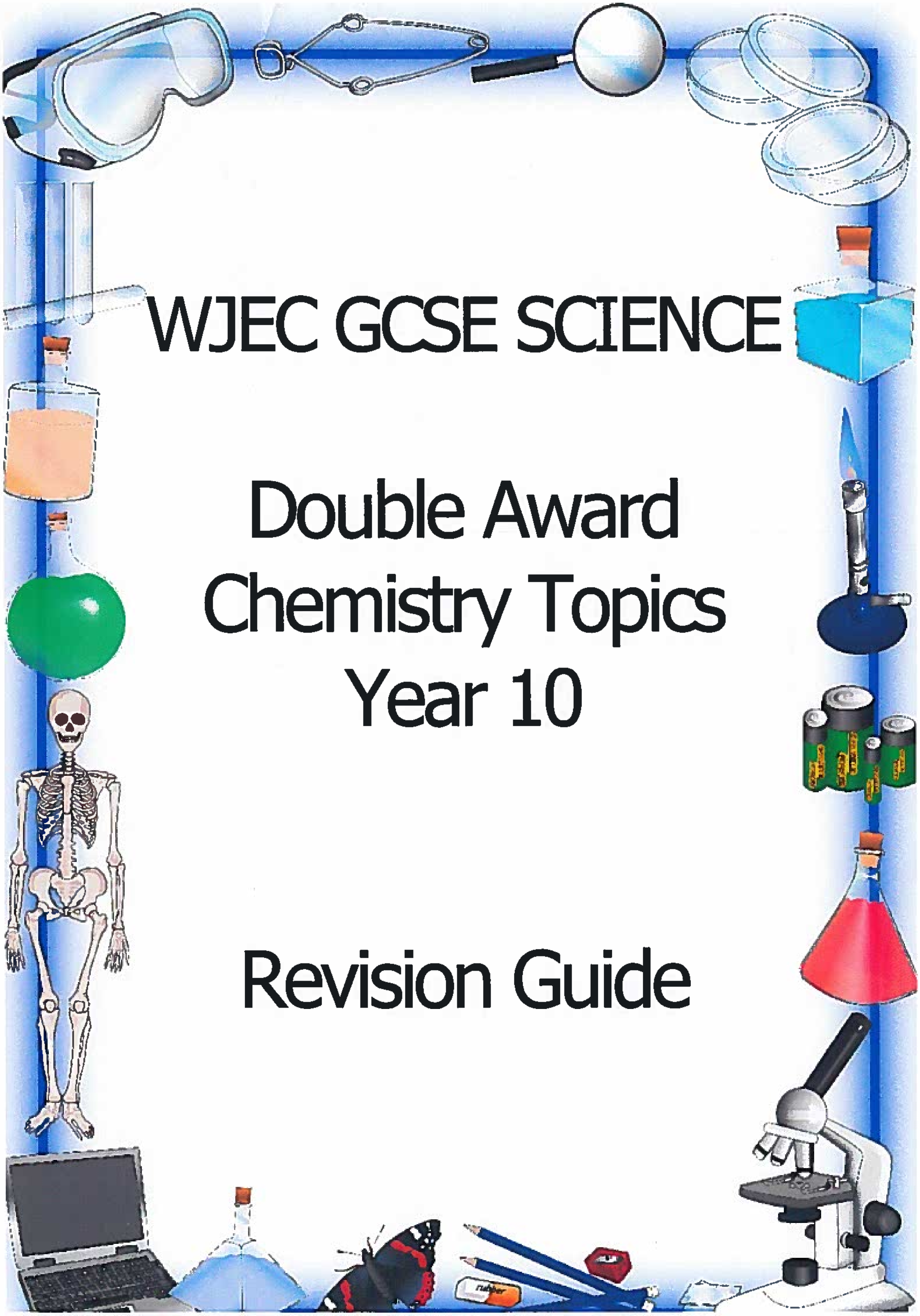


WJEC GCSE SCIENCE

Double Award Chemistry Topics

Year 10

Revision Guide

GCSE SCIENCE

Double Award

Year 10

REVISION GUIDE

CHEMISTRY TOPICS

Topic	Foundation Tier Revision	Higher Tier Revision
1: The nature of substances and chemical reactions	**Pages 1 to 11**	**Pages 1 to 15**
2: Atomic Structure and the Periodic Table	**Pages 16 to 27**	**Pages 16 to 28**
3: Water	**Pages 29 to 38**	**Pages 29 to 38**
4: The ever-changing Earth	**Pages 39 to 48**	**Pages 39 to 48**
5: Rate of chemical change	**Pages 49 to 51 and Pages 53 to 54**	**Pages 49 to 54**
Reference only: Table of formulae for some common ions	**Page 55**	
Reference only: The Periodic Table of the Elements	**Page 56**	

Chemistry

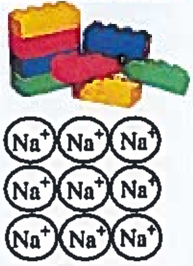
Topic 1

The nature of substances and chemical reactions

Foundation Tier Revision	**Pages 1 to 11**
Higher Tier Revision	**Pages 1 to 15**

Elements

Element

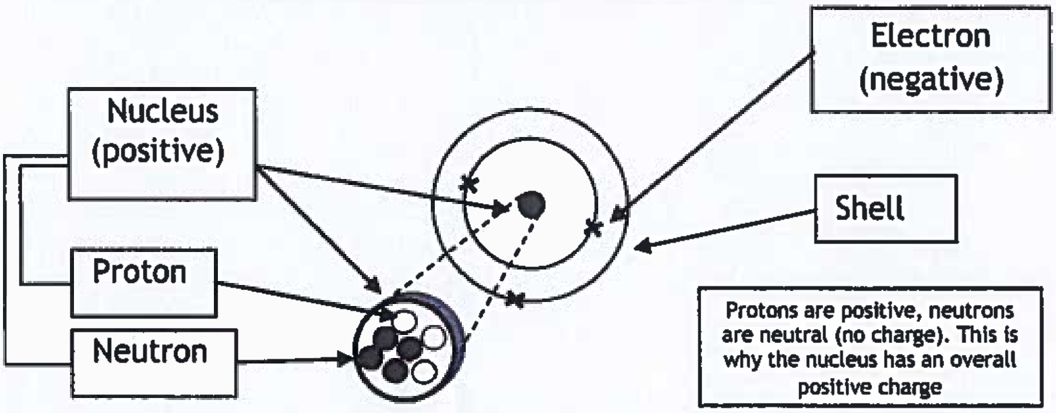


Elements are the building blocks of all substances. They cannot be broken down into simpler substances by chemical means

An Element contains only one type of atom

Atom

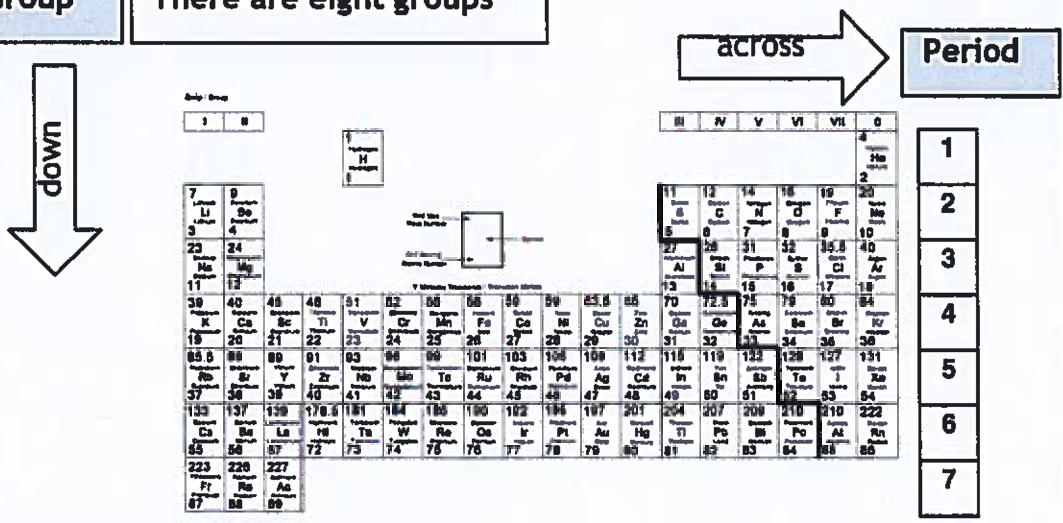
Each atom has negatively charged electrons orbiting a positively charged nucleus



Protons are positive, neutrons are neutral (no charge). This is why the nucleus has an overall positive charge

The Periodic Table - Basics

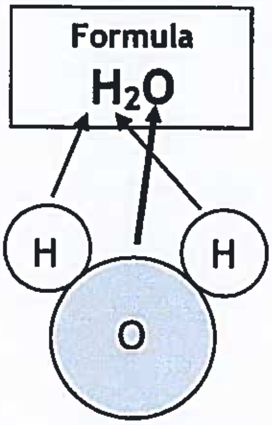
Group There are eight groups

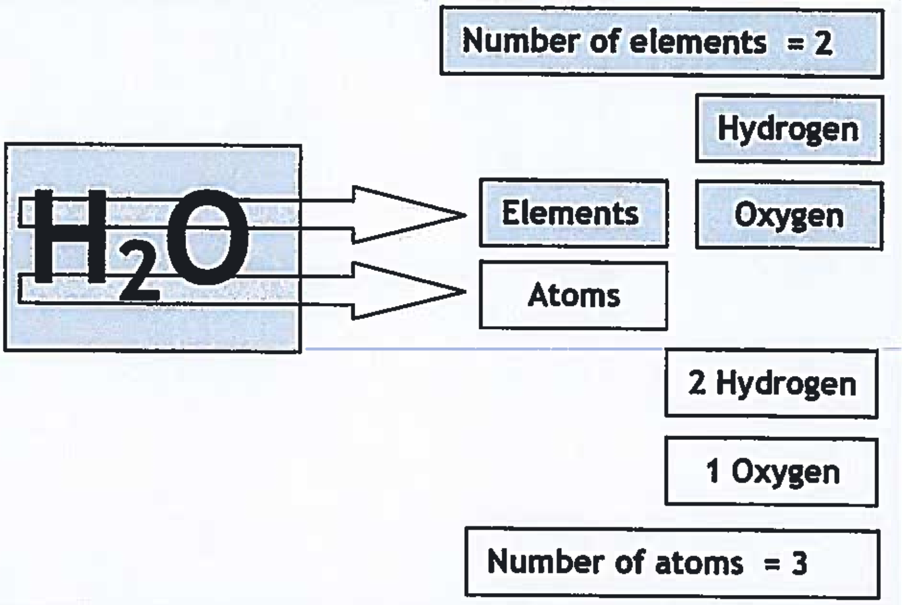


Describing Position

Sodium is in Group 1, Period 3
Helium is in Group 0, Period 1
Beryllium is in Group 2, Period 2

Compounds Substance that contains two or more elements joined together chemically

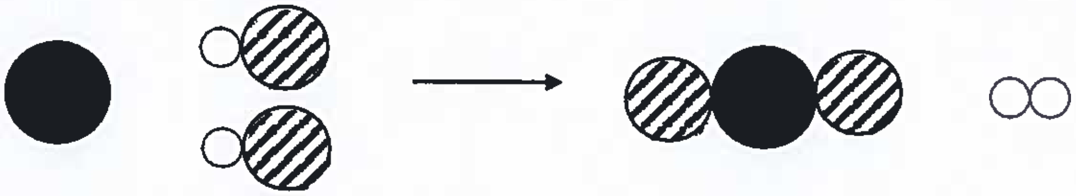




Compound	Formula	No. of elements	No. of atoms
Sodium Chloride	NaCl	2	2 (1 Na, 1 Cl)
Sodium Hydroxide	NaOH	3	3 (1 Na, 1 O, 1 H)
Sodium Oxide	Na_2O	2	3 (2 Na, 1 O)
Sodium Sulfate	Na_2SO_4	3	7 (2 Na, 1 S, 4 O)
Calcium Carbonate	$CaCO_3$	3	5 (1 Ca, 1 C, 3 O)

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.

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

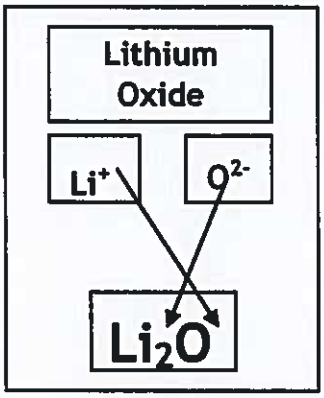
Calcium Carbonate

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

Ions cancel

$CaCO_3$

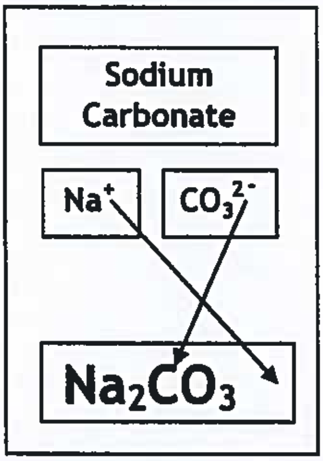
Quick method



Lithium Oxide

Li^+ O^{2-}

Li_2O



Sodium Carbonate

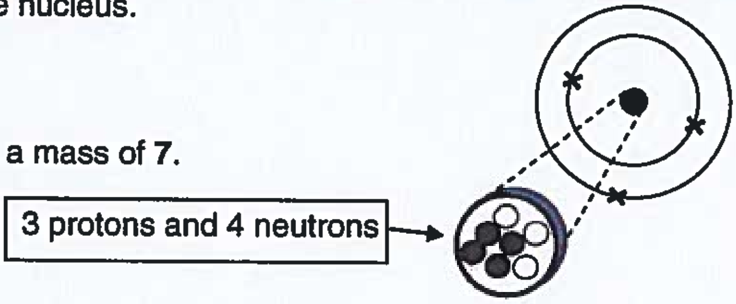
Na^+ CO_3^{2-}

Na_2CO_3

Chemical Calculations

Every atom has different mass. This is determined by the number of protons and neutrons in the nucleus.

A lithium atom has a mass of 7.



Relative atomic mass (A_r) is a way of saying how heavy different atoms are compared to each other.

The **A_r** of Lithium is 7 and that of Carbon is 12. We use the top number to determine this; this is called the mass number

Relative formula mass or **relative molecular mass (M_r)** is the mass for a compound (e.g. $MgCl_2$) so the masses for each element are

Mass numbers → **Mg** **Cl** **Cl**
24 + 35 + 35 = **94**

What is the molecular mass of ammonium sulphate $(NH_4)_2SO_4$?
(N=14, S=32, O=16, H=1)
Calculate $(NH_4)_2$ first = 14+1+1+1+1 = 18 x 2 = 36
S= 32
4 oxygen atoms 16 x 4 = 64
Mr= 132

Calculating % composition

After calculating M_r it is possible to calculate % composition, this shows how much of a specific element is in a compound in percentage form

e.g. % Mg in $MgCl_2$ =

$$\frac{\text{total } M_r \text{ of Mg in } MgCl_2 \times 100}{M_r\, MgCl_2}$$

$$\frac{24}{94} \times 100 = 25.5\,\%$$

Methods of separating mixtures: How to separate mixtures

- The ***atoms or molecules in mixtures*** are ***not chemically joined*** together. This means that mixtures can be ***easily separated*** into the different atoms or molecules that the mixture contains.

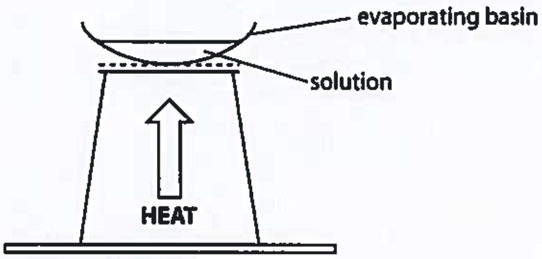
- Different processes can be used to separate mixtures depending on the physical properties of the atoms/molecules in the mixture. These processes are:

1. Filtration

- Filtering using a ***filter paper*** and a ***filter funnel.***
- Used to separate an ***insoluble solid*** from a ***liquid*** (or solution), e.g. Sand (insoluble solid) does not dissolve in water. It stays as large solid grains which will not fit through the tiny holes in the filter paper, so the solid sand collects in the filter paper. The water passes through the filter paper because the water molecules are very small.

2. Evaporation

- Heat the solution to ***evaporate*** the liquid (e.g. water) into a gas. This leaves the ***solid solute*** behind in the ***evaporating basin.***
- E.g. Separating salty water (sodium chloride solution):
  The sodium chloride is soluble and dissolves in the water to form sodium chloride solution. The dissolved sodium chloride can be separated from the water because the water evaporates when it is heated. This leaves the sodium chloride (salt) in the evaporating basin.



3. Chromatography

4. Distillation

Desalination - It is possible to desalinate sea water to supply drinking water.

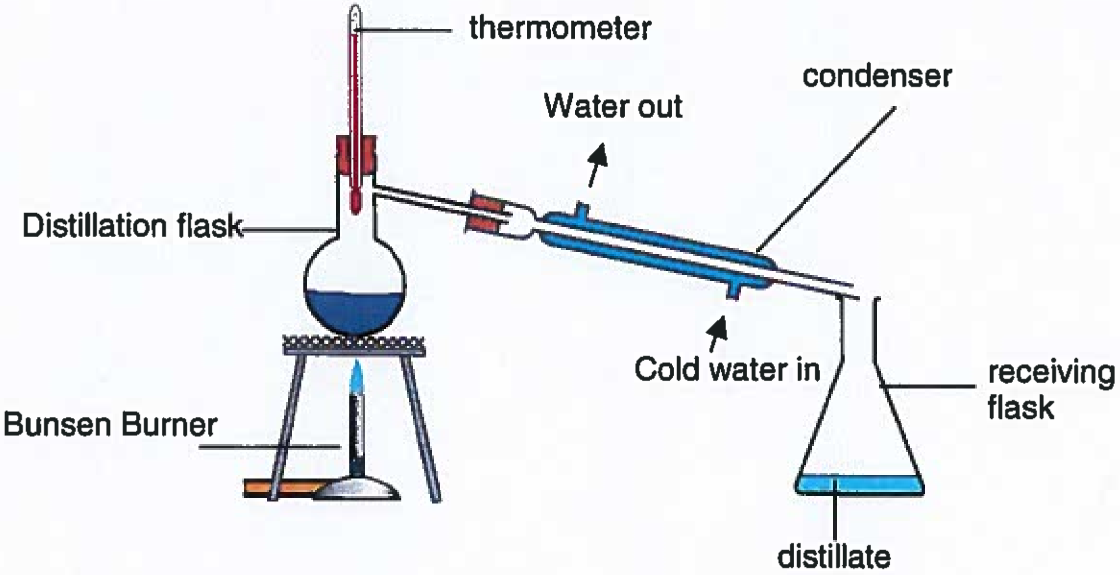
To desalinate sea water distillation of sea water by boiling is used. Boiling uses large amounts of energy which is costly. Due to this the process is not viable in many parts of the world.

If a country is to use desaliantion they need to ensure

- a renewable means of creating heat energy where no carbon dioxde is created (greenhouse effect)
- sea nearby.

Distillation – Separating water and miscible liquids.

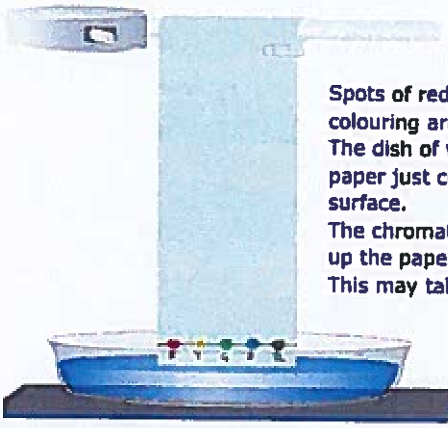
Pure liquids have specific boiling points, e.g. water boils at 100°C. Ethanol boils at 78°C. Water and ethanol are miscible (when two liquids mix together easily without separating into layers.)



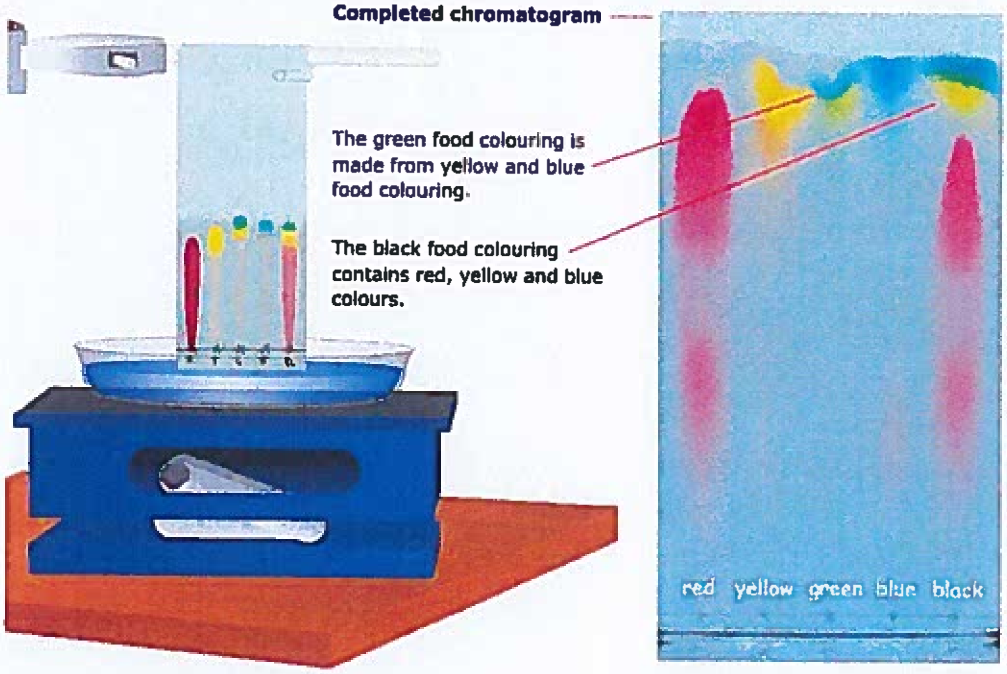
If a mixture of miscible liquids exist it is possible to separate them by distillation. In a mixture of ethanol and water, the ethanol would boil and evaporate first (as it has the lower boiling point) leaving the water behind. The ethanol would condense on the cold wall of the condenser.

Chromatography

Pigments in ink can be separated using paper chromatography.



Spots of red, yellow, green, blue and black food colouring are placed on the pencil line.
The dish of water (solvent) is raised until the paper just comes into contact with the water surface.
The chromatogram develops as the water rises up the paper.
This may take 30 minutes to complete.



Completed chromatogram

The green food colouring is made from yellow and blue food colouring.

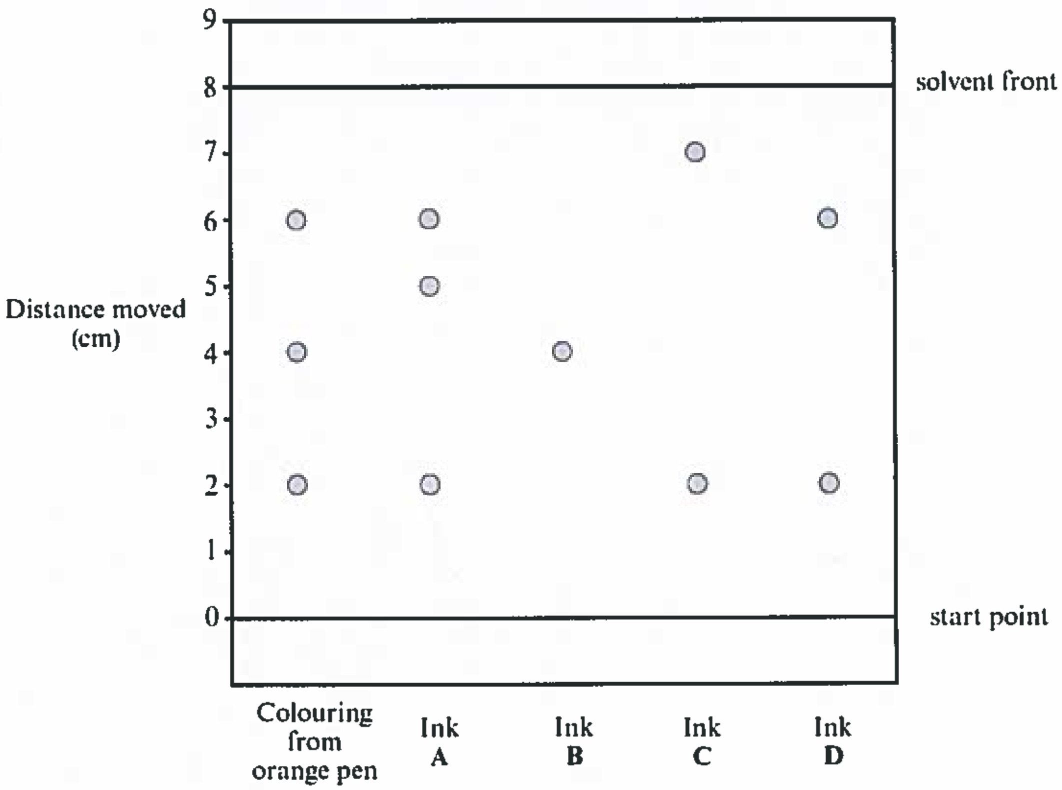
The black food colouring contains red, yellow and blue colours.

The most soluble substance will be transported furthest by the solvent.

Chromatography

The distance that a substance travels allows scientists to recognise a substance. An R_f value is calculated

$$R_f \text{ Value} = \frac{\text{distance the substance has travelled}}{\text{distance the solvent has travelled}}$$



e.g. The R_f value for ink B = 4/8 = 0.5

Gas Chromatography (Higher Tier)

Evidence that a chemical reaction has taken place
and
Writing word equations to show chemical reactions

Writing word equations to show chemical reactions.

The ***reactants*** (substances that react together) are shown in words on the ***left side*** of the arrow in the word equation.

The ***products*** (substances that are formed/produced) are shown in words on the ***right side*** of the arrow in the word equation.

Reactants → ***Products***

How do you know if a chemical reaction has happened?

- **Colour change**

  e.g. *Grey* magnesium solid metal changes to a *white* solid called magnesium oxide when magnesium is heated and it reacts with the oxygen in the air.

  magnesium + oxygen → magnesium oxide

- **Temperature change**

  In some chemical reactions, ***heat energy is produced/given out*** to the surroundings. This ***increase in temperature (temperature rises)*** can be measured using a thermometer. This type of chemical reaction is called an ***exothermic chemical reaction.***

  e.g. When sodium metal reacts with water, there is an increase in the temperature.

  sodium + water → sodium hydroxide + hydrogen

  In some chemical reactions, ***heat energy is taken in*** from the surroundings. This ***decrease in temperature (temperature falls)*** can be measured using a thermometer. This type of chemical reaction is called an ***endothermic chemical reaction.***

- **Effervescence (fizzing/bubbles seen)**

  Some chemical reactions produce a new substance that is a ***gas*** which is seen as ***effervescence (fizzing/bubbles).***

  e.g. When sodium reacts with water, the sodium floats and moves on the surface of the water and dissolves producing effervescence which is hydrogen gas.

  sodium + water → sodium hydroxide + hydrogen

Using balanced chemical equations to show the total mass of reactants and products formed is the same.

Atoms are not made or destroyed in a chemical reaction- they are only rearranged when the new products are formed.

Balanced chemical equations show what happens to the atoms in a chemical reaction.

Balanced chemical equations show the same numbers of each element on both the reactants and products side of the equation.

The total relative mass of the reactants before the reaction is the same as (equals) the total relative mass of the products formed in the chemical reaction.

Example 1

$S + O2 \rightarrow SO2$

32g of sulphur reacts with (2 x16) g of oxygen to form 32 + (2 x 16)g of sulphur dioxide

32g of sulphur reacts with 32g of oxygen to form 64g of sulphur dioxide.

Example 2

$2Mg + O_2 \rightarrow 2MgO$

2 x 24g (= 48g) of magnesium reacts with 2 x 16g (=32g) of oxygen to form

2 X (24 + 16) = 80g of magnesium oxide

48g of magnesium reacts with 32g of oxygen to form 80g of magnesium oxide

Example 3

sodium hydroxide + hydrochloric acid → sodium chloride + water

$Na\,OH + HCl \rightarrow NaCl + H_2O$

Question: Find out the mass of sodium chloride formed in this reaction.

(23 + 16 + 1) g of sodium hydroxide reacts with (1 + 35.5) g of hydrochloric acid to form X g sodium chloride and (1 x2) + 16 g of water

40g sodium hydroxide reacts with 36.5 g of hydrochloric acid to form X g of sodium chloride and 18g of water.

Total mass of reactants = 40 +36.5 = 76.5 g

Total mass of products = 18 g + X g of sodium chloride

76.5g → 18 + X g of sodium chloride

76.5g – 18g = X g of sodium chloride

58.5 g of sodium chloride are formed.

Calculating reactants or product masses

	Reactants				Products		
	NaOH	+	HCl	⇨	NaCl	+	H_2O
	23+16 + 1		1 + 35		23+35		1+1+16
	40		36		58		18
	76				76		
Units	g / tonnes				g / tonnes		

Calculating the percentage yield

When we want to create a chemical, the aim is to work carefully and to produce the maximum amount possible.

The amount formed or yield is calculated in percentage. It is very unlikely that 100% yield will be achieved e.g. some might be stuck in filter paper, evaporating dish, the product might react with the air.

Example

Magnesium metal dissolves in hydrochloric acid to form magnesium chloride.

$$\mathbf{Mg_{(s)} \quad + \quad 2HCl_{(aq)} \qquad MgCl_{2(aq)} \quad + \quad H_{2(g)}}$$

24g **95g**

(24 + 35.5 + 35.5)

(a) What is the **maximum theoretical mass** of magnesium chloride which can be made from 12g of magnesium?

12g 95/2 = **47.5g**

(b) If only **47.0g** of purified magnesium chloride was obtained after crystallising the salt from the solution, what is the % yield of the salt preparation?

$$\textbf{\% yield} = \frac{\text{actual amount obtained x 100}}{\text{maximum possible}}$$

$$\textbf{\% yield} = \frac{47.0 \text{ x } 100}{47.5} = \textbf{98.9\%} \text{ (to 1 decimal place)}$$

Calculating Reacting Masses

By using relative atomic masses and (Ar) and relative molecular masses (Mr) it is possible to calculate how much of a product is produced or how much reactants are needed.

e.g. (product calculation)

What is the mass of **magnesium oxide** is produced when 60g of magnesium is burned in air?

Symbol Equation

$$2Mg + O_2 \rightarrow 2MgO$$

Mr = 2×24 2 (24+16)
48 80

Therefore 48g (or tonnes) will produce 80g

1g 80 ÷ 48 = 1.67g

60g will produce 60 × 1.67 = 100.2g

e.g. (reactant calculation)

What is the mass of **magnesium** needed to produce 90g of magnesium oxide?

$$2Mg + O_2 \rightarrow 2MgO$$

Mr = 2×24 2 (24+16)
48 80

Therefore 48g (or tonnes) will produce 80g

Or *80g of MgO will be produced with 48g of Mg*

1g 48÷80=0.6g

90g will produce 90 × 0.6 = 54g

Determining the formula of a compound from experimental data

When 4 g of copper oxide is reduced in a steam of hydrogen, 3.2 g of copper remains.

1. Work out how much oxygen was contained in the compound

$$4 - 3.2 = 0.8 \text{ g}$$

	Cu	O
Divide with Ar	$\frac{3.2}{64}$	$\frac{0.8}{16}$
Divide with smallest	$\frac{0.05}{0.05}$	$\frac{0.05}{0.05}$
Whole number	1	1
	1 Cu	1 O

Formula = CuO

Example 2

Find the formula of iron oxide produced when 44.8g of iron react with 19.2g of oxygen. (Ar Fe = 56 and O = 16)

	Fe	O
Mass	44.8	19.2
Divide with Ar	44.8÷56	19.2÷16
	0.8	1.2
Divide with the smallest value	0.8÷0.8	1.2 ÷0.8
	1	1.5

A formula must have whole numbers therefore

	2	3

Formula = $\mathrm{Fe_2O_3}$

Converting Mass into Moles

$$\text{Moles of atoms} = \frac{\text{mass}}{Mr}$$

Moles of atoms = amount of substance
Mass = mass in grams
Mr = Molecular mass

How many moles of atoms are there in; 4.8 g of carbon ?

$$\text{moles} = \frac{4.8}{12} = 0.4 \text{ moles}$$

Ar (C) = 12

How many moles are there in; 640 g of oxygen (O_2) ?

$$\text{moles} = \frac{640}{32} = 0.4 \text{ moles}$$

Ar (O) = 16, Mr(O_2) = 16 x 2 = 32

How many moles are there in; 10 g of $CaCO_3$?

$$\text{moles} = \frac{10}{100} = 0.1 \text{ moles}$$

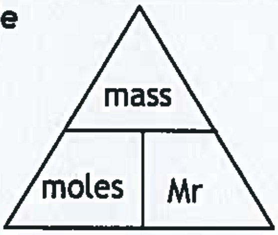
Ar (Ca) = 40, (C) = 12, (O) = 16
Mr $CaCO_3$ = 100

Converting Moles into mass

You can rearrange the equation to form

$$\text{mass} = \text{moles} \times Mr$$

If you find rearranging difficult you can use the triangle



What is the mass of 0.05 moles of carbon atoms?

$$\text{mass} = 0.05 \times 12 = 0.6 \text{ g}$$

Ar (C) = 12

What is the mass of 0.6 moles of chlorine molecules (Cl_2)?

$$\text{mass} = 0.6 \times 71 = 42.6 \text{ g}$$

Ar (Cl) = 35.5, Mr(Cl_2) = 35.5 x 2 = 71

What is the mass of 0.1 moles of calcium carbonate?

$$\text{mass} = 0.1 \times 100 = 10.0 \text{ g}$$

Ar (Ca) = 40, (C) = 12, (O) = 16
Mr $CaCO_3$ = 100

It is also possible to calculate the molar mass Mr when mass and the number of moles are known

$$Mr = \frac{\text{mass}}{\text{moles}}$$

0.5 moles of a compound weighs 80g, calculate its Mr

$$Mr = \frac{80}{0.5} = 160$$

Avogadro Constant (Higher Tier only)

Chemists use a quantity called the **amount of substance** for counting the number of atoms. The amount of substance is measured in **moles.**

The **NUMBER OF PARTICLES** (e.g. atoms or molecules or ions) in **ONE MOLE** of any substance is called **AVOGADRO'S NUMBER** (given the symbol L).

Avogadro's Number, L = 6×10^{23}

You do not need to remember this number. It is given to you in the exam at the back of the exam paper.

Avogadro's Number shows us that:

- 1 mole of hydrogen atoms contains 6×10^{23} atoms
- 1 mole of lead atoms will contains 6×10^{23} atoms
- 1 mole of oxygen molecules O_2 contains 6×10^{23} molecules
- 0.5 moles of hydrogen atoms contains 3×10^{23} atoms

Chemistry

Topic 2

Atomic Structure and the Periodic Table

Foundation Tier Revision	**Pages 16 to 27**
Higher Tier Revision	**Pages 16 to 28**

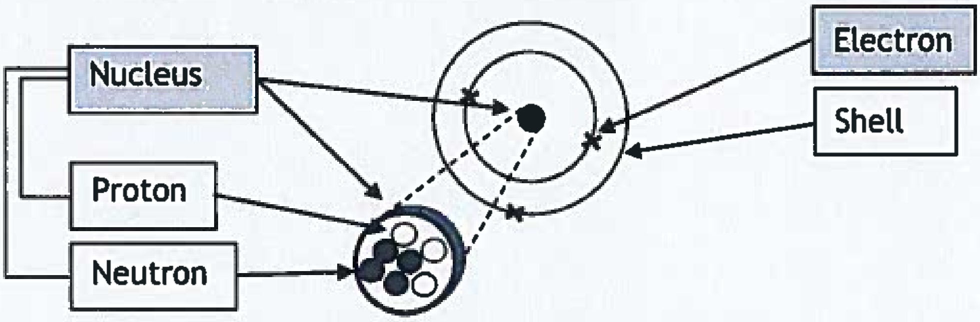
Atomic Structure

Atoms contain a **nucleus and electrons**

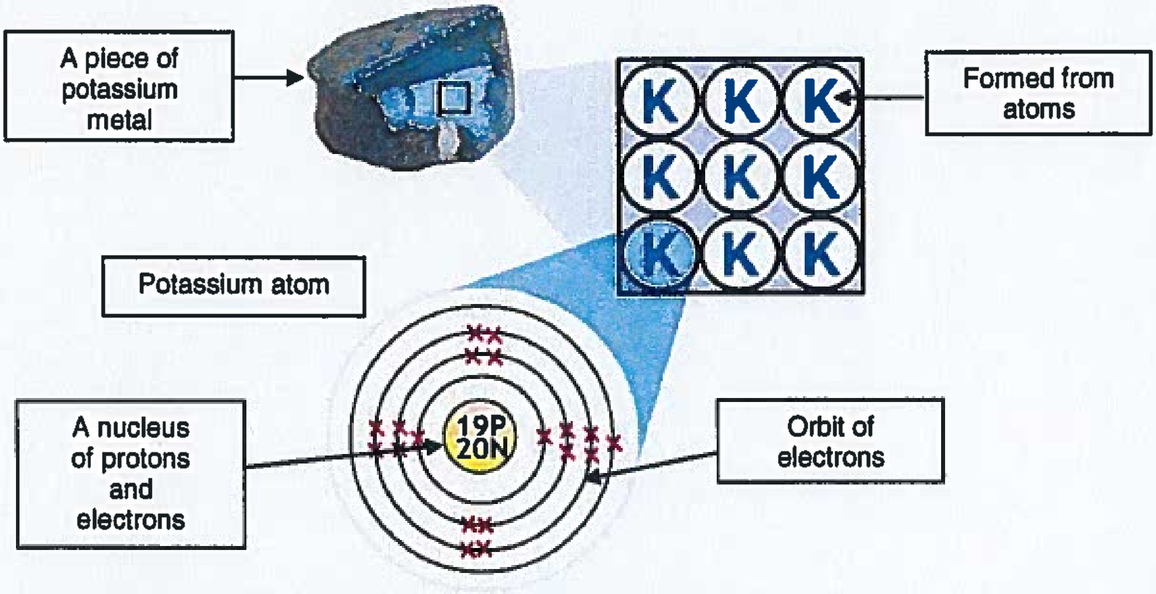
The small central nucleus is made from **protons** and **neutrons**.

Around these are **orbits** (shells) of **electrons**.

Here is a diagram showing an atom of **Lithium**



This diagram shows that a piece of **Potassium** is made up of millions of the same atom.



Atoms of **different** elements are different.

The number of **protons** is always different with different elements.

Element	*Lithium*	*Potassium*
Protons	**3**	**19**
Neutrons	4	20
Electrons	3	19

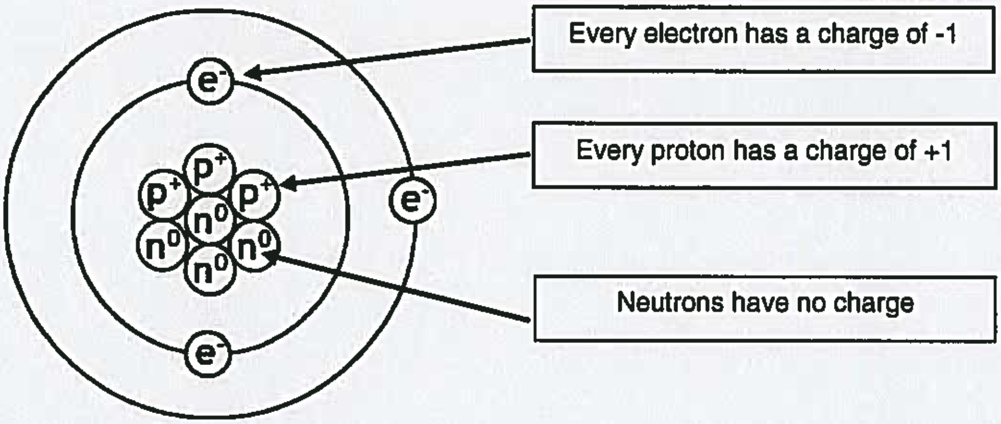
Neutron number for some elements are the same.
Electron number can be the same when the atoms have bonded.

Atomic Structure

Atoms have no charge.

The number of protons (in the nucleus) is always **the same** as the number of electrons (in shells)

Protons are positively charged. (+)
Electrons are negatively charged (-)
Neutrons do not have a charge (**0**)



Every electron has a charge of -1

Every proton has a charge of +1

Neutrons have no charge

Therefore an atom of **lithium** has no charge :- +3p + -3e = **0** **no charge**

Ion has **uneven** number of **protons and electrons**

This happens when an **electron is lost**

Or when an **electron is gained**

The proton number does not change.

Mass and **Charge** of atoms

Here are the relative mass of each particle and their electric charge.

	mass	charge
proton	1	+1
electron	0	-1
neutron	1	0

Protons and **neutrons** have similar mass.
Electrons have no mass, or extremely little amount.

Atomic Structure

Atomic Number → $^{7}_{\textcircled{3}}\mathrm{Li}$

Number on the **bottom** which means the number of protons or electrons

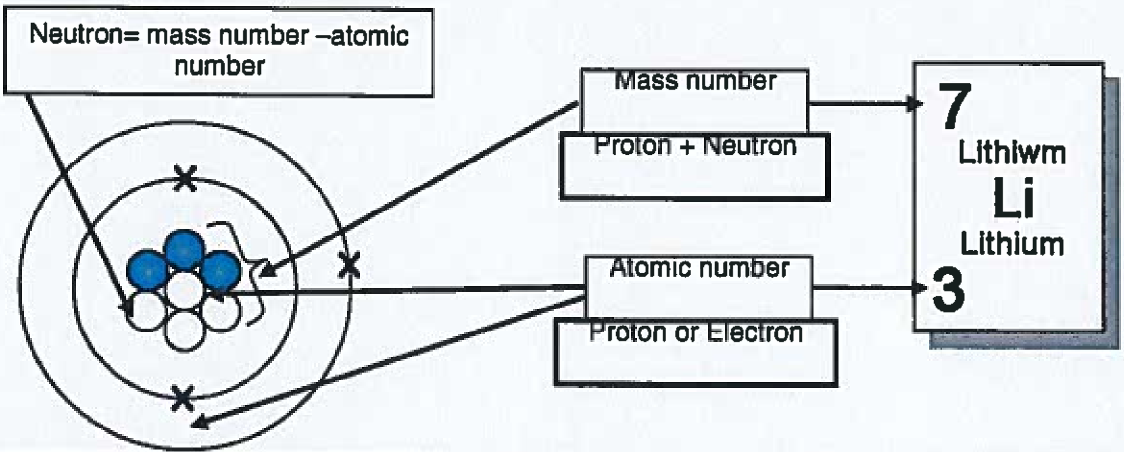
The number increases across the periodic table

Mass Number → $^{\textcircled{7}}_{3}\mathrm{Li}$

Number on the **top** which means the number of protons and neutrons in the nucleus.

Neutron Number

The number of neutrons in an atom is worked out by subtracting the number of protons (Atomic number) from the Mass number.

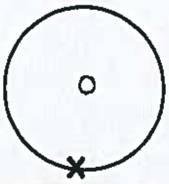


Isotopes

The same element (as it has the same number of protons) but with different number of neutrons (making the mass number different). Hydrogen

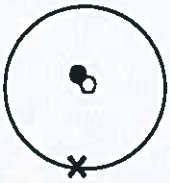
Proton = ○
Electron = ×
Neutron = ●

$^{1}_{1}\mathrm{H}$



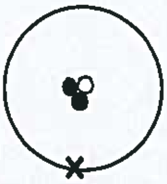
Proton number = 1
Neutron number = 0

$^{2}_{1}\mathrm{H}$



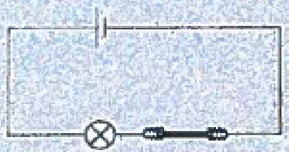
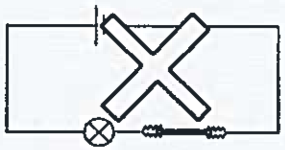
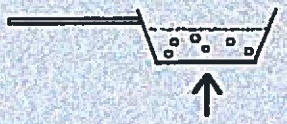
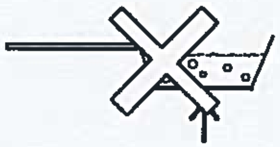
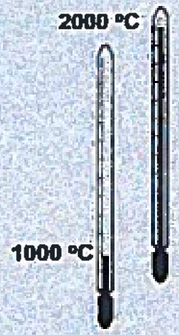
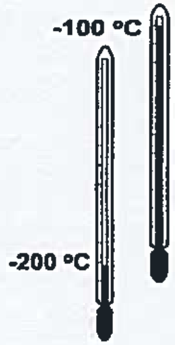
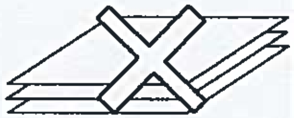
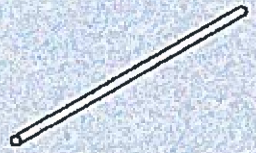
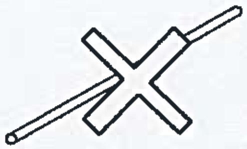
Proton number = 1
Neutron number = 1

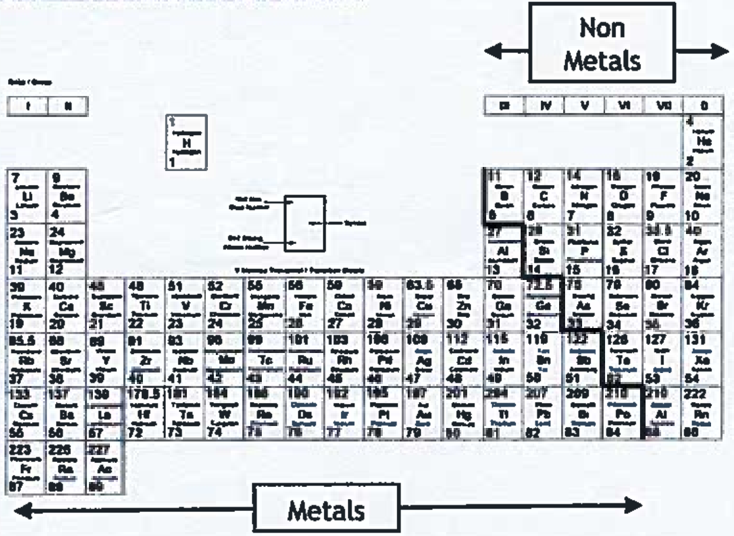
$^{3}_{1}\mathrm{H}$



Proton number = 1
Neutron number = 2

Physical Properties

Metals		Non-Metals	
	Conduct Electricity	Does not conduct Electricity	
	Conduct Heat	Does not conduct heat	
 2000 °C 1000 °C	High Melting point Boiling point	Low Melting point Boiling point	 -100 °C -200 °C
	Malleable	Not malleable	
	Ductile	Not ductile	



Can be hammered into sheets

Can be pulled into wires

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

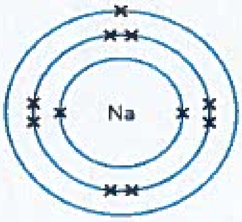
Electron Shells and Electronic Structures of Elements

- Electrons are arranged in the **electron shells** of an atom surrounding the nucleus.
- The lowest electron shells are always filled with electrons first. These are the shells that are closest to the nucleus.
- Only a certain number of electrons can fit in each shell:

1st shell: 2 electrons maximum
2nd shell: 8 electrons maximum
3rd shell: 8 electrons maximum
4th shell: any remaining electrons

- The electronic structure (sometimes called the electronic configuration) of an element shows the way the electrons are arranged in one atom of this element.
- The electronic structures of an atom of an element can be drawn in a electron-shell filling diagram.

E.g. Electron –shell filling diagram to show the electronic structure of a sodium atom:



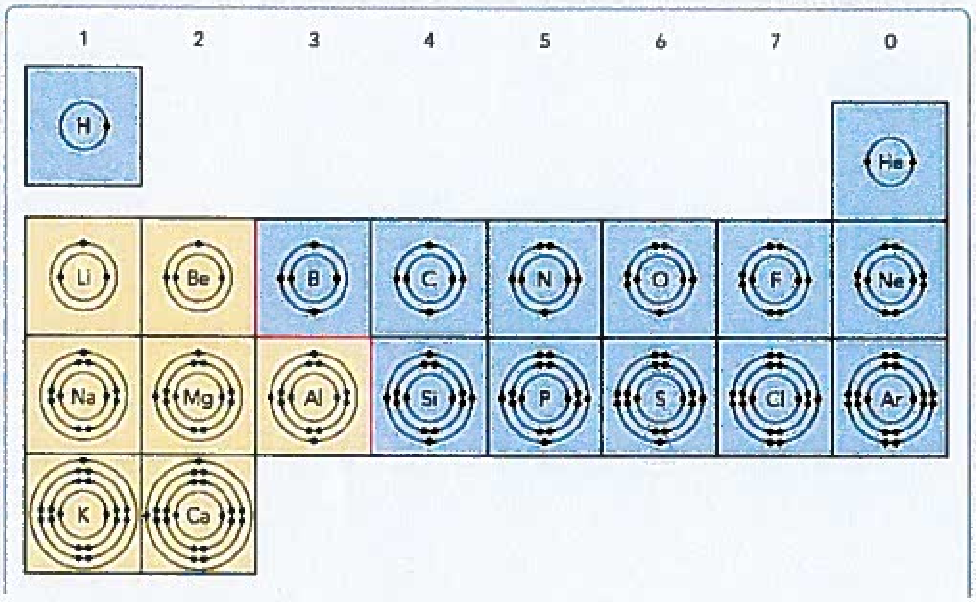
Sodium atom
Atomic number = 11= 11 protons in nucleus

11 electrons in shells

Electronic structure of a sodium atom = 2.8.1

The electronic structure shows 2 electrons in the first shell (closest to the nucleus), 8 electrons in the second shell and 1 electron in the third shell (outer shell).

- Electron-shell filling diagrams to show the electronic structures of the first 20 elements in the Periodic Table (Atomic No. 1 to 20 for elements hydrogen to calcium in the Periodic Table):



- The GROUP NUMBER (column) of an element in the Periodic Table is the same as the number of electrons in the OUTER SHELL of an element.

  e.g. Sodium is in Group 1 because it has one electron in its outer shell.

  e.g. Oxygen has 6 electrons in its outer shell so it is in Group 6 of the Periodic Table.

- The PERIOD NUMBER (row) of an element is the same as the number of occupied electron shells (shell which have electrons in them).

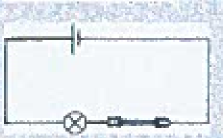
  e.g. Sodium is in Period 3 because it has electrons in its first three electron shells.

  e.g. Oxygen (atomic no. = 8; 8 protons= 8 electrons; electronic structure = 2.6) is in Period 2 because it has electrons in the first 2 electron shells.

Metals

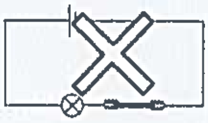
Physical Properties

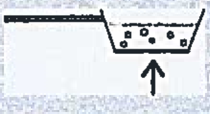
Non-Metals



Conduct Electricity

Does not conduct Electricity

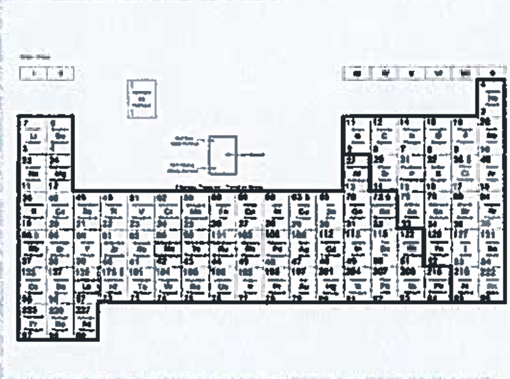




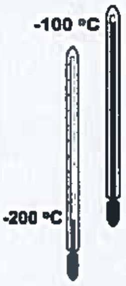
Conduct Heat

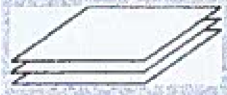
Does not conduct heat

High
Melting point
Boiling point



Low
Melting point
Boiling point

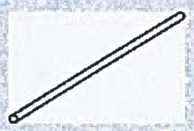




Malleable

Can be hammered into sheets

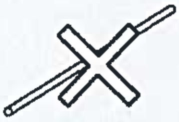
Not malleable



Ductile

Can be pulled into wires

Not ductile

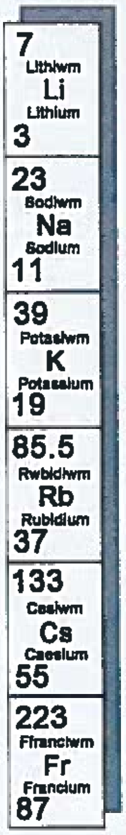


Group 1

Alkali Metals

1 electron on the outer shell

Physical Properties



7 Lithiwm Li Lithium 3
23 Sodiwm Na Sodium 11
39 Potasiwm K Potassium 19
85.5 Rwbidiwm Rb Rubidium 37
133 Cesiwm Cs Caesium 55
223 Ffranciwm Fr Francium 87

All metals look dull on the outside.

Over a short period of time a layer of oxide makes the metal look dull.

The inside of every metal is shiny

It is possible to cut every metal with a knife

They are kept in oil to prevent them from reacting with oxygen and moisture in the air.

Their **density** is low therefore most float

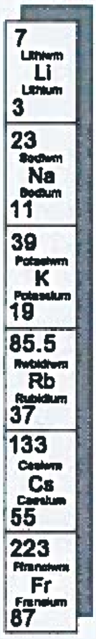
The boiling point and melting point are lower than many other metals

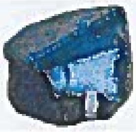
Group 1

Alkali Metals

Chemical Properties

They react with **oxygen** and **water.**





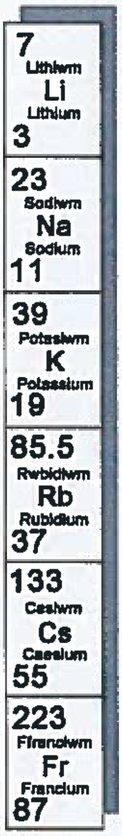
Alkali metals with oxygen and water

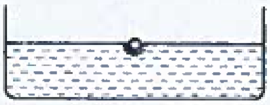
Oxygen causes the surface of the metal to turn dull by forming a layer of oxide

eg. potassium + oxygen → potassium oxide

$$4K(s) + O_2(g) \longrightarrow 2K_2O(s)$$

The oxide layer forms quicker as we go down the group





Alkali metals with water

The metal creates alkali as it reacts water (purple with universal indicator)

The metal with water creates hydrogen

The metal **floats, moves** and **fizzes.**

eg. lithium + water → lithium hydroxide + hydrogen

$$2Li(s) + 2H_2O\ (l) \longrightarrow 2LiOH\ (aq) + H_2\ (g)$$

Sodium

In addition this moves quicker and has a ball shape.

Potassium

In addition it moves quickly and has a lilac flame.

Safety Precautions

Use safety goggles
Use a small piece of metal in the water
Use tongs to hold the metal

Group 7

Halogens

Physical Properties

They react with group 1 metals and salts

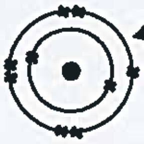
19
Fflworin
F
Fluorine
9

35.5
Clorin
Cl
Chlorine
17

80
Bromin
Br
Bromine
35

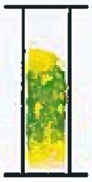
127
Iodin
I
Iodine
53

210
Astatin
At
Astatine
85



7 electrons on the outer shell

Chlorine	Yellow Green Gas
Bromine	Orange Red Liquid
Iodine	Shiny Grey Solid



State and appearance

Poisonous Vapours

Bromine
Orange gas

Iodine
Purple
gas

Vapours With colour

Halogen with group 1 metals

7
Lithiwm
Li
Lithium
3

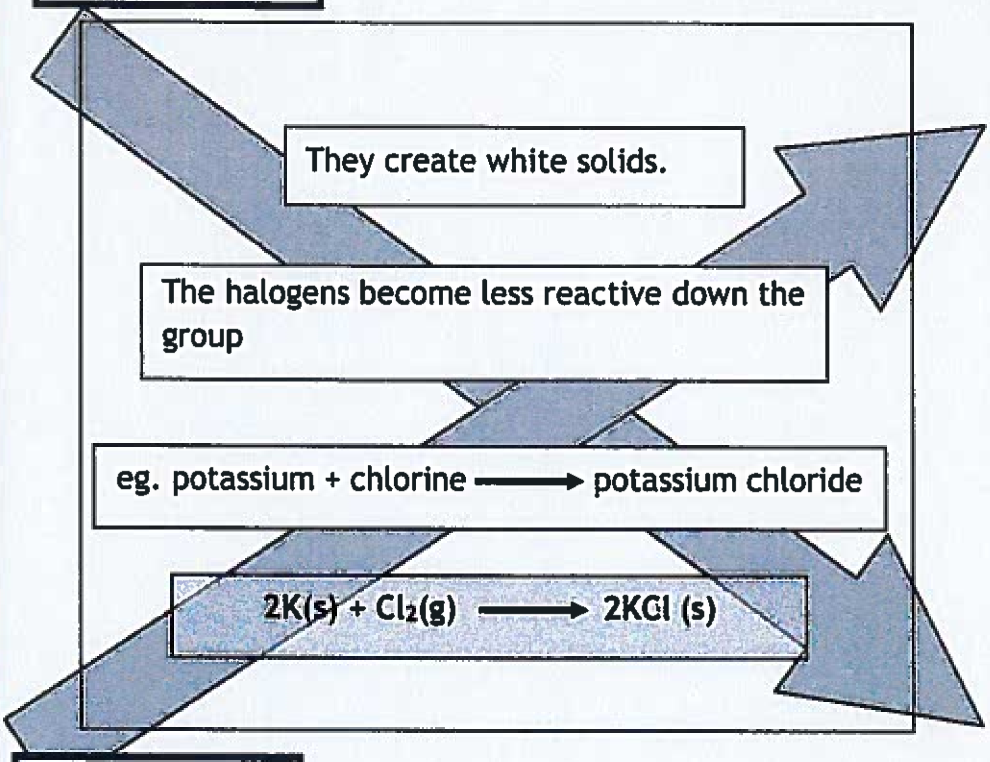
23
Sodiwm
Na
Sodium
11

39
Potasiwm
K
Potassium
19

85.5
Rwbidiwm
Rb
Rubidium
37

133
Cesiwm
Cs
Caesium
55

223
Ffranciwm
Fr
Francium
87



Least reactive

They create white solids.

The halogens become less reactive down the group

eg. potassium + chlorine ⟶ potassium chloride

$2K(s) + Cl_2(g) \longrightarrow 2KCl\ (s)$

Most reactive

19
Fflworin
F
Fluorine
9

35.5
Clorin
Cl
Chlorine
17

80
Bromin
Br
Bromine
35

127
Iodin
I
Iodine
53

210
Astatin
At
Astatine
85

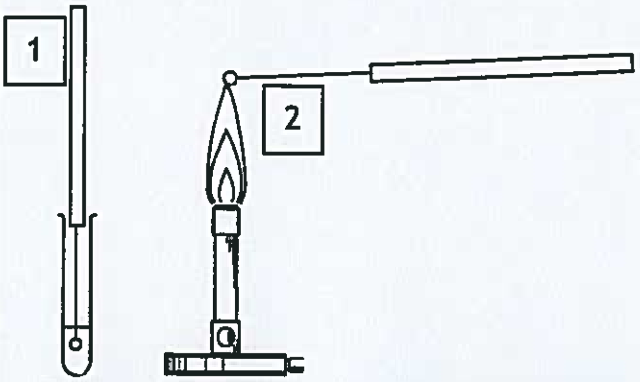
Safety Precautions

Use safety goggles
Use a fume cupboard
Use plastic gloves

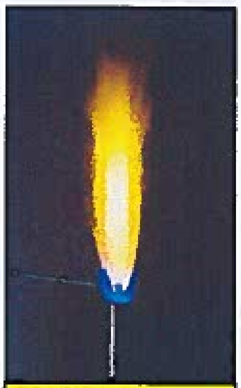
Chemical Analysis – Flame tests

Method

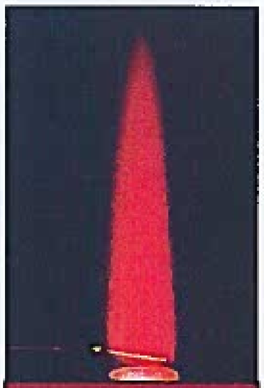
1. Dip a clean wire loop in the sample solution
2. Hold the flame test wire loop at the edge of a Bunsen flame
3. Observe the changed colour of the flame, and decide which metal it indicates
4. Clean the loop in acid, rinse with water and repeat procedure with another sample

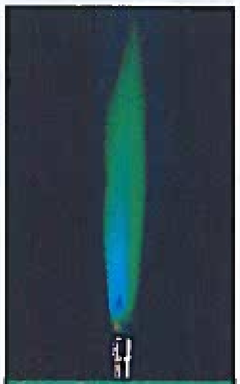


Metal	Ion	Flame test
Sodium	Na^+	Yellow-orange
Potassium	K^+	Lilac
Calcium	Ca^{2+}	Brick red
Copper	Cu^{2+}	Green


Sodium


Potassium


Calcium


Copper

Atomic Spectroscopy

This method is used to identify and show the amount (concentration) of specific atoms/ions present in the sample.

The colour of the light emitted during a flame test corresponds to a specific frequency

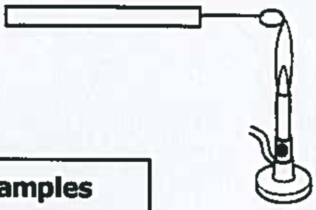
The intensity of the emission is measured - this corresponds to the amount of the metal present.

Group 7 The Halogens

Identifying compounds

Metal	**Flame test**
Lithium	Red
Sodium	Yellow-orange
Potassium	Lilac

Non-metal	**Silver Nitrate test**
Chloride	white
Bromide	cream
Iodide	yellow



Flame Test
(to identify the metal)

Silver Nitrate Test
(to identify non metal ions)

Examples
Lithium Chloride
Sodium Iodide
Potassium Bromide

Red
due to lithiwm

Yellow-orange
due to sodium

Lilac
due to potassium

White precipitate
due to chloride ions

Yellow precipitate
due to iodide ions

Cream precipitate
Due to bromide ions

Higher Tier: Silver Nitrate ionic equation:
e.e. Ag^+ (aq) + Cl^- (aq) $\Rightarrow$ AgCl (s)

Atomic Spectroscopy (Higher Tier): This method is used to identify and show the amount (concentration) of specific atoms/ions present in the sample.

Group 7: The Halogens

Halogen	Properties	Uses
Chlorine **Cl_2**	Yellow green gas Poisonous/ toxic vapours	1. Poisonous/toxic properties kill bacteria so it is used to treat (sterilise) drinking water supplies and swimming pool water. Very small quantities of chlorine are used that are carefully controlled and monitored. This is to make sure that there is enough chlorine to kill bacteria and sterilise the water, without causing any harm to us. 2. Make household cleaners, e.g. bleach
Iodine **I_2**	Shiny grey solid that vaporises easily when heated to form a purple gas. Poisonous/toxic vapours	Poisonous/toxic properties kill bacteria so it is used as an antiseptic on the skin before and following surgery operations in hospital.

Group 0: The Noble Gases

- All elements in **Group 0** belong to a group in the Periodic Table called the **Noble Gases**:
  Helium, Neon, Argon, Krypton, Xenon

- All of the elements in Group 0 contain atoms with a **FULL OUTER SHELL OF ELECTRONS.** This means that these atoms do not need to either gain or lose electrons as they are very stable due to their full outer electron shell.

- The full outer electron shell means that the Noble Gas Group 0 elements are **unreactive** (sometimes called **INERT**).

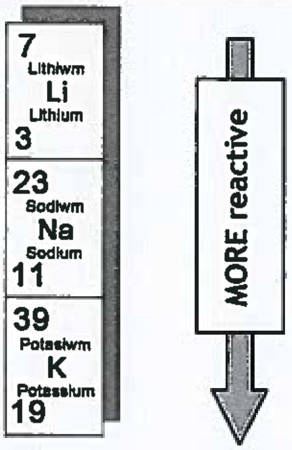
- The Noble Gases exist as single atoms (not joined with another atom: He, Ne, Ar, Kr, Xe). They are all **GASES**.

- The air is a source of neon and argon (and also oxygen and nitrogen gases). Neon and argon are found in the atmosphere (approximately 0.9%).

Noble Gas/symbol	Properties	Uses
Helium He	Very low density (lightweight) Very unreactive	Airships (float in air) Weather balloons (float in air)
Neon Ne	Emits red light when an electric current passes through it	Advertising signs
Argon Ar	Very unreactive, e.g non flammable	Lightbulbs (filament lightbulbs) Unreactive atmosphere for welding metals together

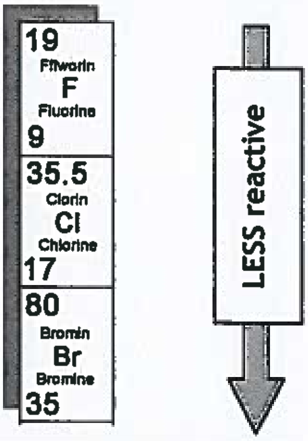
Higher Tier

Alkali Metals | Group 1 metals become more reactive down the group.

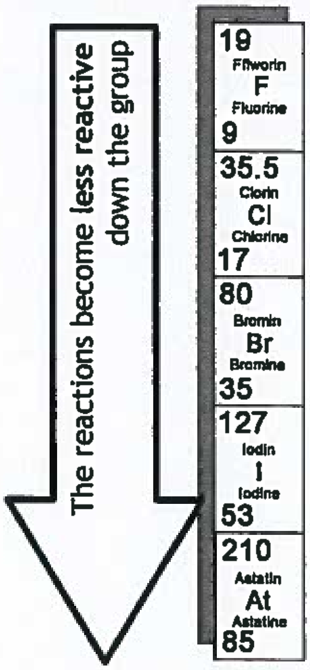


- **Group 1 metals react by <u>losing</u> 1 electron**
- There are more orbits as you go down the group.
- The outer electron becomes further from the nucleus.
- Due to less attraction it is easier to lose an electron.

The Halogens | Group 7 non-metals become less reactive down the group.

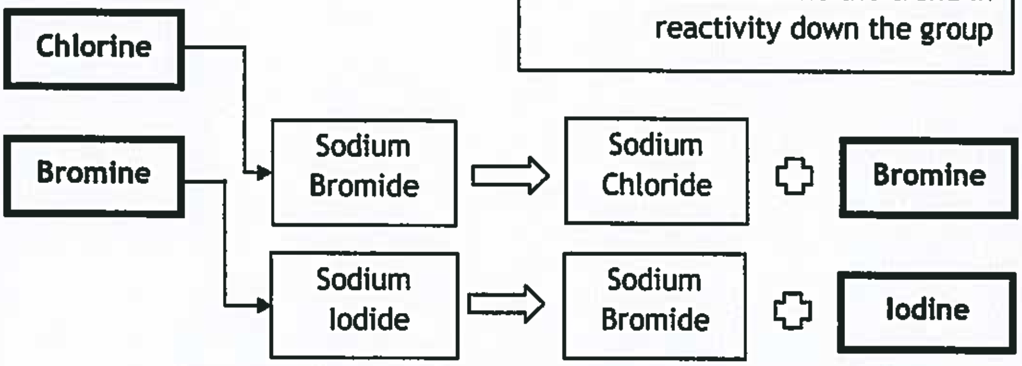


- **Group 7 non-metals react by <u>gaining</u> 1 electron**
- As you go down the group there are more orbits, because of this it is harder to attract an electron, they become less reactive



Displacement reactions

This reaction shows the trend in reactivity down the group



$Cl_2(g) + 2NaBr(aq) \longrightarrow 2NaCl (aq) + Br_2(aq)$

Chemistry

Topic 3

Water

Foundation Tier Revision	**Pages 29 to 38**
Higher Tier Revision	**Pages 29 to 38**

What is in our Water?

- A molecule of water contains 2 hydrogen atoms bonded to 1 oxygen atom to give the chemical formula H_2O.
- Water is a compound because it contains at least 2 different atoms chemically joined together.
- The properties of water (compound) are very different to the properties of the hydrogen and oxygen (elements) that water is made out of.

What is in our 'natural' water supplies, e.g. rainwater, groundwater?

- Water is an excellent **solvent** because many substances (called **solutes**) dissolve in it.

1. **Ions**
   Water flows over or through ground rocks. Mineral ions in the rocks dissolve in the water. The mineral ions are solutes:
   magnesium ions Mg^{2+}
   calcium ions Ca^{2+}
   potassium ions K^+
   sodium ions Na^+
   sulphate ions SO_4^{2-}
   chloride ions Cl^-
   hydrogencarbonate ions HCO_3^-

2. **Dissolved gases**
   Rainwater contains:
   - Carbon dioxide CO_2 which makes rain water slightly acidic (lowers the pH to approx.pH5-6)
   - Oxygen O_2 which aquatic animals need for respiration.

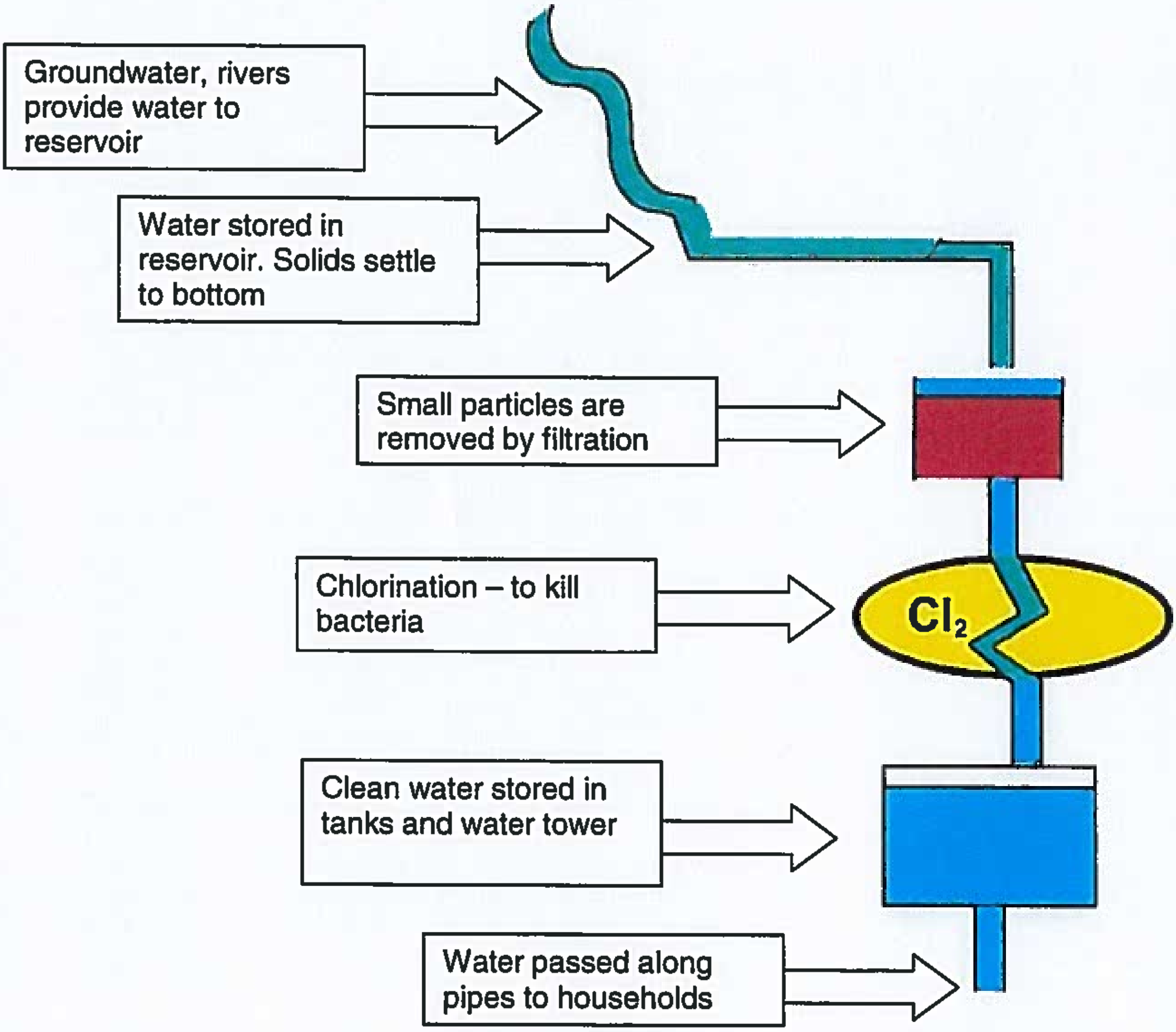
3. **Microorganisms, e.g. bacteria, viruses and other microscopic life.**
   Some microorganisms can cause disease, so it is advisable not to drink untreated water from streams, rivers and lakes. Water treatments cannot remove all microorganisms. These microorganisms are 'natural' water pollutants.

4. **Pollutants (Chemicals causing pollution)**
   Man-made chemical fertilisers, pesticides, household and animal waste washes through soil and rock in to the rivers and lakes.
   Illegal dumping of chemical pollutants, e.g. industrial waste from factories, can also pollute the water.

Water

Water is necessary for life to exist. The quality of life depends on the availability of clean water. Water in this country is made drinkable by treating rainwater.

Here are the steps involved in making water drinkable.



Groundwater, rivers provide water to reservoir

Water stored in reservoir. Solids settle to bottom

Small particles are removed by filtration

Chlorination – to kill bacteria

Clean water stored in tanks and water tower

Water passed along pipes to households

Fluoride ions are added to water to strengthen children's teeth in some areas.

Fluoride is not added to water supplies in Wales.

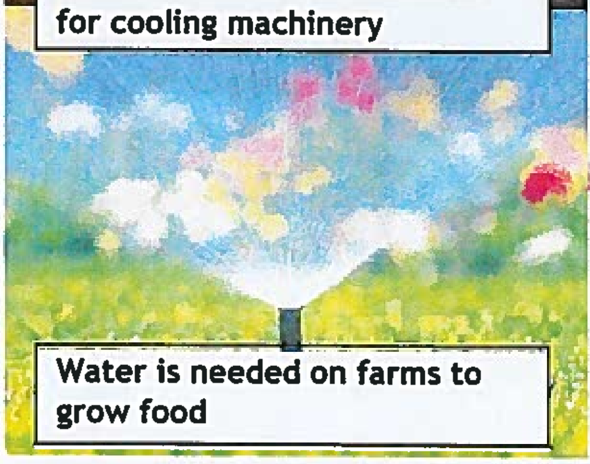
Water Preservation

Although there is ample water on Earth, only a very small fraction is safe for drinking. With an increasing population and developing industry our need for water is larger than ever.

The need for water

Water is needed in factories for cooling machinery

Hygiene - We need water to keep clean and wash clothes



Water is needed on farms to grow food

We need drinking water

We use 150 litres of water each on average every day. The water comes from natural underwater storage, rivers and different reservoirs. During dry conditions when there is not enough rain there is a strain on the water supply – areas will experience drought.

Shortage of water problems arise when there is more demand than supply of water, which is a threat to life and the environment. Water cost may increase if future climate changes cause shortage of water in the UK. Using less water in the future is very important.

Here are some ways of decreasing our use of water.

- Use washing machines and dish washers only when they are full.
- Having a shower instead of a bath.
- Use waste water for plants and to wash the car.
- Repair dripping taps.
- Do not allow the water to run excessively (e.g. when brushing teeth)

Desalination - It is possible to desalinate sea water to supply drinking water.

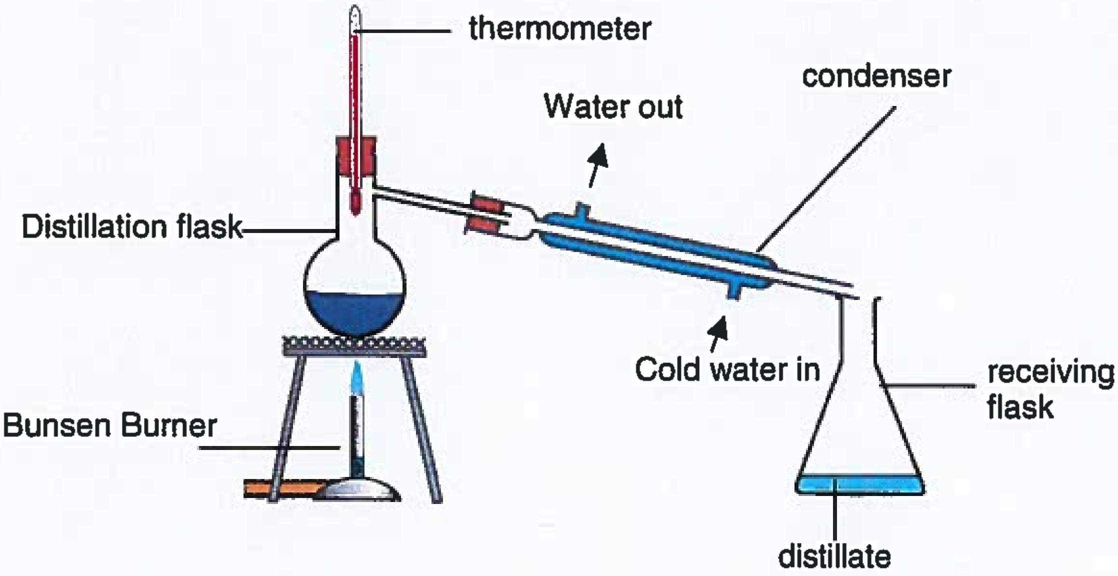
To desalinate sea water distillation of sea water by boiling is used. Boiling uses large amounts of energy which is costly. Due to this the process is not viable in many parts of the world.

If a country is to use desaliantion they need to ensure

- a renewable means of creating heat energy where no carbon dioxde is created (greenhouse effect)
- sea nearby.

Distillation – Separating water and miscible liquids.

Pure liquids have specific boiling points, e.g. water boils at 100°C. Ethanol boils at 78°C. Water and ethanol are miscible (when two liquids mix together easily without separating into layers.)



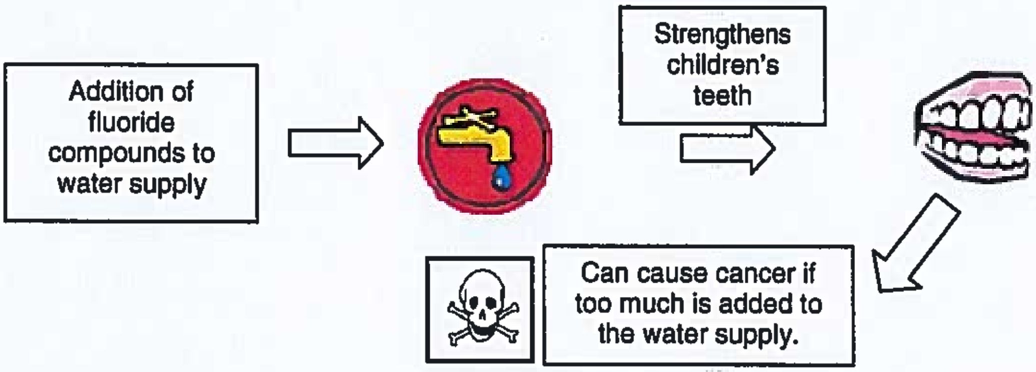
If a mixture of miscible liquids exist it is possible to separate them by distillation. In a mixture of ethanol and water, the ethanol would boil and evaporate first (as it has the lower boiling point) leaving the water behind. The ethanol would condense on the cold wall of the condenser.

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

Solubility curves

Soluble solids dissolve more readily when heated.

Every solid has a different rate of solubility. The diagram below shows that potassium nitrate dissolved more readily than copper sulphate at any temperature above 0°C.

e.g.

The amount of copper sulphate that dissolves at 40°C is 24 g in 100 cm^3 water.

The amount of potassium nitrate that dissolves at 40°C is 60 g in 100 cm^3 water.

Notice that the standard amount of water used is 100 cm^3 or 100 g.

This graph shows the maximum amount of solid that will dissolve at any temperature.

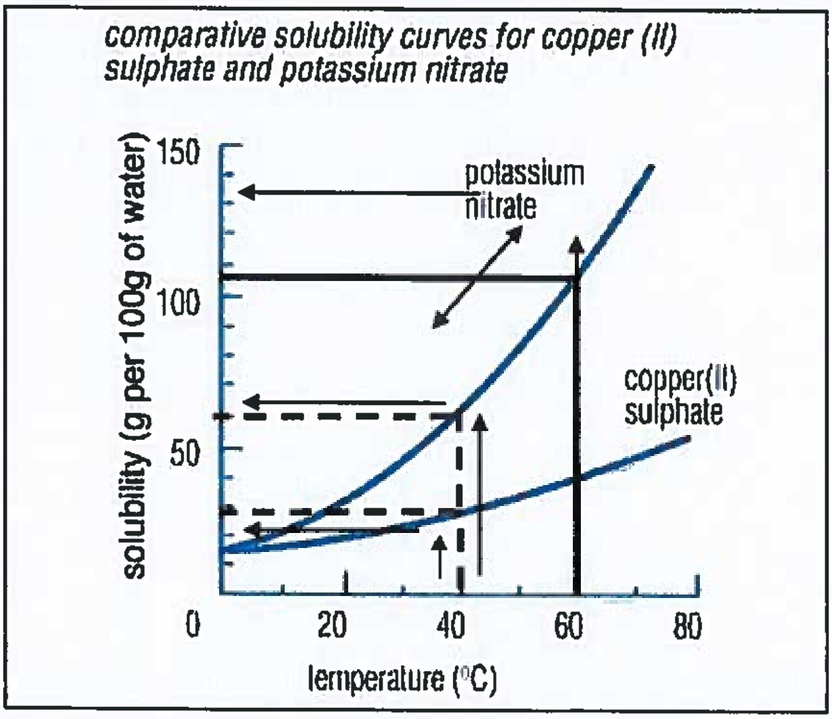
A **saturated solution** is the maximum amount of solid that will dissolve at a particular temperature.

The amount of copper sulphate that dissolves at 60°C is 107 g in 100 cm^3 water.

If a saturated solution of copper sulphate at 60°C was to cool down to 40°C not as much solid would be able to dissolve.

It is possible to work out how much less would dissolve by subtracting:

107 g – 60 g = **47 g** of solid would appear on the bottom of the beaker.

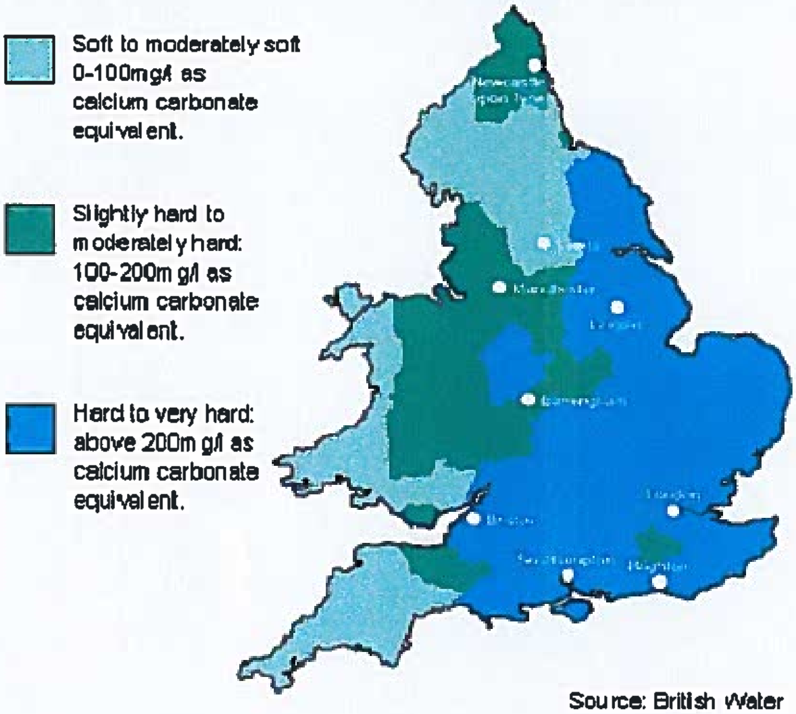

comparative solubility curves for copper (II) sulphate and potassium nitrate

Types of drinking water.

Depending on the type of rocks a region has, water can be of two types :-

Hard water and Soft water

Hard Water Areas in England and Wales



Source: British Water

Hard Water

If rainwater passes along **limestone** (calcium carbonate) rocks on its way to a reservoir, *calcium ions Ca^{2+}* will collect in the water. Other ions such as *magnesium ions Mg^{2+}* can also collect in water. These additional ions make the water hard.

Soap in hard water **does not** readily **lather, scum** is formed

Hardness in water is defined as difficulty in producing a lather with soap.

There are two types of hard water:

Temporary hard water and **permanently hard water**

Temporary hard water

Calcium and Magnesium hydrogen carbonates form *temporary hard water* because when this water is **boiled**, hardness is **removed**.

Hydrogen carbonates are decomposed.

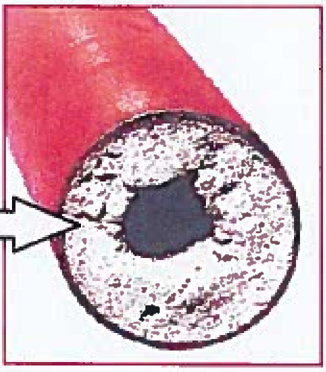
Lime scale furring up a kettle element

Magnesium and Calcium become *magnesium carbonate* and calcium carbonate which are insoluble. This lime scale collects on kettles as 'fur'.

Permanently hard water

When insoluble calcium and magnesium sulfates or carbonate exists in water it is called permanently hard water.

Lime scale clogs up hot water pipe



Treating permanently hard water.

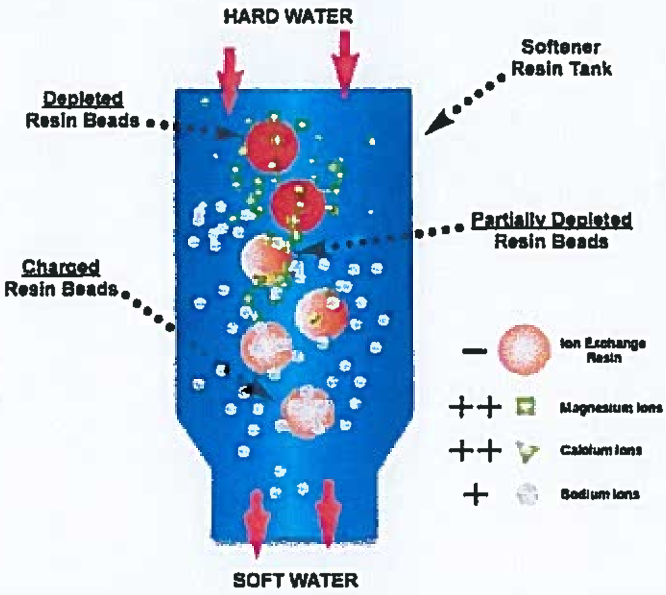
1. Adding **sodium carbonate** (washing soda).

sodium carbonate + calcium sulfate → calcium carbonate + sodium sulfate

Calcium ions are removed as solid Calcium carbonate making the water softer

2. Ion exchange column

When hard water is passed along negatively charged particles within a container, the positive ions of magnesium and calcium in hard water are attracted and held there, they are replaced with sodium ions. Water leaves the container soft.



Advantages and Disadvantages of hard water

Advantages

1. Strengthens teeth
2. Reduces the risk of heart disease
3. Some people prefer the taste of hard water

Disadvantages

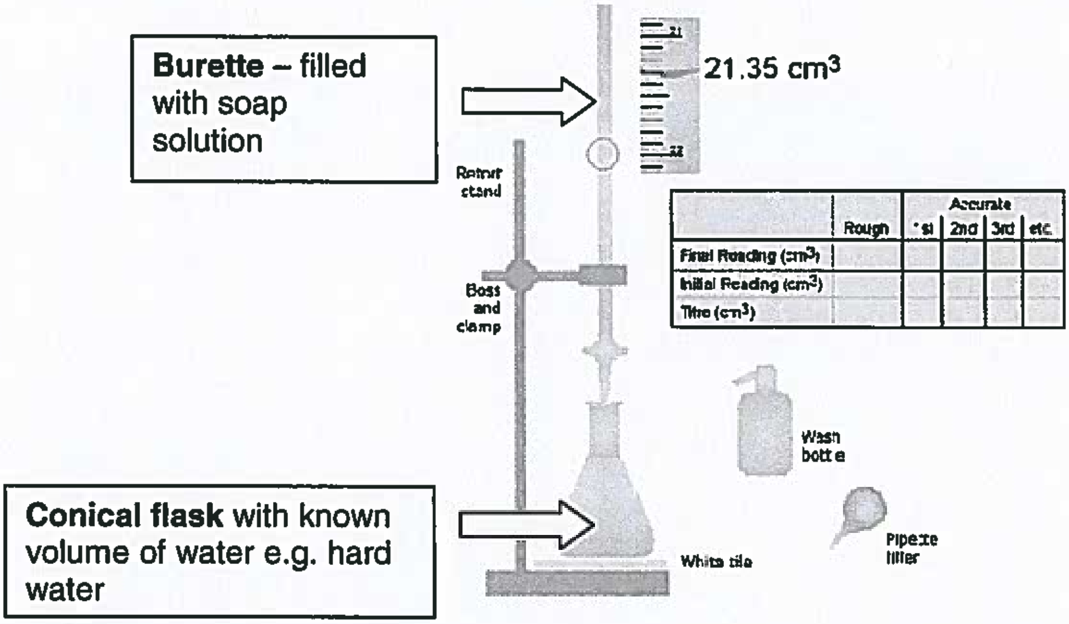
1. **Lime scale** on kettles make them less efficient at boiling water and therefore waste energy. Hot water pipes can also block up with lime scale.
2. Removing scale can be expensive.
3. More soap is needed with hard water.
4. Ion exchange water softeners release sodium ions which can be unsuitable for some uses.
5. Ion exchange units need to be ‘cleaned’ out of magnesium and calcium ions when it has filled up (usually with sodium chloride (salt))

Water

Experiments to determine the amount of hardness of water.

A **buret** is the apparatus used to measure the amount of soap solution needed.

The amount of water to be tested is kept the same in the **conical flask.**



	Rough	Accurate			
		1st	2nd	3rd	etc.
Final Reading (cm^3)					
Initial Reading (cm^3)					
Titre (cm^3)					

Soap solution is added every 1 cm^3 to the water and the flask shaken to try and form lather (bubbles). When lather starts to form the soap solution is added every 0.5 cm^3 until it stays permanently. The amount of soap solution can be determined using the buret.

Soft water lathers easily therefore little amount of soap solution is used.

Hard water lathers slowly therefore more soap solution is needed.

Experiment to determine if water is permanently hard or temporarily hard.

If two samples of water seem to be **hard water** from the above experiment, samples of both types of water could be **boiled.**

The same experiment as above could then be undertaken.

If the water is still difficult to lather then the water is permanently hard.

Chemistry

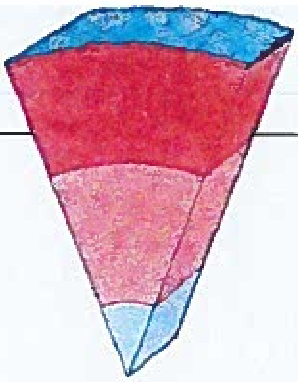
Topic 4

The ever-changing Earth

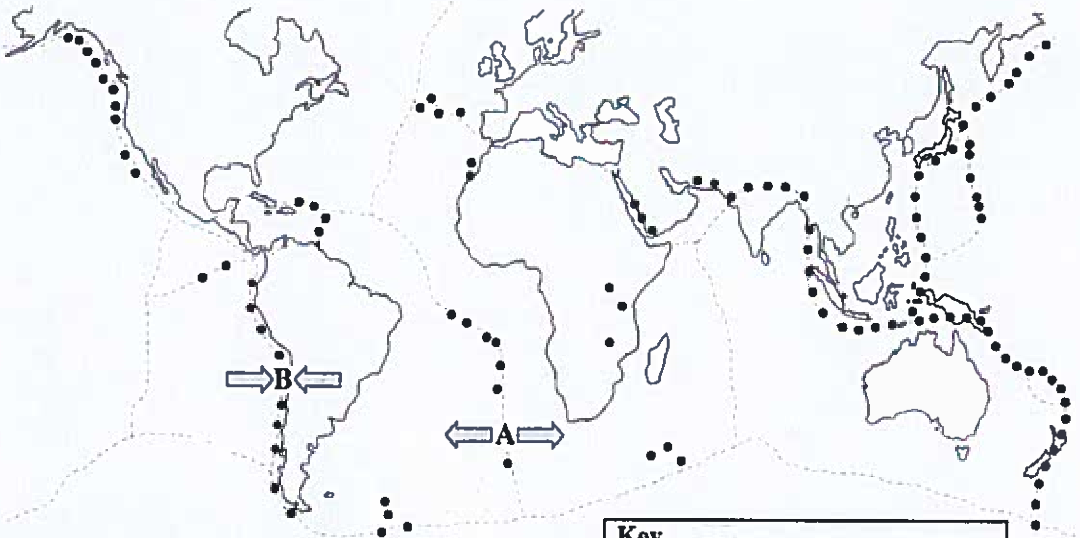
Foundation Tier Revision	**Pages 39 to 48**
Higher Tier Revision	**Pages 39 to 48**

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

Key
⇨ direction of plate movement
● volcanic activity
┈ tectonic plate boundaries

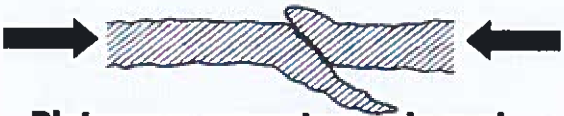
Tectonic plates movements

Any movement will cause an earthquake

Constructive plate

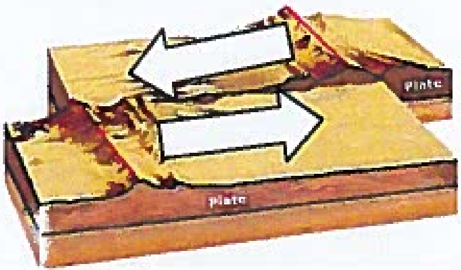
Plates can move apart. Magma pushes through to create new igneous rock (granite)
Volcanic eruption possible

Destructive plate



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

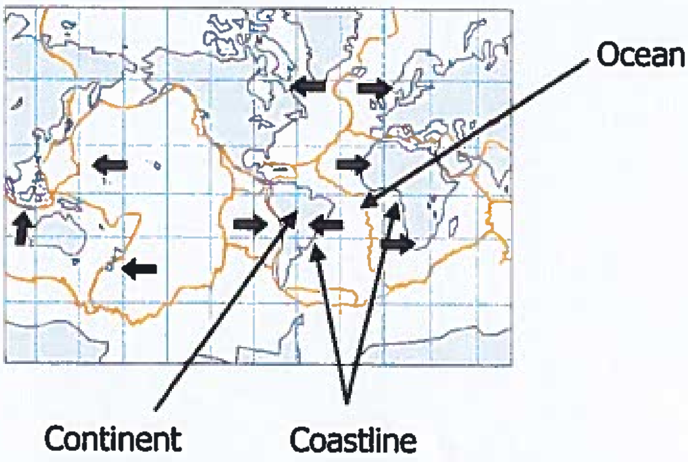
Plates can slide past each other



Alfred Wegener - Theory of Continental drift

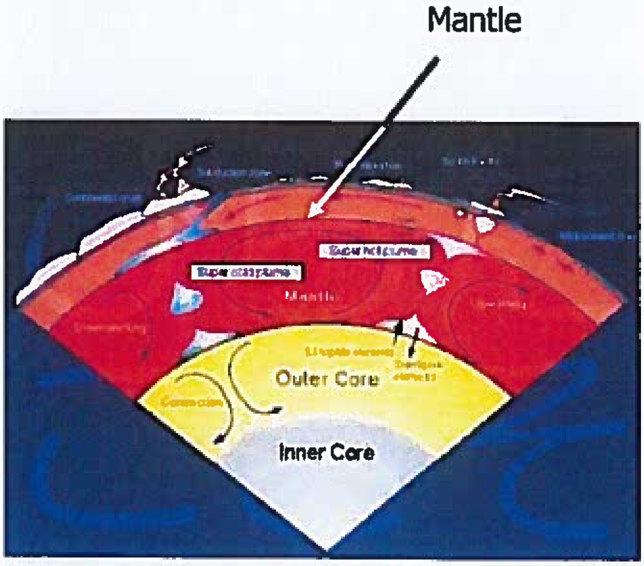
A theory that changed into scientific fact over time due to enough scientific evidence.

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



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.

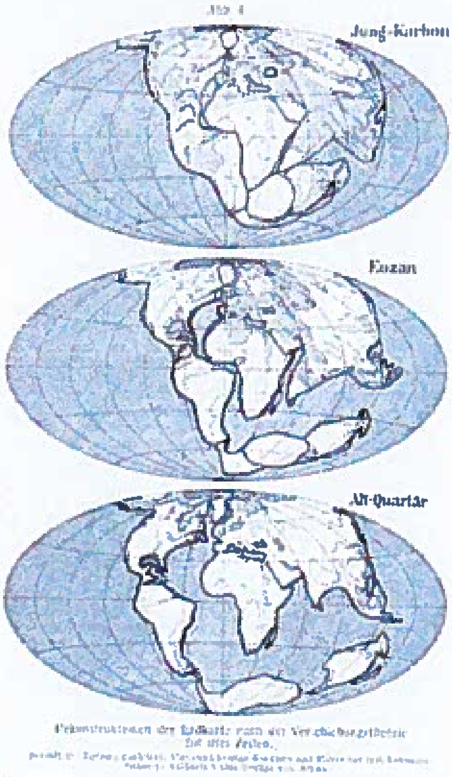


Alfred Wegener suggested that the Earth's continents were once joined

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

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

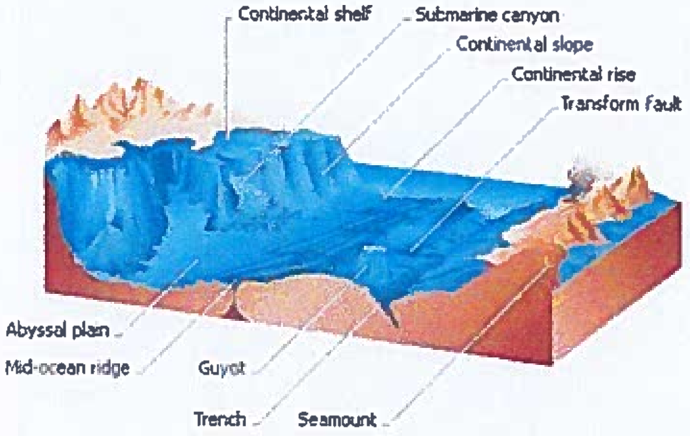
He also saw similar patterns of rocks and fossils, of continents separated by large oceans;



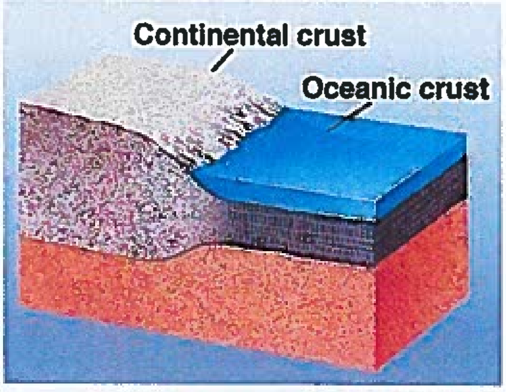
Accepting Wegener's theory

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

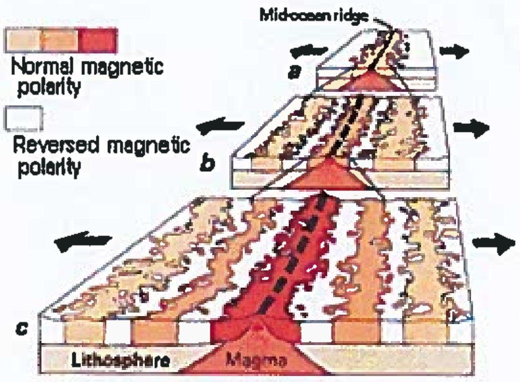
1. **Study of the ocean floor** - large mountain ranges and deep trenches found. It was originally thought that the seabed was flat



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"

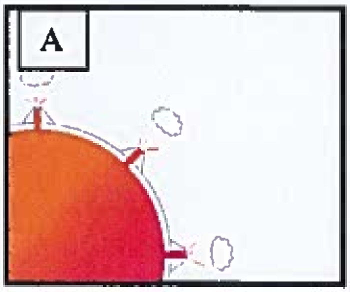


Crust forms and moves sideways in both directions

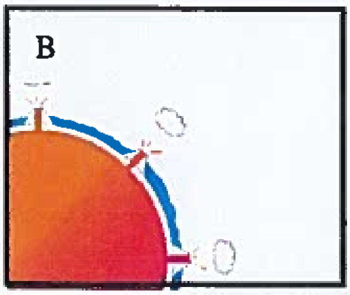
Atmosphere

Atmosphere creation

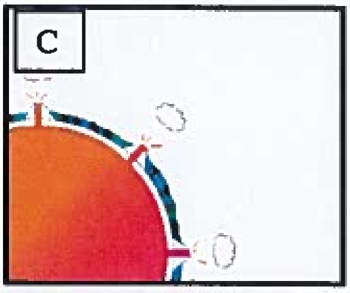
The composition of the air was different 4000 million years ago. Most Scientists agree that the initial atmosphere came from volcanoes.



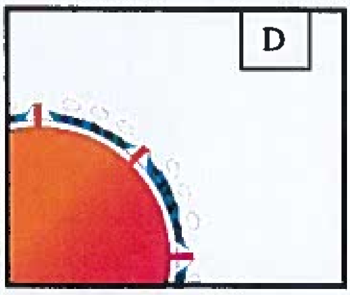
Volcanoes releasing carbon dioxide, ammonia and water vapour (steam) creating the first atmosphere



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

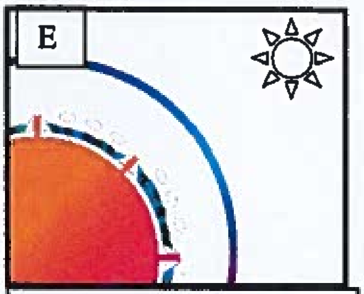


Photosynthesising bacteria form in the oceans. Carbon dioxide levels decrease.



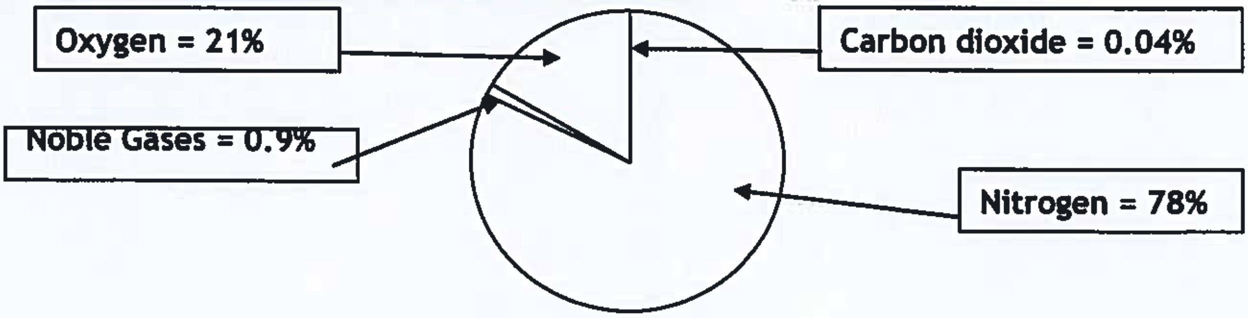
Bacteria releases oxygen in the atmosphere. Oxygen levels increase.

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



How have the gases in the Earth's atmosphere changed over time?

Earth's early atmosphere was formed from gases given out by **volcanoes.** These gases were mostly **carbon dioxide, water vapour** and **ammonia.**

The surface of the Earth **cooled quickly** and the **water vapour** in the atmosphere **condensed** forming the **oceans**.

The oceans absorbed carbon dioxide gas. The **percentage of carbon dioxide in the atmosphere decreased** slowly.

Green plants evolved on the Earth. Green plants used **photosynthesis** to **absorb carbon dioxide** and **release oxygen into the atmosphere for the first time.** The **percentage of carbon dioxide in the atmosphere decreased** slowly over billions of years.

Marine (ocean-living) animals evolved over hundreds of millions of years. The **carbon dioxide** dissolved in the oceans became locked into the **shells of marine animals** as **calcium carbonate.** The **percentage of carbon dioxide in the atmosphere decreased** slowly over billions of years.

Limestone and chalk rocks containing **calcium carbonate** were formed from the shells of dead compressed marine animals. This locked the carbon dioxide into the rocks. The **percentage of carbon dioxide in the atmosphere decreased** slowly over billions of years.

More carbon dioxide was locked into **fossil fuels:**

- **Crude oil** and **natural gas** were formed from the remains of simple marine animals.
- **Coal** was formed from the larger land plants.

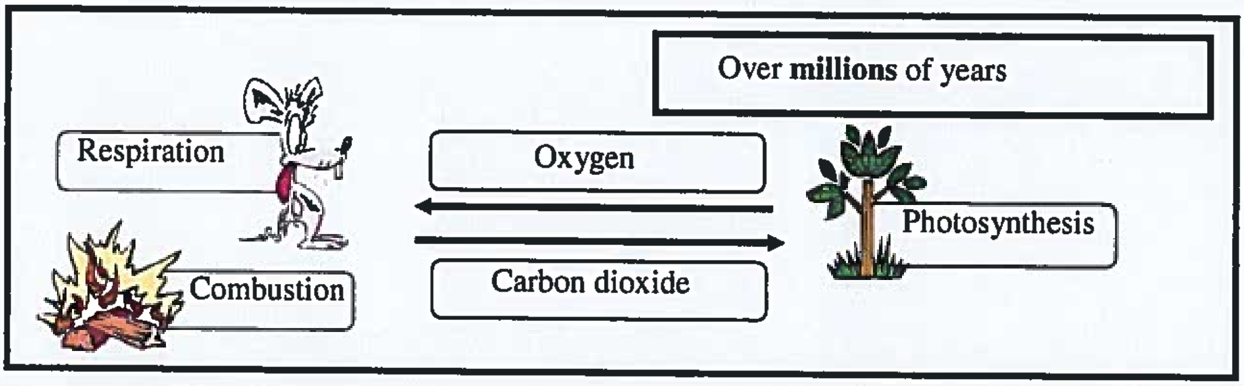
The **percentage of carbon dioxide in the atmosphere decreased** slowly over billions of years.

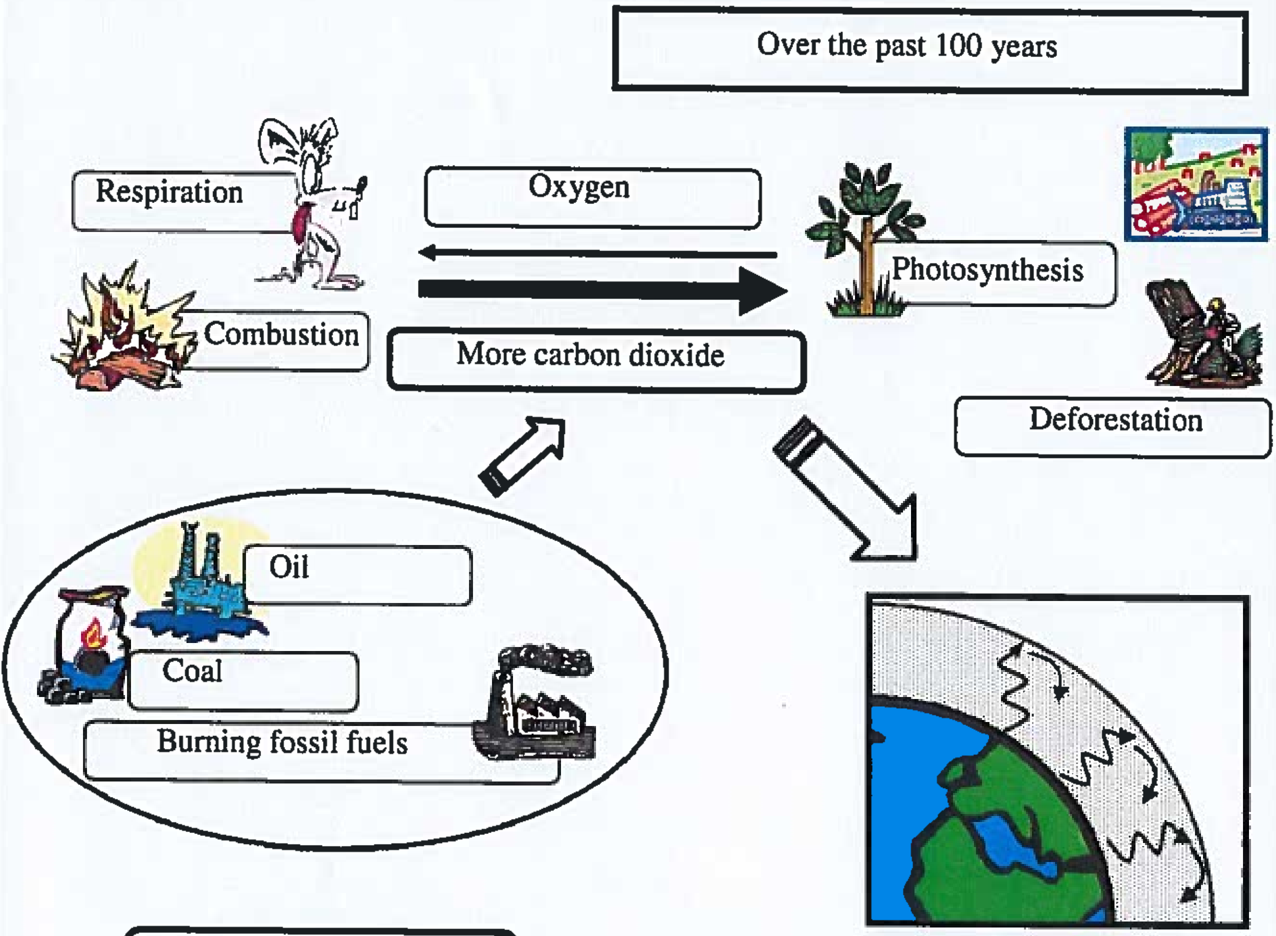
Ammonia gas decomposed (was broken down) when it reacted with **oxygen** in the atmosphere. This formed **nitrogen gas** which is the **most abundant** (highest proportion/percentage) **gas** in the atmosphere today (78%).

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

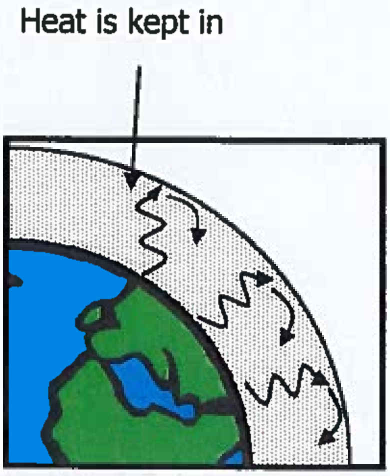
Atmosphere

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

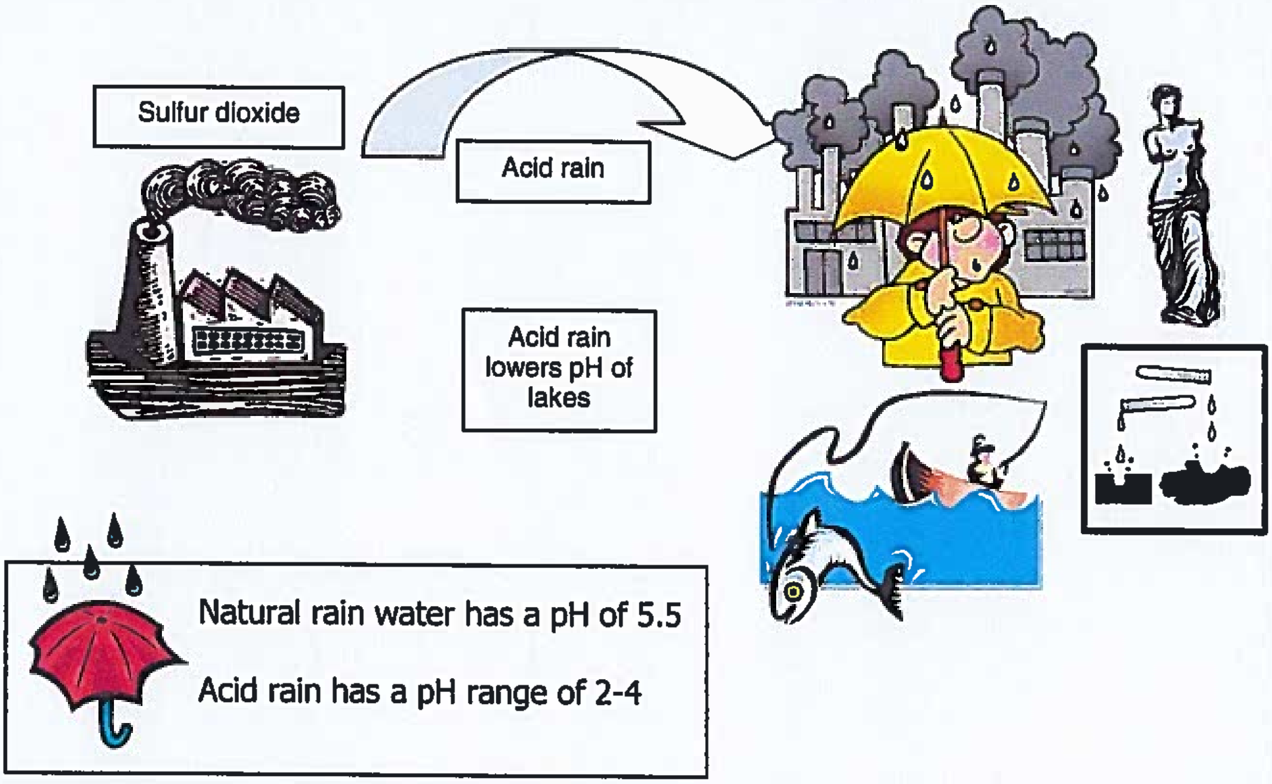
Acid Rain

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.

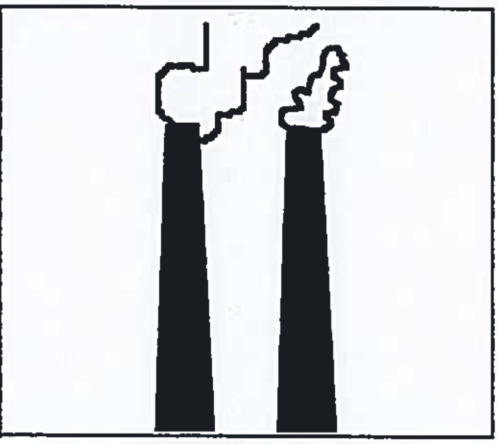


Natural rain water has a pH of 5.5

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

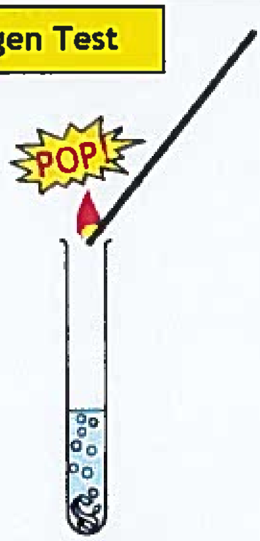


Gases from Air

- Air is useful source (supplier) of many gases that it contains:
  Nitrogen
  Oxygen
  Neon (Noble Gas in Group 0)
  Argon (noble Gas in Group 0)
- The gases in air can be separated because they have different boiling points using a method (process) called Fractional Distillation.
-

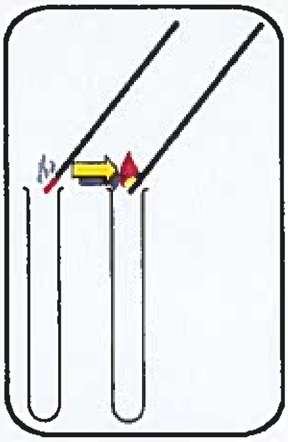
Chemical Analysis - Chemical tests for gases

Hydrogen Test



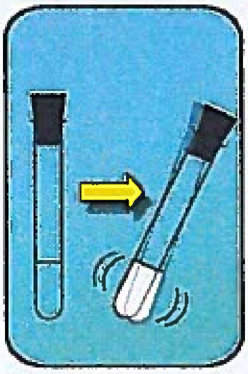
If a lit splint is placed in hydrogen it will create a squeaky 'pop' sound.

Oxygen Test



Oxygen re-lights a glowing splint

Carbon dioxide test

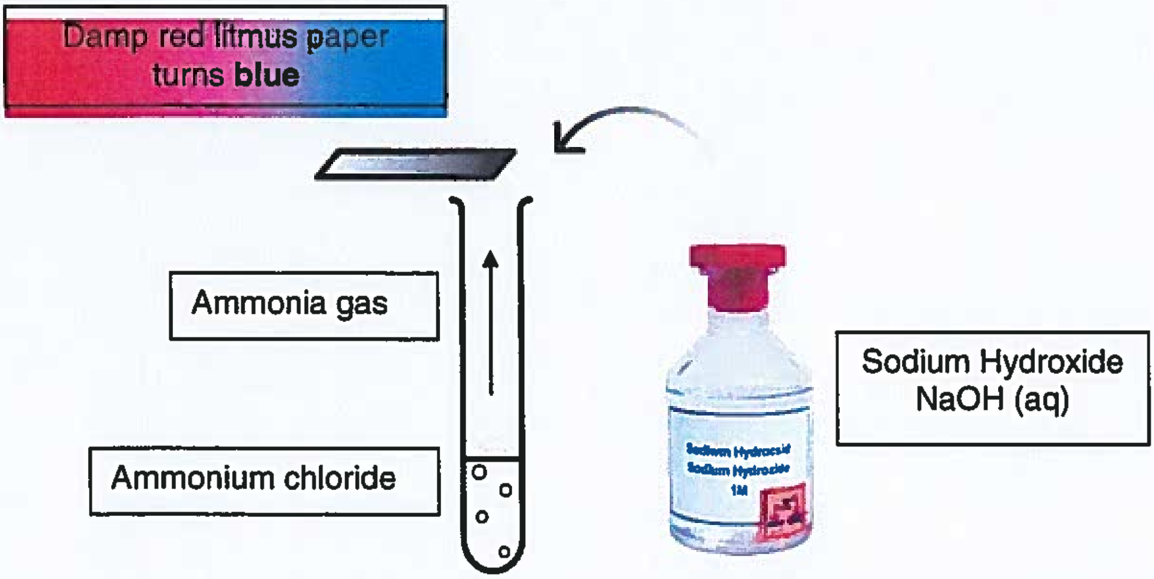


Carbon dioxide turns clear limewater milky.

Ammonia - identifying ammonium salt

If a salt containing ammonium reacts with sodium hydroxide it forms ammonia gas.

Ammonia gas will change damp red litmus paper blue.



ammonium chloride + sodium hydroxide $\longrightarrow$ sodium chloride + **ammonia** + water

Chemistry

Topic 5

Rate of chemical change

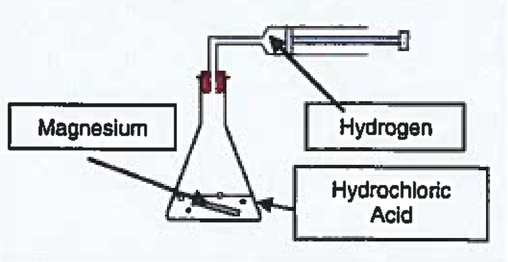
Foundation Tier Revision	**Pages 49 to 51 & pages 53 to 54**
Higher Tier Revision	**Pages 49 to 54**

Rates of Reactions

It means the speed of a reaction

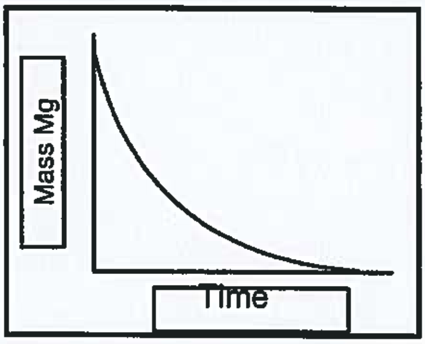
There are four ways 2 increase the rate of the reaction on the right..

1. change **concentration** of the acid (acid strength)
2. change **temperature** of the acid
3. change **surface area** of the magnesium (crush into powder)
4. use a **catalyst**

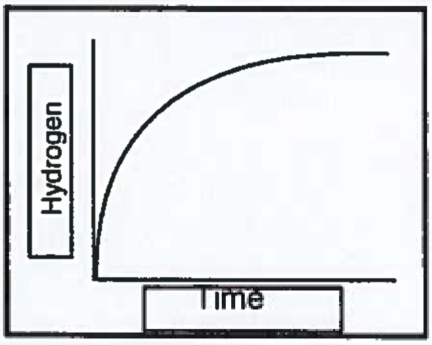


magnesium + hydrochloric acid ⟶ magnesium chloride + hydrogen

Reactants	**Products**
The substances that react together.	The substances that are produced.



The reactants are used up

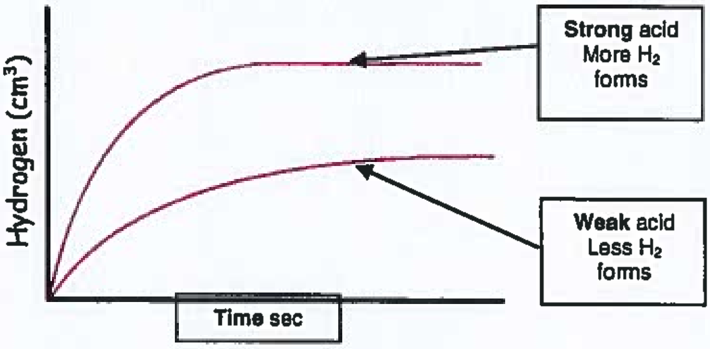


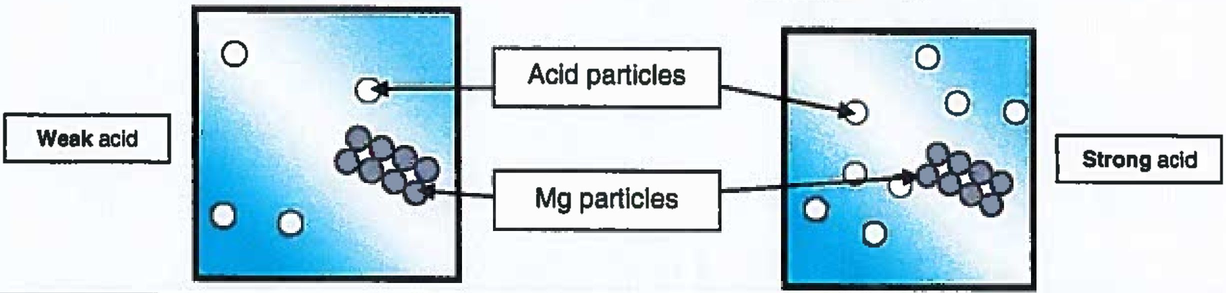
The products form

Collision Theory: Particles must collide with enough energy – these are called successful collisions

Change concentration

If the strength of the acid is weak, it will take more time for the hydrogen to be produced.



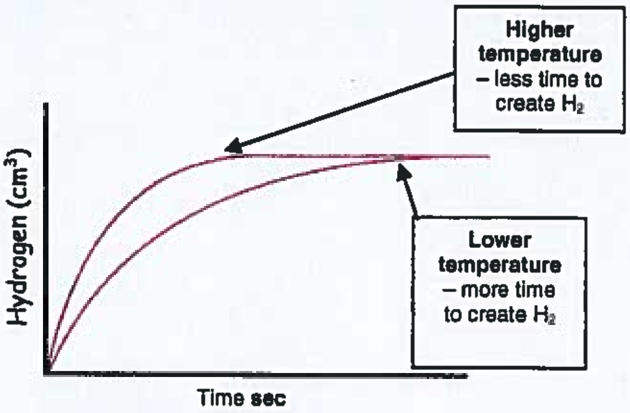


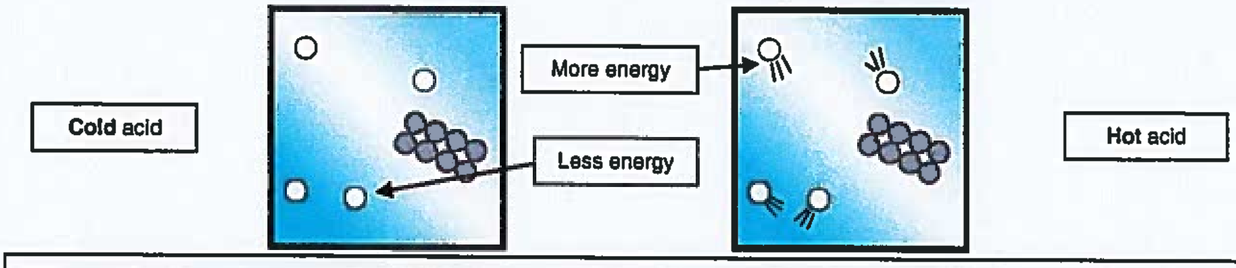
As there are **less acid particles** in weak acid the chance of them colliding with magnesium successfully is lower.

Rates of Reaction It means the speed of a reaction

Change temperature

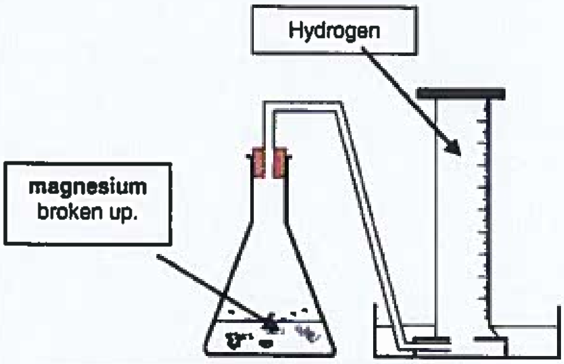
If the temperature of the acid is higher, it will take less time for hydrogen to be produced

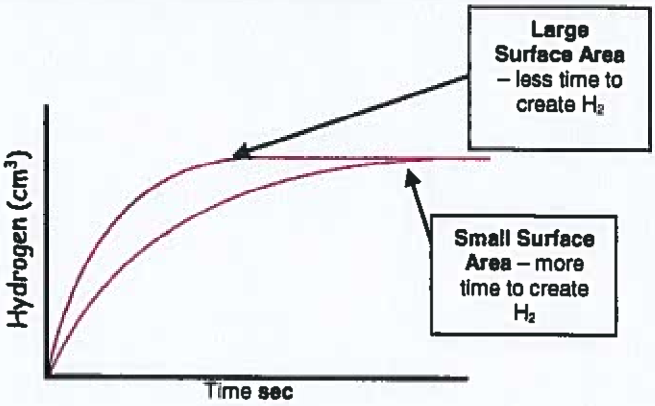




When the temperature is higher the particles have **more energy**. As a result the particles collide more frequently. The collisions have more energy – there are more successful collisions.

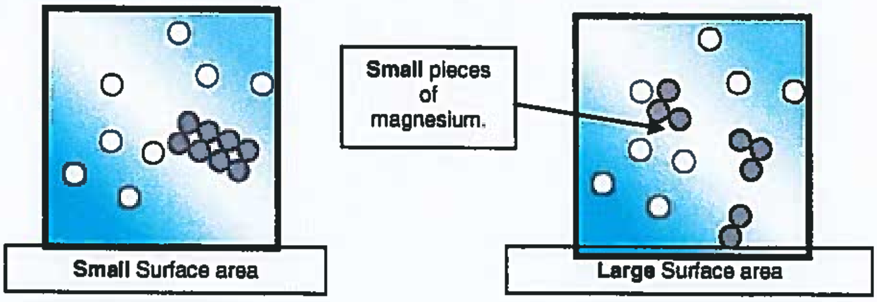
Change Surface Area





If magnesium is cut into **little pieces**, there will be more surface area for the acid to react

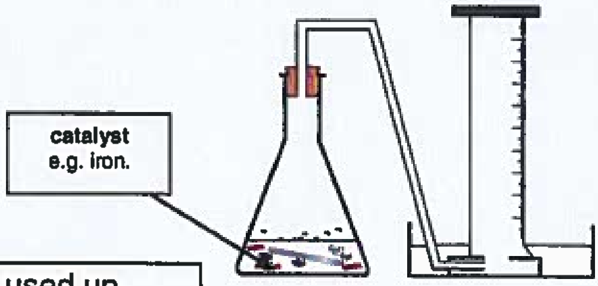
There is **more chance** for the particles to collide successfully if the **surface area is large.**



Rates of Reaction	It means the speed of a reaction

Using a Catalyst

If a catalyst (e.g. iron) is added to the acid and magnesium the reaction will be faster.



Catalyst

a substance that speeds up a reaction but is not used up (e.g. if 1g of catalyst is used, there will be 1g of catalyst left)
A catalyst can be reused over and over.

Different catalysts are used for different reactions. e.g. manganese oxide is a catalyst which is used to create oxygen quickly from hydrogen peroxide.

The development of better catalysts is extremely important as it can lead to new ways of making materials that may use less energy, use renewable raw materials or use fewer steps.

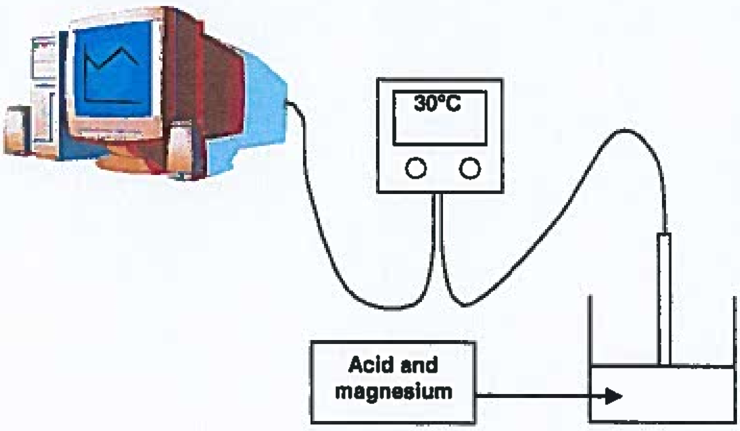
Using Sensors

Advantages of using sensors

Recording advantages
A number of results per second can be collected

Instant showing of results
Screen to show results instantly

Long term collection of results
(Can collect results day and night without a break)

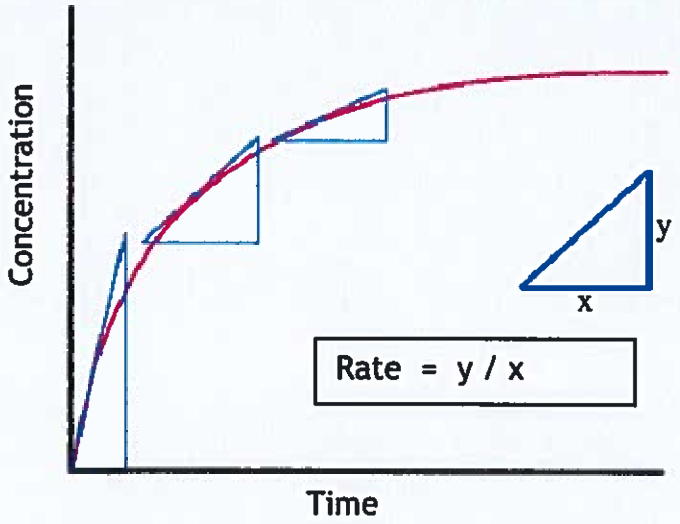


Types of sensors

- Light sensors
- Temperature sensors
- pH sensors
- Gas sensors

Calculating rate of reaction

By drawing a tangent to the curve we can calculate the rate at any point, the steeper the tangent the faster the reaction.



Rate = y / x

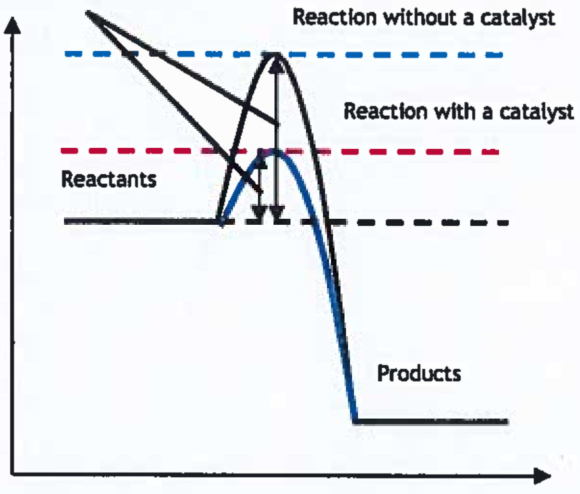
More about temperature

The energy of a collision is very important, only those collisions that have enough energy lead to reaction (these are known as successful collisions). The minimum energy required for a reaction to take place is called the Activation energy.

More about Catalysts

A catalyst reduces the activation energy, it provides an alternative pathway for the reaction

Activation Energy



PRACTICAL WORK: Investigating the factors that affect the rate of reaction between dilute hydrochloric acid and sodium thiosulphate solution.

Reaction between dilute hydrochloric acid and sodium thiosulphate solution

Sodium thiosulphate and hydrochloric acid are both colourless solutions. They react together to form a cloudy yellow PRECIPITATE (solid) of sulphur.

The time of the reaction can be measured by timing how long it takes for the cloudy yellow precipitate to form. This is done by measuring the time taken for a black cross X marked on paper under the flask to disappear.

Factors that affect the rate of reaction

1. Temperature of the solutions
2. Concentration of the hydrochloric acid
3. Concentration of the sodium thiosulphate

<u>How does changing the temperature affect the rate of reaction between dilute hydrochloric acid and sodium thiosulphate solution?</u>

Investigate: Changing the temperature of the hydrochloric acid and sodium thiosulphate

Control variables (for a fair test)

- The same concentration of sodium thiosulphate solution is used.
- The same volume of sodium thiosulphate solution is used.
- The same concentration of hydrochloric acid solution is used.
- The same volume of hydrochloric acid is used.

Method outline

Heat the sodium thiosulphate and hydrochloric acid separately in a water bath to a range of different measured temperatures, before reacting the two solutions together.

The time of the reaction can be measured by timing how long it takes for the cloudy yellow sulphur precipitate to form. This is done by measuring the time taken for a black cross X marked on paper under the flask to disappear for the different temperatures.

Temperature (° C)	Time for the X to disappear (s)			Average time (s)

How does changing the hydrochloric acid concentration affect the rate of reaction between dilute hydrochloric acid and sodium thiosulphate solution?

Investigate: Changing the concentration of the hydrochloric acid (by diluting the acid with water).

Control variables (for a fair test)
The same concentration of sodium thiosulphate solution is used.
The same volume of sodium thiosulphate solution is used.
The same volume of each concentration of hydrochloric acid is used.
The same temperature of the solutions is used, e.g. room temperature, 20 °C

Measure and record the time taken for the cross on the paper to disappear through the cloudy sulphur precipitate (solid) formed in the reaction between the different concentrations of hydrochloric acid and the sodium thiosulphate solution.

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^+	Sulfate	SO_4^{2-}
Magnesium	Mg^{2+}		
Nickel	Ni^{2+}		
Potassium	K^+		
Silver	Ag^+		
Sodium	Na^+		
Zinc	Zn^{2+}		

Avogadro's number, $L = 6 \times 10^{23}$

PERIODIC TABLE OF ELEMENTS

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

Key: