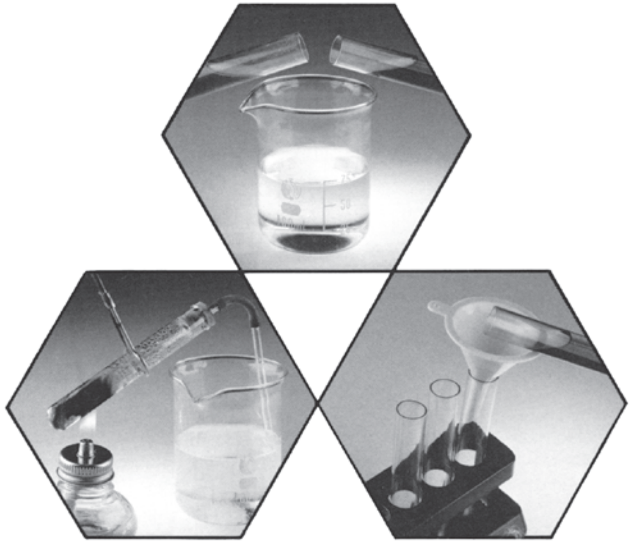
CHEMISTRY LAB KIT
INSTRUCTIONS



WARNING! Not suitable for children under 10 years. For use under adult supervision. Contains some chemicals which present a hazard to health. Read the instructions before use, follow them and keep them for reference. Do not allow chemicals to come into contact with any part of the body, particularly mouth and eyes. Keep small children and animals away from experiments. Keep the experimental set out of reach of children under 10 years old. Eye protection for supervising adults is not included.

CE

MADE IN CHINA

P38-CM001-81001003

CONTENTS :

2 Test Tubes with Stoppers
2 Glass Tubing
1 Beaker(0-100ml)
6 Filter Papers
2 Cork Stoppers with hole
1 Instruction Book
1 Test Tube Rack
1 Cleaning Brush
1 Rubber Tubing
1 Stirring Rod
8 Universal Indicator Paper
1 Funnel
1 Scoop
1 Test Tube Holder
1 Spirit Lamp
1 Measuring Spoon
1 Goggles
2 Cork Stoppers
1 Dropping Pipette

The Safety Rules

Read these instructions before use, follow them and keep them for reference.
Keep young children, animals and those not wearing eye protection away from the experimental area.
Always wear eye protection.
Store this experimental set out of reach of children under 10 years of age.
Clean all equipment after use.
Make sure that all containers are fully closed and properly stored after use.
Ensure that all empty containers are disposed of properly;
Wash hands after carrying out experiments.
DO NOT use any equipment which has not been supplied with the set or recommended in the instructions for use.
DO NOT eat or drink 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.
Disposal of chemicals should be in accordance with local regulations.

Advice for supervising adults

• Read and follow these instructions, the safety rules and the first aid information, and keep for reference.
• The incorrect use of chemicals can cause injury and damage to health. Only carry out those activities which are listed in the instructions.
• This chemical set is for use only of children over 10 years of age.
• Because children's abilities vary so much, even within age groups, supervising adults should exrcise 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.
• 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, alkalies and flammable liquids.
• 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 table with a heat resistant top should be provided.
• The Spirit Burner should be placed on a metal tray. Fill the burner three quarters full with Methylated Spirits. You need about 3mm of wick protruding from the cap. Keep the bottle of Methylated Spririts well away from the Spirit Burner. Light the burner with a match. **CAUTION!** The flame is nearly colourless and in bright sunlight it may be invisible. It is very easy to burn yourself.

General first aid information

In case of eye contact: Wash out eye with plenty of water, holding eye open if necessary. Seek immediate medical advice.
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.
In case of skin contact and burns: Wash affected area with plenty of water for 10 minutes.
In case of doubt seek medical advice without delay. Take the chemical together with the container with you.
In case of injury always seek medical advice.

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: ______________

Take Chemical with you to the hospital

Safety Goggles User Information

Instructions for use, storage and maintenance:

- Hold goggles with one hand, if possible without touching the lens.
- Pull the elastic head band over the back of your head, just above the ears so that the goggles sit on your forehead. Then pull the goggles down over the eyes carefully and adjust strap for a snug and comfortable fit.
- Ensure goggles are kept clean, dry and do not come into contact with loose chemicals or sharp objects.
- Wash with warm soapy water. Rinse and dry with a soft cloth after use.
- Store the goggles under room temperature.

Warning:

- These goggles are only to be used with the contents and instructions supplied. If goggles become damaged, do not attempt to repair and discard immediately.
- The goggles are intended for protection against liquids (droplets or splashes).
- Materials which may come into contact with the wearer’s skin could cause allergic reactions to susceptible individuals.

Goggles Markings:

Model no : A15-CM002-24000008
Manufacturer : Edu-Science (HK) Ltd

1 S – EN166 3 S H CE

- CE → compiles with EN166
- H → designed to fit small heads
- S → intended for protection against droplets or splashes
- 3 → for use with liquids
- EN166 → European Standard for Personal Eye Protection
- S → increased robustness
- 1 → Optical glass

Chemicals Contents :

CHEMICALS x 8

CHEMICAL	Danger Symbol	H-and P-Statements	CAS No	EINECS No
Sodium Carbonate		Causes serious eye irritation, Wear protective gloves and eye protection. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.	**497-19-8**	**207-838-8**
Calcium Carbonate (Marble chips, limestone)		Causes serious eye irritation, Causes skin irritation. Wear eye protection and protective gloves. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. IF ON SKIN: Wash with plenty of soap and water.	**471-34-1**	**207-439-9**
Copper Foil	-	-	**7440-50-8**	**231-159-6**
Tartaric Acid		Causes serious eye irritation, Causes skin irritation. Wear eye protection and protective gloves. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. IF ON SKIN: Wash with plenty of soap and water.	**87-69-4**	**201-766-0**
Methyl Orange		Harmful if swallowed. Do not eat, drink or smoke when using this product. IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.	**547-58-0**	**208-925-3**
Litmus Blue	-	Irritating to eyes. Irritating to respiratory system. Irritating to skin.		
Copper (II) Sulphate	 	Harmful if swallowed, Causes serious eye irritation, Causes skin irritation, Very toxic to aquatic life with long lasting effects. Very toxic to aquatic life. Do not eat, drink or smoke when using this product, Wear eye protection and protective gloves. IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. IF ON SKIN: Wash with plenty of soap and water. Avoid release to the environment.	**7758-98-7**	**231-847-6**
Calcium hydroxide		Causes serious eye damage. Causes severe skin burns and eye damage. Wear eye protection and protective gloves IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or doctor. IF ON SKIN(or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.	**1305-62-0**	**215-137-3**

Dispose of contents and container in accordance with local regulations.

Contents

CAUTION EXPERIMENTS SHOULD BE CONDUCTED IN A WELL-VENTILATED AREA. THIS IS ESPECIALLY IMPORTANT WHEN EXPERIMENTS PRODUCE FUMES. DO NOT BREATHE ANY FUMES.

You and Your Chemistry Set

Used properly, your chemistry set will open a whole new world for you; for there are substances you never dreamt of, hidden and waiting for you to discover, even in ordinary, everyday things. And by mixing certain chemicals together you can make other chemicals, and find out for yourself about chemical reactions. As you progress, you will come to realise what chemistry is really about, and how it is possible for chemists to produce entirely new substances, such as plastics, synthetic rubber and fibres, drugs, paints, dyes, etcetera.

Although some chemical reactions may seem like magic, your chemistry set is not for conjuring tricks, but is a key - your key - for unlocking some of Nature's secrets. And remember that it is only by careful experimentation and observation that the best results are obtained. Who knows, perhaps one day your study of chemistry will result in some important new discovery. Keep careful notes of your experiments. Find a suitable notebook and record what you do, what happens and what you learn.

But before you start experimenting, do read, for your own sake, Section 1 on Safety Precautions. You must have read of accidents in laboratories, and you don't want anything to go wrong in yours. For you will need to set up your own laboratory, even if it is simply an old table in the corner of a garage or workshop. Sections 2 and 3 tell you how to do this and the correct way to carry out experiments.

Section 1 Safety Precautions

1. Set up your laboratory as described in the next Section, so that you are working in conditions which are safe and there is a minimum danger of fire.

2. Always wear an apron to protect your clothing from chemicals, and goggles to protect your eyes, especially when handling acids and alkalis and when heating substances, particularly those which may spurt or give off steam or gases.

3. Handle glass tubing and other glass apparatus very carefully. Broken glass is very sharp. When pushing a glass tube through a cork always hold the tube with a thick cloth.

4. Here are some important **Don't** Rules:-

Don't taste any chemical. Most chemicals are poisonous or injurious in some way.

Don't smell any chemcial or gas.

Don't forget to wash your hands after touching chemicals and apparatus and before touching your face or food.

Don't do your own private experiments. Some chemicals react together to evolve poisonous gases or cause dangerous spurting. So follow the instructions for experiments in the booklet provided.

Don't forget that the spirit burner flame is very hot and is sometimes difficult to see in bright light.

Don't handle glass-cutting saw carelessly. It has a sharp edge.

Don't handle hot apparatus carelessly. It is easy to get painful burns if a hot tripod stand, wire gauze, test tube, etc. is touched. Hot test tubes can stand in an empty tin to cool. Do not place test tubes in the plastic test tube rack provided.

Don't fail to treat acids and alkalis with special care. Both can quickly injure the eyes.

Don't light your spirit burner unless it is first placed on a large metal lid which could if necessary contain all the spirit in the burner.

Don't place your container of methylated spirit or any other flammable substance near the lighted burner.

Don't forget to ensure that the test tube is pointing in a safe direction away from yourself, other people and equipment when you are heating a chemical in case something spurts out.

Don't stop reading here. The next paragraphs tell you what to do if you have been careless.

5. Acids, Alkalis, or other chemicals in the eyes or mouth If you get any chemical in your eyes or mouth, or forget and rub your eyes with unwashed hands, splash in plenty of water. If your eyes or mouth remain painful see your doctor.

6. Burns If you touch something hot only briefly, put your hand quickly in cold water. This will usually stop any burn forming. If you really burn yourself you should go to your parents or a doctor for first aid treatment.

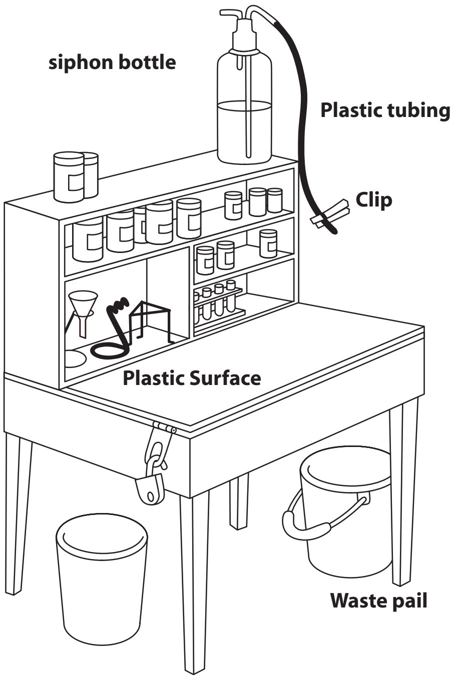
7. **Cuts** Wash a small cut in antiseptic solution, or, failing this, in clean water. Then put on a plaster. In case of any larger injury you should get first aid treatment.

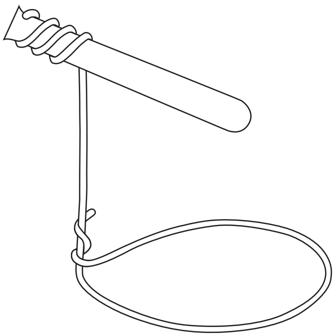
8. **Fire** A small fire on your work table, caused by the spirit burner falling over for example, can be quickly put out by smothering the fire at once with a damp cloth (which should always be kept available). In the most unlikely event that any larger fire occurs, which you cannot handle, call the fire brigade without delay.

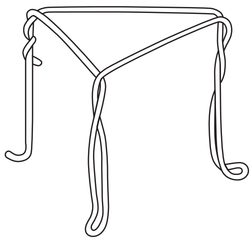
9. **Very young children** Ensure that very young children cannot touch any of your chemicals or apparatus, and do not carry out experiments when they are near you.

10. **Use of household equipment and products** Do not use spoons, containers, etc. which are normally in use in the house. Do not try experiments with household chemicals except the ones described in the booklet experiments. Dangerous accidents have occurred by mixing certain cleansing agents with chemicals.

11. **Mixing chemicals** Although any of the chemicals supplied in your set may be safely mixed together, you should not mix them with other chemicals unless instructions in the experimernts direct you to do so. This can be very dangerous (see para. 10 above). It is a good safety precaution never to do any private experiments, i.e. those not described in the booklet.







Section 2 — Your Laboratory How to Set It Up

Your place of work Your may only have a table or bench in the corner of a room, workshop, or garage. But it is much better to have a place where you will not be disturbed and where young children are not permitted.

Safety Considerations

1. The room should be well ventilated and safe from fire hazards such as stored petrol and oils, gas or electric fires, etc.

2. If running water is not available, keep a bucket of water within reach so that you can wash your hands or quickly put out a small fire with a damp cloth. Have plenty of rags for this and for mopping up spilled liquids, etc.

3. A large tin or bucket is needed for ordinary rubbish, and another for waste chemicals. Consult your local council about how to safely dispose of waste chemicals. Sand, metals, broken glass and other non-chemical items can be treated as ordinary rubbish. One metal, magnesium is an exception; any pieces of magnesium should be put aside and eventually burnt.

4. Do not have food or sweets in your laboratory.

5. Keep all chemicals locked up or at least out of reach of young children.

Work bench Your work bench or table needs to be sturdy and to have a metal or PVC or formica surface. A surface of hard wood, such as teak, is also suitable. Alternatively, you can do your experiments on a large, unpainted metal tray placed on a table.

Additional Equipment

Metal lid

Metal evaporating dish

Crystallizing dish

Length of thick wire

Pen

Microscope

Saucepan

Balances/scales

1 litre beaker

Small bottle with cork

Flask with cork or bung

Large test tube

Small jar

Dish

Wooden splint

Small Candle

Jar with two lids

Balloon

Useful additions You will want to improve your laboratory as you go on, by obtaining or making additional equipment. Here are a few ideas:

(a) Shelves for storing additional apparatus, and for bottles, jars, and tins for chemicals.

(b) Extra test tube racks.

(c) Additional tripod stands and stands for holding test tubes being heated. These can be made from fairly thick wire which is shaped and coiled as necessary, as shown.

(d) A useful form of water supply is a siphon bottle. This consists of a large glass or plastic container (1 gallon or more) fitted with a two-hole cork or bung. Through one hole a glass tube dips through the water to the bottom of the container. A length of flexible tubing is connected to the top of the tube protruding from the cork. Suction is applied to the flexible tubing to start the water running through it **(Warning : NOT to apply suction by mouth)**, and the tube can then be pinched with a clothes peg to stop the flow until needed again. The end of the flexible tubing must be below the surface of the water in the container, otherwise the flow will stop.
The above suggestions are depicted in the illustrations on page 6.

*** It should be handled by adult or with adult supervision while using the spirit burner, candle and scissors.**

Section 3 Laboratory Technique How to Do Experiments

1. Read the instructions for the experiment carefully and thoughtfully before starting. Next, get all the apparatus and chemicals ready. Then do the experiment slowly, reading the instructions again from time to time. NEVER hurry, and never do experiments when young children are around.

2. Remember all the safety precautions (read them regularly), especially those relating to the spirit burner.

3. Use the scoop provided for handling solid chemicals, not your hands. In the instructions for experiments, 'a little' or 'a small quantity' means half a scoopful or less. It is wasteful to use more.

4. The best way to add a solid chemical to a container, e.g. a test tube, is to pour some of the powder first into a creased piece of clean paper. The chemical can then be tipped slowly from the paper into the test tube. Afterwards dispose of the paper in your chemical waste tin. Liquids are best transferred by means of a funnel, or by pouring slowly down a glass rod.

5. When taking a chemical from a test tube or other container, always hold the stopper in one hand and replace it immediately afterwards. This is quite easy once you have practised it, and ensures that chemicals do not deteriorate from unnecessary exposure to air, and are not contaminated by the use of stoppers from other test tubes or containers. Do not return any unused chemical to its container unless you are fully satisfied that it is the right chemical and has not been contaminated with anything else. If in doubt, put the chemical in your chemical waste tin. When removing and replacing stoppers, be careful not ot break the test tube and cut your fingers. Wash your hands after touching chemicals.

6. If you make up solutions of chemicals for future use ensure that they are correctly labelled. It is obviously essential that all containers bear the names of the chemicals in them.

7. **The Spirit Burner** This must be handled with great care, otherwise it can be a fire hazard. It should always be placed on a metal tray or lid (not painted on the inside) large enough to contain the spirit should the burner be accidentally damaged. When it is alight, **keep the burner well away from the supply container of methylated spirit and any other flammable substance.** To fill the burner, remove the cap containing the wick and, using the filter funnel, fill the glass bottle no more than three-quarters full. Replace the cap and screw it down tightly. Then wipe the outside of the bottle dry. The wick should protrude from the cap about 3 mm to give the right size of flame. Wash the funnel. To put out the burner, place the given cap completely over it so that the tube touches the cap. Methylated Spirits burns with an almost invisible flame, so special care should be taken to ensure that the flame is extinguished before handling or moving the burner.

*** Recommended to heat the glassware by adult or under adult supervision**

8. **Heating test tubes**

(a) Use the test tube holder when heating a chemical in a test tube. If the chemical is a liquid, be very careful it does not suddenly boil and shoot out of the test tube.

(b) Do not put hot test tubes in cold water or in plastic test tube racks. Place them in a clean tin or on a tin lid.

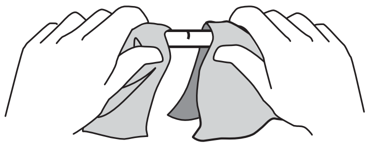
(c) Do not heat a test tube with a solid stopper in it.

(d) Hold the test tube at an angle over the flame, and pointing in a safe direction away from yourself, other people and equipment. Keep it moving about in the flame, until it is really hot, otherwise the glass may crack. This applies especially when heating solid chemicals.

9. **Cleaning apparatus** Always thoroughly wash apparatus after an experiment. There is no need to dry it, just give it a shake. Cold water is normally sufficient, but warm water and washing liquid are sometimes necessary. Rinse after using washing up liquid. Use the test tube brush for the inside of flasks and test tubes. Chemicals can usually be removed from test tubes by using the measuring spoon provided. When solid deposits cannot be removed, the test tube must be thrown away. Stains can often be removed by leaving the test tube or other container filled with acid solution for a day or so.

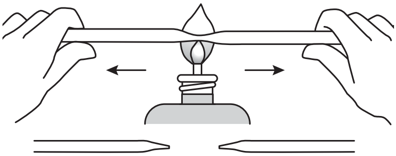
10. **Manipulation glass tubing**

(a) Cutting Try this with a short piece of tubing which should be laid on the bench or other flat surface. Make one firm scratch, with the glass cutting file, on the tube in one place. Use one stroke, do not saw. Now hold the tube in a cloth (or wear suitable gloves) between the thumb and fingers of each hand, with thumbs under the scratch. (See diagram.) Then snap the tube into two pieces with a quick jerk, pushing your thumbs towards the scratch. The tube should break quite cleanly at the scratch. If the edges are rough or sharp, hold them in the spirit flame so that the glass melts a little.



(b) Bending Take another short length of tubing and, with a hand at each end, heat 4-5 cm in the middle with the spirit flame, rotating the tube all the time with your thumb and forefinger. When the glass is soft, remove from the flame, carefully bend it into a right-angle. Be careful to get both arms of the right angle in the same plane. If you heat too much the bend will flatten or buckle. Lay the tube on a flat metal surface to cool. Do not pick it up until it is cool.

(c) Making a glass jet or nozzle Repeat the procedure in (10b), but when the glass softens, pull firmly and slowly with both hands so that the tube draws out into the shape of the diagram. When the tube is cool, cut it with the glass cutting file at the middle, to obtain two glass jets.



11. Chemical waste from experiments
You will often finish an experiment with some chemical left in a test tube, evaporating dish, etc. used in the experiment. Always put such residues in your chemical waste tin. They should not be used again.

12. Use of Household Chemicals
Many substances in your home are very useful in your laboratory. Some, which are not in your chemistry set, are needed in particular experiments. Here is a list of the main ones:-

Baking soda (bicarbonate of soda)
Citric acid (as bought for home-made lemonade)
Salt (sodium chloride)
Sugar (sucrose)
Vinegar
Washing soda (sodium carbonate crystals)
Hydrogen peroxide (10 volume)
Aluminium foil or silver milk tops
Iron nails
Fruit and vegetable juices
Cochineal food colouring
Methylated spirit (for the spirit burner)
Mud
Milk
Coloured chalk
Sand
Blue-black ink
Green food dye
Lemon juice
Baking powder/soda
Soap
Orange juice
Tomato juice
Sour milk
Tonic Water
Egg shell
Wood ashes
Lard
Fizzy lemonade
Silk - small piece
Wool - small piece
Cotton - small piece
Linen - small piece
Rayon - small piece
Nylon - small piece
String - small piece
Leather - small piece
Copper foil

13. Recording experiments You should always write up your experiments with a diagram or list of the apparatus, in a chemistry note book. This record is often helpful for future reference. But the main reason for it is to learn and practice scientific method, the essence of which is care and accuracy in experimental work and recorded observation of anything that happens. This is the way great discoveries have been made.

Check the results of your experiment in section 5 of this booklet. If you failed to obtain the correct results, do the experiment again. Finally, read in Section 6 about the chemistry involved in the experiment , i.e. the reasons for the results.

Section 4

Experiments

Important: Before you do any of the experiments, read again the pages on Safety Precautions and Laboratory Technique.

Introductory Experiments

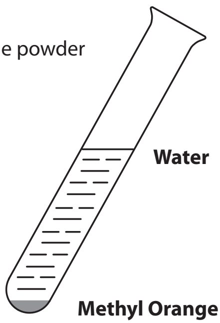
With the exception of the early experiments in Set 1, the instructions do not tell you what happens in the experiments. You must find out for yourself, as all scientists do, and this is also the best way to learn chemistry. But when you have done an experiment and recorded the results, **you can then check your results in Section 5 of this booklet. If you obtained the correct results, you should then turn to Section 6 and find out the reasons for them. If you did not achieve the correct results you should repeat the experiment.**

(Note:- Unless otherwise stated, 'test tube' means a 110 mm one)

The first six experiments are easy ones, to help you get used to handling the apparatus and chemicals. The instructions tell you exactly what to do and also the results you should obtain.

Set 1

Experiment 1
Test tube
Scoop
Methyl orange powder
Tartaric acid

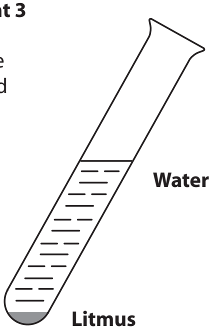


To show that some chemicals change the colour of certain substances.
Put a very small amount of the orange powder (much less than half a scoopful) in the test tube and then add water to half fill the test tube. Shake gently to make the powder dissolve. Now add a little tartaric acid until the colour changes to red. Keep this red liquid for the next experiment.

Experiment 2
Test tube containing the red liquid from Expt. 1
Sodium carbonate

To show that the chemical, sodium carbonate, changes the colour of certain substances.
Add a little sodium carbonate to the red liquid until the colour changes back to orange again. Shake the test tube gently to help the mixing. Do not place the bung in the test tube as a gas is produced.

Experiment 3
Test tube
Litmus blue
Tartaric acid

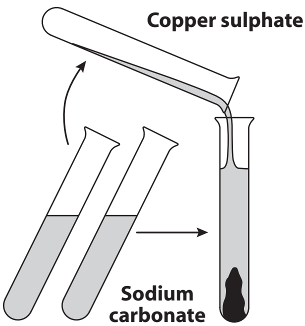


Colour changes with other chemicals.
Put a very small amount(much less than half a scoopful) of litmus blue in the test tube, and then add water as in Expt. 1. Shake gently to make the powder dissolve. Now add a little tartaric acid until the colour changes to red. Keep the red liquid for the next experiment.

Experiment 4
Test tube containing the red liquid from Expt. 3
Sodium carbonate

More colour changes with chemicals.
Add a little sodium carbonate to the red liquid until the colour changes back to blue. Shake the test tube gently to help the mixing.
Do not place the bung in the test tube as a gas is produced.

Experiment 5
Two test tubes
Copper sulphate
Sodium carbonate

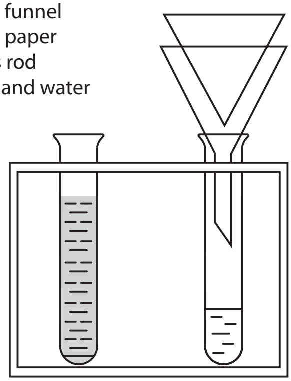


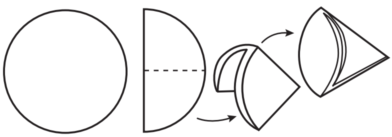
To make a solid chemical from two liquid chemicals.
Dissolve a little copper sulphate in one test tube half filled with water. Dissolve a little sodium carbonate in the same way, using the other test tube. Shake each tube to help the chemicals dissolve. Now add the two liquids together by pouring one into the other. A blue-green solid (non-liquid) chemical is made.

Obtaining Pure Substances

Chemicals are pure substances,and nearly all of them have to be obtained from mixtures of many different chemicals. Most natural substances, such as earth, oil, air, wood, rocks, cement, are such mixtures, and many important chemicals can be got from them. Thus, oxygen is obtained from air, and petrol, diesel fuel, and bottled gas from crude oil. The next experiments will show you how chemists separate mixtures into the substances they contain.

Experiment 6
Two test tubes
Test tube rack
Filter funnel
Filter paper
Glass rod
Mud and water





How to fold a filter paper

To separate muddy water into mud and water.
Thoroughly mix some mud and water in a test tube (about half full) by shaking them together. Put this test tube in the test tube rack. This mixture of mud and water is called suspension because the particles of mud are floating or suspended in the water but not dissolved in it.
Place the filter funnel in the other test tube, as in the diagram. Fit the funnel with a filter paper (the method of folding the paper into a cone is shown in the diagram) and then pour a little clean water into the paper to make it stick to the funnel. Now shake the suspension a little, and then pour it carefully and slowly down the glassrod- held in your other hand - into the funnel. The glass rod prevents the muddy water splashing and getting between the funnel and paper. Be careful not to damage the filter paper with the rod. The liquid which passes through the filter paper and collects in the second test tube is called the filtrate. Is it still muddy? What is left on the filter paper?

Experiment 7
Filtration apparatus as in Expt. 6
Test tubes and chemicals as in Expt. 5

To obtain the blue-green chemical made in Experiment 5.
Repeat Experiment 5, and then filter the mixture containing the blue-green solid. This chemical is called copper carbonate and is left on the filter paper. You will need this copper carbonate in Expt. 24, so purify it as described in the next experiment.

Experiment 8
Filter funnel and paper containing the copper carbonate
Test tubes

To purify the copper carbonate made in Experiment 7.
Pour half a test tube of clean warm water on to the copper carbonate so that other chemicals are washed away. Use a test tube for the water to drain into. Now very carefully remove the filter paper from the funnel, open it out, and lay it on a flat surface where the powder can dry. A piece of wood or cardboard on a radiator is suitable. Keep the copper carbonate out of the reach of young children and label it. When the copper carbonate is dry, tip it into a spare test tube or tin, and label it.

Experiment 9
Filtration apparatus
Milk

To see if milk can be filtered.
Milk is a suspension of substances in water, but the particles are very small. Try filtering about a quarter of a test tube of it.

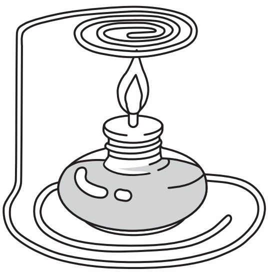
Experiment 10
Filtration apparatus
Coloured chalk

To see if a suspension of coloured blackboard chalk can be filtered.
Powder a little of the blackboard chalk and mix it with about a quarter of a test tube of water so that you have a coloured liquid. Can you filter it?

In the previous experiments you have tried to separate suspensions, or mixtures of water and solids floating in it. But many chemicals, such as salt and copper sulphate dissolve **in water and therefore pass through the filter paper with it. When you need to separate the chemicals in this kind of mixture, called a** solution**, you have to use a process called** evaporation**.**

Experiment 11

Metal evaporating dish
Test tube
Test tube holder
Spirit burner
Salt



To separate salt from salt water by evaporation.
Shake together, in a test tube, a scoopful of table salt (sodium chloride) and half a test tube of warm water. When the undissolved salt has settled, pour a little of the salt water into the evaporating dish so that the dish is about half full. Now heat the dish over the spirit flame, using the test tube holder. Boil the liquid until all the water evaporates as steam and a white residue of salt remains. When the salt begins to spurt, heat very gently. Do not taste the salt.

So that you do not have to hold the evaporating dish over the flame in this and later experiments, it is a good idea to make a small stand to place over the burner. It can be made from fairly thick wire, as in the diagram.
Allow the evaporating dish to cool before touchng it.

Experiment 12

Filtration apparatus
Evaporation apparatus
Test tubes
Salt
Sand

To separate a mixture of salt and sand

Before you read on, try to think out for yourself a way of doing this.

Mix the sand and salt together, about one scoopful of each, and place the mixture in a test tube half full of warm water. Shake well for about a minute to make the salt dissolve. Now filter, collecting the filtrate (salt water) in a second test tube. Evaporate this liquid as in Expt. 11 to obtain the pure salt. Wash the sand on the filter paper with a little warm water. Then dry it as in Expt. 8.

Experiment 13

Apparatus as in Expt. 12
Crystallizing dish
Copper sulphate
Sand

To separate a mixture of sand and copper sulphate.

Proceed as in Experiment 12, but do not completely evaporate the filtrate of copper sulphate solution. When you have boiled about half of it away and the remaining liquid is a deeper blue colour, pour it into the crystallizing dish. Leave the dish on your work bench until blue crystals of copper sulphate form.

When the water, and not the solid, is needed from a solution (e.g. salt water), the process of distillation is used. But before you do distillation experiments you will have to bend some glass tubing for the apparatus, and this is an opportunity for you to practice other methods of manipulating glass tubing.

Experiment 14

Glass tubing
Spirit burner

To bend a piece of glass tubing for Expt. 17 and later experiments.

Take a short length of tubing, not less than 7 cm, and proceed as in paragraph 10b of section 3 on Laboratory Technique.

Experiment 15

As in Expt. 14

To cut a piece of glass tubing.

Proceed as in paragraph 10a of Section 3.

Experiment 16

As in Expt. 14

To make a jet or nozzle.

Proceed as in paragraph 10c of Section 3.

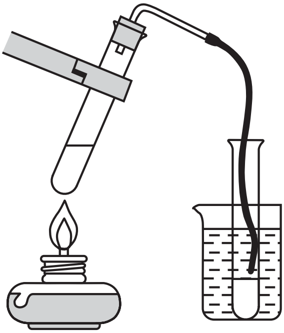
Experiment 17

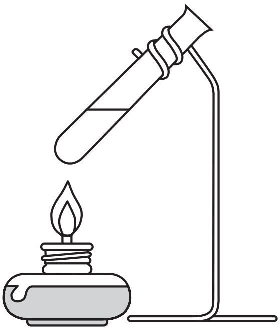
Spirit burner
One-hole cork
Test tubes
Test tube holder
Glass or cup

To obtain the water from a solution of copper sulphate by distillation.

Assemble the apparatus as in the diagram on page 17. One arm of the bent glass tube is pushed gently (Careful!) through the one-hole cork, and the rubber tubing is fixed

Test tube rack
Bent glass tube (from Expt. 14)
Rubber tubing
Copper sulphate solution





on the other arm. It is easy to slide the rubber tubing on if you wet the glass tubing first. When you are satisfied that the apparatus is ready, make up about a quarter of a test tube of copper sulphate solution and pour it into the test tube to be heated, replacing the cork and tubing afterwards. Now heat the solution, using the test tube holder.

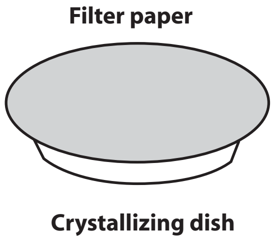
Be very careful to keep the test tube moving about over the flame so that the liquid does not suddenly boil and shoot up into the tubing. Heat until the liquid is slightly boiling and let it simmer for five or ten minutes. In this time you should be able to collect a small quantity of water in the second test tube by the condensation of the steam. DO NOT boil the solution dry. DO NOT taste the water collected. You can save yourself the trouble of holding the test tube over the flame if you make a small stand from fairly thick wire as in the diagram. But in this case you must hold the spirit burner in your hand to start with. Take great care. Keep the flame moving about under the test tube until the liquid is gently and safely simmering. The top of the flame should then be a few inches under the bottom of the test tube, which can be raised and lowered by sliding through the coils of the stand. Do not place the hand over the end of the test tube. If the test tube has been heated, move it away from the burner before holding the tube with a cloth. Take care when moving the glass tube through the metal coils.

Experiment 18
Apparatus as in Expt. 17
Blue-black ink

To obtain water from ink.
Proceed as in Expt. 17, using rather less ink than the copper sulphate solution.

Some substances are so similar in certain respects that they cannot be separated from each other in a mixture by any of the previous methods. The process of Chromatography (the word means colour writing or marking) may then be used. The substances first separated by this method were in fact coloured. It is a complicated process, but one simple way of doing it is the filter paper method described in the next experiments, in which the coloured substances form separate coloured areas or rings on the paper. Such a filter paper is then called a chromatogram, and from it solutions of the substances can be made.

Experiment 19
Crystallizing dish
Test tubes
Filter paper
Glass tube
Methyl orange powder
Dropping pipette



To separate a mixture of methyl orange and litmus by chromatography.
Mix together a little methyl orange powder and twice as much litmus powder with spatula on a clean paper. Put the mixture into a test tube, add water to about the half way mark, and shake well to dissolve the powders. Allow any excess powder to settle for a few minutes, and then pour off some of the liquid into another test tube. Place a filter paper over the crystallizing dish. Use the provided dropping pipette and put one drop of the liquid on the centre of the filter paper. After the drop has spread a little, add another drop. Repeat the process until you have added three or four drops. Now let the liquid spread outwards. Do the two substances separate?

Experiment 20
Apparatus as in Expt. 19

To separate ink into different colours.
Repeat Expt. 19, but use ordinary blue-black ink as your mixture to be separated.

Experiment 21
Apparatus as in Expt. 19, but with a larger filter paper or piece of blotting paper
Pink (cochineal) and green food dyes

To separate a mixture of pink and green food dyes.
For this experiment, better results are obtained with a circle of filter or blotting paper about 7 cm in diameter. To half a test tube of water add four drops of green food dye and mix by shaking . To another test tube half full of water add six drops of pink (cochineal)dye and shake. Add the two liquids together, and then proceed as in Expt. 19, adding drops of the liquid to the centre of the paper until the mixture has spread nearly to the edges.

What Happens
When Chemicals are Heated

You will learn at school or by reading a chemistry text book about elements and compounds. Briefly, there are over 100 elements and all substances are made from them, rather like buildings from bricks. An element contains nothing but itself. Thousands of other substances, called compounds, consist of elements combined together in a special chemical way and in certain weight proportions. They are pure substances, like elements, having special properties (characteristics) of their own. An example is water, the formula for which is H2O, as most people know. It consists of the gases hydrogen and oxygen combined chemically together. It is very difficult to get these gases out of water; ordinary heating does not split the water into gases (decompose it), so this has to be done by an electrical method. But many compounds do decompose when heated, sometimes into the elements of the compound, sometimes into simpler compounds containing these elements. For example, if silver oxide, is heated, it decomposes into its elements, the metal, silver and the gas, oxygen. Usually, if a colour change occurs, the compound being heated has decomposed. This is also true if steam (from the dry compound) or a gas is given off. Of course, an element cannot decompose like this (why?), but some elements change into compounds, when heated, by chemically combining with oxygen in the air. The element sulphur does this, forming a gas called sulphur dioxide.

In the next experiments you are going to discover for yourself what happens when some substances are heated. You will know whether they are elements or compounds from their names; a double chemical name, like copper sulphate, means a compound, but one name, such as copper or gold indicates an element. You will not find any gold in your chemistry set!

Experiment 22
Test tube
Test tube holder
Spirit burner
Copper sulphate

To find out what happens when blue copper sulphate is heated.
Put a scoopful of copper sulphate in the test tube, and, keeping the test tube horizontal in the test tube holder, heat the copper sulphate gently over the spirit flame. Be careful to move the test tube about in the flame (or move the flame up and down under the test tube) so that over-heating does not occur. Observe carfully. More than one thing happens. Check your results. Do not cover the end of the test tube or place a bung in it. Point the end of the test tube in a safe direction away from yourself, other people and equipment.

Experiment 23
Pen
Lemon juice

Another kind of invisible ink.
You can do this without a chemistry set. Write with the lemon juice and then warm the paper as before. What colour is the writing?

Experiment 24
Test tube and holder
Spirit burner
Copper carbonate

Heating copper carbonate.
You should still have some of this blue-green compound left from Expts. 7 and 8. If not, make some more. Put about half a scoopful of it in a test tube and heat until the colour changes. Do not cover the end of the test tube or place a bung in it. Point the end the test tube in a safe direction away from yourself, other people and eqipement. Allow to cool. What do you think happened?

Experiment 25
Unpainted metal lid
Spirit burner
Sugar

Heating sugar.
Heat a little sugar on an unpainted metal lid or in an old spoon. Are any gases evolved? Any colour changes? What is the residue left after much heating?

Experiment 26
Unpainted metal lid
Spirit burner
Tartaric acid

Heating tartaric acid.
Repeat Expt. 25 but use tartaric acid.

You have been heating various compounds, and these contain simpler substances called elements as you know. Now you are going to try heating some elements, the ones selected being metals.

Experiment 27
Test tube holder
Spirit burner
Copper wire

Heating copper wire.
Heat a narrow strip of copper wire, held using the test tube holder, for about half a minute, using the test tube holder, so that only a small part of the wire is in the flame. Describe what happens. Does the metal melt?

Experiment 28
Test tube holder
Spirit burner
Iron nail

Heating an iron nail.
Repeat Expt. 27, but use a small iron nail or panel pin. What happen? Does it melt?

Experiment 29
Test tube holder
Aluminium foil

Heating aluminium foil.
Heat a piece of the foil or a silver milk top, held using the test tube holder. Does it melt?

Solutions and Solubility

Several of the experiments for Set 1 showed that some substances dissolve in water, forming a solution, while others do not. In a solution the substance dissolved (called the solute) **is completely mixed up with the liquid (called the** solvent) **because the particles (little pieces) are so small, too small to be held back by a filter paper. So the solution is quite transparent. Substances which do not dissolve in water are termed** insoluble**, and even** soluble **substances differ greatly in their** solubility**, which is the amount of substance that will dissolve in a certain quantity of solvent. Most insoluble substances will dissolve in solvents other than water.**

Experiment 30
Copper oxide (black solid made in Experiment 24)
Beaker
Scoop
Glass rod
Salt (sodium chloride)
Sugar

To estimate the approximate solubility of some chemicals in cold water
Make a mark with a felt-tipped pen-about half way up the beaker. Add water to this mark, and then add exactly one levelled off scoop of salt. Stir with the glass rod for a minute or so, and note whether the substance dissolves completely and quickly, or only partly dissolves, or is insoluble. Try each substance in turn, making sure that the same quantity of water and exactly one level scoopful of substance in used each time. Record the substances as soluble, partly soluble, or insoluble.

Experiment 31
Baking powder
Calcium carbonate

Repeat Expt. 30 but use the substances here listed.

Experiment 32
Household substances

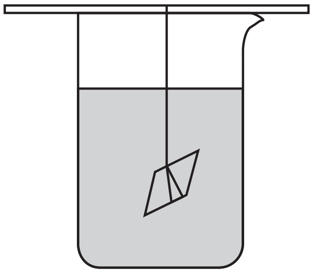
To estimate the solubility of other substances.
Repeat Expt. 30, but try various solid substances available in your home, such as washing soda, citric acid, etc. Do not test any substances labelled poisonous.

Experiment 33
Test tube
Test tube holder
Spirit burner
Home-made stand(Expt. 11)
Evaporating dish
Crystallizing dish
Copper sulphate

To make copper sulphate crystals for Expt. 34
Dissolve copper sulphate in about half a test tube of very hot water until you have a strong solution. Pour some of this into the evaporating dish and boil for about two minutes. The liquid should now be more concentrated and a deeper shade of blue. Transfer it to the crystallizing dish for crystals to form.

Experiment 34

- Spirit burner
- Home-made stand
- Beaker
- Glass rod
- Glass non-food container
- Copper sulphate



To grow a large crystal of copper sulphate.

Make a little less than half a beaker of hot saturated copper sulphate solution. Use the glass rod to stir the solution as you add the copper sulphate to the beaker on the stand. Continue to add the sulphate until the solution is fairly hot (not boiling) and a deep blue colour, and a small quantity of undissolved sulphate remains. Pour the clear solution slowly into a small jam jar or cup, being careful not to add any of the sediment, and allow to cool. Now pick out a well shaped crystal from Expt. 33 and place it very gently in the saturated solution in the jar.

Cover the glass container and leave it in a place where the temperature is even and there is no draft or dust. Turn the crystal over to a fresh face (side) every day. A better way, though a little difficult, is to tie the small crystal to a piece of cotton and then dangle it in the solution, suspended from a spatula or pencil. You do not then have to keep turning it over, and the crystal grows better. If any small crystals form in the solution pour off the liquid into another container and replace the large crystal.

Experiment 35

- Microscope
- Beaker
- Table Salt
- Dropping pipette

Watching salt crystals grow.

If you do not possess a microscope, you will need to borrow one for this fascinating experiment. First, adjust the microscope so that a few grains of table salt (sodium chloride) on a microscope slide are well focussed as small cubes. Now make a hot, saturated solution of table salt in a beaker, place one or two drops on a slide under the microscope, and focus again if necessary. Keep watching the drop of liquid until you see the crystals building up.

Chemical Reactions

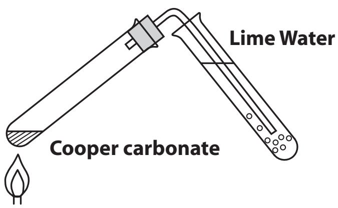
When a chemical changes its form by decomposing into other chemicals or by combining chemically with another substance, such as oxygen in the air, a chemical reaction is said to take place. In most of the heating experiments you have been doing chemical reactions like this have occurred. In another kind of chemical reaction, one element replaces another in a compound. For example, if the metal magnesium is put into a test tube containing silver nitrate solution, the magnesium replaces the silver in the silver nitrate, and magnesium nitrate is formed plus the metal, silver. This can more easily be understood if we write a word equation:-
Magnesium + silver nitrate ⟶ Magnesium nitrate + silver (The arrow means 'turns into'). There is no silver nitrate in your chemistry set, but you can do other replacement reactions.

Set 2

Experiment 36
Test tube
Small iron nail or panel pin
Copper sulphate

To make iron replace copper in copper sulphate solution.
Place a little copper sulphate in the test tube and add about a quarter of a test tube of water. Shake to get a blue solution. Drop in the iron nail, which must not be rusty. Leave for ten minutes. Now take out the nail using a measuring spoon provided or similar tool. Do not place your bare fingers in the solution.. What do you see? Explain what has happened by writing a word equation like the one above.

Experiment 37
Spirit burner
Test tubes and rack
Bent glass tube and cork
Lime water (see Experiment 44 for details)
Copper sulphate solution
Sodium carbonate solution



A decomposition reaction.
Make some copper carbonate by adding half a test tube of copper sulphate solution to the same quantity of sodium carbonate solution. Allow the insoluble copper carbonate to settle, and then pour off as much liquid from it as you can. Now gently heat the carbonate, but only enough to drive off the remaining water as steam. Be careful to move the test tube about in the flame so that over-heating does not occur. Do not cover the end of the test tube or place a bung in it. Point the end of the test tube in a safe direction away from yourself, other people and equipment. Fit a cork and

bent tube to the test tube and, with the end of the tube dipping into a test tube of lime water, more strongly heat the copper carbonate. This bung and tube can be placed over the end of the test tube as the tube prevents a seal from being formed. It changes into another chemical of a different colour and a gas is evolved which affects the lime water in a certain way. Clearly the copper carbonate has decomposed (split up) into simpler substances.

Experiment 38
Spirit burner
Evaporating dish
Glass rod
Glass tube
Copper sulphate
Dropping pipette

A combination reaction.
Make a little white copper sulphate by heating a scoopful of blue copper sulphate in the metal evaporating dish, stirring the powder gently with the glass rod supplied. Do not overheat, and stop heating as soon as all the chemical has turned white. Allow to cool, and then very carefully add drops of water with the pipette supplied until the powder is blue but still dry. Evidently the white compound has combined chemically with the water to form the blue compound, since all the water added has disappeared.

Another type of chemical reaction is called a double-decomposition reaction. Sometimes this is unofficially called 'swopping partners', as you will see by the following example of a typical reation of this kind:
Sodium carbonate + Magnesium sulphate →
Magnesium carbonate + Sodium sulphate

Experiment 39
Test tubes and rack
Sodium carbonate solution
Lime water
(see Experiment 44 for details)

A double-decomposition reation.
To half a test tube of sodium carbonate solution add a little lime water (calcium hydroxide solution). Describe the reaction which takes place, and see if you can write a word equation for it like the example above.

Acids, Alkalis, and Salts 1

Although your chemistry set contains none of the very strong and dangerous acids and alkalis, you should always handle with great care even the safer ones needed in the following experiments. You should of course be extra careful to wash your hands after touching acids and alkalis, wear an apron to protect your clothing, and goggles, especially when heating them.

Experiment 40

Acids have a sour taste.
Cut a piece from a lemon and taste it. The sour taste is due to the citric acid in it.

Experiment 41
Glass tubing
Citric acid solution
Tartaric acid solution
Lemon juice
Vinegar
Universal indicator paper
Dropping pipette

Testing acids with litmus paper.
Using the dropping pipette provided, place a drop of citric acid solution, lemon juice, vinegar, and tartaric acid solution (made from the tartaric acid in your Set) on separate parts of a piece of blue litmus paper. What happens? Does the vinegar contain any acid?

Experiment 42
Test tubes
Test tube rack
Methyl orange powder
Litmus powder
Citric acid solution
Dropping pipette

The colours of different indicators when mixed with an acid.
Litmus and methyl orange are called indicators because they tell whether a substance is an acid or an alkali. They are the only safe way of testing such substances.

Make up solutions of both indicators for this and later experiments, by shaking up less than half a scoopful of each powder with a test tube of water. Allow the mixtures to settle for a few minutes, and then pour off the liquid into other test tubes, cork and label them. Put about half an inch or less of each indicator solution in test tubes in the test tube rack. Now add a few drops of citric acid solution. What are the colour changes?

Experiment 43
Beaker
Sodium carbonate
Calcium carbonate
Acid solutions as in Expt. 41
Wooden splint or taper

The reaction of acids with carbonates.
A carbonate is a compound containing a metal, carbon, and oxygen. You have two in your Set. Use the sodium carbonate to study this reaction. Put a little in the beaker and then add an acid such as tartaric acid solution. The fizzing or effervescence indicates that a gas is being evolved. Try other acid solutions, such as vinegar, lemon juice, and citric acid solution. And try the other carbonate, calcium carbonate. The same gas is evolved in every case. Put a lighted splint of wood or taper into the beaker to see if the gas puts it out. Can you guess what the gas is?

The next experiments concern alkalis. An alkali reacts with an acid, thereby destroying the acid and itself. They are said to neutralize each other.

Experiment 44
Medium size bottle with stopper
Calcium hydroxide

To make a solution of the alkali, calcium hydroxide.
This solution is called lime water, and you will need quite a lot in your experiments. So always keep a bottle of it. Just put about one scoopful of calcium hydroxide in a medium size bottle (about 1 litre or less) and fill up with water. Replace the cork or stopper and shake up the contents. Now allow the undissolved hydroxide to settle and a clear solution to form. Calcium hydroxide is not very soluble, so you will find some of it deposited on the bottom of the bottle. This does not matter, so long as you do not shake the bottle when you pour from it. And you can keep on adding water to the bottle, to make up what you take out of it, provided there is still some of the undissolved chemical on the bottom. If not, add more of the calcium hydroxide.

Experiment 45

Test tubes
Test tube rack
Litmus solution
Methyl orange solution
Lime water
Any acid solution used in previous experiments
Dropping pipette

The colours of different indicators when mixed with an alkali.

You probably have solutions of litmus and methyl orange left from Expt. 42. If not, make some more as described in that experiment. Put about half an inch or less of each indicator into test tubes and then add a few drops of lime water to each. Do the indicators change colour? Add some acid solution to each until the colours change. Now add lime water until different colours are obtained. You can now make a table in your chemistry note book to show the following information:

	Litmus	Methyl orange
Colour with acids		
Colour with alkalis		

Check your results as usual.

Experiment 46

Test tubes and rack
Glass tube
Universal indicator papers
Various substances as suggested
Dropping pipette

To test other substances with an indicator.

Solutions of some substances do not affect the colour of indicators. Those substances are said to be neutral. An example is ordinary salt (sodium chloride). Test some of the chemical (powders) in your Set and various substances in your home, such as orange juice, tomato juice, sour milk, tap water, tonic water, etc. Always make a solution of the substance by adding a little of it to about half a test tube of water, except in the case of liquids, such as tap water. Then take a drop out of the solution with the dropping pipette provided. and put it on a piece of red litmus paper. If there is no bluish mark, test again with blue litmus paper.

Experiment 47

Test tubes and rack
Glass tube
Tartaric acid
Lime water
Dropping pipette

To show the process of neutralization.

In this experiment tartaric acid is neutralized by the alkali, calcium hydroxide. Add a very small a very small amount (much less than half a scoopful) of the acid to half a test tube of water, to make a weak solution. To this add lime water (calcium hydroxide solution) from a test tube, one or two drops at a time, using the dropping pipete provided. Continue to add the drops and eventually you will find that one drop causes a milkiness to appear in the liquid. Shake the test tube, and the milkiness will disappear. Go on adding the lime water and shaking, and the milkiness will get more and more pronounced. Finally, it will not disappear on shaking, and a white solid settles on the bottom of the test tube when this is left for a while.

At what point do you think neutralization occurred? The acid and alkali no longer exist, and one of the products of the reaction is the white powder. You will understand more about this neutralization reaction when you have read about it in Section 6.

Note that the lime water is added from a test tube, previously filled from the bottle without shaking up the deposit on the bottom, in order to obtain a clear solution.

Experiment 48

Sodium carbonate solution
Red litmus solution
Dropping pipette

To show that sodium carbonate solution contains an alkali.

Add a few drops, using the dropping pipette provided of an acid solution to blue litmus solution, just enough to turn it red. Now add a few drops of the red litmus to a solution of sodium carbonate. What happens?

Experiment 49

Test tubes and rack
Glass tube
Universal indicator paper
Tartaric acid
Sodium carbonate
Dropping pipette

Another method of demonstrating neutralization

Make up solutions of tartaric acid and sodium carbonate. To a quarter of a test tube of the acid solution, add one or two drops of the sodium carbonate solution, using the dropping pipette provided. Do not place the bung in the test tube as a gas is produced. When the fizzing has stopped, take out a drop of the mixture with a glass tube and place it on a piece of red litmus paper. As the mixture contains more acid than carbonate, the paper should remain red. Repeat the process of adding drops of the sodium carbonate and testing the mixture with red litmus paper until no more fizzing occurs and a drop of the mixture just turns the litmus paper blue. The acid and carbonate have now destroyed each other. See if you can guess the name of the salt which has been formed.

Experiment 50

Crystallizing dish
Mixture from Expt. 49

To obtain crystals of sodium tartrate.

Pour a little of the final mixture, obtained in Expt. 49, into the crystallizing dish, and leave it to evaporate so that the crystals will form.

Acids, Alkalis, and Salts 2

Litmus is a purple blue substance made from certain lichens. Other types of plants can also be used for making indicators. Red cabbage juice and any deep coloured fruit juice are satisfactory, also the colouring matter extracted from red or pink rose petals.

Experiment 51
Saucepan
Red rose
Acid solution
Alkali solution

To make a rose petal indicator.
Boil the petals of a red rose in a little water in a saucepan until the petals have almost lost their colour and a pink solution is obtained. Now test this pink indicator with acid and alkali solutions. An adult must supervise the use of a cooker.

Experiment 52
Test tubes
Fruit juices
Acid and alkali solutions

Fruit juice indicators.
Try the effect of acids and alkalis on the juices from stewed blackcurrants, blackberries, and raspberries. An easier, but less effective, way to obtain the juices is to shake a spoonful of the fruit jam with warm water and then filter to get the clear coloured liquid. An adult must supervise the use of a cooker.

Experiment 53
Test tubes
Vegetable juices
Acid and alkali solutions

Indicators from vegetable juice.
Test acid and alkali solutions with vegetable juices, such as the green water from boiled cabbage, beetroot juice, etc. An adult must supervise the use of a cooker.

A universal indicator is a mixture of indicators, and when added to acid and alkali solutions it changes colour according to the strength of the acid or alkali solutions. It is often very important to know how strong an acid or alkali is, and this is a quick way of finding out. The table below shows the colour changes:-

Red	Orange	Yellow	Pale green	Green	Blue	Violet
Strong acid	Weak acid	Weaker acid	Neutral	Weaker lkali	Weak alkali	Strong alkali

Experiment 54

Dropping pipette
Beaker
Test tube
Glass rod
Lime water
Citric acid
Universal Indicator papers

To show the colours of a universal indicator.

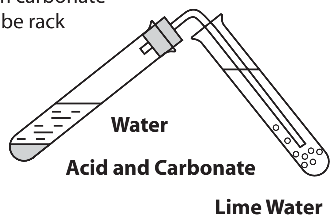
In this experiment an alkali, containing universal indicator, is slowly neutralized by an acid being added to it a few drops at a time. The starting colour is blue, and as the acid is added the colour changes from right to left in the above table. This is because the acid keeps weakening the alkali, then neutralizes it exactly (pale green colour), and thereafter gradually builds up its own strength.

Make a very dilute solution of citric acid by adding about 7 g (roughly 1/4 ounce) to a litre of water. Put two test tubes of lime water in the beaker, and drop in two pieces of universal indicator paper. Stir until an inky blue solution is obtained, then remove the pieces of paper using the glass rod or one of the measuring spoons provided. Do not place your fingers in the solution. Now add, with constant stirring, the acid to the beaker, one or two drops at a time, using the dropping pipette. Note that although quite a lot of acid has to be added to produce the different colours, it is the last drop that causes one colour to change into another. If you miss a colour by adding the acid too quickly, add a little lime water to the beaker to restore the blue colour and start again. The colours are more easily seen if the beaker is placed on a white surface. Is citric acid a strong acid?

When acids and carbonates react together, a salt, water, and carbon dioxide are always produced, but some carbonates do not react with certain acids. The following experiments show these differences.

Experiment 55

Test tubes
Cork and delivery tube
Tartaric acid
Sodium carbonate
Test tube rack



The reaction of tartaric acid with sodium carbonate.

In a test tube fitted with a cork and delivery tube place a little sodium carbonate and about the same amount of tartaric acid. With the end of the delivery tube dipping into a test tube of lime water held in one hand, add a little water to the first test tube and quickly replace the cork and delivery tube.

Experiment 56

Test tube
Glass tube
Tartaric acid
Substances as described
Dropping pipette

The reaction of tartaric acid with various substances.

Many common substances, such as egg shell, most soils, contain calcium carbonate, and wood ashes contain potassium carbonate. Try the action of tartaric acid on these substances in a test tube. Do not place the bung in the test tube as a gas is produced. Test for carbon dioxide by holding a drop of lime water, using the dropping pipette provided, in the mouth of the test tube.

Sodium hydroxide is a much stronger alkali than calcium hydroxide. In the next experiment you can make some dilute sodium hydroxide solution for use in the experiments which follow.

Experiment 57

Flask and cork
Filtration apparatus
Sodium hydroxide reagent bottle
Sodium carbonate solution
Calcium hydroxide

To make a dilute solution of sodium hydroxide.

Make half a flask of sodium carbonate solution and add to it two scoopfuls of calcium hydroxide. Shake well for two or three minutes, then filter into a clean bottle and label it.

Experiment 58

Spirit burner
Large test tube
Lard
Salt (sodium chloride)
Sodium hydroxide solution

How to make soap.

Alkalis react with fats and cooking oils, one of the products being soap. For this reason sodium hydroxide (also known as caustic soda) is used to remove fats and greasy deposits.

Add a very small piece of lard to half a large test tube of sodium hydroxide solution. Boil very gently for a few minutes, keeping the tube moving over the flame so that the liquid does not spurt out. This has to be done very carefully, and remember to wear your safey goggles and protective clothing. Pour the hot liquid into a clean test tube, and add about a quarter of a test tube of clear, saturated, sodium chloride (salt) solution. Allow to cool. A white precipitate of soap settles out from the liquid on cooling. Do not touch this soap as it may be contaminated by residual sodium hydroxide. If it touches yur skin, wash immediately with plenty of water for 10 minutes. See GENERAL FIRST AID instructions on page1. When this process is carried out on a large scale in a soap factory, the soap is separated from the liquid and pressed into blocks.

The following experiments show that sodium hydroxide, like other alkalis, can be used to make insoluble metal hydroxides by double-decomposition reactions.

Experiment 59

Test tubes
Sodium hydroxide solution
Copper sulphate solution

The reaction of sodium hydroxide with copper sulphate.
Add together solutions of these compounds. What is the blue precipitate? Write the word equation for the reaction.

You have seen that salts are made when acids neutralize alkalis, the particular salt depending on the acid and alkali used. Another way to make a salt is by the reaction of an acid with a metal oxide.

Experiment 60

Spirit burner
Test tubes
Sodium carbonate
Copper sulphate
Filtration apparatus

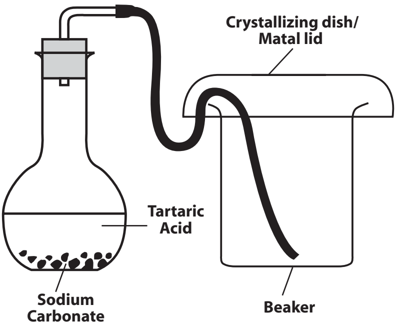
To make copper oxide from copper carbonate.
Prepare a little copper carbonate by mixing together small quantities of sodium carbonate solution and copper sulphate solution. Pour off the liquid when the copper carbonate has settled in the test tube, heat gently to evaporate the remaining liquid, and then more strongly to form the oxide. Do not cover the end of the test tube or place a bung in it. Point the end of the test tube in a safe direction away from yourself, other people and equipment. Note that the oxide could be purified by washing with water, using filtration apparatus. The test tube and oxide must be allowed to cool (place upright in an empty metal container) before washing with the cold water. Otherwise the heat-resistant test tube may break due to heat-stress.

Gases

Gases can be either elements (like hydrogen and oxygen) or compounds like carbon dioxide (whose elements are carbon and oxygen). Air is a mixture of several gases, the main ones being nitrogen and oxygen. You will have read in Section 6 about Expt. 67 and the part played by oxygen in the rusting of iron.

Set 3

Experiment 61
Flask
One-hole cork
Glass delivery tube
Rubber tubing
Beaker
Washing soda crystals
Tartaric acid solution



To make carbon dioxide.
Assemble the apparatus as in the diagram, and place a crystallizing dish or metal lid over the mouth of the beaker as far as possible; this helps the carbon dioxide displace the air from the beaker. Carbon dioxide is not collected like hydrogen and oxygen because it is soluble in water. Now place some large crystals of washing soda (sodium carbonate) in the flask. (Do not use the powdered sodium carbonate in your Set.) Add about half a flaskful of tartaric acid solution, and replace the cork and tubing. Do not use the powdered sodium carbonate in your Set. It is important that the end of the rubber tubing is near the bottom of the beaker. Hold a lighted match to the top of the beaker every now and then. When the beaker is full of carbon dioxide (it does not take long) the match will go out. Place a lid on the beaker.

Experiment 62
Spirit burner
Beaker of carbon dioxide from Expt. 61
Wood splint

To show that carbon dioxide extinguishes fires.
Light the splint of wood, remove the cover from the beaker, and quickly plunge the burning wood into the beaker.

Experiment 63
Test tube half full of clear lime water
Balloon
Rubber tube

Expired air contains carbon dioxide.
Partly blow up a balloon and gently blow some of the expired air within the balloon into the lime water through the rubber tube. What happens?

Experiment 64
Jar with two
lids to fit
Length of wire
Small candle
Lime water
Dropping pipette

A candle flame produces carbon dioxide.
Ask the supervising adult to pierce a small hole in one of the lids. Coil a length of thickish wire tightly around the candle, (so the candle can be lifted by the wire coil) and push the other end of the wire through the hole in the lid. Light the candle, and lower it into the jam jar, holding the top of the wire and keeping the lid on the jar. When the candle has gone out (Why does it?) remove it and the lid, quickly add a few drops of lime water, using the dropping pipette provided, to the jar and put on the other lid without the hole. Shake the jar. Does the lime water go milky?

Experiment 65
Spirit burner
Jar with a metal lid
Lime water
Dropping pipette

A spirit flame produces carbon dioxide.
Place the spirit burner on the metal lid, light it, and then cover it with the jar. When the flame has gone out, remove the burner, and place the jam jar, covered with the lid, upright on the bench. Now add a few drops of clear lime water, using the dropping pipette provided, to the jar, replace the lid, and shake. What happens to the lime water? Did you notice anything else?

Experiment 66
Flask
One-hole cork
Delivery tube
Test tube
Lime water

To identify the gas in fizzy lemonade.
Pour fizzy lemonade (from a new bottle) into the flask (fitted with cork and delivery tube) to about half full. Now heat the flask gently, so that the gas is driven out of the liquid and bubbles into a test tube of lime water.

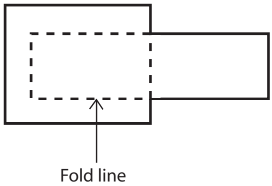
Metals

Many metals, when heated, combine chemically with some of the oxygen in the air, forming compounds called oxides.
Magnesium forms magnesium oxide, it is a white powder. Other metal oxides have various colours.

Experiment 67
Spirit burner
Test tube holder
Iron nail

Heating iron in air
Hold a non-rusty iron nail or panel pin, using the test tube holder, in the flame for about a minute. What happens? Explain the change.

Experiment 68
Spirit burner
Copper foil
Test tube holder



Heating copper in air
From a piece of copper foil, about 5 cm by 3 cm, cut a shape like the diagram with scissors. Now fold over the large flap, followed by the small ones, so as to make an 'envelope'. Seal the edges by hammering them, so that no air can get inside the envelope. Hold the envelope using the test tube holder and heat it in the flame until it goes black. What is the black powder? Allow the envelope to cool and open it out. Is it black inside? Explain what you find.

Fibres

Natural fibres are either of animal origin, such as wool and silk, or from plants, such as cotton and linen. Nylon and rayon are two synthetic fibres, being made by chemical processes. It is important to be able to carry out tests to distinguish between different types of fibre.

Experiment 69
Spirit burner
Test tube
Silk
Red litmus paper

To test silk.
Heat gently a small piece of real silk in a dry test tube, and hold at the mouth of the tube a moist piece of red litmus paper. What happens to the litmus paper? What causes this?

Experiment 70
As for Expt. 69, but wool instead of silk

To test wool.
Repeat Expt. 69, using a small piece of wool.

Experiment 71
As for Expt. 69, but cotton and blue litmus paper

To test cotton.
Repeat Expt. 69, but use a small piece of cotton material and a moist blue litmus paper instead of a red one. You can make a piece of litmus paper blue by pouring a few drops of lime water on it and then washing it in a little water.

Experiment 72
As for Expt. 69 and 71, but with the materials listed

To test rayon, etc.
Repeat Expt. 71, using a piece of rayon rather than cotton. Test also, by Expts. 69 and 71, linen, string, and leather, and see if you can decide which is likely to be of animal and which of vegetable origin.

Experiment 73
Spirit burner
Test tube
Sodium hydroxide solution
Wool
Cotton

Another way to distinguish wool from cotton.
Place a little of your sodium hydroxide solution (made in Expt. 57) in a test tube and add a tiny strand of wool. Warm the solution. What happens? Try a thread of cotton and see if the same thing happens.

Experiment 74
Spirit burner
Test tube holder
Metal lid
Materials as listed

Burning tests for fibres.
Perform this experiment in a well-ventilated location. Do not inhale the fumes produced by the heated materials. Holding each of the materials - wool, silk, cotton, rayon - in the test tube holder over a metal lid or saucer, try burning each with the spirit flame. Note how easily or otherwise they burn, whether they leave much ash or char.

Experiment 75
As for Expt. 69 and 74

Testing nylon.
Perform this experiment in a well-ventilated location. Do not inhale the fumes produced by the heated materials.Repeat Expts. 69 and 74 with small pieces of nylon. Note particularly the way nylon behaves when heated in the test tube (Expt. 69).

Dyes

Most dyes are now synthetic, being made in chemical works. Although natural dyes, from fruit, vegetables, etc. are not so strong, they are satisfactory for many purposes, especially if the correct dyeing process is followed. You can prepare several dyes from fruit juices, jams, beetroot juice, etc.

Experiment 76
Beaker
Copper sulphate solution
White wool or cotton

To test copper sulphate as a dye.
Goggles, protective goggles and protective clothing to prevent contact with the dyes. Soak a piece of white wool or cotton in copper sulphate solution, then squeeze out and wash the material under the tap. Is copper sulphate any good as a dye? You can try this with litmus solution too.

Experiment 77
As for Expt. 76 but using home-made dyes

Testing natural dyes.
Goggles, protective goggles and protective clothing to prevent contact with the dyes. Try some of your own dyes, such as plum or beetroot juice, by soaking small pieces of white wool and cotton in them for a few minutes. Then squeeze them out and wash under the tap to see if the dyes are permanent.

Experiment 78

Testing natural dyes on other materials.
Goggles, protective goggles and protective clothing to prevent contact with the dyes. Repeat Expt. 77, but use pieces of silk and nylon.

Experiment 79

Natural dyes - effect of boiling.
Goggles, protective goggles and protective clothing to prevent contact with the dyes. Repeat Expt. 77, but boil the pieces of material in the dye for a few minutes.

Experiment 80

Natural dyes - effect of boiling - other materials. Goggles, protective Goggles and protective clothing to prevent contact with the dyes.
Repeat Expt. 78, but boil the silk and nylon in the dye.

Section 5 Results of Experiments

SET 1

6 The filtrate should be clear (transparent) water. Mud is left on the filter paper.

9 Milk cannot be filtered.

10 Easily filtered.

19 The substances separate into blue and orange areas on the paper.

21 The colours separate into a green area surrounded by a pink ring.

22 The copper sulphate turns white and water condenses on the cooler parts of the test tube.

23 Brown.

24 Colour changes to black. The copper carbonate has split up into other substances.

25 Steam is evolved, and the black residue is carbon (charcoal).

26 Residue is carbon.

27 The metal does not melt. The part heated turns black.

28 As for Expt. 27.

29 The aluminium melts a little if the flame is hot enough.

30 Salt - partly soluble. Sugar - soluble. Copper oxide - insoluble.

31 Baking powder - partly soluble. Calcium carbonate - insoluble.

SET 2

36 The iron nail has turned a pinkish colour, due to a deposit of copper on it. Iron + copper sulphate $\longrightarrow$ copper + iron sulphate.

39 A white solid (precipitate) of calcium carbonate is formed. Sodium carbonate + calcium hydroxide $\longrightarrow$ calcium carbonate + sodium hydroxide.

41 Each drop causes a red spot on the litmus paper. The vinegar contains an acid.

42 Both indicators turn red.

43 The gas is carbon dioxide, and it puts the taper out.

45 When the lime water is first added, the indicators do not change colour. The acid changes their colours, and when the lime water is added again, it changes the red litmus to blue and the red methyl orange to orange.

46 Copper sulphate, iron sulphate, turn blue litmus red, or in some cases slightly pink. Calcium hydroxide and sodium carbonate turn red litmus blue. The fruit juices, sour milk, and tonic water contain acids. Tap water is normally neutral.

47 The point at which the milkiness first failed to disappear on shaking.

48 Litmus turns blue.

49 Salt formed is sodium tartrate.

51 The indicator turns redder with acids, and green with alkalis.

54 Citric acid is not a strong acid.

55 The lime water turns milky.

59 Copper hydroxide.
Sodium hydroxide + copper sulphate $\longrightarrow$ copper hydroxide + sodium sulphate.

SET 3

62 The splint goes out.

63 The lime water turns milky.

64 The candle goes out when all the oxygen has been used up. The lime water goes milky.

65 The lime water goes milky. There was moisture inside the jar after burning in Expt. 70.

66 The lime water goes milky.

67 The iron nail is covered with a black powder, iron oxide.

68 The black powder is copper oxide. The envelope is not black inside.

69 Litmus paper turns blue, caused by ammonia evolved.

70 Results as in Expt. 69.

71 Litmus paper turns red.

72 Rayon gives the same result as cotton. Linen and string - vegetable. Leather - animal.

73 The wool dissolves, the cotton does not.

74 Wool burns slowly, appearing to melt together. It chars and silk burns readily, with an orange-yellow flame. A black bead of ash is formed. Cotton and rayon burn easily, leaving only a little grey ash.

75 When nylon is heated in a test tube it first melts to a brown liquid, and ammonia is evolved. It does not burn easily.

76 Copper sulphate is a poor dye.

77/78 The dyes are not permanent.

79/80 Boiling makes the dyes wash out less easily.

Section 6 Explanation of Results

SET 1

1/4 Read the explanations of the Set 2 experiments about these substances.

5 Read the explanations for Experiment 39.

6 The mud particles are too large to pass through the filter paper.

9 The particles are too small and can pass through the filter paper.

10 As for Experiment 6.

19 The litmus moves through the filter paper more quickly than the methyl orange, so it forms a blue ring outside the central orange area.

21 The same explanation as Expt.19.

22 Copper sulphate is a compound which contains water chemically combined to itself. This "water of crystallization" is driven off when the compound is heated, causing it, now without water (anhydrous) to have a different colour.

24 The copper carbonate decomposes into black copper oxide and the invisible gas, carbon dioxide. Most carbonates split up like this on heating.

25 Sugar is a carbohydrate which is a compound of carbon, hydrogen, and oxygen in which the last two elements are usually in the ratio of two to one as in water. So when they are heated, water in the form of steam is evolved, leaving a residue of carbon which finally becomes quite black.

26 Tartaric acid also contains the elements carbon, hydrogen, and oxygen, so a residue of carton is left on heating.

27 The spirit flame is not hot enough to melt the copper. The part in the flame becomes covered with black copper oxide. Read explanations for Expts. 67 and 68.

28 The iron similarly is coated with iron oxide.

30-33 Substances vary greatly in their solubility, i.e. the weight which will dissolve in a particular quantity of water at a particular temperature. Most substances dissolve more as the water is hotter. A substance dissolved in water is called a solution, in which the particles are tiny enough to get in between the water particles, so that the liquid is quite transparent and can pass through any filter paper. The dissolved solid in a solution is called the solute, and the liquid (e.g. water) the solvent. A saturated solution is one in which the maximum amount of solute is dissolved, and when cooled some of this solute comes out of solution because the solvent cannot dissolve so much at the lower temperature.

34 As the solution slowly evaporates, excess solute deposits on the crystal, thereby increasing its size.

SET 2

36 Read the paragraph before this experiment in Section 4.

37 The copper carbonate has been split up (decomposed) by the heat into black copper oxide and a gas called carbon dioxide which turns lime water milky.

38 This reaction is the combination of an anhydrous salt with water to form a hydrate.

39 Double - decomposition reactions can take place if one of the products (substances formed) is insoluble or a gas

41-42 All acid solutions turn blue litmus red.

43 Read about acids and carbonates in explanations of Expts. 55.

44 Calcium hydroxide (slaked lime) is only slightly soluble, so its solutions is weakly alkaline.

45 Litmus is blue with an alkali and methyl orange is orange. So only acids change their normal colours.

46 Many salts in solution form acids, sometimes only small amounts.

47 An acid and an alkali neutralize each other when reacting together because they form two different compounds, a salt and water. When an alkali is slowly added to an acid, it neutralizes more and more of it until there is no more acid left. If this exact point is reached, without any extra alkali being added, only a salt and water are then present.

49 Tartaric acid, when neutralized, forms salts called tartrates, just as sulphuric acid forms salts called sulphates.

52 The explanation of results is given with the experiment (Section 4).

55 The acid has reacted with the carbonate to form a salt, carbon dioxide, and water:-
Tartaric acid + sodium carbonate
sodium tartrate + carbon dioxide + water.

57 This double-decomposition reaction between solutions of sodium carbonate and calcium hydroxide occurs because one of the products, calcium carbonate, is insoluble.

58 When sodium hydroxide reacts with fats, soap and glycerol (glycerine) are formed.

60 Nearly all carbonates decompose, like copper carbonate, into a metal oxide and carbon dioxide.

SET 3

62 There is no oxygen in the beaker.

63 The milkiness is caused by a precipitate of chalk (calcium carbonate). Expired air contains about 4% of carbon dioxide. Ordinary air contains only 0.03%.

65 When most fuels burn they form carbon dioxide and water; because, like methylated spirit, they contain carbon and hydrogen.

67-68 Most metals, especially when heated, combine with oxygen in the air, to form oxides (which therefore weigh more than the metal itself).

67 Iron can only rust in the presence of air and water. Rust is a compound of iron, oxygen, and hydrogen.

69-74 Animal fibres, like wool and silk contain nitrogen compounds, and when heated they give off ammonia, which is also a nitrogen compound.

Cotton and rayon, which are of plant or vegetable origin, do not contain nitrogen compounds, so they do not evolve ammonia. They give acid vapours when heated. Nylon, a synthetic (man-made) fibre gives ammonia when heated, but the way it melts distinguishes it from animal fibres.

77-80 Natural (non-chemical) dyes tend to wash out of the dyed material. Boiling helps a little to make the dye particles soak into the material more. The actual colour obtained with a natural dye depends on the strength of the dye, time of boiling, and type of material.

Glossary of Chemical Terms

ACID: A substance which turns blue litmus red and has a sour or sharp taste.

ALKALI: A substance which neutralises an acid to form a salt and water.

ANHYDROUS SALT: One without water of crystallization.

ATOM: The smallest particle of an element that can take part in a chemical reaction.

CATALYST: A substance which can make a chemical reaction go faster.

CHEMICAL REACTION: A rearrangement of the atoms of substances so that they change into different substances.

CHROMATOGRAM: A filter paper of other porous material on which substances have been separated by chromatography.

CHROMATOGRAPHY: A method of separating a mixture of substances depending on their moving through a porous material at different rates when aided by a suitable solvent.

COMBINATION: A chemical reaction in which a compound is formed from its elements or from simpler compounds.

COMBUSTION: Burning - a chemical reaction, involving combination with oxygen, in which heat and light are given out.

COMPOUND: Two or more elements chemically combined together in definite weight proportions.

CORRODE, CORROSION: Surface chemical action, especially on metals, by moisture, air, or other chemicals.

DECOMPOSITION: The splitting up of a substance into simpler substances, such as the separation of a compound into its elements.

DISTILLATION: The process of converting a liquid into a vapour and collecting the vapour by condensing it back to a liquid.

DOUBLE-DECOMPOSITION: A chemical reaction between two compounds causing the decomposition of both and the formation of two new compounds by an exchange of elements.

ELEMENT: A simple substance which cannot be split up into other substances by chemical means.

EVAPORATION: Conversion of a liquid into its vapour, e.g. by boiling.

FILTRATE: The clear liquid obtained by filtration through a filter paper.

HARD WATER: Water containing soluble compounds which destroy soap by reacting with it.

HYDRATE: A compound containing combined water, e.g. a salt containing water of crystallization.

INDICATOR: A substance which has different colours in acid and alkali solutions.

NEUTRALIZATION: The reaction between an acid and an alkali.

OXIDATION: The addition of oxygen to an element or compound.

PRECIPITATE: An insoluble substance formed in a solution by a chemical reaction.

PRODUCTS: The substances formed in a chemical reaction.

REACTANTS: The substances which react together in a chemical reaction.

REDUCTION (reducing): Removing of oxygen from a compound.

REPLACEMENT: A chemical reaction in which a substance replaces another in a compound, e.g. the replacement of a metal in a compound by another metal.

RESIDUE: The insoluble substance left on a filter paper; also the solid remaining after evaporation.

SATURATED SOLUTION: A solution which contains the maximum amount of dissolved solute at a particular temperature.

SOLUTE: A substance which is dissolved in a solvent to form a solution.

SOLUTION: A homogeneous mixture of two or more substances, e.g. a solid dissolved in a liquid.

SOLVENT: A substance in which other substances can be dissoloved.

SUBLIMATION: The conversion of a substance directly into vapour and the condensation of the vapour into the solid again, without passing through the liquid state.

SUPERSATURATED SOLUTION: A solution which contains more solute than the amount needed to saturate it.

SUSPENSION: A mixture of a liquid and a solid whose particles are small enough to float in the liquid, but are not dissolved in it.

VOLATILE: Capable of easily forming a vapour.

WATER OF CRYSTALLIZATION: A definite amount of water combined with a substance in the crystalline state.

Many chemicals used in the experiments can be found at the following stores:

At Grocery Stores
Acetic acid (white vinegar)
Distilled water
Food coloring
Soda straws
Sodium bicarbonate
(Baking soda)
Sodium carbonate
(Washing soda) Max. 40g
Sodium chloride (salt)
Milk
Lemon juice
Soap
Orange juice
Tomato juice
Tonic water
Lard
Fizzy lemonade

At Drugstores
methylated spirit
hydrogen peroxide
(maximum 3%, 10 volumes)
cotton, absorbent

At Hardware Stores
Candles
Copper wire, bare
Funnel, metal
Glass cutter or
triangular file
Glass tubing
Thick wire

At Stationery Stores
Blotting paper
Coloured chalk
Blue/black ink

At Flower Shops
Sand

Periodic Table of The Elements

KEY

20 **Ca** 40.080 CALCIUM

ATOMIC NUMBER → 20; **SYMBOL** → Ca; **ATOMIC WEIGHT (g/gmol)** → 40.080; **NAME** → CALCIUM

TRANSITION METALS (groups 3–12)

ALKALI METALS	ALKALI EARTH																
																	2 **He** 4.003 HELIUM
3 **Li** 6.941 LITHIUM	4 **Be** 9.012 BERYLLIUM	1 **H** 1.008 HYDROGEN										5 **B** 10.81 BORON	6 **C** 12.011 CARBON	7 **N** 14.007 NITROGEN	8 **O** 15.999 OXYGEN	9 **F** 18.998 FLUORINE	10 **Ne** 20.179 NEON
11 **Na** 22.990 SODIUM	12 **Mg** 24.305 MAGNESIUM											13 **Al** 26.982 ALUMINUM	14 **Si** 28.086 SILICON	15 **P** 30.974 PHOSPHORUS	16 **S** 32.06 SULFUR	17 **Cl** 35.453 CHLORINE	18 **Ar** 39.948 ARGON
19 **K** 39.098 POTASSIUM	20 **Ca** 40.08 CALCIUM	21 **Sc** 44.956 SCANDIUM	22 **Ti** 47.88 TITANIUM	23 **V** 50.942 VANADIUM	24 **Cr** 51.996 CHROMIUM	25 **Mn** 54.938 MANGANESE	26 **Fe** 55.84 IRON	27 **Co** 58.933 COBALT	28 **Ni** 58.69 NICKEL	29 **Cu** 63.546 COPPER	30 **Zn** 65.37 ZINC	31 **Ga** 69.72 GALLIUM	32 **Ge** 72.59 GERMANIUM	33 **As** 74.922 ARSENIC	34 **Se** 78.96 SELENIUM	35 **Br** 79.904 BROMINE	36 **Kr** 83.80 KRYPTON
37 **Rb** 85.468 RUBIDIUM	38 **Sr** 87.62 STRONTIUM	39 **Y** 88.906 YTTRIUM	40 **Zr** 91.22 ZIRCONIUM	41 **Nb** 92.906 NIOBIUM	42 **Mo** 95.94 MOLYBDENUM	43 **Tc** 98 TECHNETIUM	44 **Ru** 101.07 RUTHENIUM	45 **Rh** 102.91 RHODIUM	46 **Pd** 106.42 PALLADIUM	47 **Ag** 107.87 SILVER	48 **Cd** 112.41 CADMIUM	49 **In** 114.82 INDIUM	50 **Sn** 118.69 TIN	51 **Sb** 121.75 ANTIMONY	52 **Te** 127.60 TELLURIUM	53 **I** 126.90 IODINE	54 **Xe** 131.29 XENON
55 **Cs** 132.91 CESIUM	56 **Ba** 137.33 BARIUM	**Rare earth series**	72 **Hf** 178.49 HAFNIUM	73 **Ta** 180.95 TANTALUM	74 **W** 183.84 TUNGSTEN	75 **Re** 186.21 RHENIUM	76 **Os** 190.23 OSMIUM	77 **Ir** 192.22 IRIDIUM	78 **Pt** 195.08 PLATINUM	79 **Au** 196.97 GOLD	80 **Hg** 200.59 MERCURY	81 **Tl** 204.38 THALLIUM	82 **Pb** 207.19 LEAD	83 **Bi** 208.98 BISMUTH	84 **Po** 209 POLONIUM	85 **At** 210 ASTATINE	86 **Rn** 222 RADON
87 **Fr** 223 FRANCIUM	88 **Ra** 226.03 RADIUM	**Actinide series**														HALOGENS	NOBLE GASES

SOLIDS (white) GASES (light grey) LIQUIDS (dark grey)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rare earth series	57 **La** 138.91 LANTHANUM	58 **Ce** 140.12 CERIUM	59 **Pr** 140.91 PRASEODYMIUM	60 **Nd** 144.24 NEODYMIUM	61 **Pm** 145 PROMETHIUM	62 **Sm** 150.36 SAMARIUM	63 **Eu** 151.96 EUROPIUM	64 **Gd** 157.25 GADOLINIUM	65 **Tb** 158.93 TERBIUM	66 **Dy** 162.50 DYSPROSIUM	67 **Ho** 164.93 HOLMIUM	68 **Er** 167.26 ERBIUM	69 **Tm** 168.93 THULIUM	70 **Yb** 173.04 YTTERBIUM	71 **Lu** 174.97 LUTETIUM
Actinide series	89 **Ac** 227.03 ACTINIUM	90 **Th** 232.04 THORIUM	91 **Pa** 231.04 PROTACTINIUM	92 **U** 238.03 URANIUM	93 **Np** 237.05 NEPTUNIUM	94 **Pu** 244 PLUTONIUM	95 **Am** 243 AMERICIUM	96 **Cm** 247 CURIUM	97 **Bk** 247 BERKELIUM	98 **Cf** 251 CALIFORNIUM	99 **Es** 252 EINSTEINIUM	100 **Fm** 257 FERMIUM	101 **Md** 258 MENDELEVIUM	102 **No** 259 NOBELIUM	103 **Lr** 260 LAWRENCIUM