# METALS AND NON METALS

METALS AND NON-METALS

You don't have to be a chemist to recognize that metals and non-metals are different, however, to understand why they are so different we need to look at the structure of metals in more detail.
Metals are composed not of complete atoms, but of "cations," atoms that have lost their outer electrons. Unlike ionic solids, where the electrons become transferred to another atom, in the case of metals the electrons hang about and form a 'sea' or cloud of electrons surrounding the ions. As we learnt in Chapter 4, metals have certain properties:

- Conductivity of electricity
- Conductivity of heat
- Ductility (being able to draw out metallic structures into wires)
- Malleability (being able to hammer metals into shape)
- Metallic lustre (metals have a unique shiny surface)
- Metallic sonority (metals have a unique 'clanging' or ringing sound if you strike them with something hard)

All of these properties can be explained in terms of the structure of metals. Electricity is conducted as the electrons are free to move away from a negative charge towards a positive charge; this is the flow of an electric current. Heat is conducted because the ions are so close together; heat is really a result of kinetic energy - the energy of movement. As one ion starts to vibrate rapidly it passes this kinetic energy to the other surrounding ions, thus giving off heat. Ductility and malleability are characteristics resulting from the layers being able to slide over one another easily, thus changing the shape of the metal. Metallic sonority is similar to the property of heat in that vibrational energy is passed from one into another, due to the close nature of the ions in the metal structure. The distinctive shine of metals is the effect caused by all those free electrons on the move.

In non-metal structures (like the ionic lattice of sodium chloride), not only are the charged particles unable to move, but the ions are so far apart that energy is not easily transferred from one to another; the structure can only conduct electricity in a molten state or in solution. A giant macromolecular structure like a diamond has no charged ions at all. It is entirely composed of relatively widely spaced atoms, all covalently bonded.

The fact that we name complete stages of human civilization after metals and non-metals - stone age, bronze age and iron age - tells us how important the distinction between these two kinds of material are. The difference between a flint axe and an iron axe is great, and making iron tools may have started with simple axes, but it led us to the iron boats and locomotives of the industrial revolution.

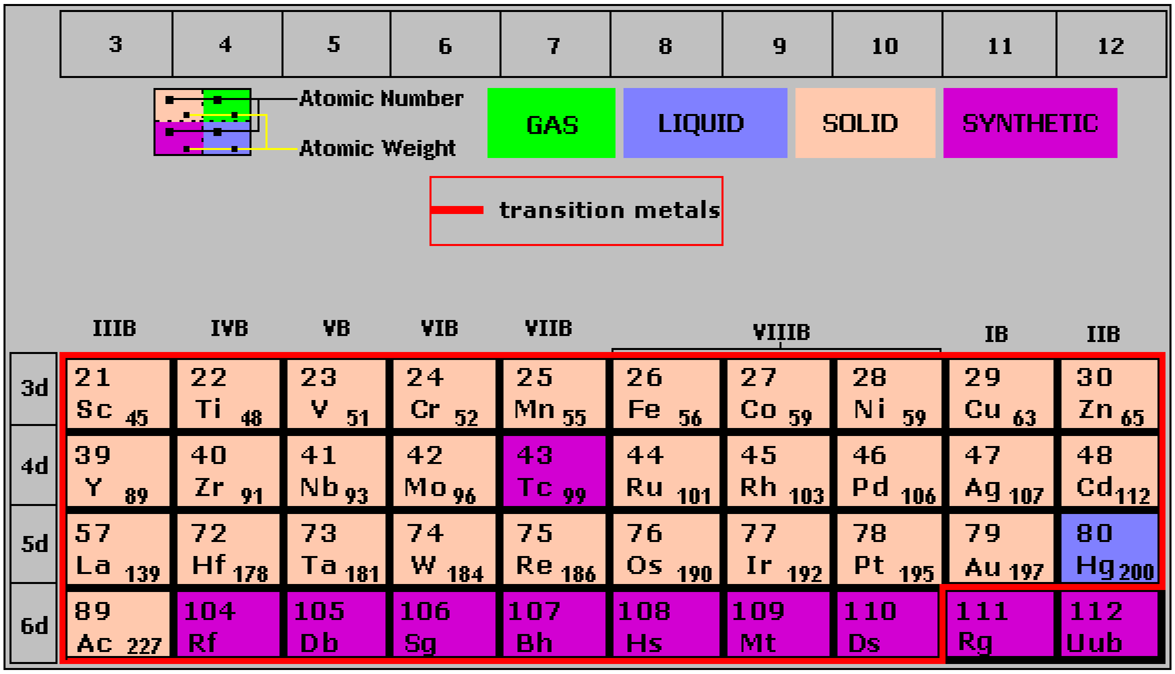
Most of us would have no problems in deciding whether a substance is a metal or a non-metal but a chemical test is helpful. A general rule is set out below.

| |
|---|
| Metals <u>tend</u> to react with oxygen to produce basic oxides. |
| Metals <u>tend</u> to react with water to form basic hydroxides. |
| Non-metals <u>tend</u> to react with oxygen to form acidic oxides. |

Please notice the word "tend" - exceptions do occur and we will meet some of these before the end of the course. For most elements however, this system works very well; for instance if we burn sulphur in oxygen it produces sulphur dioxide, proving it to be a non-metal. Likewise, if we burn copper in oxygen we produce copper oxide which is basic (see chapter 1 if you need to remind yourself about acids and bases. It is wort mentioning at this point that not all oxides are acidic or basic; some, like water ( also known as hydrogen oxide) are neither acidic nor basic and are therefore called NEUTRAL OXIDES.Aluminium oxide (in that part of the periodic table where metals and non-metals meet) sometimes acts as an acid and sometimes as a base and is called an AMPHOTERIC OXIDE.

## Periodic Trends.

TRANSITION METALS Classification of Elements 6r




**Transition metals (d block elements)**

In looking at the periodic table Elements so far we have limited our discussion to the elements on the right-hand side and those on the far left; a large number of elements fit into the middle in a block called the transition metals (or sometimes the transition elements or d-block elements.) First series of transition metals(de-) Classification of Elements We have seen in the last chapter that many of the metals in Group 1 are highly reactive and all of them are kept under oil to prevent them coming into contact with water or air. The transition metals on the other hand contain all those metals with which the human race has become very well acquainted; iron; copper; zinc; gold; silver; mercury, etc. Trends are not as obvious in the transition metals as they are in other parts of the periodic table - it seems, at first glance, that these elements all have a unique set of individual characteristics with no pattern at all to their behaviour. We can however, come up with a general list of properties of the transition elements and these are set out in the table below.

Transition metals all display typical metallic characteristics (as set out at the top of the page).*

Transition elements tend to produce coloured compounds.

Transition metals are often effective CATALYSTS and are often found at the centre of biological molecules (like iron being at the centre of haemoglobin in red blood cells).

Transition elements are at the centre of a group of chemicals called COMPLEXES 6r.

Transition elements tend to have more than one OXIDATION STATE Periodic Trends. (That is, they form compounds with another element with differing formulas - iron combines with chlorine to form iron (II) chloride - $FeCl_2$ or iron (III) chloride - $FeCl_3$.

* Mercury is the only metal which is liquid at room temperature, but when it is cooled down to a solid state it behaves just like the other transition metals.

Some of these concepts will be new to you and will be covered fully in later chapters but the important thing to grasp at the moment is that the transition metals are essential to many industrial processes, as well as the commercial and cultural aspects of their use. The biological uses of the transition metals mean that you - and most other living things - rely upon them for a great number of functions in your body .
The variable oxidation states of transition metals will need some explanation later, but for now, think of it as the ability of the transition metals to form compounds with a number of different formulas. For instance, sodium (from group I only), forms one compound with chlorine NaCl, but iron, a transition metal, forms two compounds with chlorine $FeCl_2$, called iron(II)chloride, and $FeCl_3$, called iron(III)chloride.Other members of the transition metals will have far more than two chlorides, but you can easily tell the oxidation number by looking for the Roman numerals in the name - for instance, manganese in potassium manganate (VII) - $KMnO_4$, has an oxidation number of seven.

Source : http://www.peoi.org/Courses/Coursesen/chem/frame6.html