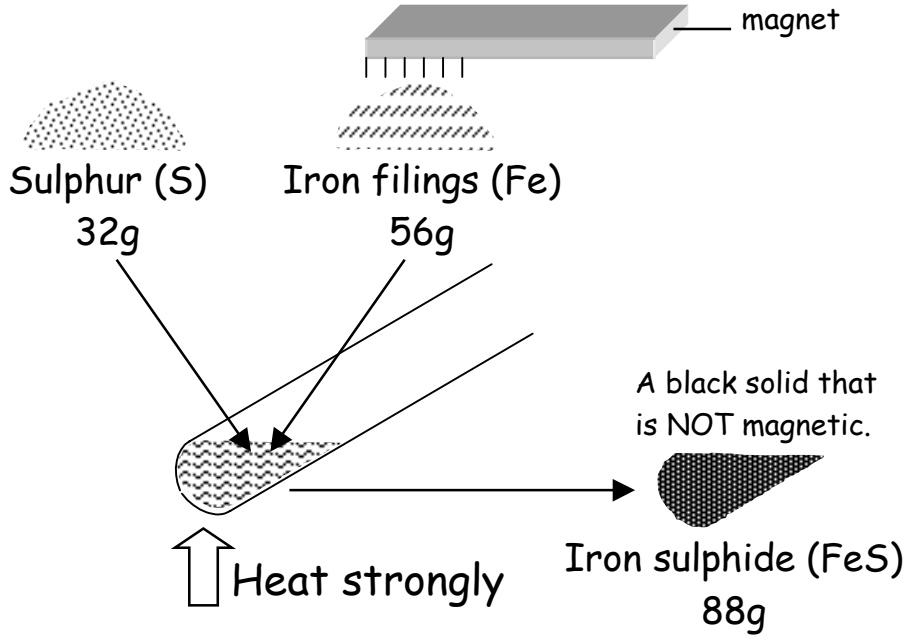
W.S.51. Chemical reactions.

Name ……

All of the different materials around us have been formed by chemical reactions from about one hundred simple elements. The diagram below shows a chemical reaction between the elements iron and sulphur.



This reaction can be shown as a word equation:

IRON + SULPHUR (REACTANTS) ⟹ IRON SULPHIDE (PRODUCT)

The new substance formed is a compound called iron sulphide. It has different properties to the iron and sulphur that it is made from.

Exercise 1 – fill in the missing words in the sentences below.

1. The mass of the reactants (starting chemicals) is E _ _ _ _ to the mass of the products (the chemicals that are made).
2. The products have different P _ _ _ _ _ _ _ _ _ _ to the reactants.
3. During a chemical reaction H _ _ _ is either taken in or given out.
4. A chemical change is difficult to R _ _ _ _ _ _ (go backwards).

Exercise 2 – Join up each word in the left hand column with its meaning on the right.

ELEMENTS	The chemicals that are made.
PRODUCTS	The simplest substances.
COMPOUND	Starting chemicals.
REACTANTS	Elements joined together.

W.S.52. Types of chemical reaction. Name ……

There are several different types of chemical reaction.

Synthesis

Two or more substances join together to make a single new substance. For example when iron and sulphur are heated together :

$$\text{IRON} + \text{SULPHUR} \xrightarrow{\text{heat}} \text{IRON SULPHIDE}$$

Decomposition

A substance breaks down into simpler substances. For example, if calcium carbonate (limestone) is heated to a very high temperature :

$$\text{CALCIUM CARBONATE} \xrightarrow{\text{heat}} \text{CALCIUM OXIDE} + \text{CARBON DIOXIDE}$$

Oxidation

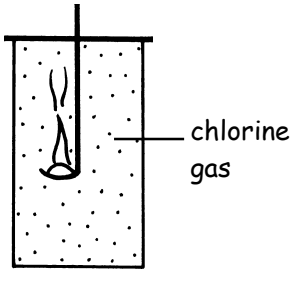
A substance gains oxygen during a chemical reaction. The substance that gains the oxygen is OXIDISED. For example, if copper is heated in air :

$$\text{COPPER} + \text{OXYGEN} \xrightarrow{\text{heat}} \text{COPPER OXIDE}$$

Exercise 1 – Complete the sentences below.

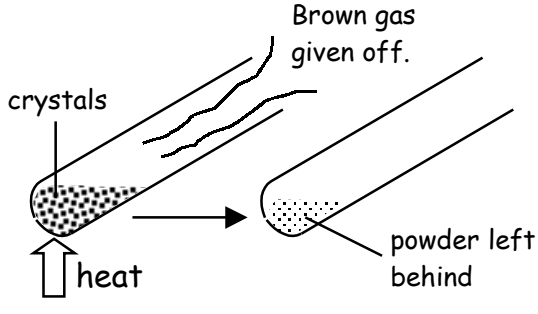
1) Synthesis means when substances _ _ _ _ together.
2) Decomposition means when a substance _ _ _ _ _ _ down.
3) Oxidation is when a substance gains _ _ _ _ _ _ in a chemical reaction.

Exercise 2 – For each diagram below write down the type of chemical reaction it shows.



1) Burning sodium metal in chlorine gas to form sodium chloride (salt). This type of reaction is :

_____



2) Heating white lead nitrate crystals to produce a yellow powder and a brown gas. This type of reaction is :

_____

3) If an iron nail is exposed to air it forms orange iron oxide (rust). This type of reaction is :

_____

W.S.53. Burning. Name ……

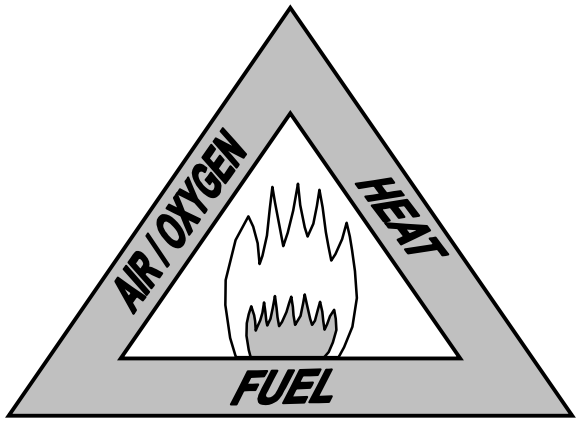
Burning is a type of oxidation reaction. It happens when a substance reacts with oxygen in the air to produce heat and light. The substance that burns is oxidised during the reaction. For example when carbon in the form of coke is burnt :

CARBON + OXYGEN ⟹ CARBON DIOXIDE + heat and light.

FUELS can be burnt to release useful energy. They burn more strongly in pure oxygen. If a smouldering wooden splint is placed into a jar that contains oxygen it will relight. This is a test for oxygen gas.

The fire triangle.

The fire triangle shows the three things that are needed for burning to happen. Removing any of them stops a fire.



Exercise – Complete the sentences below.

1) Burning is a chemical reaction between fuel and O _ _ _ _ _

2) When carbon burns C _ _ _ _ _ D _ _ _ _ _ _ gas is produced.

3) Burning can be useful because it releases E _ _ _ _ _

4) The test for oxygen is a smouldering S _ _ _ _ _

5) The three things needed for a fire are oxygen, F _ _ _ and heat.

6) A fire blanket is used to stop A _ _ getting to a fire.

7) Pouring water onto a fire takes away the H _ _ _

W.S.54. Products from chemical reactions. Name ……

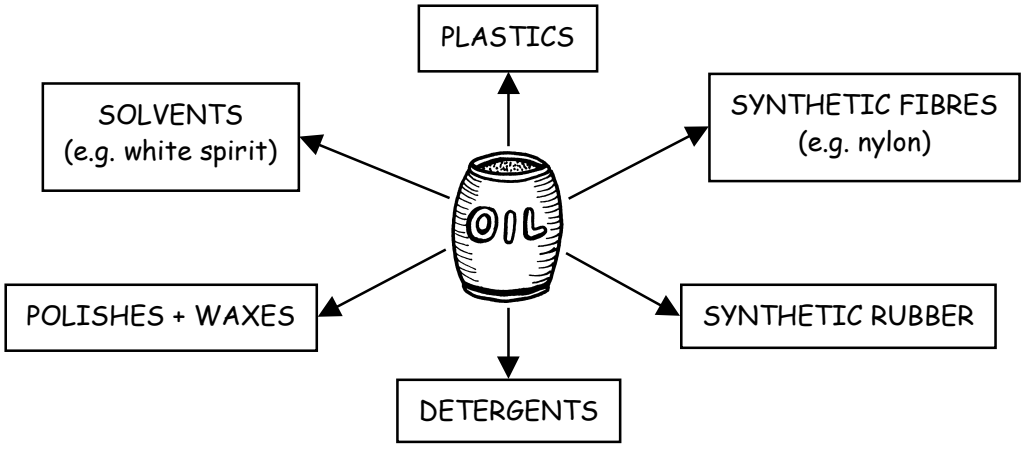
Most of the materials that we use every day have been made by chemical reactions. Some of the most common products are made from two important raw materials, METAL ORES and CRUDE OIL.

Metal ores.

Most metals exist as compounds called ORES inside rocks. Ores must be reacted with other chemicals to extract the metals that they contain. The more reactive the metal is, the more difficult it is to release from its ore. If a metal is less reactive than carbon it can be extracted by heating its ore with coke in a furnace. For example HAEMATITE (iron ore) contains iron oxide :

Crude oil.

Natural oil from the ground is called CRUDE OIL. It contains a mixture of substances that can be changed into many useful products.



Exercise – Complete the sentences below.

1) Many useful materials are made by chemical R _ _ _ _ _ _ _ _

2) An ore contains a M _ _ _ _ joined to other elements.

3) If a metal is less reactive than C _ _ _ _ _ it can be extracted using coke in a furnace.

4) Crude oil is a M _ _ _ _ _ _ of useful substances.

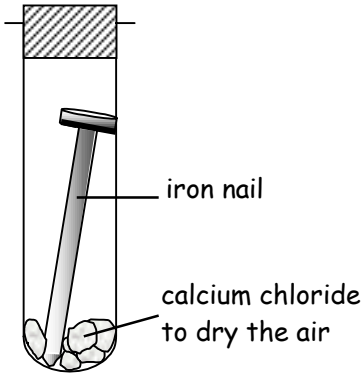
5) N _ _ _ _ is a synthetic fibre.

W.S.55. Harmful chemical reactions. Name ……

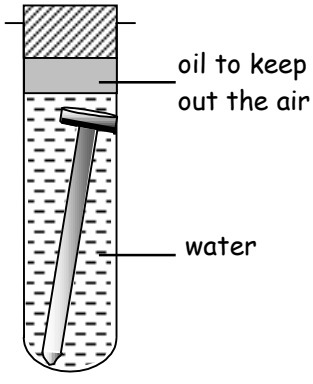
Some chemical reactions are harmful because they destroy our products.

Corrosion of metals.

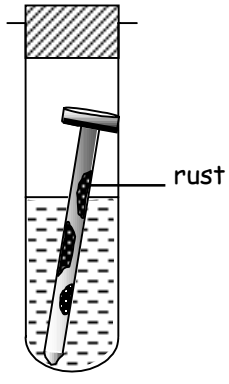
Metals may be attacked by air, water or other substances around them. Usually the more reactive the metal is, the faster it corrodes. The corrosion of iron and steel is called RUSTING. The experiment below shows that both air and water are needed for rusting to happen.



In dry air the iron nail does not rust.



In water without air the iron nail does not rust.



In air and water the iron nail rusts.

To stop rusting metals can be coated with a substance that keeps out air and water. Paint, grease, plastic, or a thin layer of tin or zinc can be used.

Oxidation of foods.

Some foods react with oxygen gas in the air. This makes them taste unpleasant. Fat can be oxidised quickly, therefore fatty foods such as butter should be kept in a fridge to slow down the rate of oxidation. Another way of stopping oxidation is to keep air away from the food by using sealed packets or tins.

Exercise – Fill in the missing words in the passage below.

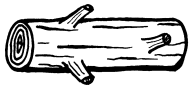
The corrosion of iron and steel is called …… Iron will only rust if it is exposed to both air and …… We can stop rusting by …… the metal with a substance that keeps out …… and water. This is why motor cars are given several layers of ……
Some foods are …… when exposed to air. This gives them an unpleasant …… Keeping foods …… will slow down the rate of oxidation. Another way of stopping …… is to make sure that the food does not come into contact with air.

air rusting taste cool water oxidation coating oxidised paint

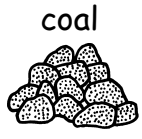
W.S.56. Energy from chemical reactions. Name ……

Heat may be taken in or given out during a reaction. Sound, light, movement or electrical energy may also be produced. When fuels are burnt they give out heat and light energy. Explosive fuels give out movement and sound energy as well. The chemical reaction that takes place inside a torch battery gives out electrical energy.

Energy from fuels.



Wood can be burnt as a fuel.



Fossil fuels form over millions of years.

Burning of fuels makes carbon dioxide, water and heat energy :

FUEL + OXYGEN ⇨ CARBON DIOXIDE + WATER + ENERGY

The heat energy can be used to keep our houses warm and to cook food. It can also be changed into movement energy to drive engines.

Effects on the environment.

Burning fuels release carbon dioxide into the air. This stops heat escaping from the surface of the Earth back into space. This is called the GREENHOUSE EFFECT and it may lead to GLOBAL WARMING.

Oil and coal release sulphur dioxide gas when they burn. This gas goes into the air and dissolves in rain droplets to form ACID RAIN. In some parts of Europe acid rain has destroyed plant and animal life in lakes and forests. Acid rain also causes corrosion of buildings and statues.

Exercise – Complete the sentences below.

1) Different types of E _ _ _ _ _ can be produced by chemical reactions.

2) When fuels are burnt they give out heat and L _ _ _ _ energy.

3) The reaction inside a battery produces E _ _ _ _ _ _ _ _ _ energy.

4) Extra carbon dioxide gas in the air may lead to G _ _ _ _ _ warming.

5) Burning of oil and C _ _ _ releases sulphur dioxide gas.

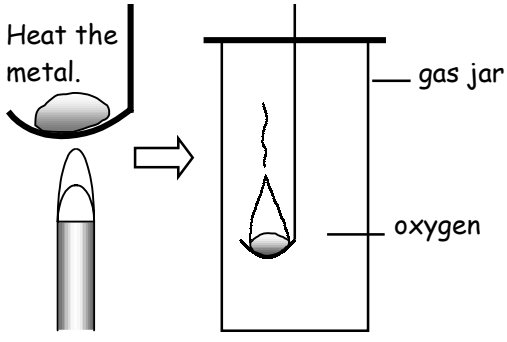
6) Sulphur dioxide gas forms A _ _ _ rain

W.S.57. Reactivity of metals.

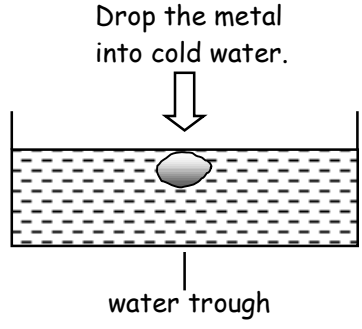
Name ……

We can arrange the metals in order of most to least reactive. The three tests below are used to judge how reactive different metals are :

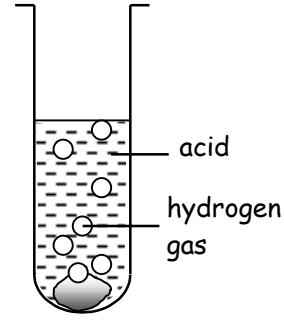
Reaction with oxygen.



Reaction with water.



Reaction with acid.



most reactive

Metal	Reaction with oxygen	Reaction with water	Reaction with acid
Potassium	Burns strongly with a lilac flame.	Very fierce and ignites (catches fire).	Too dangerous to perform.
Sodium	Burns strongly with a yellow flame.	Fierce but it does not ignite.	Too dangerous to perform.
Magnesium	Burns with a blinding white flame.	Very slow reaction but it reacts with steam.	Very fast reaction that produces hydrogen gas.
Zinc	Burns slowly with a dull red flame.	Reacts slowly with steam.	Quite a slow reaction. Some hydrogen produced.
Iron	Does not burn but it glows brightly.	Very slow reaction with steam.	Very slow reaction.
Lead	Melts but does not burn.	No reaction.	Extremely slow.
Copper	Does not burn but it forms a black coating.	No reaction.	No reaction.
Gold	No reaction.	No reaction.	No reaction.

least reactive

Exercise – Complete the sentences below.

1) _ _ _ _ _ _ _ _ _ _ is the most reactive metal.

2) _ _ _ _ is the least reactive metal.

3) Potassium and sodium are too reactive to add to _ _ _ _

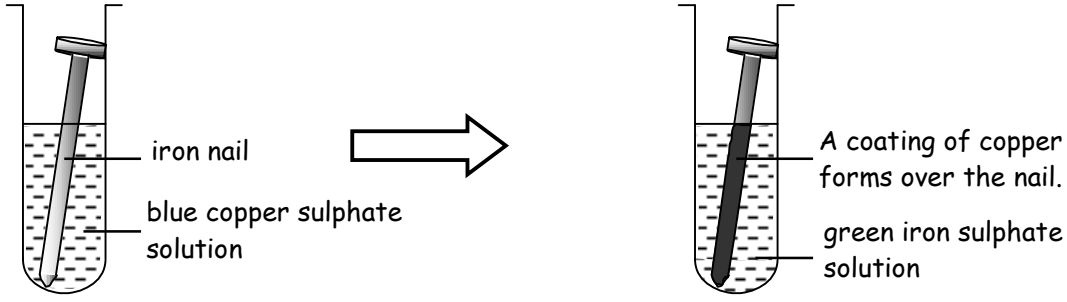
4) You should not look at _ _ _ _ _ _ _ _ _ _ when it burns in oxygen.

5) _ _ _ _ does not corrode because it is an unreactive metal.

6) Metals react faster with _ _ _ _ _ than they do with water.

W.S.58. Displacement reactions. Name ……

If two metals are put together the more reactive metal will 'win' any competition to form a compound. The experiment below shows a reaction between an iron nail and copper sulphate solution.

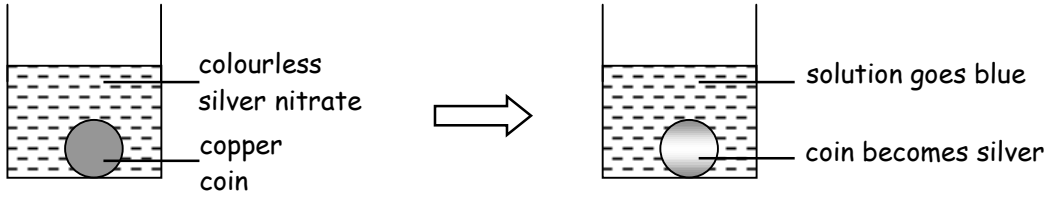


Iron and copper compete to be the compound in the solution. Iron is more reactive and so it DISPLACES (pushes out) the copper in the solution.

IRON + COPPER SULPHATE (blue solution) ⟹ IRON SULPHATE (green solution) + COPPER

A metal will always displace a less reactive metal from solutions of its compounds.

Exercise 1 – Study the experiment below and then try to complete the missing words.



COPPER + SILVER NITRATE (colourless) ⟹ COPPER _ _ _ _ _ _ _ (blue) + SILVER

Copper is _ _ _ _ reactive than silver so it displaces silver in the solution.

Displacement reactions with metal oxides.

Two metals can also compete for oxygen. For example, if magnesium powder is heated with copper oxide there is an explosive reaction :

MAGNESIUM + COPPER OXIDE ⟹ MAGNESIUM OXIDE + COPPER

Exercise 2 –Complete the missing words in the sentences below.

Magnesium 'wins' the competition for _ _ _ _ _ _ because it is higher in the reactivity series than _ _ _ _ _ _ When a metal is heated with the oxide of a _ _ _ _ reactive metal it will remove the oxygen from it.

W.S.59. Acids and alkalis.

Name ……

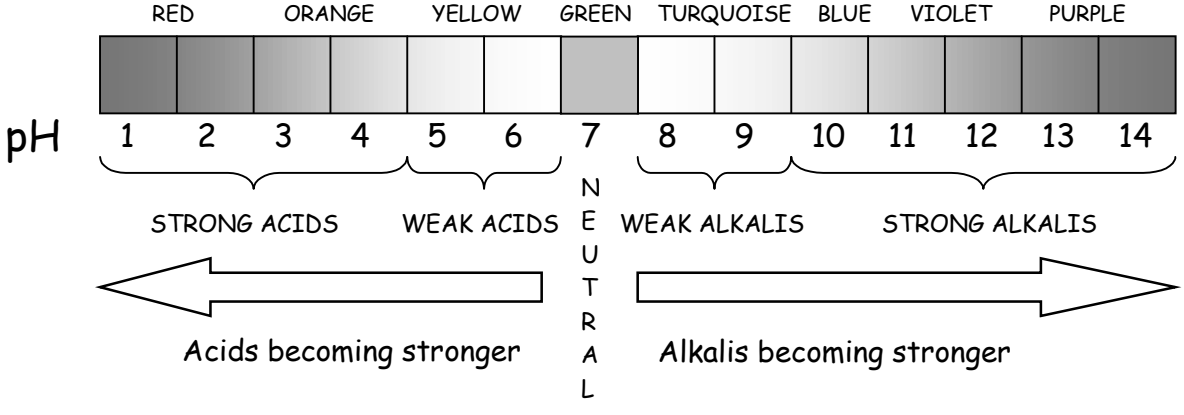
Acids are CORROSIVE (eat into materials). They react with some metals to form hydrogen gas and a salt. Acids have a sour taste, and many are poisonous. A purple dye called LITMUS changes to a **red** colour in acids.

Alkalis are the chemical opposites of acids, but some of them are also very corrosive. They dissolve in water and often have a soapy feel. Alkalis turn litmus **blue** and they can be used to NEUTRALISE (cancel out) acids. A NEUTRAL solution is neither acid or alkali.

Acids		**Alkalis**	
STRONG	WEAK	STRONG	WEAK
These are the poisonous mineral acids: - hydrochloric acid - sulphuric acid	ethanoic acid in vinegar citric acid in fruit juices carbonic acid in soda water	sodium hydroxide oven cleaner washing powder	soap sodium bicarbonate (baking powder)

Universal Indicator and the pH scale.

Universal indicator changes to different colours with acids and alkalis. The colour change tells us the pH number of the substance being tested which tells us how strong the acid or alkali is.



Exercise – Complete the sentences below.

1) If a chemical is _ _ _ _ _ _ _ _ _ it will eat into materials.

2) Acids react with some _ _ _ _ _ _ to produce hydrogen gas.

3) Litmus turns _ _ _ in acid and _ _ _ _ in alkali.

4) The pH is a measure of how _ _ _ _ _ _ the acid or alkali is.

5) A chemical with a pH number of six is a _ _ _ _ acid.

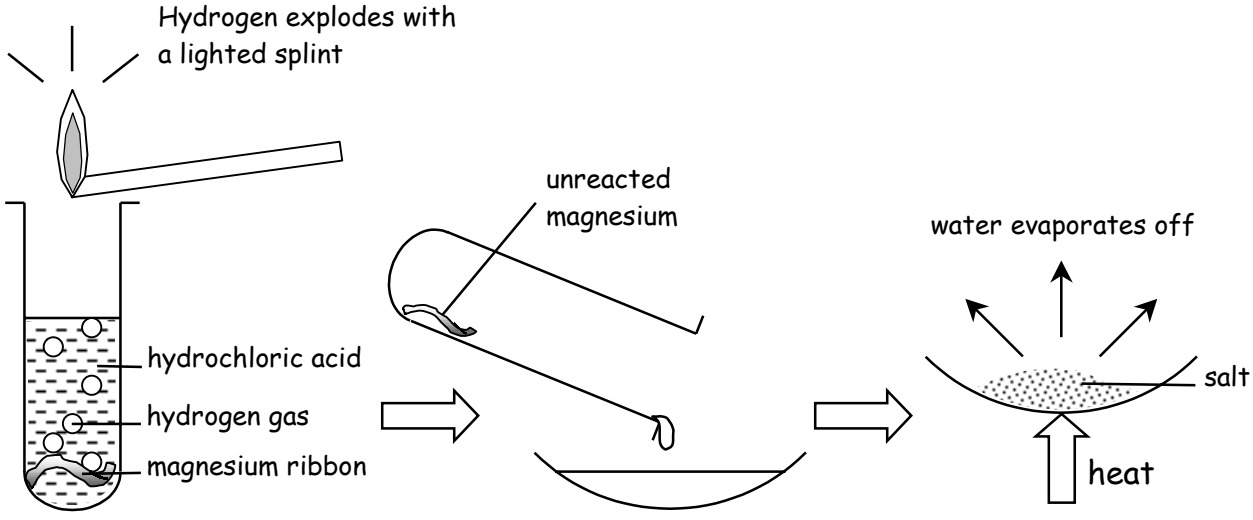
W.S.60. Acids and metals.

Name ……

Metals that are more reactive than copper will react with acids to form hydrogen gas and a salt.

ACID + METAL ⇨ HYDROGEN + SALT

The more reactive the metal is, the faster the reaction will be. The experiment below shows the reaction between hydrochloric acid and magnesium.



1) The magnesium reacts with the acid.

2) A solution of magnesium chloride has formed.

3) **Magnesium chloride** salt is left behind.

Exercise – Complete the missing words in the sentences and equations below.

1) A metal must be more reactive than C _ _ _ _ _ to react with an acid.

2) ACID + METAL ⇨ HYDROGEN + _____

3) Reactive metals produce hydrogen F _ _ _ _ _ than unreactive metals.

4) The test for H _ _ _ _ _ _ _ is a lighted splint.

5) Hydrogen is an E _ _ _ _ _ _ _ _ _ gas.

6) hydrochloric acid + magnesium ⇨ _____ + magnesium chloride

7) All of the A _ _ _ has reacted when there are no more hydrogen bubbles given off.

8) The S _ _ _ that has been made is magnesium chloride.

W.S.61. Acids and bases.

Name ……

Bases can neutralise (cancel out) acids. Bases that dissolve in water are called alkalis. A base reacts with an acid to form a salt and water :

ACID + BASE ⟹ SALT + WATER

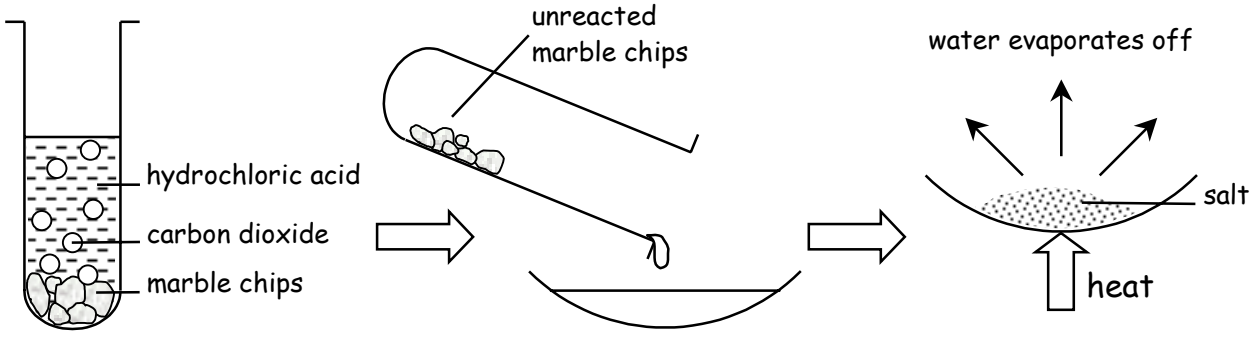
For example, if sodium hydroxide, which is a very strong alkali, is reacted with hydrochloric acid then sodium chloride (common salt) is formed.

Reaction with carbonates.

Carbonates are bases that contain the elements carbon and oxygen. They react with acids to form a salt, carbon dioxide gas and water. The reaction is fizzy due to the carbon dioxide gas given off :

ACID + CARBONATE ⟹ SALT + CARBON DIOXIDE + WATER

The experiment below shows the reaction between calcium carbonate (marble chips) and hydrochloric acid.



1) The marble chips react with the acid.

2) A solution of calcium chloride has formed.

3) **Calcium chloride** salt is left behind.

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

Exercise – Complete the missing words in the sentences and equations below.

1) A B _ _ _ is a chemical that can neutralise an acid.

2) Bases that dissolve in water are called A _ _ _ _ _ _

3) ACID + BASE ⟹ _____ + WATER

4) Sodium C _ _ _ _ _ _ _ is common salt.

5) Carbonates contain the elements carbon and O _ _ _ _ _

6) Carbonates react with acids to produce C _ _ _ _ _ D _ _ _ _ _ _

7) Marble chips will F _ _ _ in acid until it has all been neutralised.