The physical properties of metals

Metals	Non-metals
good conductors of heat and electricity	poor conductors of heat and electricity
shiny	dull
solids with a high melting point (except for mercury)	most are low melting point solids or gases
flexible and malleable	brittle (break easily instead of bending)

The chemical properties of metals

The **chemical properties** of metals refers to their reactions with other substances.

For example, metals can react with many non-metals:

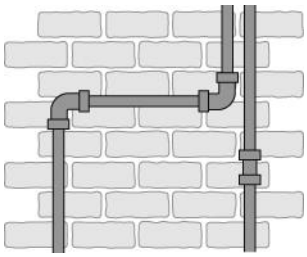
e.g. calcium + chlorine → calcium chloride

(Note: When naming a compound the ending of the non-metal is changed to **_ide**)

Metals can also react with air (oxygen), water and acids. Some metals react very quickly; they are **reactive**. Calcium is a reactive metal. Other metals do not react quickly; they are **unreactive**. Gold is a very unreactive metal.

Uses of metals

Metals have many **uses** depending on their different **properties**. For example, copper is used in electrical wires as it is flexible and a good conductor of electricity. It is also used for roof sheets as it is malleable and doesn't react quickly with water.



Metals as catalysts

Some metals act as **catalysts**. These are substances that speed up chemical reactions without being used up themselves. Catalysts have many uses, for example, platinum is used in catalytic converters in cars.

Corrosion and oxidation of metals

The reaction of metals with oxygen forms **metal oxides**:

metal + oxygen → metal oxide

e.g. **word equation**: calcium + oxygen → calcium oxide

This is called an **oxidation** or **corrosion** reaction.

Some metals like sodium react quickly with water and oxidise immediately when scratched. Other metals do not react easily, for example silver changes colour very slowly as it reacts with oxygen.

Rusting

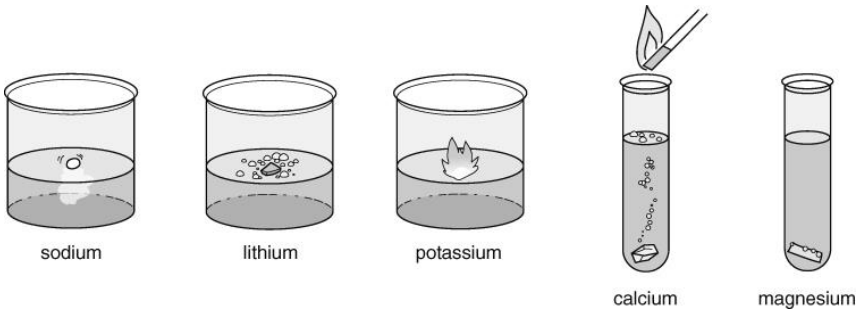
The corrosion of **iron** is called **rusting**. It destroys iron and steel structures because **rust** is weak and crumbly. Water and oxygen must be present for iron to rust.

iron + water + oxygen → iron hydroxide

Coating the iron with paint, plastic, etc. acts as a barrier to oxygen and water and stops iron rusting.

Metals and water

Some metals can react with cold water.



All the metals that react with water form a metal hydroxide (an alkaline solution) and hydrogen gas.

metal + water → metal hydroxide + hydrogen

The test for hydrogen gas is that it burns with a 'squeaky pop'.

Again, the equations can be written using words or symbols:

sodium + water → sodium hydroxide + hydrogen

$2Na + 2H_2O \rightarrow 2NaOH + H_2$

Metals and acids

The metals that react with water react very quickly with acids. Some metals that don't react with water do react with acids. When metals react with acids, they produce hydrogen and a salt.

metal + acid → salt + hydrogen

The name of the salt formed depends on the name of the acid:

- hydrochloric acid → chlorides
- sulfuric acid → sulfates
- nitric acid → nitrates

Again, the equations can be written using words or symbols:

magnesium + sulfuric acid → magnesium sulfate + hydrogen

$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

Reactivity series

The reactions of metals with oxygen, water and acids allows us to put the metals in order of reactivity:

Potassium
Sodium
Lithium
Calcium
Magnesium
Aluminium
Zinc
Iron
Tin
Lead
Copper
Mercury
Silver
Gold

Decreasing reactivity

The reactivity of metals can be linked to their uses.

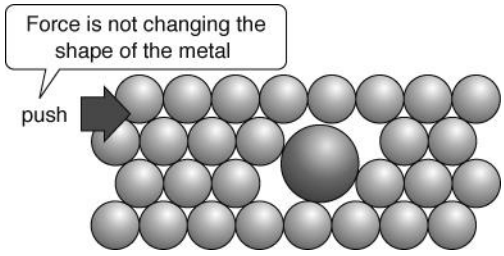
For example, metals used for building need to have a low reactivity, otherwise they will corrode away.

Alloys

Alloys are mixtures of metals with one or more other elements. Alloys have different properties from the pure metal and so can be more useful.

For example, steel, an alloy of iron, is stronger and does not rust as quickly.

Pure metals have a fixed, precise melting point where as alloys have a lower melting point and melt over a range of temperatures. Melting points can therefore be used to identify pure metals.



Alloys are usually also harder than pure metals because the different sized atoms disrupt the regular structure making it harder for the layers of atoms to slip over each other.