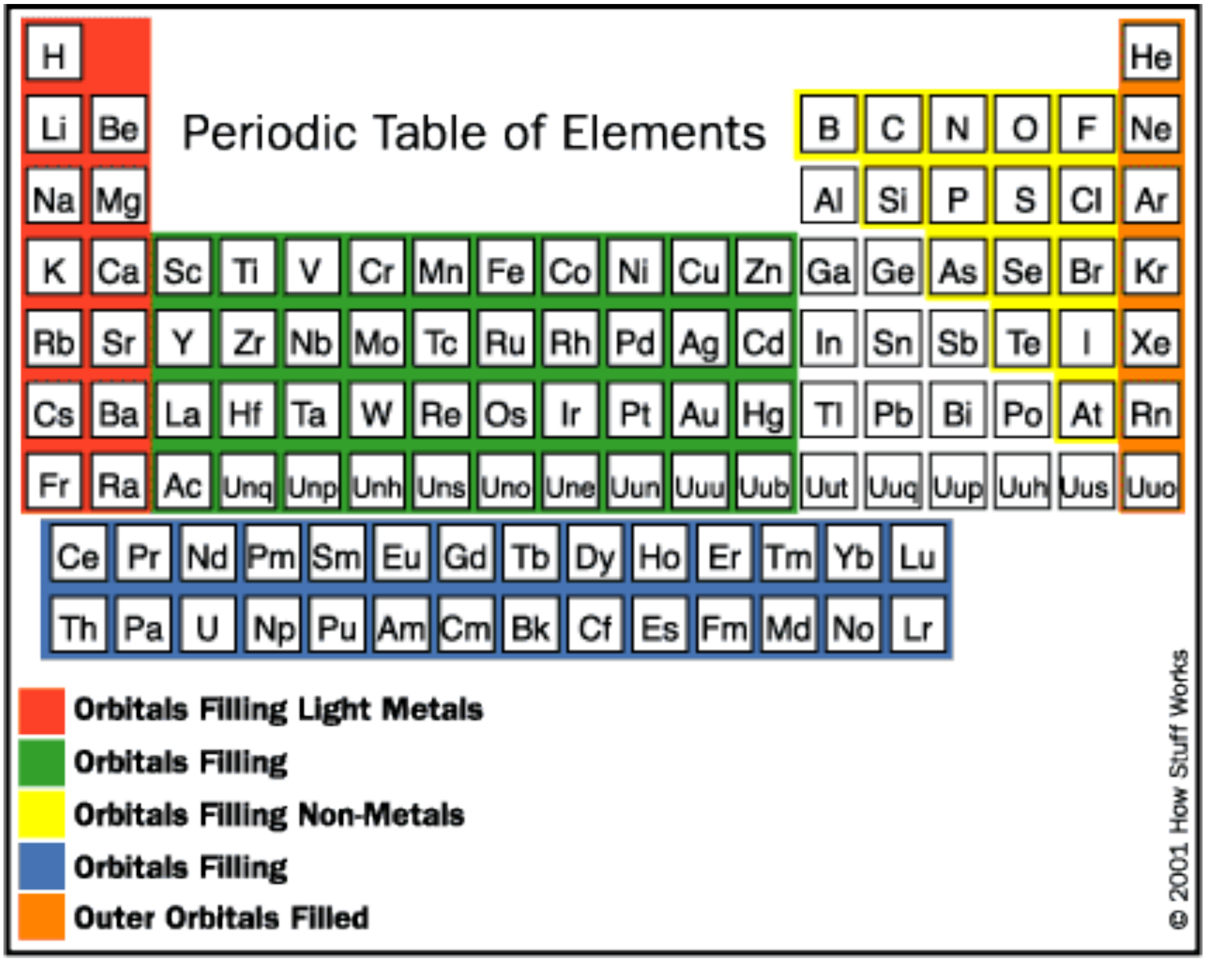
Now we need to explain a bit more about the different possible versions of each element, which you can get by changing the number of neutrons in the nucleus. The neutrons are present along with the protons in order to keep the whole nucleus together (the reasons for which are beyond this topic), but because they are electrically neutral they don’t affect the chemical behavior of the atom. Atoms with the same number of protons, but different numbers of neutrons, are called **isotopes** of the same element.

For each element there is usually just one "normal" atomic weight or isotope which is the most commonly found version in nature. Every element does have several different isotopes, but the others are less common and often are **unstable** (the term “unstable” means that the nucleus spontaneously falls apart, or decays, into smaller pieces which may be more stable). The rate at which an unstable isotope falls apart is called its **half-life** and differs widely from one isotope to another. What this means is that after one half-life has elapsed, half of the original number of atoms has decayed. After the next half-life has elapsed, half of the *remainder* has decayed; and so on.

EXAMPLE: the very first element, hydrogen, has an atomic number of 1 (one proton and one electron). It comes in three versions: hydrogen-1 (1 proton, no neutrons), hydrogen-2 or deuterium (1 proton, 1 neutron), and hydrogen-3 or tritium (1 proton, 2 neutrons). Normal hydrogen and deuterium are both stable and can be found in nature. However, tritium is unstable and spontaneously decays away over a half-life of about 12 years.

Unstable isotopes have proven to be extremely useful for measuring things like the age of the Earth (using uranium-238, which has a half-life of 4.5 billion years) or archaeological relics (using carbon-14, which has a half-life of 5,700 years).

In the periodic table, the elements (i.e., the different types of atoms) are sorted by their "atomic weights" (increasing from left to right) and also by their chemical reactive properties (elements which behave pretty much the same way in chemical reactions are all placed in the same column of the table. Each element is denoted by a one-letter or two-letter abbreviation.



For example, look at the leftmost column. From top down, the 6 elements in the column are named *hydrogen; lithium; sodium; potassium; rubidium; cesium; and francium.* They are chemically similar: they all have one electron sitting on their outer margins which is relatively easy to transfer to another atom. The other electrons sit deeper inside and are harder to move around.

(Incidentally, you may have noticed that the abbreviation for sodium is “Na”, and potassium is “K”. Why?? Well, these elements were known so long ago that their abbreviations are the old Latin ones used by the mediaeval alchemists. Sodium was called “natrium” and potassium was called “kalium”. There are several others in this historical category. If you’re interested, track them down!)

(If you are *really* interested in historical trivia, we can tell you that there are actually *four* elements named in different ways after a single small town in Sweden. Name these four, and the town.)

When Mendeleev invented the periodic table in the 1860's, he found that there were several gaps (unfilled places) in the table, and made the bold prediction that these "empty" boxes were unknown elements that would eventually be discovered -- and he was right! Every box is now filled with a known element. The boxes at the lowest row – ones labelled Uux – correspond to very heavy nuclei that have been made only in the laboratory, many of which don't have official names yet; in fact, some of these boxes are just placeholders for ones not yet synthesized. All of these heavy nuclei are quite unstable and fall apart rather quickly, which is why they are not found naturally.

For more information on the periodic table, see http://www.chemicalelements.com