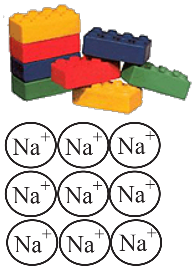
Contents	

Elements

Element

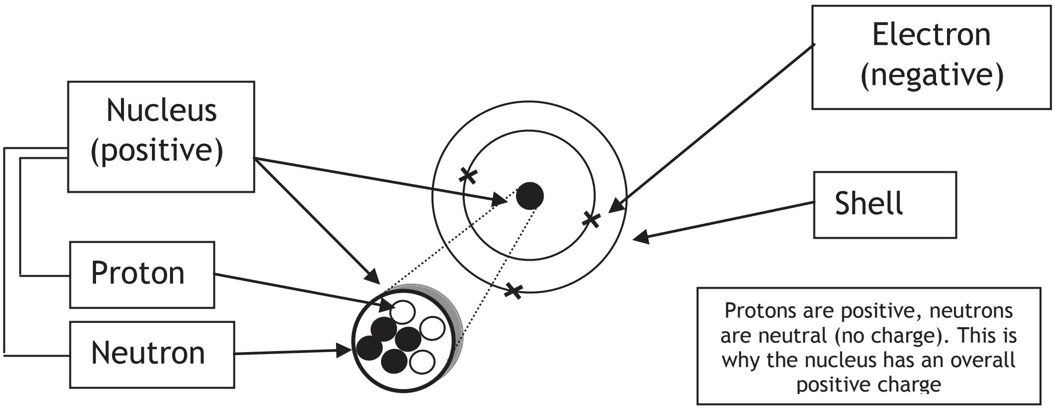


Elements are the building blocks of all substances. They cannot be broken down into simpler substances by chemical means

An Element contains only one type of atom

Atom

Each atom has negatively charged electrons orbiting a positively charged nucleus



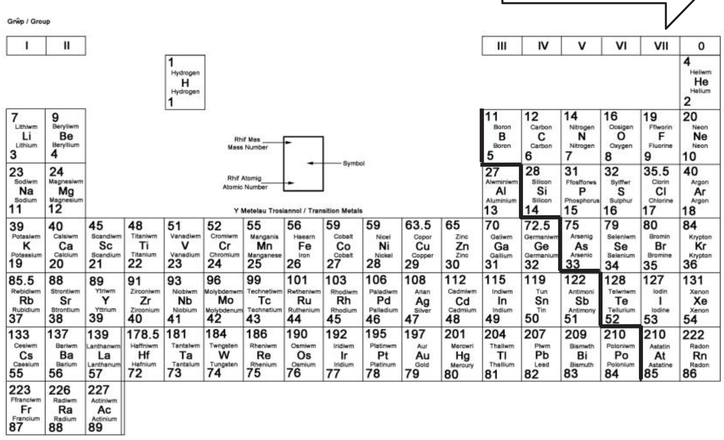
The Periodic Table - Basics

Group — There are eight groups

down

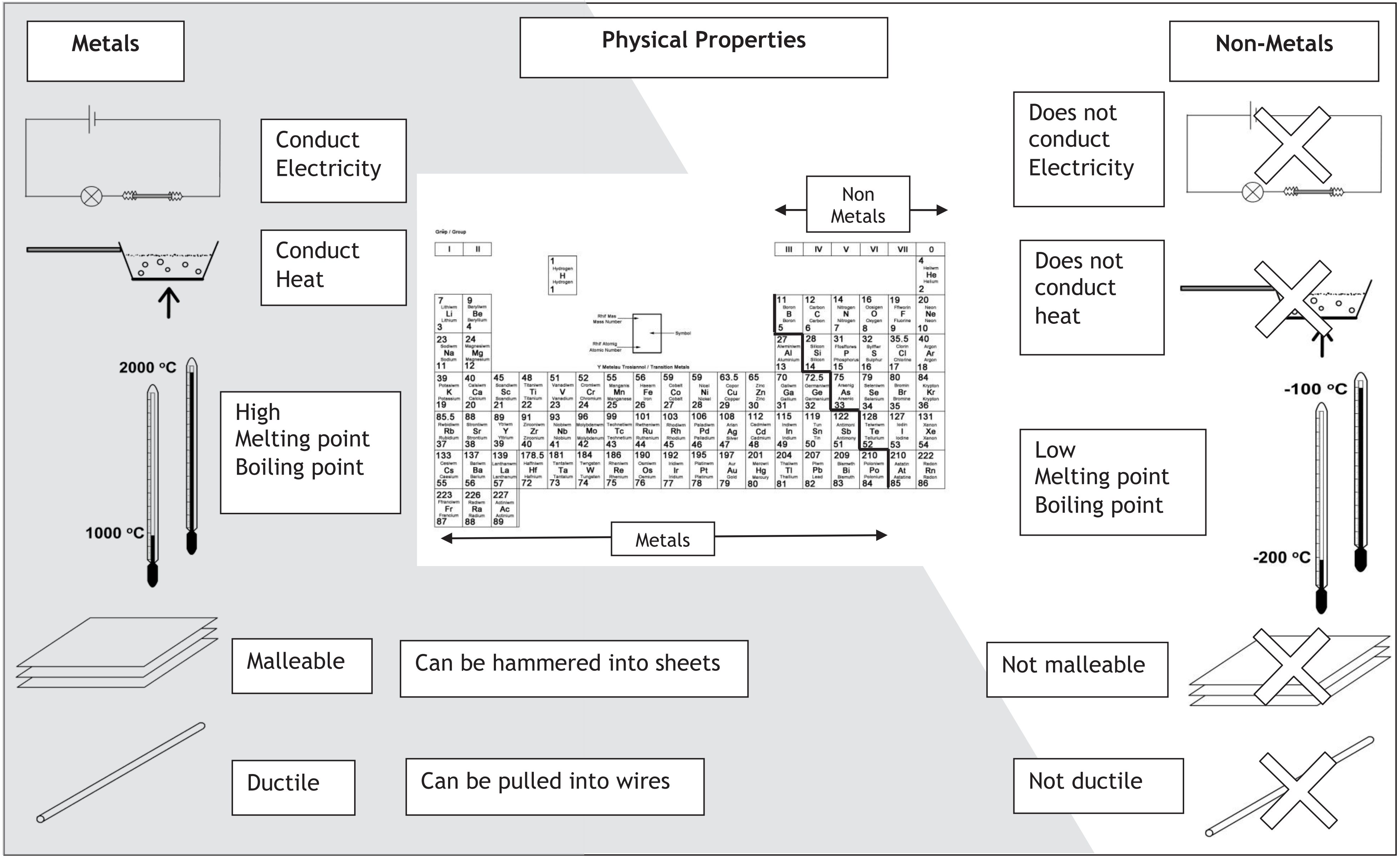
across

Period



1
2
3
4
5
6
7

<u>Describing Position</u>
Sodium is in Group 1, Period 3
Helium is in Group 0, Period 1
Beryllium is in Group 2, Period 2

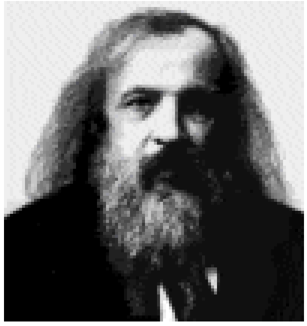


Elements change from being metals to non-metals on going from left to right across the Periodic Table

Many elements in Group 3, 4, 5 show metallic and non-metallic properties

Periodic Table

Scientists as far back as 1817 found patterns in the reactivity of elements; however it was Mendeléev (1869) who first arranged the elements in a layout recognisable as a Periodic Table.



He placed the elements into 8 groups, in each group elements reacted similarly. Elements were arranged according to

1. Increasing atomic mass (top number)
2. Similar chemical properties

Confident in his work he left **gaps** predicting that some elements that were not discovered at the time should be placed there as they would have similar properties

In the old group1 there are different elements such as Copper, Silver and Gold

Gaps where he predicted an element with similar properties should exist

Reihen	Gruppe I. — R^2O	Gruppe II. — RO	Gruppe III. — R^2O^3	Gruppe IV. RH^4 RO^2	Gruppe V. RH^3 R^2O^5	Gruppe VI. RH^2 RO^3	Gruppe VII. RH R^2H^7	Gruppe VIII. — RO^4
1	H = 1							
2	Li = 7	Be = 9, 4	B = 11	C = 12	N = 14	O = 16	F = 19	
3	Na = 23	Mg = 24	Al = 27, 3	Si = 28	P = 31	S = 32	Cl = 35, 5	
4	K = 39	Ca = 40	— = 44	Ti = 48	V = 51	Cr = 52	Mn = 55	Fe = 56, Co = 59, Ni = 59, Cu = 63.
5	(Cu = 53)	Zn = 65	— = 68	— = 72	As = 75	Se = 78	Br = 80	
6	Rb = 85	S = 87	?Yt = 88	Zr = 90	Nb = 94	Mo = 96	— = 100	Ru = 104, Rh = 104, Pd = 106, Ag = 108
7	(Ag = 108)	Cd = 112	In = 113	Sn = 118	Sb = 122	Te = 125	J = 127	
8	Cs = 133	Ba = 137	?Di = 138	?Ce = 140	—	—	—	— — — —
9	(—)	—	—	—	—	—	—	
	—	—	?Er = 178	?La = 180	Ta = 182	W = 184	—	Os = 195, Ir = 197, Pt = 198, Au = 199.
11	(Au = 198)	Hg = 200	Tl = 204	Pb = 207	Bi = 208			
12	—	—	—	Th = 231	—	U = 240	—	— — — —

Group 4 has many elements which are in the transitional group today

Group 8 and not Group 0 like today.

The periodic table is also arranged by now in increasing atomic number (bottom number)
There are many more elements now as scientists have discovered them over the years. These elements have fitted into the gaps left by Mendeléev.

Tabl Cyfnodol yr Elfennau — Periodic Table of the Elements

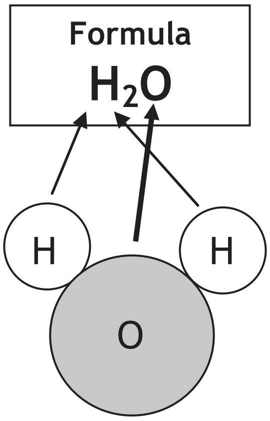
Grŵp / Group

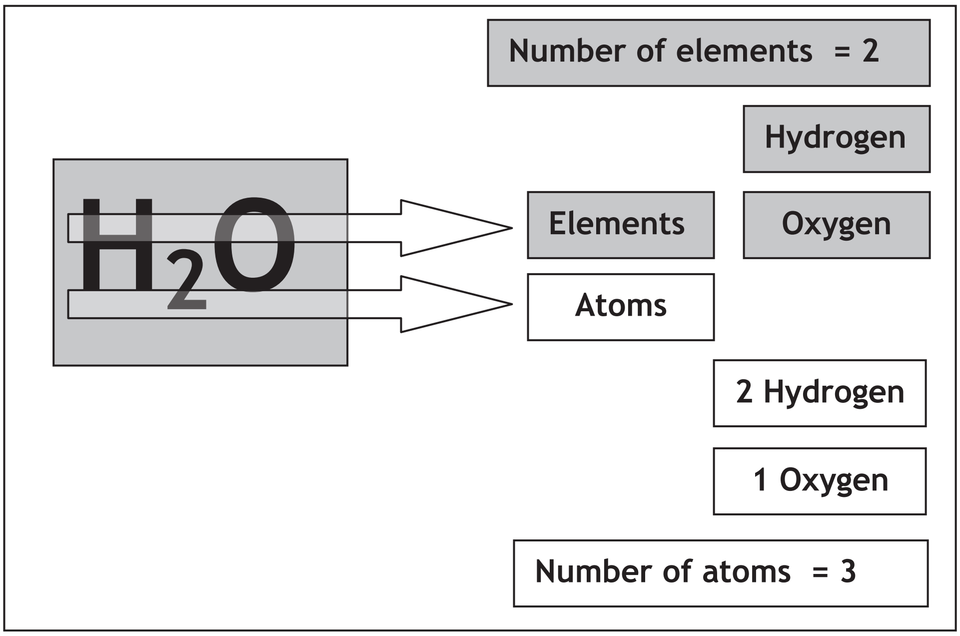
Rhif Mas / Mass Number; Symbol; Rhif Atomig / Atomic Number

Y Metelau Trosiannol / Transition Metals

I	II											III	IV	V	VI	VII	0
				1 Hydrogen H Hydrogen 1													4 Heliwm He Helium 2
7 Lithiwm Li Lithium 3	9 Beryliwm Be Beryllium 4											11 Boron B Boron 5	12 Carbon C Carbon 6	14 Nitrogen N Nitrogen 7	16 Ocsigen O Oxygen 8	19 Fflworin F Fluorine 9	20 Neon Ne Neon 10
23 Sodiwm Na Sodium 11	24 Magnesiwm Mg Magnesium 12											27 Alwminiwm Al Aluminium 13	28 Silicon Si Silicon 14	31 Ffosfforws P Phosphorus 15	32 Sylffwr S Sulphur 16	35.5 Clorin Cl Chlorine 17	40 Argon Ar Argon 18
39 Potasiwm K Potassium 19	40 Calsiwm Ca Calcium 20	45 Scandiwm Sc Scandium 21	48 Titaniwm Ti Titanium 22	51 Vanadiwm V Vanadium 23	52 Cromiwm Cr Chromium 24	55 Manganis Mn Manganese 25	56 Haearn Fe Iron 26	59 Cobalt Co Cobalt 27	59 Nicel Ni Nickel 28	63.5 Copor Cu Copper 29	65 Zinc Zn Zinc 30	70 Galiwm Ga Gallium 31	72.5 Germaniwm Ge Germanium 32	75 Arsenig As Arsenic 33	79 Seleniwm Se Selenium 34	80 Bromin Br Bromine 35	84 Krypton Kr Krypton 36
85.5 Rwbidiwm Rb Rubidium 37	88 Strontiwm Sr Strontium 38	89 Ytriwm Y Yttrium 39	91 Zirconiwm Zr Zirconium 40	93 Niobiwm Nb Niobium 41	96 Molybdenwm Mo Molybdenum 42	99 Technetiwm Tc Technetium 43	101 Rwtheniwm Ru Ruthenium 44	103 Rhodiwm Rh Rhodium 45	106 Paladiwm Pd Palladium 46	108 Arian Ag Silver 47	112 Cadmiwm Cd Cadmium 48	115 Indiwm In Indium 49	119 Tun Sn Tin 50	122 Antimoni Sb Antimony 51	128 Telwriwm Te Tellurium 52	127 Iodin I Iodine 53	131 Xenon Xe Xenon 54
133 Cesiwm Cs Caesium 55	137 Bariwm Ba Barium 56	139 Lanthanwm La Lanthanum 57	178.5 Haffniwm Hf Hafnium 72	181 Tantalwm Ta Tantalum 73	184 Twngsten W Tungsten 74	186 Rheniwm Re Rhenium 75	190 Osmiwm Os Osmium 76	192 Iridiwm Ir Iridium 77	195 Platinwm Pt Platinum 78	197 Aur Au Gold 79	201 Mercwri Hg Mercury 80	204 Thaliwm Tl Thallium 81	207 Plwm Pb Lead 82	209 Bismwth Bi Bismuth 83	210 Poloniwm Po Polonium 84	210 Astatin At Astatine 85	222 Radon Rn Radon 86
223 Ffranciwm Fr Francium 87	226 Radiwm Ra Radium 88	227 Actiniwm Ac Actinium 89															

Compounds	Substance that contains two or more elements joined together chemically

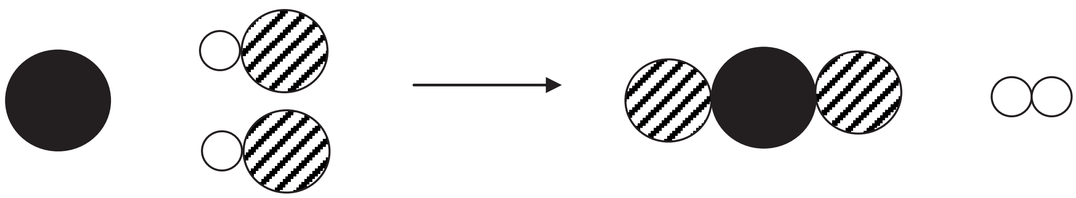




Compound	Formula	No. of elements	No. of atoms
Sodium Chloride	NaCl	2	2 (1 Na, 1 Cl)
Sodium Hydroxide	NaOH	3	3 (1 Na, 1 O, 1 H)
Sodium Oxide	Na_2O	2	3 (2 Na, 1 O)
Sodium Sulfate	Na_2SO_4	3	7 (2 Na, 1 S, 4 O)
Calcium Carbonate	$CaCO_3$	3	5 (1 Ca, 1 C, 3 O)

Chemical Reactions	Atoms are rearranged but none are created or destroyed

e.g.



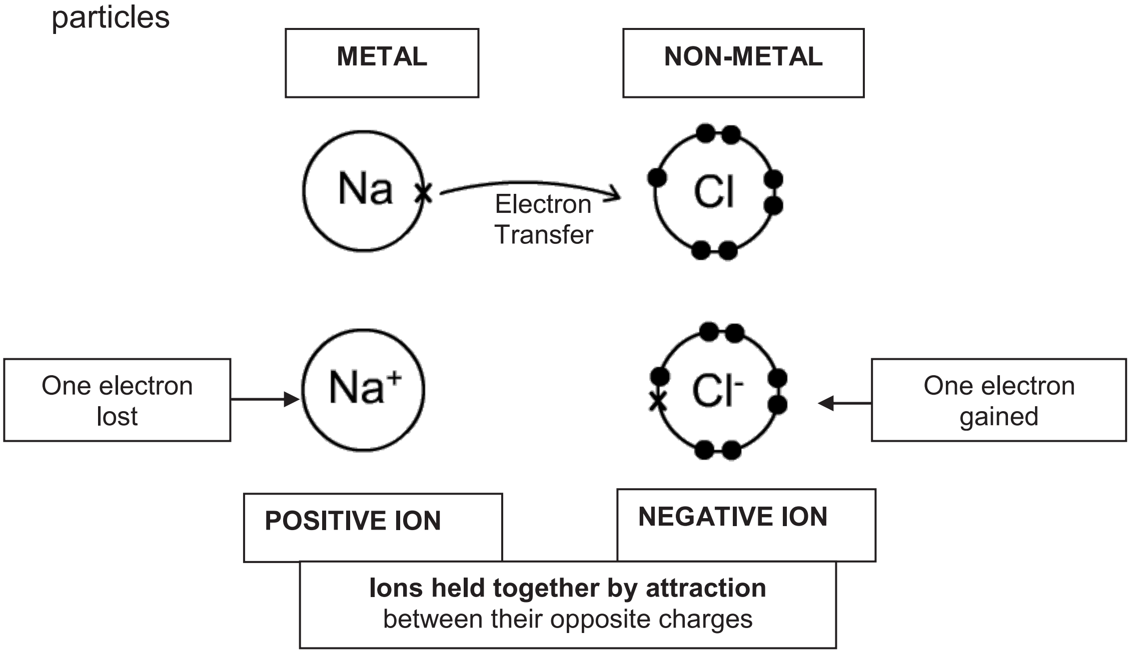
$$Mg + 2HCl \longrightarrow MgCl_2 + H_2$$

Same number of atoms in reactants and products, atoms are differently arranged.

Ionic Compounds

When a chemical reaction takes place new bonds are formed. Ionic compounds form by the **transfer of electrons** from <u>metal to non-metal</u> atom. Charged particles called **ions** are formed

e.g.
When sodium chloride (NaCl) forms, one electron is transferred from sodium to chlorine. This will form a **full stable outer shell** (like noble gasses) for the two particles



Using ions to create formulae

Lithium = Li^+

Sodium = Na^+

Potassium = K^+

Magnesium = Mg^{2+}

Calcium = Ca^{2+}

chloride = Cl^-

oxide = O^{2-}

bromide = Br^-

sulfide = S^{2-}

iodide = I^-

Sodium Chloride

Na^+ Cl^-

Ions cancel

$NaCl$

Magnesium Oxide

Mg^{2+} O^{2-}

Ions cancel

MgO

Lithium Oxide

Li^+ O^{2-}

Li^+

Ions cancel

Li_2O

Magnesium Chloride

Mg^{2+} Cl^-

Cl^-

Ions cancel

$MgCl_2$

Hydroxide= OH^-

Sulfate= SO_4^{2--}

Carbonate = CO_3^{2--}

Nitrate = NO_3^-

Sodium Hydroxide

Na^+ OH^-

Ions cancel

$NaOH$

Magnesium Hydroxide

Mg^{2+} OH^-

OH^-

Ions cancel

$Mg(OH)_2$

Two sets of OH^- (brackets used)

Sodium Carbonate

Na^+ CO_3^{2--}

Na^+

Ions cancel

Na_2CO_3

Calcium Carbonate

Ca^{2+} CO_3^{2--}

Ions cancel

$CaCO_3$

Quick method

Lithium Oxide

Li^+ O^{2-}

Li_2O

Sodium Carbonate

Na^+ CO_3^{2--}

Na_2CO_3

Extraction of Metals

Ores – Metals are found in compounds in rocks which make up the Earth's crust, these are called ores

Ore	Formula	Metal extracted
Bauxite	Al_2O_3	Aluminium
Haematite	Fe_2O_3	Iron

Extraction is the term for getting pure metal out of the ore; there are two methods of extracting metals which depend on their reactivity

Reduction is the process of removing oxygen from the ore using carbon

Electrolysis is the process of using electricity to extract a metal

Reactivity Series – metals are placed in order of reactivity by reacting them with oxygen, water and acid. From this data a reactivity series is produced

Increasing Reactivity

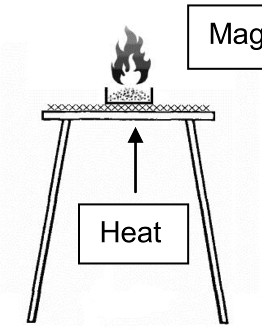
The Reactivity Series	Extraction Method
Potassium Sodium Calcium Magnesium Aluminium	Metals <u>more reactive</u> than carbon are extracted using **ELECTROLYSIS**
(Carbon)	
Zinc Iron Lead	Metals <u>less reactive</u> than carbon are extracted by **CHEMICAL REDUCTION** using CARBON
Hydrogen	
Copper Silver Gold	Unreactive - occur naturally as elements (NATIVE)

At the top metals naturally bond to oxygen stronger which makes it difficult to remove.

Displacement Reactions

Reduction is the loss of oxygen from a compound

Oxidation is the gain of oxygen to form a compound



Magnesium and copper oxide

$Mg + CuO \rightarrow MgO + Cu$

oxidation

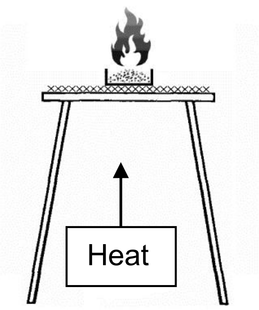
Magnesium + copper oxide → magnesium oxide + copper

reduction

Blast Furnace Reaction

Iron oxide and carbon monoxide

$Fe_2O_3 + \mathbf{3}CO \rightarrow \mathbf{3}CO_2 + \mathbf{2}Fe$



oxidation

iron oxide + carbon → carbon monoxide + iron

reduction

The Thermite Reaction

$Fe_2O_3 + \mathbf{2}Al \rightarrow Al_2O_3 + \mathbf{2}Fe$

oxidation

Iron oxide + aluminium → aluminium oxide + iron

reduction

Displacement Examples

Iron and copper chloride

$Fe + CuCl_2 \longrightarrow Cu + FeCl_2$

iron + copper chloride ⟶ copper + iron chloride

iron is more reactive than copper, as a result iron displaces copper

copper and silver nitrate*

$Cu + 2AgNO_3 \longrightarrow 2Ag + Cu(NO_3)_2$

copper + silver nitrate ⟶ silver + copper nitrate

copper is more reactive than silver, as a result copper displaces silver

zinc and copper sulphate*

$Zn + CuSO_4 \longrightarrow Cu + ZnSO_4$

zinc + copper sulfate ⟶ copper+ zinc sulfate

zinc is more reactive than copper, as a result zinc displaces copper

* higher tier only

The Blast Furnace - The extraction of iron

There are 4 raw materials; iron ore, coke, limestone and hot air

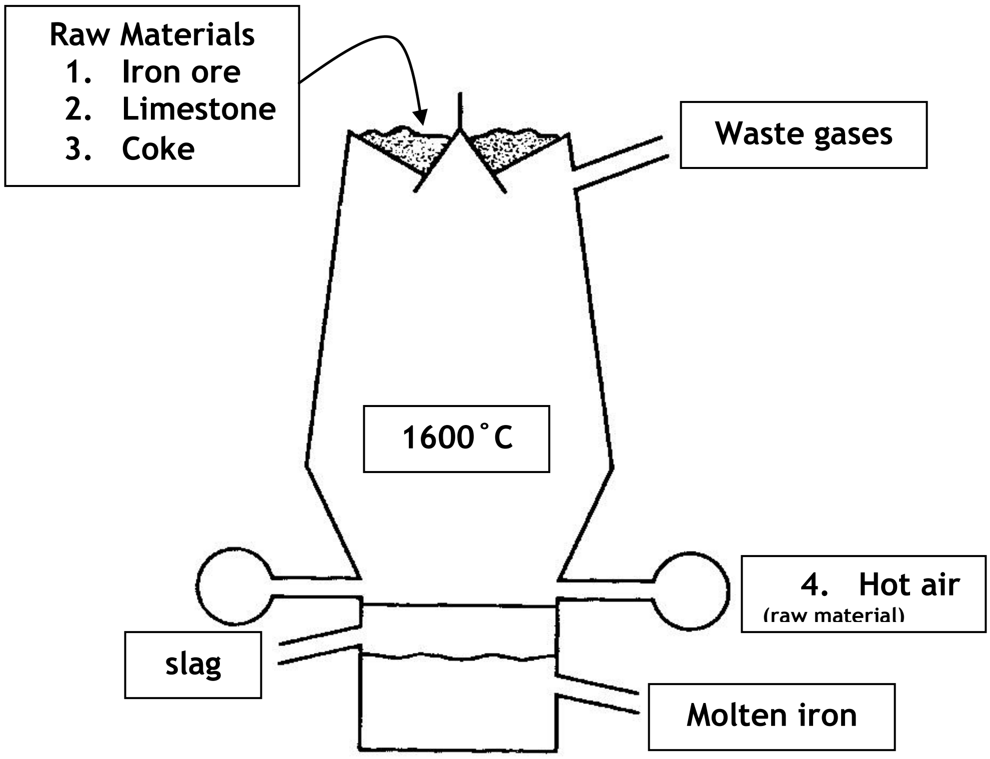
Iron ore – the source of iron

Coke – a fuel that produces carbon monoxide for the reduction reaction

Limestone – to remove impurities. Limestone breaks down and reacts with sand from the rocks to form slag

Hot air – the fourth raw material

Required for coke to burn



Carbon (coke) and oxygen (from the hot air) produce carbon monoxide and gives off heat. Reduction is achieved by Carbon monoxide at a high temperature

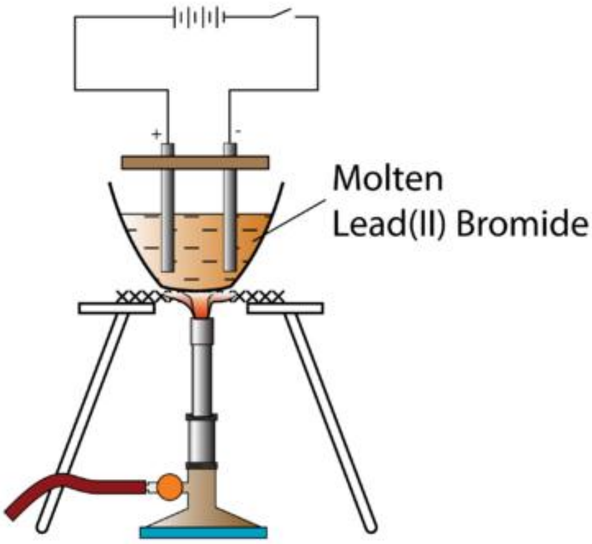
Iron oxide + carbon monoxide $\longrightarrow$ iron + carbon dioxide

$$Fe_2O_3 + \boxed{3}CO \longrightarrow \boxed{2}Fe + \boxed{3}CO_2$$

Getting the furnace up to temperature takes a lot of time and costs a lot. As a result raw materials are constantly added and products removed – the process is continuous.

At the factory in Port Talbot iron ore, limestone and coke are imported from other countries even though they are available in Wales. Using raw materials from Wales is not sustainable due to cost and the effect it could have on the environment (quarrying).

Electrolysis of Lead (II) Bromide



At the negative electrode / cathode

$$Pb^{2+} + 2e^- \longrightarrow Pb$$

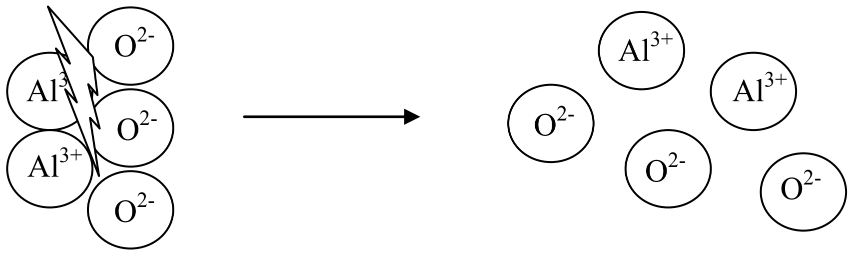
At the positive electrode / anode

$$2Br^- - 2e^- \longrightarrow Br_2$$

The positive ions Pb^{2+} move towards the cathode where they gain electrons

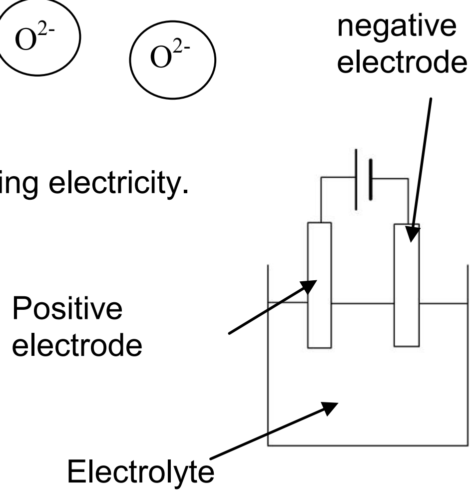
The negative ions Br^- move towards the anode where they lose electrons

Electrolysis is the method used to extract aluminium from aluminium oxide As aluminium is a reactive metal, aluminium oxide is very stable, a more powerful method is needed to break the bonds



Electrolysis is the decomposition of a compound using electricity.

Electrodes carry the current into and out of the molten compound, they are conducting rods. One is positive and the other is negative.



Anode = positive electrode

Cathode = negative electrode

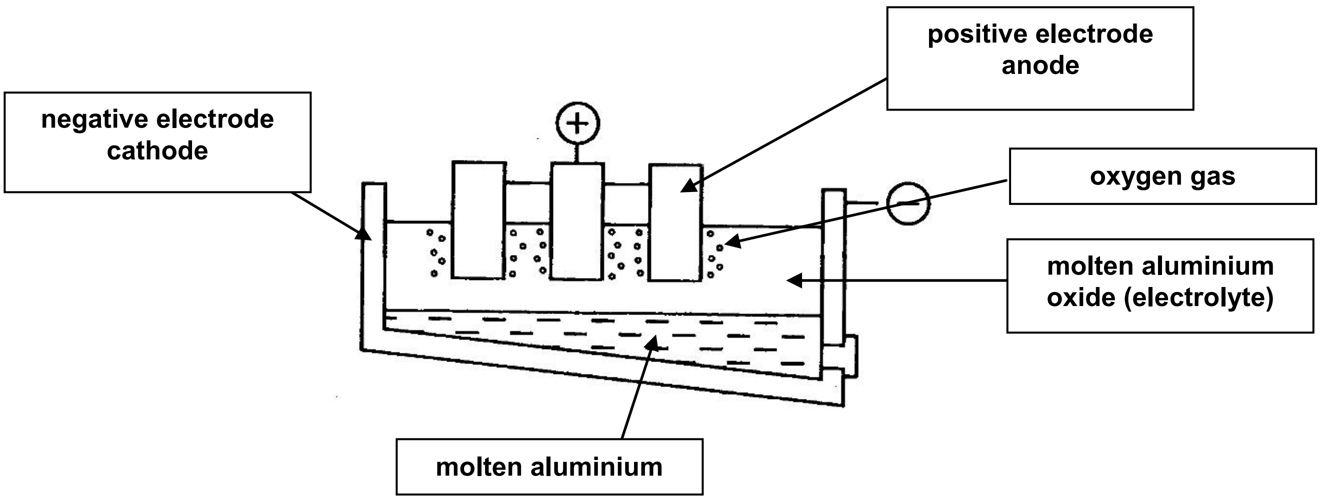
Electrolyte is a solution containing ions.
Must be dissolved or molten to allow ions to move and carry charge

Aluminium Extraction (Separating aluminium oxide to create aluminium)

Electrolyte = molten aluminium oxide (950°C)

Electrodes = Carbon

Both **electrodes** are placed in molten aluminium oxide (electrolyte). This contains ions of aluminium (+ charge) and oxygen (- charge). These are able to move when molten and therefore allow conduction of electricity.



Aluminium ions are attracted to the **negative electrode** (cathode)

Oxygen ions are attracted to the **positive electrode** (anode)

Reaction at the negative electrode **cathode**	aluminium ions+ electrons → aluminium atoms $Al^{3+} + 3e \rightarrow Al$
Reaction at the positive electrode **anode**	Oxide ions – electrons → oxygen molecules $2O^{2-} - 4e \rightarrow O_2$

Aluminium has many uses due to its physical properties

Uses	Property
Car manufacturing	Resistant to corrosion
Power lines	Electrical conductivity
Saucepans	Heat conduction
Aeroplanes	Low density

Locating aluminium plants

Electrolysis is an expensive process as it **needs a lot electrical energy** constantly. Most are located **next to a power station**

Aluminium is reactive so it needs an enormous amount of electricity to separate it from oxygen. Also it is expensive as it needs **heat** energy to heat up the ore to 1000°C

The energy costs associated with aluminium production are very high and when Wylfa Power Station was decommissioned, Anglesey Aluminium closed. When it was running the plant accounted for around 10-15% of all the electricity used in Wales. Without a power station close by, guaranteeing the supply of electricity, this became unsustainable and the plant closed.

Factories are located **near the coast** as they need **to import the aluminium** ore from abroad.

To increase the lifetime of metal ores such as aluminium oxide and iron oxide it is necessary to **recycle** metals.

Recycling aluminum uses only about 5% of the energy needed to extract it from bauxite and saves waste. Less electrical consumption means less greenhouse gas (CO_2) emissions. The environment is spoilt by quarrying.

Copper

Copper has many uses due to its physical properties

Uses	Property
Jewellery	Shiny
electrical Wires	Electrical conduction
saucepans	Heat conduction
pipes	Malleability (create sheets)
Electrical wires	Ductility (create wires)

Titanium

Titanium is important as an alloying agent with aluminum, molybdenum, manganese, iron, and other metals. Alloys of titanium are principally used for aircraft and missiles where **lightweight strength** and ability to **withstand extremes of temperature** are important.

Titanium is as strong as steel, but 45% lighter. It is 60% heavier than aluminium, but twice as strong. Does not corrode in water. 1660 °C M.pt

An alloy is a mixture made by mixing molten metals; the properties can be changed by altering the amount of each metal

Steel

Steels are a large family of metals. All of them are **alloys** in which iron is mixed with carbon and other elements. Steels are described as mild, medium- or high-carbon steels according to the percentage of carbon they contain, although this is never greater than about 1.5%.

Type of steel	Percentage of carbon	Strength
Mild steel	Up to 0.25%	hard
Medium carbon steel	0.25% to 0.45%	harder
High carbon steel	0.45% to 1.50%	hardest

The metal in the scissors contains nearly twenty times as much carbon and is many times harder than the steel in a drinking can.

Steel is recycled on a large scale.

Recycling steel saves 50% of the energy used in the extraction of iron.

Recycling helps to conserve iron ore

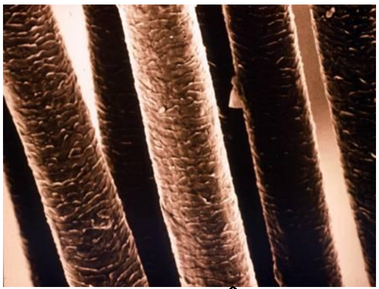
Recycling cuts down on the emission of greenhouse gases (carbon dioxide)

Nanoscience

Scientists have a great interest in the nano range because the properties of materials can be different than when they are at a larger scale. The properties change from 100 nm downwards.

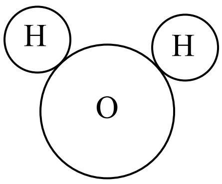
Comparing sizes in nanometre scale

80,000 nm wide is a piece of hair



7,000 nm o wide is 1 red blood cell

0.3 nm wide is 1 molecule of water



Many new materials are possible with this technology of building materials from atoms.

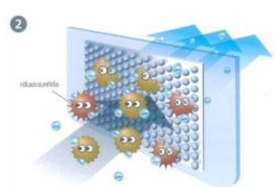
Uses which are made from nanotechnology

In sterilising sprays.

Silver particles of nano size are sprayed to kill bacteria, fungus and viruses

In fridges

A layer of silver atoms kill bacteria, fungus and viruses.



Nanoscience

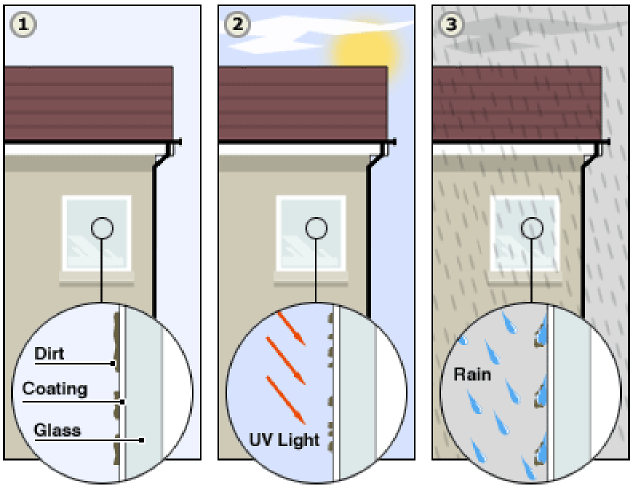
The new properties of these materials will allow people to create many new products.

Sun screen

There are nano particles in sun screens to prevent ultraviolet radiation damage to skin cells causing cancer.

Nano-sized TiO_2 and ZnO are used, they absorb and reflect UV light. Being transparent is appealing to customers

Self-cleaning glass



Self-cleaning glass is coated with nano-scale TiO_2 particles, which are hydrophobic (water repellent), dirt breaks down in sunlight and is washed away by rainwater.

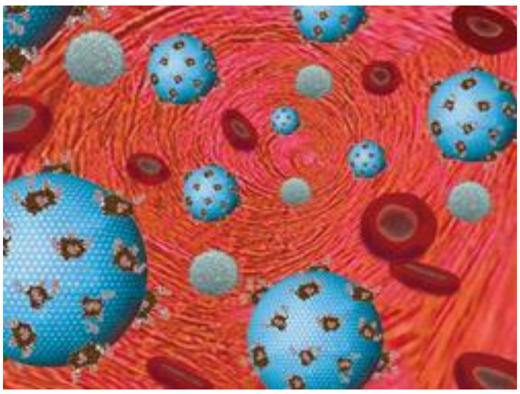
Dangers with nano particles

Although there are major benefits to nanoscience , nano particles could potentially harm humans and the environment.

Environmental and human experiments have to be performed on nano particles before they can be released commercially

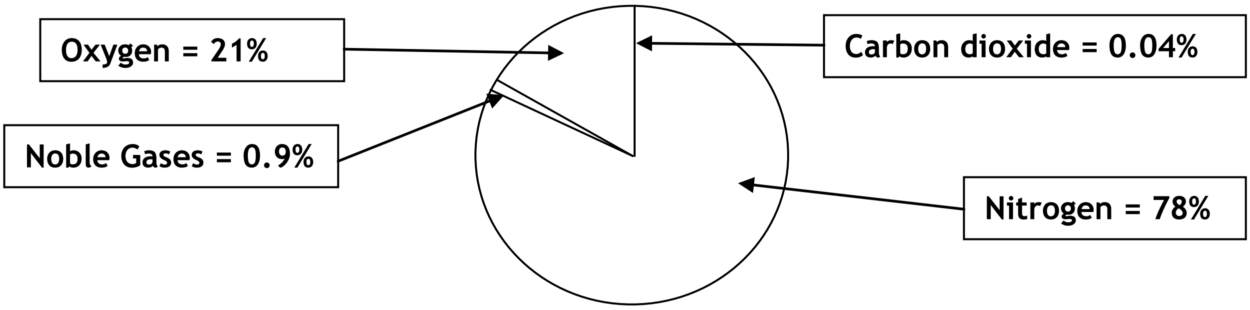
As nano particles are so small and light the can move in the atmosphere. They can also move in rivers. These are methods by which nano particles can enter the body.

Dangerous nano particles can enter the blood stream



Non-metals

Composition of the air

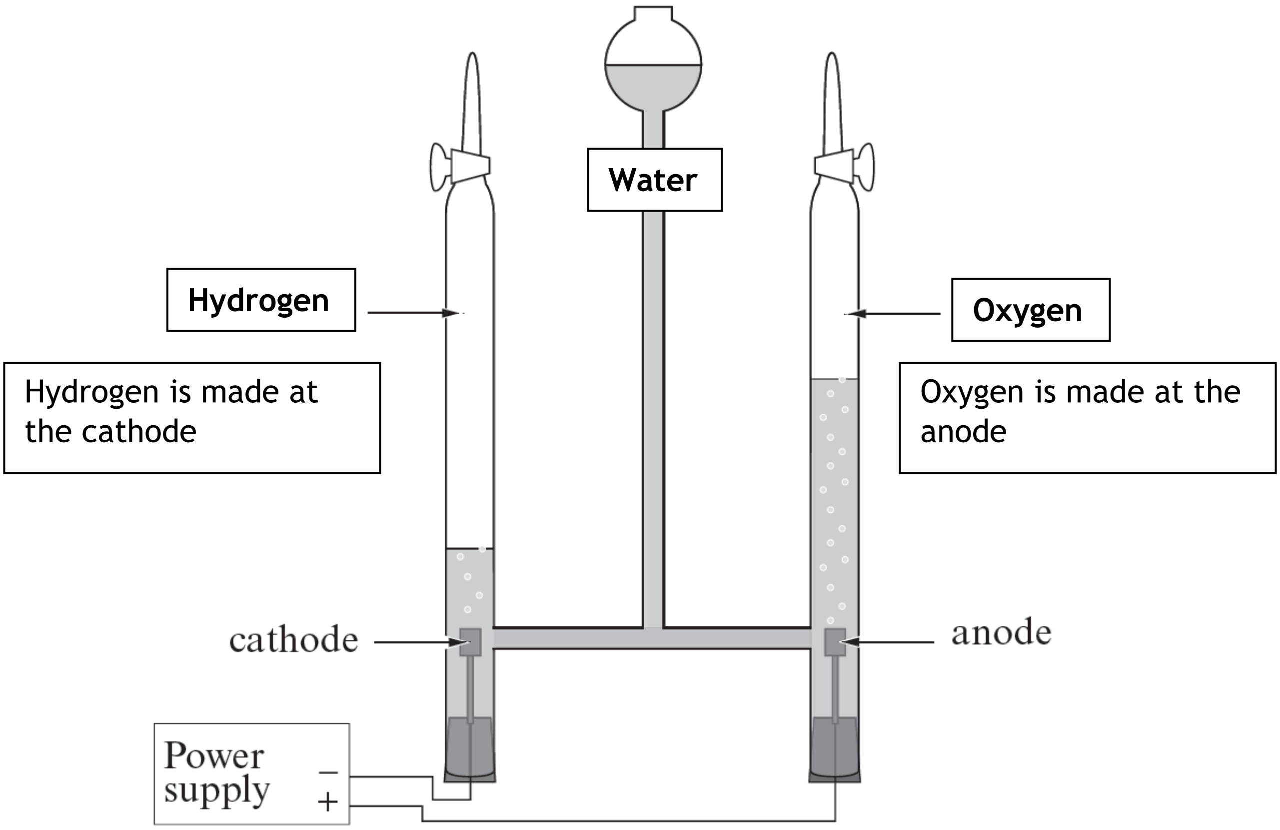


Air as a raw material

Non-metals such as nitrogen, oxygen, neon and argon are obtained from the air.

Electrolysis of water - the Hoffmann Voltameter

Oxygen and hydrogen can be made from the electrolysis of water. The equipment below is used



Twice the volume of Hydrogen as oxygen is made, this is because the formula of water is H_2O.

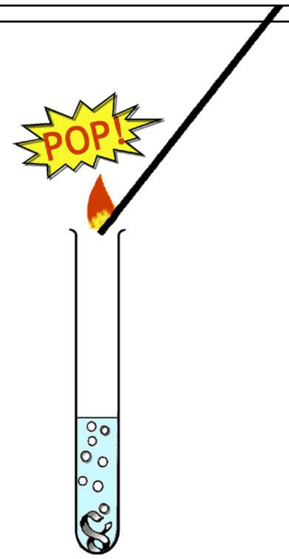
$$2H_2O_{(l)} \longrightarrow 2H_{2\,(g)} + O_{2\,(g)}$$

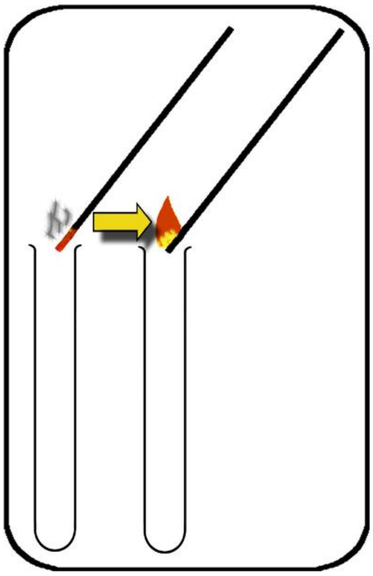
Identifying Hydrogen and oxygen gas

It is possible to test for the gases made by the electrolysis of water

Hydrogen Test

If a lighted splint is placed in hydrogen it will create a squeaky 'pop' sound.





Oxygen Test

Oxygen will re-light a glowing splint

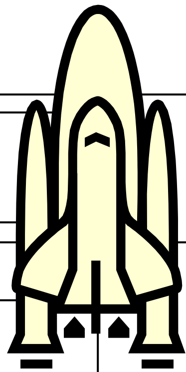
Hydrogen as a fuel

Hydrogen burns in air to make only water. The reaction is exothermic and produces a lot of energy. [exothermic – releases energy]

Hydrogen + Oxygen $\longrightarrow$ Water

$$\boxed{2}\, H_{2\,(g)} + O_{2\,(g)} \longrightarrow \boxed{2}\, H_2O_{(l)}$$

Advantages and Disadvantages of Hydrogen as a fuel



The Chevrolet Sequel car

Hydrogen is a rocket fuel.

It is also used to power hydrogen fuel cell cars.

Fuel cells were invented by a Welshman Sir William Grove in 1839. It is only recently that they have been used to power cars. The technology has benefits and drawbacks.

Advantages	Disadvantages
Only water is produced and no carbon dioxide released – therefore it does not contribute to global warming.	Large amount of electricity needed to produce hydrogen in the first place
Does not contribute to acid rain	Storage requires bulky and heavy pressurised containers
	Safe storage is also important as hydrogen makes an explosive mixture with air

NOTE: In order for the process to remain green Hydrogen must be made by the electrolysis of water using renewable energy (solar/wind)

Non metals

Physical Properties

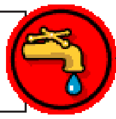
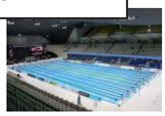
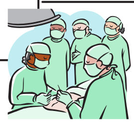
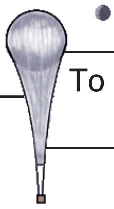
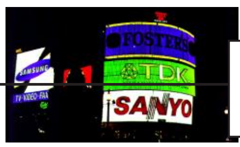
Seawater compounds

e.g.
Sodium chloride
Magnesium chloride
Magnesium sulfate
Sodium Iodide

the concentration of chlorine compounds is **more than** iodine compounds.

Chlorine and Iodine can be produced from seawater compounds.

Today improved methods that are more economic mean that iodine is not extracted from sea water.

Element	Use	Properties
Chlorine	treatment of water supplies 	poisonous/toxic, kills bacteria
	treatment of swimming pool 	poisonous/toxic, kills bacteria
	 making household cleaners	poisonous/toxic, kills bacteria
Iodine	 antiseptic following hospital procedures 	poisonous/toxic, kills bacteria
Helium	 To fill weather balloons	low density, very unreactive
Argon	 To fill light bulbs	very unreactive inert atmosphere
Neon	 Advertising lights	emits light when electric current passes through it

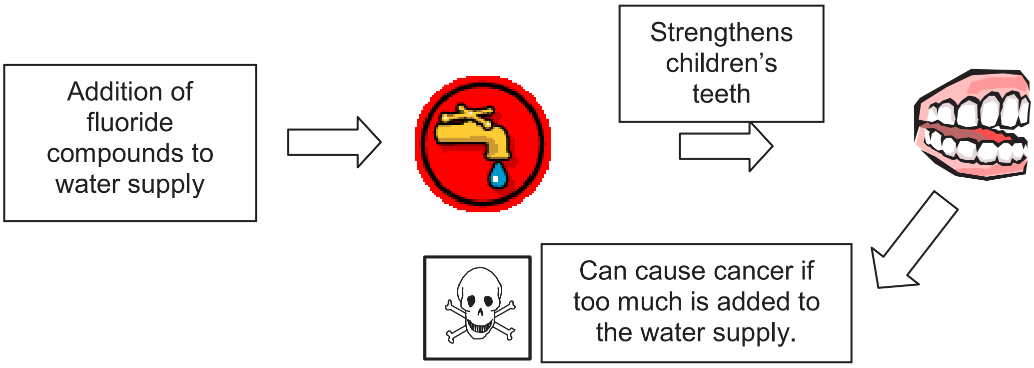
Quantities of chlorine **controlled** and **monitored** to kill bacteria and sterilise the water, without causing any harm to us.

Fluoridation of tap water

There is a difference of opinion for the addition of fluoride to water supplies.

Scientific studies show that its addition helps **strengthen children's teeth from decay** (there are reduced number of fillings in areas that have extra fluoride added)

The problems;
(1) high concentrations of fluoride can be poisonous and may cause cancer (bone and teeth).
(2) It can cause discolouring or decay of teeth (fluorosis) and
(3) it can cause infertility.
(4) Some people oppose it because they feel it is not right to force everyone to consume fluoride without the individual's consent.



Collecting evidence

Questionnaire - data of the state of children's teeth are collected by counting the number of fillings, loss of teeth and decayed teeth children of all ages have.

The data is reliable because all the children of the school are tested with exception of absent pupils.

The comparison of areas which have been fluoridated with unfluoridated areas can be unfair without the consideration to other factors (e.g. social and economic) which are important for those areas.

Fluoride is normally in toothpaste, mouthwash and sometimes it is added to special milk

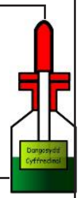
Acid Reactions

Form salts

Sulfuric Acid	Nitric Acid	Hydrochloric Acid
H_2SO_4	HNO_3	HCl
Sulfate	Nitrate	Chloride

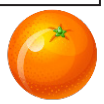
Indicator

Universal Indicator (pH) = A substance that changes colour when added to an acidic, alkaline or neutral substance. The colour corresponds to the strength of the acid or alkali (e.g. strong or weak alkali)



0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

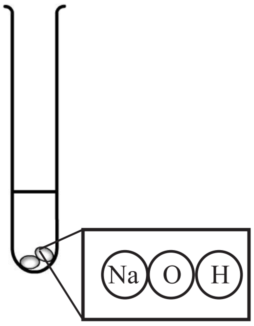
Strong Acid (0–2)	Weak Acid (3–6)	Neutral (7)	Weak Alkali (8–11)	Strong Alkali (12–14)
Sulfuric Acid	Orange	Pure water	Soap	Oven cleaner Sodium Hydroxide



Base — Metal oxide or metal hydroxide

Most are insoluble in water

Alkali — A water soluble base



NEUTRALISATION REACTIONS

1. Acid + Alkali

When the correct amount of acid and alkali are added together a neutral solution is made

ACID + ALKALI $\longrightarrow$ SALT + WATER

Hydrochloric Acid + Sodium Hydroxide $\longrightarrow$ Sodium chloride + Water

$HCl\ (aq) + NaOH\ (aq) \longrightarrow NaCl\ (aq) + H_2O\ (l)$

Sulfuric Acid + Sodium Hydroxide $\longrightarrow$ Sodium sulfate + Water

$H_2SO_4\ (aq) + 2NaOH\ (aq) \longrightarrow Na_2SO_4\ (aq) + H_2O\ (l)$

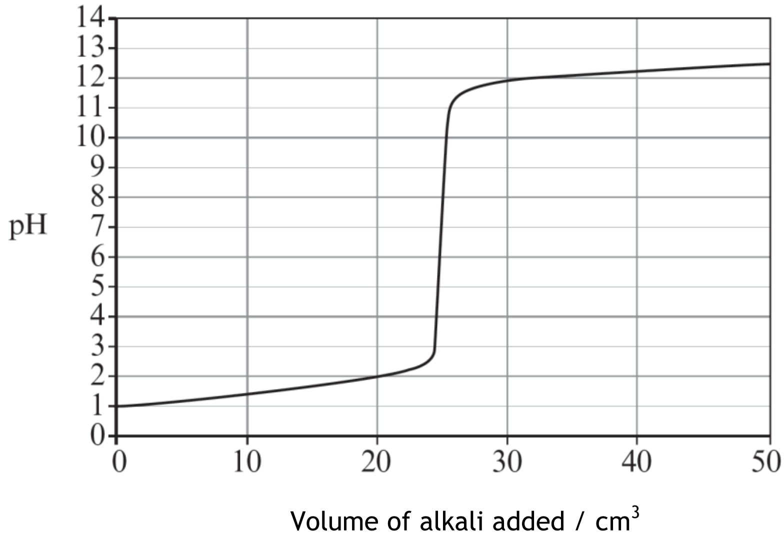
Nitric Acid + Sodium Hydroxide $\longrightarrow$ Sodium nitrate + Water

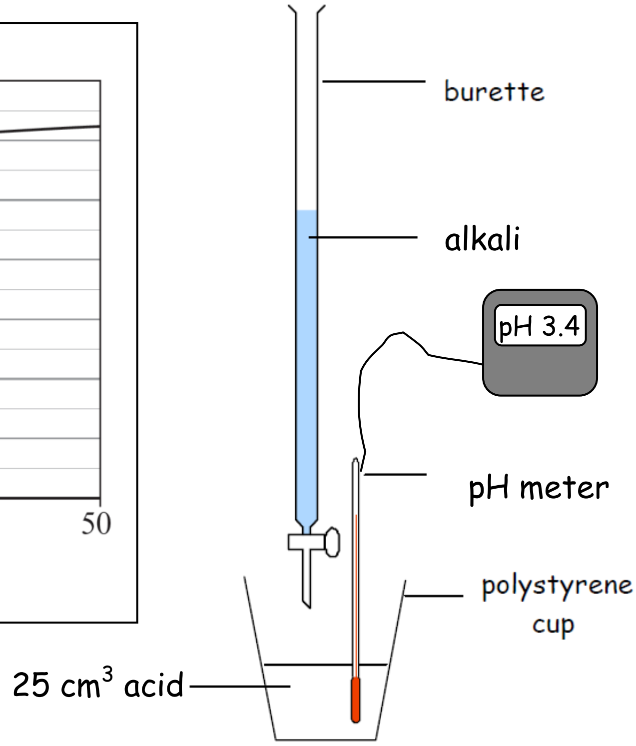
$HNO_3\ (aq) + NaOH\ (aq) \longrightarrow NaNO_3\ (aq) + H_2O\ (l)$

Investigating a Neutralisation Reaction

A pH sensor can be used to monitor a neutralisation reaction; in the reaction below alkali (potassium hydroxide) is added slowly to 25 cm^3 acid

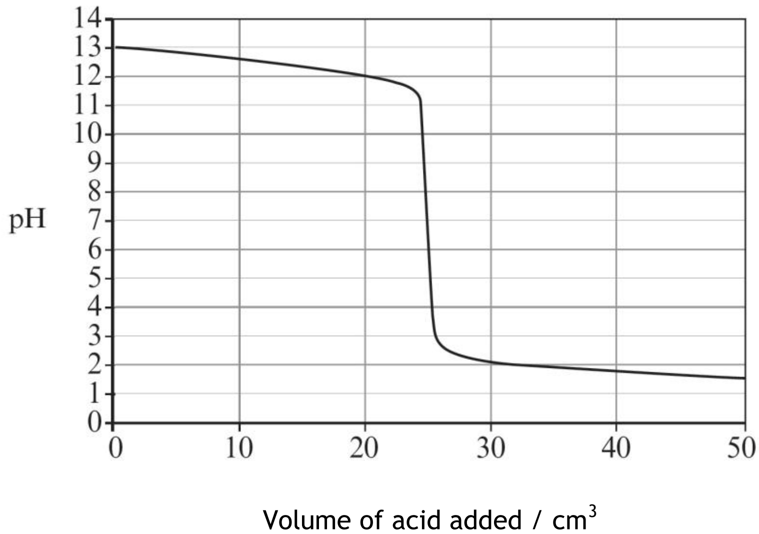
Alkali added to Acid





0 - 24 cm^3 - solution is acidic
25.00 cm^3 - neutralisation point
26- 50 cm^3 - solution is alkaline
(too much alkali added)

Acid added to Alkali



0 - 24 cm^3 - alkaline
25.00 cm^3 - neutralisation point
26- 50 cm^3 - acidic

If too much acid (excess) is added the substance will be acidic at the end.

If the correct volume is added (25 cm^3) the solution becomes

REMEMBER - All neutralisation reactions are exothermic (heat is released)

3. Acid + Base

ACID + BASE ⟶ SALT + WATER

Sulfuric Acid + Copper oxide ⟶ Copper sulfate + Water

H_2SO_4 (aq) + CuO (s) ⟶ $CuSO_4$ (aq) + H_2O (l)

Hydrochloric Acid + Copper oxide ⟶ Copper chloride + Water

2HCl (aq) + CuO (s) ⟶ $CuCl_2$ (aq) + H_2O (l)

2. Acid + Carbonate

CO_2 is made in addition to salt and water

ACID + Carbonate ⟶ SALT + WATER + CARBON DIOXIDE

Sulfuric Acid + Copper Carbonate ⟶ Copper sulfate + Water + Carbon Dioxide

H_2SO_4 (aq) + $CuCO_3$ (s) ⟶ $CuSO_4$ (aq) + H_2O (l) + CO_2 (g)

Sulfuric Acid + Sodium Carbonate ⟶ Sodium sulfate + Water + Carbon Dioxide

H_2SO_4 (aq) + Na_2CO_3 (s) ⟶ Na_2SO_4 (aq) + H_2O (l) + CO_2 (g)

Hydrochloric Acid + Sodium Carbonate ⟶ Sodium chloride + Water + Carbon Dioxide

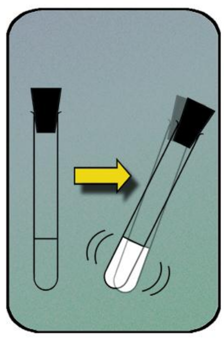
2HCl (aq) + Na_2CO_3 (s) ⟶ 2NaCl (aq) + H_2O (l) + CO_2 (g)

Carbonate test

When acid reacts with a carbonate **fizzing** is observed. Bubbles are seen as CO_2 is a gas

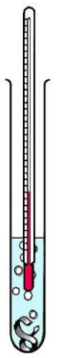
Carbon dioxide test

If clear limewater turns milky there is carbon dioxide present.



4. Metal + Acid

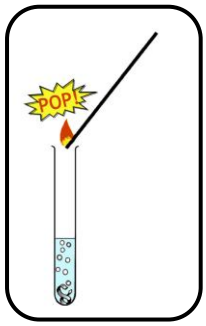
A reactive metal produces hydrogen with acids



METAL	+	ACID	→	SALT	+	HYDROGEN
Magnesium	+	hydrochloric acid	→	Sodium chloride	+	hydrogen
$Mg\ (s)$	+	$2HCl\ (aq)$	→	$MgCl_2\ (aq)$	+	$H_2\ (g)$
Zinc	+	sulfuric acid	→	zinc sulfate	+	hydrogen
$Zn\ (s)$	+	$H_2SO_4\ (aq)$	→	$ZnSO_4\ (aq)$	+	$H_2\ (g)$

Hydrogen Test

If a lighted splint is placed in hydrogen it will create a squeaky 'pop' sound.



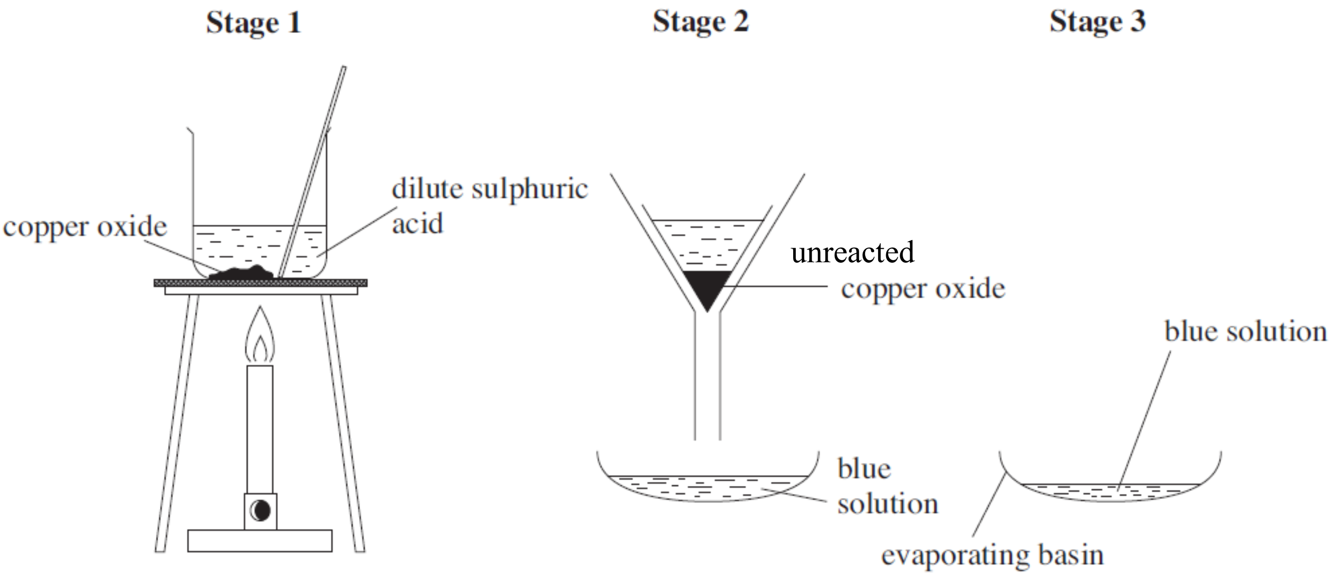
Acid Reactions Summary

Acid	Salt
Hydrochloric	Chloride
Sulfuric	Sulfate
Nitric	Nitrate

- Acid + Metal → Salt + Hydrogen
- Acid + Alkali → Salt + Water
- Acid + Base (Metal Carbonate) → Salt, Carbon Dioxide, Water
- Acid + Base (Metal Oxide) → Salt + Water

Method of preparing salt crystals

The method below is used to obtain salt from metal oxides and carbonates



Stage 1: <u>Excess</u> base (copper oxide) is added to the dilute acid to make sure all the acid has been reacted and used up. Heat and stirring will assist the process

Stage 2: The excess (unreacted) base is removed by the process of <u>filtration</u>, using a filter funnel and filter paper

Stage 3: Salt is obtained by <u>evaporation</u> - water evaporates and crystals of salt left behind. Water can be evaporated slowly near a window or with additional heating using a Bunsen Burner, 1/3 of the solution should be left behind to evaporate naturally.

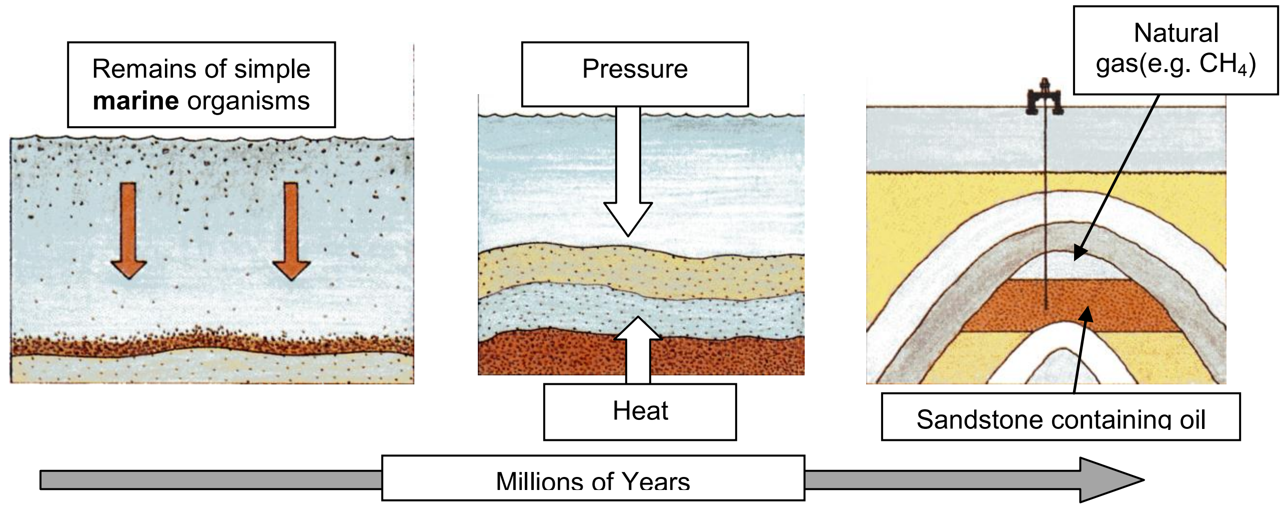
Obtaining salt from the metal and acid reaction

The only difference in the method is stage 1 - excess metal is used - to make sure all the acid has been used up

Production and uses of fuels

Crude oil (petroleum)

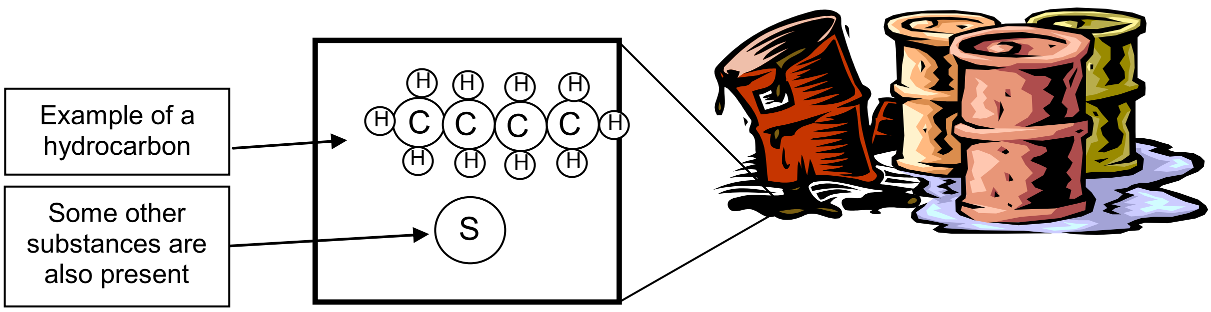
Formed over millions of years from the remains of simple marine organisms



There is a limit to coal, crude oil (petroleum) and natural gas life as they will run out over time – they are **finite** – or **non-renewable**.

Crude oil is a mixture of hydrocarbons

Hydrocarbons are compounds that contain the elements **hydrogen** and **carbon** only.



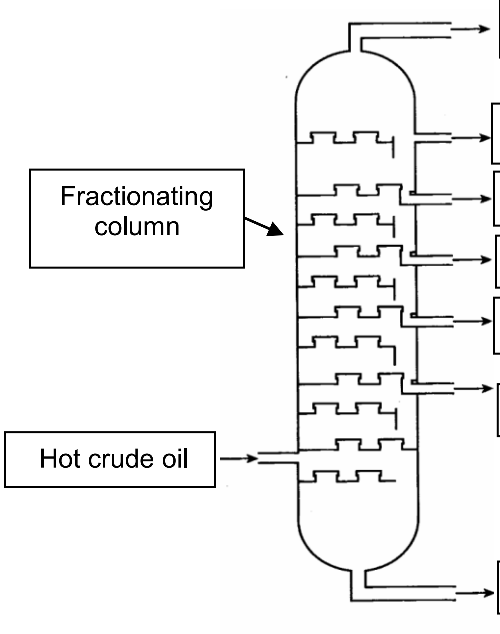
Carbon has the ability to form bonds with other carbon atoms resulting in the formation of carbon atom chains, e.g.

Crude oil contains a mixture of different sized hydrocarbon chains

Production and uses of fuels

Crude oil is separated into fractions

The process is called **Fractional Distillation**



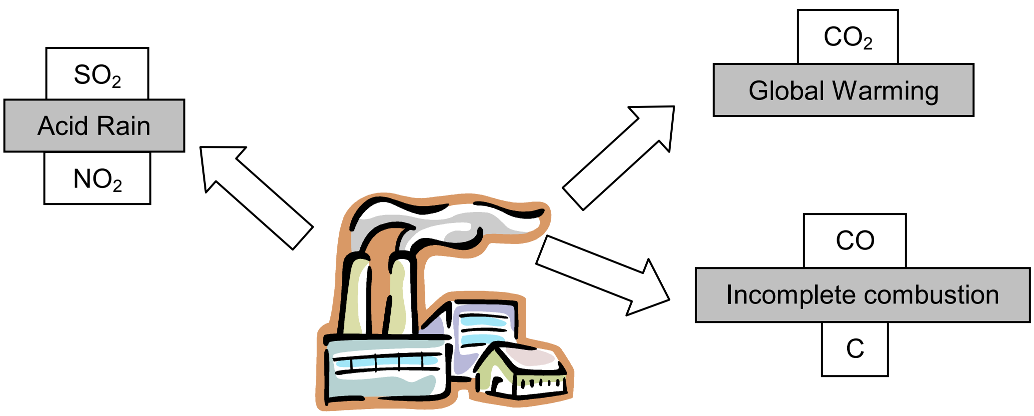
Fraction	No. of Carbon atoms in chain	Boiling point range / ˚C
Gas	1 – 4	-160 to 25
petrol	4 – 12	40 to 100
naphtha	7 – 14	100 to 150
paraffin/kerosine	11 – 15	150 to 250
diesel oil	15 – 19	250 to 350
Lubricating oil	20 – 30	over 350
Bitumen	C30 – and above	over 400

Fractions contain hydrocarbons with **boiling points in the same range**, e.g. the petrol fraction has hydrocarbons with boiling points in the range 40-100 ˚C

Long chain hydrocarbons are at the **bottom** of the column as they do not boil until a very high temperature

Some of the fractions are used as **fuels** (e.g. Kerosine - aeroplane fuel) others are further processed by **cracking**. (see next page)

Problems with burning fossil fuels



Cracking and Addition Polymerisation

Cracking

At high temperature long hydrocarbon chains are broken down into smaller, more useful hydrocarbons.

This can create **ethene.**

Shorter more useful

Used to make the plastic polythene

Decane → **Octane** + **Ethene**

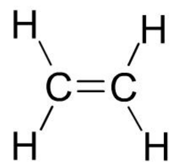
Ethene is a **small reactive molecule**, a **monomer**

If many ethene molecules are linked together it is called polythene which is used to make many plastics

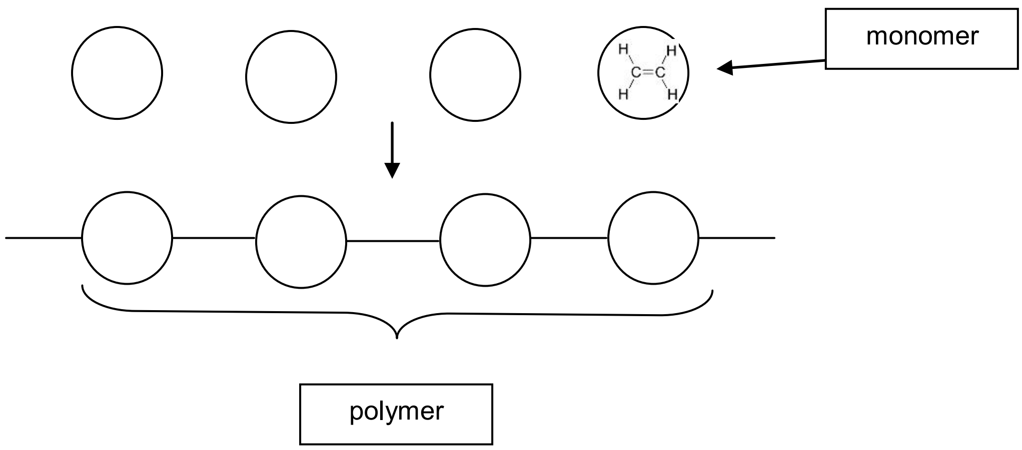
Creating Plastics

When small **reactive** molecules such as ethene react together in a chemical reaction a long chain molecule called a **polymer** is formed.

Monomer is the name given to small reactive organic molecule



Ethene has a double bond. One of the bond breaks to allow the molecule to join with another

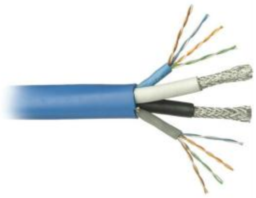


The process whereby **monomers link** to create a polymer is **polymerisation.**

The type of polymerisation that happen here is **addition polymerisation** as there is only **one product** formed

Properties of Plastics

There are many types of plastics, all made by polymerisation, e.g. polythene, PVC, PTFE (Teflon) and polystyrene.

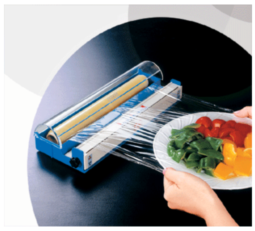


Electrical insulator / flexible

Strong / low density

Thermal insulator

Strong / low density



Transparent / flexible

Plastics versus traditional materials

Plastics are used widely in place of natural materials such as paper and iron

PVC plastic is used to make water pipes/guttering because they are light, do not rust like iron, cheaper and last longer

Polythene is used to make plastic bags in place of paper as they are stronger, do not rip and are waterproof

The disadvantages of plastics are that the do not rot i.e. the do not decompose (takes hundreds of years) and fill landfill sites.

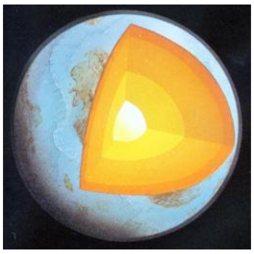
With heat some plastics **melt** easily

If plastics burn they form **poisonous gases**

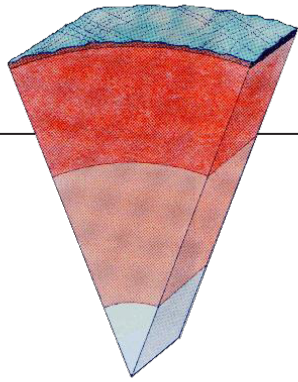
Recycling waste plastic:

1. reduces the amount of waste but equally importantly
2. conserves crude oil reserves and
3. requires less energy than making new plastics

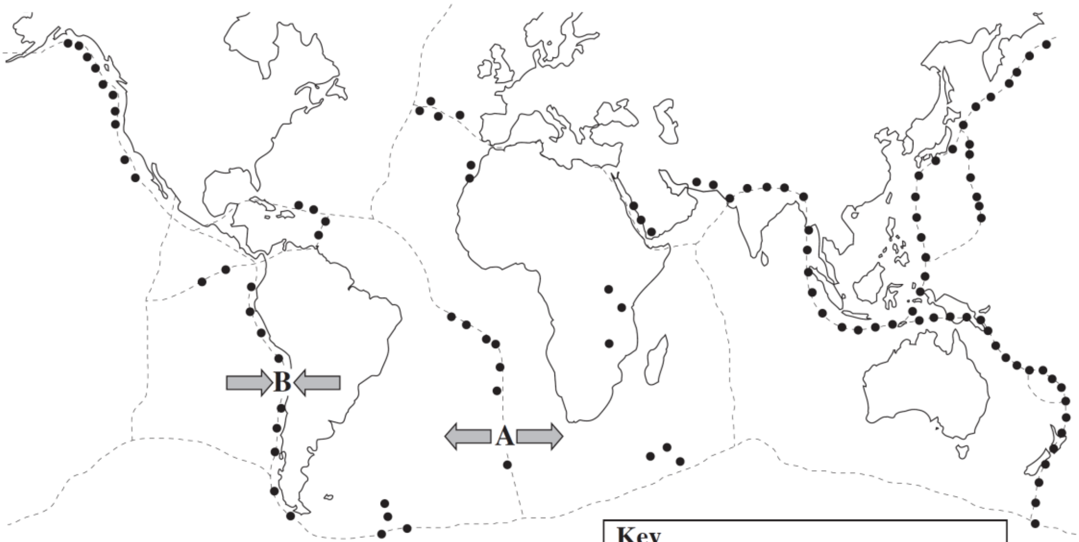
Geology



Lithosphere – outer layer of the earth contains three types of rocks. They create tectonic plates



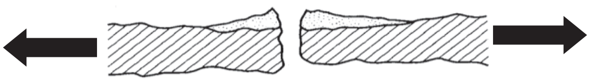
Tectonic Plates – The lithosphere has been split up into pieces called tectonic plates which move very slowly in different directions as seen in the diagram.



Plotting the epicentres of major earthquakes and the sites of active volcanoes shows the location of plate boundaries

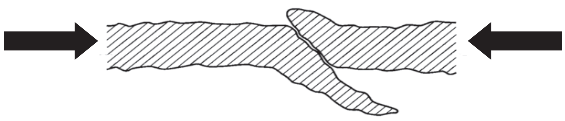
Tectonic plates movements	*Any movement will cause an earthquake*

Constructive plate



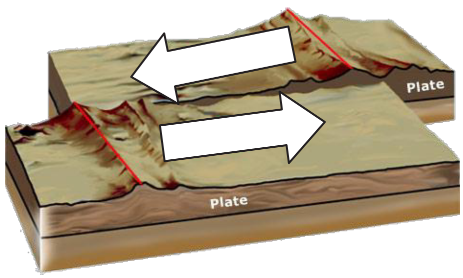
Plates can move apart. Magma pushes through to create new igneous rock (granite)
Volcanic eruption possible

Destructive plate



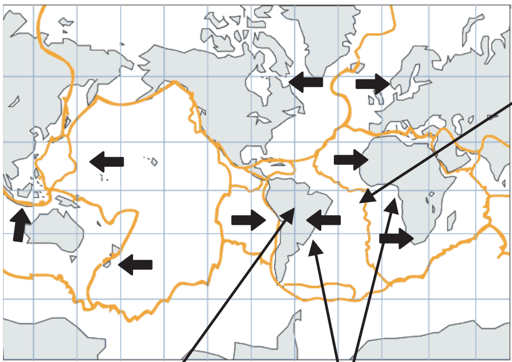
Plates can move towards each other. More dense plate (heavy) melts to form magma
Mountain ranges can be formed
Explosive volcanoes possible

Plates can slide past each other



A theory that changed into scientific fact over time due to enough scientific evidence.

Alfred Wegener idea in 1915 was not scientifically accepted until more concrete facts were put forward. At the time Wegener could not explain **WHY** the plates moved



Ocean

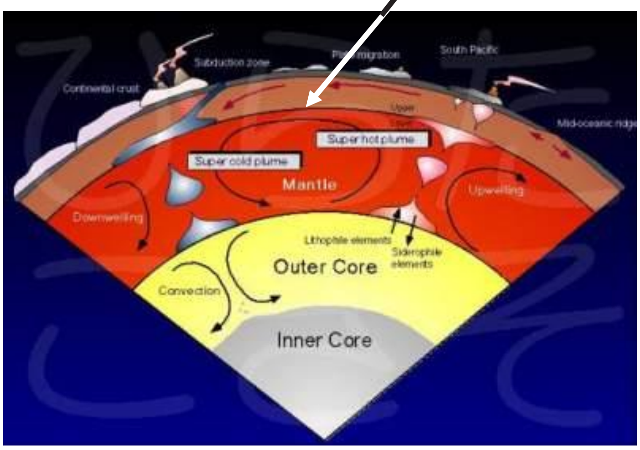
Continent

Coastline

The current theory of plate tectonics became widely accepted in the 1960's.

By which time other scientists had found evidence to show that it is the Earth's plates that move and that they do so as a result of convection currents in the mantle.

Mantle

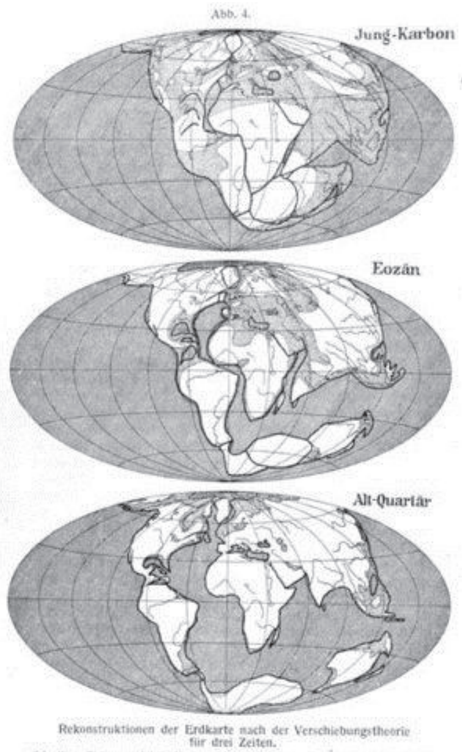


Alfred Wegener suggested that the Earth's continents were once joined

He said the continents had moved apart to their present positions;

He observed the close fit of coastlines, of different countries (continents). Jigsaw fit

He also saw similar patterns of rocks and fossils, of continents separated by large oceans;

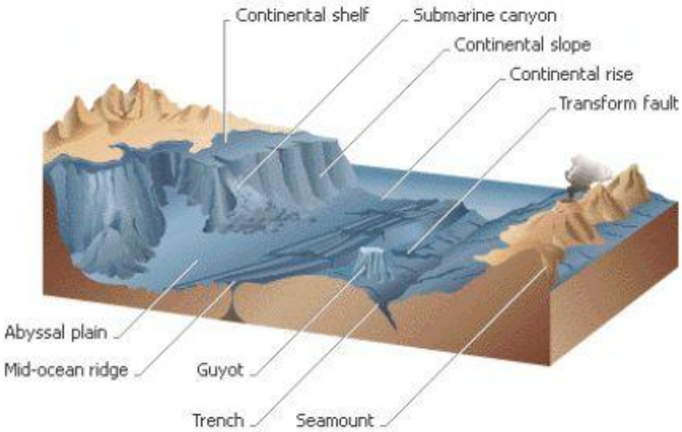


Rekonstruktionen der Erdkarte nach der Verschiebungstheorie für drei Zeiten.

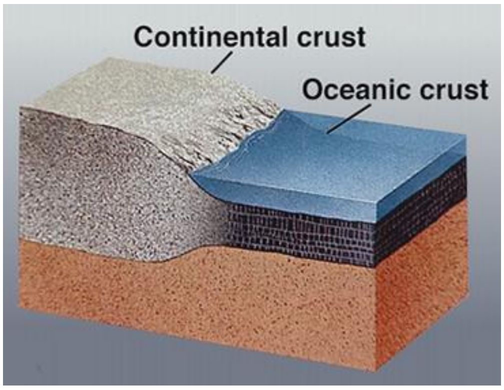
Accepting Wegener's theory

To convince people that the continents could move (continental drift) new evidence was needed and found;

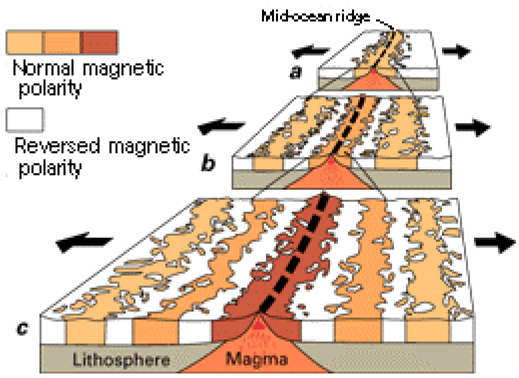
1. **Study of the ocean floor** - large mountain ranges and deep trenches found. It was originally thought that the seabed was flat



2. **Dating techniques using radioisotopes** - oceanic crust was very young compared to the continents



3. **Rocks keep a record of the magnetic field** of the Earth, which changes from time to time. Evidence of "seafloor spreading"

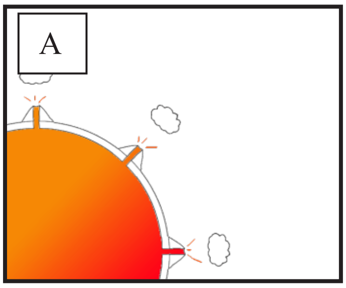


Crust forms and moves sideways in both directions

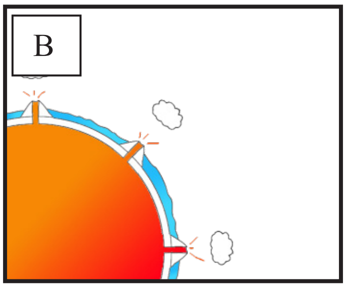
Atmosphere

Atmosphere creation

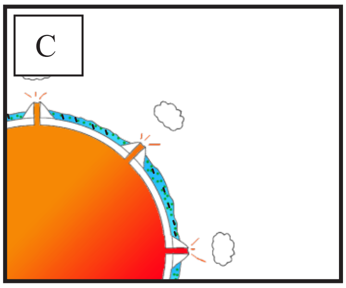
The composition of the air was different 4000 million years ago. Most Scientists agree that the initial atmosphere came from volcanoes.



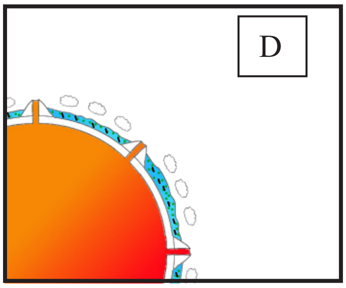
Volcanoes releasing carbon dioxide, ammonia and water vapour (steam) creating the first atmosphere



The Earth cools causing the steam to condense, forming oceans. This was fast.

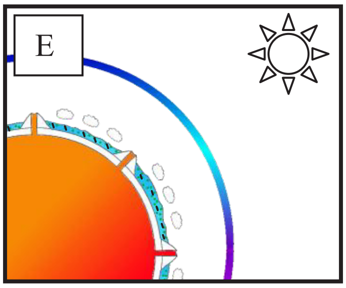


Photosynthesising bacteria form in the oceans. Carbon dioxide levels decrease.



Bacteria releases oxygen in the atmosphere. Oxygen levels increase.

Oxygen reacts with ammonia - nitrogen made - the most abundant gas in the atmosphere

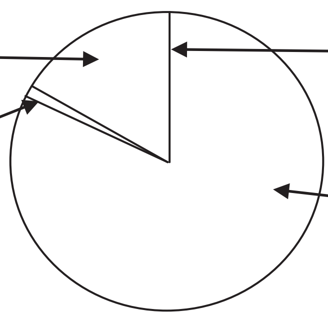


Oxygen combines to form ozone. It prevents ultraviolet light from entering the Earth. It helps to prevent skin cancer.

Percentage of oxygen in the air

Oxygen = 21%

Noble Gases = 0.9%



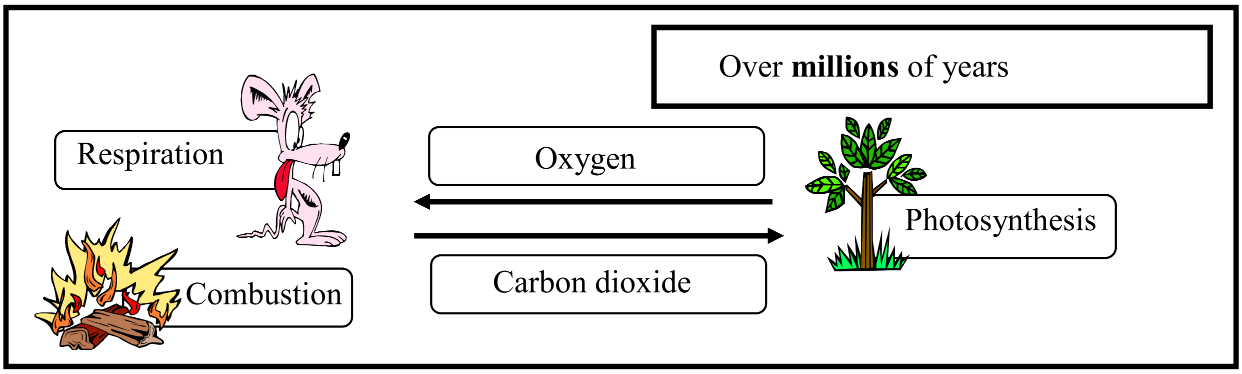
Carbon dioxide = 0.04%

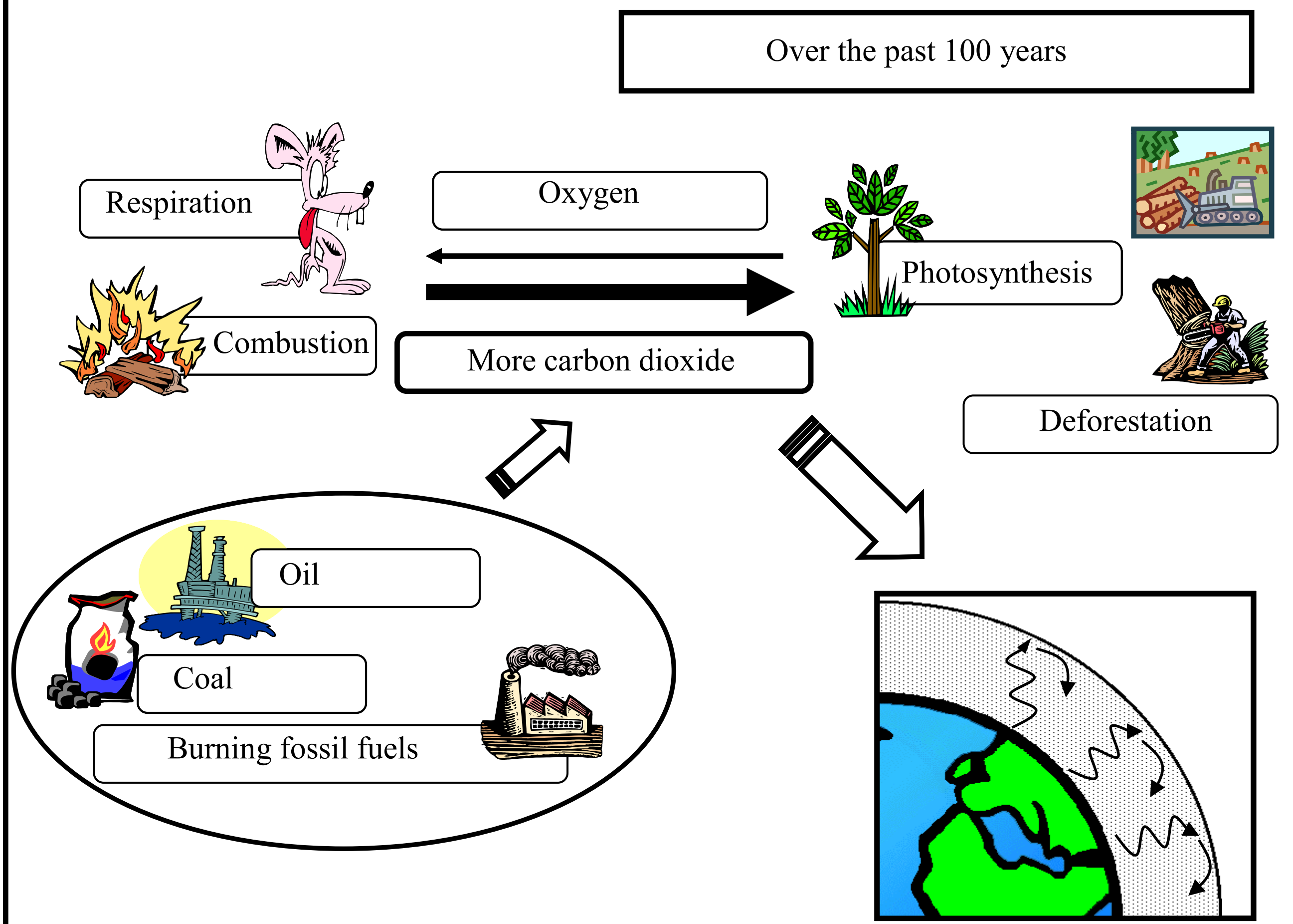
Nitrogen = 78%

Atmosphere

Carbon Cycle

The levels of oxygen and carbon dioxide have remained fairly constant for many years due to the carbon cycle.





Global Warming

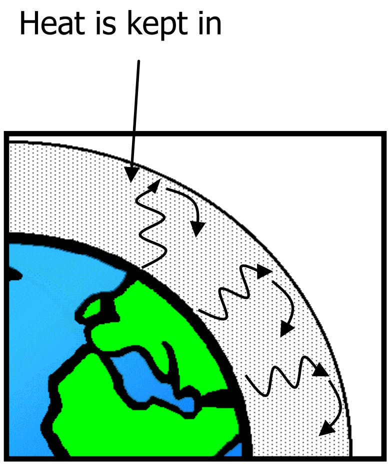
Higher level of carbon dioxide causes the temperature of the Earth to rise. Heat can not escape as easily

Global Warming

There is evidence to suggest that the Earth is warming but scientists do not all agree on the cause of this.

Many think that it is due mainly to increased levels of carbon dioxide in the atmosphere as a result of the combustion of fossil fuels and deforestation.

As a result the carbon cycles has been imbalanced



Higher level of carbon dioxide causes the temperature of the Earth to rise. Heat can not escape as easily

The effects of global warming

Global warming can cause :-

1. Changing weather patterns e.g. drier, hotter summers in some parts of the world leading to drought.
2. Flooding due to increase rainfall in some areas
3. Quicker melting of ice caps and glaciers
4. Rising sea levels

Carbon capture
Scientists are thinking of storing the CO_2 produced by burning fossil fuels under the sea or underground in geological formations

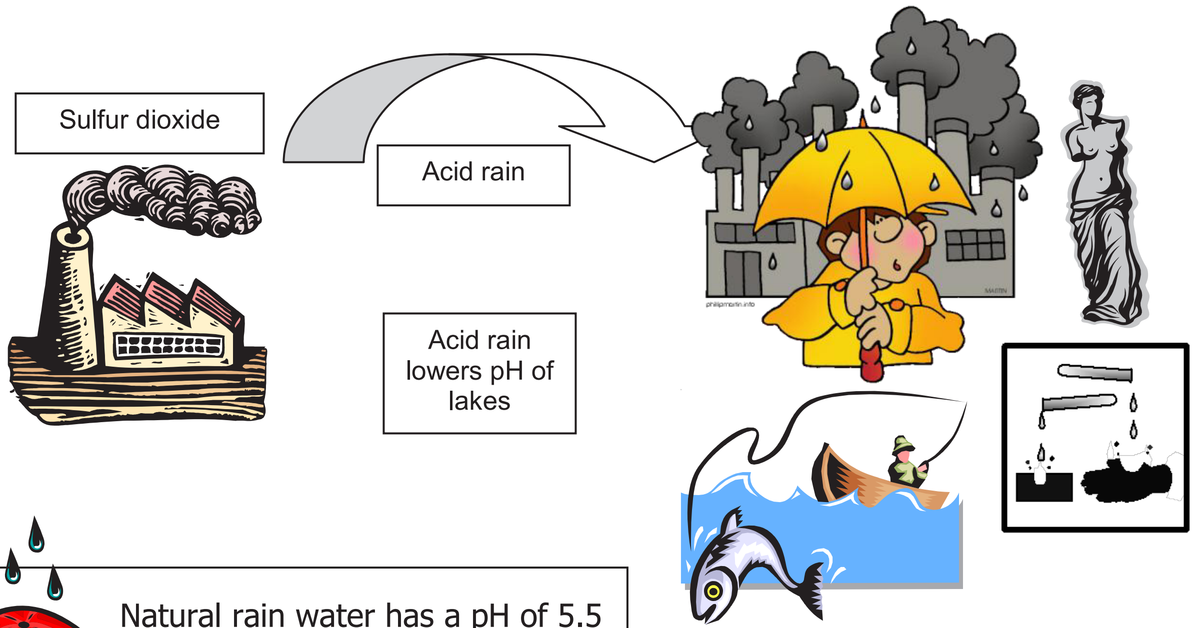
Acid Rain

In fuels such as oil and petrol there are **impurities** (i.e. oil is not pure hydrocarbons), compounds such as sulphur and nitrogen are present.

When these burn they form **polluting gases**, such as **sulfur dioxide** and **oxides of nitrogen**.

Acid rain forms when sulfur dioxide is released from factories. Acid rain forms when **sulfur dioxide** reacts with **rain** to form **sulfuric acid**.

It kills plants (forests) and aquatic life such as fish. It also damages buildings and statues made of limestone (calcium carbonate) and metals e.g. bridges.

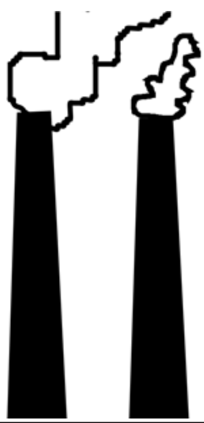


Natural rain water has a pH of 5.5

Acid rain has a pH range of 2-4

Sulfur Scrubbing

The process of removing sulphur dioxide from exhaust flue gases of fossil fuel powered plants



FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	**Formula**	**Name**	**Formula**
Aluminium	Al^{3+}	Bromide	Br^{-}
Ammonium	NH_4^{+}	Carbonate	CO_3^{2-}
Barium	Ba^{2+}	Chloride	Cl^{-}
Calcium	Ca^{2+}	Fluoride	F^{-}
Copper(II)	Cu^{2+}	Hydroxide	OH^{-}
Hydrogen	H^{+}	Iodide	I^{-}
Iron(II)	Fe^{2+}	Nitrate	NO_3^{-}
Iron(III)	Fe^{3+}	Oxide	O^{2-}
Lithium	Li^{+}	Sulphate	SO_4^{2-}
Magnesium	Mg^{2+}		
Nickel	Ni^{2+}		
Potassium	K^{+}		
Silver	Ag^{+}		
Sodium	Na^{+}		

PERIODIC TABLE OF ELEMENTS

1	2						Group					3	4	5	6	7	0
								$^{1}_{1}\mathrm{H}$ Hydrogen									$^{4}_{2}\mathrm{He}$ Helium
$^{7}_{3}\mathrm{Li}$ Lithium	$^{9}_{4}\mathrm{Be}$ Beryllium											$^{11}_{5}\mathrm{B}$ Boron	$^{12}_{6}\mathrm{C}$ Carbon	$^{14}_{7}\mathrm{N}$ Nitrogen	$^{16}_{8}\mathrm{O}$ Oxygen	$^{19}_{9}\mathrm{F}$ Fluorine	$^{20}_{10}\mathrm{Ne}$ Neon
$^{23}_{11}\mathrm{Na}$ Sodium	$^{24}_{12}\mathrm{Mg}$ Magnesium											$^{27}_{13}\mathrm{Al}$ Aluminium	$^{28}_{14}\mathrm{Si}$ Silicon	$^{31}_{15}\mathrm{P}$ Phosphorus	$^{32}_{16}\mathrm{S}$ Sulphur	$^{35}_{17}\mathrm{Cl}$ Chlorine	$^{40}_{18}\mathrm{Ar}$ Argon
$^{39}_{19}\mathrm{K}$ Potassium	$^{40}_{20}\mathrm{Ca}$ Calcium	$^{45}_{21}\mathrm{Sc}$ Scandium	$^{48}_{22}\mathrm{Ti}$ Titanium	$^{51}_{23}\mathrm{V}$ Vanadium	$^{52}_{24}\mathrm{Cr}$ Chromium	$^{55}_{25}\mathrm{Mn}$ Manganese	$^{56}_{26}\mathrm{Fe}$ Iron	$^{59}_{27}\mathrm{Co}$ Cobalt	$^{59}_{28}\mathrm{Ni}$ Nickel	$^{64}_{29}\mathrm{Cu}$ Copper	$^{65}_{30}\mathrm{Zn}$ Zinc	$^{70}_{31}\mathrm{Ga}$ Gallium	$^{73}_{32}\mathrm{Ge}$ Germanium	$^{75}_{33}\mathrm{As}$ Arsenic	$^{79}_{34}\mathrm{Se}$ Selenium	$^{80}_{35}\mathrm{Br}$ Bromine	$^{84}_{36}\mathrm{Kr}$ Krypton
$^{86}_{37}\mathrm{Rb}$ Rubidium	$^{88}_{38}\mathrm{Sr}$ Strontium	$^{89}_{39}\mathrm{Y}$ Yttrium	$^{91}_{40}\mathrm{Zr}$ Zirconium	$^{93}_{41}\mathrm{Nb}$ Niobium	$^{96}_{42}\mathrm{Mo}$ Molybdenum	$^{99}_{43}\mathrm{Tc}$ Technetium	$^{101}_{44}\mathrm{Ru}$ Ruthenium	$^{103}_{45}\mathrm{Rh}$ Rhodium	$^{106}_{46}\mathrm{Pd}$ Palladium	$^{108}_{47}\mathrm{Ag}$ Silver	$^{112}_{48}\mathrm{Cd}$ Cadmium	$^{115}_{49}\mathrm{In}$ Indium	$^{119}_{50}\mathrm{Sn}$ Tin	$^{122}_{51}\mathrm{Sb}$ Antimony	$^{128}_{52}\mathrm{Te}$ Tellurium	$^{127}_{53}\mathrm{I}$ Iodine	$^{131}_{54}\mathrm{Xe}$ Xenon
$^{133}_{55}\mathrm{Cs}$ Caesium	$^{137}_{56}\mathrm{Ba}$ Barium	$^{139}_{57}\mathrm{La}$ Lanthanum	$^{179}_{72}\mathrm{Hf}$ Hafnium	$^{181}_{73}\mathrm{Ta}$ Tantalum	$^{184}_{74}\mathrm{W}$ Tungsten	$^{186}_{75}\mathrm{Re}$ Rhenium	$^{190}_{76}\mathrm{Os}$ Osmium	$^{192}_{77}\mathrm{Ir}$ Iridium	$^{195}_{78}\mathrm{Pt}$ Platinum	$^{197}_{79}\mathrm{Au}$ Gold	$^{201}_{80}\mathrm{Hg}$ Mercury	$^{204}_{81}\mathrm{Tl}$ Thallium	$^{207}_{82}\mathrm{Pb}$ Lead	$^{209}_{83}\mathrm{Bi}$ Bismuth	$^{210}_{84}\mathrm{Po}$ Polonium	$^{210}_{85}\mathrm{At}$ Astatine	$^{222}_{86}\mathrm{Rn}$ Radon
$^{223}_{87}\mathrm{Fr}$ Francium	$^{226}_{88}\mathrm{Ra}$ Radium	$^{227}_{89}\mathrm{Ac}$ Actinium															

Key:

Mass number → A

X ← Element Symbol

Atomic number → Z

Name