National 4 chemistry

chemical reactions, the periodic table and inside atoms

Chemical reactions

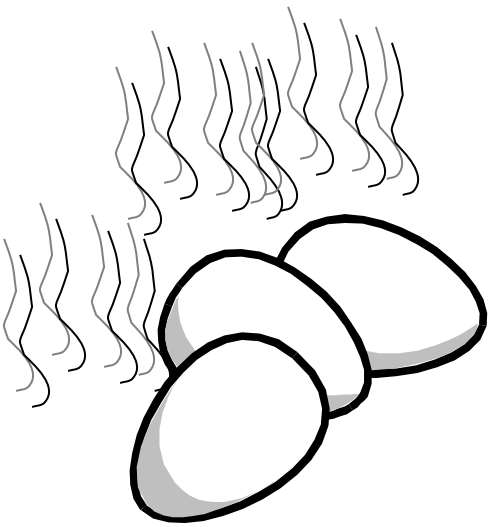
Read

When some chemicals touch each other they can react to make new chemicals. This is called a **chemical reaction**. If a chemical reaction happens a **new substance is always made**.

For example baking a cake is a chemical reaction because the flour, butter, eggs, milk and sugar are changed into new substances by the heat in the oven.

If a chemical reaction happens we might see:

- A **change in colour** - for example a rusting car or making toast.
- A **gas** being made – for example a rotting egg or a decaying body.
- A **solid** being made – for example milk turning sour.



- **Heat or light** being given out or used up – for example any kind of burning e.g. burning coal, burning wood, burning petrol, burning paper etc.

Sometimes a solid is made when two clear solutions are mixed. This solid has a special name – it is called a **precipitate**. A reaction where two solutions mix to form a solid is called a **precipitation** reaction.

Write a heading and try the work below.

1. What is always made in a chemical reaction?
2. Give an example of an everyday reaction
   a) where you might see a colour change.
   b) where you might notice a gas being made.
   c) where a solid forms from a liquid but **not** by freezing.
   d) that gives out heat.
3. What is the reaction called when two solutions react to form a solid?
4. What is the special name for a solid that is made when two solutions are mixed?
5. Collect a copy of the reactions table before you start the next experiments and fill it in as you go along.

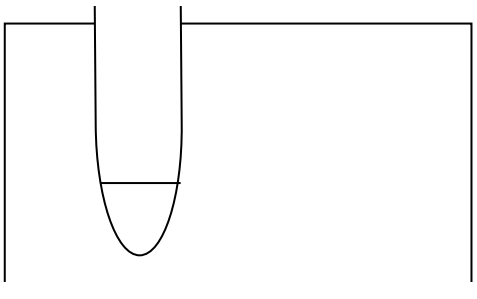
What to do

Experiment 1

Collect

Cobalt chloride solution
Potassium carbonate solution
a test tube rack containing 1 test tube

1. Pour some cobalt chloride into the test tube until it is about 1/3 full.
2. Then pour in about the same volume of potassium carbonate and fill in your table with what happened.



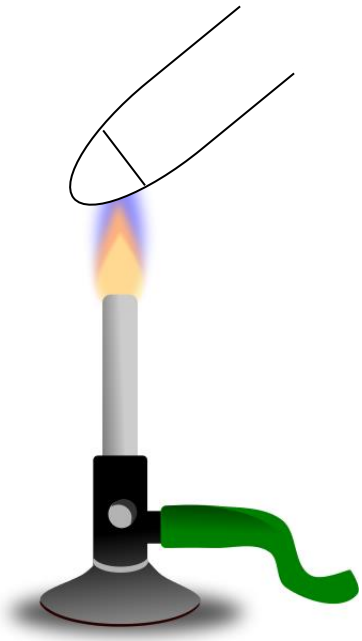
Put away the chemicals but wash the test tube and keep it for the next experiment.

Experiment 2
Collect
A tub of chalk
1 mol/l hydrochloric acid
a spatula

1. Half fill the test tube with some hydrochloric acid.
2. Add a spatula of chalk and fill in your table with what happens.

Put away the chemicals and change the test tube for a dry one. Make sure it is a **pyrex** tube as you are going to heat it.

Experiment 3
Collect
a tub of copper carbonate
a heat proof mat and bunsen burner
test tube tongs (these look like big clothes pegs)



1. Add a spatula of copper carbonate to the test tube.
2. Use the tongs to hold the test tube in the blue bunsen flame until you see what happens to fill in your table.

Put away the chemicals but keep the rest of the equipment for the next experiments.

Experiment 4
Collect
A piece of magnesium ribbon
A set of metal tongs.

Hold the magnesium in the bunsen flame for a few seconds and fill in your table with what happens. N.B. **do not** look directly at the burning magnesium.

Experiment 5
Collect
A bottle of 2 mol/l sodium hydroxide
A bottle of 2mol/l hydrochloric acid
A 100ml beaker
A 100ml measuring cylinder
A thermometer

1. Measure out 20ml of the acid and put it into the beaker.
2. Put the thermometer into the acid and check its temperature.
3. Measure out 20ml of the sodium hydroxide and put it into the acid in the beaker.
4. Stir the mixture with the thermometer and observe what happens.

Put away all of your chemicals and equipment.

Experiment 6
Look at the melting ice.

Experiment 7
Switch the kettle on and watch it when it boils.

Continue your work about reactions by answering the questions below.

1. Which experiment showed an example of a precipitation reaction?
2. What state of new substance (solid, liquid or gas) was made in experiment 2? How did you know this?
3. How did you know that a new substance had been made in experiment 3?
4. What types of energy were released in experiment 4?
5. In experiment 5 there was no colour change or solid or gas made. How did you know that this was a chemical reaction?
6. Explain why melting and boiling are **not** examples of chemical reactions even though a liquid and gas are made.

Energy in reactions

Read

Sometimes it is not easy to see the new substance that is made. If we can measure a **change in energy** this is a clue that a chemical reaction has happened. Sometimes we can see or hear this energy for example, light or sound in explosion reactions but other times we might need to use a scientific instrument such as a thermometer.
Chemists use special words to describe reactions that give out or use up energy.

Your teacher may demonstrate some reactions that give out or use up energy.

Continue your work by trying the questions below

1. Copy the box below into your jotter.

Reactions that give out energy are called **exothermic** reactions. Any kind of **burning** is an exothermic reaction. Reactions that use up energy are called **endothermic** reactions.

Read

Photosynthesis is one of the most important natural endothermic chemical reactions on earth. In photosynthesis, plants use light energy, water and carbon dioxide and produce oxygen and glucose.

2. Which experiments in the last section showed exothermic reactions?
3. Give an example of an everyday exothermic reaction.

4. Give an example of an important endothermic reaction and give a reason for your answer.

The aim of the next experiment is to react 20 cm^3 of 1 mol/l hydrochloric acid with 20 cm^3 1 mol/l sodium hydroxide and work out whether the reaction is endothermic or exothermic.

You have available:
Hydrochloric acid
Sodium hydroxide
A thermometer
Other standard lab equipment in the room.

5. What is the aim of the experiment?

6. Devise a **plan** for the experiment and **write the plan** into your jotter. Include a list of chemicals, equipment and a labelled diagram of the experiment.

Show the plan to your teacher **before** you start.

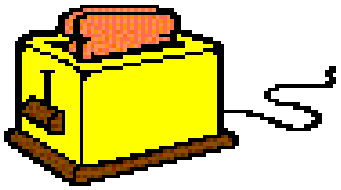
Take a rough note of any important numbers in your jotter as you go along.

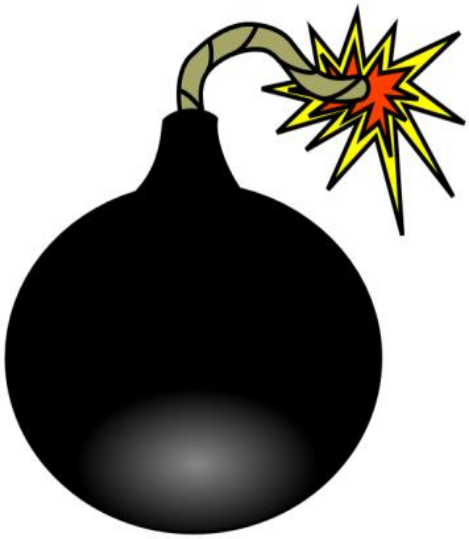
7. Complete your experimental report by writing out your rough results **neatly** and by writing a conclusion (look at your aim first).

Changing the speed of chemical reactions

Read

Some reactions go faster than others. An explosion is an extremely fast reaction, making toast is a reaction that happens in minutes while a car rusting or a body rotting will take years. Making fossil fuels is a reaction that takes a very, very long time.





There are things that chemists can do to change how fast reactions happen. We can change:

- The temperature of the chemicals
- The concentration of the chemicals
- The particle size of the chemicals (whether it is powder or lumps).

Write a heading and try the following work

1. List examples of some chemical reactions from fastest to slowest.
2. Copy and complete the following sentences and choose words to show what you think or already know from earlier chemistry courses.

I ***already know/think*** that higher temperature will make a reaction go ***faster/slower***.

I ***already know/think*** that higher concentration will make a reaction go ***faster/slower***.

I ***already know/think*** that powder will react ***faster/slower*** than lumps.

If you already know what happens to the speed of reactions depending on temperature, concentration or particle size from earlier courses, your teacher may give you some work to do that is different from the next few pages.

Temperature and the speed of reactions

Read

The temperature of chemicals can change the speed of a reaction. Time is measured in units called seconds, temperature is measured in units called **degrees celsius (°C)**.

Collect

A test tube rack containing two test tubes
A bottle of 1 mol/l hydrochloric acid
2 pieces of zinc

1. Half-fill both test tubes with acid and place one of the tubes into the hot water bath to heat up for a few minutes.
2. Once it is heated, put the hot acid tube back into the rack and immediately put a piece of zinc into each tube at the same time.
3. Observe what happens.

Wash out your test tubes but keep the equipment and acid for the next experiment.

Write a heading and try the following work.

1. Make a list of the three things that chemists can do to change the speed of a reaction.
2. What are the units that temperature is measured in?
3. What did you find out from the experiment?
4. What did you do to make sure the experiments were a fair comparison? Remember you should not use the word **amount** in your answer.

5. Where would food rot faster - in a fridge or in a freezer? Explain.
6. The acid was heated using a water bath instead of a Bunsen burner. Give 2 reasons why a water bath might be used instead of a Bunsen burner to heat chemicals for experiments.

Your teacher may ask you to complete an assessment report using the learner guide sheet for the experiment you did about temperature and speed of reactions.

Concentration and the speed of reactions

Read

Concentration tells us how much of a chemical is dissolved in water. Concentration is measured in units called **moles per litre**. This has the short symbol **mol/l** or just a capital **M** and is often shown on the labels for chemical bottles.

Collect

4 mol/l hydrochloric acid
2 mol/l hydrochloric acid
1 mol/l hydrochloric acid
2 pieces of zinc

1. Half-fill one test tube with 1 mol/l hydrochloric acid one with 2 mol/l acid and the other with 4 mol/l acid.
2. Put one piece of zinc into each tube at the same time and observe what happens.

Put away your chemicals and apparatus.

Continue your work by answering the questions below.

7. What does concentration tell us?
8. What are the units for concentration? – give the long and the two short ways to write it.
9. Why can a lower case m not be used for the units of concentration?
10. What did you find out from the experiment?

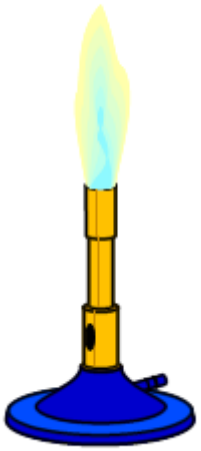
11. Firefighters are taught to be very careful when opening doors in burning houses. Sometimes opening doors can cause flash flames. You already know that burning is a chemical reaction. Why do you think the flames get hotter when the door is opened?
12. Explain what happens to the flame of a Bunsen burner when you open the hole in the collar.

Your teacher may ask you to complete an assessment report using the learner guide sheet for the experiment you did about concentration and speed of reactions.

Particle size and the speed of reactions

Read

The speed of a reaction can be affected depending on whether the chemicals are in big lumps or tiny pieces.



Collect

A tub of iron powder
A spatula
A large iron nail
Metal tongs
A heat proof mat and bunsen burner

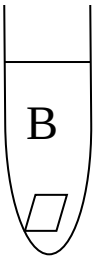
1. Light the bunsen and use the tongs to hold the large nail in the flame. Observe what happens.
2. Place the hot nail **on the mat** to cool down again.
3. Use the spatula to scoop out a small amount of the iron powder.
4. Flick the powder very gently into the flame and observe what happens.

Continue your work by answering the questions below.

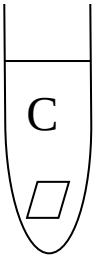
13. What did you find out?
14. What do you think iron powder can be used to make?
15. Which will burn faster - a wooden log or sawdust?

16. Look at the following diagrams.

1 mole per litre acid
10°C
zinc powder



1 mole per litre acid
10°C
zinc lump



1 mole per litre acid
20°C
zinc powder

a) Which two experiments would you set up to compare the effect of particle size on the speed of a reaction?
b) Which two experiments would you set up to compare the effect of temperature on the speed of a reaction?
c) Which reaction would be faster - B or C? Explain your answer.

Speed of a reaction - skills

1. The following table shows the results from an experiment with metal and acid.

Temperature(°C)	1st experiment time for all of the metal to be used up (s)	2nd experiment time for all of the metal to be used up (s)	Average time for the metal to be used up (s)
0	78	75	
20	45	49	
40	23	27	
60	10	8	

Copy and complete the table by calculating the average values for the last column.

2. This table shows the results from Harley's experiment.

Temperature(°C)	time for all of the metal to be used up (sec)
0	85
20	60
40	40
60	50
80	20

a)Collect half a sheet of graph paper and draw a line graph to show the results of Harley's experiment.

b) Harley made a mistake in one of the experiments but she didn't notice she had made a mistake. Can you tell which point is the one that is wrong? Draw a red circle around this point and label it as a "rogue point".

Catalysts

Read

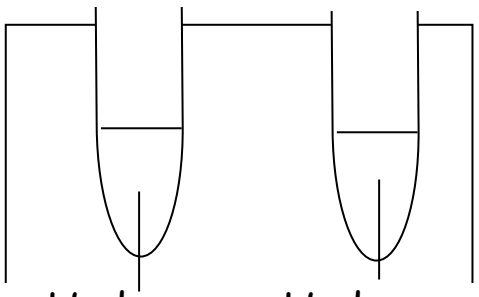
Another way to speed up a chemical reaction is to use a special chemical called a **catalyst**. A **catalyst** speeds up a reaction but is **not used up** so it can be used over and over again.

Hydrogen peroxide is a chemical that reacts to produce oxygen gas and water.

Write a heading and collect

A tub of manganese dioxide
A test tube rack with two test tubes
A bottle of hydrogen peroxide
A spatula

1. Half fill the test tubes with hydrogen peroxide.
2. Add a small spatula full of manganese dioxide to one of the test tubes.
3. Look to see how fast the oxygen gas is made.



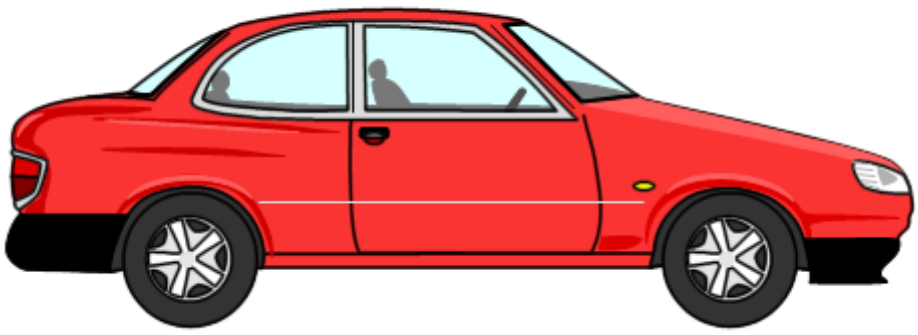
Continue your work by answering the questions below.

1. What is a catalyst?
2. Copy the diagram of the experiment and add bubbles to show where oxygen gas was made.
3. How could you test that it was oxygen and not another gas that had been made?

4. What is the name of the catalyst in this experiment?
5. In a similar experiment, John weighed out his manganese dioxide before he started. He used 1.5g.
   a) How much manganese dioxide would he have at the end of the reaction?
   b) Explain your answer to the last question.
   c) What could he do to get the manganese dioxide back? (clue: think about experiments that we can use to separate solids from liquids – you did this in S1-3 chemistry).
6. Copy the sentences below.

Use of catalysts

Catalysts are often used in vehicle exhaust systems. The part of the exhaust that contains the catalyst is called a **catalytic convertor**. The catalytic convertor **changes harmful and poisonous gases into safer ones** that can go out into the air.



Collecting experimental data to work out reaction rates

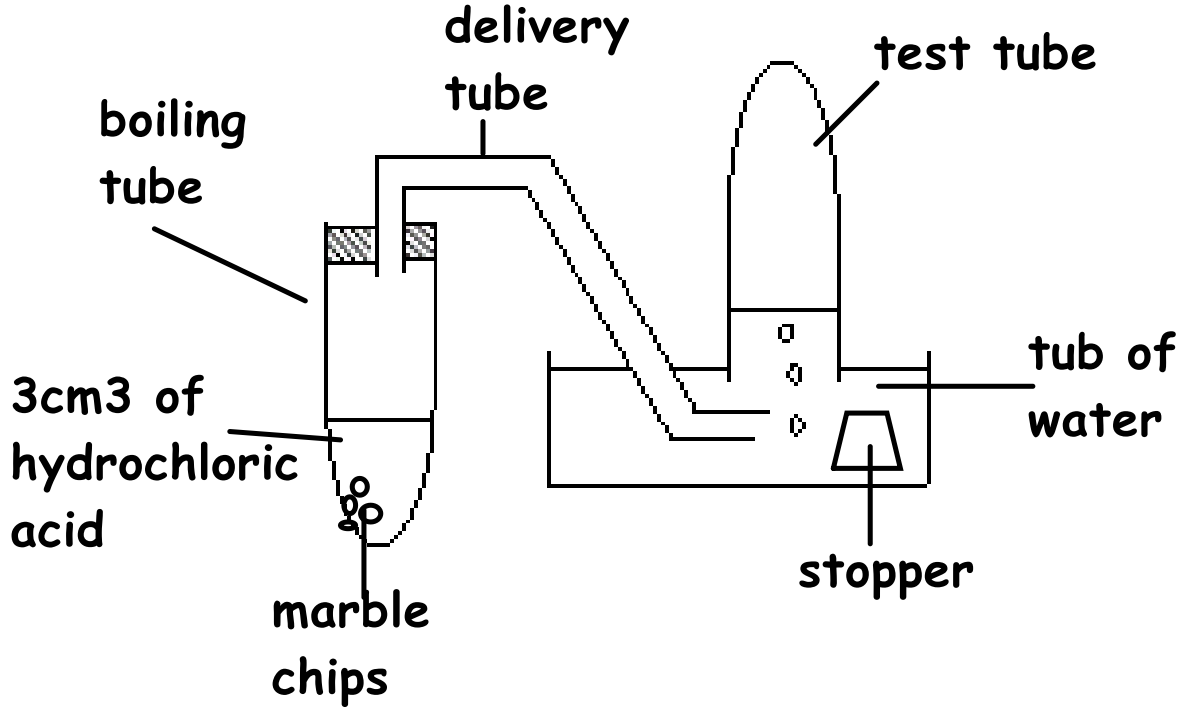
Read

The speed of a reaction is sometimes called the rate of the reaction. To compare rates of reaction we can measure changes in mass or volumes of the chemicals.

In the next experiment you will be reacting hydrochloric acid with marble chips (calcium carbonate). The word equation is

calcium carbonate	+	hydrochloric acid	⟶	calcium chloride	+ water +	carbon dioxide

We can get an idea of the rate of the reaction by using the apparatus shown below



We can time how long it takes for the gas to fill the test tube.

The aim of the experiment is to compare the rates of the reaction depending on whether the concentration of the acid is 1 mol/l or 2 mol/l.

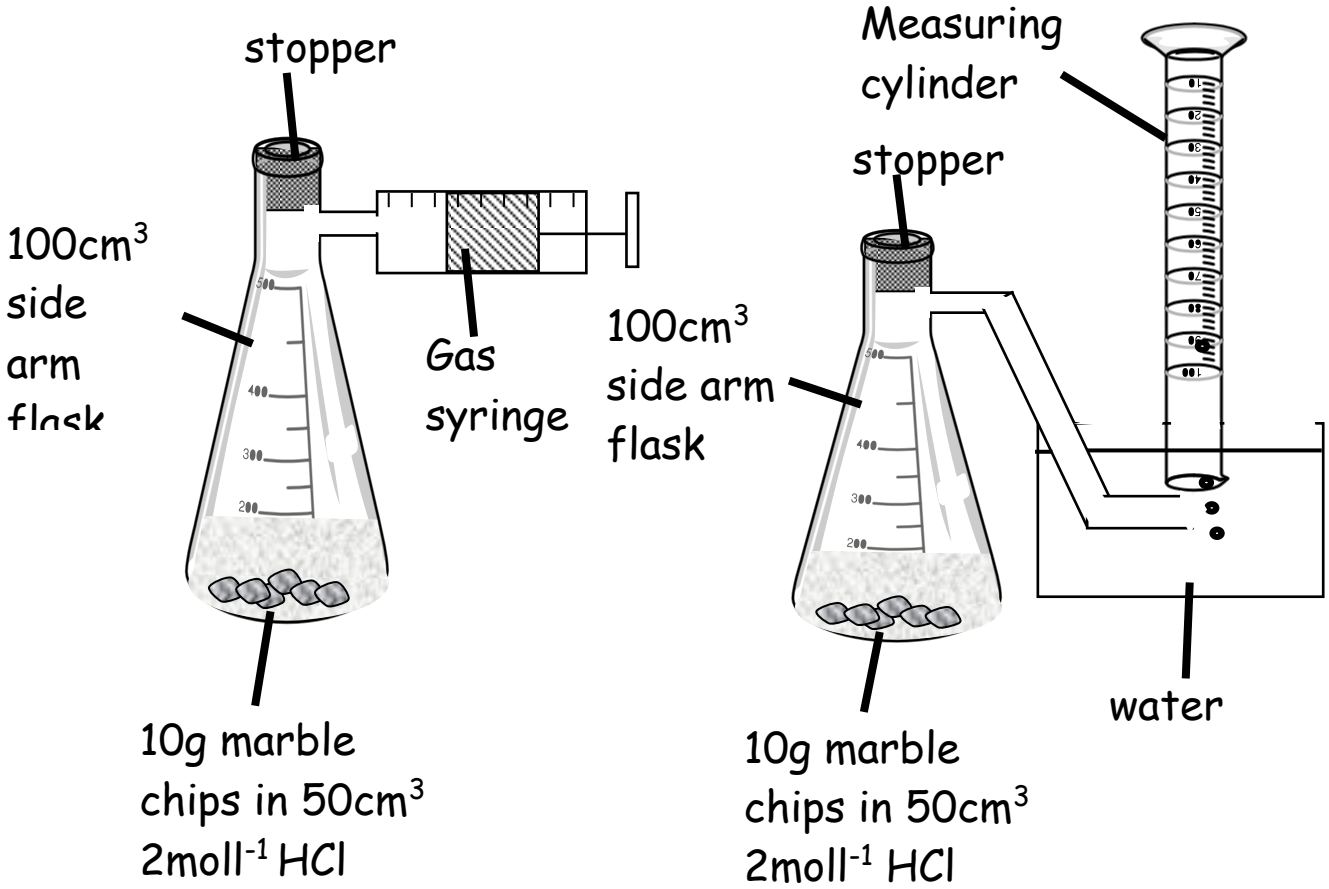
Write a heading and try the following work

1. What is the speed of a reaction often called?
2. What can we measure to compare rates of reactions?
3. What is the aim of the experiment?
4. Write a hypothesis about what you think will happen.
5. Copy the diagram of the apparatus.

Decide which concentration of acid you will try first and use the diagram to collect what you need for the experiment. Do the experiment and write the raw results in your jotter.

6. Turn your notes of the raw results into a neat table using correct headings and units.
7. Read your aim and then decide what the conclusion is from your experiments?
8. Was your hypothesis correct?
9. Collect a copy of the following diagrams.
   a) What is different about the way the volume is measured in these experiments compared to how you measured the volume of gas in your experiment?
   b) Which of the 2 diagrams would you choose to use for a gas that may be slightly soluble in water – explain your answer?

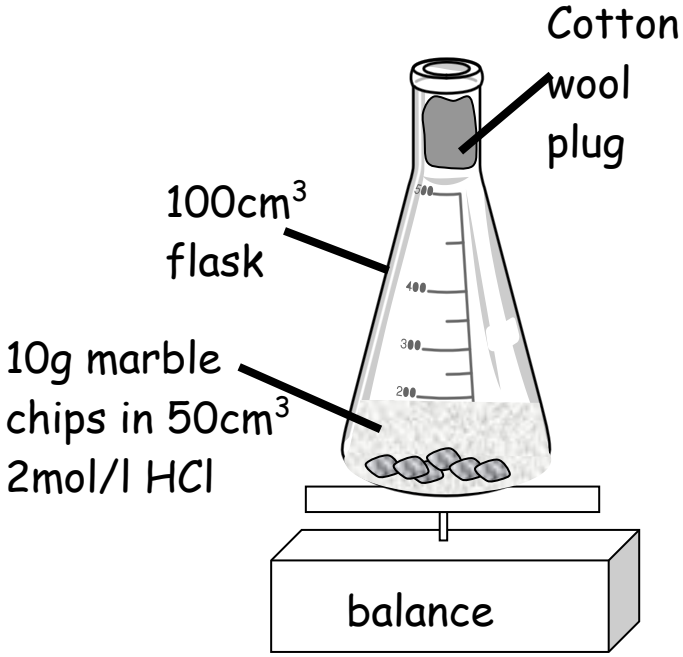
These diagrams show a different way to catch the gas made and measure the volume. The experiment with the syringe is more accurate than the one with the measuring cylinder because some of the gas might dissolve in the water and not go into the cylinder.



Using mass changes to measure the rate of a reaction

Read

We can also measure the **mass** of the gas that is made in a reaction because, if we let the gas escape, the apparatus will get lighter. We can measure this very accurately by putting the whole apparatus on a balance.



We measure the mass lost when the carbon dioxide escapes into the air. The cotton wool plug stops any liquid from fizzing out of the flask.

Your teacher may demonstrate how the rate of reaction can be measured using changes in mass.

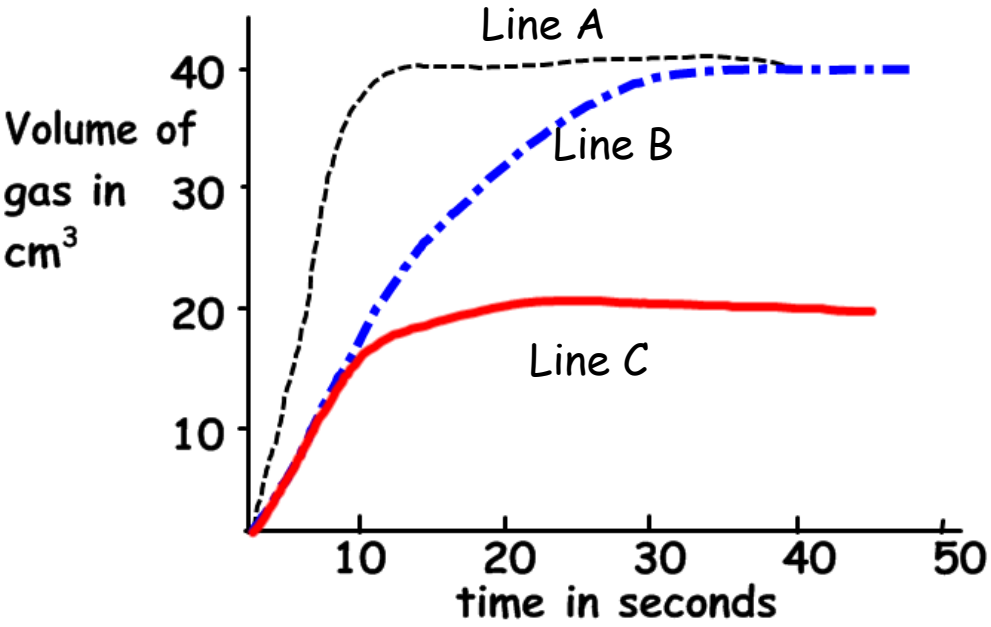
Write a heading and try the following work

1. Copy the diagram of the experiment that shows how mass can be measured to show the speed of a reaction.
2. What was the
   a) volume of the flask used in the diagram?
   b) concentration of acid used in the diagram?
   c) mass of marble chips used in the diagram?
   d) volume of acid used in the diagram?
3. Why does the apparatus get lighter?
4. Why is the cotton wool in the top of the flask important?

Presenting results for rates of reactions

Read

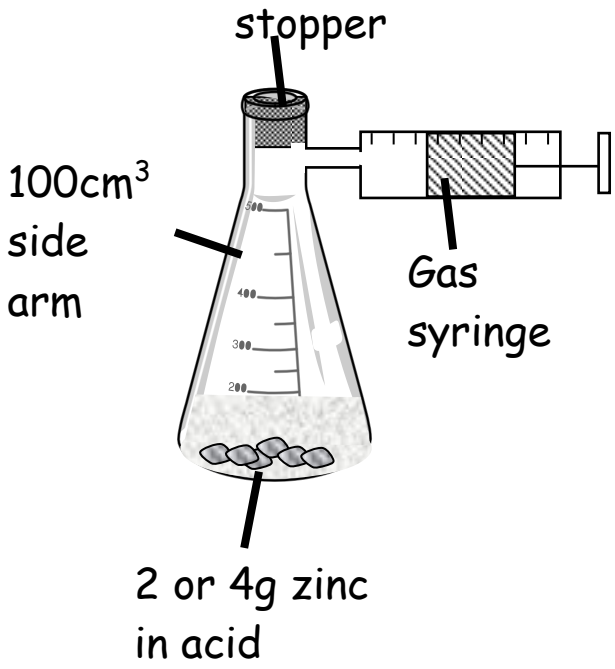
When we get results about rates of reactions, the results are often presented in graphs.



The slope and height of graphs tell us about the reaction.
The slope tells us about the rate of the reaction and the height tells us about how much new substance has been made. The steeper the slope, the faster the reaction.

Write a heading and try the following work

1. What does the height of the graph tell us?
2. Collect a copy of the graph and stick it into your jotter.
3. The graphs shows 3 experiments that were done at different temperatures or had different masses of zinc added.



The experiment was carried out either with 2 or 4g of zinc and either at 20°C or 30°C.

Copy the following table and match up the experiment to the graph lines.

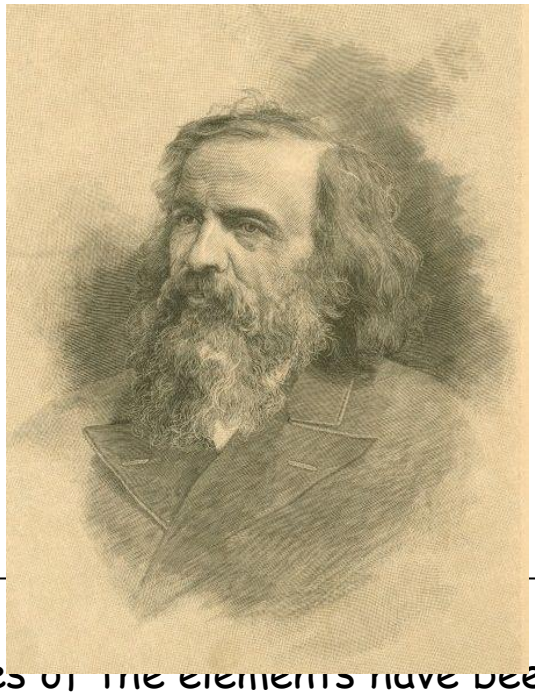
Experiment	line on graph A/B/C	My reason
4g zinc at 30°C		
4g zinc at 20°C		
2g zinc at 20°C		

Your teacher may give you some exercises to learn about how we can use graphs to show reactions.

Atoms, elements and the periodic table

Read

All matter is made from atoms. If the atoms are the same the substance is called an **element**. All elements are listed in a special chart called the **Periodic Table**. A Russian scientist called Dimitri Mendeleev was one of the main people who worked out the order and he has an element named after him as a reward for all of his work.



Dmitri Mendeleev,
Russian Chemist,
1834 - 1907

Names of the elements have been decided in different ways

- Some are named after scientists
- Some are named after planets
- Some are named after continents
- Some are named after countries
- Some are named after states in the USA

The periodic table is arranged with the elements in

- Vertical lines called groups or columns
- Horizontal lines called rows or periods.

Lucky for you that you will not need to memorise the names of the elements because you can always look them up in a periodic table. **Even in exams!!!!!!!!**

Write a heading and try the work below.

1. What is all matter made from?
2. Describe the atoms in an element.
3. Approximately how many elements are there?
4. What is the name of the special chart that all the elements are arranged in?
5. Collect a periodic table sheet.

> Your periodic table will be used a lot so stick it somewhere in your jotter that will be easy to find.

Make a list of at least 5 of the elements you have heard of before.

6. Make a list of 5 elements you have not heard of before.
7. Put a star beside or highlight the elements you wrote that are non-metals (this is revision from earlier chemistry courses).

The names and symbols of elements

Read

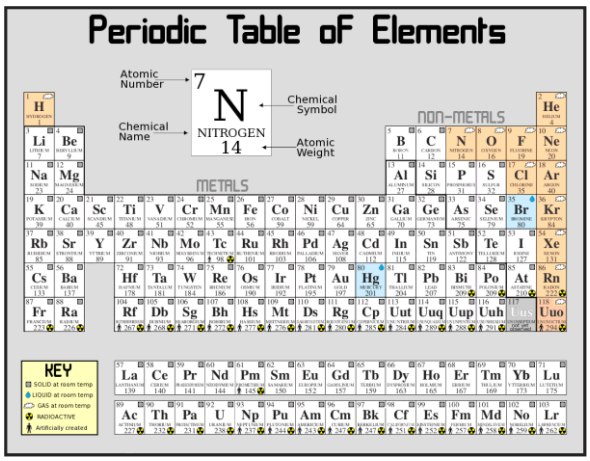
Every element has a **name** and **symbol**. The symbol is a short way of writing elements.

The symbol is made up of one letter or two letters.
The first letter is **always a capital letter** and, if there are two letters, the **second is always a small letter**,

- Boron has the symbol **B not b**
- Calcium has the symbol **Ca not CA**.

Some of the symbols don't seem to make sense. For example the symbol for iron is Fe, the symbol for silver is Ag. This is because when iron and silver were named the main language was latin.

- The latin name for iron is ferrum.
- The latin name for silver is argentum.



Write a heading and try the work below

1. What is meant by an element symbol?
2. Explain how capital and small letters are used in element symbols.
3. Choose 10 elements and write a list of their names and their symbols. You may choose to present this information in a table. Put a star beside or highlight the ones you chose that are non-metals.

Ask your teacher if you have time to test your memory of symbols using symbol cards or by working with a partner or by trying the game at
http://www.kscience.co.uk/animations/element_pairs.htm

Rows and columns, periods and groups

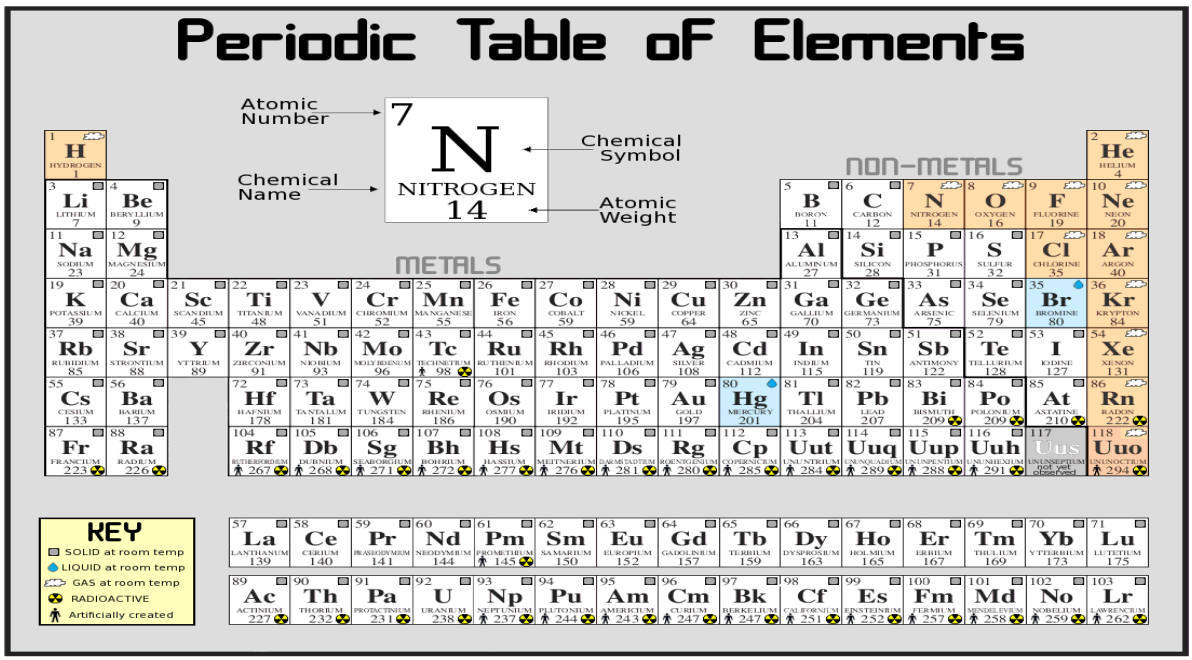
Read

The periodic table is divided into horizontal and vertical lines of elements.

Vertical lines go from top to bottom and are called **groups or columns**. Horizontal lines go from left to right and are called **rows or periods**. This is where the periodic table got its name.

Write a heading and try the following work

1. What are vertical lines of elements called in the periodic table?
2. What are horizontal lines of elements called in the periodic table?
3. What is the name of the element that is in
   a) row two, group 4?
   b) row 1, group 0/8?
   c) row 4, group 7?
4. What happens to the atomic number of the elements going from lithium across the periodic table to Neon?

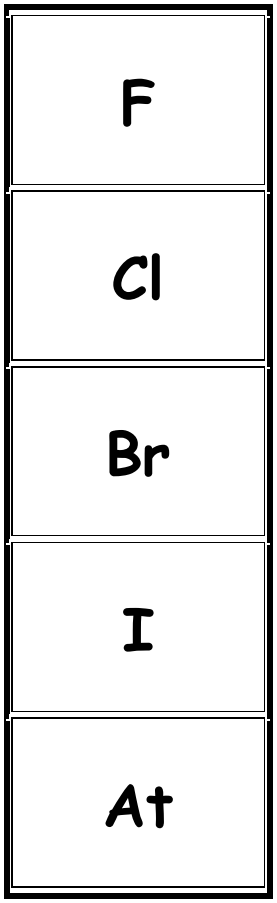


Classifying elements

Read

The periodic table is arranged in columns and rows.

Elements that are in the same column have similar reactions, for example, fluorine will have similar reactions to chlorine and bromine but won't have similar reactions to oxygen or neon.



Your teacher will go over the families of elements in column 1, 7 and 0 of the periodic table. Listen and colour in a periodic table to show which column is

Reactive metals
Reactive non-metals
Unreactive gases

Metals and non-metals are also separated in the periodic table. You should have learned about this in previous chemistry courses.

Write a heading and try the following work

1. What can you say about the reactivity of elements if they are found in the same group?
2. A pupil was about to study the chemistry of the element Xenon. What would you be able to tell him about this element before he started to do his experiments?
3. Make a list of 3

a) very reactive metals.

b) very unreactive gases.

c) reactive non-metals.

4. Describe how you can use the periodic table to decide if an element is a metal.

5. Choose any 10 random numbers between 1 and 100 and write them down in a vertical list in your jotter.

6. Find the matching element for each of your atomic numbers you chose and write the name of the element beside each number in your list.

7. Choose a way to distinguish between the metals and the non-metal elements in your list e.g. use highlighters/different coloured stars/circle the metals, square the non-metals etc.

8. Out of your 10 random numbers, how many metals did you choose and how many non-metals did you choose?

Special names for groups

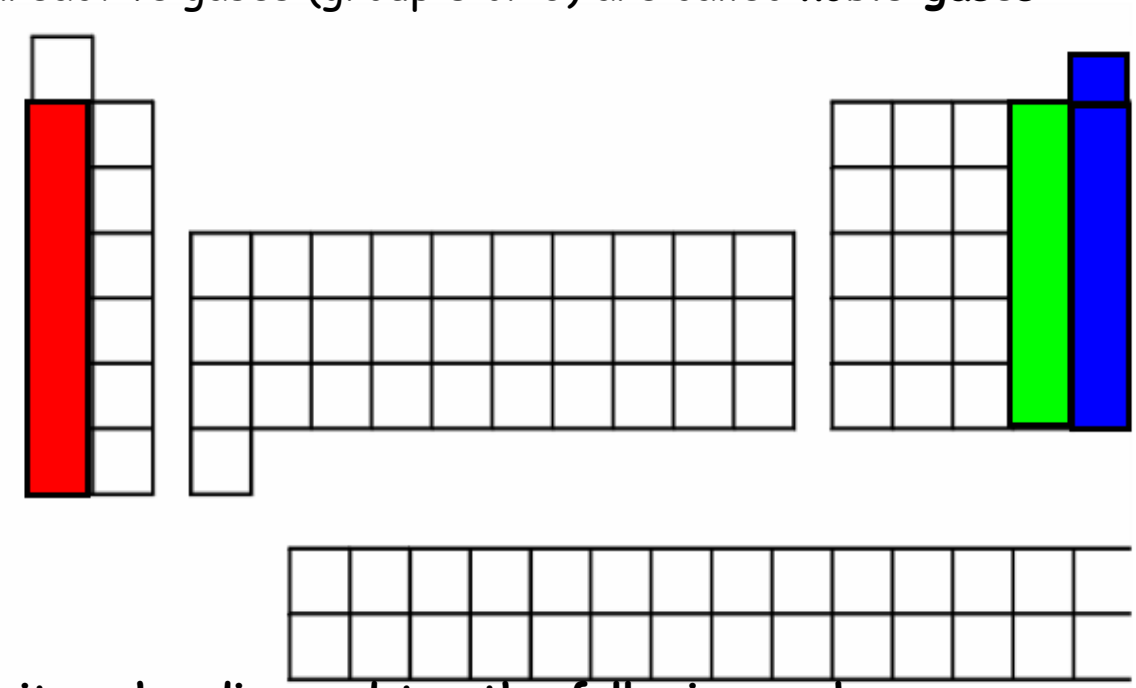
Read

The groups for the

Reactive metals (group 1)
Reactive non-metals (group 7)
Unreactive gases (group 8 or 0)

have been given special names:

Reactive metals (group 1) are called **alkali metals**
Reactive non-metals (group 7) are called **halogens**
Unreactive gases (group 8 or 0) are called **noble gases**



Write a heading and try the following work

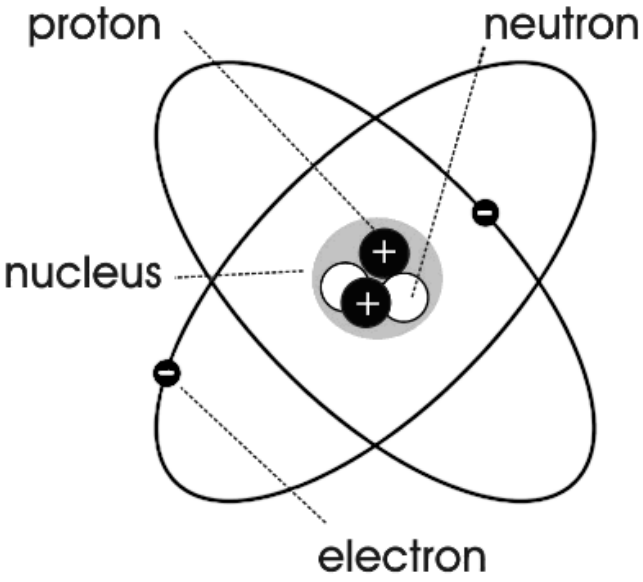
1. Go back to your periodic table and label the groups with the special family names.
2. Present the names of the 6 alkali metals, the 5 halogens and the 6 noble gases in a way of your choice in your jotter.

Try the games at
http://www.kscience.co.uk/animations/groups.htm

http://bpes.bp.com/secondary-resources/science/ages-14-to-16/chemical-and-material-behaviour/periodic-table-challenge/?utm_source=http%3a%2f%2feducation.edcoms.co.uk%2fedu_edcomslz%2f&utm_medium=email&utm_campaign=Sec+Registrants&utm_term=Free+Periodic+Table+game&utm_content=1451429

Inside an atom

Read



Until now you might have been told that atoms are the smallest particle but this isn't true. There are even smaller particles inside an atom. These particles are called

- **Protons**
- **Electrons**
- **and neutrons**

Even though these particles are tiny scientists know some facts about them

- **Protons have a mass of 1 amu**
- **Neutrons have a mass of 1 amu**
- **Electrons are so small we say they have 0 mass.**

As well as being different masses, these particles have different charges

- **Protons are positively charged**
- **Electrons are negatively charged**
- **Neutrons don't have a charge (they are neutral).**

Read

The protons, electrons and neutrons in an atom are <u>not spread</u> out randomly all over the atom.

The protons and the neutrons are in the centre of the atom in a part of the atom called the nucleus. The electrons are whizzing around outside the nucleus.

Write a heading and try the work below

1. What are the names of the three particles that can be found inside atoms?
2. Explain why chemists often say that electrons have zero mass.
3. Copy and complete the following table

Name of particle	mass	charge

4. Describe where the protons, electrons and neutrons are in an atom?
5. What part of the atom will be the heaviest?
6. An atom contains ten protons, ten electrons and eleven neutrons.

   a) How many positive charges are inside the atom?

   b) How many negative charges are inside the atom?

   c) What will the **total** charge of the atom be?

d) Why do neutrons not affect the charge of an atom?

e) How heavy will the nucleus of this atom be?

7. Copy and complete the following sentence by choosing the correct words.

Even though an atom contains ***positive/negative*** protons and ***positive/negative*** electrons, the whole atom is electrically neutral (not charged) because the number of protons and electrons is ***balanced/not balanced*** so the charges cancel out.

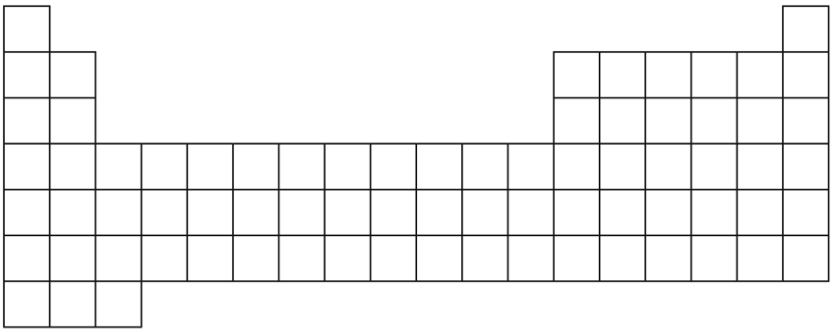
How many protons

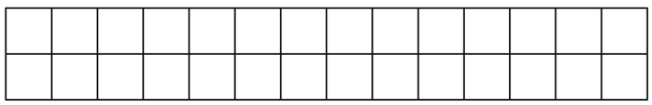
Read

You already know that each element has been given a special number called the atomic number. Different elements have different atomic numbers (no two elements can have the same atomic number). The atomic number can be found on most periodic tables.

The **atomic number always tells us the number of protons** that are present in an atom.

Collect a data book, look at a periodic table and try to work out what the atomic number is for sulphur.





The atomic number for sulphur is 16 so a sulphur atom has 16 protons in the nucleus.

Now look for carbon. The atomic number for carbon is 6 so a carbon atom has 6 protons in the nucleus.

Write a heading and then answer the work below.

1. Describe how you found the atomic number for sulphur.
2. Explain how you knew a sulphur atom has 16 protons in the nucleus.
3. Choose 8 of the following questions and use a data book to write down the atomic number for the ones you have chosen

a) magnesium
b) fluorine
c) the metal element that is a liquid at room temperature
d) the non-metal element that is a liquid at room temperature
e) the element that is in column 7, row 3 of the periodic table
f) the element that is 20% of the air
g) the element that is used in pencils
h) the element that is 80% of the air
i) the element that is used to kill bacteria in swimming pools
j) the element that is used in party balloons
k) the main metal that is used to make nails
l) the metal that is used for roofs
m) the yellow metal that is used to make jewellery
n) the element that is used to make water and gas pipes
o) the element that is in milk that gives us healthy teeth and bones
p) the element with the symbol Pt

4. Choose 8 of the following questions and use a data book to write down the **number of protons** the atom has in it's nucleus

a) magnesium
b) flourine
c) the metal element that is a liquid at room temperature
d) the non-metal element that is a liquid at room temperature
e) the element that is in column 7, row 3 of the periodic table
f) the element that is 20% of the air
g) the element that is used in pencils
h) the element that is 80% of the air
i) the element that is used to kill bacteria in swimming pools

j) the element that is used in party balloons
k) the main metal that is used to make nails
l) the metal that is used for roofs
m) the yellow metal that is used to make jewellery
n) the element that is used to make water and gas pipes
o) the element that is in milk that gives us healthy teeth and bones
p) the element with the symbol Pt

5. What is the rule about atomic number and the number of protons an atom has in it's nucleus?

How many electrons

Read

The number of electrons in an atom is the same as the number of protons.

Sulphur
the atomic number is 16
so the number of protons is 16
so the number of electrons is 16.

Carbon
the atomic number is 6
so the number of protons is 6
so the number of electrons is 6.

Write a heading and then answer the questions below.

1. Choose any 10 elements apart from sulphur and carbon – write the number of electrons they have in each atom.
2. Explain how you made sure you made sure you were successful for question 1.
3. What charge does a whole atom have? – explain your answer.

The mass number for an atom

Read

You already know that atoms have a special number called the atomic number which always tells us the number of protons in the nucleus. The mass number for an atom is about how heavy atoms are.

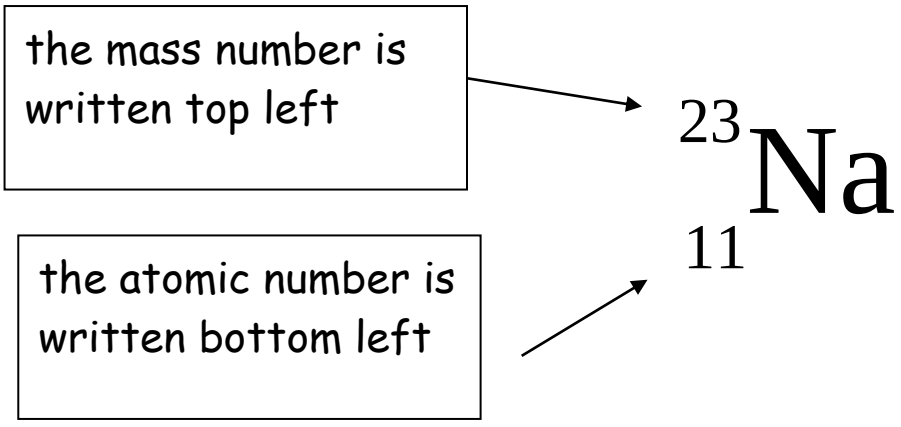
The mass number tells us the total number of protons and neutrons in the nucleus.

The electrons are **not part** of the mass number because they have zero mass.

Sodium has atomic number 11. The nucleus of a sodium atom contains 12 neutrons.

mass number = protons + neutrons
= 11 + 12
= 23

We can present this information as shown below



Write a heading and try the following work

1. What does the atomic number always tell us about an atom?
2. What does the mass number tell us about an atom?
3. Why are electrons not part of the mass number?
4. Copy the diagram showing where the atomic number and the mass number are written for sodium.

Read

The difference between the mass number and the atomic number tells us the number of neutrons.

We can show fluorine in a similar way:

$^{19}_{9}F$ Neutrons = 19-9
= 10

There are 9 protons so there must be 9 electrons to make the atom neutral.

Copy and complete the following diagrams and fill in the missing information.

$^{37}_{17}Cl$

atomic no. =
mass no.=
no.protons =
no. neutrons =
no. electrons =

$^{11}_{5}B$

atomic no. =
mass no.=
no.protons =
no. neutrons =
no. electrons =

$^{80}_{35}Br$

atomic no. =
mass no.=
no.protons =
no. neutrons =
no. electrons =

More about where electrons are -Electron layers

Read

Electrons are particles that move around very fast. They move in layers around the nucleus of the atom.

Collect a data book and look at the content page. What page should you look at to find out about electron arrangements?

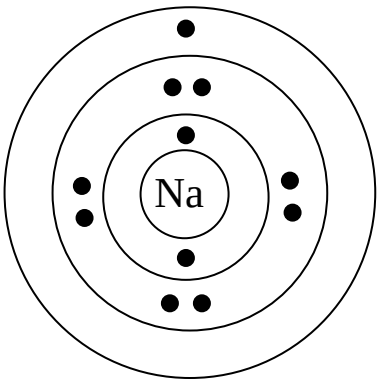
key

atomic number name of element symbol **electron arrangement**

Look at the electron arrangement page. The key tells us what each bit of information is.

Look for sodium and you can see that the electron arrangement for sodium is 2,8,1.

The numbers tell us how many electrons are in each layer. So a sodium atom has 2 electrons nearest the centre, 8 electrons in the next layer and 1 electron in the outside layer. We can show this in a diagram.



The black dots are the electrons and the circles are the layers.
The total number of electrons is 2+8+1=11

The first electron layer, closest to the nucleus, is small and can only hold 2 electrons but the other layers can contain 8.

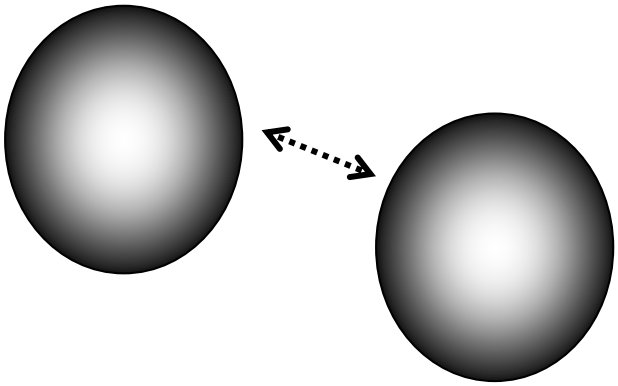
Write a heading and then answer the following questions.

1. What page did you look at to find out about electron arrangements?
2. Using sodium as an example, describe how electrons are arranged in an atom.
3. Explain how the electron arrangement can be used to work out the total number of electrons in an atom.
4. Why can the first electron layer only contain 2 electrons?
5. Use a data book to write down the electron arrangements for
   a) potassium
   b) aluminium
   c) fluorine
   d) argon
6. Draw a diagram to show how the electrons will be arranged in an atom of sulphur.
7. How many electrons are there in:
   a) the outside layer of an atom of nitrogen
   b) the outside layer of an atom of phosphorus
   c) the outside layer of an atom of arsenic
8. How many electrons are there in:
   a) the outside layer of an atom of lithium
   b) the outside layer of an atom of sodium
   c) the outside layer of an atom of potassium
9. Use what you noticed about your answers to the last 2 questions to devise a rule about number of the outside electrons as you go from top to bottom down a column of the periodic table.
10. How many electrons are there in:
    a) the outside layer of an atom of lithium
    b) the outside layer of an atom of beryllium
    c) the outside layer of an atom of boron

d) the outside layer of an atom of carbon
e) the outside layer of an atom of nitrogen
f) the outside layer of an atom of oxygen
g) the outside layer of an atom of fluorine
h) the outside layer of an atom of neon

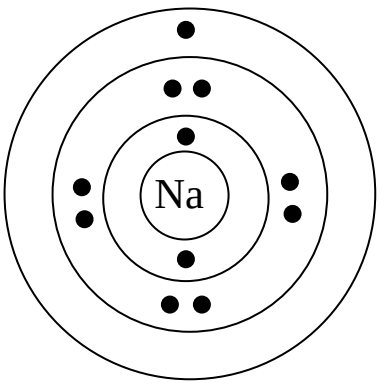
11. Use what you noticed about your answers to this question to devise a rule about what happens to the outside electrons as you go from left to right across the periodic table.
12. An atom contains 14 electrons in total. Write down the electron arrangement for this atom.
13. How many electrons are there in an atom of
a) nickel
b) silver

Electrons that react

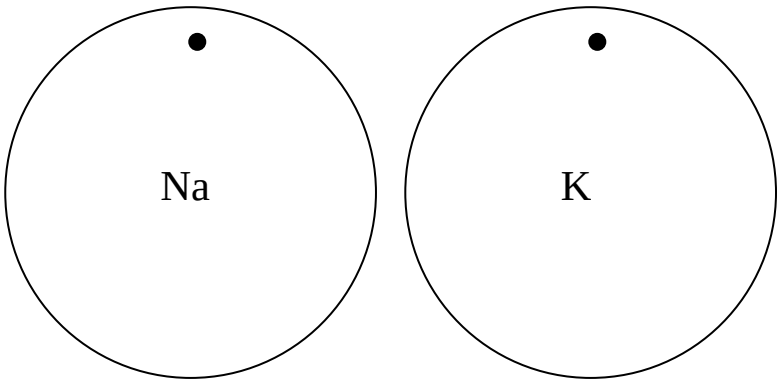


When atoms react they must collide (bang into each other) before they can turn into new substances so it is the **outer electrons** which are involved in chemical reactions.

An outer electron picture is a simplified picture of an atom that shows only the outside electrons. Sodium has an electron arrangement of 2,8,1 so there is 1 outer electron. Potassium has electron arrangement 2,8,8,1 so it also has 1 outer electron. The pictures below show the full electrons for sodium and the middle and right picture shows only the outside electrons



full electron diagram for sodium



outer electron pictures for sodium and potassium

Collect a data book , turn to the electron arrangement page. Look at group/column 1. You should notice something about the outer electrons.

Now, look at column 2. You should notice something about the outer electrons for the elements in column 2. If you look at the other columns you should see a pattern in the outer electrons.

Elements in the same group have similar chemical properties and reactions because they have the same number of outer electrons.

Write a heading and do the work below in your jotter.

1. Why is it the outer and not the inner electrons that are involved in chemical reactions?
2. What is common about the outer electrons in column 1 – Use examples to prove you understand.
3. What is common about the outer electrons in column 2 - Use examples to prove you understand.
4. Compare the outer electrons in row 2 across columns 1 to 7. What can you say about the pattern of outer electrons as you go from left to right across the periodic table?
5. Draw a full electron picture and an outer electron picture for
   a) magnesium
   b) calcium
6. Explain why magnesium and calcium have similar chemical properties.

Your teacher may give you a chance to "build an atom" using the following internet sites.

http://phet.colorado.edu/en/simulation/build-an-atom
http://www.kscience.co.uk/animations/atom.htm

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http://www.wpclipart.com/index.html