WARNING! Materials which may come into contact with the skin could cause allergic reactions to susceptible individuals. In the case of irritation discontinue use. If the lens becomes scratched or damaged, the goggles should be replaced. Eye protectors/goggles worn over standard ophthalmic spectacles may transmit impacts, thus creating a hazard to the wearer.

CAUTION! This set contains some chemicals which are classified as a safety hazard.

Read the instructions before use, follow them and keep them for future reference.

Do not allow chemicals to come into contact with any part of the body, particularly the mouth and eyes.

Keep small children and animals away from experiments.

Store the chemistry set out of reach of young children.

Eye protection for supervising adults is not included.

This toy contains functional sharp points and edges.

Dispose of unwanted chemicals by greatly diluting with water and running into the waste water system.

For chemicals labelled as hazardous to the environment, please contact your local council for safe disposal information.

WARNING! Supervising adults: This Chemistry Set contains harmful chemicals and is only for use by children over 10 years of age. Adult supervision is necessary.

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NATIONAL GEOGRAPHIC™

CHEMISTRY SET

50 EXPERIMENTS
ALL SAFETY TESTED

INSTRUCTION MANUAL

Do not hold any of the equipment in a flame; NOT to be heated.

WARNING! Only for use by children over 10 years old. To be used solely under the strict supervision of adults that have studied the precautions given in the experimental set.

CONTENTS OF THE CHEMISTRY SET

CAUTION! Contains some chemicals that are classified as a safety hazard.
Chemicals supplied and the CHEMICAL RISK.

Ammonium Chloride	**Harmful if swallowed Irritating to eyes**
Calcium Carbonate	**Irritating to eyes**
Calcium Hydroxide	**Irritating to eyes**
Copper (II) Sulphate	**Harmful if swallowed or inhaled. Possible irritant. Hazardous to the environment**
Iron (II) Sulphate	**Harmful if swallowed**
Iron Fillings	**Flammable**
Litmus Blue	**None**

Magnesium Strip	**Flammable**
Magnesium Sulphate	**None**
Methyl Orange	**Toxic**
Aluminium Potassium Sulphate	**None**
Potassium Iodide	**None**
Sodium Carbonate	**Irritating to eyes**
Sodium Hydrogen Sulphate	**Irritating to eyes**
Sodium Sulphate	**None**
Sodium Thiosulphate	**None**

Note: On the chemical containers the word 'sulphate' may have the American spelling 'sulfate'

Below are the actions that should be taken should an accident occur. Look at the risk for a particular chemical and take the following action.

Flammable

Keep well away from naked flame. Do not inhale the fumes from the burning material.

Irritating to eyes

In the case of eye contact, wash out eye with plenty of water, holding the eye open if necessary. Seek immediate medical advice.

Harmful if swallowed

If swallowed wash out mouth with water, drink some fresh water. DO NOT induce vomiting. Seek immediate medical advice.

In case of inhalation: Remove person to fresh air.

Corrosive - can cause burns

If swallowed wash out mouth with water and give water to drink followed by milk. DO NOT induce vomiting. Seek immediate medical advice. In the case of eye contact wash out eye with plenty of water, holding the eye open if necessary. Seek immediate medical advice.

Toxic - handle carefully!

If swallowed, inhaled or absorbed through the skin. Eye, skin and respiratory irritant. Contact a doctor or poison centre/hospital immediately!

Hazardous to the environment

These chemicals may cause long term damage in the environment. Avoid release to the environment. Please contact your local council for safe disposal information.

EQUIPMENT SUPPLIED

- 1 x 100ml beaker
- 1 x Universal Indicator papers
- 1 x 100ml conical flask
- 2 x Stoppers – cork
- 3 x Stoppers – cork with hole
- Filter papers
- 1 x Plastic funnel
- 3 x Glass tubing
- 1 x Measuring spoon
- 1 x Plastic dropping pipette
- 1 x Rubber tubing
- 1 x Safety goggles
- 1 x Small scoop
- 4 x Test tube caps
- 1 x Test tube rack
- 4 x Test tubes
- 1 x Instruction booklet

CHEMISTRY...'A VERY IMPORTANT SCIENCE'

You, the water you drink, the air you breathe, the food you eat and the hills you climb, are all chemical substances.

Chemistry is a very important science, because everything in the universe is made of chemical substances.

All chemical substances are made from about 100 elements. You, for example, are a very complicated mixture of chemicals, but 98 percent of you is made from just 6 of these 100 elements (hydrogen, carbon, nitrogen, oxygen, phosphorus and calcium). Many other elements make up the remaining 2 percent of you, such as iron in your blood and sodium in the cells of your body.

When you carry out chemical experiments, you are studying how the many different chemical substances behave. This Chemistry Set contains the equipment and chemicals to carry out many interesting experiments, but no chemistry set can be 'complete' as there are millions of possible chemistry experiments. You must regard your Chemistry Set as the heart of a laboratory to which you can add other equipment and chemicals (only those suggested on pages 11-12 in this manual or listed in each experiment in this manual).

Some of the experiments here require other equipment and chemicals and these are described in the section **Additional Equipment and Chemicals**. **DO NOT** use anything not listed as a requirement in this manual.

It is a good idea to get together as much of this equipment and as many of these chemicals before you start. Certainly gather them before you start the experiment which needs them. These additional chemicals and equipment need not be expensive. Part of the fun of using a chemistry set at home is to improvise: making equipment from common household items and using common household chemicals as much as possible.

SAFETY MATTERS

THE SAFETY RULES

DO read the instructions before use, follow them and keep them for reference.

DO keep younger children, animals and those not wearing eye protection away from the experimental area.

DO always wear eye protection provided (eye protection for supervising adults not included).

DO store experimental sets out of reach of young children.

DO clean all equipment after use.

DO make sure that all containers are fully closed and properly stored after use.

DO wash hands after carrying out experiments.

DO dispose of any material which has been mixed and is not for further use.

DO dispose of all chemicals and foodstuffs immediately upon completion of an experiment, **do not** consume (the only exception is the sugar candy in experiment 10.1).

DO NOT use equipment which has not been supplied with the set (unless suggested in instructions on pages 11/12).

DO NOT eat, drink or smoke in the experimental area.

DO NOT allow chemicals to come into contact with the eyes or mouth.

DO NOT replace foodstuffs in original container. Dispose of immediately.

DO NOT dispose of any material from this kit in the kitchen; all materials must be flushed down the toilet.

ADVICE FOR SUPERVISING ADULTS

a) Read and follow these instructions, the safety rules and the first aid information and keep for reference.

b) The incorrect use of chemicals can cause injury and damage to health.

c) Only carry out those experiments which are listed in the instructions

d) This chemical set is for use only by children over 10 years of age.

e) Because children's abilities vary so much, even within age groups, supervising adults should exercise discretion as to which experiments are suitable and safe for them. The instructions should enable supervisors to assess any experiment to establish its suitability for a particular child.

f) The supervising adult should discuss the warnings and safety information with the child or children before commencing the experiments. Particular attention should be paid to the safe handling of acids, alkalis and flammable liquids. Plus experiments where hot or boiling liquids are necessary.

g) The area surrounding the experiment should be kept clear of any obstruction and away from the storage of food. It should be well lit and ventilated and close to a water supply. A solid, flat table with a heat resistant top should be provided.

FIRST AID INSTRUCTIONS

- In case of skin contact and burns: wash the affected area with plenty of water for five minutes.
- If materials come in contact with eyes or mouth, immediately flush with large amounts of water for 15 minutes. If irritation occurs, seek medical attention.
- If fumes are inhaled, move to an area of fresh air. If any adverse symptoms occur, seek medical attention.
- If materials or solutions are swallowed, immediately rinse the mouth; drink several glasses of milk or water. Do not induce vomiting. Seek medical advice.
- In case of doubt seek medical advice without delay. Contact your local poison control centre or hospital and take the chemical(s) together with the relevant container(s) with you.

Record the telephone number of your local hospital (or local poison centre) in the box below.

(Write the number in NOW so you do not have to search for it in an emergency)

Telephone Local Hospital: ______________________

N.B.: Take the chemical with you to the hospital!

SAFETY GOGGLES USER INFORMATION

INSTRUCTIONS FOR USE, STORAGE & MAINTENANCE

- Hold the goggles with one hand, if possible without touching the lens.
- Pull the elastic headband over the back of your head, just above the ears so that the goggles sit on your forehead. Then pull the goggles down over your eyes carefully and adjust strap for a snug and comfortable fit. Ensure the goggles are kept clean and dry and cannot come into contact with loose chemicals or sharp objects.
- Wash and allow to dry after use. Wash with warm soapy water and a soft cloth (not to be placed in dishwasher).
- **These Safety Goggles are only to be used with the contents and instructions supplied.**
- If goggles become damaged, do not attempt to repair; please discard.

NOTE: Eye protectors/goggles only protect against high-speed particles at room temperature.

CONTENTS OF THIS INSTRUCTION BOOKLET

INTRODUCTION

This Chemistry Set Instruction Booklet has been written by David Webster. Dr. Webster is a Fellow of the Royal Society of Chemistry and a Chartered Chemist. He has been teaching practical chemistry for over 40 years, and is the author of a chemistry textbook for younger secondary school children.

He has designed and tested the 50 experiments in this manual.

The experiments are a collection of safe chemical experiments for you to carry out using both the chemicals and equipment in the chemistry set and common chemicals and other readily available materials, many of which you will already have at home.

The experiments are intended to show you some of the magic and mystery of chemistry, and the relevance of chemistry to your understanding of what is to be found in your home and in the world around you.

CONGRATULATIONS!

You are now the owner of a Chemistry Set. We hope that you enjoy the many interesting chemistry experiments which are outlined in this manual.

ADULT SUPERVISION IS NECESSARY AT ALL TIMES.

We have added an adult alert icon throughout the manual to highlight and draw your attention to higher risk experiments, however you are requested to supervise **ALL** experiments regardless of the degree of risk.

A chemistry set, such as this, is not for 'playing' with. When carrying out chemistry experiments you need to take **GREAT CARE** in both following the instructions and in keeping a Laboratory Notebook of your experiments and results. (Although there are some blank pages in the manual to allow you to make notes, it will be much better if you create your own special notebook).

If you do this, you will be working safely and learning some chemistry at the same time. Working safely must always be your main concern.

Always be careful to avoid bodily contact with the chemicals, particularly with your eyes or mouth. To avoid injury, read and observe all the safety rules which follow.

SETTING UP YOUR LABORATORY

You need to set up your laboratory work space in a well lit and ventilated room with, if possible, a stain- and heat-resistant surface to work on. You will soon discover that an experimental chemist spends a lot of time washing dirty equipment, so a close supply of running water or a large container to hold waste water is essential.

For most people the kitchen is the best place to set up your laboratory.

You also need a clean area nearby where you can write in your laboratory notebook and keep other items safe and dry.

It is unlikely that you will have a laboratory area that is not to be used by other people at other times. This is certainly so if you work in your kitchen. You need, therefore, to be able to easily pack away your Chemistry Set. You can, of course, use the box which we have supplied, but you will quickly acquire other equipment and chemicals, so we strongly recommend that you get a large strong cardboard or plastic box in which you can conveniently pack and unpack everything and store it away when not in use.

IT IS VERY IMPORTANT that you store this set somewhere that young children do not have access to it. N.B., **Read and act upon all the safety advice within this manual!**

HAVE READILY AVAILABLE AT ALL TIMES THE FOLLOWING 5 ITEMS:

1
A sink or container for liquid waste.

2
A waste bin for solid waste. (N.B: If a chemical is hazardous to the environment, see page 5 regarding its disposal.)

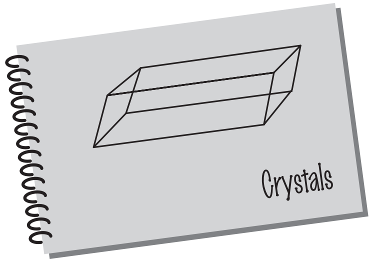
3
A piece of hard board or thick cardboard or similar (newspaper in an emergency) to put on the work bench. Then if you have any spills you can easily clean up the mess.

4
A kitchen roll, or some cloths, for keeping your laboratory area clean and tidy.

5
A tea-towel (not one normally used in the kitchen) for drying your apparatus after you have washed it.

WORKING IN YOUR LABORATORY

Keep accurate records of your work. There is little point in doing chemical experiments if you don't know what you have done, why you did it and what happened. Follow the instructions carefully and watch very closely **what** happens, and then try to work out **why** it happened. At the back of these instructions are answers to what you should see and conclude from your observations.



The Record Book/ Laboratory Notebook

The best type of book to use is a hardcover book or one with a spiral binder.

Write up each experiment with the following information:

- When you did the experiment (the date).
- What the experiment was about (its title).
- What you did (the method).
- What happened (the results).
- Why it happened (the conclusions).

Laboratory Techniques

Practical chemistry requires you to carry out various tasks which will at first be unfamiliar to you. This section contains some hints and tips that will help you with these tasks.

Using the Test Tubes

For the experiments in this set you will normally be using less than a 3cm depth of water in the test tubes. Do not overfill as the more liquid you have in a test tube, the more difficult it is to control.

Solids can be added to a test tube with the measuring spoon. You might find it easier to add liquids by using the funnel, or by pouring the liquid into a beaker and then into the test tube. Be extra careful when pouring hot liquids.

TIP:
A wooden clothes peg makes a good test tube holder.

For all experiments, the easiest way to dissolve solids in water is to put a cork (or cap) in the test tube and shake it.

When you clean your test tubes, do not forget to clean the stoppers too (if used).

Cleaning the test tubes:
Wash them with running water, and clean with a small tube brush (not included). If necessary use a little washing-up liquid. To dry inside the test tubes, use rolled up kitchen paper towel.

Water supply

For washing dirty equipment, a tap and sink are best.

When carrying out the experiments you will need a 'water bottle' for adding small quantities of water, in a controlled way, to the chemicals in the test tubes. Two suggestions are a 'washing-up liquid bottle' or a 'hand sprayer'.

TIP:
A washing-up liquid bottle.

Remove the cap from an empty bottle, or better, get an adult to do so for you by prising the cap off with the edge of a knife. Thoroughly wash the bottle, particularly the cap, to remove all traces of detergent.

You can fill the bottle with water, replace the cap and use it by gently squeezing the bottle. However, the jet of water you get is usually too much. The bottle can be considerably improved for your purpose if an **adult** heats a needle held in a pair of pliers in a flame, and melts a small hole through the centre of the top of the cap. **DO NOT** try this yourself. Then click shut the top of the cap and squirt the water out of this fine hole.

TIP:
A hand sprayer.

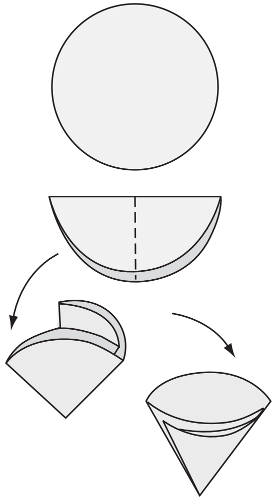
A small (1 pint) garden or indoor plant sprayer that is readily available at garden centres and DIY stores is ideal. It has a trigger action and is designed to give a spray. By rotating the spray head a fine jet of water can be produced instead. This is very controllable by lightly squeezing the trigger. Additionally the sprayer has the advantage of being easy to refill by unscrewing the water container.

Temperature:
Assume use of cold water in all experiments unless otherwise stated, i.e., warm or hot.

Using Filter Papers

You will use the filter papers supplied to separate solids from liquids and for any Paper Chromatography experiments.

Always use a new paper for each experiment. You may need more papers than supplied in the set. Very cheap filter papers can be cut from coffee filter papers; get the white ones rather than the brown ones if you can. You are advised to use the small filter papers and coffee filter papers for filtering, and retain the large filter papers supplied in the set for the chromatography experiments. Filter papers are folded as shown in the diagram.



Using Chemicals

NEVER TASTE A CHEMICAL.

REMEMBER to be careful when carrying out all the experiments. Wear your safety goggles, but should you get any chemical in your eyes, get someone else to wash them immediately with your water bottle or under a running tap.

You only have a limited supply of chemicals. Although these can be added to by buying more elsewhere, you only want to work with small quantities.

In the experiments, 'one measure' is a level scoopful of the chemical in the round measuring spoon.

You will add other chemicals to those supplied and make up 'stock solutions' of some of the chemicals that you will need for many experiments. Keep these in containers and bottles with well-fitting stoppers or lids that will not leak. It is most important that you always label any chemicals or solutions when you put them in your own bottles or containers. Always store these containers away from small children, pets and foodstuffs. It is best to keep all your chemical set items together in a safe place.

TIP:
You will need some empty bottles and containers. Small bottles that have had fizzy drinks or something similar are satisfactory, although smaller bottles would be better – you will need four. Small plastic containers that have been used for 35mm films are perfect for solids. You can normally get as many of these as you want for nothing from your local photo processor. They will be pleased to give them to you as they usually throw them away.

NEVER store chemicals and solutions near or with foodstuffs.
NEVER store chemicals or solutions in containers that might be confused with foodstuffs.

Using Glassware

If you do have an accident and break some glassware, clean it up immediately. Wipe up tiny fragments with several pieces of kitchen roll and throw them away. Wash your hands under running water when you have cleaned up.

One of the trickiest tasks you will have to do is to push the glass tubing into a cork. It is very, very easy to break the tubing and cut your hand when doing this, so take great care, or ask an adult to do it.

TIP:
Thoroughly wet the cork and the end of the tubing with a strong solution of washing-up detergent. Hold the glass tubing and the cork in a tea-towel, or other cloth, and push the tubing gently with slight twisting into the cork.

Wash the excess detergent off the cork and tubing, and allow them to dry. Once it is in the cork, it is usually impossible to remove the tubing without breaking it unless you cut the cork. Don't try!

ADDITIONAL EQUIPMENT AND CHEMICALS

In order to carry out the full set of experiments described in this instruction booklet, it is necessary to add other equipment, household items and chemicals. The more important of these are listed below. You should have no difficulty in finding these but some sources are given. You should get these together before you start on the experiments; check the list of required elements by each experiment. N.B. Some experiments may require more of a chemical than we have supplied with your set, check before you start!

Equipment needed:

A small ruler
To measure the amount of liquid in a test tube.

Crystallising dishes
Make them from yogurt pots or small plastic beakers by carefully cutting round the pot approximately 1cm from the base. The small dishes that you make are ideal. Make five or six. Wash and dry them after use as they are reusable if handled carefully.

A water dispenser (washing-up liquid bottle or garden spray)
See the section on 'Water Supply', page 9.

Coffee filter papers
(Preferably white) from a supermarket.

Small bottles and containers
See the section 'Using Chemicals', page 10.

Small self-adhesive labels

Wooden ice-cream or lolly sticks

Small tube brush
For cleaning test tubes.

A small artist's paintbrush or cotton buds

A pencil

A small mirror

Writing paper
(preferably unglazed)

Tea towels

Kitchen roll

A roll of sellotape

A pair of scissors
(cutting must always be supervised)

5 x small DIY nails

A wooden clothes peg
(very useful as a test tube holder)

Emery paper

Cotton thread

Garden tools
(you need something to dig out some garden soil)

A knife
(cutting must always be supervised)

Wooden spoon

Pyrex jug

Small bottles with lids/caps

Drinking glass

Magnifying glass
(not necessary but useful)

A small saucepan

An old cup or mug

An old bowl

2 x teaspoons
(Use stainless steel spoons)

An egg cup

A small plate

DO NOT RE-USE cutlery, plates, glasses or mugs, etc., used in experiments for drinking and eating. Ask an adult for old or spare items you can add to your set, or buy items cheaply from a charity shop. It can be fun hunting for the equipment needed!

Chemicals that you will need for certain experiments:

(Check the list for each experiment before you start.)

Colourless (distilled malt) vinegar
284ml bottle from supermarket.

Citric acid
50g packet from a pharmacist.

Sodium chloride (common salt)
From a supermarket.

Sodium bicarbonate (Sodium hydrogen carbonate)
From a pharmacist or a supermarket.

Magnesium sulphate (Epsom salts)
500g packet from a pharmacist.

Hydrogen peroxide 3%
150ml (from a pharmacist); we recommend a weak solution of 3 percent only.

N.B. You will also need to purchase more Aluminium Potassium Sulphate, and Copper Sulphate from a chemical supplier to complete ALL experiments.

Other items that you will need for specific experiments (check before you start):

Orange juice

Sparkling water

White sugar

Coarse ground pepper

Vitamin C tablets

Aluminium foil

Spray starch

Black ink

Black food dye

Green food dye

Black and coloured felt-tipped pens

Lemons

A potato

Indigestion tablet

An apple

Important! For items not included in this set: Always read and follow the manufacturer's instructions for safe use (as seen on their packaging).

NEVER substitute chemicals listed in each experiment for anything else.

THE CHEMISTRY EXPERIMENTS

1
Before starting any of the experiments, read and make sure you understand the two earlier sections in this booklet on 'Safety Matters' and 'Setting Up Your Chemistry Laboratory'.

2
Collect together the 'Additional Equipment and Chemicals' listed earlier.

3
Some of the experiments will need equipment that you should be able to easily find at home. The chemicals and equipment needed for each experiment are given at the side of the instructions. Get everything ready before you start an experiment.

4
In this booklet the experiments are arranged with the easiest ones first. It is therefore best to carry them out in the order given here. You can however start at the beginning of any chapter which interests you. Please note, however, that the later experiments may ask you to use solutions made in earlier experiments.

5
Remember: one measure is a level scoopful in the round scoop.

6
The amount of liquid needed in an experiment is given as a length in the test tube. You do not need to have exactly this amount. If, for example, it says 2cm then anything from $1^1/_2$ cm to $2^1/_2$ cm is satisfactory. Use your ruler to check the amount of liquid in a test tube. You will find that after a few experiments you will be able to guess the amount accurately enough.

When scientists carry out an experiment, they carefully observe what happens and then try to work out why it happens. This is what you will have to do here. Some of the experiment instructions do not explain what happens. Do the experiments, record your results and try to explain them. You can check to see if you have the correct result in the section 'Experiment Results' at the end of this manual.

If the results of your experiment are different from those given, check to see if you followed the instructions correctly and try the experiment again.

IMPORTANT! If you have hot water in the test tube, you can safely put it into the test tube rack. If you have a hot solid in the tube, then the tube may be **VERY HOT** and could melt the rack – put the hot tube into an empty beaker and leave it there until it is cool.

CHAPTER 1
- SOLUBLE AND INSOLUBLE SUBSTANCES

Some substances dissolve in water to form a solution, they are said to be **soluble**; others do not dissolve, they are called **insoluble**. When the substance dissolves, the water is called a **solvent,** and the substance which dissolves is called a **solute**.

EXPERIMENT 1.1 What substances dissolve in water?

Copper sulphate
Calcium carbonate
Test tubes

You will need to supply
Sodium chloride (common salt)
White sugar
Coarse ground pepper

Put $^1/_4$ measure of copper sulphate into a clean dry test tube and add about 2cm of water. Gently shake the tube. Does the copper sulphate disappear and the solution become coloured?

Repeat the experiment four more times using sodium chloride, then sugar, then calcium carbonate and then coarse ground pepper instead of copper sulphate.

Record your results for each substance as **soluble** or **insoluble**.

EXPERIMENT 1.2 Solubility of substances in cold and in hot water

Sodium sulphate
Test tube
Flask

Adults please note HOT WATER to be used in this experiment. NEVER USE BOILING WATER OR WATER AT TEMPERATURES THAT CAN BURN

Put 1 measure of sodium sulphate into a clean dry test tube and add about 2cm of water. Gently shake the tube. Roughly time how long it takes for the sodium sulphate to dissolve. Repeat the experiment, but this time use hot water from the tap. Let the water run till it is **hand hot** and collect some in your flask, then carefully pour into the test tube; do not burn yourself, ask an **adult** to assist.

Does the sodium sulphate dissolve slower or quicker in the warmer water?

Keep the remaining solution for Experiment 1.4.

EXPERIMENT 1.3

To recover a dissolved substance by crystallisation

Copper sulphate

Test tube

Flask

You will need to supply

Crystallising dish (that you have made)

Adults please note HOT WATER to be used in this experiment. NEVER USE BOILING WATER OR WATER AT TEMPERATURES THAT CAN BURN.

If you allow the water to evaporate away, then the chemical is left behind – often as beautifully shaped crystals. This process is called crystallisation.

Put 1/2 measure of copper sulphate into a clean dry test tube and add 2cm of hot water from a tap. Let the water run till it is hand hot and collect some in your flask, then carefully pour into the test tube, do not burn yourself; ask an **adult** to assist.

Dissolve by gentle shaking. Pour the solution into a crystallising dish and leave it somewhere warm, such as a safe place (away from young children, pets and foodstuffs) in your kitchen or in an airing cupboard, until the water has evaporated away.

What is left in the crystallising dish?

You cannot see the copper sulphate when it is in a solution in water as the particles of the chemical are very, very small.

This property can be used to separate insoluble solids from solids which have dissolved.

You can filter off the solid, and then recover both the solid and the chemical from the water.

EXPERIMENT 1.4

To separate a mixture of a soluble substance and an insoluble substance.

Sodium sulphate solution (kept from experiment 1.2)

2 test tubes

Funnel

Filter paper (not one made from a coffee filter paper)

You will need to supply

Coarse ground pepper

You should have a solution of a soluble substance, sodium sulphate, from Experiment 1.2. Add 1 measure of coarse ground pepper to the solution and gently shake the test tube.

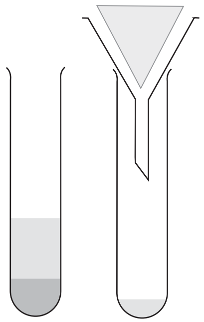
The pepper will not dissolve.

Place the funnel and filter paper into the mouth of a clean test tube and pour the solution and pepper into it.

Continued...

EXPERIMENT 1.4

Continued...



The liquid filtrate passes through the fine holes in the filter paper into the test tube, leaving the pepper stuck onto the filter paper.

To recover clean and dry pepper, move the funnel into another test tube and gently wash the pepper with water. Then carefully lift the filter paper out of the funnel and put it somewhere warm for a few hours until it is dry. Carefully scrape the pepper off the paper. You can repeat this experiment with other mixtures of soluble and insoluble substances.

CHAPTER 2 - INVISIBLE INKS

Some substances are a different colour when they are cold and when they are hot. We can use this property to make invisible inks. You can write on paper with the ink, and it only becomes visible when you 'develop' it by heating the paper with an iron or holding it in front of a fire.

EXPERIMENT 2.1

Invisible ink from a lemon

You will need to supply

Artist's paintbrush or a cotton bud

Writing paper

A lemon

Crystallising dish (that you have made)

IMPORTANT! Adults please note HEAT from an iron or fire has been suggested for this experiment. NEVER leave a child unattended with an iron, electrical equipment or near a fire. ADULT PARTICIPATION NECESSARY!

Squeeze a lemon and pour some juice into a crystallising dish. Use the paintbrush or a cotton bud to write (with juice) on a piece of white paper. N.B. Unglazed writing paper is best.

Let the writing dry.

Get an **adult** to help you carefully heat the paper by pressing it with an iron or holding it in front of a fire. Take great care not to let the paper catch fire.

What colour is the writing?

EXPERIMENT 2.2

Other invisible inks

Iron sulphate
Test tube

You will need to supply

Artist's paintbrush or a cotton bud
Writing paper
Crystallising dish (that you have made)

IMPORTANT! Adults please note HEAT from an iron or fire has been suggested for this experiment. NEVER leave a child unattended with an iron, electrical equipment or near a fire. ADULT PARTICIPATION NECESSARY!

Dissolvea quarter measure of iron sulphate in about 1cm of water in a test tube. Pour the solution into a crystallising dish and write (with solution) on unglazed paper as in Experiment 2.1.

Develop the invisible ink by heating as in Experiment 2.1. What colour is the writing?

EXPERIMENT 2.3

An invisible ink made from two chemicals

Copper sulphate
Ammonium chloride
Test tube

You will need to supply

Crystallising dish (that you have made)
Artist's paintbrush or a cotton bud
Writing paper

IMPORTANT! Adults please note, HEAT from an iron or fire has been suggested for this experiment. NEVER leave a child unattended with an iron, electrical equipment or near a fire. ADULT PARTICIPATION NECESSARY!

Put a quarter measure of copper sulphate and a quarter measure of ammonium chloride into a clean dry test tube and add 1cm of cold water. Shake the tube gently until the chemicals have dissolved (do not use warm water). Pour the solution into the crystallising dish and write on unglazed paper as in Experiment 2.1.

Develop the invisible ink by heating as in Experiment 2.1. What colour is the writing?

EXPERIMENT 2.4

Preparation of iodine developer for Experiment 2.5

Potassium iodide
Sodium hydrogen sulphate
Test tube
Pipette

You will need to supply

Small clean dry bottle
3% hydrogen peroxide solution
Label

Put half a measure of potassium iodide and a quarter measure of sodium hydrogen sulphate into a clean dry test tube and add about 2cm of water. Add 10 drops of hydrogen peroxide solution; yellow-brown iodine will be formed. Add water until the test tube is half full. Carefully pour this solution into a bottle. **Label it 'Iodine Solution'; THIS IS VERY IMPORTANT.**

EXPERIMENT 2.5

Using a chemical developer for invisible ink

Iodine solution from Experiment 2.4
Conical flask
Filter paper
Dropping pipette

You will need to supply

Crystallising dish (that you have made)
Artist's paintbrush
Small plate
Spray starch
Old mug, cup or bowl
Pipette

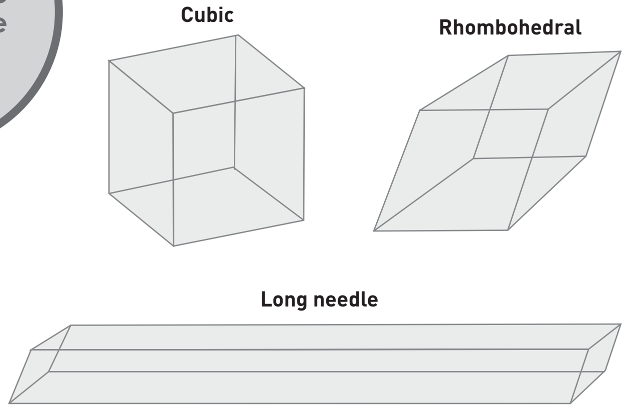
Collect some starch from a spray starch spray in a small container (for example, a mug or a bowl). The starch is likely to be in a foam format. Let the foam settle, and then pour the solution into the crystallising dish and write on a filter paper with the paintbrush. Let the writing dry. You will need the iodine solution you made in Experiment 2.4 as the developer.

When the writing is dry, put 30ml of water into the conical flask. Add 10 drops of iodine solution using the dropping pipette. Pour a little of this iodine solution onto a small plate. Drop the filter paper into the iodine and the writing will magically appear. What colour is it?

CHAPTER 3 – CRYSTAL CHEMISTRY

Crystals are solid substances in which all the particles are arranged in a regular pattern.

In Experiment 1.3 you made some crystals of copper sulphate. Crystals can be many shapes like cubes, rhombohedra or long needles.



Crystals form in solutions when the solution contains as much of the substance (the solute) as it can dissolve. The solution is said to be **saturated** with the solute. Any excess amount of solute that is present in the solution forms crystals. As most substances increase in solubility as the temperature is increased, one way to form crystals is to start with a hot saturated solution and let it cool. As it cools the amount of solute needed to keep the solution saturated decreases, and the excess is deposited out of solution as crystals. Crystals formed in this way are usually small ones.

The other way to form crystals, and the way that must be used if you want to make big crystals, is to start with a saturated solution and then let the solvent slowly evaporate away.

As the solvent evaporates, the excess solute is deposited as crystals. A general rule for crystal growing is that the slower the crystals grow, the bigger they will be.

Using the chemicals supplied with this Chemistry Set you can grow big crystals if you are patient and let them grow over several days. N.B. To grow really big crystals you will need to buy more chemicals from a chemical supplier. Always store the solutions in your crystallising dishes in a place where they cannot be confused with a drink or any other foodstuff and away from young children and pets!

EXPERIMENT 3.1 Copper sulphate crystals

Copper sulphate
Test tube
Conical flask

You will need to supply
Pencil
Magnifying glass (if you have one)
Crystallising dish (that you have made)

Adults please note HOT WATER to be used in this experiment. NEVER USE BOILING WATER OR WATER AT TEMPERATURES THAT CAN BURN.

Put 8 measures of copper sulphate into a clean conical flask and add 3cm of hand-hot tap water from a test tube (no warmer than-hand hot). Gently shake until it has dissolved. Pour the solution into a crystallising dish, and leave it somewhere warm for several days until all the water has evaporated away. If possible prop up one side of the crystallising dish, e.g., with a pencil, so the solution is not spread too thinly over the bottom of the dish. (Store away from young children, pets and foodstuffs.)

You will have formed some large blue copper sulphate crystals. Grown in this way crystals do not have a regular shape, but look carefully at them (use a magnifying glass if you have one) and decide which of the three shapes shown in the earlier diagram these copper sulphate crystals most resemble.

You can re-dissolve the crystals in water and grow them again if you wish. If you grow a lot of small crystals and want to grow bigger ones, try growing them where it is not so warm and the water takes longer to evaporate away.

Do not throw the crystals away when you have finished crystal growing. Put the crystals somewhere warm until they are thoroughly dry and return them to your copper sulphate container.

EXPERIMENT 3.2 Potassium aluminium sulphate crystals

Aluminium potassium sulphate
Test tube
Conical flask

You will need to supply
Pencil
Crystallising dish (that you have made)

Adults please note HOT WATER to be used in this experiment. NEVER USE BOILING WATER OR WATER AT TEMPERATURES THAT CAN BURN.

Repeat Experiment 3.1 using 8 measures of aluminium potassium sulphate in place of copper sulphate, and 6cm of water instead of 3cm. Which of the three shapes shown in the diagram do potassium aluminium sulphate crystals most resemble? (Remember to store away from young children, pets and foodstuffs.)

EXPERIMENT 3.3 Sodium chloride crystals

Test tube
Conical flask
Beaker
Funnel

You will need to supply
Drinking glass
Sodium chloride (common salt)

Adults please note HOT WATER to be used in this experiment. NEVER USE BOILING WATER OR WATER AT TEMPERATURES THAT CAN BURN.

Fill 6cm of a test tube with solid sodium chloride. Use the funnel to transfer it from the test tube into the conical flask. Add 20ml of hand-hot water from a tap (measured in your beaker). Gently shake the flask to help the sodium chloride dissolve. It may not all do so. Allow the solution to cool.

Pour the solution into a glass container with a clear bottom (a drinking glass is ideal) and leave it somewhere warm. (Store away from young children, pets and foodstuffs.)

Look at the container each day. You will see crystals of sodium chloride forming in the bottom of the container (some may also form on the surface).

Which of the three shapes in the diagram do sodium chloride crystals most resemble? You can see the crystals more clearly if you look up through the bottom of the container.

EXPERIMENT 3.4 Magnesium sulphate crystals

Magnesium sulphate (N.B. You will need more of this chemical than supplied in the set for this experiment!)
Beaker
Test tube

You will need to supply
Small saucepan
Glass container
MORE magnesium sulphate
Wooden spoon

IMPORTANT! Please note that use of a saucepan and stove are part of this experiment. NEVER leave a child unattended near a working stove, or with saucepans of heated liquids! ADULT PARTICIPATION NECESSARY!

There is a sample of magnesium sulphate in the Chemistry Set, but to carry out this experiment you will need to buy more. It is sold in pharmacies as Epsom salts. Magnesium sulphate has this name because it is an important chemical in drinking water that was first found in spring water at Epsom in Surrey over 300 years ago in 1695.

Put half a beakerful (60g) of magnesium sulphate into a small saucepan and add 3 test tube-fulls (60ml) of water.

Continued...

EXPERIMENT 3.4 Continued...

Gently heat on a stove, whilst stirring, until the magnesium sulphate has dissolved. Allow it to cool, and then pour it into a glass container. Put this to stand undisturbed in a warm place. (Store away from young children, pets and foodstuffs.)

As the water evaporates away, a mass of clear crystals of magnesium sulphate are formed. Which of the three shapes shown in the diagram do magnesium sulphate crystals most resemble?

Sometimes magnesium sulphate crystallises as big crystals over a period of time, sometimes as small crystals quickly. Exactly what will happen will depend on the conditions, such as how slowly the solution cools, how warm it is where you are keeping it, and how much it gets disturbed. If small crystals grow, try again. You can safely experiment using a slightly larger or slightly smaller quantity of magnesium sulphate.

EXPERIMENT 3.5 Ammonium chloride crystals

Ammonium chloride
Test tube
Dropping pipette

You will need to supply
Small mirror
Magnifying glass (if you have one)
Crystallising dish (that you have made)

Put half a measure of ammonium chloride into a clean dry test tube, add 2cm of water and shake the test tube until the ammonium chloride has dissolved. Pour the solution into a crystallising dish. Use the dropping pipette to put some of the solution onto a small mirror. Put the mirror somewhere warm for the water to evaporate. (Store away from young children, pets and foodstuffs).

You can clearly see ammonium chloride crystals on the mirror. Which of the three shapes shown in the diagram do ammonium chloride crystals most resemble? Their beauty is best seen if you look at them through a magnifying glass.

EXPERIMENT 3.6 Growing large crystals

Aluminium potassium sulphate

You will need to supply

Saucepan

Wooden spoon

Glass container (e.g., a drinking glass)

Sewing thread

Pencil

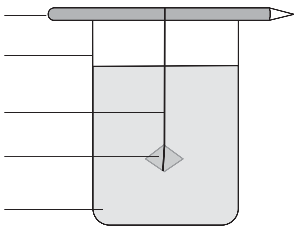
Kitchen roll

More aluminium potassium sulphate

IMPORTANT! Please note that use of a saucepan and stove are part of this experiment. NEVER leave a child unattended near a working stove, or with saucepans of heated liquids! ADULT PARTICIPATION NECESSARY!

Note: There are insufficient chemicals supplied in your lab to carry out this experiment. Before you can carry out this experiment, you need to buy more aluminium potassium sulphate from a chemical supplier.

To grow really large crystals you need to suspend a small one (known as the seed crystal) in a saturated solution of the chemical and let the water slowly evaporate away. As it does so the chemical will grow as one large crystal on the seed crystal. The best chemicals for growing large crystals are aluminium potassium sulphate and copper sulphate. The method is described here for aluminium potassium sulphate.



First you need a seed crystal of aluminium potassium sulphate which you have grown (as in Experiment 3.2).

Get a suitable container (e.g., an egg cup, a drinking glass or a jam jar) the size of which will depend on the amount of the aluminium potassium sulphate that you have available. Measure the volume of the container that you are using.

You now need a saturated solution of aluminium potassium sulphate that will fill your container. Prepare this by measuring into a small saucepan 32g of aluminium potassium sulphate and 1 measure of sodium hydrogen sulphate (to keep the solution acidic and prevent decomposition of the aluminium potassium sulphate) for every 100g (100ml) of water. (It is best to weigh the potassium aluminium sulphate but, if this is not possible, 32g is 1 test tube-full plus another 6cm in the test tube.) Gently heat on a stove; stir the solution with a wooden spoon until all the aluminium potassium sulphate has dissolved.

Continued...

EXPERIMENT 3.6

Continued...

When cool enough, pour the solution into the container and leave it for 24 hours. (Store away from young children, pets and foodstuffs.)

Some aluminium potassium sulphate crystals should be formed, leaving a saturated solution. Filter, or carefully pour, off this solution into another temporary container, and wash and dry the container in which you are going to grow the crystal.

One of the crystals deposited during this initial cooling may be a suitable seed crystal.

Tie a piece of sewing thread around your seed crystal. Tie the other end of the thread around a pencil, so that the seed crystal hangs in the middle of the container.

Carefully fill the container with the cold, saturated solution and hang the seed crystal in place. Put the container where it will not be disturbed – somewhere where the temperature does not change much from day to night is best; otherwise the crystal may grow during the cold night and dissolve again during the warm day! Store well away from young children, pets and foodstuffs. A good tip is to grow the crystal only at night when the temperature is falling. Each morning take the crystal out of the solution and lay it on a piece of paper towel. Each night put it back into the solution. A large crystal will grow over a period of several weeks. Take it out of the solution from time to time to look at it and to remove any small crystals that are growing on it and on the thread.

If small crystals grow on the sides and bottom of the container, pour out the solution, wash and dry the container and refill it, then continue the experiment.

In this way over a period of weeks and months very large crystals can be grown. It is easy to grow crystals, but difficult to grow perfect big crystals. Sometimes you may see competitions for crystal growing. If you are interested in crystal growing, you can buy a book on crystals and crystal growing and get the chemicals from a chemical supplier.

National Geographic also offers an excellent Crystal Growing Kit (NG16).

EXPERIMENT 3.7 Growing large crystals (2nd type)

Copper sulphate

You will need to supply

Saucepan

Wooden spoon

Glass container (e.g., drinking glass)

Sewing thread

Pencil

Kitchen roll

More copper sulphate

IMPORTANT! Please note that use of a saucepan and stove are part of this experiment. NEVER leave a child unattended near a working stove, or with saucepans of heated liquids! ADULT PARTICIPATION NECESSARY!

Note: There are insufficient chemicals supplied in your lab to carry out this experiment. Before you can carry out this experiment you need to buy more copper sulphate from a chemical supplier.

Follow the same instructions as Experiment 3.6 to grow your crystals, substituting the following ingredients.

First you need a seed crystal of copper sulphate which you have grown as in Experiment 3.1.

As you are growing a copper sulphate crystal you will need to add 60g of copper sulphate and 1 measure of sodium hydrogen sulphate for every 100g (100ml) of water. (60g of copper sulphate is 2 test tubes-full.) Follow the remaining instructions in the previous experiment.

CHAPTER 4 – PAPER CHROMATOGRAPHY

Paper chromatography is a method of separating two or more substances. It is particularly useful if the substances are coloured.

EXPERIMENT 4.1 To separate a mixture of litmus and methyl orange

Methyl orange

Litmus blue

Test tube

Beaker

Dropping pipette

Filter paper

You will need to supply

Pair of scissors

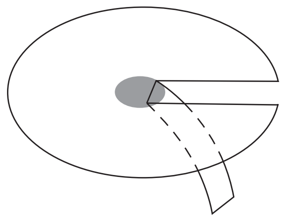
Crystallising dish (that you have made)

Put a quarter measure of methyl orange and a quarter measure of litmus blue in a clean dry test tube; add 1cm of warm tap water. Gently shake the solution. Let it cool.

Fill the beaker with water to within 5mm of the top. Pour the methyl orange and litmus solution into a crystallising dish. Use the dropping pipette to put 2 or 3 drops in the middle of a filter paper. Cut a 'wick' in the middle of the paper with the scissors as in the diagram.

Continued...

EXPERIMENT 4.1 Continued...



Lay the filter paper on top of the beaker with the wick in the water. Water will be drawn up and spread out on the filter paper, taking the methyl orange and litmus with it. Stop the experiment when the water reaches the edge of the paper. You've produced a chromatogram. What does it show? Dry it and label it.

EXPERIMENT 4.2 The analysis of black and green food colourings

Test tube

Conical flask

Large filter paper

Dropping pipette

You will need to supply

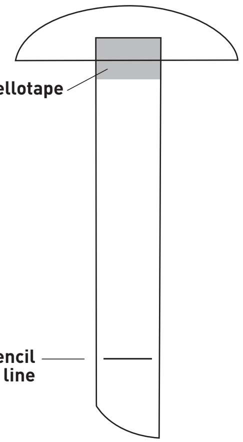
Sellotape

Pair of scissors

Pencil

Small paintbrush (or use the pipette)

Black and green food colouring



Here we use an alternative method of making a chromatogram, using less filter paper than above.

1 filter paper can be used for 4 chromatograms.

Cut four $1^1/_2$ cm-wide strips from the widest part of a large (11cm) filter paper. Stick a second piece cut from the waste filter paper across the top as in the diagram. Draw a pencil line 2cm from the bottom end of each strip.

Put 3 strips aside for other experiments.

Use the paintbrush to paint a line of black food colouring on the pencil line, or add 2 drops of the colouring in the middle of the line using the dropping pipette.

Put a test tube-full of water in the conical flask and hang the strip in the flask. The colouring will be just above the water, which will rise up the paper taking the colouring with it, and separating the different dyes that make up the black food colouring.

Stop the experiment when the water reaches the top of the filter paper strip. Dry the chromatogram and label it. Describe what it shows.

Repeat the experiment using green food colouring.

The two food colourings should have listed on their labels the single dyes which they contain. Do your paper chromatograms agree with what is given on the labels?

EXPERIMENT 4.3 The analysis of inks

Test tube
Conical flask
Large filter paper
Dropping pipette

You will need to supply
Black felt-tipped pen
Other inks or different colour felt-tipped pens
Sellotape
Pair of scissors
Pencil
Small paintbrush (or use the pipette)

Use the method given in Experiment 4.2 to analyse food colouring. Repeat the experiment using a black felt-tipped pen. How many dyes does it contain?

Then try the experiment with other inks or different colour felt-tipped pens.

Some colours will be just a single dye, others will be mixtures. Try several colours, for example, red, green, blue, purple and brown felt-tipped pens. Do many of those that you try contain a single dye?

CHAPTER 5 – ACIDS AND ALKALIS

Solutions of acids and of alkalis must be handled with care. Always wash your hands if you spill any of the solutions on yourself. **Always wear your goggles!**

The word 'acid' is commonly used in everyday life where it is usually regarded as a dangerous liquid that eats away metal and burns your skin. It is said to be 'corrosive'. An acid is not necessarily corrosive, but they should all be treated with care. You will read in chemistry books that all acids have a sour taste and turn blue litmus red.

An alkali is the opposite of an acid and neutralises an acid.

EXPERIMENT 5.1 Making sodium hydrogen sulphate solution

Sodium hydrogen sulphate
Conical flask
Test tube
Funnel

You will need to supply
Small clean bottle with lid/cap
Label

Sodium hydrogen sulphate is an acidic salt. You will need a solution of it for many of the experiments.

Put 8 measures of sodium hydrogen sulphate into a clean dry conical flask and add a test tube-full of warm water (from a tap). Gently shake to dissolve. Now add a second test tube-full of water.

Carefully pour the solution into a clean, dry bottle using the funnel if necessary. Add 2 more test tubes-full of water into the bottle. **Label and seal the bottle – THIS IS VERY IMPORTANT**.

EXPERIMENT 5.2 Making lime water

Calcium hydroxide

You will need to supply
Small clean bottle with lid/cap
Label

Lime water is a solution of calcium hydroxide.

Put 2 measures of calcium hydroxide into a bottle and add 80ml of water (measured) in the beaker. Put the cap on the bottle and shake for a minute or so. Leave it to stand, and the solid particles of the calcium hydroxide which remain will settle leaving a clear solution. This clear solution is lime water. To use, carefully pour off the clear solution. **Label and seal the bottle – THIS IS VERY IMPORTANT**.

EXPERIMENT 5.3 Making sodium carbonate solution

Sodium carbonate
Beaker
Conical flask
Funnel
Filter paper

You will need to supply
Wooden lolly stick
Small clean bottle with lid/cap
Label

Add 3 measures of sodium carbonate to 50ml of warm water in the beaker. Stir the solution with a wooden stick until all the solid has dissolved. Filter the milky solution into the conical flask through a filter paper and funnel. Pour the solution into an empty bottle. **Label and seal the bottle – THIS IS VERY IMPORTANT**.

EXPERIMENT 5.4 To show that acids have a sour taste and are neutralised by alkalis.

You will need to supply
A lemon
Citric acid
Sodium hydrogen carbonate (sodium bicarbonate)
A plate
An egg cup

Please note (as you are going to taste things in this experiment) DO NOT use apparatus previously used for other chemical experiments. Wash your hands before starting this.

Normally you should **NEVER TASTE** a chemical. However some chemicals that are in our food are obviously safe to taste. One such chemical is citric acid. This is the acid found in most citrus fruits such as oranges and lemons. It is also put into many sour-tasting sweets and fizzy drinks.

Continued over...

EXPERIMENT 5.4

Continued...

An alkali which we can eat is sodium hydrogen carbonate (sodium bicarbonate). This is used in cooking to make cakes rise and in stomach powders that are taken if you have indigestion.

Squeeze a lemon and taste the juice. Does it taste sharp and sour? You are tasting citric acid; make a note of the taste.

Put a little citric acid from the pharmacist and a little sodium hydrogen carbonate (sodium bicarbonate) onto a plate. Wet a clean finger, dip it into the citric acid and taste it. Does it have the same sharp taste as the lemon juice?

Now do it again and immediately after putting the citric acid on your tongue, dip your finger in the sodium hydrogen carbonate and taste it. Has the sharp citric acid taste disappeared?

You can carry out a similar experiment by putting a little lemon juice into an egg cup. Taste the lemon juice and then add a little sodium hydrogen carbonate (sodium bicarbonate) and taste again. Keep doing this until the sharp taste of the lemon juice has disappeared.

Why do you think citric acid has this name?

EXPERIMENT 5.5 Using litmus to test for acids and alkalis

Litmus blue

Test tube

You will need to supply

Citric acid

Sodium hydrogen carbonate (sodium bicarbonate)

Dissolve a 'pinch' (less than a quarter measure) of litmus blue in 2cm of warm tap water in a test tube. Shake gently to help the litmus dissolve. Adda quarter measure of citric acid. The blue colour changes to red.

Now adda half measure of sodium hydrogen carbonate (sodium bicarbonate) and shake the tube. Does the colour go back to blue? If not, add more sodium hydrogen carbonate until it does.

The litmus is red in acidic solution and blue in alkaline solution. It is acting as an acid-alkali indicator.

EXPERIMENT 5.6 Using methyl orange to test for acids and alkalis

Methyl orange

Sodium hydrogen sulphate solution (made in 5.1)

Sodium carbonate solution (made in 5.3)

Test tube

Conical flask

Dropping pipette

You will need to supply

2 crystallising dishes (that you have made)

There are many different 'indicators'. Put a 'pinch' (less than a quarter measure) of methyl orange into a test tube with 2cm of very warm tap water, shake gently to dissolve it. Pour the methyl orange solution into the conical flask.

Pour a little of your sodium hydrogen sulphate solution into a crystallising dish. Add 10 drops of this solution to the methyl orange solution using the dropping pipette. The colour of the methyl orange changes to red.

Pour some of your sodium carbonate solution into a clean crystallising dish. Sodium carbonate is an alkali. Add drops of it with the dropping pipette to the red solution in the conical flask, gently shaking your flask as you do so. Suddenly the red-coloured methyl orange solution will turn to yellow. This is when the solution changes from being acidic to being alkaline.

You can make this solution acidic again by adding more drops of the sodium hydrogen sulphate solution. Very few will be needed before the colour turns back to red. You can keep changing the colour between red and yellow in this way forever. N.B. Wash out your dropping pipette between acid and alkali solutions so you do not contaminate either.

EXPERIMENT 5.7 Testing the soil from a garden

Universal indicator paper

Dropping pipette

You will need to supply

Cup

Garden tools for digging up some soil

Lolly stick

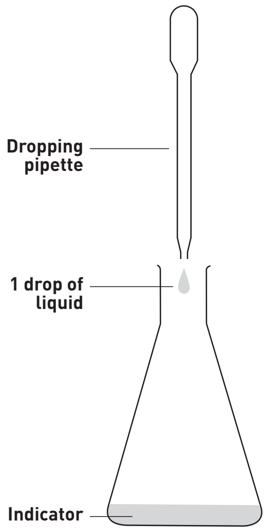
It is important for a gardener to know whether the soil is acid or alkaline, as some plants will only grow in acid soil and some in alkaline soil.

Dig a little soil from a garden (ask permission from an adult before doing this!). Do not take the surface soil, but go down a few centimetres. Add about a dessert spoonful of soil to twice as much water in a cup (or mug). Stir the mud and leave it to settle overnight. Take a sample of the clear liquid with your dropping pipette and test it on a piece of universal indicator paper. Is it acid or alkaline? Try the same experiment from a different area of the garden or a neighbour's, friend's, relative's garden (always ask permission first). Make a note of your findings.

EXPERIMENT 5.8 Neutralisation of an acid with an alkali using a universal indicator

Universal indicator paper
Sodium hydrogen sulphate solution (made in 5.1)
Sodium carbonate solution (made in 5.3)
2 test tubes
Conical flask
Dropping pipette

You will need to supply
2 crystallising dishes (that you have made)
Sheet of white paper
Citric acid (from pharmacist)
Sodium hydrogen carbonate (sodium bicarbonate)



The indicator chemicals in a piece of indicator paper can be dissolved in water and used in solution. Tear a piece of universal indicator paper into several pieces, and put them into a clean conical flask. Add 2cm of water from a test tube. Gently shake to dissolve the indicator from the paper, a green solution will be formed. Stand the conical flask on a piece of white paper so the colour of the indicator shows clearly.

Dissolvea half measure of citric acid in 5cm of water in a test tube and pour the solution into a crystallising dish. Dissolvea half measure of sodium hydrogen carbonate (sodium bicarbonate) in 5cm of water in a second test tube, and pour this solution into a second crystallising dish.

Using the dropping pipette, add 10 drops of the sodium hydrogen carbonate to the indicator.
What colour is the indicator?

Wash the dropping pipette and use it to add the citric acid solution DROP-BY-DROP into the conical flask. Gently shake the flask after each drop and note the colour of the indicator. Suddenly the colour will change over one or two drops and remain the same as more citric acid is added.
What colour is the solution now?

Repeat the experiment using sodium hydrogen sulphate solution instead of citric acid and sodium carbonate solution instead of sodium hydrogen carbonate. What are the colours of the indicator in sodium carbonate solution and in sodium hydrogen sulphate solution?

Try to explain what has happened as the indicator has changed colour from its original colour, to that with sodium hydrogen carbonate, and then with citric acid, and then with sodium carbonate and with sodium hydrogen sulphate.

CHAPTER 6 – REACTION OF CARBONATE WITH ACID

When a metal carbonate reacts with an acid it forms a salt, water and carbon dioxide.

EXPERIMENT 6.1 The reaction of carbonate with acid

Sodium carbonate
Sodium hydrogen sulphate solution (made in 5.1)
Calcium carbonate
Test tube

You will need to supply
Indigestion tablet

Put half a measure of sodium carbonate into a test tube and add 2cm of your sodium hydrogen sulphate solution. A violent fizzing occurs as carbon dioxide gas is formed.

Repeat the experiment with 1 measure of calcium carbonate instead of sodium carbonate.

Repeat the experiment again, this time with a crushed-up indigestion tablet, or a little indigestion powder (not one that fizzes when you add water).

What makes some indigestion tablets fizz when you add water?

CHAPTER 7 – REACTIONS WHICH GIVE INSOLUBLE SUBSTANCES

Often when solutions of two chemicals are mixed, a solid substance if formed. The solid is called a precipitate.

EXPERIMENT 7.1 The formation of copper carbonate

Copper sulphate
Sodium carbonate solution (made in 5.3)
2 test tubes
Funnel
Filter paper

You will need to supply
Small container
Label

Dissolve half a measure of copper sulphate in 1cm of water in a test tube. Add 2cm of your sodium carbonate solution.

A blue-green precipitate of copper carbonate is obtained. Filter it off and dry it as described in Experiment 1.4. You have produced a precipitate!

EXPERIMENT 7.2 The formation of magnesium carbonate

Magnesium sulphate
Sodium carbonate solution (made in 5.3)
Sodium hydrogen sulphate solution (made in 5.1)
Test tube

Dissolve half a measure of magnesium sulphate in 1cm of water in a test tube then add 2cm of your sodium carbonate solution.

A white precipitate of magnesium carbonate is formed.

Magnesium carbonate readily dissolves in acids. Add a little of your sodium hydrogen sulphate solution and the precipitate will disappear!

EXPERIMENT 7.3 The formation of sulphur

Sodium thiosulphate
Sodium hydrogen sulphate solution (made in 5.1)
Test tube

Dissolve half a measure of sodium thiosulphate in 2cm of water in a test tube. Add 2cm of sodium hydrogen sulphate solution. The white milky precipitate formed is actually the fine particles of sulphur.

The rest of the experiments in Chapter 7 are reactions which give metals. If a reactive metal (let us call it A) is added to a salt of a less reactive metal (let us call that B), then a metal salt of A is formed, and the metal B that was originally in the salt is seen as a precipitate or as a coating on metal A.

EXPERIMENT 7.4 The replacement of copper by iron

Copper sulphate
Test tube

You will need to supply
Small iron nail
Cotton thread
Emery paper (if nail is rusty)

Dissolve half a measure of copper sulphate in 2cm of water in a test tube. Tie a piece of cotton thread on a small clean iron nail (clean the nail first with sandpaper or emery paper if it is rusty), and put the nail in the copper sulphate solution. After 10 minutes pull the nail out. What has happened to the nail?

EXPERIMENT 7.5 The replacement of copper by iron

Copper sulphate
Iron fillings
2 test tubes
Funnel
Filter paper

You will need to supply
Crystallising dish (that you have made)

Repeat Experiment 7.4 using 1 measure of iron fillings instead of the nail. Leave the test tube and contents for several hours by when the solution should have lost its blue colour. Filter off the solids, and pour the filtrate into a crystallising dish and leave it in a warm place. (Store away from young children, pets and foodstuffs.) Iron sulphate crystals will form. What colour are they?

EXPERIMENT 7.6 The replacement of copper by magnesium

Copper sulphate
Magnesium strip
2 test tubes
Funnel
Filter paper

You will need to supply
Emery paper (if your strip is dull)
crystallising dish (that you have made)

Repeat Experiment 7.4 using a 2cm piece of magnesium strip (clean it with sandpaper or emery paper if it is not bright and shiny) instead of the nail. Describe what happens. Does the blue colour of the copper sulphate solution disappear as the copper is replaced by magnesium?

Leave the solution for a few hours (store away from young children, pets and foodstuffs), and then filter off the solids and crystallise the magnesium sulphate that is in the filtrate as in Experiment 7.5.

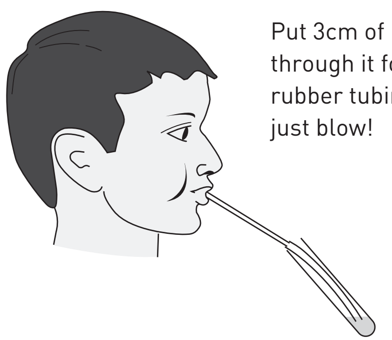
CHAPTER 8 – THE CHEMISTRY OF CARBON DIOXIDE AND OXYGEN

About one fifth of the Earth's atmosphere is oxygen.

Carbon dioxide is an important gas. It is present in air and all animals produce it when breathing in a process called respiration. It is used by plants during a process called photosynthesis when the plants use the carbon dioxide as their source of carbon. Oxygen is also a very important gas. All animals need it to live, and it is used by our bodies to 'burn' food in our cells.

EXPERIMENT 8.1 To show that animals produce carbon dioxide

Lime water (made in 5.2)
Test tube
Glass and rubber tubing



Carbon dioxide can be detected by bubbling it through lime water (calcium hydroxide solution). The clear lime water turns milky due to the formation of the solid calcium carbonate.

Put 3cm of lime water in a test tube, and gently blow through it for a half a minute using the glass and rubber tubing. What happens? N.B. DO NOT suck, just blow!

EXPERIMENT 8.2 To show that air contains carbon dioxide

Lime water (made in 5.2)

You will need to supply
Small glass

Put a little lime water into a small glass and leave it standing for a day or so. (Store away from young children, pets and foodstuffs.) Observe what happens. What does this show you?

EXPERIMENT 8.3 To show that carbon dioxide is an acid

Universal indicator paper
Test tubes
Glass and rubber tubing

Carbon dioxide dissolves in water to give carbonic acid.

An accurate test for this is by using universal indicator in solution. Fold up one sheet of universal indicator paper and put it into a test tube. Add 3cm of water. Gently shake to dissolve the indicator from the paper; a green solution will be formed. Pour about a half of this solution into another test tube. Keep the original for the next experiment.

Blow gently through the indicator in the second test tube for about one minute using the glass and rubber tubing. **DO NOT** suck, just blow! Compare the colour of the indicator in this test tube with the original test tube. Is the one you have blown into more yellow coloured?

EXPERIMENT 8.4 To identify the gas in sparkling water

Universal indicator paper
Test tube
Dropping pipette

You will need to supply
Sparkling water

Because carbon dioxide is an acid, with the characteristic sharp sour taste, it is used to put the fizz into sparkling water and fizzy drinks. It is also the gas in beer. Here you can test for the acidity of sparkling water by using universal indicator in solution.

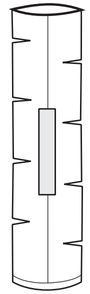
Pour some of the universal indicator solution left over from Experiment 8.3 into a test tube, and with your dropping pipette add an equal volume of sparkling water. What is the colour of the indicator?

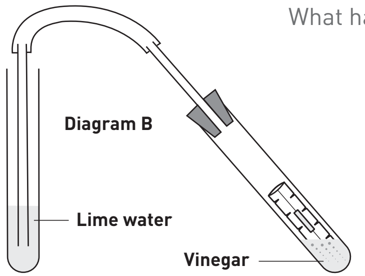
EXPERIMENT 8.5 The reaction of carbonates with acid

Sodium hydrogen sulphate solution (made in 5.1)
Lime water (made in 5.2)
2 test tubes
Glass and rubber tubing
Cork with hole for test tube

You will need to supply
Sodium hydrogen carbonate (sodium bicarbonate)
Vinegar
Aluminium foil
Lolly stick
Sellotape
Pair of scissors

Diagram A





In Experiment 6.1 you carried out the reaction between carbonate and an acid and saw a violent fizzing. You did not test that the gas was carbon dioxide by passing it through lime water. This is difficult to do as the reaction is so quick you do not have time to assemble the bubbling apparatus in time. This experiment is a trick used to slow down the reaction long enough for you to put the apparatus together.

Have ready 3cm or 4cm of lime water in a test tube and have your gas tube all assembled (see section at beginning of manual regarding glass tubing).

Cut a 4cm square of aluminium foil and fold it round a lolly stick to make a packet. Let the end of the foil extend over the end of the stick and fold it over to make a sealed bottom. Put a piece of sellotape on the foil edge to hold the packet together and slide it off the lolly stick. It should be about $3^1/_2$ cm long. Carefully fill the packet with sodium hydrogen carbonate (sodium bicarbonate) and when full, very carefully cut 4 'nicks' up each side with a pair of scissors extending about a quarter of the way across the packet as in Diagram A.

Put 3cm of vinegar in a test tube, drop in the packet of sodium hydrogen carbonate and assemble the gas tube as in the following Diagram B. The ethanoic acid in the vinegar will slowly mix with the sodium hydrogen carbonate and produce plenty of carbon dioxide gas. Bubble this into the lime water. What happens?

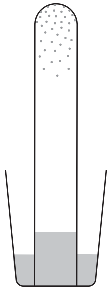
EXPERIMENT 8.6 The proportion of oxygen in air

Iron fillings

Test tube

You will need to supply

Small glass



Wet the inside of a test tube and then sprinkle in some iron fillings so they stick to the glass. Turn the tube upside down in 1cm of water in a small glass. Leave it for 2 or 3 days. (Store away from young children, pets and foodstuffs.) When the level of water inside the test tube no longer changes, estimate the proportion of the test tube containing water.

What has happened to the oxygen in the air inside the test tube? What proportion of air is oxygen? What is the main gas left in the test tube? What has happened to the iron fillings?

EXPERIMENT 8.7 The rusting of iron

2 test tubes

You will need to supply

4 DIY nails

Sodium chloride (common salt)

2 crystallising dishes (that you have made)

IMPORTANT! Adults please note there is call in this experiment for boiled water! Let the water cool down a little before use. NEVER USE BOILING WATER OR WATER AT TEMPERATURES THAT CAN BURN. NEVER leave children unattended with electrical equipment, near lit stoves or with saucepans of hot liquids. ADULT PARTICIPATION NECESSARY.

Get 4 bright shiny nails. Put one nail in an absolutely dry test tube and put the cap on the test tube. Put the second nail in a test tube with some water that has been boiled (ask an **adult** to provide this). Put the third nail in a crystallising dish with some cold water. Put the fourth nail in another crystallising dish with some water in which has been dissolved one measure of sodium chloride.

Leave them all for a few days. (Store away from young children, pets and foodstuffs.) Describe what has happened to each of the nails. From the results of this experiment, what do you think is necessary for iron to rust?

EXPERIMENT 8.8 Bleaching with oxygen

Litmus blue

Test tube

You will need to supply

3% hydrogen peroxide solution

Oxygen in hydrogen peroxide is used for bleaching. Hairdressers use it to bleach hair!

Mix a 'pinch' (less than a quarter measure) of litmus blue with 2cm of warm tap water in a test tube, gently shake to dissolve. N.B. Not all of it will dissolve. Add an equal volume of hydrogen peroxide solution. Is the blue colour bleached away?

EXPERIMENT 8.9 Oxidation of fruit

You will need to supply

An apple

Vitamin C tablet

Knife

2 identical teaspoons

Many fruits, when they have had their skin removed, readily react with oxygen and spoil.

Crush a vitamin C tablet by breaking it into a few pieces, and crush these to a powder by putting them into the bowl of a teaspoon and pressing the back of the bowl of an identical spoon on them. Cut an apple in half. Put one half aside. Rub the crushed vitamin C onto the second half of the apple.

Leave the two apple pieces and check them after a few hours. (Store away from young children pets and foodstuffs.) Describe what you see.

Vitamin C is a substance known as an antioxidant (something that stops oxidation). Do your observations agree with this?

CHAPTER 9 – SOME IODINE CHEMISTRY

EXPERIMENT 9.1 The preparation of a solution of iodine

Potassium iodide

Sodium hydrogen sulphate solution (made in 5.1)

Test tube

Dropping pipette

You will need to supply

Label

3% hydrogen peroxide solution

N.B. If you still have your solution of iodine from Experiment 2.4, you do not need to do this experiment.

Dissolve 1 measure of potassium iodide in 2cm of sodium hydrogen sulphate solution in a test tube. Add 10 drops of hydrogen peroxide solution with the dropping pipette.

A yellow-brown solution of iodine is formed. Half fill the test tube with water. **Label and seal the tube – THIS IS VERY IMPORTANT**.

EXPERIMENT 9.2 Testing for iodine with starch

Iodine solution (made from either 9.1 or earlier in 2.4)

Test tube

Dropping pipette

You will need to supply

Starch solution (read 2.5 instructions to learn how to collect this)

In Experiment 2.5 an invisible message written with starch solution turned blue when dipped in iodine solution. The formation of this blue colour with starch is a very sensitive test for iodine.

Add 4 drops of iodine with the dropping pipette to half a test tube of water, followed by 4 drops of starch solution. Use laundry spray starch (see Experiment 2.5) or the starch solution prepared in the next experiment. The solution turns deep blue.

EXPERIMENT 9.3 Starch from a potato

Iodine solution (made from either 9.1 or earlier in 2.4)

Test tube

Dropping pipette

You will need to supply

Starch solution (see 2.5)

A potato

Saucepan

Knife

Pyrex® jug (or other heatproof jug/saucepan)

IMPORTANT! Please note that use of a saucepan and stove are part of this experiment. NEVER leave a child unattended near a working stove or with saucepans of heated liquids! BOILING WATER ALERT! ADULT PARTICIPATION NECESSARY.

Many foods contain starch; it is an important part of our diet.

Cut a small potato into small pieces. (Potatoes are quite hard, so a sharp knife may be necessary and adult assistance is required!) Put these into a small saucepan and just cover with water. **ADULTS NOTE!** Boil on the stove for 5 minutes. Carefully pour off the boiling liquid into a heatproof jug. Wait for it to cool before use. (Store away from young children and pets where it cannot be knocked over or pulled down.)

Repeat Experiment 9.2 using the potato liquid instead of the starch. The solution turns blue showing that this liquid contains starch.

You can also put a few drops of your iodine solution onto the cut surface of an uncooked potato. Do you get a blue colour?

Continued...

EXPERIMENT 9.3 Continued...

See if you can find any starch in other foods (for example in bread and in breakfast cereals). Boil a little of the food with water in a saucepan, and after cooling the liquid test it, as in Experiment 9.2.

EXPERIMENT 9.4 The reaction of iodine with sodium thiosulphate

Sodium thiosulphate

Iodine solution (made from either 9.1 or earlier in 2.4)

Test tube

Dropping pipette

Dissolve a quarter measure of sodium thiosulphate in about 2cm of water in a test tube. Add iodine solution with the dropping pipette. The iodine colour disappears as each drop falls into the sodium thiosulphate solution.

Continue adding the iodine drop-by-drop and eventually all the sodium thiosulphate is used up and the yellow-brown iodine colour remains.

EXPERIMENT 9.5 Testing for vitamin C

Iodine solution (made from either 9.1 or earlier in 2.4)

3 test tubes

Dropping pipette

You will need to supply

Starch solution (see 2.5)

Vitamin C tablet

Orange and/or lemon juice (optional)

Vitamin C is an important vitamin. It is present in many foods, particularly citrus fruits.

Put 4 drops of starch solution into half a test tube of cold water. Add 4 drops of your iodine solution. The dark blue solution produced is your test solution for vitamin C.

Crush a vitamin C tablet as in Experiment 8.9 and dissolve it in 3cm of cold water in a test tube.

Put 2cm of the blue test solution into another test tube and add the vitamin C solution drop-by-drop using the dropping pipette. The blue colour will quickly disappear as the iodine reacts with the vitamin C.

Try adding drops of lemon juice or orange juice to a sample of the test solution. Do they contain vitamin C?

You can test any food for vitamin C with this test.

EXPERIMENT 9.6 A clock reaction

Potassium iodide

Sodium thiosulphate

Sodium hydrogen sulphate solution (made in 5.1)

3 or 4 test tubes

Conical flask

You will need to supply

White paper

3% hydrogen peroxide solution

Starch solution (see 2.5)

Labels

IMPORTANT! Adults please note HOT WATER to be used in this experiment. NEVER USE BOILING WATER OR WATER AT TEMPERATURES THAT CAN BURN.

The reactions of iodine with starch and of iodine with sodium thiosulphate in the previous experiments can be combined in a very clever chemical reaction that you can use to amuse and amaze your friends. All good magicians practise, so try out this experiment on your own before showing it to someone else!

It is very important that you use the exact quantities given here if the experiment is to work.

Dissolve 1 measure of potassium iodide and a quarter measure of sodium thiosulphate in water in a test tube, and then add water to fill the test tube. This is **solution A**. Label it!

In a second test tube mix 2cm hydrogen peroxide solution and 2cm sodium hydrogen sulphate solution, and then add water to fill the test tube. This is **solution B**. Label it!

Measure 2cm of **solution A** in another test tube, put it into the conical flask and add 4 drops of starch solution (either spray starch or potato starch will do). Add 2cm of **solution B** from its test tube. The solution in the flask will be clear.

Stand the conical flask on a sheet of white paper and wait.

After about 30 seconds the solution suddenly turns blue. This is called a clock reaction.

What is happening here is that iodine is being produced as in Experiment 9.1. This is immediately reacting with the sodium thiosulphate as in Experiment 9.4.

Continued...

EXPERIMENT 9.6 Continued...

Eventually all the sodium thiosulphate is used up, and some iodine remains in the conical flask. This then reacts with the starch as in Experiment 9.2 to give the blue colour.

If you warm the tubes of **solutions A** and **B** by holding them in hot water (hand-hot water from a tap is sufficient; run into a bowl and then hold the test tubes in the bowl) before mixing, the blue colour will appear in a shorter time.

If this experiment does not work it is most likely that you have too much sodium thiosulphate (or too little potassium iodide) in solution A. Make new solutions and try again.

CHAPTER 10 – MAKE SUGAR CANDY

EXPERIMENT 10.1 Making sugar candy

Beaker

You will need to supply

Sugar

Heatproof glass container (a Pyrex® jug is suitable)

Saucepan

Strong thread

Pencil

Wooden spoon

Container (for poured-off cold syrup)

Kitchen roll

WARNING! ADULTS! BOILING LIQUID ALERT! VERY HOT SUGAR SOLUTION WILL BURN! NEVER leave a child unattended near a stove or with boiling liquids. ADULT PARTICIPATION NECESSARY!

This last experiment is a treat to celebrate that you have now carried out all the experiments in this booklet. (You have done them all haven't you?)

In Chapter 3 you made crystals of a number of different chemical substances. Here you will make a large crystal which you can eat.

You will need the help of an **adult** for this experiment as you have to make a large quantity of very hot sugar solution.

Get a large glass container into which you can safely put hot sugar solution. A 1-pint Pyrex® glass kitchen measuring jug is ideal. A jam jar is not suitable as the hot sugar solution may crack it.

Continued over...

EXPERIMENT 10.1

Continued...

Fill the container with water to within 3cm of the top and measure this volume of water. You can use your beaker to do this; keep filling the beaker with the water 100ml at a time and count how many beakerfuls there are.

You need to put half of this volume of water into a saucepan and add $2^1/_2$ times as much sugar (by volume) as water. If, for example, you do use a kitchen measuring jug then when it is filled to within 3cm of the top, it contains 500ml. So you would put 250ml of water and 625ml (note measured by volume) of sugar into the saucepan.

ADULT ASSISTANCE! Heat and stir the mixture of sugar and water on a stove until it boils. Once it boils, STOP STIRRING and continue boiling gently for two minutes. This sugar syrup is **VERY HOT**. Let it cool for five minutes (keep away from young children and pets) and then pour it carefully into the glass container. It should almost fill the container. When the syrup is cool enough to handle move the container to a place where you can easily see it. Cover it with a piece of kitchen roll to keep out dust, flies, etc. Leave for two or three days by which time there should be some sugar crystals on the bottom (and maybe floating on the top) of the container. If none have formed put a sprinkle of sugar into the syrup.

When some sugar crystals have formed, pour off the syrup into a temporary container and get a lump of the sugar crystals. This will be your seed-crystal. Pat it dry with kitchen roll and tie a piece of strong thread around it.

Wash the remaining sugar out of the heatproof container, dry it and put the syrup from temporary container back into it.

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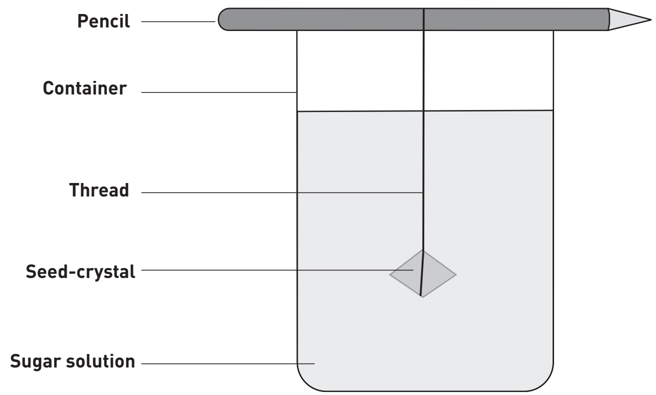

Hang the seed-crystal from a pencil resting across the top of the glass container. You want to hang the seed-crystal in the middle of the container.

The next part is the most difficult. Let the syrup solution stand for two or more weeks WITHOUT TOUCHING IT. If you move the container it may spoil the experiment. Ask an adult where you can keep your container without it being moved in any way. You should select a clean place where it will not attract dust and dirt. Day by day you should see the seed-crystal grow into a large irregular lump of sugar candy.

When you can wait no longer, remove the sugar candy from the syrup. Do this in a sink as there will be a lot of sticky sugar syrup to throw away. Quickly wash the syrup off the crystals and pat them dry with kitchen roll. Keep the candy in a dish and eat it a little at a time, but remember that sugar is very bad for your teeth, so don't eat too much and thoroughly clean your teeth afterward. ENJOY!

EXPERIMENT RESULTS

1.1 The copper sulphate, sodium chloride and sugar are soluble; the calcium carbonate and pepper are insoluble.

1.2 Sodium sulphate dissolves fairly quickly in both cold and warm water, but the one in warm water is the quickest.

Most chemicals increase in solubility the hotter the solvent.

1.3 Blue crystals of copper sulphate.

2.1 Lemon juice creates brown writing.

2.2 Iron sulphate creates brown writing.

2.3 Yellow-green writing.

2.5 Blue writing.

3.1 Copper sulphate – rhombohedra crystals.

3.2 Aluminium potassium sulphate – rhombohedra crystals.

3.3 Sodium chloride – cubic crystals.

3.4 Magnesium sulphate – long needle-like crystals.

3.5 Ammonium chloride – long, thin fern-like crystals.

4.1 The blue litmus travels farther than the methyl orange. There is a circular blue band surrounding a circular orange band. The two indicators have been separated.

4.2 Black food colouring has blue, yellow and red bands on the chromatogram from top to bottom. Green food colouring has blue and yellow bands on the chromatogram from top to bottom. Green food colouring contains Tartrazine (a yellow colouring) and Green S (a blue-green colouring). Black food colouring contains the same two dyes as green and also contains Carmoisine (a red food colouring). The chromatograms agree with this.

4.3 Different black inks may be made up of different dyes. 'Parker Quink' black ink has an upper, thin blue band, an orange band and a large blue band. This indicates that it is made up of two different blue dyes and an orange one. Another black ink that we have tested has a dark-blue and a dark-green band. One black felt-tipped pen that we have tested contained purple and yellow dyes, another contained blue and dark-red dyes. Few felt tip pens are made up of just one dye. The only one that we have found is red.

5.4 Citric acid has this name because it was found to be the main acid in citrus fruits like lemons, oranges, limes and grapefruits.

5.8 Dark-green in sodium hydrogen carbonate solution. Yellow in citric acid solution. Blue-violet in sodium carbonate solution. Red-orange in sodium hydrogen sulphate solution. Sodium hydrogen carbonate is a weak alkali; citric acid is a weak acid; sodium carbonate is a strong alkali; sodium hydrogen sulphate is a strong acid.

6.1 Some indigestion tablets fizz because they contain both an alkali, such as sodium hydrogen carbonate (sodium bicarbonate), and an acid, such as citric acid. When the tablet is added to water, the two chemicals dissolve and react together to give carbon dioxide gas.

7.4 The nail has become coated in brown copper metal. The iron has replaced copper in the copper sulphate to form iron sulphate.

7.5 The iron sulphate crystals are green. (You have some in the Chemistry Set).

7.6 The magnesium strip turns brown as it gets coated in copper metal. After some time there is a brown-black precipitate of copper in the test tube.

8.1 The lime water turns milky showing that you are blowing carbon dioxide gas through it. The clear lime water turns milky due to the formation of the solid calcium carbonate.

8.2 The lime water slowly turns milky showing that air contains carbon dioxide gas.

8.3 Acids turn the universal indicator yellow, then red. Your result here should show that carbon dioxide is an acid. The universal indicator goes yellow showing that carbon dioxide is a weak acid in solution.

8.4 Universal indicator solution is yellow showing that sparkling water is a weak acid.

8.5 The lime water rapidly turns milky showing that carbon dioxide gas is produced.

8.6 The oxygen has reacted with the iron fillings to form iron oxide. About one fifth of the test tube fills with water. This has replaced the oxygen so air is aboutone fifth oxygen. The main gas left is nitrogen. The iron fillings have gone black-brown as they rust.

8.7 The nail in the dry tube remains bright and shiny. The nail in the boiled water will also be bright and shiny if all the air has been removed from the water. The two nails in the crystallising dishes will be rusting. The dish with sodium chloride should show more rust than that in water only. For iron to rust both water and oxygen are necessary. Rust is an iron hydroxide.

8.8 Yes, the blue colour disappears.

8.9 The cut apple quickly browns in air (some varieties of apple quicker than others). The half with vitamin C on it does not go brown. The oxidation by the oxygen in air is stopped by the vitamin C.

9.5 Lemon juice and orange juice both contain vitamin C, and decolourise the test solution.

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