1 What is a chemical reaction?

Substances on Earth are being continually changed due for example to extremes of hot and cold, to wind and weather, to acid rain and to solutions of different chemicals coming into contact with each other.

How can we tell that chemical reactions are taking place?

Notes: Copy the following information

Chemical reactions are continually taking place on Earth. Four ways of recognising a chemical reaction are:

(a) a change of colour taking place
(b) heat is given out or taken in
(c) a gas is given off
(d) a solid forms when two solutions mix

Experiment: There are eight short experiments set out around the room.
Each one illustrates a kind of chemical reaction.

Try out each experiment and decide what evidence there is that a chemical reaction has taken place.

You can do these experiments in any order but before starting you should copy the table on the next page into your jotter.

Notes: Copy the table.

Experiment	Evidence of Chemical Reaction
1. Heating copper carbonate	
2. Adding lime to water	
3. Adding acid to marble	
4. Mixing cobalt chloride and sodium carbonate solutions	
5. Mixing acid and alkali	
6. Adding ammonium nitrate to water	
7. Adding ammonia to copper sulphate solution	
8. Adding starch to iodine solution	

2. More Chemical Reactions

A change which makes a new substance is called a chemical change. We say that a chemical reaction has taken place.

Five short experiments are described on the next page.

Experiment: In each case you should mix the two substances and observe what (if anything) happens. You should then try to decide whether a chemical reaction has taken place or not.

Notes: Before you start you should think about how you are going to write down your results.

Experiment: You may carry out the experiments in any order.

Only collect the apparatus you think you will need for one experiment at a time..

Do not use larger quantities than suggested below.
NO Bunsen Burners required.

Carry out the experiments.

1. $3cm^3$ dilute sulphuric acid + $\frac{1}{2}$ spatulaful of bicarbonate of soda

2. $3cm^3$ water + $\frac{1}{2}$ spatulaful of copper oxide

3. $3cm^3$ lead nitrate solution + $3cm^3$ potassium iodide solution

4. $3cm^3$ dilute sulphuric acid + $\frac{1}{2}$ spatulaful of copper carbonate

5. $3cm^3$ copper sulphate solution + 1 spatulaful of iron filings

3. Energy In or Out?

Energy is taken in or given out when a chemical change takes place.

Sometimes we can observe this:

- the temperature may change
- we may see light or sound.

Experiment 1

Collect: small beaker, thermometer, spatula, citric acid powder, sodium bicarbonate powder

Experiment:

1. Put 50 cm^3 of cold water in the beaker. Add one spatulaful of citric acid and stir to dissolve.
2. Read the temperature of the solution and write it down in your jotter.
3. Add one spatulaful of sodium bicarbonate to the beaker. Stir and note the temperature.
4. Add another 4 spatulafuls of sodium carbonate **one at a time,** measuring the temperature after each addition.

Notes: Write a few sentences to explain what you did and what happened to the temperature.

Experiment 2

Collect: small beaker dilute sulphuric acid
thermometer sodium hydroxide solution
measuring cylinder

CAUTION!! Sulphuric acid and sodium hydroxide can burn your skin. Handle with care. Wipe up spills immediately.

Experiment:

1. Measure 20 cm^3 of dilute sulphuric acid into the beaker.
2. Read the temperature and write it down in your jotter.
3. Rinse out the measuring cylinder. Add 30 cm^3 of sodium hydroxide solution to the measuring cylinder.
4. Add 5cm^3 sodium hydroxide from the measuring cylinder to the acid. Stir and note the temperature.
5. Add a further 25 cm^3 of sodium hydroxide solution, **5 cm^3 at a time,** stirring and noting the temperature after each addition.

Notes: Write a few sentences to explain what you did and what happened to the temperature.

Notes: Copy the following information.

Most chemical reactions **give out** energy.
They are called **exothermic** reactions.

Some reactions **take in** energy from the surroundings.
These are called **endothermic** reactions.

Notes: Answer the following questions in your jotter.

1. What happened to the temperature in Experiment 1?

2. Was Experiment 1 **exothermic** or **endothermic**?

3. What happened to the temperature in Experiment 2?

4. Was Experiment 2 **exothermic** or **endothermic**?

Did you know? Our mouth feels cold when you eat sherbet. The reaction of sherbet with water is **endothermic**. The reaction takes in heat from your mouth, so it cools it down.

4 Chemical and Physical Changes

In the previous lessons we have been looking at chemical reactions. When a new substance is made, we say a chemical change has taken place.

It is not easy to reverse a **chemical change**.

We noticed that energy is given out or taken in when a new substance is formed but this is not always true. When there is little or no energy given out or taken in, it can be difficult to decide whether a chemical change has taken place or not.

Demonstration: Your teacher will show you two changes and help you to decide if a chemical change has occurred or not.

When a change occurs but no new substance is formed it is called a physical change.

Which demonstration was an example of a physical change?

A physical change can be reversed.

Experiment

Copy:

Experiment	After heating	After cooling	Physical or chemical change?
1. Burning splint			
2. Zinc oxide			
3. Magnesium			

Collect:

Bunsen burner
Test tube
Test tube holder
Metal tongs
magnesium ribbon
wooden splint
zinc oxide

Follow the instructions below and fill in your table as you complete each experiment.

Experiment 1. Set a splint alight in your Bunsen burner and allow to cool on the bench mat.

Experiment 2. Hold a piece of magnesium ribbon in a Bunsen flame using metal tongs, until it catches alight.

Experiment 3. Place one spatula of zinc oxide in a test tube. Hold in a test tube holder and heat strongly in a Bunsen flame.
Allow the test tube to cool in a test tube rack.

Activity: Without doing the experiments decide whether the following changes are chemical or physical.

Write: Put your answers in a table, headed chemical change and physical change. HINT: Try to decide whether you can get back to the starting material or not.

1. Boiling water
2. Melting butter
3. Frying an egg
4. Coal burning on a fire
5. Water evaporating in the oceans
6. Eating meat
7. A plant growing
8. Dissolving sugar in a cup of tea

Now think of 6 everyday changes and add these to the correct columns in your last table.

5. Acids and Alkalis

Have you heard of acids and alkalis?
What do you know about them already?

These substances are important to us in everyday life. They are used to make clothes, paints, soaps, fertilisers, medicines and many other things.

There are even acids and alkalis inside your body!
Your stomach wall makes acid. If too much acid is made it can be a problem. Later you will find out how to solve the problem.

Acids and **alkalis** are chemical opposites.

Indicators can be used to show which things are acids and which are alkalis.

Using different indicators.

Notes: Copy the table below

Name of Indicator	Colour in acid	Colour in alkali
Litmus Phenolphthalein Methyl orange Bromothymol blue Thymol blue Methyl red Xylene cyanol Congo red		

Collect: Dimple tray
Bottle of acid
Bottle of alkali
Bottle of indicator

Experiment:
1 Put 3 drops of acid into 10 dimples in the tray.

2 Add one drop of indicator to one of the dimples.

3 Record any colour change in the results table.

4 Repeat for each of the indicators.

5 Wash the dimple tile and dry it with a paper towel.

6 Repeat steps 1 – 5 for the alkali.

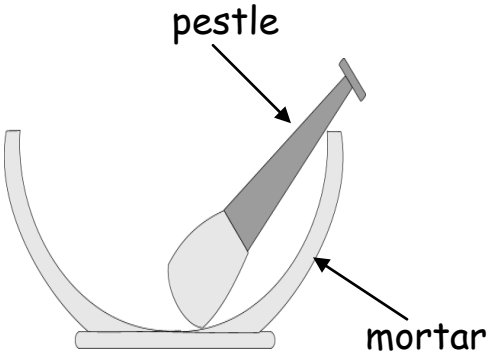
Notes: Copy the sentence below:

An indicator is a chemical which turns one colour when mixed with an acid and a different colour when mixed with an alkali.

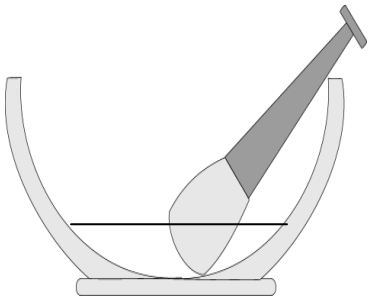
6. Making An Indicator

Some brightly coloured berries, flower petals and vegetables make good indicators.

The pictures below show how you can make your own indicator.



1. Crush your plant pieces



2. Add a little water

3. Keep crushing until all the colour has come out.

4. Use a dropper to put the liquid into a test tube.

You are going to use this method to make some indicators for the next investigation.

Which indicator is the best?

In your group discuss what makes a good indicator.

Notes: Make a list of your ideas.

Activity: Use these ideas to find out which of the petals, fruits or berries makes the best indicator.

Use the method shown on the previous page to make your own indicators.

When you have made your indicators your teacher will give you some acids and alkalis for you to test using the indicator you have made. [see p 10 for test.]

Notes: Write a report on what you did.

Which was the best indicator out of the ones you made?

Think about the practical work you did in today's lesson.
Make a list of the things you did well.
Make a list of the things you didn't do well
Write down two things you could improve next time.

7. The pH Scale

All the indicators used before have their uses but chemists had to develop an indicator which was able to distinguish more carefully between acids and alkalis.

The indicator chosen was Universal Indicator.
It is a very dark green colour to start with.

Notes: Copy the table below.

Household Chemical	Colour of Indicator	pH	Acid / alkali

Collect: Dimple tray various household chemicals
pH scale Universal Indicator solution

Activity: 1. Put 2 drops of Universal Indicator into each dimple.

2. Add two drops of each household chemical in turn and fill in the first two columns of your table.

Collect; A copy of the pH scale

Activity: Your teacher will give you instructions on how to colour in the scale correctly.

Stick the pH scale into your jotter.

pH numbers 1 - 6 represent ACIDS

pH numbers 8 - 14 represent ALKALIS

pH number 7 is NEUTRAL

The acids **decrease** in strength from pH 1 – pH 6

The alkalis increase in strength from pH 8 to pH 14

Notes: Use the information above to do the following.

1. Label the acids on your pH scale.

2. Use arrows to show which numbers represent the strongest and weakest acids.

3. Label pH 7.

4. Label the alkalis on your pH scale.

5. Use arrows to show which numbers represent the strongest and the weakest alkalis.

6. Using your pH scale go back to the table you copied earlier and fill in columns 3 and 4.

7. Why is Universal Indicator better than the fruit and vegetable dyes?

8. Write down the names of two household chemicals that are
   (a) acids
   (b) alkalis

If you have time, read Starting Science Book 2 Page 88 and attempt to answer the questions.

8. Neutralisation

Discuss: What do you think will happen when an alkali is added to an acid?

What do you think will happen to the pH of an acid if we add an alkali to it?

Notes: Copy the table below.

Volume of alkali added	0	1	2	3	4	5	6	7	8	9	10
Colour											
pH											

Collect:
- 2 small beakers
- 1 10cm^3 measuring cylinder
- 1 10cm^3 syringe
- stirring rod
- hydrochloric acid
- sodium hydroxide
- universal indicator

Experiment:

1. Measure 8 cm^3 of hydrochloric acid into a small beaker.

2. Add a few drops of universal indicator to it and note the colour and the pH number in your table.

3. Pour a little sodium hydroxide solution into a small beaker.

4. Fill the syringe with the sodium hydroxide solution and add 1cm^3 of alkali to the acid. Stir and note the colour and pH number in your table.

5. Keep adding 1 cm^3 at a time until 10 cm^3 of alkali have been added in total.

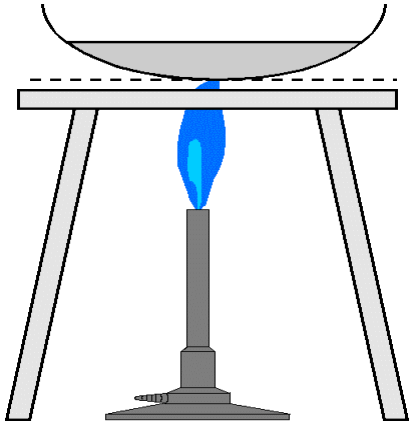
Discussion: Was your prediction correct?

What happens to the pH of an acid when we add alkali to it?

The second part of this lesson is about making the salt.

Experiment:

1. Pour 5cm^3 of hydrochloric acid into a small beaker.
2. Add 5 cm^3 of sodium hydroxide to the beaker.
3. Pour the solution into an evaporating basin.
4. Set up the apparatus as shown below. This allows you to evaporate off the water which has been formed.



5. Heat the solution until the volume is reduced by half. Turn off the Bunsen Burner. Leave the evaporating dish to cool.

6. Look at what has been formed.

Notes: Copy the information below.

When an acid reacts with an alkali and a neutral solution is produced we say that **neutralisation** has taken place.

A chemical reaction has occurred which has produced two new chemicals. One of these is water. The other is a **salt.**

Acid + alkali ⟶ salt + water

When hydrochloric acid is used in a neutralisation experiment the salt formed is a chloride.
In this reaction the salt made is called sodium chloride.
It is common salt used as seasoning on food.

In this experiment the word equation is

Hydrochloric acid + sodium hydroxide ⟶ sodium chloride + water

Different acids and alkalis form different salts.

9.Curing Sourness

Collect:

test tube rack	stomach powder
Test tube	citric acid
Spatula	Indicator solution.

Notes: Copy the table below for your results.

Amount of stomach powder added	Colour	pH
0		
1		
2		
3		
etc		

Experiment:

1. Put 2 cm depth of water in the test tube. Add one spatula measure of citric acid, and shake to dissolve.

2. Add 2 drops of pH indicator solution, note the colour and pH number.

3. Add $\frac{1}{2}$ spatula measure of stomach powder. Note the colour and pH of the solution. Continue adding the stomach powder and note the colour and pH until no further change occurs.

Notes: Answer the following questions in sentences.

1. What happened to the pH of the citric acid solution when stomach powder was added?

2. What other change did you observe when stomach powder was added to citric acid?

3. What is the pH of stomach powder? (Test some if you do not know the answer.)

4. Suggest why stomach powder removes the sour taste of an acid.

Experiment: Repeat the experiment using sugar instead of stomach powder.

Notes: Draw a table for your results before you begin.

Notes: Answer questions 1, 3 and 4 for the sugar experiment.

Using your results to both experiments write a conclusion.

10. A Balancing Act!

Indigestion tablets or stomach powders can be used to 'settle' your stomach. There are many different brands and types available. In this lesson you are going to plan and carry out an investigation to answer the problem set out in the letter below.

SCI-CO Healthcare

Your health is our care

Memo to: ***Analysts*** ***From: Chris Williams***

The company wishes to test three stomach powders, A,B and C to see if they neutralise stomach acid.
Please carry out some tests to tell me how much of each powder you need to neutralise the stomach acid. Make sure you do fair tests. Be as accurate as possible.
Our first tests show that one powder will not work at all. Please check this. I'd like a report on:

(a) how you carried out the tests.
(b) the quantities you used in each test
(c) the results
(d) which powder is best at neutralising stomach acid.

This is urgent. *Thanks*

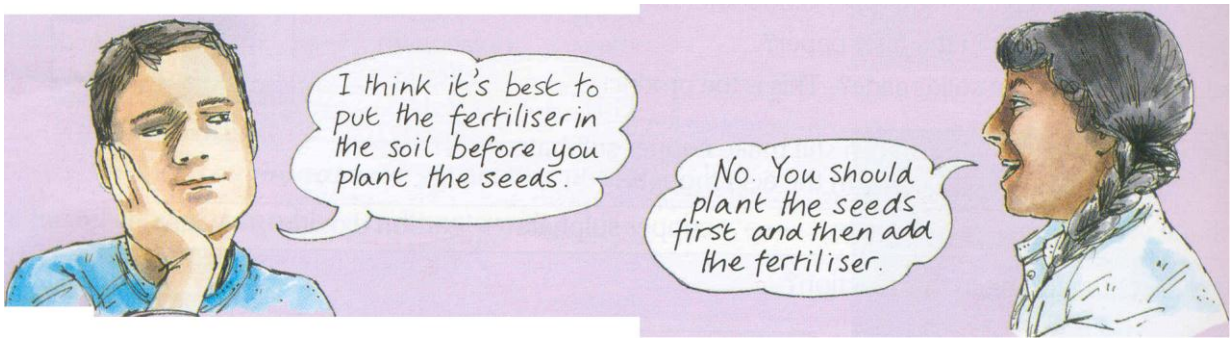
11. Salt of the Earth – making a fertiliser.

Some salts can be used as fertilisers.
The three main elements in fertilisers are Nitrogen (N), Phosphorus (P) and Potassium (K).

In this lesson you are going to make a fertiliser and then use it to investigate the problem below.

Using fertilisers

Rupa and Tim are talking about fertilisers.



Who do you think is right?
Plan an investigation to find out.
In the next activity you can make a fertiliser. You can use it to carry out your investigation.

You are going to make the fertiliser ammonium sulphate.
Ammonium sulphate is made by neutralisation.

Collect:

2 Small beakers	0.1mol/l Sulphuric acid
Measuring cylinder	0.1mol/l ammonium
20cm^3 syringe	hydroxide
evaporating basin	universal indicator solution

Experiment:

1. Put 10 cm^3 of sulphuric acid into the beaker.
2. Add 5 drops of universal indicator to the beaker.
3. Add some ammonium hydroxide to the second beaker.
4. Using the syringe add ammonium hydroxide 1 cm^3 at time to the sulphuric acid in the beaker. Count the number you are adding. Stop when the solution just becomes pale green.

Repeat the experiment but this time DO NOT ADD ANY UNIVERSAL INDICATOR.

You will have a colourless solution. Neutralisation has taken place and you have a solution of ammonium sulphate.

5. Pour the solution into an evaporating basin. Place the evaporating basin on top of a beaker which is half full of water. and evaporate off the water until the solution has reduced by half. Leave the evaporating basin to cool.
6. Collect the apparatus you need to filter the solution.
7. Filter the crystals from any solution left.

8. Dry them with a paper towel.

Notes: What is the name of the salt you have made?

Experiment: You can now use your fertiliser to carry out the investigation . Your teacher will give you seedlings.

12. Acids and metals

We have seen that acids react with alkalis to form a salt and water. In the next three lessons we are going to see how acids react with metals, metal oxides and metal carbonates.

When metals react with acids hydrogen gas is given off.

Collect: 4 test tubes
Test tube rack
hydrochloric acid
sulphuric acid
Magnesium
Zinc
Tin
Copper

Notes: Copy the table below.

Metal	Reaction with hydrochloric acid

Activity:
1. Pour hydrochloric acid into the test tubes until there is about 2 – 3 cm depth.
2. Add a piece of the four different metals to the test tubes.
3. Note your observations in the table.

4. Repeat your experiment using sulphuric acid. Put your results in a similar table.

Notes: Copy the following.

When a METAL reacts with an ACID , a gas is formed.

The gas is HYDROGEN.

METAL + ACID $\longrightarrow$ SALT + HYDROGEN

Testing for Hydrogen Gas

Hydrogen gas can be tested for using a burning splint. If hydrogen is present, it will burn with a 'pop'.

Collect: 1 test tube
hydrochloric acid
Magnesium piece (1 cm)

Activity: 1. Put two cm depth of hydrochloric acid in a test tube.

2. Add one piece of magnesium ribbon.

3. Place your thumb over the top of the test tube.

4. When you feel gas pressing against your thumb, take your test tube to the Bunsen which is lit at

the front of the room.

5. Light a splint and put the lit splint into the test tube.

Notes: Write a few lines to say what you did and how you test for hydrogen gas.

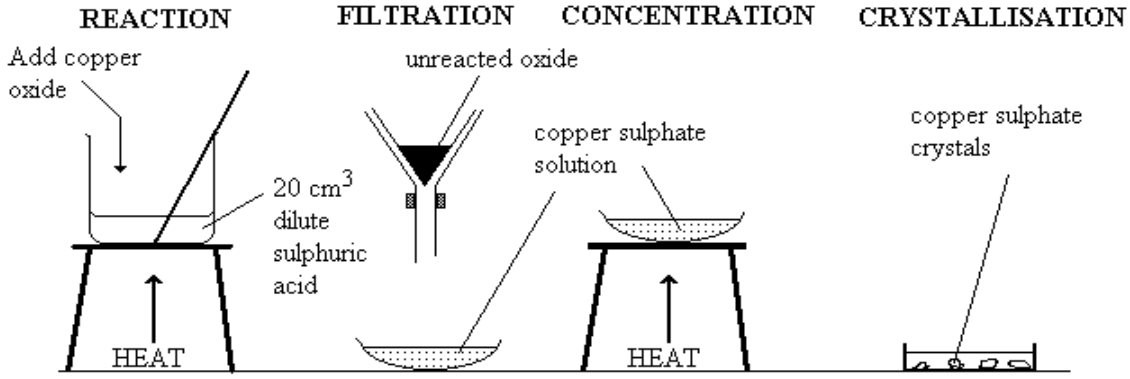
13. Acids and metal oxides

Acids react with metal oxides to make salts.
The metal oxide neutralises the acid.

Collect: 1 beaker
filter funnel
filter paper
evaporating basin
Bunsen burner
copper oxide
sulphuric acid

Activity: 1. Pour 10 cm^3 of sulphuric acid into the beaker.
Turn off the Bunsen burner just before it boils.

2. Add copper oxide and stir. Continue until no more will dissolve.



3. Filter your solution into an evaporating dish and evaporate
until you have half the original volume.

4. Leave in a safe place until the next lesson.

Notes: Write a short method to describe what you did and draw a labelled diagram of the apparatus.

Notes: Write answers to the following questions.

1. Which metal oxide did you use?

2. Which metal does this oxide contain?

3. Describe what is left in the evaporating dish. [Colour and shape]

4. Can you work out the name of the salt you have made [see L].

Copy the following.

METAL OXIDE + ACID ⟶ SALT + WATER

Copy and complete the equation below for the experiment you have just carried out.[see L 8]

_____ oxide + sulphuric acid ⟶ _____ + water

_____

14. Acids and metal carbonates

Marble chips are an example of a carbonate. They are calcium carbonate.

Collect:

1 boiling tube	marble chips
1 test tube rack	hydrochloric acid
2 test tubes	lime water
1 boiling tube delivery tube	Universal Indicator

Activity:

1. Place two marble chips in the boiling tube and put the boiling tube in a test tube rack.

2. Put 3 cm depth of Universal Indicator in 1 testtube and about 3 cm depth of limewater in the other test tube.

3. Add 10cm^3 of hydrochloric acid to the marble chips and stopper the boiling tube.

4. Place the other end of the delivery tube in the lime

water solution. Wait until there is a change and then place the delivery tube into the indicator solution.

Notes: Write a short method to describe what you did and draw a labelled diagram of the apparatus.

Notes: Write answers to the following questions.

1. What happened to the indicator solution?

2. What does this tell us about the gas?

3. What happened to the limewater solution?
   This tells us that Carbon Dioxide Gas has been formed.

Copy the following.

METAL + ACID ⟶ SALT + WATER + CARBON DIOXIDE
CARBONATE

Copy and complete the equation below for the experiment you have just done.

_____ + hydrochloric acid ⟶ _____ + _____ + _____
_____

8. Neutralisation stomach powder and sugar
9. What is formed in neutralisation?
10.Indigestion tablets investigation
11 Making a fertiliser