Atomic Number and Mass Number

Mass Number
Total number of Protons and Neutrons

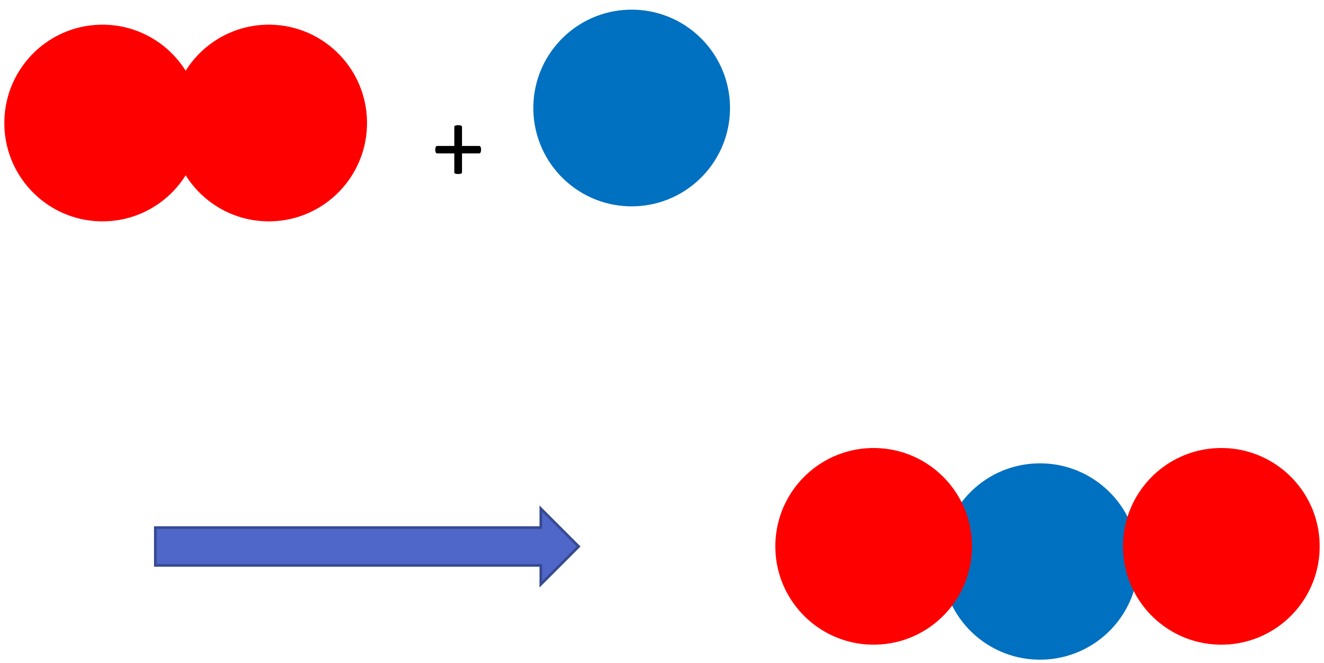
$$^{23}_{11}\mathrm{Na}$$

Atomic Number
- Number of Protons
- Number of Electrons

Particle	Mass
Proton	1
Neutron	1
Electron	Very small

Compounds

Formed when 2 or more elements are chemically joined together.



Relative Atomic Mass (Ar)

Mass of atom.

Relative Formula Mass (Mr)

The mass of all the atoms in the compound combined.

e.g. $MgCl_2$

Mg = 24
Cl = 35.5 x2

24 + 71 = 95

Percentage Mass

Question - What is the percentage by mass of oxygen (O) in sodium hydroxide (NaOH)?

1. First, work out the relative formula mass of the compound, using the A_r values for each element. In the case of sodium hydroxide, these are Na = 23, O = 16, H = 1. (You will be given these numbers in the exam.)

2. Next, divide the A_r of oxygen by the M_r of NaOH, and multiply by 100 to get a percentage.

Back to C1

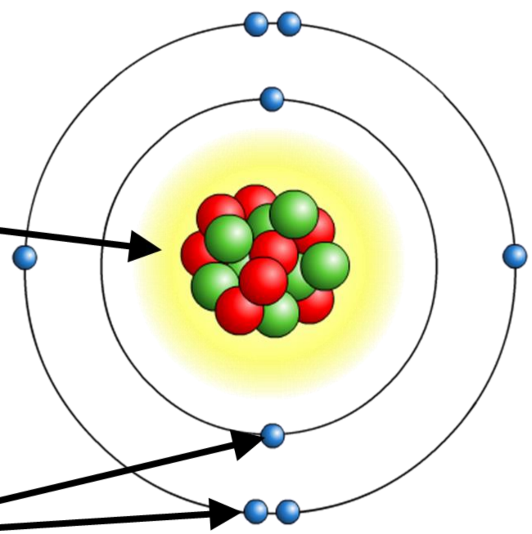
The structure of the atom

Relative = size and charge in comparison to the other particles

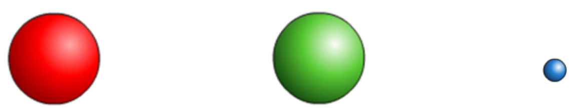
Actual mass of electron, $m_e = 9.11 \times 10^{-31}$ kg

Protons, neutrons and electrons are **not** evenly distributed in an atom.

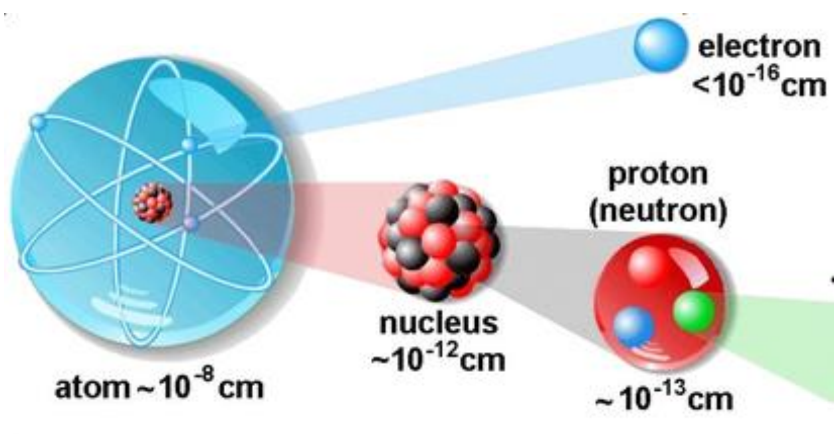
The protons and neutrons exist in a dense core at the centre of the atom. This is called the **nucleus**.



The electrons are spread out around the edge of the atom. They orbit the nucleus in layers called **shells**.



proton **neutron** **electron**



Subatomic particle	Relative charge	Relative mass
Proton	+1	1
Neutron	0	1
Electron	-1	1/1836

Back to C1

The history of the atom

John Dalton described atoms as tiny balls of material. He said the atoms of a particular element are all identical.

In 1897 at Cambridge University JJ Thomson discovered ‘Cathode rays’

On closer examination it was decided that these ‘rays’ were in fact tiny, negatively charged particles being emitted from atoms. He has discovered the electron

In 1911 Ernest Rutherford, (a New Zealand scientist working in Britain) carried out an experiment that proved that atoms were not solid lumps of material as thought by Thomson but were in fact mostly empty space with a very small solid centre called the nucleus.

The Bohr model. A central, positive nucleus and the electrons in fixed orbits or shells around it. Larger atoms have more shells.

Back to C1

The history of the periodic table

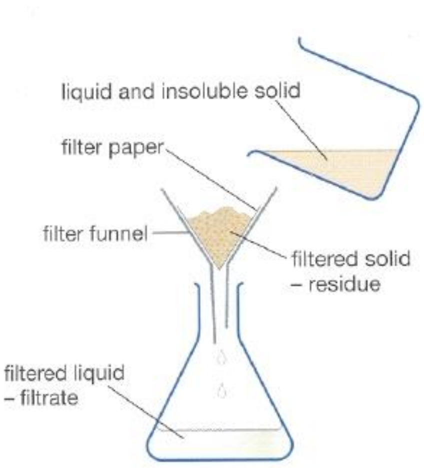
Döbereiner = A German scientist called Johann Döbereiner put forward his **law of triads** in 1817. Each of Döbereiner's triads was a group of three elements. The appearance and reactions of the elements in a triad were similar to each other.

Newlands = An English scientist called John Newlands put forward his **law of octaves** in 1864. He arranged all the elements known at the time into a table in order of *relative atomic mass*.

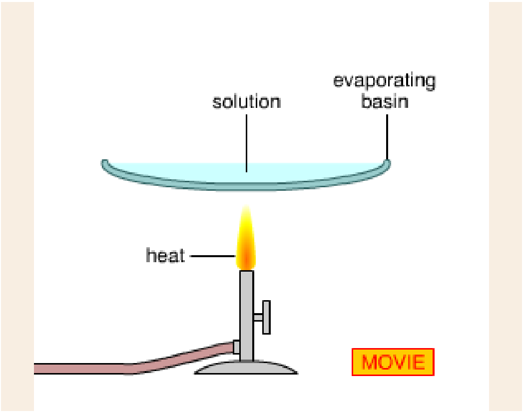
Mendeleev = Mendeleev also arranged the elements known at the time in order of *relative atomic mass*, but he did some other things that made his table much more successful.

Back to C1

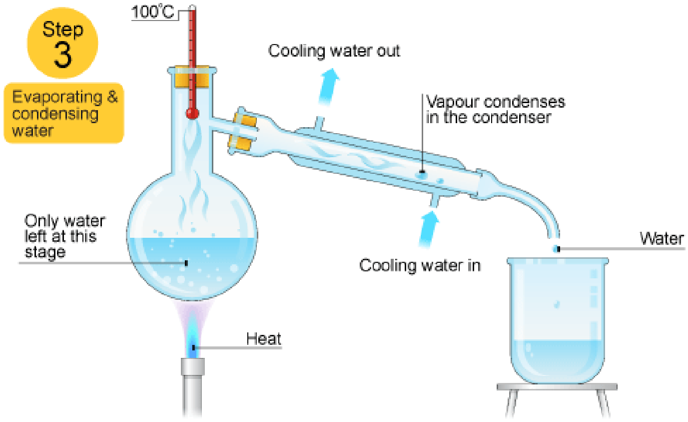
Separating Mixtures



Filtration: separates a solid from a liquid



Crystallisation: if a solid is dissolved in water it can be recovered by evaporation or crystallisation



Distillation is a process that can be used to separate a pure liquid from a mixture of liquids or a solid. It works when the liquids have different boiling points.

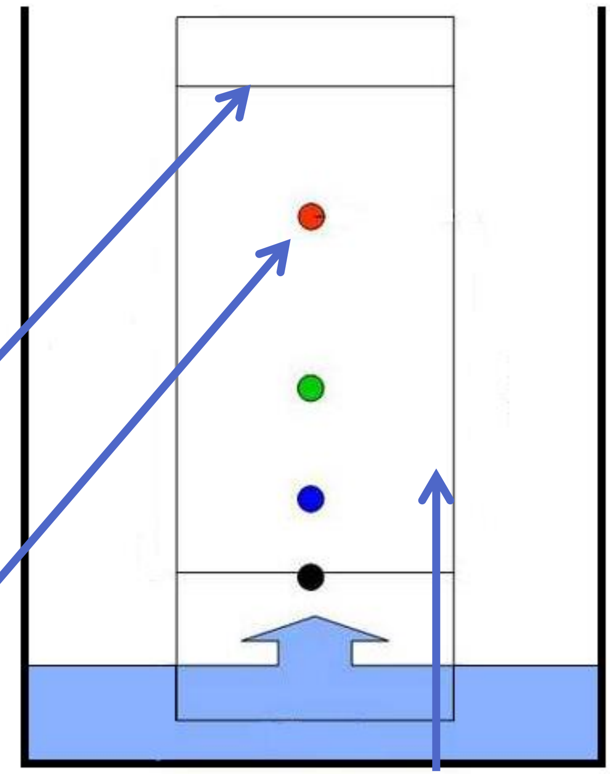
Back to C1

Chromatography

This technique separates out the different components within the food additives based on how well they dissolve in a particular solvent.
Their solubility determines how far they travel across a surface (chromatography paper).

The Rf factor is used to compare the components of various samples. The Rf values of suspect samples can be compared with known samples.

$$Rf = \frac{\text{distance from the base line to the spot}}{\text{distance from the base line to the solvent front}}$$



Solvent front
the point at which the water stopped moving up the paper

Spot
the point at which a band or spot of colour is

Base line
the line where the original sample was placed

If two substances have the same Rf value, they are likely (but not necessarily) the same compound. If they have different Rf values, they are definitely different compounds.

Back to C1

The Halogens

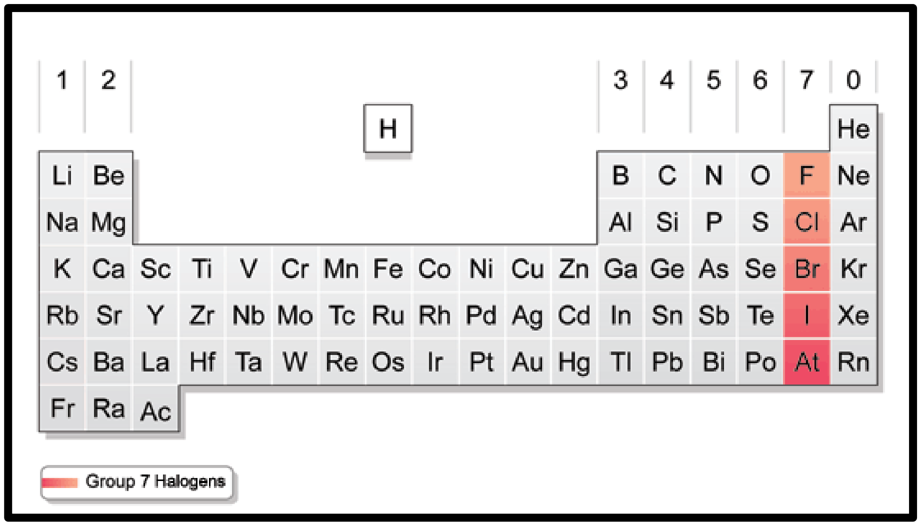
The halogens are in group 7 of the periodic table

The halogens are diatomic - this means they exist as a pair. Chlorine molecules have the formula Cl_2, bromine Br_2 and iodine I_2.

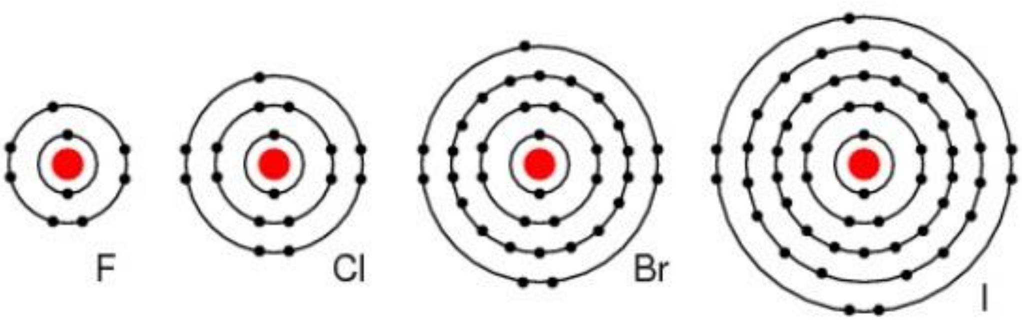
Fluorine and chlorine are gases

Bromine and Iodine are liquids

Astatine is a solid



The halogens have low melting points and boiling points.



Elements	BP / °C
Fluorine	-188
Chlorine	-34
Bromine	58.8
Iodine	184

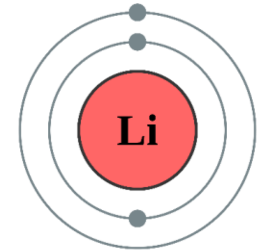
The get less reactive as they move down the group-

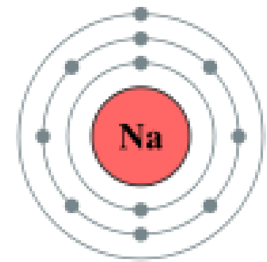
Back to C1

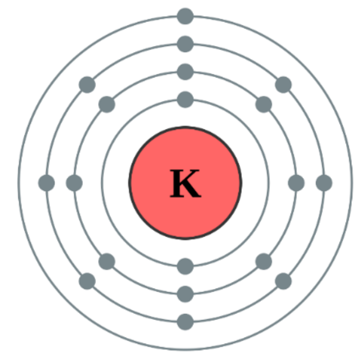
The Alkali metals

Element	Symbol	Reactivity	Melting / Boiling Point	Hardness
Lithium	Li			
Sodium	Na			
Potassium	K	Increases	Increases	Increases
Rubidium	Rb			
Caesium	Cs			

H	
Li	Lithium
Na	Sodium
K	Potassium
Rb	Rubidium
Cs	Cesium
Fr	Francium





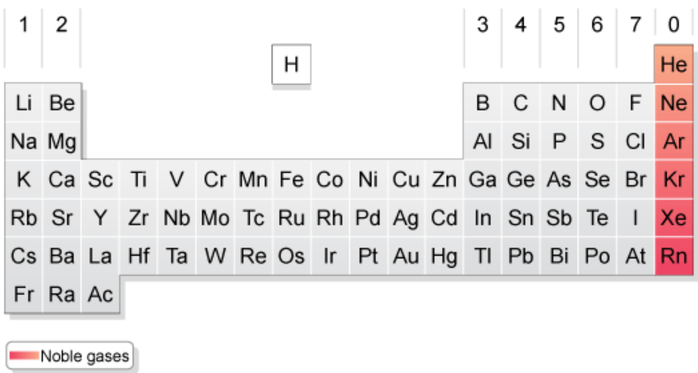


Reaction with oxygen	**Form metal oxides which are white powders**
Reactions with chlorine	Form metal Chlorides which are white powers e.g NaCl
Reactions with water	Produce hydrogen and metal hydroxide.

Back to C1

The Noble gases

Found on the far right of the periodic table in group 0 (which can also be called 18)

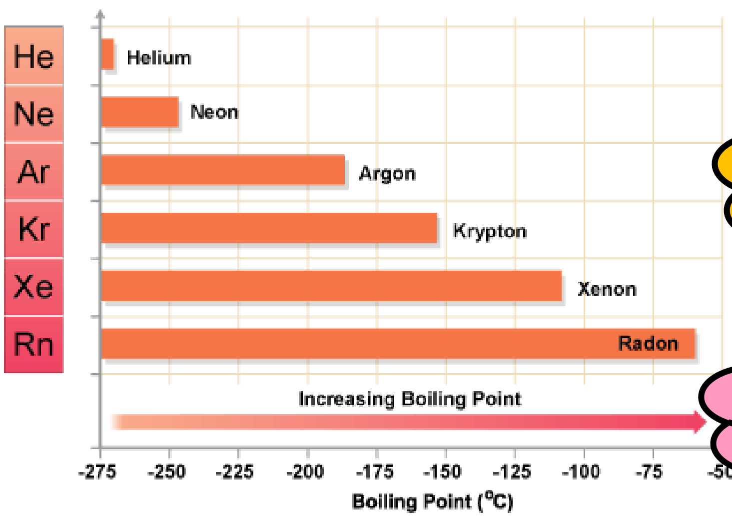


They have 8 electrons in their outer shell

Common properties

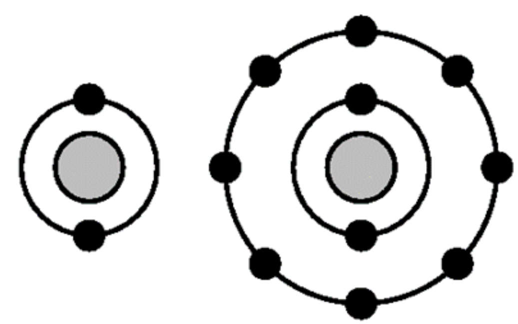
The noble gases have the following properties in common:

- They are non-metals
- They are very unreactive gases
- They are colourless
- They exist as single atoms (they are monatomic)



High melting and boiling points

Do not react easily



Helium Neon

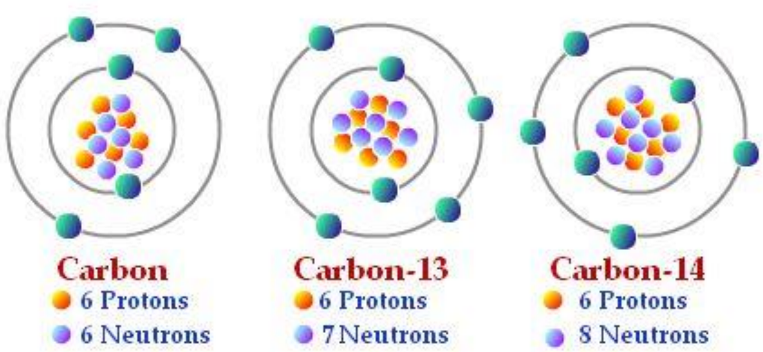
Ion and Isotopes

Back to C1

Isotope

When an element has a different number of neutrons it is called an isotope.
It still has the same number of electrons and protons = so reacts in the same way

Isotopes have different mass numbers but the same atomic number.



Ion

When atoms loses electrons they become IONS Electrons are negative.

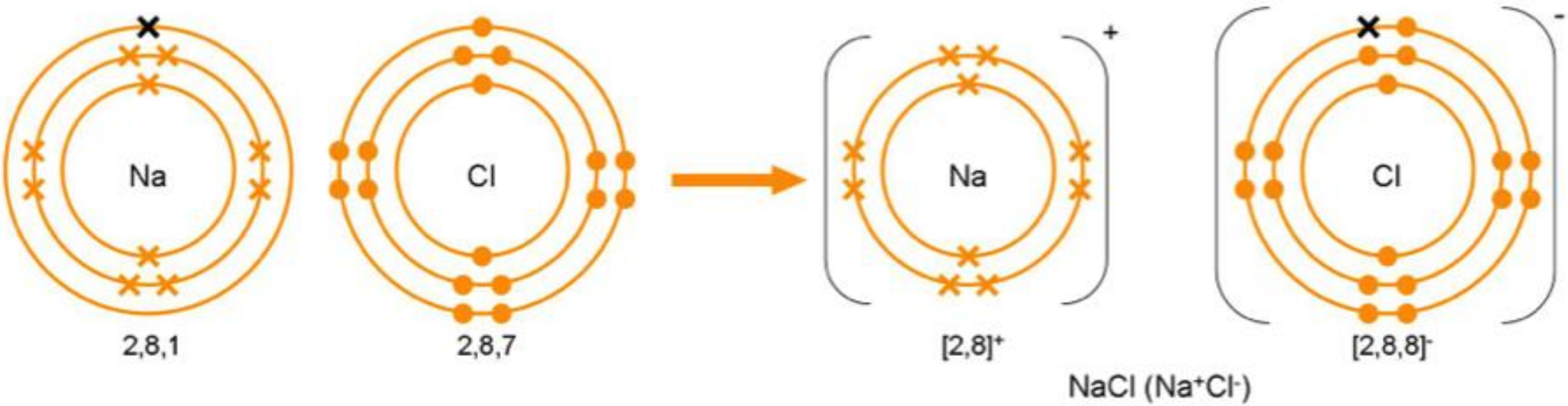
The outside ring needs to add up to 8.
For metals we LOSE electrons to make this happen
This is called a CATION

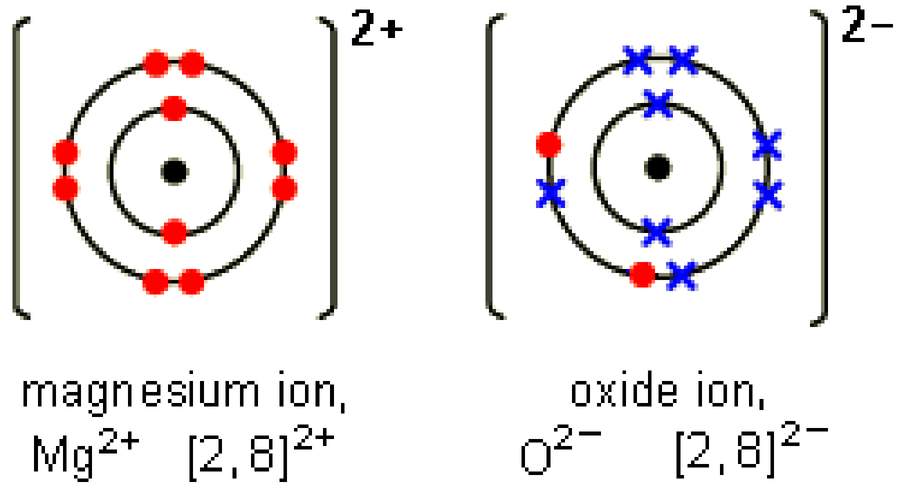
The outside ring needs to add up to 8.
For non-metals we GAIN electrons to make this happen
We call this an ANION

Ionic Bonding

Transferring Electrons.

Atoms lose or gain electrons to form **charged** particles called **IONS**.

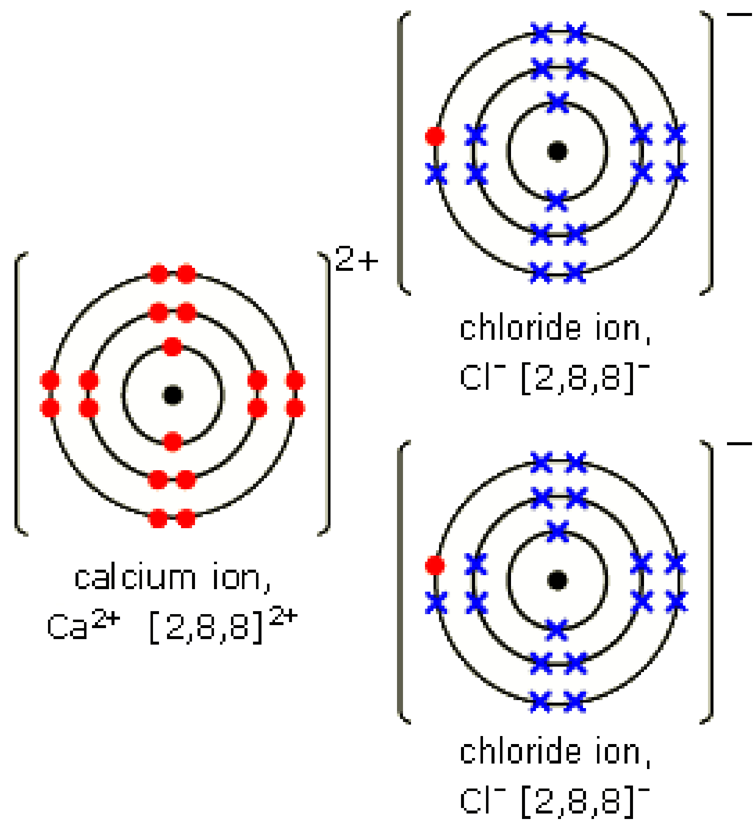




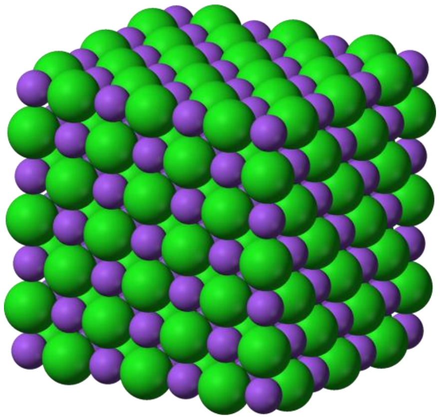
<u>You also need to know:</u>

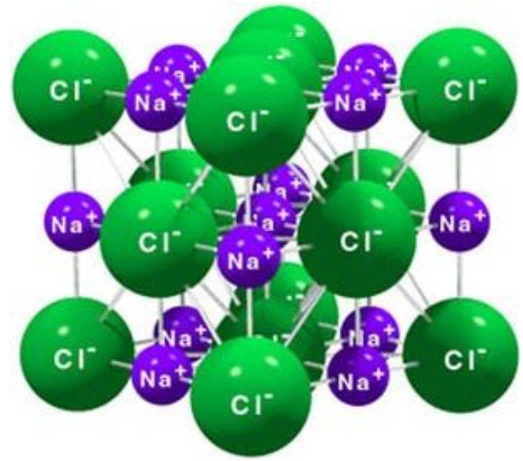
Magnesium Oxide

Calcium Chloride



Ionic Compounds

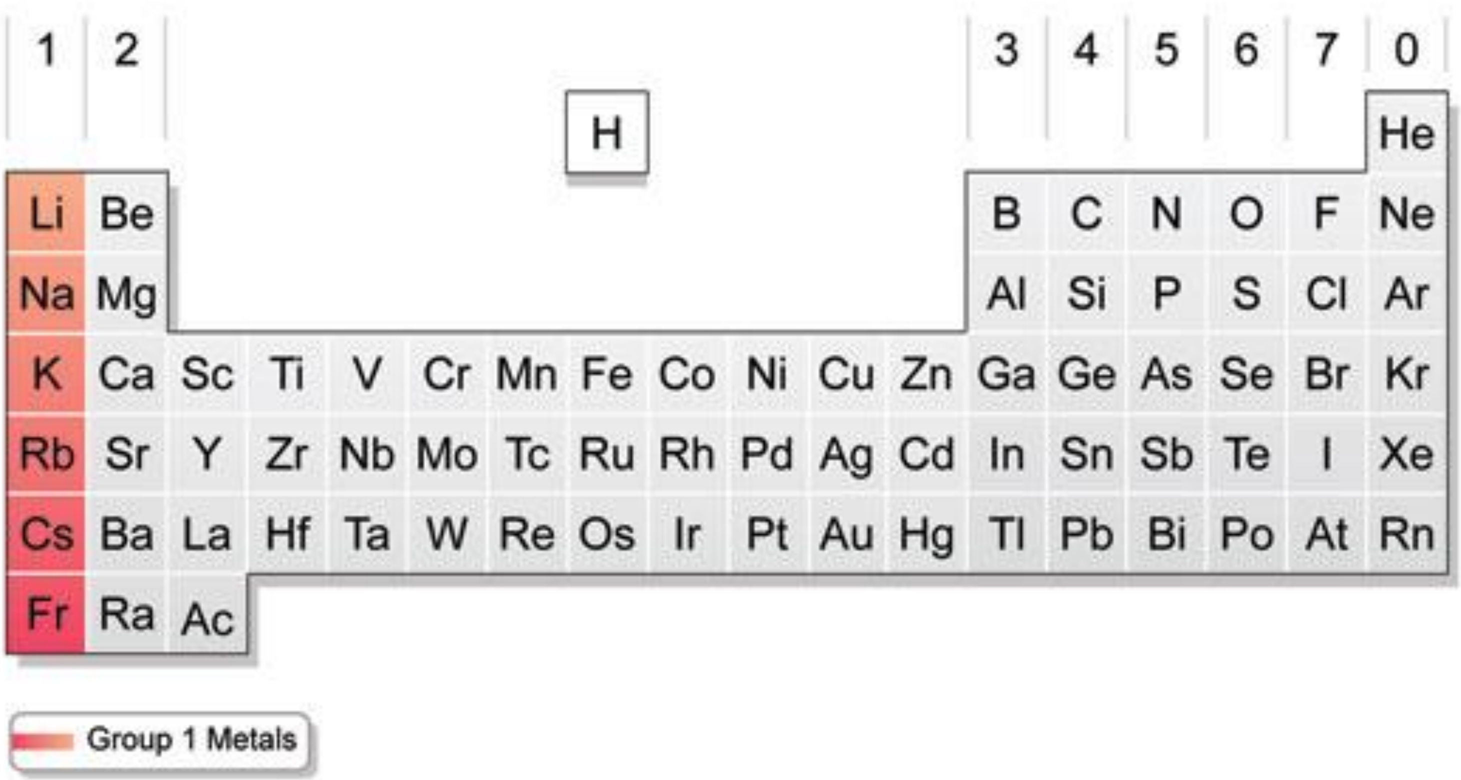




-Lattice structure
-Regular arrangement
-Strong electrostatic forces
-High melting points
-High boiling points
-Conduct electricity when molten or dissolved

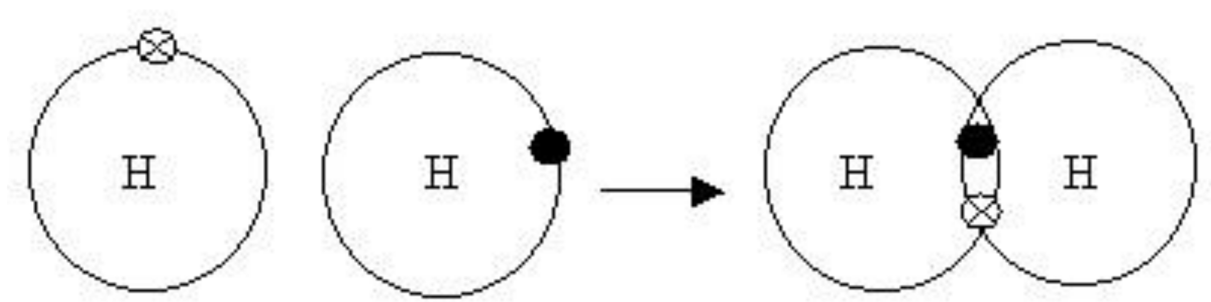
Ions and Formulas

Groups 1 & 2 and 6 & 7 are most likely to form Ions.

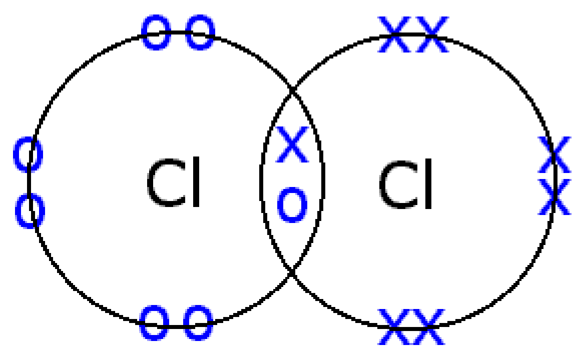


<u>Covalent Bonding</u>

Atoms **SHARE** electrons. E.g.

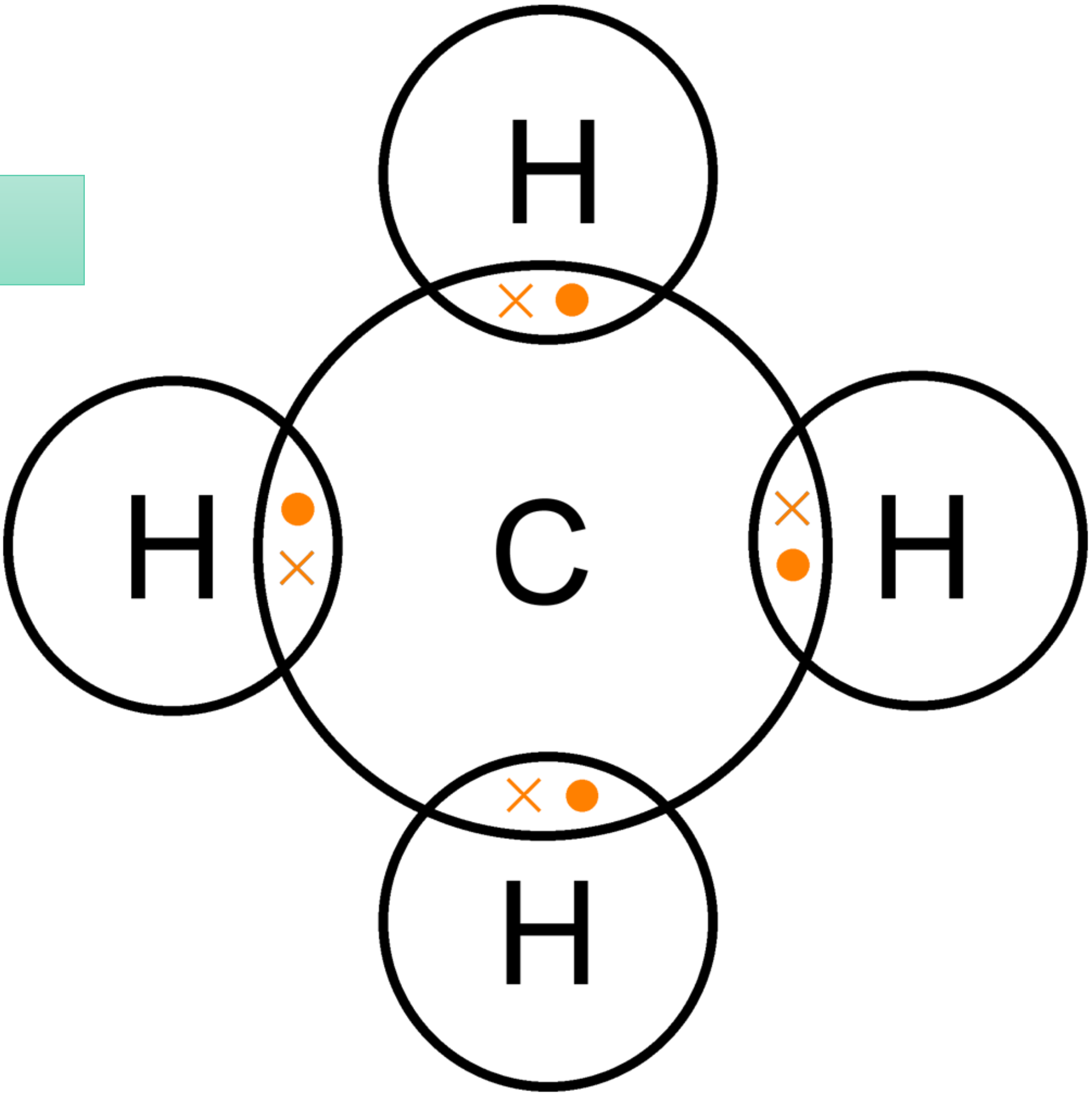


Hydrogen



Chlorine

Methane



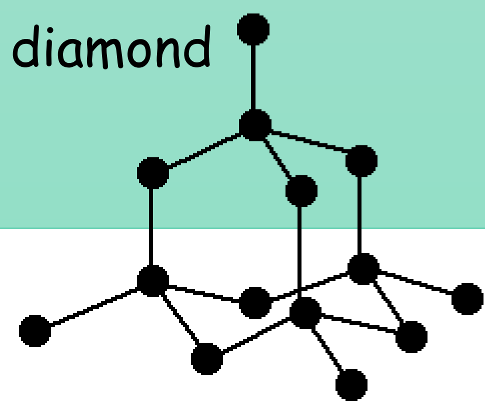
2 Kinds of Covalent Substances

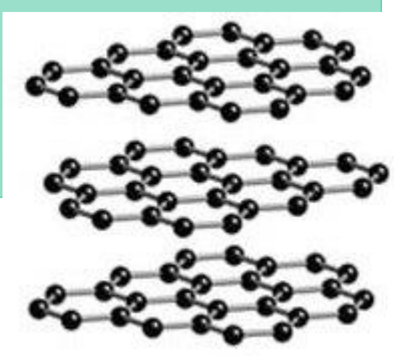
Simple Molecular

-Strong bonds
-Weak forces of attraction
-Low melting and boiling points
-Do not conduct electricity

Giant Covalent Structure

-Strong bonds
-High melting and boiling points
-Do not conduct electricity
-Examples include graphite and diamond



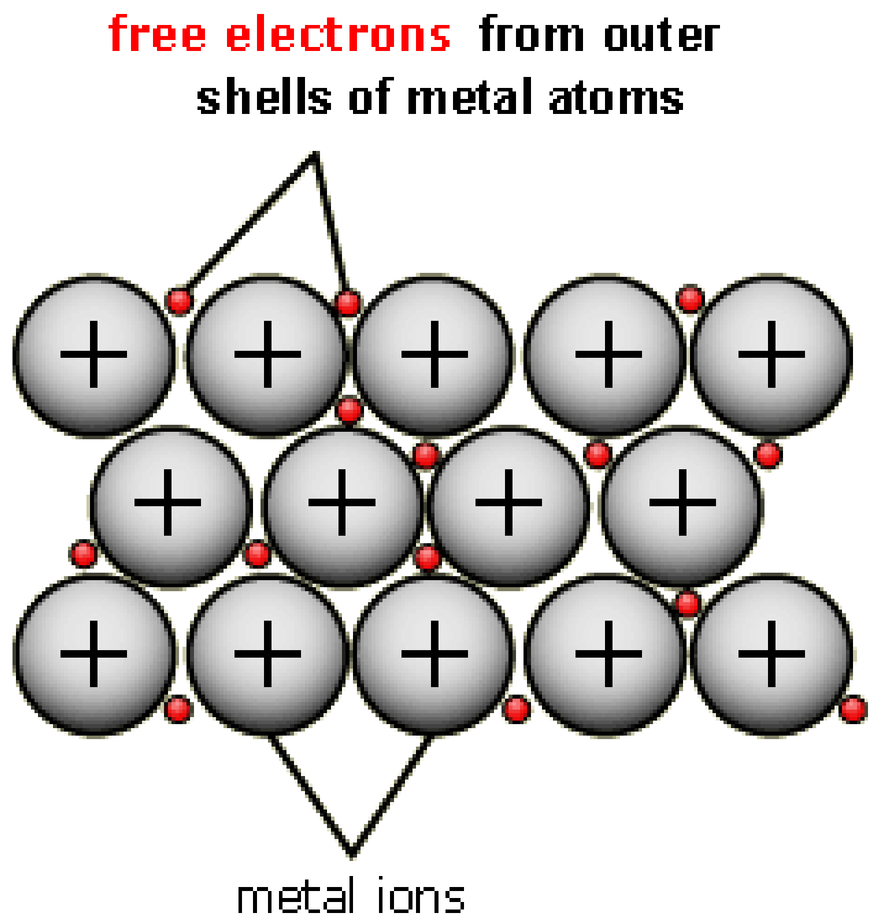


Metallic Structures

-Free electrons which make them good conductors of electricity.

- Regular pattern

-Can bend as have layers that slide over each other

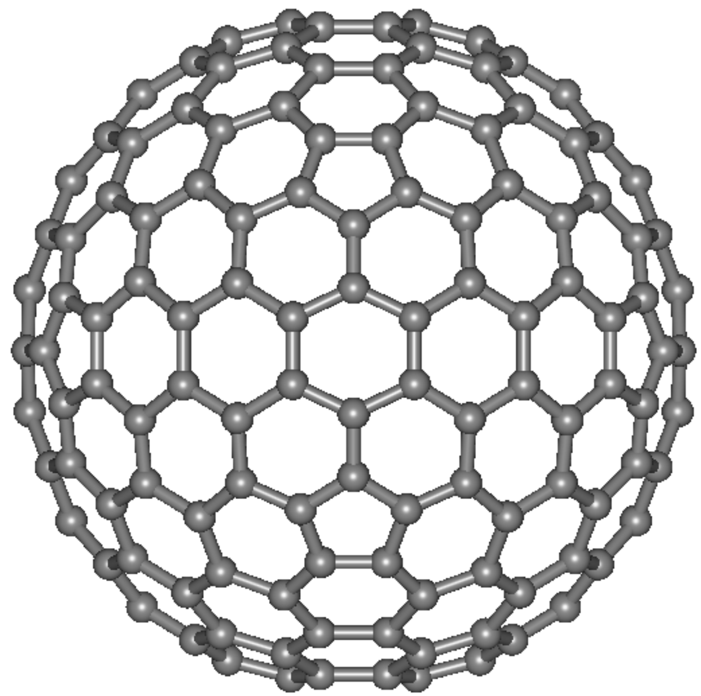


Nanoparticles

' 1-100 nanometres across'

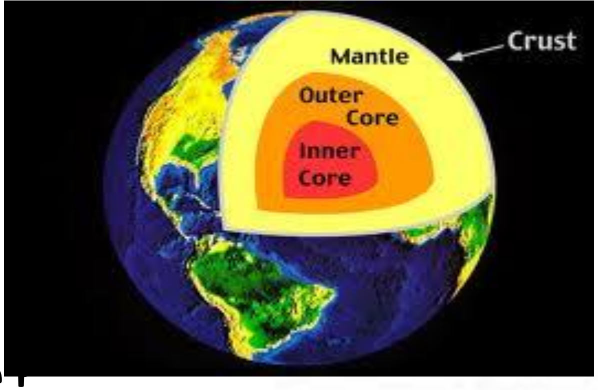
Uses

Sun tan cream
Deodorant
Self cleaning glass
Computer chips



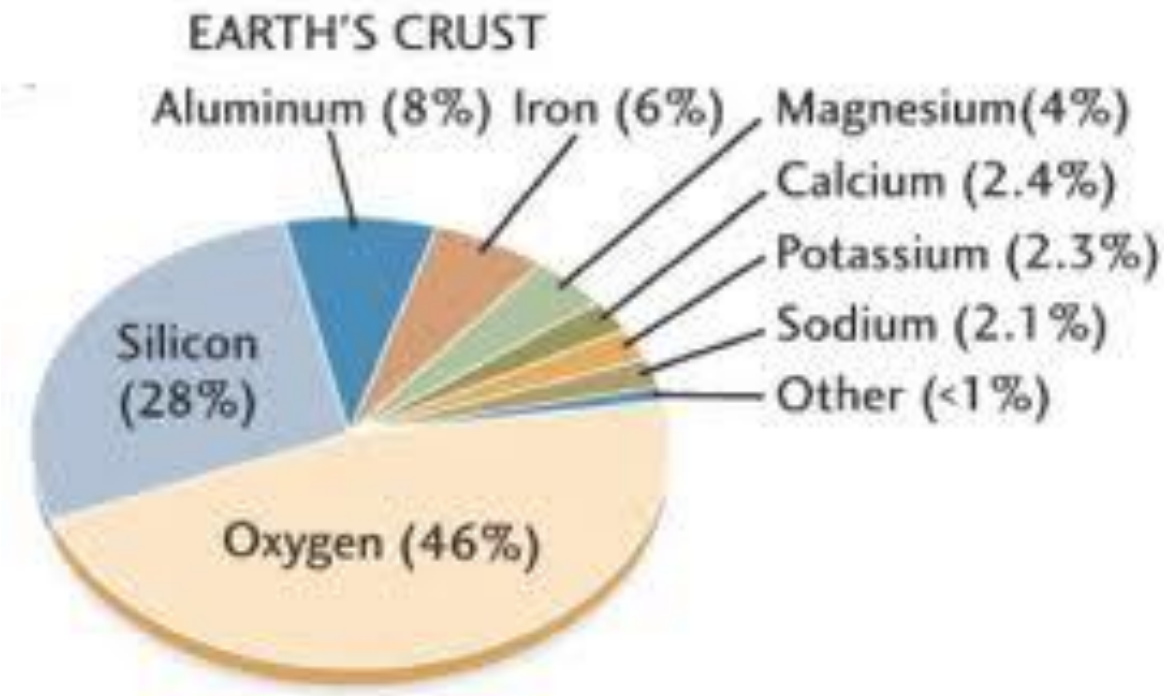
- Where on Earth are they found?

In the Earths Crust



The earths crust contains many different elements

- What is a metal ore?



Ores are naturally occurring rocks that contain metal or metal compounds **in sufficient amounts to make it financially worthwhile** extracting them. For example, iron ore is used to make iron and steel.

- Some metals are not very reactive and exist in the earths crust in their **Native** state such as Gold

Carbon and hydrogen are there to show the relative reactivities.

Elements below hydrogen are often found native. Elemetns below carbon can be extracted by displacement. Elements above carbon can only be extracted by electolysis.

K	Potassium
Na	Sodium
Ca	Calcium
Mg	Magnesium
Al	Aluminium
C	*Carbon*
Zn	Zinc
Fe	Iron
Sn	Tin
Pb	Lead
H	*Hydrogen*
Cu	Copper
Ag	Silver
Au	Gold
Pt	Platinum

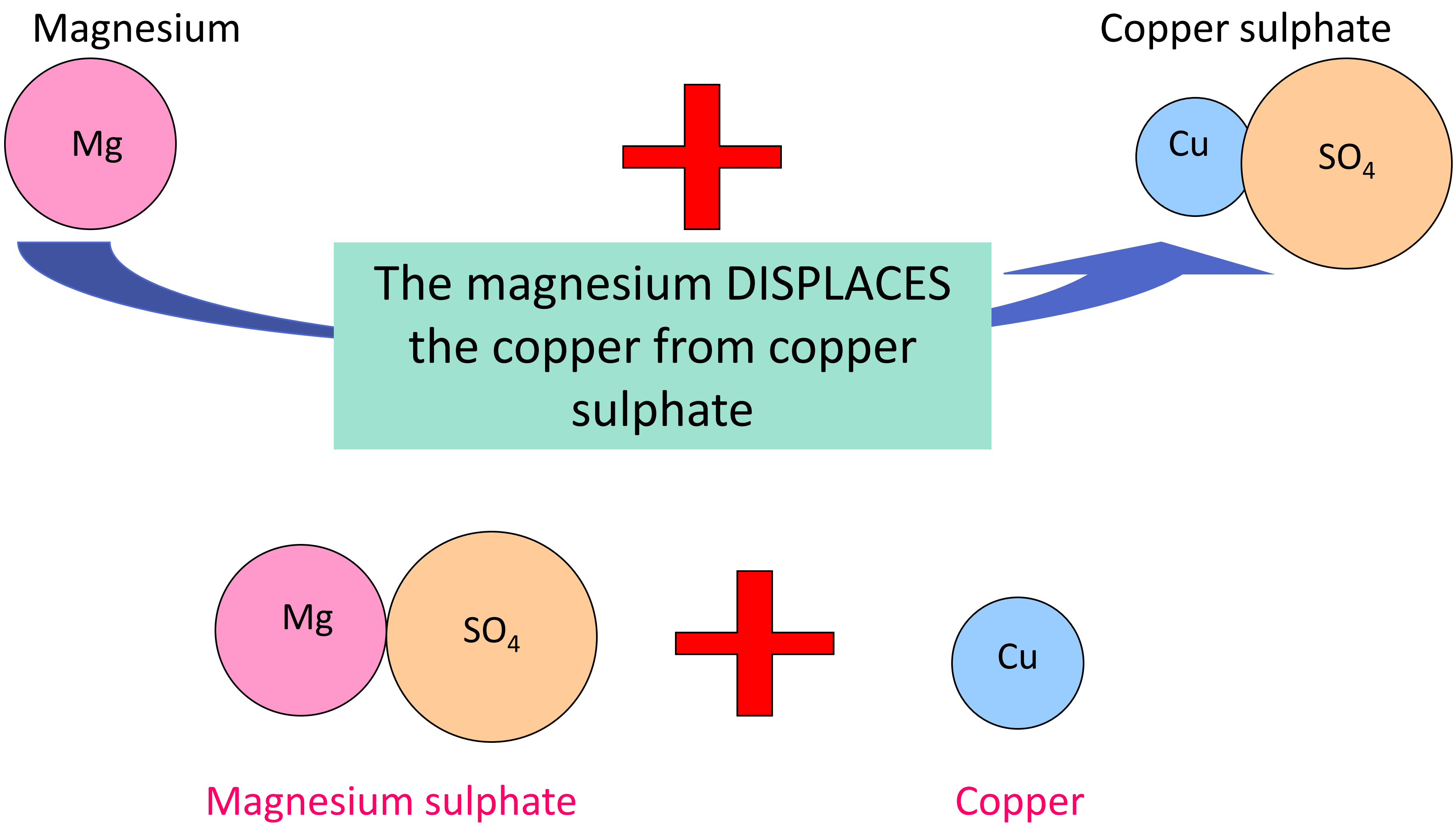
most reactive

least reactive

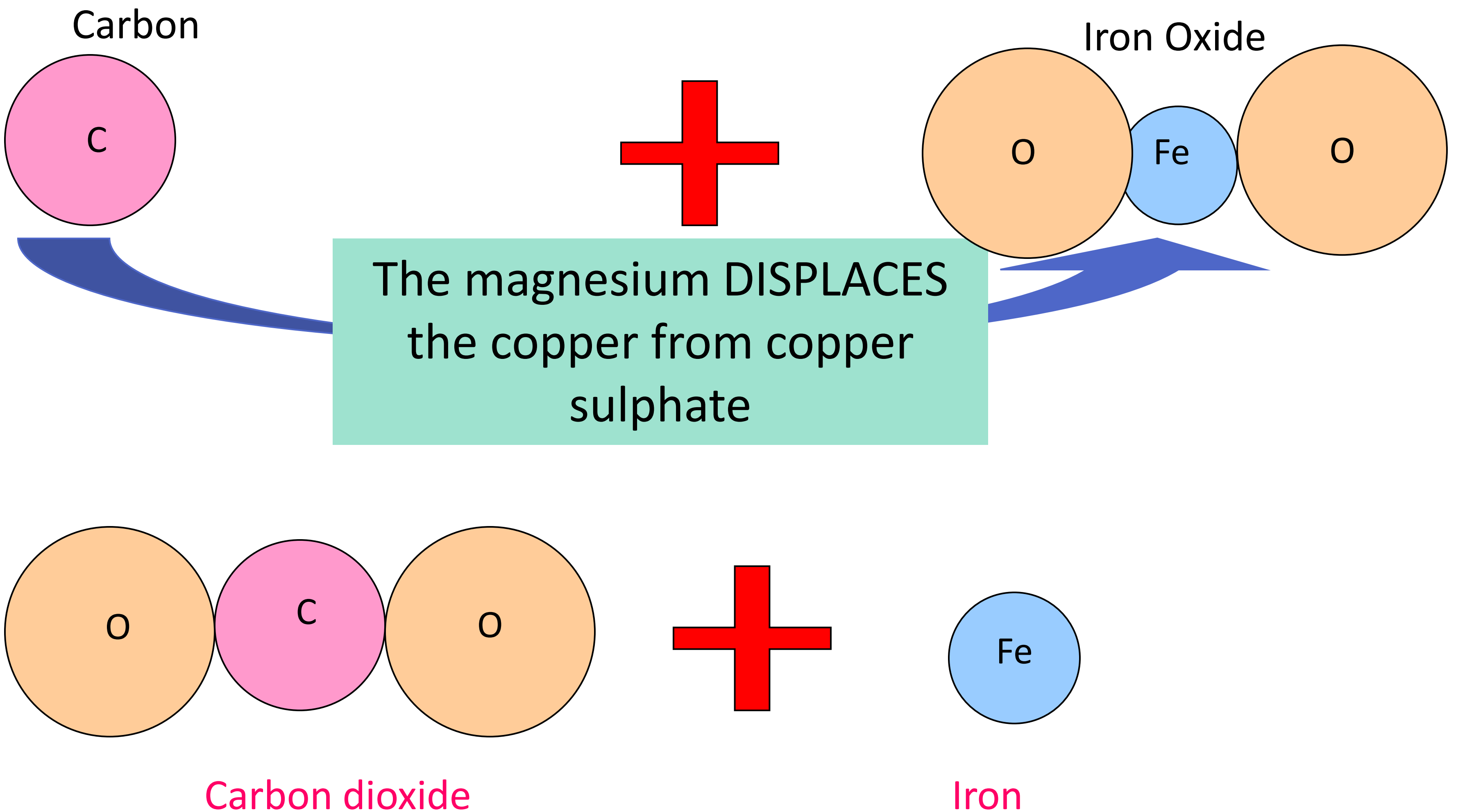
(added for comparison)

Displacement reactions

A displacement reaction is one where a MORE REACTIVE metal will DISPLACE a LESS REACTIVE metal from a compound.

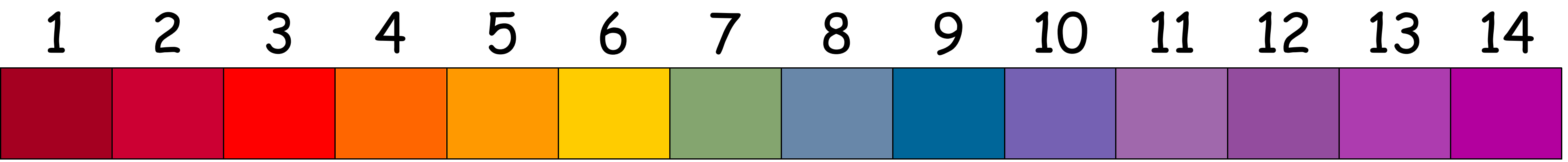


Displacement reactions



Universal Indicator and the pH scale

Universal Indicator is a mixture of liquids that will produce a range of colours to show how strong the acid or alkali is:



Stomach acid Lemon juice Water Soap Baking powder Oven cleaner

Strong acid

Neutral

Strong alkali

H_2O = neutral

An <u>acid</u> contains hydrogen ions, H^+

An <u>alkali</u> contains hydroxide ions, OH^-

Neutralisation

Acid + Base → Salt + Water

Neutralisation

The general equations for these reactions are:

acid + metal oxide → salt + water

acid + metal hydroxide → salt + water

acid + metal carbonate → salt + water + carbon dioxide

The salt that is formed in a neutralisation reaction depends on the acid:

- sulfuric acid produces sulfate salts
- nitric acid produces nitrate salts
- hydrochloric acid produces chloride salts.

Acids

Name of acid	Formula
Sulphuric acid	H_2SO_4
Hydrochloric	HCl
Nitric acid	HNO_3

Salts are made when neutralisation occurs

Sulphuric acid → **Sulphates**

Nitric acid → **Nitrates**

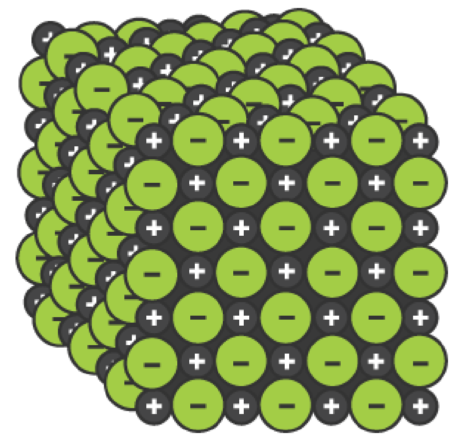
Hydrochloric acid → **Chlorides**

Ionic compounds

Ions are atoms, or groups of atoms, that have lost or gained electrons.

- Metal atoms lose electrons, forming positive ions (**cations**) such as Na^{+}, Cu^{2+} and Fe^{3+}.

- Non-metals gain electrons, forming negative ions (**anions**) such as Cl^{-}, O^{2-}, NO_3^{-} and SO_4^{2-}.



Ionic lattice

Why ionic compounds cannot conduct electricity in solid state?

Ions are held firm in place and cannot move to carry current

Why ionic compounds conduct electricity when molten or dissolved in water?

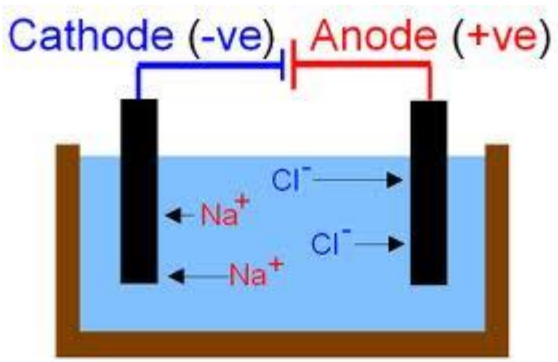
Ions are free to move and carry current.

The electrode

Remember don't panic!!

Example:

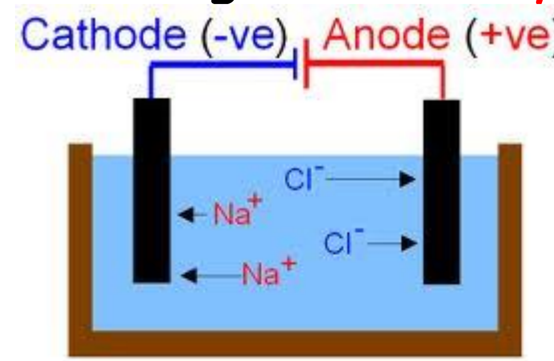
D
O
N'
T
P OSITIVE
A NODE
N EGATIVE
I S
C ATHODE



Changes at the electrode

Electrolysis is the process whereby an ionic substance that is molten or dissolved is broken down into elements using electricity.

Example:



Electrolysis decomposes **molten** sodium chloride

$2NaCl(l) \rightarrow 2Na(l) + Cl_2(g)$

- The negatively Cl^- move towards anode (+ve). Each ion loses one electron. Losing electrons is called **oxidation**.
- The positively Na^+ move towards cathode (-ve). Each ion gains one electron. Gaining electrons is called **reduction**.

Half equations

Cathode (-ve electrode):

$Na^+ + e^- \rightarrow Na$ **Reduction**

Anode(+ve electrode):

$2Cl^- \rightarrow Cl_2 + 2e^-$ **Oxidation**

OIL RIG

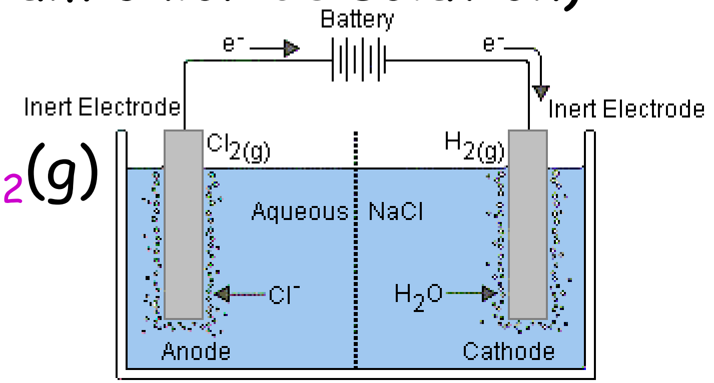
Oxidation is loss

Reduction is gain

Electrolysis of brine

The electrolysis of brine (concentrated sodium chloride solution) produces three products:

$$2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH + Cl_2(g) + H_2(g)$$



Half equations

Cathode (-ve electrode):

$$H_2O \rightleftharpoons H^+ + OH^-$$

$$2H^+ + 2e^- \rightarrow H_2$$ **Reduction**

Anode(+ve electrode):

$$2Cl^- \rightarrow Cl_2 + 2e^-$$ **Oxidation**

The remaining solution

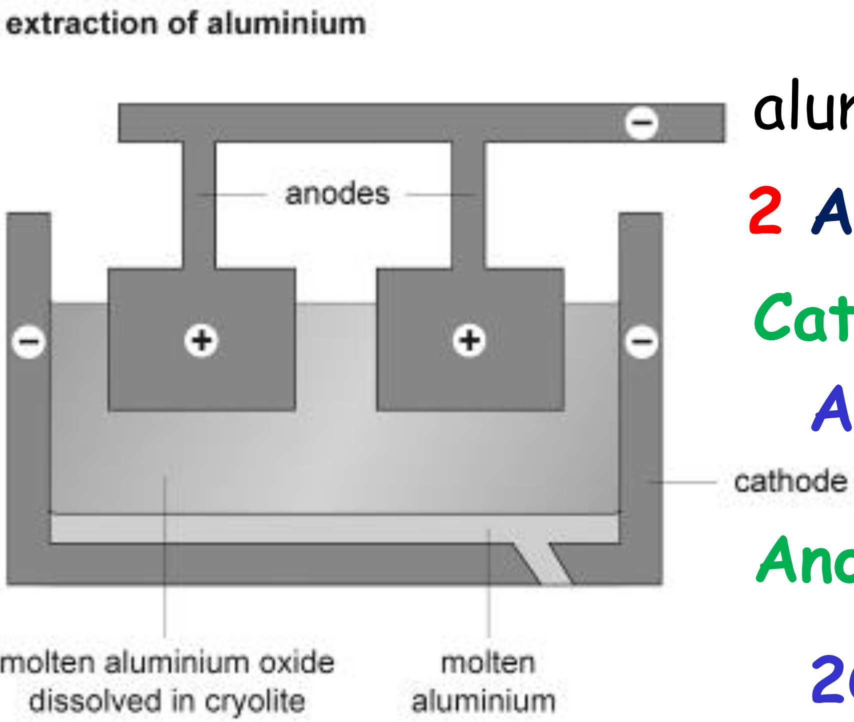
$$Na^+(aq) + OH^-(aq) \rightarrow NaOH(aq)$$

- **Chlorine** is used to make bleach
- **Hydrogen** is used to make margarine by reacting with vegetable oil.
- **Sodium hydroxide** is used to make soap and paper.

Extracting aluminium

Aluminium is extracted from **bauxite** ore (impure Al_2O_3)

Aluminium is extracted electrolysing molten Al_2O_3. The Al_2O_3 is mixed with **cryolite** to lower the melting point from 2100 ^oC to about 900 ^oC.



aluminium oxide → aluminium + oxygen

$$2\ Al_2O_3 \rightarrow 4\ Al + 3\ O_2$$

Cathode (-ve electrode):

$$Al^{3+} + 3e^- \rightarrow Al$$

Anode(+ve electrode):

$$2O^{2-} \rightarrow O_2 + 4e^-$$

The O_2 reacts with the hot, positive carbon electrode, making CO_2 gas. So the positive electrode gradually burns away. They need to be replaced in the cells regularly.