1 Sorting out elements

Elements are _____ substances that contain only _____ sort of _____

There are over _____ elements are found in nature.

By chemically combining _____ or more elements we can make all the

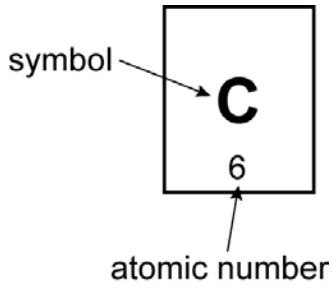
different _____ in the world.

1	2	92	atom	compounds	pure

Elements can be solids, liquids or gases.

When we sort elements we put them into a chart called the Periodic Table in the order of their atomic number.

Remember how to read the shorthand for the elements.



The elements become heavier as you go along the rows from the top left hand corner.

The full periodic table is made in the same way.

- Collect a copy from your teacher and use it to help you answer these questions.

  Where are the metals?

  Where are the gases?

  Where are the non-metals?

- Use the internet to find the names of the first 20 elements.
  Find out whether the element is a metal or non-metal.
  Find out whether each element is a solid a liquid or a gas at room temperature.
  Fill in the chart about them.
  A few lines have been left for your own choice of elements.

	name	metal	solid	liquid	gas
H					
He					
Li					
Be					
B					
C					
N					
O					
F					
Ne					
Na					
Mg					
Al					
Si					
P					
S					
Cl					
Ar					
K					
Ca					

Notes to teacher:

These are excellent interactive Periodic Tables that you can print from

http://www.rsc.org/periodic-table/?gclid=CJfclNGW3LYCFfQetAodonYAxw

http://www.chemicool.com/

http://www.chemicalelements.com/

this site is also worth a look

http://www.helium.com/zone/1751-periodic-table-of-elements

1A Making a periodic table

Cut out the 20 boxes showing the symbol and atomic numbers for the elements.

H 1	He 2	Li 3	Be 4	B 5	C 6	N 7	O 8
F 9	Ne 10	Na 11	Mg 12	Al 13	Si 14	P 15	S 16
Cl 17	Ar 18	K 19	Ca 20				

Paste the boxes that you cut out in the correct position in the grid below.

2 Metals

Use the instruction sheet to test the metals your teacher has given you.

Fill in the results table.

metal	hard or soft?	shiny	conducts electricity	conducts heat
aluminium				
brass				
copper				
iron				
lead				
magnesium				
nickel				
steel				

- Now test all your metals with a magnet.

  Are all metals magnetic? YES / NO

  Which metals are magnetic? _____

- Complete these sentences.

  Most metals are h_____ and s_____

  All metals conduct h_____ and e_____

Notes to teacher:

This lesson and 5.3 can be run in parallel if you choose, as the tests are the same.

You may also choose to have each group of students do all 4 tests on any one metal or get a group to do one test on all the metals.

It might also help to have a 'recorder' that fills all the results in on a class copy on the data projector.

For the purpose of this specification, we do not have to distinguish between metals and alloys.

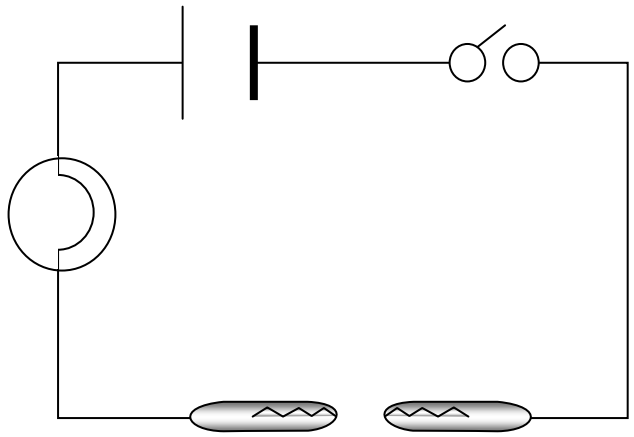
Practical points for this investigation:

- metal strips are preferred
- 100 ml beaker with hot water (preferably from the hot water tap), sandpaper are needed, as well as a basic electrical circuit.
- it is a good idea to wrap magnets in cling wrap before use

2A Investigating metals and non-metals

- These are the metals to use: iron, copper, magnesium, aluminium, steel, lead, nickel, brass
- Fill all your answers in the results chart as you do each test.
- Which ones are hard and which are soft?
- Which ones are shiny? (You may need to sandpaper the surface to get rid of dirt and grime.)
- Which ones conduct electricity?

  This is how you test for conduction of electricity.



a battery,

switch,

bulb

two crocodile clips

  Connect up an electric circuit as shown with a gap between the crocodile clips

  Grip each end of the metal with the clips.

  The bulb will light up if the metal conducts electricity.
- Which ones conduct heat?

  This is how you test for conduction of heat.

  Pour about 1 cm depth of hot water into a beaker.

  Place each metal in turn in the beaker so that the bottom is dipping into the hot water and the top is out of the water.

  Leave it for about a minute.

  Then gently feel the top of the metal, if it is hot the metal conducts heat.
- These are the non-metals to use: carbon, sulfur, nitrogen, oxygen

3 Non-Metals

Use the instruction sheet to test the non-metals your teacher has given you.

Fill in the results table.

non-metal	hard or soft?	shiny	conducts electricity	conducts heat
carbon				
TEACHER ONLY chlorine				
nitrogen				
oxygen				
sulfur				

- Now test all your non-metals with a magnet.

  Are they magnetic? YES / NO
- Complete these sentences.

  Most non-metals are g _____ at room temperature

  Most non-metal gases are _____ but chlorine is _____

  and bromine is _____

  Most non-metal do not _____ heat or electricity
- Fill in the revision sheet on metals and non-metals.

Notes to teacher:

This lesson and #2 can be run in parallel if you choose as the tests are the same.

You may also choose to have each group of students do all4 tests on any one non-metal or get a group to do one test on all the non-metals.

It might also help to have a ‘recorder’ that fills all the results in on a class copy on the data projector.

Practical points for this investigation:

- use carbon electrodes and lumps of roll sulfur
- label a gas jar with lid ‘oxygen’ and a second one ‘nitrogen’ rather than use the actual gases
- do the gas jar of chlorine in a fume cupboard-TEACHER DEMO ONLY
- 100 ml beaker with hot water (preferably from the hot water tap), sandpaper are needed, as well as a basic electrical circuit.
- it is a good idea to wrap magnets in cling wrap before use

3A Revision on metals and non-metals

- Use the words in the box to complete the following sentences.

  You can use words more than once.

metallic	non-metallic	solids

Most metals are _____ .

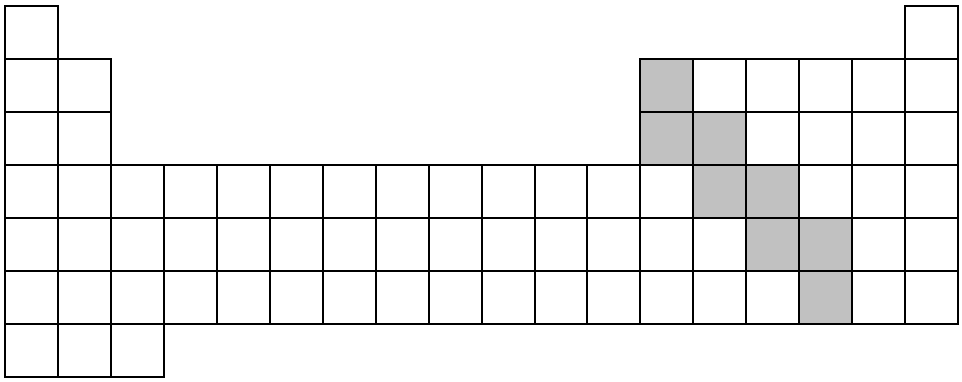
Many of the _____ elements are hard with shiny surfaces.

Many gases are _____ elements.

There are more _____ elements than there are

_____ elements.

- Here is diagram of the periodic table:



1. Colour the area for metals.
2. Label the area ‘metals’.
3. Use a different colour, and colour the area for non-metals.
4. Label the area ‘non-metals’.

- Answer these questions

1. Describe a simple test for a metal or non-metal.

_____

_____

2. Sulfur is a poor conductor of electricity.
   What type of element do you think sulfur is?

_____

3. Copper is a metallic element.
   Name the smallest particle present in a piece of copper wire.

_____

4. Is copper a good conductor of heat?

_____

5. Write down the names of two precious metals.

_____

6. Write down the name of two metals used in buildings.

_____

- Decide whether the following statements are true or false.
  Put a tick in the correct column.

statement	true	false
most metallic elements are gases		
most non-metals do conduct electricity		
most metallic elements are shiny		
most metallic elements are not hard		
metallic elements conduct electricity		
most non-metals do not conduct heat		
metallic elements do not conduct heat		
many non-metals are gases		

4 Uses of metals

Metals have different uses because they all have different properties.

All metals are good conductors of heat, but some are better than others.

- Fill in this table for the conduction of heat in metals experiment.

metal	time at which the wax first started to melt	time at which all the wax had melted	Best conductor = 1 Worst conductor = 5

- Use your results to help you choose which of these metals is ***best*** to make cooking pans from.

  The best metal to use is _____ because _____

  _____

  Some metals are stronger than others.

  Some metals always stay shiny and never rust or oxidise.

  Some metals are very expensive.

- Fill in the 'stays shiny' column. (hint……three of them can be used for cooking pots)

metal	strength	stays shiny	cost for scrap metal
gold	100		£940 / 30g
copper	210		£4.00 / kg
steel (iron)	350		£0.80 / kg
aluminium	40-50		£1.30 / kg

- Answer these questions about metal uses.

  Which metal is used to make concrete stronger (reinforce concrete)?

  _____

  because _____

  Which metals are used in jewellery?

  _____

  because _____

  Which metals are used for water tanks?

  _____

  because _____

  Which metals are used to make electrical wires?

  _____

  because _____

- Use the internet to find out which metal was used to cover the Statue of Liberty. This metal has now gone green.

  metal is _____

- Use the internet to find out which metal was used to make the Angel of the North.

  metal is _____

Notes to teacher:

You may have a class set of a suitable conduction apparatus

(http://www.philipharris.co.uk/Searchresults.aspx?style=0&kw=conduction) which you can use; otherwise watch this clip

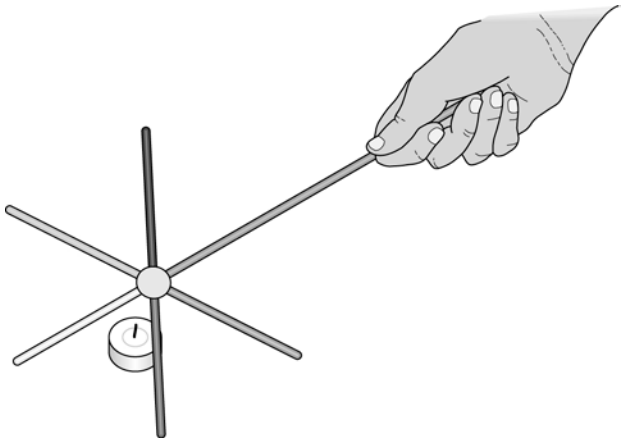
http://www.youtube.com/watch?v=RHQ17S72ON4

The instructions are for the '5-star' experiment-with the ends dipped in wax (pre-done by technician is helpful) but without drawing pins/ball bearings/match heads as these can be problematic.

4A Investigating the conduction of heat in metals

Collect this apparatus; a 'conductivity star': it should have 5 of the arms coated in wax, and one longer arm without any wax. The longer arm is non-heat conducting.

You also need a small candle.



As you do the experiment, write your answers on the worksheet.

- What are the 5 metals?

Clamp the un-waxed end in a retort stand, so that

- it is about 2 cm above the candle and
- the middle is directly above the candle.

Light the candle and start the stopwatch.

Write down the times at which the wax starts to melt on each metal.

Write down the times at which the wax has completely melted from each metal.

Work out which metal conducts heat the best.

Write this down in the table with 1 for the best conductor, 2 for the next best……and so on until you get to 5 for the worst conductor.

5 Getting metals from the Earth

Very few metals are found as elements. Most metals are obtained from their compounds by chemical reactions. These compounds, which are mainly metal oxides, are found in rocks called **ores**.

- Use the internet to help you fill in the table about some different metals that are obtained from the Earth.

When metals are found as pure elements, they are easy to extract.

When metals are found as ores, we have to extract the metals using chemical reactions. It is always harder to extract metals from their ores than to re-cycle the pure metals.

Sometimes this is quite simple to do eg to extract iron, we have to heat iron ore with carbon and oxygen.

Your teacher will show you how to extract iron using a match.

On a large scale we use a blast furnace to extract iron.

Some metals like aluminium very hard and expensive to extract from their ore.

- Watch this clip which shows how to extract copper.

http://www.youtube.com/watch?v=V1kP674X3dI

Finding out which metal is which

When a miner finds a new rock, he has to test the rock to find out which metal is present.

He can do this with a flame test.

The colour of the flame tells him which metal he has.

- Use the instruction sheet to test the colours of the flames.
- Fill in your results in this table.

metal compound	colour of flame
lithium chloride	
sodium chloride	
potassium chloride	
calcium chloride	
strontium chloride	
copper chloride	

Notes to teacher:

This is a standard RSC experiment, if you have time it is possible to do this as a class experiment- it is referred to as a demo above.

Worksheet CFNS 41 from RSC : http://www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/800/cfns%20experiment%2041%20-%20extraction%20of%20iron%20on%20a%20match%20head!.pdf?v=1366655333128

Flame tests video:

http://www.youtube.com/watch?v=o3nn4zqzf6M nicely done

http://www.youtube.com/watch?v=PVj8aQwuUMo good colours but not many done

The RSC worksheet has been re-written to remove unnecessary (for students) detail, but you can get all the technical details from: http://www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/839/CFNS%20Experiment%2080%20-%20Flame%20colours%20-%20a%20demonstration.pdf?v=1366655549532

Results:

sodium = yellow-orange (typical ‘street lamp’ yellow)

potassium = purple-pink, traditionally referred to as ‘lilac’ (often contaminated with small amounts of sodium)

lithium = crimson red

copper = green/blue

calcium = orange-red (probably the least spectacular)

strontium = crimson

5A Getting metals from the Earth

Metal name	Is it found as a pure element?	Is it found as an ore?	What is the name of the common ore?	Where in the world is it mined?	Can it be found in the UK?	Is it common or rare?
gold		no		South Africa	yes	
silver		yes	argentite	Mexico	yes	
platinum	yes	no		Colombia / Zimbabwe	no	rare
iron				China	yes	
copper				Zambia/U S	yes	
aluminium	no	yes		Canada/Russia	yes	
tin				China / South America	yes	

5B Investigating the flame colours from metal compounds

What you need:

Small amounts of these solutions in boiling tubes ● lithium chloride (harmful) ● sodium chloride ● potassium chloride ● calcium chloride ● strontium chloride ● copper chloride (harmful)	● eye protection ● Bunsen burner ● heat resistant mat(s) ● boiling tube racks ● boiling tubes of solutions, labelled ● wooden splints soaked in distilled water ● distilled water ● beaker half filled with water

Safety notes:

- Wear eye protection
- Wash hands after this experiment

What you do:

1. Light the Bunsen burner on a small blue flame.
2. Dip the wet end of a wooden splint into the first solution.
3. Hold the wet end into the Bunsen flame.
4. Write down the colour you see.
5. Put the used splint into the beaker of water.
6. Repeat steps 1-5 for each solution using a new splint each time.

Hints: It is important not to let the splint burn too vigorously, so keep the burner flame small.

For added safety, you can use tongs to hold the wooden splints.

6 Metals and acids

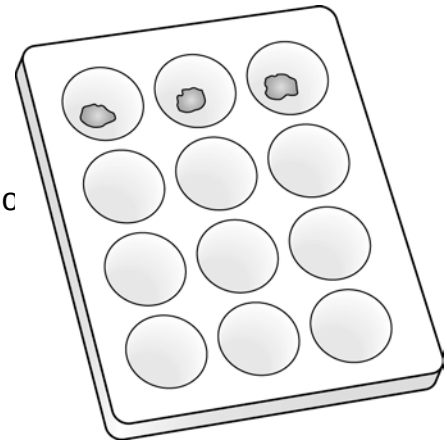
You will need:

● dilute hydrochloric acid, 0.4 mol dm^{-3} ● dilute nitric acid, 0.4 mol dm^{-3} ● dilute sulfuric acid, 0.2 mol dm^{-3} ● copper turnings ● magnesium ribbon ● zinc metal – small granules ● iron filings ● tin granules	● two spotting tiles ● magnifying glass ● labelled test tubes of the acids ● three plastic pipettes, one for each acid

Safety notes:

- Wear eye protection
- Wash hands afterwards

What you do:



1. Put a few copper bits into the top three spaces on the spotting tile.
2. Use a clean pipette for each acid.
3. Put a few drops of dilute hydrochloric acid on the first bit c copper.
4. Watch what happens and draw your observations in the table.
5. Put a few drops of dilute sulfuric acid on the middle bit of copper.
6. Watch what happens and draw your observations in the table.
7. Put a few drops of dilute nitric acid on the last bit of copper.
8. Watch what happens and draw your observations in the table.
9. Now use the second row and repeat the steps 1 to 8 for magnesium
10. Repeat the steps for zinc, iron and tin.

Use your results to answer the questions.

Did all the metals react in the same? _____

Which metal was the fastest to react with hydrochloric acid?

_____

Which metal was the fastest to react with sulfuric acid?

_____

Which metal was the fastest to react with nitric acid?

_____

Which metals did not react with any of the acids?

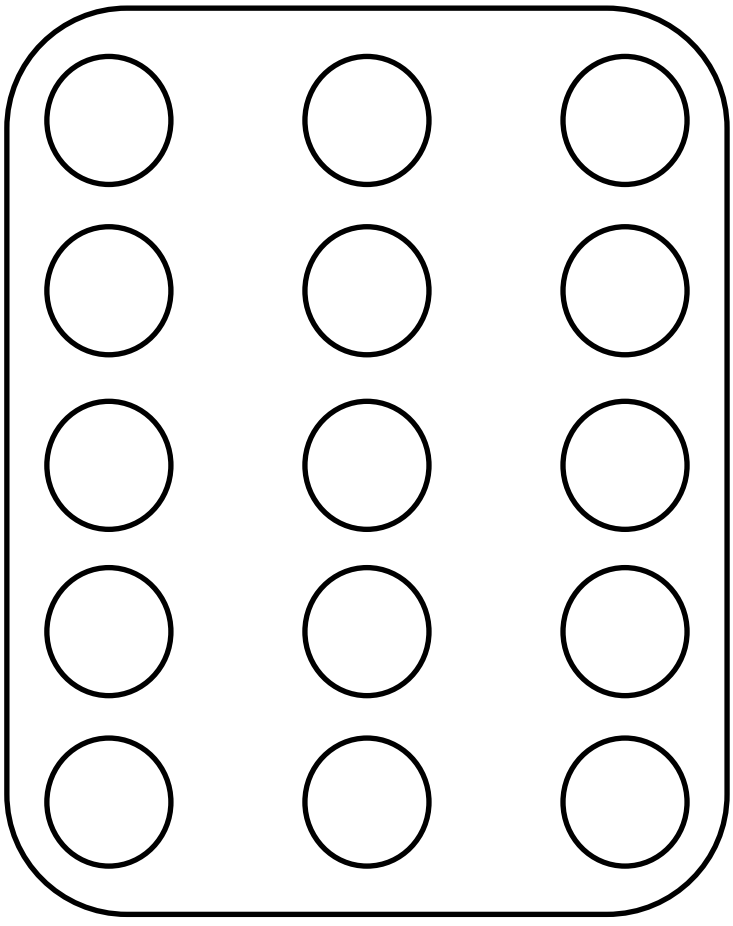
_____

Try to sort out an order for the metals from the fastest to the slowest.

1	
2	
3	
4	
5	

This is called the **reactivity series**.

Results table…don't forget to label



Notes to teacher:

standard class experiment, but done with spotting tile rather than test-tubes

You may wish to demonstrate the reaction of copper and conc nitric acid in a fume cupboard. (see HAZCARD 67 for further information)

You can also relate the results to everyday life: copper roof tiles, rusty nails, tarnished silver, but sparklingly clean gold.

7 Naming salts

In chemistry, a **salt** is the name given to a compound which has a metal part bonded to an acid part.

E.g. sodium sulfate is made from sodium metal and sulfuric acid

- Name the metal part and the acid part in these salts.

salt	metal part	acid part
sodium chloride		
potassium chloride		
lead nitrate		
copper sulfate		
calcium nitrate		

Making Salts

In order to make a salt we have to attach a metal part to an acid part.

This is easy for metals at the top of the reactivity series, because the metal will react with the acid.

However, metals at the bottom of the reactivity series do not react with acids. For these metals, we have to react a metal compound with the acid.

The common compounds used are oxides and carbonates.

- Use the instruction sheet to make copper sulfate from copper oxide or copper carbonate.
- Which acid is used to make copper sulfate? _____
- What colour is copper oxide? _____
- What colour is copper carbonate? _____
- What colour is copper sulfate? _____
- Why did you warm the acid? _____

  _____
- How did you know when the reaction had finished? _____

  _____

- The copper oxide is not soluble.

  How did you remove it after the reaction had finished?

  _____

  _____

- How can you obtain crystals of copper sulfate from the solution?

  _____

  _____

- Watch the video clip.

  http://www.bbc.co.uk/learningzone/clips/universal-indicator-acid-alkali-or-neutral/121.html

- Test the acid and the copper sulfate with universal indicator paper.

  Write down their pH values.

  Sulfuric acid has a pH of _____ and it is an _____

  Copper sulphate has a pH of _____ and it is n_____

- Why can't we test the pH of copper oxide? _____

  _____

The reaction of an oxide and an acid is called a **neutralisation reaction** because the acid has become neutral.

Any neutralisation reaction can be written as

metal oxide + acid → salt + water

7A How to make copper sulfate

What you need:

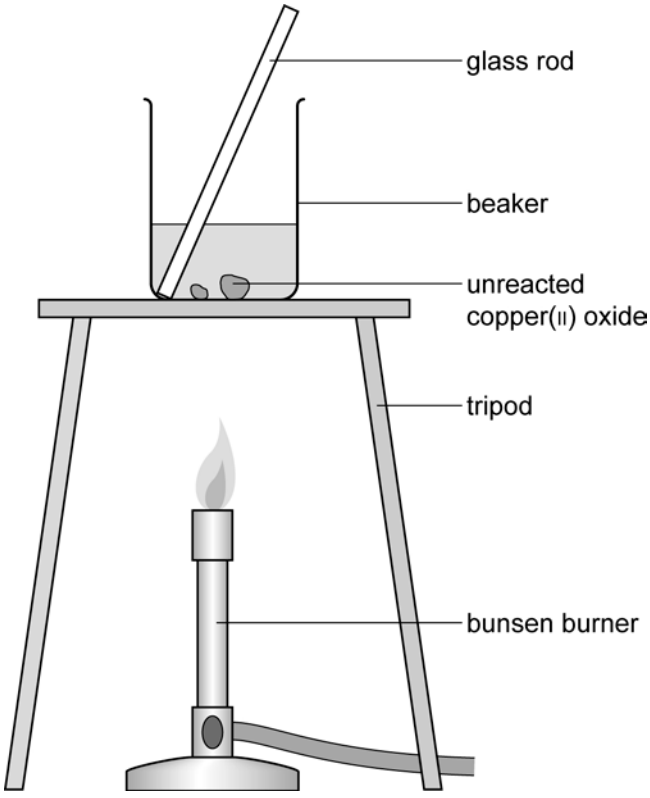
● copper(II) oxide powder (harmful) ● sulfuric acid, 0.2 mol dm^{-3} (irritant)	● 100 ml beaker ● small conical flask ● spatula ● stirring rod ● heating apparatus ● evaporating dish ● filter funnel and paper

Safety notes:

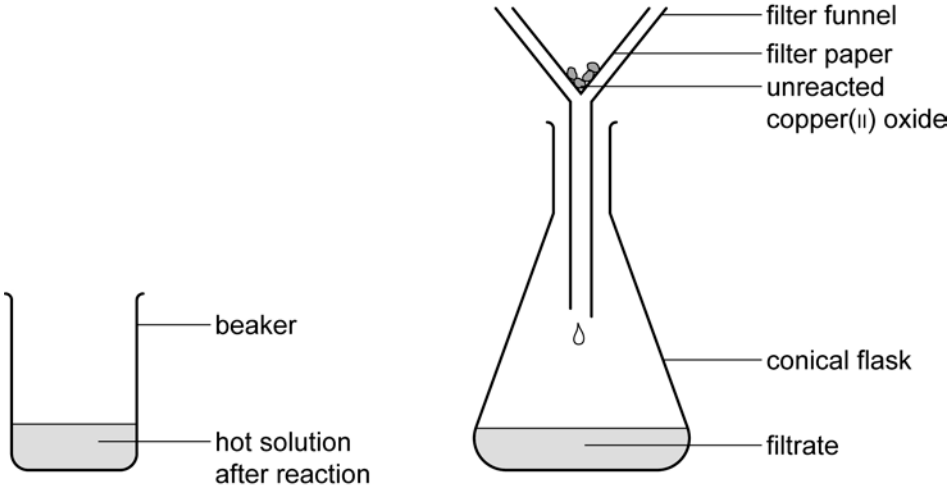
- Wear eye protection
- Wash hands after you have finished the experiment

What you do 1.

1. Set up you equipment as shown and heat the acid gently with a blue flame
2. When the acid is hot, add a spatula full of copper oxide.
3. Stir and continue to heat gently.
4. If you can't see any copper oxide in the beaker, add another spatula full of copper oxide.
5. Repeat the steps 1 to 4 until some copper oxide remains at the bottom and it won't react.
6. It is important not to boil the mixture dry.
7. Turn off the Bunsen burner and let the beaker cool on top of the tripod stand.



What you do 2.



1. Put the filter funnel in the neck of the conical flask.
2. Fold the filter paper to fit the funnel, and put it in the funnel.
3. When the beaker is cool enough to hold at the top, stir the beaker so that the contents mix.
4. Pour the mixture into the filter paper a little bit at a time until all of it has gone into the filter paper.
5. You should get a clear blue liquid in the flask and black solid left of the filter paper.
6. If you have any black solid in the conical flask, you have to filter again.

What you do 3.

1. Pour the warm, blue liquid into the evaporating dish.
2. Put a label on it with your name.
3. Leave it for about a week in a warm safe place. This allows the water to evaporate.
4. You should get some crystals on the bottom on the evaporating dish.
5. Carefully pick these up and put on a paper towel.

Notes for the teacher:

This is adapted from the http://www.nuffieldfoundation.org/practical-chemistry/reacting-copperii-oxide-sulfuric-acid

Their notes are included here:

Practical points**:**

The safety warnings in Stage 1 of the procedure are particularly relevant to younger or more inexperienced students.

For lifting the hot beaker, the provision of beaker tongs of suitable size is a good solution. But many schools will not have these. *Do not* be tempted to use ordinary tongs. If there is any doubt about the safety of this step, the teacher should lift each beaker down onto the heat-resistant mat.

Chemistry notes:

Most metal oxides react with dilute acids. Soluble metal oxides and hydroxides are called alkalis, and react with acids in solution. Most metal oxides are insoluble solids. The reaction between an insoluble metal oxide and a dilute acid is often quite slow so it is possible to observe the progress of the reaction as the solid reactant disappears as a soluble product is formed.

In 1, students should be able to observe the colour change from colourless to blue, at the same time as the black powder disappears. The blue colour intensifies as more black powder is used.

In 2 and 3, students may be able to use their previous experience of blue solutions/crystals to recognise the familiar colour of copper sulfate.

This can then be used as the starting point for teaching about
acid + metal oxide → salt + water reactions.

Note that there is no easy way of demonstrating that water is the other product.

8 Uses of chemical salts - neutralisation

Fireworks Metal salts are used in fireworks to make different colours.

- Use your results from #5 to complete the chart

Salt name	Colour of firework
calcium chloride	
copper chloride	
_____ carbonate	red
potassium chloride	
sodium nitrate	
strontium carbonate	

Fertilisers

Fertilisers are chemicals that farmers put on fields to help their crops grow strongly.

All plants need some special _____ known as minerals.

The _____ needed are nitrogen, potassium, phosphorous and magnesium.

The fertilisers contain _____ salts of the minerals that plants need.

They are soluble so that the plants can absorb then through their _____

chemicals	elements	minerals	roots	soluble

People….watch this video: http://www.bbc.co.uk/learningzone/clips/neutralising-stomach-acid/126.html

Our bodies have many _____ in them, each with its own job to help us live.

One of these chemicals is _____ acid

It is found in our _____

Its jobs are 1. to help us _____ our food and

2. to kill _____ in our food.

Sometimes we have too much _____ in our stomach.

This makes us feel _____

We can take indigestion tablets to _____ the acid.

acid	**bacteria**	**chemicals**	**digest**	**hydrochloric**
	neutralise	**stomach**	**uncomfortable**	

- Use the instruction sheet to investigate how much acid one indigestion tablet will neutralise.
- Answer these questions about the investigation.
  - What colour is the indicator when it is in the indigestion tablet and water?

    (step 3) _____
  - Is the mixture of the indigestion table and water an acid or an alkali?

    _____
  - What happens to the colour as you add a little acid? _____

    _____
  - Does it stay this colour? _____
  - What is the pH when the indicator is green? _____
  - How much acid did you use? _____ ml
  - The amount of acid that is neutralised by one indigestion tablet

    = _____ ml

Notes for teacher:

The stomach acid experiment is done to show that neutralisation occurs. It is not necessary to be as accurate as you would be if you were making a salt by neutralisation.

Colour chart for fireworks is here for convenience

Colour	Which salt is used
red	lithium carbonate strontium carbonate
orange	calcium chloride
yellow	sodium nitrate
green	barium chloride
blue	copper chloride

8A Neutralising stomach acid

What you need:

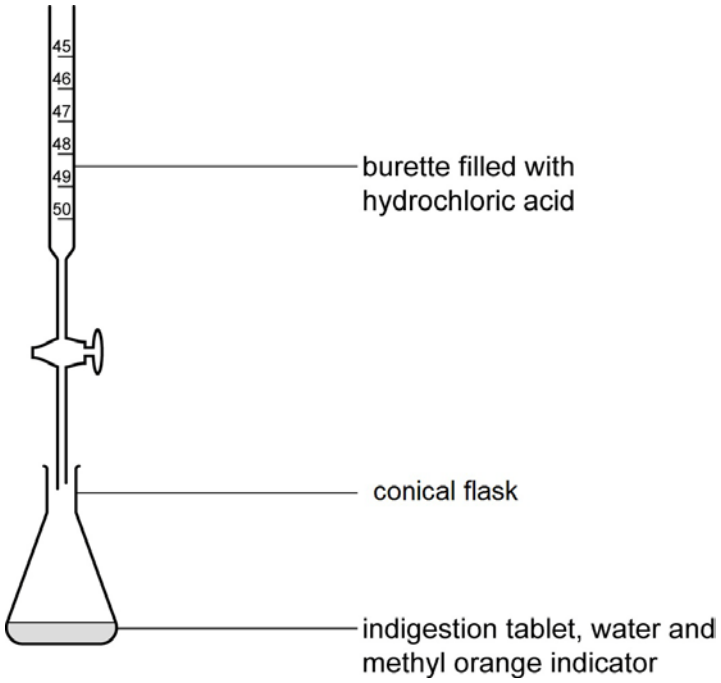
● dilute hydrochloric acid, 0.4 mol dm^{-3} ● one indigestion tablet ● Universal Indicator solution ● deionised or distilled water	● burette ● 100 ml or 250 ml conical flask ● beaker ● 25 ml measuring cylinder ● pestle and mortar ● stirring rod ● spatula ● small plastic filter funnel ● burette stand and clamp

Safety notes:

- Wear eye protection
- Wash your hands after the experiment

What you do

1. Crush an indigestion tablet using a pestle and mortar and carefully transfer it to a conical flask
2. Use the measuring cylinder to put about 25 ml of deionised water into the flask.
3. Add a few drops of indicator.
4. Write down the colour of the indicator.
5. Your teacher will show you how to set up the burette filled with acid. Follow those instructions carefully.
6. Use the burette to add a little acid to the flask.
7. Stir the flask and write down the colour of the indicator.



8. Repeat the steps 6 & 7 until the indicator colour has just turned yellow from green.
9. Write down how much acid you used all together.
10. The acid has now neutralised the indigestion tablet.

9 Electricity and hydrochloric acid

Some liquids conduct electricity.

- Use the equipment from #2A and connect two carbon rods (called electrodes) onto the crocodile clips.
- Test each of these liquids by dipping both rods into the liquid. (be careful that the rods don't touch each other)
- Write your results on the table.
- Look carefully at the liquids and write down anything you see or smell when you test the liquid.

liquid	**does it conduct electricity?**	**observations**
pure water		
tap water		
table salt solution		
dilute hydrochloric acid, 0.4 mol dm^{-3}		
sodium hydroxide solution, 0.4 mol dm^{-3} **(CARE!)**		
copper sulphate solution, 0.1 mol dm^{-3}		
vegetable oil		

When the liquids conduct electricity, you should notice bubbles of gas or a layer of shiny metal on one electrode or a smell of gas.

In these cases the electricity is splitting up the compounds in the liquid and releasing the original elements.

The chemical formula for hydrochloric acid is HCl, so it is made from 2 elements.
Fill in the table to name these elements.

HCl	H = _____
	Cl = _____

- Your teacher will show how the apparatus can be used to pass electricity through dilute hydrochloric acid and collect some test-tubes of gas.
- When there are full test tube of each of the gases, they will be testedfor the different gases.

***Test for hydrogen*:**

Put a lighted splint into the tube of gas. A squeaky 'pop' sound is the result for hydrogen.

***Test for chlorine*:**

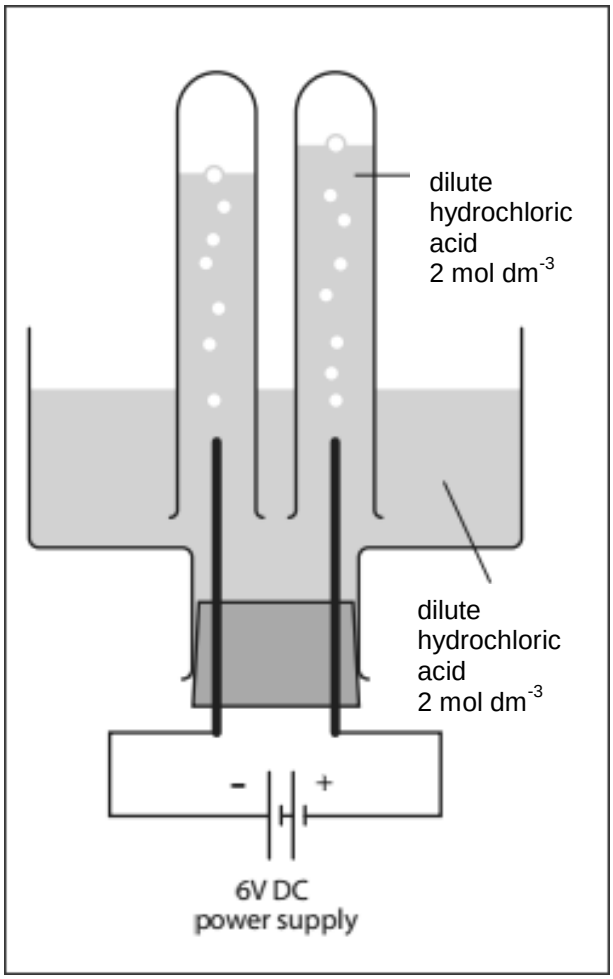
Put a piece of damp Universal Indicator paper into the tube of gas. The indicator paper turning red then white is the result for chlorine. The gas also has a smell of bleach.

***Test for oxygen*:**

Put a glowing splint into the tube of gas. The splint relighting is the result for oxygen.

***Test for carbon dioxide*:**

Pour a little limewater into the tube gas and shake the tube. The limewater turning cloudy is the result for carbon dioxide



Write down which gases you obtained when you passed electricity through the hydrochloric acid.

gas 1 = _____

gas 2 = _____

These gases are elements.

Are they metals or non-metals?

_____

10 Chlorine

- Fill in this fact card about Chlorine.

chemical symbol = _____

element or compound? = _____

solid, liquid or gas at room temperature = _____

colour = _____

smells like _____

atomic number = _____

- Explain why a bottle of chlorine has this symbol on the outside.

_____

_____

_____

- Explain why chlorine is used for purifying water used for drinking and water used in swimming pools.

_____

_____

_____

_____

Chlorine is often made into bleach which is used in houses.

- What is bleach used for in your house?

_____