National 4/5 Chemistry

Unit 1a - Chemical Changes and Structure

Kirkcaldy High School

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Rate of reactions (N4*)

Aim: How fast are chemical reactions?

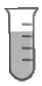
Activity 1.1 Your teacher will demonstrate some Chemical reactions for you

Chemical reactions do not all occur at the same rate. In the lab, the reaction of sodium sulphate solution and barium chloride solution to form a white solid (precipitate) is almost instantaneous but the reaction of magnesium with dilute hydrochloric acid to form bubbles of gas takes place over minutes. Very much slower is the reaction of aluminium with the oxygen of the air.

Everyday reactions are no different; some are over in a fraction of a second (fast) while others can take years (slow). Most reactions occur at rates between these two extremes (medium).

Complete the following table. Use a ✓ to show the rate of the reaction.

Chemical reaction	**Reaction rate**		
	Slow	**Medium**	**Fast**
food rotting			
firing caps in a toy gun			
bread toasting			
formation of oil			
iron rusting			
a cake baking			
a gas explosion			
coal burning			



Carry out Activity 1.2

Changing the rate (N4*)

Aim: How can we change the rate of a chemical reaction?

Chemists are not only interested in the rate of a chemical reaction. They also want to know how to make them go faster or even how to slow reactions down.

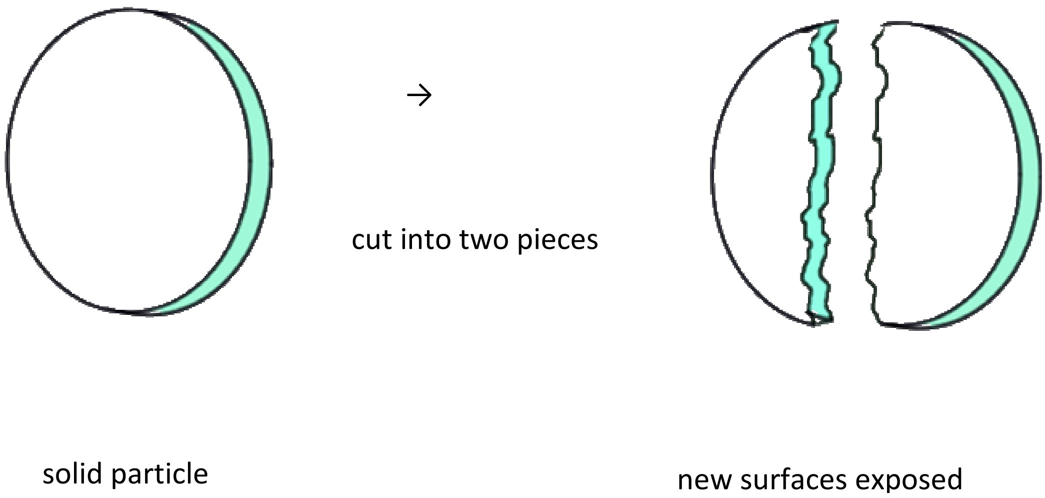
(a) Surface area/particle size

Carry out Activity 1.3

What happens to the rate of a chemical reaction as the particle size decreases (surface area increases)?

Calcium carbonate powder reacts faster with dilute acid than calcium carbonate lumps.

As the particle size decreases, the surface area of reactant particles increases. The new surfaces give more opportunities for ‘bumps’ and so the reaction rate increases.



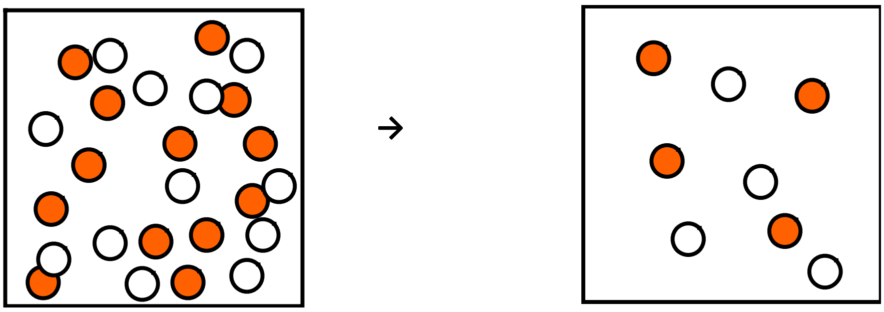
(b) Concentration

 ***Carry out Activity 1.4***

What happens to the rate of a chemical reaction as the concentration decreases?

When an acid is diluted,the rate of reaction between the acid and magnesium decreases.

As concentration decreases, there are fewer opportunities for ‘bumps’ and so the reaction rate decreases.



high concentration of reactants **low concentration of reactants**

With gases, pressure is a measure of the concentration. The rate of reaction of gases in industry is increased by increasing the pressure of the reactants.

(c) Temperature

Carry out Activity 1.5

What happens to the rate of a chemical reaction as the temperature increases?

Coal burns (reacts with oxygen) in a hot fire but it doesn’t react with oxygen to any extent at room temperature.

The increase in the rate of a chemical reaction with increasing temperature is not really due to ‘more bumps’ because reactants are moving faster at the higher temperature, *e.g.* nitrogen and oxygen of the air do not begin to react to form oxides of nitrogen even with a large increase in temperature.

The ‘bumps’ must have a critical level of energy before a reaction will take place.

As a rough guide, the rate of reaction doubles for every increase in temperature by 10 °C.

Explain each of the following.

Small sticks of wood burn faster than log

When bellows are used to blow air on to a fire, the fire burns brighter.

Food is preserved longer when stored in a fridge.

Plants grow faster in a green-house than in the open-air.

Large potatoes take longer to cook than small potatoes.

An oxy-acetylene flame is hot enough to cut through metal. The flame obtained by burning acetylene in air is not.

The Haber Process for the industrial manufacture of ammonia (NH_3) is carried outat a temperature of about 250 °C and at high pressure.

Measuring rate of reactions (N5)

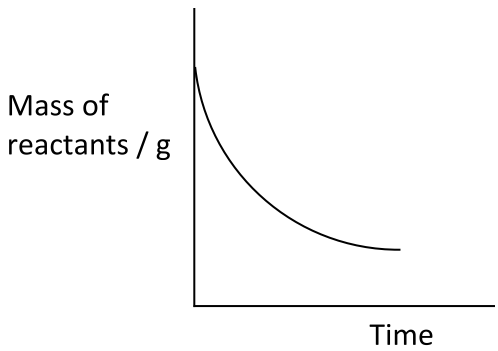
Aim: How can we measure the rate of a chemical reaction?

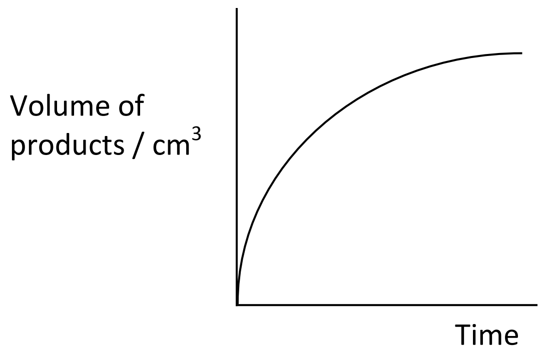
Carry out Activity 1.6

As a chemical reaction proceeds, reactants are being used up while products are being formed. The rate at which this happens can be followed by measuring the change in a 'property' of a substance involved in the reaction over a period of time, *e.g.* the reaction of calcium carbonate with dilute hydrochloric acid:

$$CaCO_3\,(s) \quad + \quad HCl\,(aq) \quad \rightarrow \quad CaCl_2\,(aq) \quad + \quad H_2O\,(l) \quad + \quad CO_2(g)$$

The change in mass (due to gaseous product being given off), volume of gas produced, concentration of acid or pH of acid can all be measured with time.

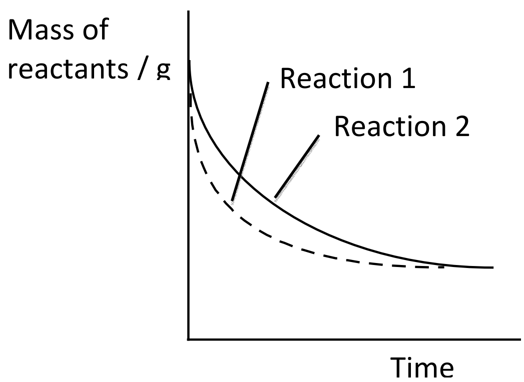


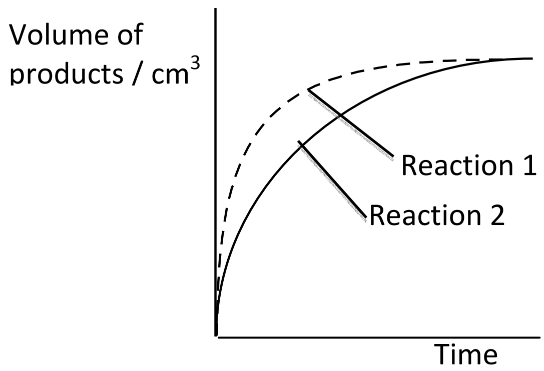


Special probes can be used to measure changes in concentration and also pH.

The reaction rate is most rapid at the start of the reaction and decreases as the reaction proceeds.

The steeper the slope, the faster the rate of reaction, *e.g.* in the following examples, Reaction 1 is faster than Reaction 2.





The shorter the time for a particular change to take place, the faster the rate of reaction,

i.e. rate is inversely proportional to time:

$$\text{rate} = \frac{1}{t}$$

The **average rate of reaction** can be defined as the measured change divided by the time taken for this change, *i.e.*

$$\text{average rate of reaction} = \frac{\text{measured change}}{\text{time taken for change}}$$

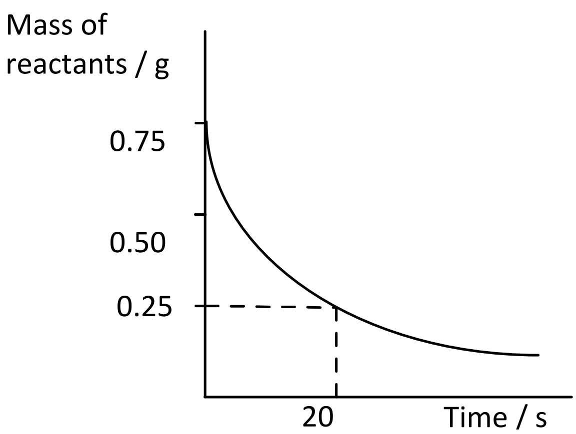
The table shows units for average rate of reaction when the time is expressed in seconds.

Measured change	**Unit**
Mass of reactants / g	$g\ s^{-1}$ (or g/s)
Volume of gas produced / cm^3	$cm_3\ s^{-1}$ (or cm^3 /s)
Concentration / mol l^{-1} (or mol/l)	mol l^{-1} s^{-1} (or mol/l/s)

Example 1

The average rate of reaction over the first 20s is:

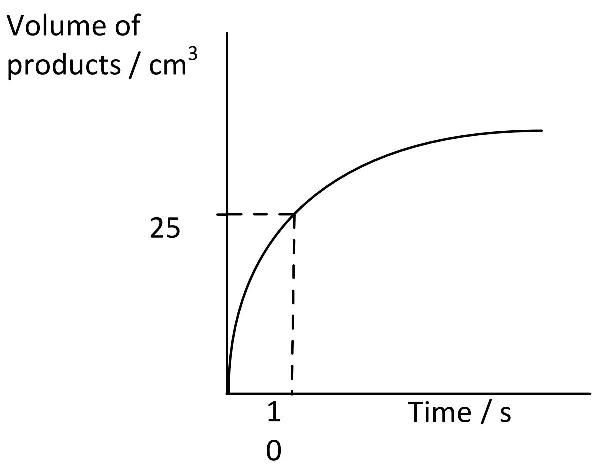
$$\frac{\text{change in mass}}{\text{time}} = \frac{0.75 - 0.2}{20} = \frac{0.5}{20} = \mathbf{0.025\ gs^{-1}}$$



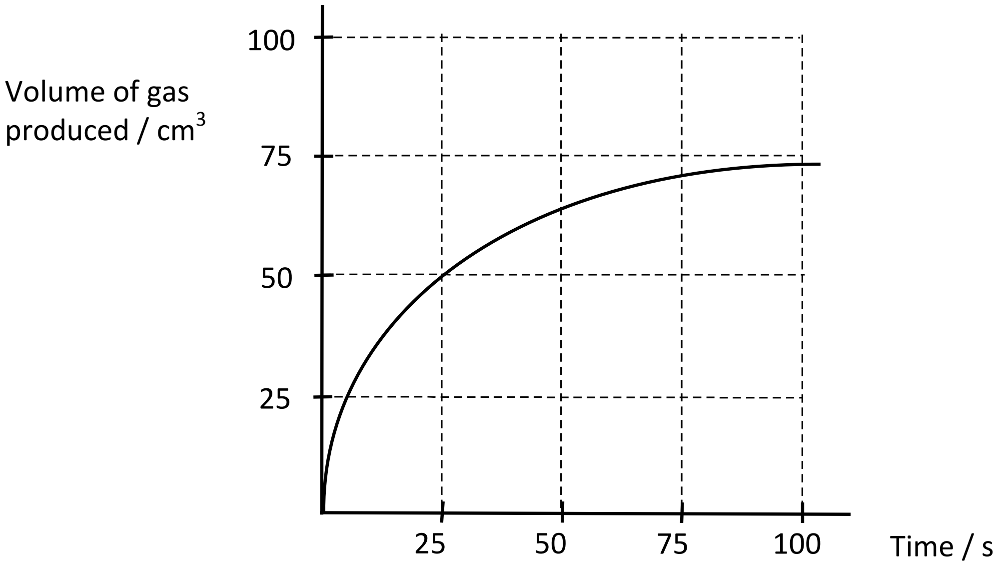
Example 2

The average rate of reaction over the first 10s is

$$\frac{\text{change in mass}}{\text{time}} = \frac{25 - 0}{10} = \frac{2.5}{10} = \mathbf{0.025\ gs^{-1}}$$



The graph shows how the volume of gas produced varies with time in a chemical reaction.

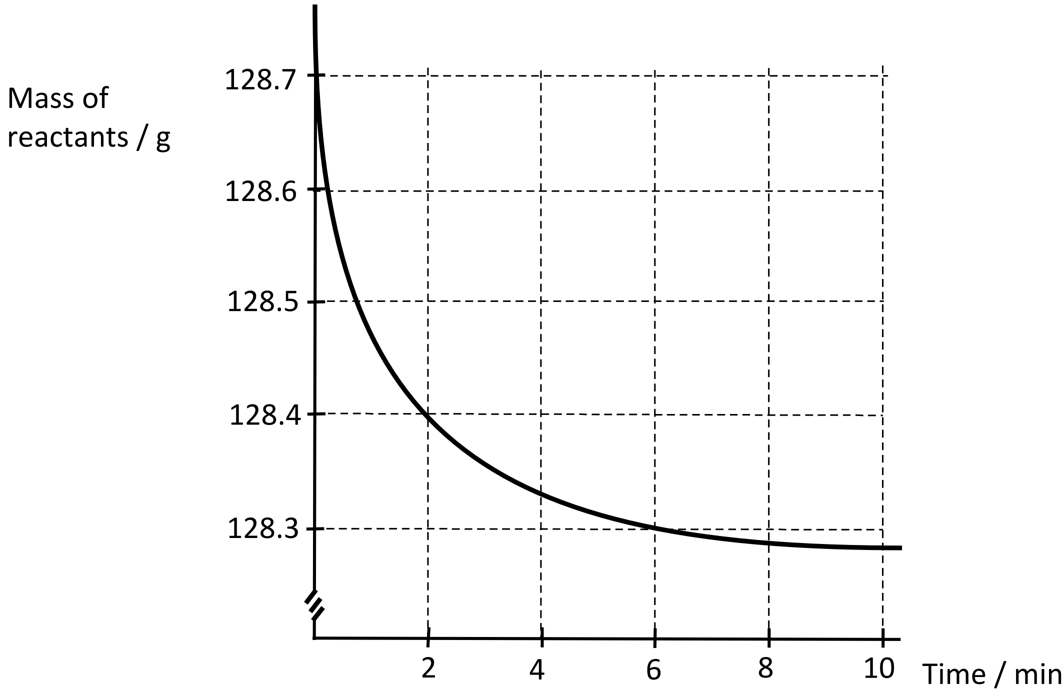


Calculate the average rate of reaction over each of the following periods.

0 to 25 s

25 to 50 s

The graph shows how the mass of reactants changes with time in a chemical reaction.



Calculate the average rate of reaction over each of the following periods.

0 to 2 minutes	*2 to 4 minutes*	*4 to 6 minutes*

Catalysts (N4*)

Aim: What is a catalyst?

Carry out Activity 1.7

Even when particle size is decreased and concentration and temperature are increased, many chemical reactions are slow. How can the rate of these reactions be increased?

Catalysts are special substances that can be used to increase the rate of chemical reactions. Different reactions require different catalysts.

Catalysts do take part in reactions … what they do is provide an 'easy route' from reactants to products. However, we can show that the 'amount' of catalyst at the end of the reaction is the same as at the start, *i.e.* the catalyst is not used up in the reaction. If need be, the catalyst can be recovered chemically unchanged at the end of reaction.

A catalyst is found in a **catalytic convertor**, fitted to the exhaust systems of cars.

An **enzyme** is a biological catalyst, *i.e.* enzymes catalyse the reactions taking place in the living cells of plants and animals.

What is meant by a catalyst?

Does a catalyst take part in a reaction?

Is the catalyst chemically changed in the reaction?

Can the catalyst be recovered at the end of the reaction?

What is meant by an enzyme?

In the chemical industry, give an example of the use of … a catalyst … an enzyme.

Why do manufacturers fit a catalytic converter to car exhaust systems? Name a metal that is used as the catalyst.

Elements (N4*)

Aim: What are elements?

Activity 1.8 Your Teacher will show you the display of Elements

Elements are the building blocks of all the substances in the world just as letters are the building blocks of all the words in our language.

Some letters, like ‘a’, ‘e’, ‘s’ and ‘t’, are found in many words while other letters, like ‘x’ and ‘z’, are found in few words. In the same way, elements like carbon and hydrogen are found in many substances while others like argon and krypton are found in few substances.

gold

carbon

bromine

You will find all the elements in a chart called the Periodic Table. About 94 elements are found in the ground or in the atmosphere. Chemists have been able to make new elements that otherwise would not exist and there are now over 100 known elements.

A property of a substance is something about the substance that is worth knowing … so that the substance can be used in particular ways. Although the properties of an element largely determine its use, other things must also be considered, *e.g.* gold does not corrode but no manufacturer is going to make cars from gold.

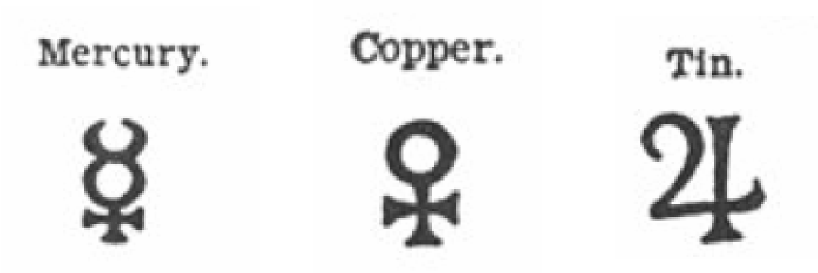
Complete the following table for at least FIVE elements.

Element	**Use**	**Reason for use**
Copper	Electrical cables	
Gold	Jewellery	
Carbon		It is soft and leaves a trail on paper
Mercury		It is liquid
Nitrogen	Filling Crisp packets	

Chemical symbols (N4*)

Aim: How can we represent elements?

A **chemical symbol** is a shorthand way of representing an element. Each element has its own chemical symbol.



The ancient chemists (or alchemists) were the first to use symbols for elements in place of their names.

Modern symbols for elements consist of one or two letters. The first letter is always a capital letter; if there is a second letter, it is always a small letter.

A few elements have symbols that come from the Latin name for the element.

REFER TO A PERIODIC TABLE.

Complete the following tables.

Element	**Symbol**
hydrogen	
	C
iodine	
	N
sulphur	
	V

Element	**Symbol**
chlorine	
	Mg
calcium	
	Sc
argon	
	Si

What is the symbol for helium? Why is it not just H?

What is the symbol for cadmium? Why is it not just C or Ca?

Complete the following table.

Element	**Symbol**	**Latin name**
silver		
gold		
iron		
sodium		
potassium		

What is the origin of the word "plumber"?

Naming of compounds (N4*)

Aim: How can we name compounds?

Compounds containing only two elements have names ending in **–ide**, *e.g.* hydrogen oxide is made up only of hydrogen and oxygen.

Compounds containing more than two elements, one of which is oxygen, have names ending in **–ate** or **–ite**, *e.g.* calcium nitrate is made up of calcium, nitrogen and oxygen, sodium sulphite is made up of sodium, sulphur and oxygen.

YOU MAY WISH TO REFER TO A PERIODIC TABLE.

Complete the following table.

Compound	**Elements present**
iron sulphide	
sodium chloride	
magnesium nitride	
	hydrogen, fluorine
	lithium, oxygen
	calcium, iodine
copper sulphate	
lead phosphate	
aluminium sulphite	
zinc carbonate	

Name TWO possible compounds containing potassium, nitrogen and oxygen.

Note that ‘hydroxide’, the second part of the name of some compounds, means that two elements, hydrogen and oxygen, are present so compounds ending in hydroxide contain three elements, *e.g.* sodium hydroxide contains sodium, hydrogen and oxygen.

Gathering elements together (N4*)

Aim: What types of elements are there?

Pupils in school are gathered together by age and subject being studied to form a class. In a supermarket, similar foods are gathered together, *e.g.* fruits, cereals, meats. When we are faced with a wide variety of things we often try to gather those that have something in common. This is called **classification**.

Everything in the world is made up of **elements**. There are now over 100 known elements. These can be gathered together in different ways. All the elements in the one 'class' have something in common.

Complete each of the three following tables with at least SIX elements for each column.

Naturally occurring	**Made by scientists**

Metal	**Non-metal**

Solid	Liquid at 20 °C	Gas
	There are only two elements which are liquid at 20 °C	

To which side of the Periodic Table are the metals to be found? … the non-metals to be found?

Where in the Periodic Table are the gases to be found?

What is meant by the transition metals? Name SIX transition metals.

Name THREE elements that have been made by scientists. Where in the Periodic Table are these elements to be found?

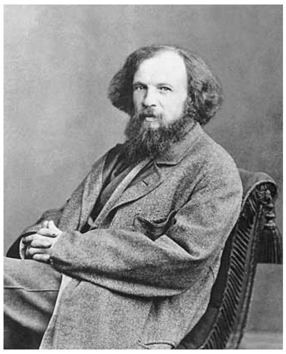
Families of elements (N4*)

Aim: What families of elements are there?

Activity 1.9 Your teacher will carry out some reactions of Families of elements

The elements are arranged in the **Periodic Table**.

The one in use today is not very different from the one drawn up by a Russian chemist called Dmitri Mendeleev in 1869. When he arranged the elements in order of increasing 'weight of atom' he noticed that elements with similar chemical properties appeared at regular intervals, *i.e.* 'periodically' and this is why the arrangement is called the Periodic Table. He used this observation to form columns, with chemically-like elements placed the one below the other.



Each row in the modern Periodic Table is called a **period**.

The vertical columns are called **groups** (or families).

Group ↓

Period →

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** 1.008																	2 **He** 4.0026
3 **Li** 6.94	4 **Be** 9.0122											5 **B** 10.81	6 **C** 12.011	7 **N** 14.007	8 **O** 15.999	9 **F** 18.998	10 **Ne** 20.180
11 **Na** 22.990	12 **Mg** 24.305											13 **Al** 26.982	14 **Si** 28.085	15 **P** 30.974	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.948
19 **K** 39.098	20 **Ca** 40.078	21 **Sc** 44.956	22 **Ti** 47.867	23 **V** 50.942	24 **Cr** 51.996	25 **Mn** 54.938	26 **Fe** 55.845	27 **Co** 58.933	28 **Ni** 58.693	29 **Cu** 63.546	30 **Zn** 65.38	31 **Ga** 69.723	32 **Ge** 72.63	33 **As** 74.922	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** 83.798
37 **Rb** 85.468	38 **Sr** 87.62	39 **Y** 88.906	40 **Zr** 91.224	41 **Nb** 92.906	42 **Mo** 95.96	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57-71 *	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.23	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89-103 #	104 **Rf** (265)	105 **Db** (268)	106 **Sg** (271)	107 **Bh** (270)	108 **Hs** (277)	109 **Mt** (276)	110 **Ds** (281)	111 **Rg** (280)	112 **Cn** (285)	113 **Uut** (284)	114 **Fl** (289)	115 **Uup** (288)	116 **Lv** (293)	117 **Uus** (294)	118 **Uuo** (294)
		* Lanthanide series	57 **La** 138.91	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.05	71 **Lu** 174.97
		# Actinide series	89 **Ac** (227)	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)

All the elements in the one group show very similar chemical properties. Down a group there is a trend in physical properties, *e.g.* melting and boiling points.

With only a few elements discovered at the time there were gaps in the early Periodic Table. Mendeleev was able to predict the properties of the yet to be discovered elements.

What is meant by a group in the Periodic Table? a period in the Periodic Table?

Which group of elements is known as the alkali metals?
How are the alkali metals kept? Why are they kept in this way?

Which group of elements is known as the halogens?

Which group of elements is known as the noble gases?
Why are the noble gases often referred to as the inert gases?
Describe some uses of the noble gases.

Why did the early Periodic Table only have seven groups?

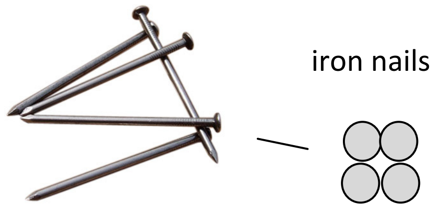
What are elements made up of? (N4*)

Aim: What are elements made up of?

Everything that exists is made up of atoms (from the Greek word ‘atmos’ meaning indivisible). An **element** is a substance that is made up of atoms of only one kind.

A silver ring contains millions of silver atoms which are all the same. Every atom in an iron nail is an atom of iron, and all atoms of iron are the same. But an iron atom is different in size and mass from a silver atom.

silver ring



iron nails

When scientists make new elements they make new kinds of atoms.

It is difficult to imagine anything as small as an atom. 100 million of them side by side will only measure about $1cm^3$.

A single atom is so small that it cannot be weighed on a balance. There has to be a special scale to measure the mass of something so light. The mass of an atom is measured on the **relative atomic mass scale**. Since this is a relative scale, it has no units. The relative atomic mass for some elements is shown on page … of the Data Booklet.

What is meant by an element?

REFER TO A PERIODIC TABLE. ***Complete the following table.***

Element	Relative atomic mass
oxygen	
aluminium	
gold	

Element	Relative atomic mass
	12
	207
	1

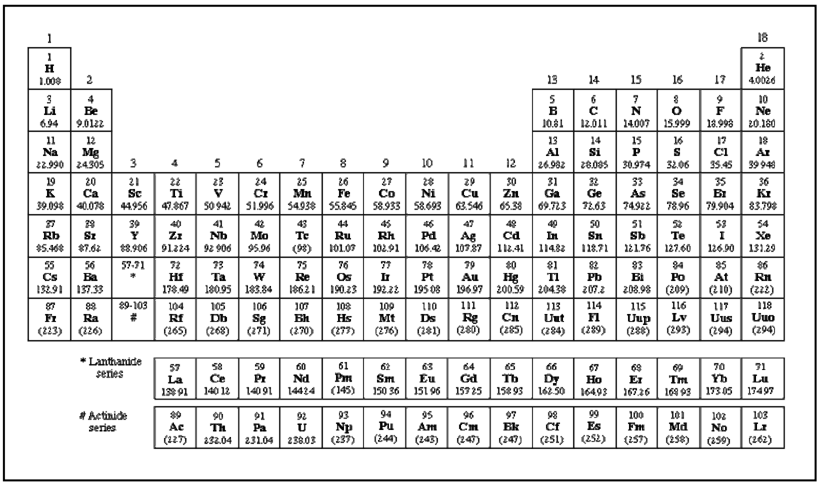
Atomic number (N4*)

Aim: What are does the number of the element mean?

There are over 100 different elements. All the atoms in the one element are different from atoms of other elements.

Each different atom has a 'number'. This is called the **atomic number**. All atoms of the one element have the same atomic number. Atoms of different elements cannot have the same atomic number. An element can be defined as a collection of atoms all with the same atomic number.

Elements are arranged in the Periodic Table in order of increasing atomic numbers. A new period begins when an element has similar chemical properties to the other elements in Group 1.



REFER TO A PERIODIC TABLE. ***Complete the following table.***

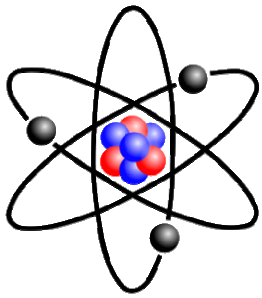
Element	Atomic number
magnesium	
chlorine	
iron	
	19
	53
	82

What are atoms made up of? (N4*)

Aim: What are atoms made up of?

Atoms themselves consist of even smaller particles (sub-atomic particles) called **protons, neutrons and electrons**. The numbers of these particles vary from element to element.

Protons are found in a very small 'core' at the very centre of the atom.



This is called the **nucleus**. The nucleus is very small compared to the size of the rest of the atom; if atoms were magnified to the size of a football park, then the nucleus would be about the size of a pin-head.

Protons have a positive charge. This gives a positive charge to the nucleus.

Electrons move outside of the nucleus.

Electrons have a negative charge, equal and opposite to that of protons.

Atoms are overall neutral, *i.e.* they are neither positive nor negative.

This means that the total positive charge of the protons in the nucleus is equal to the total negative charge of the electrons, *i.e.* the positive and negative charges cancel out.

Neutrons are also found in the nucleus.

Neutrons do not have a charge, *i.e.* they are neutral.

The masses of the sub-atomic particles are measured on the **atomic mass scale**.

On this scale, protons and neutrons have a mass of one atomic mass unit (amu).

Compared to protons and neutrons, even on this scale, electrons have a negligible mass.

The way in which the sub-atomic particles are arranged is referred to as the structure of the atom.

Why are atoms electrically uncharged?

Complete the following table.

	Mass	Charge	Where found
Proton			
Neutron			
Electron			

The protons in the nucleus have a positive charge; the electrons have a negative charge. We know that positive and negative charges attract.

Why does the attraction of opposites not result in the electrons being pulled into the nucleus?

The protons in the nucleus have a positive charge. The nucleus is a very small 'core' at the centre of the atom. We know like charges repel.

Why do the protons not push each other out of the nucleus?

More about the atomic number (N4*)

Aim: Why is the atomic number important?

Each element in the Periodic Table has its own atomic number.

The atomic number is important … it gives the number of protons in an atom of an element. Since atoms are neutral and the charge on an electron is equal and opposite to the charge on a proton, the atomic number also gives the number of electrons in an atom.

An element can be defined as a collection of atoms all with the same atomic number or the same number of protons.

What information is given by the atomic number of an element?

REFER TO A PERIODIC TABLE.
Complete the following table.

Element	Atomic number	Number of protons	Number of electrons
carbon			
hydrogen			
magnesium			
	7		
			20
		11	

Mass number (N4*)

Aim: What gives an element mass?

Both the proton and the neutron have a mass of 1 amu.

The mass number of an atom of an element is the number of protons (atomic number) plus the number of neutrons in the atom.

The atomic number and the mass number provide all the information necessary to calculate the number of protons, neutrons and electrons in an atom.

Note that the mass number of an atom of an element cannot be found in the Data Booklet.

Atomic number	see Periodic Table
Mass number	not on Periodic Table (has to be given)
Number of protons	equal to atomic number
Number of neutrons	mass number minus number of protons
Number of electrons	equal to number of protons

What is meant by the mass number of an atom of an element?

REFER TO A PERIODIC TABLE. ***Complete the table below.***

Element	Atomic number	Mass number	Number of protons	Number of neutrons
lithium		7		
	17			18
			26	30
		65		29
lead				126
uranium		238		

Electron arrangement (N4*)

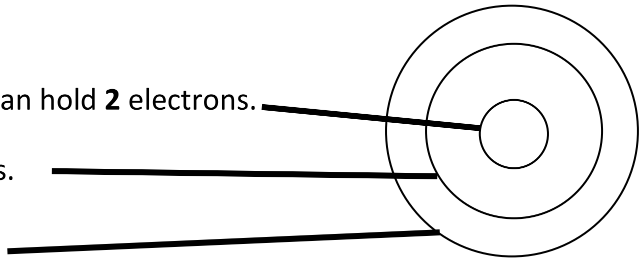
Aim: How are the electrons arranged in an atom?

Most of the atom is empty space. Electrons move through this space. The electrons do not however move in a haphazard fashion; they are arranged in a particular way.

The **first** shell (nearest the nucleus) can hold **2** electrons.

The **second** shell can hold **8** electrons.

The **third** shell can hold **8** electrons



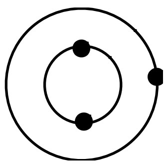
Electrons are arranged in **shells (energy levels)**. There is a limit to the number of electrons each shell can hold.

(for the first twenty elements).

Electrons always enter the shell in which there is space. This is the shell nearest the nucleus, *e.g.*

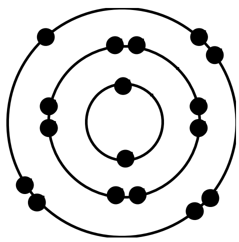
lithium (atomic number 3)

has 3 electrons arranged 2, 1



chlorine (atomic number 17)

has 17 electrons arranged 2, 8, 7



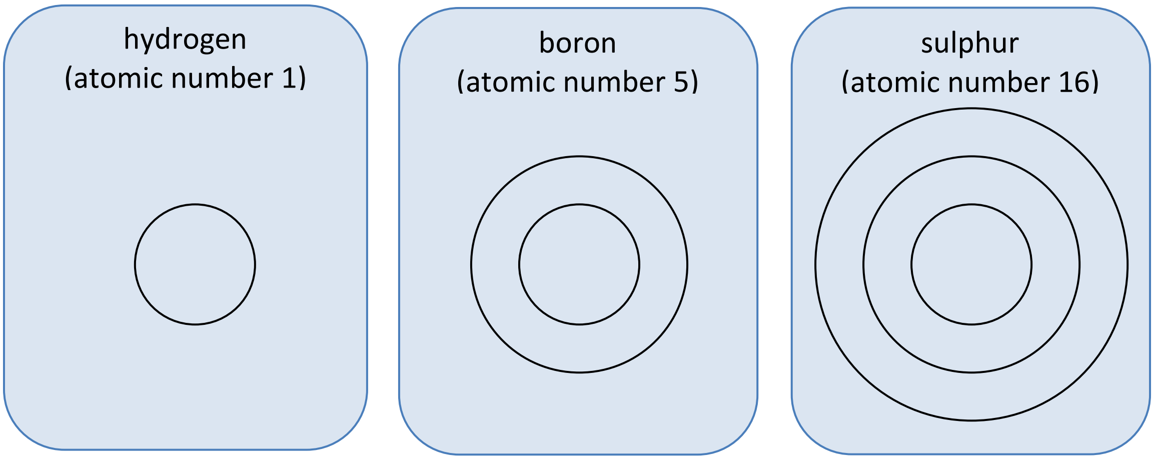
All the atoms of elements in the one group have the same number of electrons in the outer shell, *e.g.* 1 electron for all the atoms of the alkali metals.

The chemical reactions of an element depend on the number of electrons in the outer shell. This is the reason for all the elements in the one group having similar chemical reactions, *e.g.* all the alkali metals are stored under oil because they are very reactive.

The electron arrangement of atoms of all the elements is given on page of the Data Booklet

Carry out activity 1.10 Use target diagrams and counters to show electron arrangements

Draw diagrams to show how the electrons are arranged in shells (energy levels) in each of the following atoms.



REFER TO A PERIODIC TABLE.
Complete the table below.

Element	Atomic number	Electron arrangement
carbon		
silicon		
helium		
	7	
	15	
		2, 7
		2, 8, 8

Nuclide notation (N5)

Aim: How can we write the number of protons, neutrons and electrons easily?

This atomic number and the mass number can be written with the symbol of the element in the following way.

Mass number - $^{35}_{17}\text{Cl}$
Atomic number -

The atomic number gives the number of protons in the atoms of chlorine. This is not always given. knowing the symbol of the element, the atomic number can be found from a Periodic Table.

The mass number gives the number of protons plus the number of neutrons in the atoms of chlorine.

REFER TO A PERIODIC TABLE.
Complete the following table.

Element	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons
$^{35}_{17}\text{Cl}$	17	35	17	18	17
$^{12}_{6}\text{C}$					
$^{22}_{10}\text{Ne}$					
$^{214}_{82}\text{Pb}$					
	20	40			
		7		4	
		9			4
	1			1	
				7	7
			16	16	
	88	226			

Isotopes (N5)

Aim: What is an isotope?

Carry out Activity 1.11

Atoms of the same element always have the same number of protons (same atomic number).

However, atoms of the same element can be different; they can have different numbers of neutrons. This means that the mass numbers will not be the same.

Atoms of the same element with different numbers of neutrons are called **isotopes**.

Isotopes show similar chemical reactions because the different kinds of atom still have the same number of electrons, *i.e.* electron arrangement.

Complete the first TWO columns of the following table for the isotopes of chlorine.

Now complete the last column to indicate whether what is in the row is the SAME or DIFFERENT.

	$^{35}_{17}Cl$	$^{37}_{17}Cl$	
Symbol			
Atomic number			
Number of protons			
Number of electrons			
Mass number			
Number of neutrons			

Isotopes are different kinds of atoms of the same element.

What will be the same for isotopes of the one element? What will be different?

Relative atomic mass (atomic weight) (N5)

Aim: How do isotopes affect the relative atomic mass?

Most elements exist as a mixture of isotopes, each with atoms of a different mass.

The relative proportion of each isotope is always the same.

This allows the atomic mass of an 'average' atom to be calculated.

This mass is called the **relative atomic mass (atomic weight)**.

For some elements the relative atomic mass (atomic weight) is shown on page … in the Data Booklet.

The relative proportions of isotopes of different elements are shown below.

^{35}Cl	75%	^{1}H	99.98%
^{37}Cl	25%	^{2}H	0.015%
		^{3}H	Trace
^{12}C	98.89%	^{16}O	99.76%
^{13}C	1.11%	^{17}O	0.037%
^{14}C	Trace	^{18}O	0.204%

The relative atomic mass of each of the elements is not a whole number because it is the mass of an 'average' atom.

Chlorine has a relative atomic mass of 35.5. The average atomic mass is between 35 and 37 and closer to 35 because ^{35}Cl is more abundant than ^{37}Cl.

The relative atomic mass is often listed as a whole number because one of the isotopes is much more abundant than the others and so the average mass is very close to a whole number, *e.g.* hydrogen (relative atomic mass 1), carbon (relative atomic mass 12) and oxygen (relative atomic mass 16).

What is meant by the relative atomic mass (atomic weight)?

Two types of copper atom are ^{63}Cu and ^{65}Cu.
Copper has a relative atomic mass of 63.5.
What can be said about the proportion of each type of atom in copper?

Bromine has a relative atomic mass of 80. Bromine has two isotopes, one with a relative atomic mass of 79 and the other with a relative atomic mass of 81.
What can be said about the proportion of each type of atom in bromine?

Lithium has two isotopes - ^{6}Li and ^{7}Li. The relative atomic mass of lithium is 6.9.
Which kind of atom is more common in lithium?