TEACHER'S GUIDE

Simply Science 2

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INTRODUCTION

Aims and content of the course

Simply Science is based on the Pakistan National Curriculum for Primary Science and the exemplar scheme of work prepared jointly by the Qualifications and Curriculum Authority (QCA) and the Standards and Effectiveness Unit of the Department for Education and Employment in Britain. The course aims to meet the needs of teachers and students by building on the core scientific themes in carefully graded stages, thereby providing a comprehensive introduction to science for pupils aged 3 to 11 years.

The course is designed to do three main things:
1) To give students a solid body of knowledge in the natural, physical and earth sciences.
2) To introduce them to the nature of scientific enquiry.
3) To enable them to explore values and attitudes through science.

These three elements are developed side by side through the books which make up the complete course. At the same time, the course aims to provide all the help and guidance necessary to allow the busy non-specialist teacher to cope with the demands of primary school science. To this end, it is hoped that the course will save the teacher time, resources and preparation.

The Course

The Course consists of units to be taught in years Prep to 6. These units are planned to cover the programme of study in three two-year cycles, thus ensuring that key areas are revisited, consolidated and extended. However, care has been taken to ensure that, though the course builds on students' earlier experiences, it does not repeat activities and investigations. This approach will also support those teachers planning for mixed ability and mixed age classes. The units in any one year are interchangeable and do not have to be delivered in the order given within any one student's book. This will help to meet the demands imposed by the availability of materials and the local seasonal and climatic conditions that may affect when certain environmental aspects of science can be taught. Each unit starts from real-life situations, and much of the information is presented in both picture and text. The context for activities within the units can be either cross-curricular or specifically scientific, depending upon the preferred teaching style. *Simply Science* is aimed at the average student but is flexible enough to allow use by students of all abilities. It also promotes the development of independent learning by pupils.

Using this Teacher's Guide

The demands which the *Simply Science* course make upon the teacher depend entirely on how far he or she wishes to progress with a particular class or group of children. The student's books are intended to provide core material on the three broad themes of:

- Life and living processes
- Materials and their properties
- Physical processes

The themes chosen are based firmly on the students' own experience and cover areas affecting their everyday lives. The units in the student's books contain a high proportion of direct teaching, so that they can be used as they stand or as part of a more extensive science programme, with the help of the appropriate Teacher's Guides.

The themes within any one student's book can be taught in almost any order. If there are two or more teachers with classes of students of the same age, they could each choose different themes. The teachers could acquire the materials for their particular theme and then, after the work is completed, they could exchange materials and ideas, and discuss any problems that arise.

For practical activities, it may be necessary to divide the class into groups of a size you consider appropriate for each particular activity. The groups should be as small as possible but should have enough students to adequately handle the materials and to keep a record of the results. For most activities, two or three students is probably the optimum number for a group. Many of the activities can be done individually. Certainly the groups should never be so large that some students are merely spectators. In the case of activities which require a great deal of the teacher's attention, it is suggested that the class is divided into two, and while part of the class is engaged in the practical activity, the other part is kept busy with the 'desk-bound' written or other activities in the student's books or in the ***Going Further*** sections of this Teacher's Guide.

Most of the sections in this Teacher's Guide are self-explanatory. There is an introductory section, directed specially at the non-specialist teacher, which aims to explain what science is and how it works.

Background information is aimed at giving the non-scientist teacher confidence. It contains all of the scientific knowledge necessary to teach a particular unit.

Answers provides, where possible, the expected results of any activity and answers to any questions posed under the headings of *Rapid fire* and *Try it out*.

Going further contains activities, experiments, demonstrations and suggestions for discussion which can be used to add depth to each lesson, or to reinforce it.

Worksheets The worksheets are designed to be photocopied and used within the purchasing institution. They are designed to allow the students to record their findings on the actual worksheets, but you should also encourage the students to use IT and other methods of recording, as appropriate.

Although it is in the *doing* of science that students learn best, this involves more than just practical work. As well as needing to observe, record, predict, measure, look for patterns, classify, ask questions and so on, students need time to discuss their work. In this connection, the worksheets should be discussed both before and after the completion of the activity. This is particularly important with those students who are not fluent readers. Such discussion also helps to clarify the main ideas and will help you to monitor progress and discover what interests the students, with a view to developing their interests in future sessions. Discussion will also reveal any misunderstandings which can then be corrected as soon as possible.

Notes on individual worksheets explains the key idea behind each worksheet. It also describes briefly expected results or answers and makes suggestions for further activities and investigations. This section also warns of any safety considerations involved in the topic. The question of safety is dealt with more fully in the section below.

Glossary The glossary at the end of the book is intended for use by the teacher and it gives brief definitions of some of the most important scientific words in this Teacher's Guide.

Equipment and materials

Essential materials and equipment are listed under 'What you need' on each worksheet. Nearly all the items are readily available. It may be necessary from time to time to call upon the school kitchen for access to a refrigerator or deep freeze. The students themselves may be able to collect some of the materials if they are given sufficient notice.

Safety!

The activities described in this Teacher's Guide and in the student's books mainly use everyday items of equipment, and materials which are perfectly safe if used sensibly. All the activities have been checked for safety as part of the reviewing process. In particular, every attempt has been made to ensure that all recognized hazards have been identified, suitable safety precautions are suggested, and, wherever possible, the procedures are in accordance with commonly used risk assessments.

However, it is important to be aware that mistakes can be made. Therefore, before beginning any practical activity, you should carry out your own risk assessment in relation to local circumstances. In particular, any local guidelines issued by your employer **must** be observed, whatever is recommended here. As a general principle if, on safety grounds, you are not completely sure about the ability of your class to carry out an experiment, then demonstrate it to them rather than risk an accident.

General safety precautions

There are a number of general safety rules which you should observe:

- If the students taste or handle food, ensure they wash their hands before doing so and that tables and utensils are clean and foods are fresh and uncontaminated. Do not use nuts, as some children are allergic to them, particularly peanuts. Be sensitive to different dietary requirements.
- Young children have little say or control over what they are given to eat at home. When discussing the components of a balanced diet, take care to ensure that children do not feel that you disapprove of their dietary habits. Similarly, when comparisons are made between students, it is important to emphasize that we are all different. Children are built differently, grow at different rates, and have different backgrounds and likes and dislikes.
- Visits beyond the school grounds must be carried out in accordance with the guidelines of your school or employing authority.
- Warn students never to look directly at the Sun. It could damage their eyesight or cause blindness.
- Some students are allergic to certain plants, e.g. some flower bulbs, and pollen (from flowers), and remember that some plants are poisonous. Many children are allergic to certain animals.
- Many seeds bought from garden centres will have been treated with pesticides and are not safe for students to handle. Seeds bought from health food shops are usually safe, although it is best to avoid red kidney beans.
- Whenever possible, use transparent plastic containers, rather than glass containers, particularly for holding water or collecting living things outside.
- Night lights and short, stubby candles are difficult to knock over. When using a naked flame always work in a metal tray, such as a baking tray, filled with sand.
- Use soils free from glass, nails and other sharp objects, and collect soil samples from places that are unlikely to be contaminated with dog or cat faeces. Wash hands after handling soils.
- Wash hands after handling animals.
- Be alert to the potential risks of suffocation associated with polythene bags.
- Students should not touch ice immediately after it has been taken out of a freezer.
- Take great care with hot water or steam.
- Mercury thermometers (recognizable by the silver colour of the liquid inside them) are not suitable for use in primary schools because of the dangers from the toxic metal mercury if they are broken.
- Warn students of the dangers of mains electricity. However, assure them that the batteries they use in class are safe.
- Use plastic mirrors wherever possible. If you have to use glass mirrors, ensure that they do not have sharp edges; bind edges with masking tape or insulating tape.

What is science?

Before taking a class for science, it may be helpful for the non-specialist teacher to consider what this 'mysterious' subject is all about. The word 'science' comes from the Latin word *scire*, to know. Science is concerned with our knowledge of the universe and all that is in it. Science is an organized body of subject matter, and in this it is no different from geography, history or any of the other subjects in the school curriculum. Where science differs from these other subjects is that it involves a method of discovery based on experimentation. Experiments entail finding an answer to a question by observing the effects of making systematic changes.

The first stage in the development of any science is based largely on observation. Science begins when we notice something interesting and ask questions about it. 'I can crush this drink can by standing on it.' 'Will all metal cans crush as easily as this?' 'This block of wood floats. Will all types of wood float?' 'How many seeds are there in a dandelion 'clock'? Will they all grow?' It is important to remember that careful observation is a practical skill which can be encouraged and enhanced by regular practice.

It comes naturally for young children to try things out to see how they work, to manipulate, to feel, to be curious, to ask questions, and to seek answers. That is science. They should ask Who? Where? When? Why? How many? How much? How far? and so on. They should be encouraged to find their own answers, as far as possible by devising simple experiments.

The testing out of an idea, properly called a hypothesis, is the usual way in which scientists carry out an experiment, but students often carry out an experiment with no particular hypothesis in mind, simply to see what happens.

A useful test in science is the controlled experiment, in which two situations are compared that are identical except for the one factor (called a variable) being tested. Having observed mung bean seeds growing on moist cotton wool, and dying when the cotton wool was allowed to dry out, we might decide that water is an important factor in initiating the germination of mung bean seeds (our hypothesis). We might then take two saucers filled with cotton wool, on which equal numbers of mung bean seeds are sprinkled. The saucers are placed next to each other on a sunny window sill. They are identical except that the cotton wool in one is kept moist while the other is left dry. The saucer with the dry cotton wool in it is the 'control' experiment.

The notion of a 'fair test' or control experiment is an important one, but devising suitable controls for experiments is difficult for many primary school students, and indeed many secondary school students and some university students. However, young students do have a well-developed sense of fairness, and this is a necessary stage in the development of an understanding of the need for controlled experiments. If, for example, we try to see which of two snails can move fastest over a sheet of paper, we may soon be rebuked by the student who points out quite rightly. 'That's not fair, this snail is bigger than that one!' We should, whenever possible, encourage students to see that their experiments are 'fair' and that they can identify the variables involved.

All experiments 'work', although not always in the way we expect them to. When experiments fail to produce expected results, it is sometimes because the hypothesis being tested needs to be thought out again, or because the experiment itself may be badly designed. Deciding which is the case is a matter of experience, but also provides a golden opportunity for more scientific thought and experimentation.

Another possible cause of difficulty is that sooner or later a student will ask a question to which the teacher does not know the answer. Teachers who are unsure about areas of science are then placed in a situation where their areas of greatest insecurity may well be called upon by the students without warning.

What the teacher and students together can do is to set about finding the answer, by experiment if possible, with the aid of reference books or the Internet or, if all else fails, by asking someone more knowledgeable. If the teacher can approach the finding out by experiment without any preconceived ideas, then the experience will be very valuable for both teacher and taught. This is definitely one situation where the clear-thinking, 'non-scientist' teacher has a distinct advantage.

Sometimes it will be necessary for a primary school student to be told, tactfully, that the answer to a question is quite simply too difficult for him or her to understand at present.

Active learning

Students learn most effectively through 'doing' and being actively involved. This is what this Teacher's Guide, and the student's books that make up *Simply Science*, hope to encourage.

It should be emphasized that, all the way through, it is important that the students have understood the activity or problem that has been set before they begin any practical work. It is also important to remember that students learn not only by doing but also by thinking and talking about what they have done. Students learn by fitting their latest activity or discovery into their existing pattern of experience, and thus continue to develop and refine the ideas they are already forming about the world in which they live. Quality learning, with time to think out theories, develop ideas and talk them through, is very difficult to achieve in a busy classroom, with all the pressures on the teacher's time and attention.

Lesson objectives

- To introduce simple ideas on the classification of food and the components of a healthy diet.
- To show how teeth are adapted to diet and to emphasize the importance of dental care.

Background information

Food supplies us with energy and it is important to remember that all this energy comes either directly from plants or from animals that feed on plants. The plants in turn obtain their energy from sunlight. We also need food to enable us to grow, to repair damaged parts of our bodies, and to keep us warm and healthy. These functions are best fulfilled by eating a varied and balanced diet containing proteins, carbohydrates, fats, vitamins and mineral salts, together with adequate water and fibre or roughage. The latter aids the movement of the food through the digestive system and so prevents constipation and possibly also heart disease and bowel cancer.

How much energy an individual needs depends upon his or her physical size, level of activity, and rate of growth. If a person regularly eats foods containing more energy than is needed, then the extra food is stored in the body as fat. It is a sobering thought that one in three adults is overweight or obese.

Weight for weight, fatty foods contain most energy, but many of us eat excessive amounts of starchy or sugary carbohydrate foods, such as cakes, biscuits and sweets, all of which have a high energy content. The latter foods are also important agents in the formation of mouth acids that lead to tooth decay.

Scientifically it should be remembered that there are no good or bad foods, only bad diets. All the food we eat falls into a few basic categories and it is important for our health and well-being that we have a diet that contains a balance of these food categories.

Carbohydrates such as sugars and starches release energy when they are digested and this energy can be used by the body cells. Carbohydrates are found in bread, cakes, pasta, potatoes, rice and jam, amongst other things. If you eat more carbohydrates than you need for your body's energy requirements, the surplus is stored as fat.

Proteins are found in eggs, meat, fish, dairy products, cereals, lentils, beans, including soya beans, and peas. During digestion, proteins are broken down into small units called amino acids. These are then rearranged in the human body to form new proteins that are used to build cells, tissues and organs. Since proteins form part of every cell in the human body they are essential for growth.

Fats can produce twice as much energy as an equivalent weight of carbohydrate, but if the energy is not used immediately, the fat is stored under the skin until it is needed. About a quarter of the energy we use each day comes from fats. Sources of fat include butter, margarine, nuts, fatty meat, cream, vegetable oil and, of course, fried foods.

Mineral salts or 'minerals' describes a whole collection of chemicals that are essential for good health. Calcium and phosphorus salts, for example, are needed to build healthy bones and teeth, while sodium and potassium salts are needed to keep nerves functioning properly. Iron salts are important for the formation of healthy blood cells. Mineral salts are found in small amounts in most foods, while fresh fruits and vegetables are good sources of many of these nutrients.

Vitamins are essential for health but, again, are only needed in tiny quantities. About 12 vitamins, known by the letters of the alphabet, are essential for health. There are small amounts of vitamins in most foods, and fresh fruit and vegetables are good sources of many vitamins. Vitamin C, needed for healthy teeth, gums and skin is found mainly in fresh fruits and green vegetables, while vitamin D, needed for strong bones and teeth, can be made by the skin using the energy of sunlight. It is also found in butter, margarine, eggs and fish oils.

Fibre or roughage from parts of food that the body either cannot use or does not want. Fruits, vegetables, cereals, peas, beans, brown rice and wholemeal bread, contain a lot of indigestible fibre. Fibre absorbs water as it travels through the digestive system and helps push waste food out of the body as faeces. If food takes too long to pass through the intestines it can cause constipation and possibly diseases such as bowel cancer and heart disease.

In general, to achieve a balanced diet, we should eat more fruit, vegetables and cereals, and more low-fat sources of protein such as chicken, fish and beans. We should eat fewer fried foods, crisps, butter, sweets, jams and cakes, and less factory processed food since the latter often contains preservatives and excessive amounts of sugar and salt. Finally, it should also be remembered that the body needs water to replace that lost during breathing, sweating and excretion.

Teeth and eating

Teeth are the hardest part of the human body—and usually the first to decay. They are easy to care for and yet the most neglected.

All teeth are covered by an outer protective coat of enamel. The enamel contains no living cells, so it cannot repair itself if it is damaged. Under the enamel is the dentine, which is hard and makes up most of the tooth. In the centre of the tooth is the pulp, containing nerves and blood vessels. Nearly two-third of each tooth is embedded in the jaw. The root is held in place by a kind of cement.

At around six months of age, babies begin to grow their first or ‘milk teeth’. The front teeth usually appear first. Eventually, by the time the child is about three years-old, it has 20 of these first or ‘milk’ teeth, ten in the upper jaw and ten in the lower jaw. These teeth are small to fit a baby’s small mouth.

At about the age of six, the first permanent molar teeth come through right at the back, behind the last milk molars. From then on, until the age of about twelve, all the first teeth start to loosen and come out, and the permanent teeth come through in place of them. Children are often puzzled by how small the milk teeth are. In fact they have lost their long roots which were re-absorbed into the body as it prepared to shed them. At about thirteen years of age, more molars appear right at the back. The final molars, the so-called wisdom teeth, do not come through until the late teens, if at all. Adults have 28 teeth plus these four extra ‘wisdom’ teeth, making 32 in total.

The teeth are designed for the jobs they do. The front teeth—or incisors—are perfect for cutting. Next to them are the slightly pointed canines, which are excellent for gripping and tearing. At the side and back are the broad-topped and bumpy premolars and molars, designed for grinding food.

Tooth decay

Teeth will decay if you allow food debris to remain on and between the teeth for too long, because bacteria present in the mouth convert food residues into acid. The bacteria live in a sticky, spongy film which covers the teeth. Dentists call this film plaque. Plaque would collect on the teeth even if we ate nothing. However, sticky, processed starchy foods and sugars cling to the teeth and are converted by the bacteria more rapidly than any other type of food into acid. This acid starts to dissolve the enamel and eventually eats into the bone-like dentine underneath, producing a cavity. Over a period of six months or so, a superficial cavity may reach the central nerve-containing pulp cavity, which will become inflamed and ache. Worse still, the tooth pulp may die and bacteria may enter the tooth root to form an abscess.

A childhood diet containing plenty of calcium, phosphorus and vitamins C and D may build strong healthy teeth, but neglect and poor dental hygiene will lead to decay in the end.

Gum disease

As well as turning sugar into acid to attack the teeth, the bacteria in plaque make poisons which soak down into the soft gums around the neck of the teeth. This makes the gums swollen and red, although they do not hurt. However, if the attack is not seen and treated by a dentist, the poisons destroy the little elastic fibres which hold the teeth in place until they become loose and have to be extracted.

Dental hygiene

The current advice on cleaning the teeth is that teeth should be brushed regularly and kept clean, but not after every meal. This is because the acid produced after eating etches the enamel of the teeth, and brushing at this time may cause extra wear. It is best to clean teeth before breakfast and before going to bed, or at least an hour after eating. Eating an apple or some other crunchy food does not seem to clean the teeth to any great extent, although eating a piece of cheese after a meal does help. This is because cheese contains a substance that neutralizes the acid that causes tooth decay. And of course, cheese is a rich source of the calcium salts which are needed to produce healthy bones and teeth.

To sum up, to have healthy teeth we should ideally:

- Brush the teeth properly twice a day using a fluoride toothpaste in the morning and before going to bed.
- Floss once a day.
- Eat a well-balanced diet, including food from all the food groups, and limit sugary, starchy and acid food and drink to meal times.
- Replace the toothbrush every three months.
- Have a check-up by a dentist at least once a year.

Orthodontic treatment

More and more children these days are having orthodontic treatment. This treatment is given to correct problems like overcrowding of the teeth, poor bite, or damage caused by thumb-sucking. Commonly a brace is fitted on the teeth and this keeps a regular, gentle pressure on the teeth until they are correctly aligned. The treatment works because teeth can be moved around by this gentle long-term pressure. The technique can be applied to adults, but it is much easier with a developing child or adolescent.

Herbivores, carnivores and omnivores

All teeth are adapted to deal with the kinds of foods that an animal normally eats. Since we humans eat both plant and animal materials, we are considered to be omnivores, and our general purpose teeth are adapted to deal with both plant and animal foods.

In plant-eating animals, or herbivores, the molars and premolars are large and have many ridges to grind up tough grass and other plant materials. The incisors are large with sharp edges for biting. Sheep and other grazing animals have only the lower incisors and these move across a thick pad on the upper jaw. Rats, mice and other rodents have long incisors with sharp edges like chisels, for gnawing. The herbivores and rodents do not have canine teeth as they do not need them.

Flesh-eating animals, or carnivores, have long canine teeth to puncture the skin of their prey and hold onto it. The molars and premolars are large and pointed and the edges of these teeth slide past each other like the blades of shears, so that they can crack bones and cut flesh.

Safety

Although students should be made aware of the importance of having a balanced diet and oral hygiene and the care of their teeth, these matters should be approached in a sensitive way. A five-or six-year-old child has little or no say in what food he or she is presented with and whether or not he or she has a toothbrush.

Answers

Food and feeding: **Rapid fire, pg 3.**

1) Open answers.
2) All meats, some fish and shellfish, some fruits and vegetables.
   As well as its colour, the texture and taste of food changes when it is cooked.
3) Open answers.

A healthy diet: **Rapid fire, pg 5.**

1) Open answers.
2) You can eat as much as you like of fruit, vegetables and salads. You should eat only small amounts of cakes, sweets, fried foods and biscuits, and drink fizzy drinks only occasionally.
3) Foods for energy include rice, pasta, bread, cereals, potatoes, fat meat, and fried foods.
   Foods for quick bursts of energy include biscuits, cakes, and sweets.
   Foods for growth include meat, fish, eggs, cheese, peas, beans, lentils, and milk.
   Foods for fighting illness and keeping us healthy include fruits, vegetables, and milk.

We need teeth when we eat: **Rapid fire, pg 7.**

1) a) smile; b) front; c) back; d) chewed; e) gums; f) milk; g) permanent; h) white; i) root.

Animal teeth and diets: **Rapid fire, pg 9.**

1) Cow—grass; mouse—seed; spider—fly; snail—lettuce; bird—caterpillar; squirrel—nut.
2) Plant-eaters: hare, deer, elephant, cow, sheep, zebra.
   Animal or flesh-eaters: lion, fox, tiger, seal.
3) Squirrels need strong incisor teeth for gnawing and opening nuts and other hard foods. Cows have large, flat premolar and molar teeth to grind up grass.

Looking after your teeth: **Rapid fire, pg 11.**

1) All but the sweets are effective to some extent in cleaning the teeth. Bacteria turn the sugar in sweets to acid which causes tooth decay.
2) Ali, who eats lots of chocolate biscuits and forgets to clean his teeth, is most likely to suffer from tooth decay.
3) Cleaning the teeth at bedtime removes any fragments of food that may decay and produce acid during the night. The toothpaste also neutralizes any acids already present on the teeth.

Going further

Discuss why we need food: energy, warmth, materials for growth and to keep us healthy, and also for enjoyment. What is the longest gap between meals? This can lead to a discussion of the importance of starting the day with a good breakfast. (As some students may start the day with little or no breakfast, this should be handled tactfully).

Ask each student to keep a record of all the kinds of fruits, vegetables and other foods they eat over the next seven days. Which countries do they come from? Look at the labels and packets to find out. Find a small map of the world. Glue it to a larger sheet of card. Use pins, little flags and thread to show where the foods come from.

Plan a healthy picnic or school lunch box.

Using suitable hygienic precautions, let the students identify different foods by taste while they are blindfolded.

Talk about the correct way to brush teeth, and make a graph to show when students in the class brush their teeth. Ask the students to make an illustrated strip of the sequence involved in cleaning the teeth.

Feel your teeth with clean fingers and then look at them in a mirror. Describe what each kind of tooth looks like:

Incisors ____________________

Canines ____________________

Molars ____________________

Ask a volunteer to donate some teeth that have fallen out. Leave one tooth in a glass of tap water for a week, and leave the other in a fizzy sweet drink. After a few days you will notice that the tooth in contact with the fizzy drink has started to turn brown as the enamel is eaten away.

Discuss what happens on a visit to the dentist. If possible, ask a dentist or a dental nurse to come and discuss his or her work with the class.

Collect pictures of carnivores and herbivores. Compare not only their teeth but also their body shapes and behaviour. How many differences can you find?

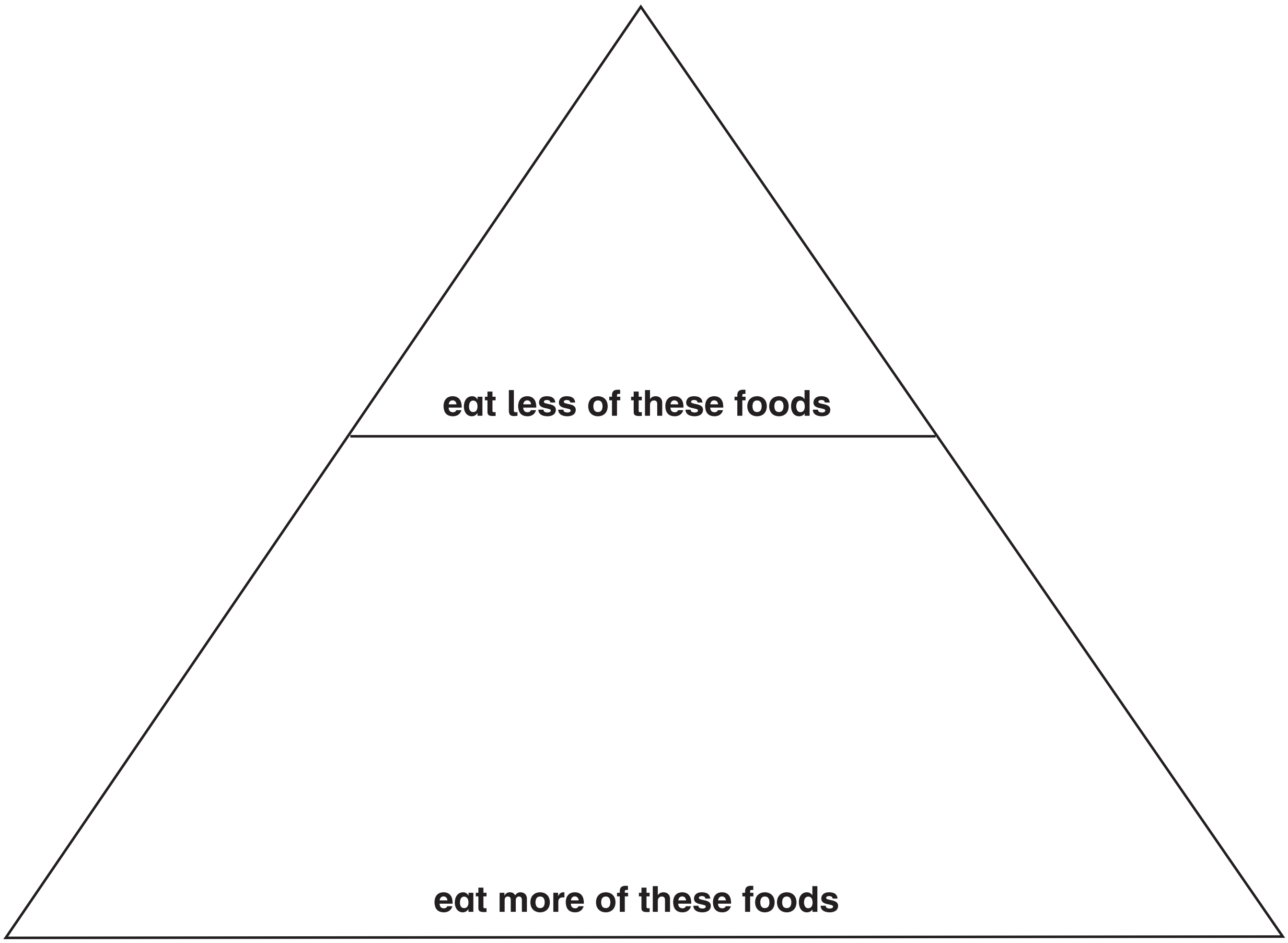
1. A food triangle

What you need:

- pencil

What you do:

Look at this large triangle. It has a smaller triangle at the top.



In the small triangle, write the names of some foods you should eat or drink less of.

In the large triangle, write the names of some foods you should eat or drink more of.

Here are some names of foods to help you:

cabbage, cream cake, apple, orange, tomatoes, lettuce, lean meat, chips, chicken, cheese, cauliflower, sweets, fizzy drinks, milk, chocolate, biscuits, carrot, broccoli, fish, egg.

2. A healthy diet

What you need:

- pencil

What you do:

If we are to stay fit and healthy we must eat a variety of different foods.

Use this table below to plan three healthy meals.

Breakfast	
Lunch	
Dinner	


toast


rice bowl


potatoes

orange juice


boiled egg

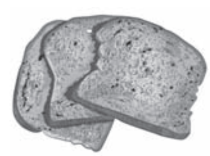

tea


tomotoes

milk



apple


brown bread


fizzy drink


cornflakes


butter


peas

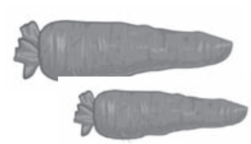

roasted chicken


lettuce


grapefruit

yogurt


cheese


carrots

3. Faiza's food

What you need:

- pencil

What you do:

Faiza made a list of all the different foods she ate in a week. Here are a few of them:

fish, chicken, sausages, chips, beans, cabbage, cornflakes, oranges, apples, sweets, jam, cakes, crisps, butter.

a) Name TWO of the foods Faiza ate which would help to keep her healthy.

i) ____________________ ii) ____________________

b) Name TWO of the foods which contain a lot of fibre.

i) ____________________ ii) ____________________

c) Explain why we need plenty of fibre in our diet.

____

d) Write down TWO of the foods Faiza should eat more of.

i) ____________________ ii) ____________________

e) Write down TWO of the foods Faiza should eat less of.

i) ____________________ ii) ____________________

f) Why should Faiza eat less of the foods you have chosen?

____

4. Favourite foods and the weather

What you need:

- pencil
- crayons

What you do:

What are your favourite foods and drinks on a hot day?

What are your favourite foods and drinks on a cold day?

Write them in the table or draw pictures of them.

On a hot day	On a cold day

Compare your results with those of your friends. Are they the same or different?

5. Teeth

What you need:

- pencil
- a small mirror

What you do:

We use our teeth to help us eat our food.
We also use our teeth to help us do other things.
The picture shows one of them.
Can you think of some more?
Look at your teeth in the mirror.
Fill in the chart below.
If a tooth has a filling, put a small black circle.
If a tooth is missing, put a cross on your chart.
If a tooth is decayed (bad), shade that part of the tooth.

How many teeth do you have? ______________________________

How many teeth do your friends have? ________________________

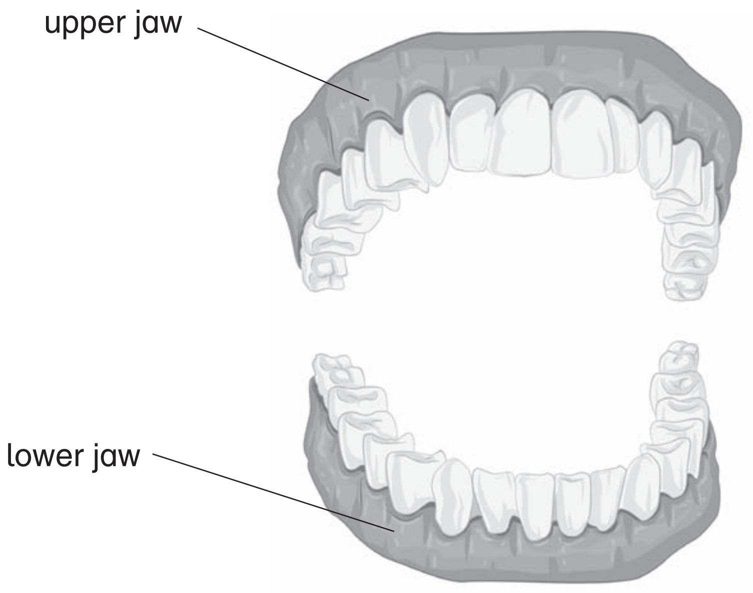
6. Looking after our teeth

What you need:

- pencil

What you do:

Look at this picture of our teeth.



a) What do we use our front teeth for?

____

b) What do we use our back teeth for?

____

c) Babies do not have any teeth. Why is this?

____

Bacteria, food and acid collect on our teeth and make a layer called plaque.

d) How can we get rid of plaque?

____

e) What might happen if we do not get rid of plaque?

____

Notes on individual worksheets

1. A food triangle

Key idea To investigate foods we can eat as much of as we like and those foods we should eat only in moderation, if at all.

Outcome Foods we should consume less of: cream cake, chips, sweets, fizzy drinks, biscuits, chocolate. Foods we should consume more of: any of the remaining foods listed, but especially the fruits and vegetables.

Extension Discuss why some foods are called junk foods.

2. A healthy diet

Key idea A healthy diet consists of a wide variety of foods.

Outcome It is not possible to predict the results of this activity, but ideally the meals should contain as many portions of fruit and vegetables as possible, together with some energy-giving and body-building foods. Hopefully the fizzy drink will be avoided!

Extension Make a class chart and graph of favourite foods. How many favourite foods are also healthy foods?

3. Faiza's food

Key idea To test understanding of the importance of a healthy diet and why it is possible to have too much of some types of nutrient.

Outcome

a) Any two from cabbage, beans, cornflakes, oranges, apples.
b) Any two from cabbage, beans, oranges, apples, and cornflakes.
c) Basically fibre absorbs water as it travels through the digestive system of the body and helps push the waste food through the body. Fibre is not digested. Student's answer is likely to be that fibre makes it easier for us to go to the lavatory.
d) Any two from chicken, fish, conflakes, and any of the fruit and vegetables.
e) Any two from sausages, chips, sweets, jam, cakes, crisps, butter.
f) Sausages, chips and butter contain a lot of fat. Sweets, jam, cakes, and crisps produce a lot of quick energy and can also lead to tooth decay.

Extension Let the students make their own list of foods and drinks consumed during a week and analyze these in the same way.

4. Favourite foods and the weather

Key ideas We consume a wide variety of foods and drinks. People differ in their food preferences.

Extension Construct a bar chart of favourite summer and winter foods. Plan three meals for a day to ensure a balanced diet.

5. Teeth

Key idea We have different numbers of teeth.

Outcome A complete set of baby or milk teeth is 20. Adults have 32 teeth. The milk teeth start to fall out and are replaced between the ages of six and twelve years.

Extension Collect pictures of the teeth of carnivores and herbivores and make wallcharts or scrapbooks with them.

6. Looking after our teeth

Key idea Our teeth are important when we eat and they have to be looked after since they have to last a lifetime.

Outcome a) For biting; b) for chewing or grinding tough food; c) babies do not eat solid foods but are fed on milk; d) by cleaning/brushing our teeth, particularly first thing in the morning and at bedtime; e) the teeth will go bad/decay and hurt.

Extension Make a large frieze showing the layout of the different teeth. Use different colours or different patterns of sticky paper to indicate the different types of teeth.

Lesson objectives

- To extend the student's knowledge of the range of materials we use and of the properties which characterize them.
- To show that the uses we find for materials are dependent on these properties.

Background information

As we saw in Teacher's Guide 1, the *Concise Oxford Dictionary* defines material as 'matter from which a thing is made'. By this broad definition, everything in the universe is made up of materials, including all living organisms.

If we consider only the common raw materials used by people, then a distinction can be made between natural materials, which come from animals and plants or from the Earth's crust, and synthetic or manufactured materials such as glass, paper, and plastics, which are made from other natural materials.

Some common natural materials and their sources are given in the table below.

Material	Source
Chalk	The Earth
Coal	Dead trees and other plants compressed in the Earth over millions of years.
Cork	Trees
Cotton	Plants
Crude oil	Dead plants and animals compressed in the Earth over millions of years.
Iron ore	The Earth
Leather	Animal skins
Rock	The Earth
Rubber	Trees
Wood	Trees
Wool	Animals

Synthetic or manufactured materials are made from natural materials, but the natural materials have been processed, often by burning or mixing with other substances, or both. Some common synthetic materials are:

Synthetic material	Natural source
Bricks	Baked clay
Charcoal	Wood
Glass	Sand, soda and limestone
Nylon	Coal, oil
Petrol	Crude oil
Plastic	Coal, oil
Pottery	Baked clay
Steel	Iron ore
Tiles	Baked clay

All materials have characteristics or properties. Many materials are classified according to whether they are strong, soft, hard, flexible, easily shaped, transparent or opaque, magnetic, or good conductors or insulators of heat and electricity.

Glass

Little is known about the first attempts to make glass. It is probable though that it was discovered in ancient Mesopotamia as an accidental product of copper smelting. Instructions for making glass have been found on clay tablets, dating back 3300 years. In ancient Egypt glass was considered more valuable than gold.

Glass is made from crushed white sand, crushed limestone rock and sodium carbonate (washing soda). These materials are blended and heated in a furnace at 1500°C for up to 24 hours. This produces molten glass, a thick red-orange syrup, which is then blown, pressed, drawn or rolled quickly before it cools.

Glass is strong, resists scratches and gives slightly under stress and returns to its original shape as long as the breaking point has not been reached. It is resistant to chemicals and can withstand extremes of temperature. Glass absorbs heat and is a good electrical insulator. Its optical properties allow it to transmit light (i.e. it can be transparent), bend light, reflect light and absorb light with great accuracy.

When molten glass is taken from the furnace, it may be fed straight into moulds to make jars, bottles, tumblers, dishes, bowls and other inexpensive items. Blowing compressed air into the glass makes it take up the shape of the mould. Blowing by hand is used to make quality glasses, and vases and other ornaments. Molten glass is drawn out to make tubing and rolled to make flat glass. The rollers can be embossed to produce patterned glass. Float glass is a process where the glass is floated on a bath of molten tin to produce a polished surface. Glass which needs to be very strong, for safety purposes, is cooled slowly and then reheated, in a process known as annealing.

Paper

Paper is a synthetic material made from plant fibres matted together to form a sheet. Paper was being made in China about 1900 years ago. In ancient Egypt papyrus, a kind of paper, was made from the papyrus reed, a plant that still grows in the swamps of the Nile Delta. Paper was made in Europe during the Middle Ages, but it was rare and expensive until the 19th century, when it was discovered how to make paper from wood pulp instead of from cotton and linen.

Today, most of our paper is produced from wood pulp, mainly from conifers such as pines, spruces and firs. Increasingly, though, paper is being made from waste paper, thus saving millions of trees.

In making paper from wood pulp, when the logs reach the paper mill the bark is stripped from them. The logs may then be ground between heavy rollers or ‘cooked’ with powerful chemicals to break the wood into fibres. Water is added to the resulting pulp and the mixture is passed through beaters which fray the fibres so that they will readily mat together.

The pulp then passes into the paper-making machine where it goes onto a fast-moving belt of fine mesh. Some of the water is removed from the pulp at this stage. The remaining pulp then goes onto rollers which squeeze out even more water and press the fibres firmly together so that they form a sheet. The paper is then led around a large number of heated rollers which continue to dry it. Finally the paper emerges from the paper-making machine in a huge roll.

There are many different kinds of paper and many go through other processes. To make glossy paper, for example, the paper from the paper-making machine is moistened and passed through heated rollers. Some papers have coatings of china clay added to make them into the high-quality papers used for art and printing.

Plastics

Another major group of synthetic materials, which has replaced wood and metals for some functions, is plastics. Chemically plastics are very complicated substances which always contain carbon and hydrogen and often oxygen and other non-metals as well. Most plastics are made from chemicals obtained from oil, although a few come from coal. Plastics can be rigid or flexible, soft or tough. They are good insulating materials and can be made in any colour.

Strictly speaking a plastic substance is one that can readily have its shape changed. Not all synthetic polymers are plastic in this sense, but since the word plastic is a common one, as in ‘plastic bag’, ‘plastic spoon’, or ‘plastic ruler’, the term is also used here.

There are three broad groups of plastic. *Thermoplastics* are those which can be softened by heat. This makes them easy to shape. If they are reheated they become soft once more. Examples of thermoplastics are polythene, used in plastic bottles and for plastic bags, Perspex, PVC, polystyrene, and such synthetic fibres as Acrilan, polyester (Terylene), and nylon.

Thermosets can be moulded when first made, but cannot be remoulded if they are heated again. They are much more rigid than thermoplastics and are good at withstanding heat and acting as insulators. Examples of thermosets are Formica, used in table tops and kitchen surfaces, melamine, used in electric plugs and sockets, picnic crockery and telephones, and the polyester resins used in fibreglass for some cars, boats, and furniture.

Elastomers, the third group of plastic substances, are materials that stretch and then return to their original shape. Rubber is an example of a natural elastomer. Synthetic elastomers are used in certain kinds of swimwear, stretch clothes, and divers’ wet suits.

Safety

It is not wise to heat the various plastic substances in the classroom since some of them give off toxic fumes.
Be alert to the dangers of suffocation by unperforated polythene bags.

Answers

Classifying materials: **Rapid fire, pg 13.**

1) a) silk dress—silk; b) pottery vase—clay; c) wooden chair—wood; d) woollen jumper—wool; e) storybook —paper, made from wood.
2) Hard: brick, steel nail, spanner, screwdriver.
   Bendy: newspaper, plastic bags, aluminium can.

Choosing the right material: **Rapid fire, pg 15.**

1) Windows are made from glass because glass is transparent (‘see-through’), it is quite strong and it can be made into flat, thin sheets.
2) a) Plastic is used to make trays because it is light.
   b) Wood is used for matches because it burns.
   c) Steel is used for nails because it does not bend easily.
3) Open answers.

Choosing the right material: **Try it out, pg 15.**

1) Bicycle frame made from steel because it is tough/strong.
   Hand grip made of rubber because it does not slip or is easy to grip. It is also warm to the touch.
   Seat made of plastic with springs underneath because it is soft/comfortable to sit on.
   Brake cable made of steel wire because it is strong.
   Tyre made of rubber because it grips the road and can be inflated so that it is softer to ride on.

Wood: **Rapid fire, pg 19.**

1) a) Wood comes from the trunks of trees.
   b) Wood is seasoned to dry it out so that it does not crack, bend or twist later.
   c) Wood is seasoned by drying it in the open air or in a special oven called a kiln.
   d) Plywood is made from sheets of thin wood glued together.
   e) Blockboard is made from strips of wood glued together.
   f) Chipboard is made from tiny pieces (or chips) of wood glued together.
   g) Most paper is made from wood (or wood pulp).
   h) Charcoal is partly burnt wood.
   i) Charcoal is used for cooking and heating, drawing, making certain metals and some inks and paints, as well as in gunpowder, fireworks and rubber.
2) Open answers.
3) Chipboard is often cheaper than planks of wood because it is made from sawdust and other tiny pieces of wood that are too small to be used for anything else.

Paper: **Rapid fire, pg 21.**

1) Objects made from paper include books, magazines, newspapers, posters, banknotes, tickets, wrapping paper, toilet paper and tissues and many others.
2) Most of our wood pulp comes from quick-growing conifers such as pine and spruce trees.
3) Recycling paper saves trees and energy. It also uses a ‘waste material’ that might otherwise litter the countryside or have to be buried in holes in the ground.

Glass everywhere: **Rapid fire, pg 23.**

1) Uses of glass include windows and doors, bottles and jars, aquaria and fish tanks, light bulbs and tubes, drinking glasses, vases and other ornaments, spectacles, microscopes, telescopes, binoculars, cameras, hand lenses and magnifying glasses. Glass fibre is also used for the heat insulation of walls and roofs, for making some car bodies and boats, fishing rods and certain telephone cables.
2) Open answers.

3 The glass used in spectacles, cameras and microscopes must be pure to allow the maximum amount of light to pass through without distortion.

Glass everywhere: **Try it out, pg 23.**

3) Recycling glass saves energy and also the raw materials sand, soda and limestone. There is therefore less need to dig these raw materials from the ground and fewer large holes in the countryside.

Using plastics: **Rapid fire, pg 25.**

1) Open answers.
2) a), b) and c): The main advantage of plastics over the other materials is that plastics are light and virtually unbreakable, and they do not rust, rot or need painting. Plastics are also cheaper to produce than items made from metals or china clay.
3) Plastics are often used in the doors, door frames and window frames of buildings, where they have replaced wood. The water pipes and guttering pipes of a house are often made from plastic, where they have replaced metals.

Going further

Find something made from each of these materials and complete the table.

Material	Object
Plastic	
Paper	
Metal	
Wood	
Rock	

Collect pictures which show how and where plastics are used in making houses. Make a wallchart or scrapbook with the pictures.

Discuss with the students whether they think plastic bottles are better than glass bottles. In what ways are glass bottles better than plastic ones?

Make a collection of different kinds of plastic materials. Show, for example, how plastic materials are used in packaging foods and other materials used in the kitchen, and how plastics are used to make toys and clothes.

To introduce the concepts of recycling and reusing, ask the students how many ways they can think of in which we could use plastic washing-up liquid bottles for new purposes.

Set up a glass museum in the classroom with examples of as many different objects made from glass as the students can find. As well as glass containers, do not forget the optical uses of glass in lenses, spectacles, microscopes, binoculars, cameras, magnifying glasses, etc. Write display cards for each item.

Design and make a house for a pet duck. Discuss what properties are important in the materials for the duck house. Do they need to be strong, flexible, waterproof, and so on?

Discuss which materials can be changed into different shapes. Give the students the opportunity to explore a range of materials which can be modelled into different shapes. These could include wood, sand, clay, papier mâché, bread dough and plaster of Paris.

Many clothes are now made from yarns that are man-made. Let the students devise a fair test to find out which yarns are the strongest.

Get the students to use hand lenses to look closely at a range of fabrics, made from natural and man-made materials. Encourage them to make some close observational drawings of their findings.

Bury a plastic bag and a paper bag which is the same size. Mark the spot where each bag is buried and then leave them for a few weeks. Dig up the bags and examine them carefully. Discuss why we should recycle plastic materials.

1. Sorting materials

What you need:

- pencil and crayons
- small objects made of different materials, such as a pencil, rubber, cork, plastic spoon, cup, elastic band, paper, feather, paper clip

What you do:

Sort your materials into these groups or sets:

warm	cold	bendy	not bendy
shiny	not shiny	hard	soft

Draw and label pictures of your groups or sets.

2. Properties of materials

What you need:

- everyday objects made of different materials, such as a plastic bag, paper towel, cup, rubber, metal spoon, plastic spoon, wooden ruler
- bowl of water
- magnet
- pencil

What you do:

Compare your different objects and materials.
Test each object or material to find out whether it is:

- hard or soft
- magnetic or non-magnetic
- bendy or stiff
- absorbs (soaks up) water or waterproof.

Fill in the table below:

Object	Hard	Soft	Absorbs water	Waterproof	Magnetic/ Non-magnetic	Bendy	Stiff
metal spoon							
plastic bag							

3. Choosing the right material

What you need:

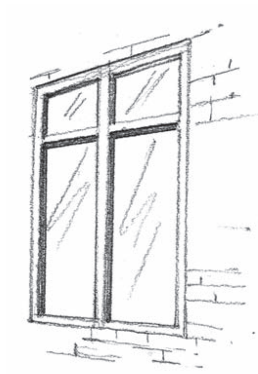
- pencil

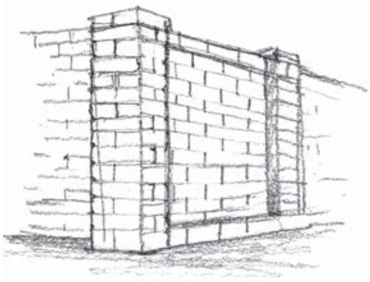
What you do:

Look at the list of materials below.

Write the material used to make each of the objects shown below.

concrete	**brick**	**wool**	**rubber**	**glass**	**stone**	**wood**	**plastic**





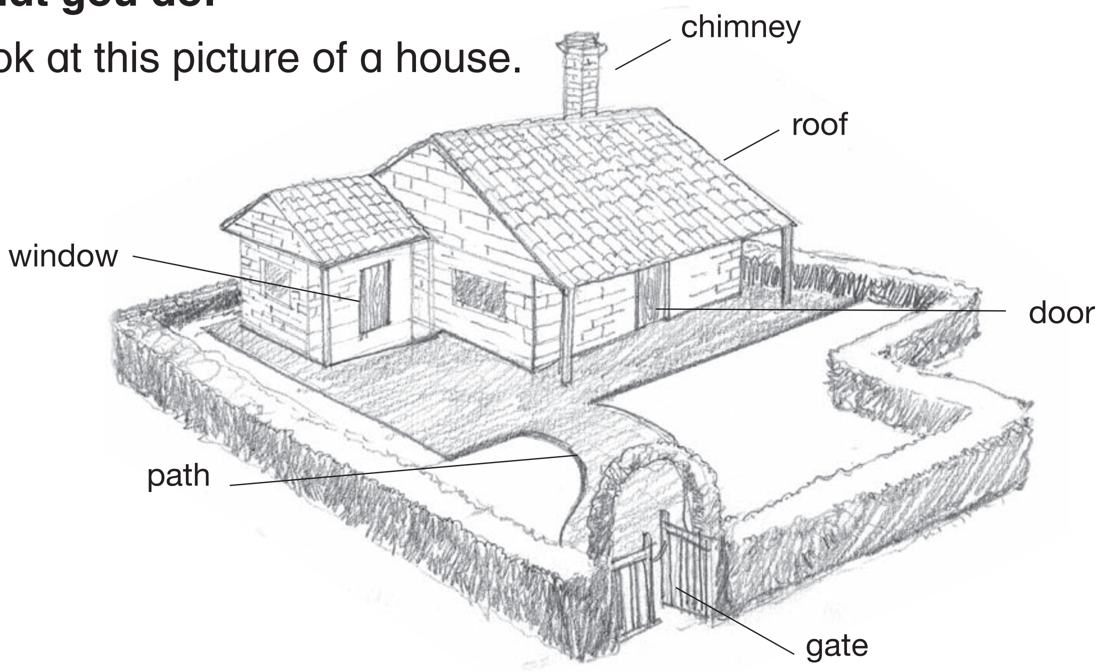
4. Building a house

What you need:

- pencil

What you do:

Look at this picture of a house.



What materials were used to build the house?

Fill in the chart below.

The chart has been started for you.

Material	Where it has been used	Why it was used
glass	window	You can see through it.

What materials were used to build your home?

____

____

5. Comparing different kinds of paper

What you need:

- pencil
- pieces of different kinds of paper, all the same size
- glue or sticky tape

What you do:

Compare the different kinds of paper.

How are they the same? How are they different?

Fill in the chart below.

Paper sample (stick a piece here)			
Can you write on it?			
Can you trace with it?			
Does it crumple easily?			
Does it tear easily?			
Is the paper shiny?			
What is the paper used for?			

6. Mopping up water

How good are different kinds of paper at mopping up water?

What you need:

- pieces of different kinds of paper that are used for mopping up spills, such as tissues, paper towels and kitchen roll
- trays or plates
- hand lens or magnifying glass
- scissors
- basin of water
- pencil

What you do:

Cut all the pieces of paper to the same size.

Use a hand lens to look closely at each piece of paper. What can you see?

Which paper feels thick? Which paper is thin?

Which paper do you think will soak up most water?

Test each piece of paper. Dip it in the basin of water. Shake it. Then squeeze out the water onto a dry plate or tray.

Do this with all the pieces of paper.

Which piece of paper soaked up most water?

7. Plastics

Plastics are manufactured materials. Most plastics are made from oil.

What you need:

- pencil

What you do:

These objects are all made of plastic.

Write YES or NO in each column of the table to answer the questions.

Object	Will it bend?	Is it transparent?	Is it strong?	Will it hold water?
plastic bag				
ruler				
watering can				
spoon				
bucket				
lemonade bottle				

Now find some more plastic objects. Add them to the table.

Notes on individual worksheets

1. Sorting materials

Key idea There are many different ways of sorting or classifying materials, including their physical properties and uses.
Extension Find out about the production of a natural material such as wood or sand.

2. Properties of materials

Key idea To compare the properties of the materials used to make some common objects to be found in the classroom.
Extension Compare the properties of some of the materials used to make objects found in the home.

3. Choosing the right material

Key idea We choose the right material to make any particular object.
Outcome Statue—stone; bridge—concrete; tyre—rubber; jumper—wool; bottle—plastic; window—glass; chair—wood; wall—brick; book—paper.
Extension Choose three of the objects on the worksheet and say why that particular material was used to make each.

4. Building a house

Key idea To show that the properties of a material tell us how it can be used in the construction of a house.
Outcome Tile—roof—waterproof and strong. brick—walls and chimney—strong, waterproof and fireproof.
wood—doors and window frames—warm, strong, easily shaped.
wood—gate—light and easily shaped, concrete—path—strong.
Extension Compare samples of different kinds of wood to see whether they float or sink.

5. Comparing different kinds of paper

Key idea To compare different kinds of paper.
Extension Devise other tests to carry out, for example, how easy is it to cut the paper, can you paint on it?
Safety Use a water-based glue.

6. Mopping up water

Key idea To compare the ability of different papers to absorb water.
Extension Repeat the experiment using the same kinds of paper to mop up other substances such as tomato juice, jam or washing-up liquid. Which paper is best for these? Do the papers work better when they are damp or dry?

7. Plastics

Key idea To examine the properties and uses of plastics.
Outcome Will bend—plastic bag, spoon and ruler; Transparent—plastic bag and lemonade bottle;
Strong—ruler, watering can, bucket; Holds water—watering can, bucket, and lemonade bottle.
Extension Invent a fair test to compare the strengths of different plastic bags.

Lesson objectives

- To extend the student's experience of forces, including the attraction and repulsion between magnets, the compression and stretching of springs and the stretching of elastic bands.
- To show that these forces have direction and size.
- To investigate the materials attracted to a magnet and to examine some of the uses of magnets and springs.

Background information

Magnets

The Earth we live on acts like a giant bar magnet whose magnetic field is slightly tilted away from the axis on which it spins. The Earth thus has two North Poles and two South Poles. The geographic North and South Poles are the points where the Earth spins on its axis, the other two Poles are its magnetic poles.

Not surprisingly, magnetic rocks can be found in the Earth's crust. These are called lodestones. However, magnets can also be made out of any magnetic material. Such materials include the metals iron, steel, nickel, and cobalt and their alloys. These are the only materials that are attracted to magnets.

Every magnet has poles—places where the magnetic attraction is strongest. There are two kinds of poles. One kind is attracted towards the Earth's magnetic North Pole and is called the north-seeking pole. The other kind is attracted towards the Earth's magnetic South Pole and is called the south-seeking pole. A compass consists of a magnetic needle, which swings towards the magnetic pole, contained in a box made of a non-magnetic material. Whichever way the compass is turned, the needle always points towards the Earth's magnetic North Pole.

Magnets attract or repel other magnets. Two similar poles—that is two north-seeking poles or two south-seeking poles—repel each other. Two unlike poles attract each other. No matter how a magnet is cut up, it always has a north-seeking pole and a south-seeking pole. It is not possible to cut off a single pole. There is no significance in the colour of a single-coloured magnet. The paint is only to prevent the magnet from rusting when it comes into contact with moist hands. In dual-coloured magnets, the red end of the magnet is the north-seeking pole while the blue or black end is the south-seeking pole.

Magnets can attract magnetic materials at some distance from them. We can think of the space around a magnet as being under the influence of the magnet. We call this space a magnetic field. The closer something is to a magnet, the more strongly the magnet pulls on it.

As well as compass needles, other uses of permanent magnets include magnetized tools, such as hammers and screwdrivers which help prevent small objects such as nails and screws from being lost. There are magnetized clips and holders for tools and kitchen knives, while a magnetized can-opener holds up the lid after it has been removed from the can. Refrigerators and cupboards often have magnetized strips to hold their doors shut. One of the most important uses of magnetic materials today is in the storage of data in terms of sound (audio tapes), pictures (videotape) and electronic data (computer disks).

Take care with magnets

There are a few rules about the use and handling of magnets which need to be observed if they are to retain their magnetism:

1) Do not drop, bang, tap or heat magnets—it weakens them.
2) Keep magnets away from compasses used for direction finding. The magnetic needle in the compass can be completely ruined.

3) Store magnets in the way they set themselves—do not force them. The soft iron ‘keepers’ (which are not magnets) should be kept in place—one across a horseshoe, one across each end of a pair of bar magnets.

Electromagnets

An especially useful kind of magnet can be made by passing an electric current through a coil of wire surrounding an iron bar. When there is a current, the iron bar acts like a magnet. When the current is switched off, the iron is no longer a magnet. This type of magnet, called an electromagnet, is widely used in industry for sorting iron, steel, cobalt, and nickel from other metals. It is also used in electric bells, telephones, electric clocks, loudspeakers, television sets, radios, and electrical motors.

Springs

We already know that forces can change the shape of things. You can squeeze on a lump of clay and it will change its shape. If you pull on both ends of an elastic band it will stretch. The elastic band tries to pull back and is said to be in a state of tension. If you let go of the elastic band, it will return to its original shape, but if you pull harder, the elastic band will pull back even harder. You can carry on doing this until eventually the elastic band breaks, often with painful consequences. Anything which behaves like an elastic band, which pulls back against the deforming forces and which returns to its original shape when these forces are withdrawn is said to be elastic.

Metal springs are specially made so that they behave in an elastic way. We can use this property of springs to store energy for a short time or a long time. This stored energy can then be allowed to escape quickly or slowly from the spring. As the energy escapes it can be used to move an object or dial or drive a piece of machinery around. Clocks and watches were once driven by coiled up springs as they slowly unwound. The ‘clockwork’ motors in some toys work in a similar way.

A spring is usually made of a special type of steel so that it will return to its original shape after it has been squeezed, bent or stretched. Of course, there is a limit beyond which a spring, like an elastic band, will become permanently deformed if too great a force is applied to it. You have exceeded the ‘elastic limit’ of the spring. If you keep squeezing or stretching the spring, it will eventually reach breaking point, and snap.

Springs come in all shapes and sizes, but the most common ones are coil-shaped. A forcemeter or spring balance allows objects to be weighed. If, for example, a brick is suspended from a force meter or spring balance, the brick will stretch the spring as it is pulled down by the force of gravity. As the spring stretches, it exerts more and more force on the brick until eventually the brick stops falling. When the brick is no longer moving, the upward force exerted by the spring must be equal to the downward force of gravity. The forces are balanced and the extension of the spring can be read off on a scale.

In a similar way, when springs are compressed they exert a force on whatever is compressing them. If, for example, a person lies on a mattress containing coiled springs, the weight of that person will squash or compress the springs. As the springs are compressed, they exert an upward force on the person’s body. When the upward force of the springs equals the downward force of the person’s weight, then the person will be lying at rest, comfortably supported by the upward force.

Safety

Pins are probably too sharp and too easily lost for most experiments on the strengths of magnets.
‘Panel pins’ about two or three centimetres long are available from hardware shops and provide a good alternative. If not, use wire paper clips.
Keep magnets away from watches and television screens. They may become magnetized and stop working. In addition, magnets can ‘wipe’ the data or recordings from computer disks, audio tapes, and

videotapes.

Warn the students of the dangers to their face and eyes if elastic bands and springs are overstretched. The students should wear safety spectacles, if these are available.

Answers

Forces everywhere: **Rapid fire, pg 27.**

1) A push or pull can make something move, speed up, slow down, stop, change direction or change shape.
2) You could start someone swinging by either pushing them forward or pulling them (and the swing) back and then letting go. To make the person on the swing go higher, you would need to push them harder. To stop the swing, it would be safer to gently push on the swing or the person on it from a safe position at the front.
3) Everyday twist and turn movements include opening a jar or bottle that has a screw top, turning a tap on or off, turning a key or a door knob or door handle, and using a screwdriver.

Forces everywhere: **Try it out, pg 27.**

1) You could push down on bathroom scales with one finger, a hand, both hands, one foot and both feet. You could sit on the scales if you were small enough. You could also hold the scales vertically against a wall and press on them with your fingers, hands and feet.

Magnetic forces: **Rapid fire, pg 29.**

1) A large magnet is not always stronger than a small one. The strength of a magnet depends upon the type of metal it is made from and how it was magnetized. A magnet will also lose some or all of its power if it is mishandled.
2) The only four metals that are magnetic are iron, steel, cobalt and nickel. A magnet will pick up small objects made from a magnetic material. One pole of the magnet will also repel the same pole of another magnet. Magnetic materials will not behave in this way.
3) To make two magnets attract each other you would have to put unlike poles (i.e. south and north or north and south poles) together.

Magnetic forces: **Try it out, pg 29.**

1) The magnet will pick up a paper clip, safety pin, needle, and small nails.

How we use magnets: **Rapid fire, pg 31.**

1) True: b), d), and e). False: a), and c).
2) a) Like poles of two magnets ***repel***.
   b Unlike poles of two magnets ***attract***.
   c) A pull by a magnet is called ***attraction***.
   d) A push by a magnet is called ***repulsion***.

Elastic bands and springs: **Rapid fire, pg 33.**

1) Some objects and materials which stretch if you pull them include anything made of rubber or elastic, some plastics such as polythene and nylon, Plasticine, clay, a sponge, chewing gum.
2) When you blow air into a balloon, the force of the air pushes against the sides of the balloon and stretches them, so that the balloon grows larger.

3) Basically springs that are easy to stretch or squash are small or are made from thin strands of metal or wire. The springs which show greater resistance are generally larger and made of thick metal.
   Some of the objects which contain springs include many scales and balances, force meters, some seats and cushions, mattresses, retractable ballpoint pens, clockwork toys and clocks, locks, the suspension of some vehicles.

Using springs: **Rapid fire, pg 35.**

1) See item 3) above.
2) a) and b) The strongest spring was C because it stretched the least.
   c) If the spring is not stretched beyond its elastic limit, it will stretch to 16 cm if a 2 kg mass is added to it.

Going further

Invite the students to invent a game using magnets. Ask them, for example, to design and make cardboard racing cars which can be moved along a track by a magnet hidden beneath, or set up a race using boats made of balsa wood in a tank or dish of shallow water.

Investigate whether objects can be picked up at any point along the length of a magnet.

Compare the strengths of different magnets by seeing how many paper clips they can hold. How many paper clips can be lifted to form a linked chain? Are the clips in the chain magnetic?

Attach a paper clip to thin elastic. How much does a magnet stretch the elastic? The strength of different magnets can be compared by seeing by how much they stretch the elastic.

Will a magnet work through paper, card or a glass of water? If so, through what thickness of paper and cardboard and through what depth of water will the magnetism pass?

Give the students a magnetic compass and ask them to plot a route around the school. Can their friends follow the route?

Make a collection of springs, and objects containing springs. Display them in the classroom.

Magnetic attraction and repulsion are invisible forces that work at a distance. What other forces do the students know of which act at a distance? (gravity).

Drop a few small ball bearings into a thin-walled bottle filled with water. Use a magnet to remove the balls, without spilling any water.

Use a magnet to search for steel ball bearings in a shallow bowl filled with fine dry sand.

Float a tin lid in a shallow plastic dish or tray supported at the corners on wooden blocks or bricks. Then make the metal boat sail about, by manipulating a magnet on a stick, held under the dish or tray.

Make a toy octopus using a cork and some small iron nails. Paint the octopus if you wish. The octopus should just float in a jar of water. Use a magnet to pull the octopus down to the bottom of the jar. The octopus will resurface when the magnet is removed.

Magnetize a large steel needle by stroking it many times, going one way from head to point, using one pole of a bar magnet. Rest the needle on a slice of cork and float it on a saucer of water to make a simple compass.

Use a magnet to sort drink cans. If a can is made of aluminium it will not stick to a magnet. If the can does stick it is made of steel.

1. Magnetic strength

What you need:

- pencil

What you do:

Ali has three magnets.

He tried to find out how many paper clips each magnet would pick up.

Ali did each test five times with each of the magnets.

Here are the results of his experiment:

Magnet	Number of paper clips				
bar magnet	5	4	5	6	5
horseshoe magnet	5	4	4	3	4
cylindrical magnet	3	3	2	4	3

a) For each magnet, add up the number of paper clips lifted.

i) bar magnet ____________________

ii) horseshoe magnet ____________________

iii) cylindrical magnet ____________________

b) For each magnet, work out the average number of paper clips lifted.

i) bar magnet ____________________

ii) horseshoe magnet ____________________

iii) cylindrical magnet ____________________

c) Which magnet was the strongest? ____________________

d) Describe ONE thing Ali should do to make his experiments fair?

____

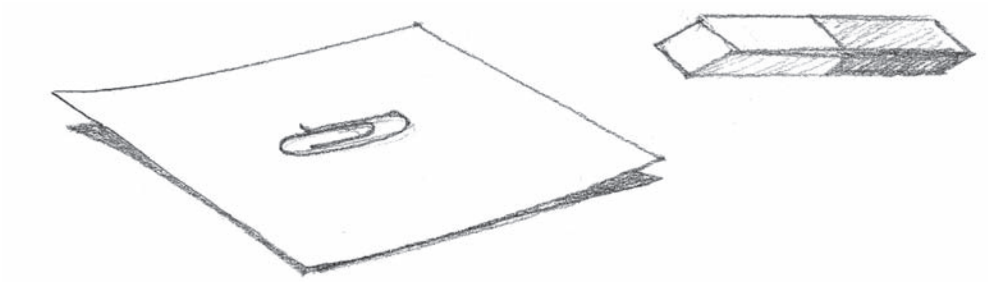
2. The moving paper clip

What you need:

- pencil
- magnet
- paper clip
- sheet of card
- thin wood, newspaper, plastic, polystyrene, tin lid or metal baking dish, tinfoil

What you do:

Put the paper clip in the middle of the card.



Place the magnet under the card.

Can you make the paper clip move? ______________________________

Now test the other materials.

Which materials did the magnetism pass through?

____

Was your experiment fair? Say why ______________________________

____

____

3. The paper clip in a jar

What you need:

- pencil

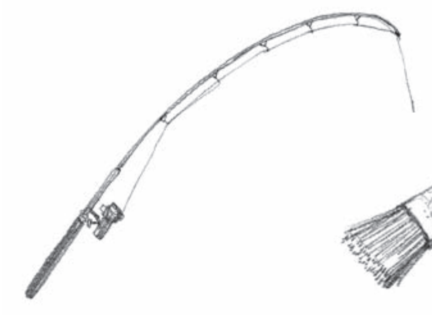
What you do:

Look at the jar of water in the picture.
At the bottom there is a paper clip.

How could you get the paper clip out of the jar?

You must not spill the water or get your fingers wet.

Here are some things you might use.

Which of them would be best?

Write or draw how you would do it.

4. Bendy, stretchy and squashy materials

What you need:

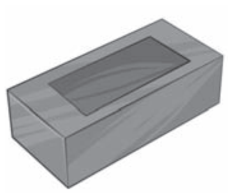
- pencil

What you do:

Look at the pictures carefully.

Put a ‘T’ against all the things that can be stretched.

Put an ‘S’ against all the things that can be squashed.



brick

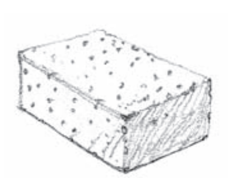
Plasticine

pencil

handkerchief

spring

hot-water bottle



sponge

elastic band

Which of the things above stays in its new shape when you have stretched or squashed it? ______________________________

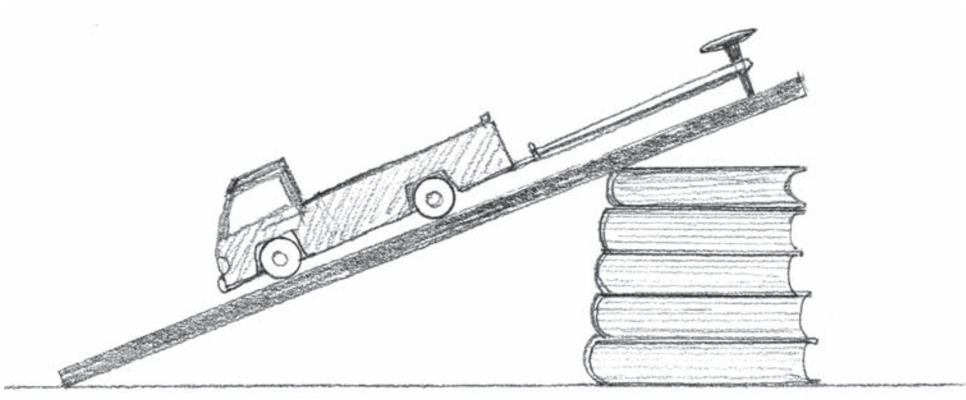
5. Stretching elastic

What you need:

- pencil
- plank of wood with a nail or hook at one end.
- toy plastic truck
- thick elastic band
- books
- ruler
- marbles or other small weights

What you do:

Use books to raise the end of the plank with the nail or hook in it.
Fix the elastic band to the nail or hook and the toy truck.



Let the truck roll down the slope until the elastic is tight.

Measure the length of the elastic band ______________________ cm.

Now put a small weight in the truck.

Measure the new length of the elastic band ____________________ cm.

What do you think will happen if you
put another weight in the toy truck?

____

Safety: Keep your face well away from the elastic band in case it breaks.

6. The jack-in-the-box

What you need:

- pencil

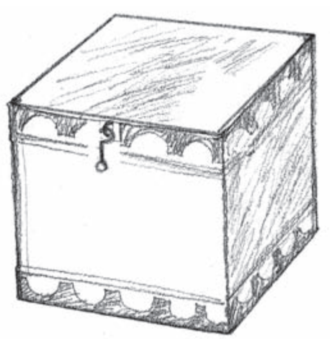
What you do:

Look at the jack-in-the-box.

What would you have to do to get him back in his box? ______________

____

What happens to the spring?



If you undo the hook, what two things will happen?

a) ______________

b) ______________

Explain why these things happen. ______________

____

Look around your home or classroom. Can you find two other things that work with springs?

a) ______________

b) ______________

Notes on individual worksheets

1. Magnetic strength

Key idea To analyze data from a comparison between the strengths of three different magnets.

Outcome
a) Total paper clips: bar magnet 25; horseshoe magnet 20; cylindrical magnet 15.
b) Averages: bar magnet 5; horseshoe magnet 4; cylindrical magnet 3.
c) The strongest magnet was the bar magnet.
d) To make sure the experiment is fair, Ali should ensure the paper clips are exactly the same size and place the paper clips exactly the same distance from each of the magnets.

Extension Investigate whether the two poles of the magnets are equally strong.

2. The moving paper clip

Key idea Magnetism will pass through non-magnetic materials.

Outcome The magnetism will pass through the non-metallic items, as long as the materials are not too thick or the magnet is too weak. The magnetism will not pass through even thin sheets of iron, steel, cobalt or nickel.
The experiment is not really fair unless the same magnet is used all the time and unless all the materials are of the same thickness.

Extension Magnetize a large steel nail by stroking it with an existing magnet an increasing numbers of times. See how many paper clips the nail will attract if it is stroked 10, 20, 30 and 40 times in the same direction.

3. The paper clip in a jar

Key idea To investigate whether magnetism will pass through water.

Outcome The simplest method of removing the paper clip from the jar of water is to suspend the magnet from a piece of the fishing line and then lower the magnet over the paper clip.

Extension Will magnetism pass through another liquid such as cooking oil?

4. Bendy, stretchy and squashy materials

Key idea To recognize that some objects and materials have elastic properties.

Outcome Objects that can be stretched and squashed: elastic band, hot-water bottle, spring, Plasticine, sponge. The handkerchief can be squashed. Only the Plasticine and handkerchief will remain in their squashed shape, while the Plasticine will also stay in its stretched shape.

Extension Measure how much a small spring or large elastic band stretches when different (small) weights are tied to it.

5. Stretching elastic

Key idea The stretch of an elastic band or spring is proportional to the weight added.

Outcome Within reason, the more weights added to the truck, the more the elastic band will stretch.
When the weights are removed, the elastic band will return to its original length.

Extension Try this experiment with a small spring instead of an elastic band.

Safety If possible, wear eye protection and do not stretch the elastic band to breaking point.

6. The jack-in-the-box

Key idea A spring can be used to store energy or to make an object move.

Outcome To get the jack back in his box you would have to push down on him so that the spring is squashed or compressed.
When the hook on the box is undone, the compressed or squashed spring will push against the lid of the box and jack will pop up.

Extension Experiment with a clockwork vehicle and see how far it will travel when the spring is wound an increasing number of times.

Lesson objectives

- To introduce some of the properties of light and to show the relationship between light, an object and the formation of shadows.
- To demonstrate the apparent movement of the Sun and the associated changes in shadows that can be used to measure the passage of time.

Background information

Light is a form of electromagnetic radiation to which the human eye is sensitive. Without light we cannot see. The Sun, stars, electric lights, candle flames, and other forms of fire all give out light—they are luminous. But nearly everything else we see reflects at least some light. Even the moon is a reflector—it does not produce its own light but reflects that from the Sun.

Light is only one form of electromagnetic radiation. Radio waves and infrared waves are electromagnetic radiations with lower frequency than light, while ultraviolet waves, X-rays, and gamma rays have a higher frequency.

Unlike sound which can travel around corners, light travels in straight lines. Some modern inventions, such as the instruments that allow doctors to examine the interior of the human digestive system, give the impression that light can be made to move along a curved path, but this is not the case. Such instruments rely on large numbers of reflections from the source to the eye of the viewer. But each of the individual reflections is still a small straight line that, together with all the others, forms a zigzag path.

The speed of light

Light travels extremely quickly, at a speed of 300,000 kilometres per second (186,000 miles per second). Indeed, scientists believe that nothing can travel faster than light. Even so, light takes eight minutes to reach us from the Sun. In other words, the sunlight entering our eye now left the Sun eight minutes ago. Light from the nearest star takes four years to reach the Earth, while light from some other stars has been travelling to us for hundreds or even thousands of years. Light travels much faster than sound, which is why we see the lightning before we hear the thunderclap that was produced at the same time. Similarly, from a distance, we hear the bat hit the ball after we see the impact of the two. In the case of a thunderstorm, we can tell how far away it is by the time difference between the lightning flash and the thunderclap. Since sound travels about three kilometres in 10 seconds in air, for every 10 seconds between the lightning flash and the thunderclap, the storm is three kilometres away.

Transparent, translucent and opaque objects

As we have seen, light goes through some materials and not others. When light goes through a material, such as spectacle lenses, window glass, air, or clean water, and forms a clear image on the other side, the material is said to be transparent. Translucent describes a material, such as tissue paper or frosted glass, that allows some light to pass through, but not enough for objects to be seen clearly through it. Opaque materials, such as wood, brick, or cardboard, do not allow any light to pass through them.

Shadows

Everything that is visible is capable of casting a shadow. This is evidence that light travels in straight lines. Opaque objects, that let no light through, cast the darkest shadows, with sharp edges; translucent materials cast lighter shadows, and even objects made of transparent materials, such as a glass bottle, will cast feint shadows. If light was able to travel in curved lines, it would bend round the opaque objects, so that the edge of the shadow would be diffuse. However, dark shadows can be made lighter, or even be made to disappear, by shining or reflecting light on to them.

Night and day

The Earth is a sphere, slightly flattened at the Poles—a shape called an oblate spheroid. The diameter of the Earth at the Poles is 12,714 kilometres and it is 43 kilometres greater at the Equator. Like the other planets in our solar system, the Earth moves in its own orbit around the Sun. As the Earth orbits the Sun it also rotates on its own axis, an imaginary line through the centre of the Earth between the two Poles. One complete rotation takes 24 hours. At any one time, the part of the Earth facing the Sun has its day, and the rest is in the area of dark shadow we call night.

Safety

Warn students never to look directly at the Sun. It could damage their eyesight or cause blindness.

Answers

Learning about light: **Rapid fire, pg 37.**

1) a) The Sun.
   b) In straight lines.
   c) 299,000 kilometres per second (or 300,000 kilometres per second in round figures).
   d) Light is reflected.
   e) To make their food.
2) Other sources of light include electric lamps and torches, stars, fires, candles, lighted matches, fireworks, television sets, computers, and certain insects and fish.

Materials and light: **Rapid fire, pg 39.**

1) Opaque materials: a) rubber, c) wood, d) stone.
   Transparent materials: b) glass, e) polythene sheeting (some is translucent)
2) Some light bulbs are translucent because they give a more even light with less harsh shadows than transparent bulbs. Translucent bulbs are also easier to look at because they do not dazzle.
3) Open answers.

Materials and light: **Try it out, pg 39.**

3) The mirror reflects the light from the torch. The mirror is opaque.

How shadows are formed: **Rapid fire, pg 41.**

1) A shadow is formed when an object blocks the light. The darkest shadows are formed by opaque objects. When light shines on an opaque object, none of the light rays can pass through it so a dark area, called a shadow, forms on the other side. Transparent and translucent objects form paler shadows since they allow some light rays to pass through. Shadows are not clear on a cloudy day because the clouds scatter the rays of light coming from the Sun, so that many of them do not reach the Earth.
2) Coloured lights do not form coloured shadows.
3) Shadows created by sunlight do change shape and direction during the day as the Earth rotates on its axis.

How shadows are formed: **Try it out, pg 41.**

3) An empty drinking glass does make a feint shadow, so does a full glass. The ripples create moving shadows.

Earth and the Sun: **Rapid fire, pg 43.**

1) Open answers.
2) a) The sun seems to rise in the ***east*** and set in the ***west***.
   b) When our part of the Earth faces the Sun it will be ***daytime***.
   c) When it is daytime where we live it is ***night-time*** on the other side of the Earth.
   d) The shadow of an object is shortest at ***midday***.

Earth and the Sun: **Try it out, pg 43.**

1) The position of the Sun on the window changes. As the Earth rotates on its axis, the Sun appears to be shining from a slightly different direction.

Shadows and time: **Rapid fire, pg 45.**

1) A shadow of an object in the morning is longer and points further to the left than a shadow of the same object at midday.
2) A sundial consists of a round or square dial on which the hours are marked. A pointer, called a gnomon, casts a shadow on the dial, and this shadow moves as the Sun moves across the sky. The position of the shadow on the dial shows the time.
3) A shadow made by an artificial light cannot be used to tell the time. A sundial only works because the Earth rotates on its axis.

Going further

Make a collection of different light sources and display them in the classroom, or collect and mount pictures of different light sources for display in the classroom.

Make posters warning of the dangers of looking directly at the Sun. Ask when the danger is greatest, summer or winter?

Observe the position of the Sun through the same window during a whole school day. Taking care not to look directly at the Sun, carefully tape cutout pictures of the Sun on the window to show its apparent movement across the sky.

Discuss the differences between being in a room when it is light and when it is dark.

Blindfold a volunteer and lead him or her around the classroom. Discuss the problems of not being able to see because everything is dark. What would it be like to be blind?

Investigate the use of lights (and colours) as signals, including traffic lights, railway signals, hazard warning lights, and the flashing lights used by the emergency services.

Work out on the playground on a sunny day. Discuss what a shadow is and why we make them. Ask questions such as: How can you make your shadow change its shape? Can you make a tall, short, wide or narrow shadow? Is it possible to lose your shadow? Can you make your shadow into a funny or frightening shape? Let the children work in pairs to play ‘shadow tag’.

Demonstrate, using a globe or a ball and a torch or desk lamp in a darkened room, how the Earth turns on its axis, producing the changes we call night and day.

See how the shadows of familiar objects change when they are held in different ways in sunlight. Choose objects with simple, easily recognizable shapes such as a broom, an umbrella, a doll, a chair, etc.

Use a desk lamp or table lamp to cast shadows on a stretched piece of white sheet or a projector screen. Make a shadow play or pantomime.

Make a simple portable sundial. Use it to tell the time. Discuss its advantages (cheap and simple) and disadvantages (inaccurate, can only be used in bright, sunny weather, not very portable). When setting up the sundial, it is important that it points to the north, otherwise it will not be accurate as a timepiece.

Draw around your friends' shadow profiles cast on white paper. Mount the cut-out silhouettes on black paper to form a portrait gallery.

Explore the different shadows that can be made with an open and closed umbrella. Compare the sizes of its shadows in sunlight outdoors and indoors under an artificial light.

Investigate whether soap bubbles, smoke or a piece of transparent plastic can make a shadow. (They can, but the shadows are delicate and rather fuzzy.)

Use a toy figure to investigate how it is possible to make two shadows at the same time. (Shine two torches or other lights on the figure from different directions.)

1. Shadows on the playground

What you need:

- pencil
- potted plant
- chair
- plastic bottle
- bucket or watering can
- football
- blackboard chalk

What you do:

On a sunny day take all of these objects out on the playground.
Space them a little way apart.
Draw around the shadows of each object with chalk.

Which object has the largest shadow? ______________________________

____

Which object has the smallest shadow?______________________________

____

Leave the objects out on the playground for an hour. Then go back and look at the shadows again.

Have the shadows changed?____

____

Which one has the biggest shadow now?______________________________

____

Safety: Remember not to look straight at the Sun. It could damage your eyes.

2. What causes night and day?

What you need:

- pencil
- globe or large ball
- desk lamp or torch

What you do:

Work in a darkened room.

Stand the globe or ball on the table.

Shine the light on to it, as shown in the picture alongside.

Pretend the lamp or torch is the Sun.
Which part of the globe is light? Which part is dark?
Draw what you see.

Slowly turn the globe or ball. Draw what you see now.

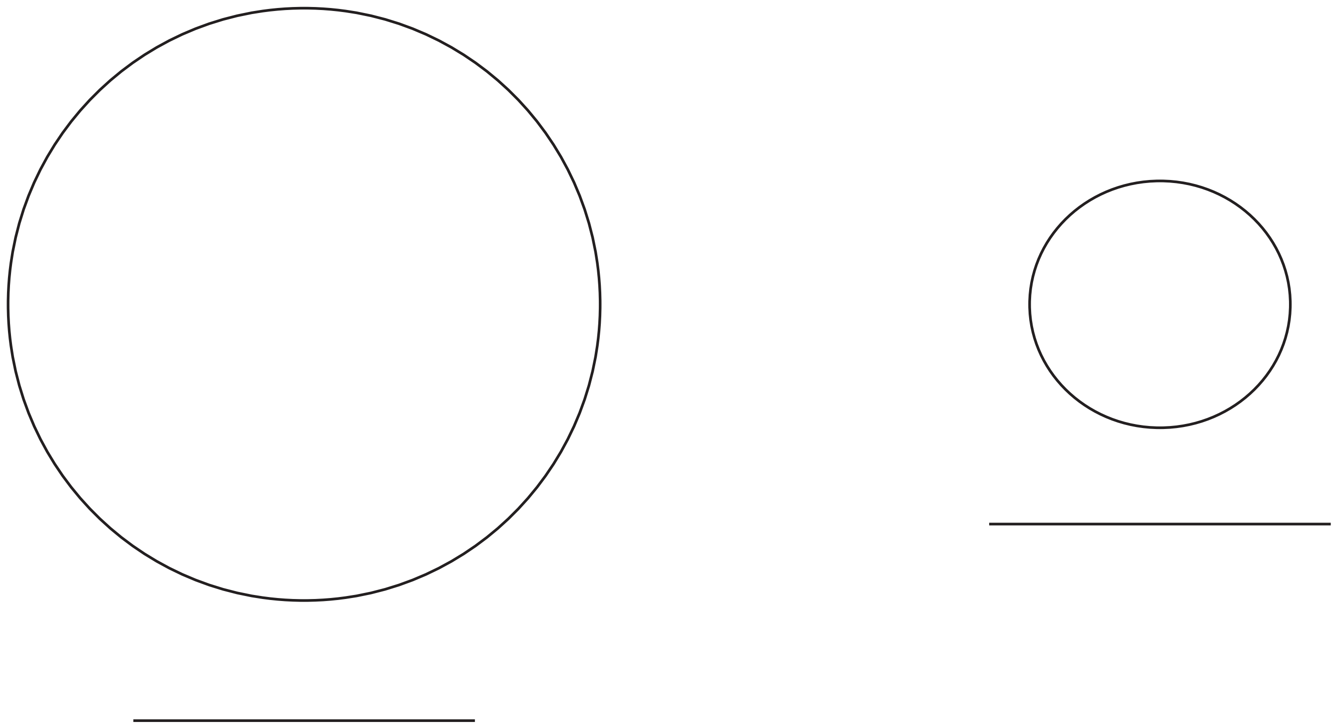
3. The Sun and day and night

What you need:

- pencil

What you do:

The picture below shows the Sun and the Earth.



a) Label the Sun and Earth on the picture.

b) On part of the Earth it is night. Shade that part on the drawing above.

c) How does it become daytime on the part of the Earth where it is night-time now?

____

____

____

4. Moving shadows

What you need:

- pencil
- small stones
- sand
- short stick
- plastic bottle

Do this activity on a sunny day.

What you do:

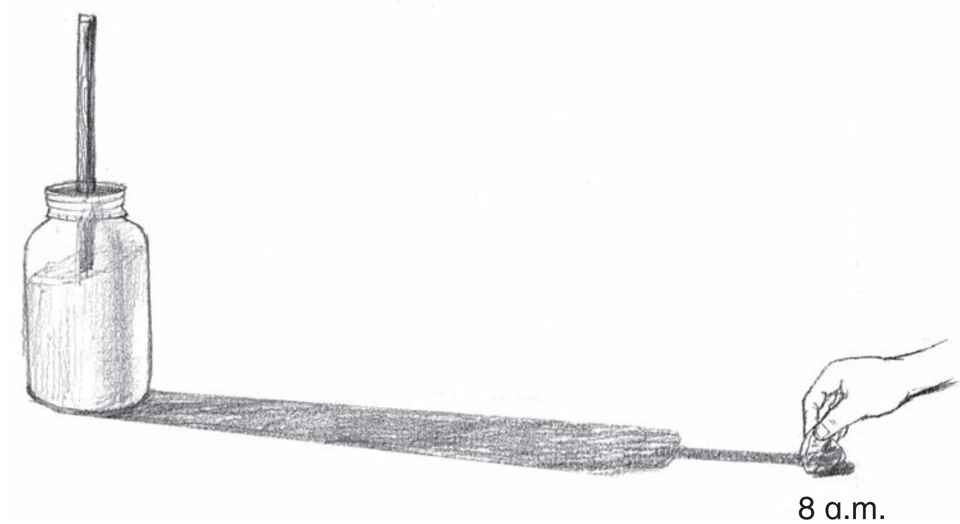
Fill the plastic bottle with sand.

Push the stick into the sand in the bottle.

Stand the bottle on the playground first thing in the morning.

Mark the end of the shadow of the stick with a small stone.

Every hour mark the end of the shadow with another stone.



Why does the shadow move?

____

____

How could you use the shadow of the stick to tell the time?

____

____

5. Changing shadows

How can you make a shadow change its size?

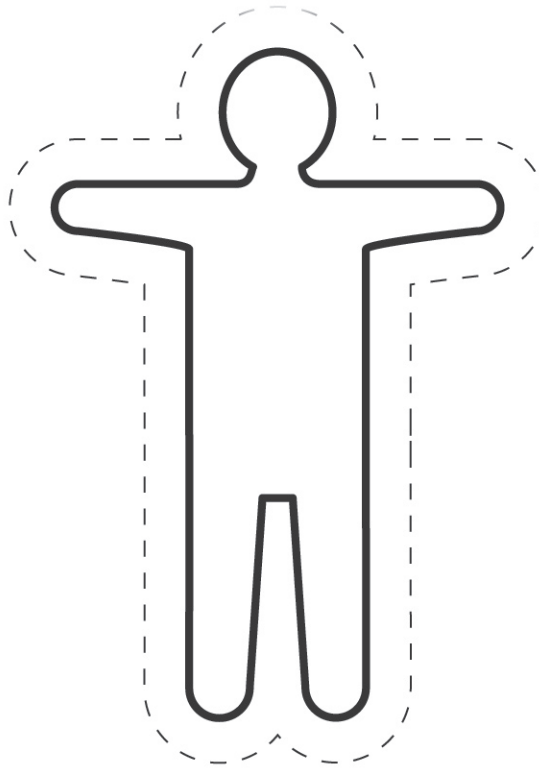
What you need:

- pencil
- torch or desk lamp
- thin card
- scissors
- clay or Plasticine

Work in a dark corner or room.

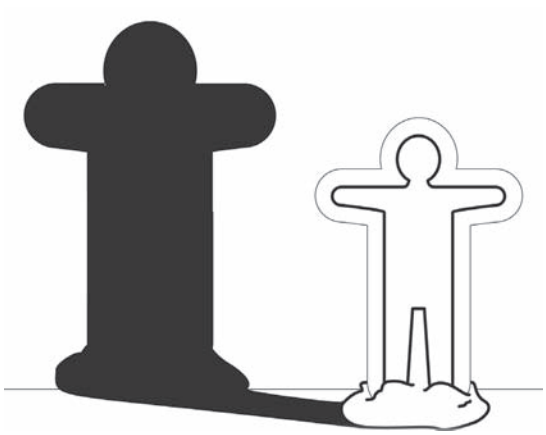
What you do:

Copy this shape on to thin card.



Use scissors to cut it out and stand it up on a lump of clay or Plasticine.

Place the light about 30 cm in front of the figure so that the light shines on the shape and the wall behind.



Can you see the shadow of the shape? ______________________

Now move the torch closer. What do you notice?

____

Move the torch further away. What do you notice?

____

Move the shape further away? What do you notice?

____

Move the shape closer to the light. What do you notice?

____

6. Transparent and opaque

You can see clearly through things that are transparent. You cannot see through things that are opaque.

What you need:

- pencil

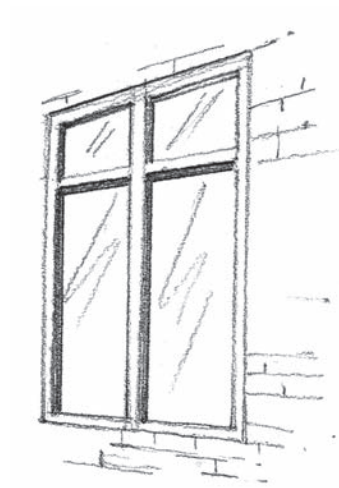
What you do:

Which of these things are transparent?

Which of these things are opaque?





Put a tick in the correct column.

Object	**Transparent**	**Opaque**
window		
book		
spectacles		
fish tank		
lemonade bottle		
pencil		

Now add some more things to the table. Tick the correct column.

Notes on individual worksheets

1. Shadows on the playground

Key idea Objects form shadows in sunlight. The shadows are roughly the shape of the object making them.

Outcome It is not possible to predict the exact outcome of this activity. It depends upon the time of day at which the activity is carried out. The shadows will be longer in the morning or afternoon than they are in the middle of the day. What is certain is that the shadows will be approximately the shape of the objects making them and that the largest object (probably the chair) will make the largest shadow. After an hour the shadows will have moved slightly as the Earth orbits on its axis.

Extension Compare shadows with silhouettes. Discuss the use of silhouettes in, for example, road signs.

Safety Warn the student not to look directly at the Sun. It could damage their eyes or even blind them.

2. What causes day and night?

Key idea Day and night are caused by the Earth rotating on its axis. The part of the Earth facing the Sun has day while the part in shadow has night.

Extension Make a list of some of the places where it is night-time when it is daytime where you live.

3. The Sun and day and night

Key idea To show how the turning of the Earth results in day and night.

Outcome The larger circle represents the Sun. It is night-time on the part of the Earth which is furthest away from the sun. The Earth spins around (on its axis) so that the part of the Earth that was in shadow (night-time) slowly turns until the Sun's light is shining on it, when it is daytime on that part of the Earth.

Extension Use a compass to find out the direction in which the Sun rises and sets.

4. Moving shadows

Key idea To show how the position of a shadow moves during the day as the Earth turns.

Outcome The shadow could be used to tell the time on a sunny day because every stone marks an exact hour. As the shadow moves between the stones one could estimate the number of minutes past each hour.

Extension Discuss why shadows are not always visible outdoors.

Safety Warn the students not to look directly at the Sun.

5. Changing shadows

Key idea The size of a shadow depends upon the distance between the light source and the object making the shadow.

Outcome When the light source and the object are close together the shadow formed is large and dark. With the light source further away from the object, the shadow is smaller and less dark.

Extension Investigate the length and position of a shadow when the light source is moved overhead slowly through an angle of 180°, keeping the light at the same distance from the object all the time. This will help the children to understand why shadows change as the Earth orbits the Sun.

Safety Warn the students not to look directly at bright artificial lights.

6. Transparent and opaque

Key idea To classify some objects and materials into opaque and transparent.

Outcome Transparent: window glass (but not the frame), spectacle lenses, fish tank, lemonade bottle. Opaque: book and pencil.

Extension Make a list of translucent objects and materials.

Lesson objectives

- To show that underneath all of the Earth's surface there is rock and that there are different kinds of rock with different properties and uses.
- To show how soils are formed and to emphasize the importance of soil in providing our food, clothing and other materials.

Background information

Rocks

Rocks are the substances that make up the Earth. Three common rocks are granite, sandstone, and marble, which we often see in the walls of buildings. But not all rocks are hard. Technically, both clay and sand are rocks. There are three main kinds of rock, named after their method of formation, namely igneous, sedimentary, and metamorphic rocks.

Igneous rocks

All rocks were originally formed during the period when the Earth was completely molten and then cooled down. A great deal of this fire-made or igneous rock still exists, and more is being formed all the time. Molten rock usually reaches the surface at the points of weakness in the Earth's crust that form volcanoes. The molten rock cools and solidifies, forming igneous rocks such as granite, basalt, and pumice. Igneous rocks are often rich in minerals.

Sedimentary rocks

Sedimentary rocks are produced from other rocks. As we shall see later, the Earth's crust is continually being broken down, or weathered, by the action of wind, water, Sun, and ice, into smaller pieces such as gravel, sand, and mud. These products are transported away by the wind or rivers and deposited in layers, most often in shallow water where a river meets the sea. Similar breakdown of rocks, and transportation of the rock fragments, occurs where glaciers slide down valleys. At the same time, the sea is constantly wearing away the land, and changing the coastline, while rivers erode their banks and bottoms, resulting in the formation of ever-deeper and wider valleys.

However they are formed, as the layers of sediment get thicker, the lowest layers of rock fragments become compressed and hardened into sedimentary rock. This can also happen to the remains of dead plants and animals, as when fossils or coal are formed. Most of the Earth's crust is covered by a thin layer of sedimentary rocks, such as chalk, limestone, sandstone, and clay. These form valuable building materials and are also used as raw materials in certain industries.

Metamorphic rocks

Both sedimentary and igneous rocks can be changed by great heat and pressure into a different form called metamorphic rocks. The heat and pressure causing this change can come from hot molten rock rising deep inside a volcano, or the enormous forces that occur when two or more of the sections of the Earth's crust, known as plates, collide. The two best known metamorphic rocks are slate and marble. Often new minerals are produced when metamorphic rocks are formed. One unusual example of this is the formation of diamonds in layers of coal subjected to heat and pressure deep underground.

The rock cycle

Sedimentary rocks are formed from the broken down fragments of other rocks. Metamorphic rocks are made when sedimentary and igneous rocks are changed by heat and pressure. In places in the Earth's crust, the existing rocks of all kinds are sucked down into the Earth's interior where they melt and mix with the molten rock already there. They may later emerge from volcanoes as new igneous rocks. These slow but repeated changes from one type of rock to another make up what is called the rock cycle.

Soil

Soil is produced from rock that has been broken down into smaller particles. As we have seen, this breaking down is caused by the weather and also by chemicals. Physical weathering usually produces fairly large particles. Any particles smaller than sand are generally produced by chemical weathering.

A fertile soil contains particles of different sizes, as can be seen if a sample of soil is shaken up with water and then allowed to stand. The particles settle in order of size, with gravel and stones settling first, followed by sand and then silt. Smallest of all are the clay particles, many of which are so small that they remain suspended in the water for a considerable time. It is the intermediate-sized silt particles that are present in a fertile soil in large quantities.

The other important constituent of a fertile soil is humus, the dead and decaying remains of plants and animals. These are broken down by invertebrate animals, bacteria, fungi, and other soil micro-organisms. These same soil organisms slowly convert the humus into mineral salts, which plants can take in through their roots and use as food—a natural form of recycling. At the same time, humus improves the soil structure, so that plant roots can grow vigorously.

The living soil

It is important to remember that soil is not a dead, inert substance. It is literally alive with countless millions of micro-organisms—small living plants and animals that can usually be seen only with a microscope. They include bacteria, fungi, algae and protozoa (tiny one-celled animals), and they live in the water film around the soil particles. There are also millions of larger organisms, including nematode worms, insects and their larvae and, of course, earthworms. Without these living constituents of soil, the world could not function in its present form.

Safety

Use soils free from glass, nails and other sharp objects, and collect soil samples from places that are unlikely to be contaminated with dog or cat faeces. Wash hands after handling soils and rock samples.

Answers

Rocks and our Earth: **Rapid fire, pg 47.**

1) Some of the places where we can see rocks uncovered are mountains, deserts, cliffs, some river valleys, waterfalls, caves, volcanoes, glaciers, beaches, quarries, road and railway cuttings, and the newly-dug excavations for the foundations of buildings.
2) Some common rocks include granite, limestone, chalk, sandstone, marble, slate, coal, clay, sand, and flint.
3) Rocks are solids, they are opaque, most rocks do not dissolve in water, and most are hard.
4) Rocks are natural materials.
5) Not all rocks are hard. Sand and clay are rocks.

Obtaining rocks: **Rapid fire, pg 49.**

1) All of these objects and materials are rocks or they are made from rocks. In the case of the pencil, although the casing is made of wood, the graphite or pencil lead is made from rocks.

2) and 3) Open answers.

Obtaining rocks: **Try it out, pg 49.**

3) Basically fossils are the hardened remains or shapes of organisms preserved in rock. They were formed when animals or plants died and fell into mud millions of years ago. The mud was later compressed into rock. Animal footprints were sometimes preserved in the same way.

What we use rocks for: **Rapid fire, pg 51.**

1) Concrete is rigid and strong and is also quick-drying. Concrete is particularly strong and rigid if it is reinforced with steel rods (called reinforced concrete).
2) Rocks or things made from rocks which we use to keep ourselves clean include toothpaste and pumice; the detergents widely used to keep us and our clothes and homes clean are mostly made from crude oil, which comes from rocks. The talc in talcum powder also comes from rocks.
3) It is warmer if you go down a deep coal mine because you are nearer to the Earth's mantle, which consists of very hot rocks, some of which are molten.

Soil: **Rapid fire, pg 53.**

1) If farmers and gardeners plough or dig too deeply, they will bring the subsoil to the surface. This may have been compacted for many, perhaps hundreds, of years and it will not contain humus or soil animals, so it will not be fertile.
2) A soil without animals would not be fertile because the animals are necessary to aerate and drain the soil with their burrows. The animals also eat some of the organic matter in the soil, breaking it down so that it decays more easily and forms humus.
3) True: a) and c) False: b) and d)

Soil animals: **Rapid fire, pg 55.**

1) Animals help to improve the soil by aerating and draining it with their burrows, and dragging leaves and other organic matter into the soil where these materials later decay to form humus. The animals' faeces also help to fertilize the soil.
2) Earthworm burrows drain and aerate the soil.
3) The dead leaf may be eaten by earthworms or other small soil animals or be dragged into the soil. Either the leaf, or the animals' faeces formed after eating the leaf, will decay and form humus.
4) The burrowing of the earthworms mixed up the layers of sand and soil, while the earthworms had dragged the leaves into their burrows.

The importance of soil: **Rapid fire, pg 57.**

1) a) fertile; b) food, clothing, timber, firewood, paper; c) rock fragments and humus; d) humus; e) there are not enough plants or animals, or water, for decay and the formation of humus to occur; f) earthworm burrows aerate and drain the soil, the worms break up the soil particles and mix up the soil layers, while the worms also break up plant leaves and other organic materials which later decay and form humus.
2) Assuming the cabbage seeds were planted at the same time, Mr Khan's soil may have been more fertile than Mr Smith's. Mr Khan may have spaced his seedlings out more or watered his cabbages more, or added manure or some other fertilizer to the soil.

3) The easiest way to sample the earthworm population would be to measure the area of the flower bed and then use hoops or wooden frames (called quadrats) of known area to take samples of the earthworm populations. The number of earthworms in the sample hoops or quadrats would then be multiplied to give a value for the whole flower bed.

Going further

Make a display on the science table of the rocks and rock-products which are used as building materials.

Analyze and compare different samples of dry soil by sieving them, using sieves with different-sized holes or mesh. Which size particles make up the largest proportion of each type of soil?

Make a collection of sands and soils. Collect a few grammes of sand from as many locations as possible. Examine them with a hand lens or magnifying glass and look for differences between the various samples. Put the sand in thin layers in a tall, clear-plastic bottle. Alternatively, keep the samples separately in small clear-plastic tablet bottles. Each sample can be labelled saying where and when it was collected. A collection of soils can be made in a similar way.

Plan a fair test to see whether seeds grow best in sand, clay or soil.

Grow cress, mustard, mung bean or grass seeds in soil from the top few centimetres of a garden and from the bottom of a hole at least 30 cm deep. Compare the results.

Half fill a deep-sided plastic tray with some freshly collected soil, ideally from under a tree. Place the tray under a warm lamp and observe closely. The warmth of the lamp, and its light, should encourage any small animals to reveal themselves. After the animals have been examined, record their presence and then remove them either to the garden or to somewhere damp and cool to prevent them from drying out. Compare a sample of soil from a different location.

Make a wormery from a large clear-glass or clear-plastic jar. Fill the jar to 5 or 6 cm of the top with alternating thin layers of moist soil and sand or moist soil and powdered blackboard chalk. Put two or three large earthworms in the top of the jar, together with two or three dead and decaying tree leaves. Surround the jar with black paper, or put it in a dark cupboard for a few days. Remove the black paper every few days and examine the wormery to see how the soil layers have been mixed up by the worms and how they have plugged their burrows with the decaying leaves.

Discuss how oil and coal are formed in the Earth's crust and how they are extracted.

Collect pictures of the machines used to prepare and deliver mortar and concrete. Make a wallchart with the pictures.

Devise an experiment to compare the rate at which water drains through different kinds of soil.

Sow quick-growing seeds, such as those of grass, mustard, cress or mung beans, on the surface of pots of two different kinds of soil. Compare the results.

Make a collage of various coloured soils.

1. Sorting rocks into groups

What you need:

- pencil
- eight or ten different kinds of rocks. You can if you wish, include small pieces of artificial rock such as brick, mortar, cement and concrete.
- pieces of strong paper, such as sugar paper.

Work with some friends.

What you do:

Place each rock on a piece of paper.

Look at your rocks carefully.

Think of a way to sort your rocks into two groups.

Write down the names of the groups you have chosen.

Group 1 ________________

Group 2 ________________

Ask your friends to come and look at your groups of rocks. Can they guess how you have sorted them? Let them look at your answer when they have made their guess.

Can you think of some more ways of sorting your rocks? Write down the different ways of sorting your rocks. ____________________________

____

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____

____

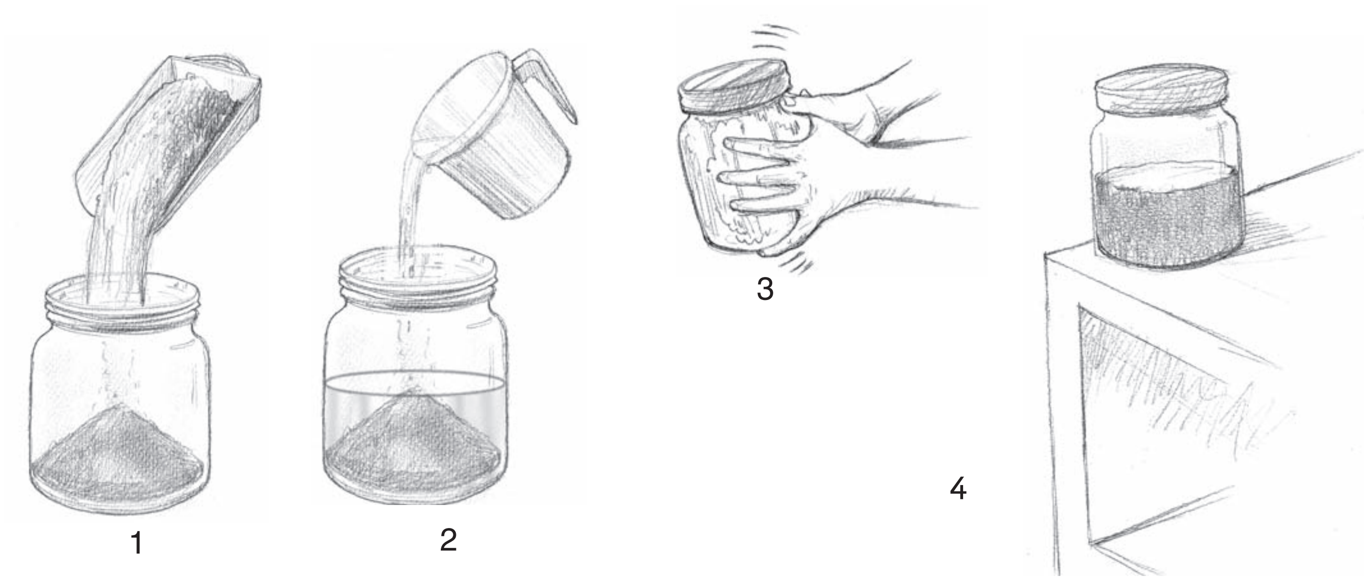
2. What is soil made of?

What you need:

- pencil
- clear plastic jar with a lid
- soil
- water

What you do:

1. Put a handful of soil in the jar.
2. Fill three-quarters of the jar with water.
3. Put the lid on the jar and shake it hard.
4. Leave the soil to settle for a few days.



What happens to it? How many layers can you see?

Now try soils from other places.

Are they the same?

How can you make your tests fair?

3. Is there air in soil?

What you need:

- pencil
- clean jars
- water
- samples of soil
- a drinking straw

What you do:

1. Blow down the drinking straw into some water in a jar. The bubbles of air are those which came out of your mouth and lungs.
2. Half fill a jar with dry soil.
3. Carefully pour some water in and watch what happens.

Do air bubbles rise to the surface? ____________________

If so, these are bubbles of air which were in the soil.

Draw what happened.

Now test other samples of soil.

Which sample had the most air in it?

____

Can you think why the soil needs to have air in it?

____

____

4. Investigating clay

Not all rocks are hard. Clay is a kind of rock.

What you need:

- pencil
- samples of different kinds of clay (including Plasticine)
- drawing paper
- clean jars or bowls
- hand lens

What you do:

1. Look at each piece of clay with a hand lens. Can you see any differences between them?

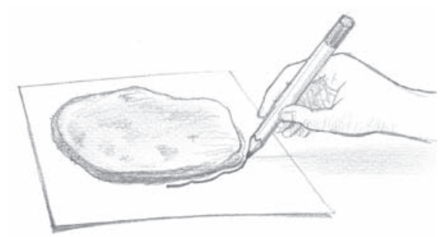
   ____

2. Compare the way the pieces of clay smell and feel.
3. Mix each type of clay with water. Is there any difference in the way they react?

   ____

4. Press each piece of clay on to paper. Draw round it.





Leave the clay to dry on the paper. What do you notice?

____

____

Which kind of clay dries out most? ____________________

Does the shape of the lump of clay (flat, round, long, thick, etc.) make a difference as to how quickly it dries out? Do an experiment to find out.

5. Looking for signs of weathering

The wind, rain, heat and frost can make rocks start to break up, or weather.

What you need:

- pencil

What you do:

Look around your school buildings and playground for signs of weathering. Do not forget to look at artificial rocks such as brick, concrete, tarmac and mortar, as well as natural rocks.

What problems is the weathering causing?

Fill in the table below:

Where did you see it?	What has happened?	What problems is it causing?

Notes on individual worksheets

1. Sorting rocks into groups

Key idea A number of different criteria can be used to sort rock samples.

Outcome The rocks can be grouped on the basis of colour, roughness and smoothness, hardness and softness, having grains or crystals visible, how easily they can be scratched, and whether or not they soak up water.

Extension Show the students pictures of the rock fragments, or scree, on the side of a mountain. Let them use porous rocks (or small pieces of brick or blackboard chalk) and investigate the effects of alternate freezing and thawing on the rock samples.

2. What is soil made of?

Key idea Soils consist of different proportions of stones, sand, clay and humus.

Outcome The heaviest particles of soil (stones and then sand) settle out first, forming a layer at the bottom of the jar. The lighter particles settle out, in order, later. The particles of humus float on the surface of the water.

Extension Make a collage of various coloured soils.

Safety Use soils free from glass, nails and other sharp objects, and collect soil samples from places that are unlikely to be contaminated with dog or cat faeces. Wash hands after handling soils.

3. Is there air in soil?

Key idea Soil samples contain varying amounts of air.

Outcome All soils contain air. There is most air in sandy soils, and least in compacted clayey soils. Plant roots need air to breathe, as do earthworms and all the other small living organisms that inhabit the soil.

Extension Devise an experiment to find out how much water there is in different samples of soil.

Safety Use soils free from glass, nails and other sharp objects, and collect soil samples from places that are unlikely to be contaminated with dog or cat faeces. Wash hands after handling soils.

4. Investigating clay

Key idea There are different types of clay, all of which consist of minute particles of rock material.

Outcome Clays differ in the colour and size of the particles from which they are made. When clay dries it shrinks slightly. The greatest shrinkage is found in those shapes which are somewhat flattened. Use Plasticine in this activity only if natural kinds of clay are not available.

Extension Use clay to make some simple pots. Which type of clay makes the best pots?

5. Looking for signs of weathering

Key idea The weather can make natural and artificial rocks crumble and wear away.

Outcome It is not possible to predict the outcome of this investigation, but it will probably be found that any soft sandstone or limestone will show signs of weathering, as will the mortar between bricks. Places, such as tarmac, where water has accumulated and then frozen may also show signs of weathering. The weathering will be worst in urban areas where there is a lot of traffic and industrial pollution, since the effects of weathering will have been made worse by acid rain.

Extension Discuss why water pipes sometimes burst in cold weather. Fill a small plastic bottle to the brim with water and screw on the top. Leave the bottle in a freezer overnight and then examine it carefully the next day. The water will have expanded as it turned to ice and will probably have split the bottle.

Lesson objectives

- To show the importance of plants in providing our food.
- To introduce simple ideas on plant propagation, and to show what plants need to grow well and why it is important that they do so.

Background information

The structure of a flowering plant

Plants contain the green material called chlorophyll, and in this respect they differ from all forms of animal life. Plants are also different from animals in that they are able to make their own food, using the process known as photosynthesis. A plant has two main parts: the shoot and roots.

Stem

The main part of the shoot is the stem. Most stems are upright, supporting the leaves and flowers. Some, however, grow along the ground, including the runners of strawberry plants. Other stems may even grow horizontally under the ground as in couch grass and the swollen underground stems, or tubers, of potatoes. The functions of stems are to carry water and mineral salts from the soil to the leaves, and also to carry food made in the leaves to other parts of the plant. In addition, upright stems support and space out the leaves so they receive the maximum amount of sunlight. Stems also hold the flowers above ground, which helps pollination by insects or wind and also aids the dispersal of the seeds.

Leaves

Leaves grow out from the sides of the stem. They are flat and green and their job is to absorb sunlight and make food by photosynthesis. The green colour of the leaves and stems is due to the presence of chlorophyll inside them. Leaves have a network of veins which stiffen them and help to prevent them drooping. In some plants, the leaves (and stems) are hairy or have spines which help to protect them from attack by insects and other animals. Each leaf is attached to the stem by a leaf stalk.

On the underside of the leaf are minute pores, called stomata (singular stoma), which allow the exchange of carbon dioxide, oxygen, and water vapour with the air outside the leaf.

Buds

Buds that occur at the tip of a shoot are called terminal buds. Other buds grow from the side of the stem at a point just above the leaf attachment. These are lateral buds. In either case, the buds consist of tightly packed, overlapping leaves on a short stem. The outer leaves, called bud scales, are often thick and tough to protect the inner leaves from drying out or from attack by insects. When a bud sprouts, the bud scales fall off and the stem elongates, spacing out the leaves which expand and turn green. When terminal buds sprout, they continue the stem's growth in length. Lateral buds produce branches. Either type of bud may produce flowers.

Roots

Roots do two jobs: they anchor the plant in the soil to prevent it from falling or being blown over, and they absorb water and mineral salts from the soil and pass them to the rest of the plant. The main root is called the taproot and this produces lots of short side (or lateral) roots. Near the tip of each root is a covering of fine root hairs, which can only be seen properly with a hand lens or microscope. In some plants, such as carrots, parsnips, and dandelions, the taproot is swollen with stored food.

Some plants, such as grasses, do not have a taproot. Instead they have a bundle of slender roots which spread out from the base of the stem. These are called fibrous roots.

Flowers

Flowers are the reproductive structures of a flowering plant. Each flower contains sexual organs which produce male or female sex cells. The male cell is in the pollen grain and the female cell (the ovule or egg cell) is in the ovary. After fertilization, the female sex cell forms the seed and the ovary forms the fruit.

Plants as food

Plants have always been a major part of the human diet. We have already seen in *Teacher's Guide 1* that no two people are exactly alike. Such variation also exists in other living things, including plants, which reproduce sexually. However, many plants can also reproduce by vegetative means, such as bulbs, corms, tubers and runners, when the offspring are identical to the parent plant. The offspring are also identical to the parent plant when people take cuttings.

Our earliest ancestors collected seeds from wild plants for food. Some of these that were accidentally dropped to the ground probably germinated, and grew into mature plants around the nomadic camps. By 6000 BC, in Palestine, people had become settled and grew crops, rather than searching for suitable plants in the wild. As long ago as 4500 BC, people not only grew crops from seed, but there is evidence that they selected and used seeds only from the strongest, most productive plants.

This process of selection, by using only the best plants, is still the most widespread method of producing new kinds of plants from old. Today, plants are selected not only for yield, but also for such features as speed of ripening, disease resistance, and the ability to withstand bad weather, atmospheric pollution and poor soils.

Selection to produce the required new plant is usually a very long process, and can require the equivalent of up to 20 years of growing seasons. Occasionally, however, a quite different individual appears spontaneously in a crop. This is called a 'sport' or mutation, and if it bears characteristics useful to people, it can be propagated. Nowadays it is possible to induce mutations by the use of chemicals, X-rays and other forms of radiation. In some instances once a desired mutant or variation has been found, it is possible to grow new individuals from single cells of the new plant contained in test tubes, so increasing rapidly the production of an economically large stock of the new plant.

One of the reasons for conservation is to preserve as wide a variety of wild plants as possible, so that in the future it may be possible to use some of their characteristics in new cultivated plants.

Seeds and germination

The flowering plants which reproduce sexually, bear seeds. These consist of a food store surrounding a miniature or embryo plant. In order for a seed to start to grow, or germinate, air (or oxygen), water and warm conditions are necessary. A few seeds need light if they are to germinate, and all seedlings must have light if they are to grow into healthy plants.

A fruit is the part of a plant which encloses the seeds. When we eat a fruit, we should remember that its original function was, and still is, to assist in dispersing the seeds.

Vegetables are the parts of the plants we eat, other than fruits. When we eat most vegetables, we are eating plants organs containing food which the plant has stored for its own use. Often, as in the case of potatoes, carrots, turnips and onions, this stored food is needed to enable the plant to reproduce, or to begin growing again when warmer conditions return after the winter period of dormancy.

Grasses

The grass family is vital to humans because it includes not only lawn and pasture grasses, but also cereals and a number of other economically important plants. There are over 10,000 species in the world, ranging in size from dwarf mountain and desert grasses, to species more than 6 metres high. Pasture grasses, either fresh, dried in the form of hay, or preserved as silage, are the main food for sheep, cattle, horses and other domesticated herbivores. Wild grasses are also food for many wild herbivores. Grasses, with their fibrous roots, also prevent soil erosion on hills and slopes.

Of the cereals, wheat has been cultivated for more than 10,000 years, while rice, barley, oats, maize and millet are widely cultivated. Two other Asian grasses are very important: sugar cane, from which much of the world's sugar is extracted, is a giant grass 3 to 6 metres tall. It is now grown mainly in the New World, where it was introduced by Columbus. Today sugar cane is the main crop of the West Indies and Brazil. Bamboo, another giant grass, is used for making houses, furniture, mats, screens, containers, fishing rods, knives and a whole catalogue of other items. The young bamboo shoots are often used for food. Marsh grasses include reeds, sedges and rushes, all of which can be used for thatching, matting and making baskets.

In the case of cereals, it is the seeds (grains) which are used as food. A cereal grain consists of a small embryo (the germ) that will grow into a seedling, and a supply of food (called endosperm) to nourish it. The food is mainly starch, although the grain also contains other nutrients such as proteins and vitamins. In recent years, plant-breeders have succeeded in producing high-protein varieties of the common cereals.

Wheat, the oldest and most widely cultivated cereal, is grown in most temperate parts of the world. Its grains are ground (milled) to make flour, from which bread, cakes and many other foods can be made.

Rice is the staple food of over half of the world's population, particularly in southern and eastern Asia. It is mostly grown as a swamp crop, and the seed is planted either directly in the flooded paddy fields, or in well-fertilized waterlogged nursery beds, from which the seedlings are later transplanted into the fields.

Barley is a cereal grass which is widely grown for animal and human food, and to make alcoholic drinks.

Rye is coarser than wheat, and is grown only in soils which are too poor for wheat, such as those found in parts of eastern Europe and Russia. Rye is used to make black bread and also for cattle foods. Oats, which can be grown in moist climates with short summers, is used to make oatmeal for porridge and cakes and as an animal food.

Maize (or corn) is a large cereal plant which originated in the Americas. It is widely used for animal food, but some is used for human consumption in, for example, cornflakes, while the young seed heads provide sweet corn. Another edible grain, mainly grown in the tropics, is millet, also known as sorghum.

Safety

Some children are allergic to certain plants, e.g. some flower bulbs, and pollen (from flowers), and remember that some plants are poisonous. Always wash the hands thoroughly after handling plants, seeds, or soil.

Many seeds bought from garden centres will have been treated with pesticides and are not safe for students to handle. Seeds bought from health food shops are usually safe, although it is best to avoid red kidney beans. Some children are allergic to nuts and foods containing nuts.

Answers

Plants: **Rapid fire, pg 59.**

1) and 2) Open answers.

3) The stem holds the plant up to the light.
   The leaf uses sunlight to make the plant's food.
   The flower helps to make the fruit.
   The root takes in water from the soil.
   The fruit protects the seeds.

How new plants are formed: **Rapid fire, pg 61.**

1) The seeds did not grow because the temperature of the soil was too low for them to germinate.
2) Seeds need to be dispersed so that they are not competing with the parent plant for light, water and mineral salts.
3) A seed would not grow well under a large tree because the tree would shade it and take most or all of the available mineral salts and water.
4) Seeds do not grow in the packet because of the absence of water and possibly even of air if the packet is sealed firmly enough.

Food from plants: **Rapid fire, pg 63.**

1) Open answers.
2) Some dried fruits include sultanas, raisins and currants (dried grapes), prunes (dried plums), and dried apples, bananas, apricots, figs and dates.
3) Open answers.

Grasses: **Rapid fire, pg 65.**

1) Open answers.
2) Most rice is grown in flooded fields, called paddies, but upland rice grows like wheat, barley, oats or any other cereal. More than 14,000 different varieties of rice are known. Rice is a rich source of carbohydrates. It also contains some proteins and some of the B vitamins.
3) Wheat forms compact elongated seed heads (known as 'ears') in which the grain is tightly packed, whereas the seed heads of rice are loosely arranged. Both plants have the typical grass-type leaves. Wheat grows best in temperate parts of the world, whereas most rice is grown in flooded paddy fields.

Plants and water: **Rapid fire, pg 67.**

1) a) A plant needs water to pack its cells and hold it upright, to help make its food and to carry dissolved substances to all parts of the plant.
   b) If a plant does not get water, it wilts and eventually dies.
   c) Water is absorbed from the soil by the tiny root hairs on the plant roots. The water passes into the roots and then travels up the stem in tiny tubes. From the stem the water passes into the veins of the leaf. Most of the water then evaporates from the leaf through tiny holes on its underside, although some is used to help to make food for the plant.
2) Fibrous roots: runner bean, daisy, grass, pelargonium.
   Taproots: beetroot, swede, carrot, turnip, parsnip, dandelion, lettuce.
3) None of the plants will grow healthily. Plant a) was not watered while Plant b) did not get enough sunlight.

Helping plants to grow: **Rapid fire, pg 69.**

1) Animals help some plants to grow by dispersing their seeds or by pollinating them. Animals also produce manure which acts as a fertilizer.
2) Possible answers: Give the bean plants warmer temperatures, more water, more light, or fertilize the soil.
3) Farmers and gardeners help plants to grow bigger and faster by watering (irrigating) them in dry weather, adding manure or other fertilizers to the soil, and by improving the climate with greenhouses, cloches or polytunnels.

Helping plants to grow: **Try it out, pg 69.**

1) Wood or forest plants grow and flower early in the spring so that they complete their growth and reproduction before the leaves open on the trees above them and deprive them of rain and light.
2) One way would be to turn the plant so that its shoot is pointing away from the light, and to leave it for just long enough until it has straightened up.

Going further

Make a collection of living plants, including seedlings. Ask the students how they should look after them. What do the plants need in order to stay healthy? Develop an understanding of what makes a plant healthy. How would the students recognize a plant that is unhealthy?

Cut out pictures from seed catalogues. Stick them on card. Use them to make sure that the students know the names of the different common fruits and vegetables. These pictures can also be used to help the students learn the names for the parts of plants (root, stems or stalks, flowers, petals, stamens, buds, leaves, veins, hairs).

Make a collection of fruits which can be opened to view the seeds inside. Good examples are tomatoes, thistles, poppies, sunflowers, dandelions and acorns. Try to grow some of the seeds.

Make a table with four columns. Head the columns: one seed, many seeds, stone around the seed, no stone around the seed. Let the students help you to fill in the table, putting the names of all the fruits they can think of in the correct columns.

Sprouting seeds can be grown at any time of the year indoors. Some common sprouting seeds include alfalfa, mung beans, and fenugreek. They can be eaten raw or fried. Put a handful of the seeds in a clean jar. Cover the jar with a piece of muslin or some other clean, porous cloth held in place with an elastic band. Wash the seeds through the cloth under the cold water tap. Shake them around inside the jar and then drain them thoroughly. Stand the jar on its side somewhere warm (the seeds do not need sunlight). Water and drain the seeds morning and night every day until the seedlings are ready to eat (five to seven days in a warm room).

If you sow half a seed, does it grow into half a plant? Ask the students to find out.

Completely fill a matchbox with dried pea seeds. Close the matchbox and stand it in a jar of cold water overnight. Observe what has happened the next day.

Stand a stick of celery or a white flower in a jar of water to which a little ink or food colouring has been added. Look at the celery or flower each day for a few days. What do the students notice?

Look at a cabbage leaf. Ask the students to draw the pattern made by the veins. Put some water on the leaf. Does the water soak in? Strip off a piece of the skin from the underside of the leaf. Look at it with a powerful hand lens or, better, a microscope. Can the students see the little pores that are on the underside of the leaf?

Leah was given a plant in a pot. Draw a picture of the plant Leah might have been given. Label the parts of the plant. Now draw the plant one week later if Leah forgets to water it. Draw the plant four weeks later if Leah never waters it.

Dig up a dandelion plant. Cut the root into pieces of different length. Plant them in pots of moist soil or compost. What is the smallest piece of root that you can get to grow?

Choose three fruits and three vegetables. Find out where these fruits and vegetables are grown and at what time of the year they are ready to eat. Draw a picture of each fruit and vegetable and describe how to prepare it ready to eat.

Collect pictures of desert plants and mount them on a wallchart or in a scrapbook. Write a sentence or two about each plant.

Not all fruits are eaten by people. Some fruits are poisonous. Let the students make a list of all the poisonous fruits they can think of. Are any of them eaten by birds and other animals?

Find out how to make a compost heap. What kinds of things would you use to make a compost heap? What kinds of things would you not put on a compost heap? Say why.

Discuss why farmers and gardeners use fertilizers, manures and compost. Grow grass seeds with and without appropriate amounts of fertilizer and compare the results.

Investigate how to make the shoot of a runner bean plant grow round in a circle. (Place the seedling in a large box with a small hole at one end. When the bean shoot starts growing towards the hole, move the box so that the hole is pointing in a slightly different direction. Keep on turning the box in the same direction until the shoot has grown in a complete circle.)

Investigate in which conditions a plant (or a piece of a plant) takes in most water: warm or cold, still or windy?

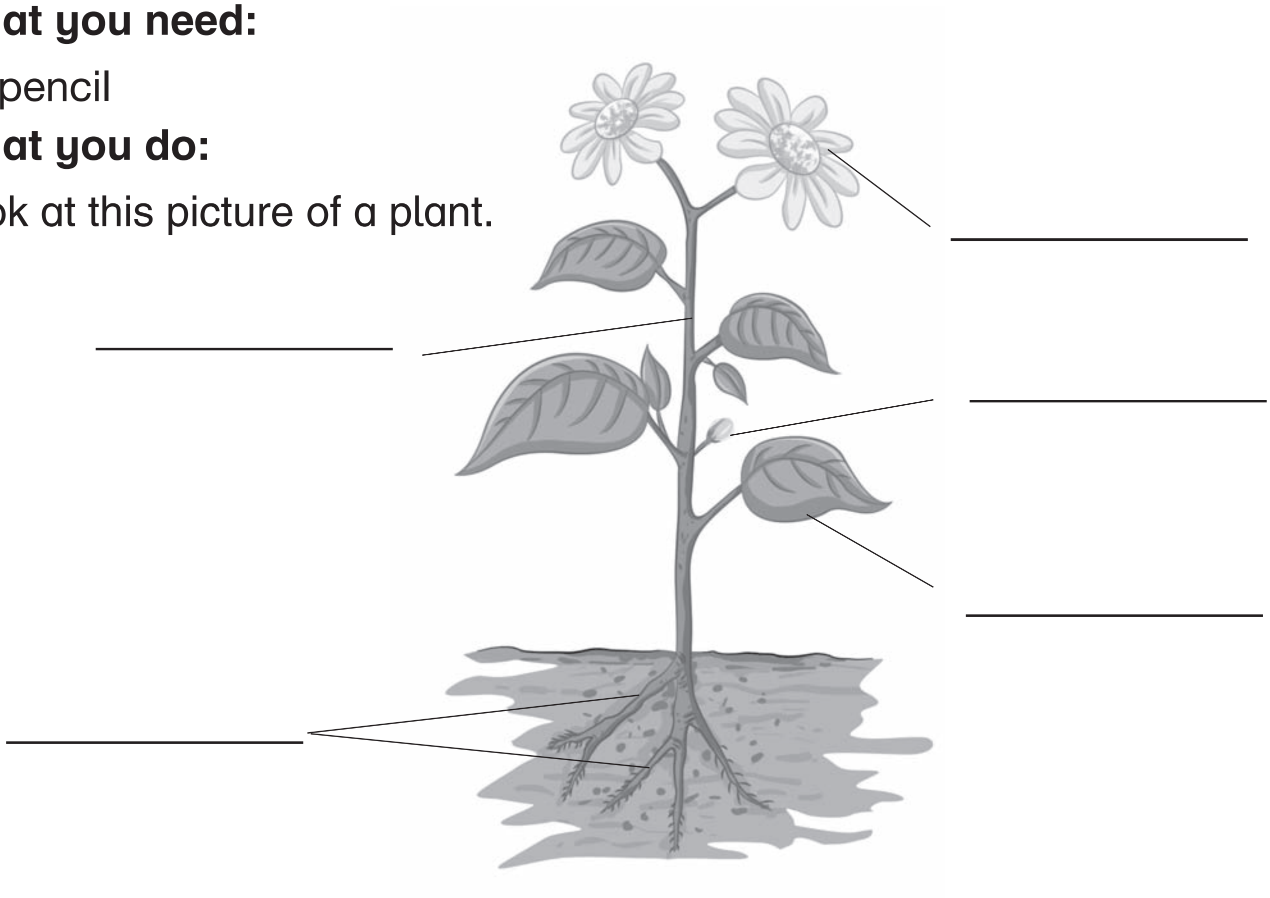
1. The parts of a plant

What you need:

- pencil

What you do:

Look at this picture of a plant.



Label the picture. Use these words:

stem **leaf** **flower** **roots** **bud**

Answer these questions:

a) Which part of the plant takes up water from the soil?

____

b) Which part makes food for the plant?

____

c) Which part makes the seeds?

____

d) Which part holds the plant upright?

____

e) Which part will open into a leaf or flower?

____

2. Plants and light

What happens to a plant when it does not receive any sunlight? What happens to a plant if it receives only artificial light?

What you need:

- pencil
- three small pots, all the same size
- soil or compost
- quick-growing seeds, such as mustard, cress, mung bean or grass
- labels
- desk lamp or table lamp

What you do:

Fill the three small pots with moist soil or compost.

Sprinkle the same kind of seeds on the top of each pot.

Label the pots: no light, artificial light, and sunlight.

Leave the first pot in a dark cupboard.

Leave the second pot near a desk lamp or table lamp.

Leave the third pot on a sunny window sill.

See that the soil or compost does not dry out.

Record each day how your seeds are growing.

Day	No light	Artificial light	Sunlight

Is your experiment fair? Say why ______________________________

____

3. Food from plants

What you need:

- pencil
- a collection of fruits and vegetables, or visit the local market
- crayons

What you do:

Look carefully at as many different fruits and vegetables as you can.

Which part of each plant do we eat?

Write the names of the fruits and vegetables or draw pictures in this table.

Tick the part of the plant we eat. One has been done for you.

Plant	Roots	Stems	Leaves	Fruit	Seeds
Carrot	✓				

4. Growing an onion

What you need:

- onion
- water
- pencil
- jar
- ruler

What you do:

Find an onion and a jar of the same size.

Fill the jar with water nearly to the top.

Place the onion on top of the jar.

Put the jar in a warm, dark place until the onion grows roots.

Then put the jar on a sunny window sill.

Watch what happens.

Measure the onion roots as they grow. Fill in the chart below.

Length of roots	Other changes
5 days ______________ cm	
10 days ______________ cm	
15 days ______________ cm	
20 days ______________ cm	
25 days ______________ cm	

5. What do plants need?

What you need:

- pencil

What you do:

Ahmed was given three plants, all exactly the same.

The **sentences** tell you what Ahmed did to each of the plants.

The **pictures** show what the plants looked like a few days later.

Plant A

Plant B

Plant C

Ahmed gave this plant some water and kept it in a dark cupboard.

Ahmed put this plant on a sunny window sill but forgot to water it.

Ahmed gave this plant some water and kept it on a sunny window sill.

Join each **sentence** to the correct **picture**.

Which two things do plants need besides soil or compost?

a) ______________________________

b) ______________________________

Would a plant grow in the refrigerator?

Why or why not? ______________________________

____

6. Growing seeds

What you need:

- pencil
- cotton wool
- crayons or felt-tipped pens
- three clean yoghurt pots
- mustard, cress or grass seeds

What you do:

Fill all three pots with cotton wool.

Sprinkle seeds on the cotton wool.

Pot A
Wet the cotton wool in one pot and put it in a dark cupboard.

Pot B
Wet the cotton wool in another pot and put it on a sunny window sill.

Pot C
Leave the cotton wool dry in the third pot and put that on the sunny window sill.

Look at the seeds every day.

Draw what happens.

Pot A

Pot B

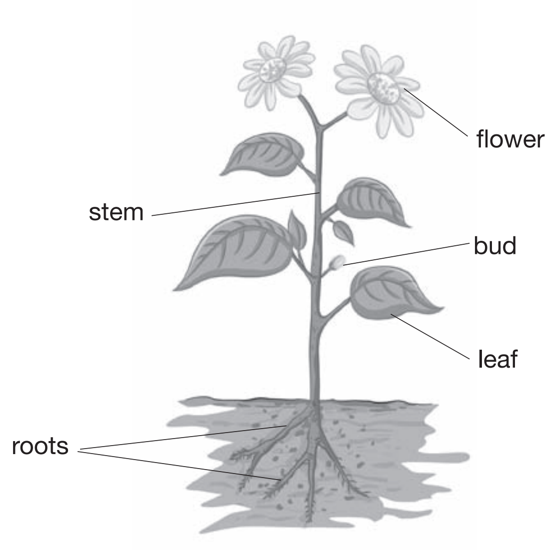
Pot C

Notes on individual worksheets

1. The parts of a plant

Key idea To show the structure and functions of the parts of a flowering plant.

Outcome



Extension Make model flowering plants and trees using scrap materials.

2. Plants and light

Key idea Plants need light in order to make their food and stay green and healthy.

Outcome The exact results of this investigation will depend upon the intensity of the light and the type of seeds grown. The seedlings grown in the dark will be yellow and straggly, while those grown in the light will be green and healthy looking. The latter may, however, bend over towards the light if the light is coming from one side and they are not turned regularly. Strictly speaking the experiment is not fair, because the three batches of seeds and seedlings may not be subjected to the same temperatures. This could well be a problem if the desk lamp or table lamp used gives out a lot of heat.

Extension Grow seedlings in a box with a small hole cut in one end to show how seedlings and adult plants bend over to grow towards the light.

3. Food from plants

Key idea We eat parts of many plants.

Extension Discuss why fruits and vegetables are an important part of a healthy diet.

4. Growing an onion

Key idea To observe and measure the growth of an onion bulb.

Outcome It is not possible to predict the outcome of this activity as the growth of the onion roots and shoots will depend upon the prevailing conditions of light and temperature. It will, be noticed, however, that as the onion grows, the level of water in the jar falls and may need regular topping up.

Extension Compare the growth of an onion left in the dark with one grown in the light, as above. Try this activity with a flower bulb.

5. What do plants need?

Key idea To stay healthy plants need water and light as well as soil to grow in.

Outcome Plant A—in a sunny place but forgot to water it.

Plant B—some water and kept in a sunny place.

Plant C—some water and kept in the dark.

Plants require water and sunlight. A plant would not grow in the refrigerator because there would be no sunlight or water and the temperature would be too low.

Extension Plan an investigation to find out how much water is taken up by a flowering plant or a piece of a flowering plant.

6. Growing seeds

Key idea To investigate the conditions necessary for seeds to germinate.

Outcome Pot A—the seeds will germinate but the seedlings will be yellow and straggly (a condition called *etiolated*).

Pot B—the seeds will germinate and the seedlings will be strong and dark green.

Pot C—the seeds will not geminate in the absence of water.

Extension Investigate whether bean seeds will germinate and grow if they are planted upside down.

GLOSSARY

This glossary gives brief definitions of some of the most important scientific words in the text.

Acid One of a class of sour-tasting substances that contain hydrogen, neutralize alkalis and turn blue litmus red.

Adaptation The process by which organisms change to increase their chances of survival.

Alloy A special metal that is made when two or more different metals are melted together.

Animal A living organism that is not a plant and which moves about in search of food.

Atmosphere The layer of air that surrounds the Earth.

Breathing The act of taking air into the body through the lungs, gills or other structures and giving it out again.

Carbohydrates Sugary and starchy foods which are the main source of energy for humans and most animals. Carbohydrates are made by green plants.

Carnivore A flesh-eating animal or predator.

Carpel The part of a flower that makes the seeds. It consists of a stigma, style and an ovary.

Cell (1) The basic unit of living matter. It contains a jelly-like material, called protoplasm, surrounded by a thin cell membrane. Plant cells also have a stiff cell wall on their outside made of cellulose. (2) A container with materials for producing electricity.

Chlorophyll The green pigment in plants which absorbs sunlight energy to start the chemical reactions of photosynthesis in which the plant manufactures its own food.

Climate The usual weather conditions of a region of the Earth throughout the year.

Community A group of organisms that live together in a habitat.

Compost (1) A mixture of decayed organic matter used as a fertilizer. (2) A mixture of soil and other ingredients for growing seeds, cuttings etc.

Conifer A tree, usually evergreen, that produces cones containing seeds.

Control A standard of comparison for checking the validity of the results of an experiment. (Often an additional experiment where any possible variables are not allowed to vary, and which is run alongside the experiment under investigation.) It is used to eliminate possible sources of error.

Cotyledon A leaf found within a seed. Some seeds have only one cotyledon (monocotyledons). Other seeds have two (dicotyledons).

Decomposer A living organism which causes decay, breaking down the remains of dead plants or animals.

Digestion The process by which food is made soluble by the action of digestive juices containing enzymes.

Dissolve To absorb a solid, liquid or gas into a liquid. Together they form a solution. This process is reversible.

Ecology The science that deals with the relationship of animals and plants to their environment and to each other.

Egg A female reproductive cell (or ovum) in a plant or animal.

Electricity A supply of energy provided by a flow of electrons.

Electromagnet An iron bar, surrounded by a coil of wire, which acts as a magnet when an electric current flows through the wire.

Electromagnetic radiation Rays combining electric and magnetic forces that pass through space, air or other materials.

Energy The power and ability something has to do work.

Environment The surroundings in which animals and plants live.

Erosion The gradual wearing away of weathered land by the action of wind, rain, rivers, ice and the sea.

Experiment A test carried out in order in order to discover something unknown or to demonstrate something that is already known.

Explanation A statement or circumstance that explains something.

Fair test A test or experiment in which only one thing (called a variable) at a time is allowed to change or be tested.

Fibre (1) A thin strand or thread of a material. (2) Plant fibre or cellulose which forms a very important part of our diet and helps to keep the digestive system healthy and functioning properly.

Flower The reproductive part of a seed-bearing plant.

Force A push or pull that starts or stops the movement of an object, changes its direction when it is already moving, or changes the shape of an object.

Fuel A material that is used to produce heat or power by burning or nuclear fusion. Most fuels (with the exception of nuclear fuels) are carbon compounds.

Germination The process whereby seeds or spores start to grow and form seedlings.

Gravity The invisible force exerted by the Earth and other bodies in space. It attracts smaller objects, on or near the Earth's surface, towards its centre.

Growth An increase in size or development of a plant or animal.

Habitat The local environment occupied by a plant or animal.

Heat A form of energy (contrast it with temperature). Heat energy can only be transferred from a hotter object to a colder object.

Hemisphere Half a sphere. The Earth is divided by the Equator into a northern and a southern hemisphere.

Herbivore An animal that feeds on plants.

Humus Dark brown organic matter in the soil formed by the decay of plants and animals. It is rich in nutrients and helps to keep the soil moist and fertile.

Hypothesis A principle put forward to serve as the starting point for an argument or an experimental procedure; an idea that can be tested.

Igneous rock Rock formed by the cooling and hardening of liquid rock (magma) forced out during volcanic eruptions.

Insulation Any material in which an electric current will not flow or through which heat and sound cannot easily pass.

Insulator A material or substance that stops heat or electrical energy escaping.

Invertebrate An animal that does not have an internal skeleton or backbone.

Lens A piece of glass or transparent material that has been given a convex or a concave shape.

Light A form of electromagnetic radiation that makes it possible for animals with light-sensitive organs, such as the human eye, to see objects.

Machine A device that uses energy to do work.

Magnet A piece of iron, cobalt or nickel (or an alloy of these) that can attract iron or steel (or cobalt or nickel).

Mammal A vertebrate animal that is warm-blooded and usually covered with hair or fur. The female produces the young inside her body and feeds them on milk.

Material Any matter from which other things can be made.

Melt To change a solid into a liquid by heating.

Metal A shiny solid substance (with the exception of mercury which is a liquid at room temperature) that conducts heat and electricity.

Metamorphic rock A rock that has been changed into a new form by great heat or pressure.

Micro-organism A living organism, such as a bacterium, which can only be seen through a microscope.

Mineral A natural substance in the Earth's crust that has a definite chemical composition and which does not come from animals or plants.

Mineral salt A soluble mineral substance needed by living organisms to stay alive.

Moon (1) Any natural satellite of any planet. (2) The Earth's natural satellite.

Ore Any mineral found in the Earth's crust from which metals can be extracted.

Opaque Describes any material that does not let light pass through it.

Petal One of the parts of a flower which is usually brightly coloured and helps to attract insects to pollinate the flower.

Photosynthesis The process by which green plants make their food from simple raw materials, using the energy from sunlight.

Planet Any one of the (large) bodies in space, including the Earth, in orbit around the Sun.

Plant A living organism; a member of the plant kingdom. All plants make their own food by photosynthesis. Like animals plants respire, grow, reproduce, excrete, and respond to stimuli; but unlike animals, they cannot move from place to place.

Plastic Any synthetic material that can be moulded into a shape when heated, and then sets hard when cooled.

Pole (1) The northern or southern end of the Earth's axis. (2) A point on a magnet where the magnetic force is strongest.

Power Force or energy that can be made to do work; the rate of doing work.

Prediction Fortelling or prophesying; suggesting and outcome.

Protein One of the main body-building materials in foods.

Recycle To use a product from a chemical or manufacturing process over and over again.

Reflect To turn back; e.g. when a mirror reflects a beam of light it turns it back, or when a surface reflects sound.

Reproduction The process by which living organisms produce offspring.

Rock The hard part of the Earth's crust underlying the soil; the hard compact material of which this consists.

Science The ever-growing body of knowledge about the physical or natural world.

Sediment (1) Particles of solid matter that sink to the bottom of a liquid. (2) Particles of soil or rock that are deposited by wind or moving water.

Sedimentary rock Rocks, such as sandstone and limestone, that were formed from particles of hard rocks laid down by rivers, glaciers and winds.

Sepal One of the parts of a flower. Sepals are usually green and lie outside the petals. They protect the flower in the bud stage.

Shadow The dark shape that is cast by an object when it blocks light falling on its surface.

Solution A liquid in which one or more solutes are dissolved. The solute molecules are spread evenly throughout the solvent.

Species A group of organisms that can breed with each other to produce fertile offspring.

Sperm A male reproductive cell.

Spore A special reproductive cell produced in large numbers by certain plants that do not bear flowers.

Stamen The male reproductive organ in a flower that produces pollen.

Star A luminous body in space.

Temperature A measure of the relative hotness or coldness of something. If heat energy is added to a system its temperature will rise. If heat energy is removed, the temperature will fall.

Theory A general view based on a number of hypotheses or suppositions (often with widespread support).

Translucent Describes a material that is not transparent but that that allows some light to pass through.

Transparent Describes any material that lets light pass through it to form a clear image on the other side.

Universe Everything that exists, including the Sun, Earth, planets, galaxies and other bodies in space.

Variable Any classifiable feature of the subject to be investigated: light intensity, temperature, height, weight, etc.

Vertebrate An animal that has an internal skeleton of bone or cartilage with a backbone, a skull and a well-developed brain.

Vitamin A nutrient, needed in minute quantities, which speeds up some chemical reactions in the body and helps to keep us healthy.

Water vapour The gaseous form of water.

Weathering Physical, chemical and biological changes resulting from exposure to the atmosphere, that accompany soil formation from rock.