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Properties of materials

Teacher's Resources Interactive PDF

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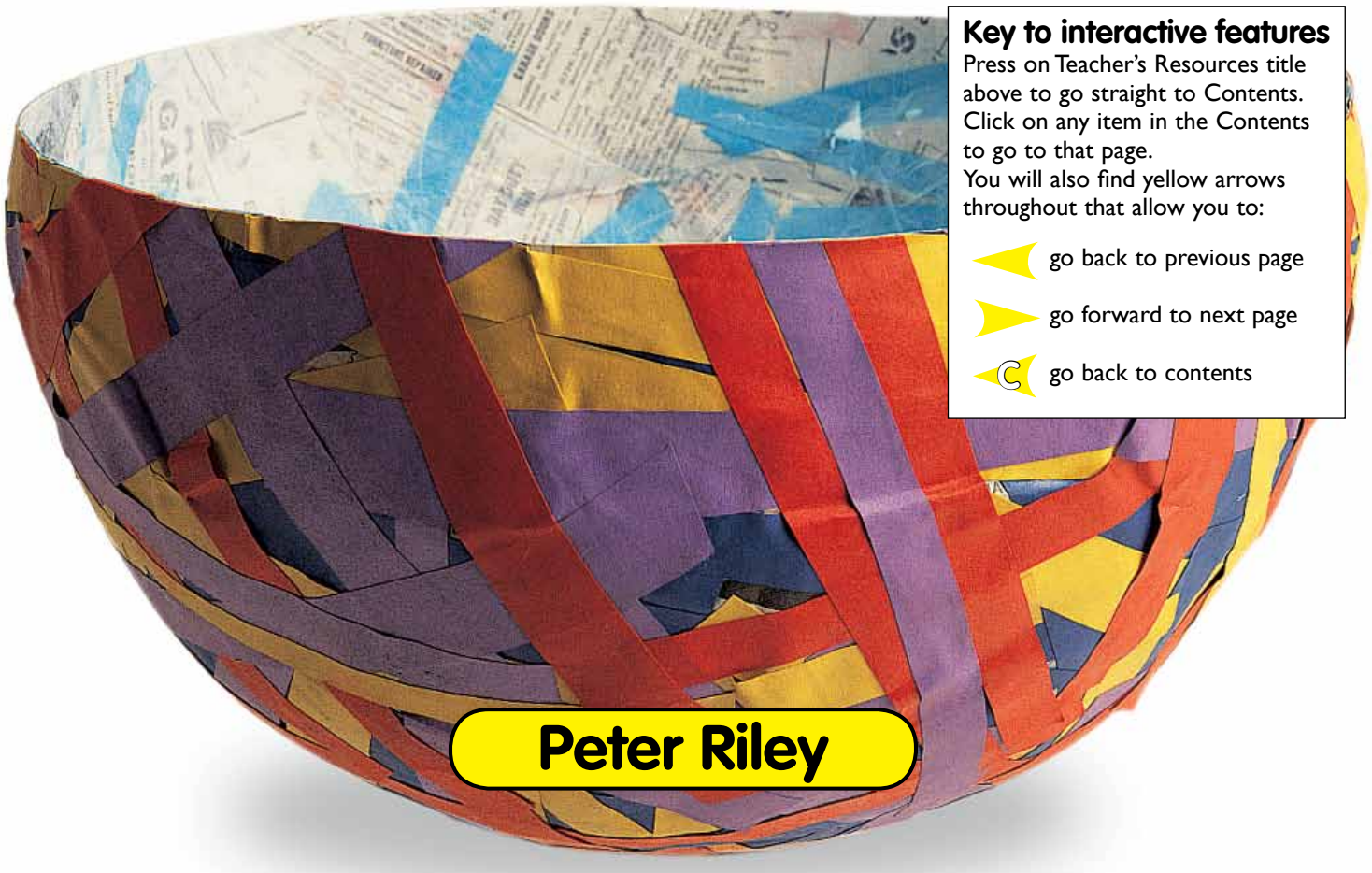

Key to interactive features

Press on Teacher's Resources title above to go straight to Contents.
Click on any item in the Contents to go to that page.
You will also find yellow arrows throughout that allow you to:

- go back to previous page
- go forward to next page
- C go back to contents

Peter Riley

Curriculum Visions

A CVP Teacher's Resources
Interactive PDF

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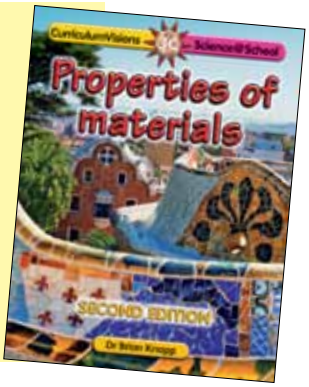
Contents

Section 1: Resources

Welcome to the Teacher's Resources for *Properties of materials*. The resources we provide are in a number of media:

1 The Properties of materials pupil book is the full-colour paperback book that covers the scientific principles which give materials their range of properties and examines the ways in which we use these materials in our daily lives – all in simple, easy-to-follow units making it accessible to a wide range of abilities.



3 You can buy various Science @School sets, for example Year 3 set, KS2 class book set, KS2 TG set or the complete Book Box set.

2 Our Learning Centre at

www.curriculumvisions.com

has almost everything you need to teach your primary curriculum in one convenient Virtual Learning Environment.

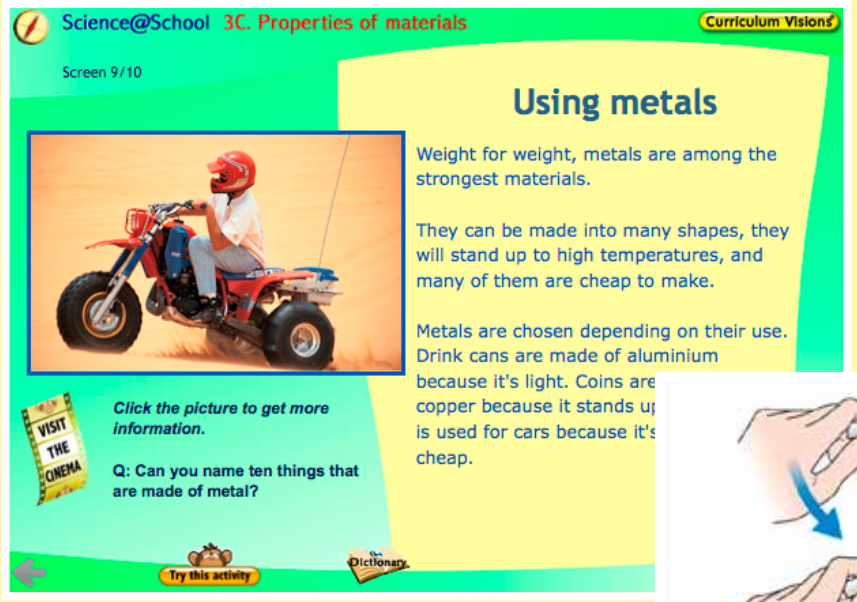
You can use support videos, e-books, picture and video galleries, plus additional Creative Topic books, graphic books called Storyboards, and workbooks. Together they cover all major curriculum areas.

All topics are easily accessible, and there is a built-in context search across all media.

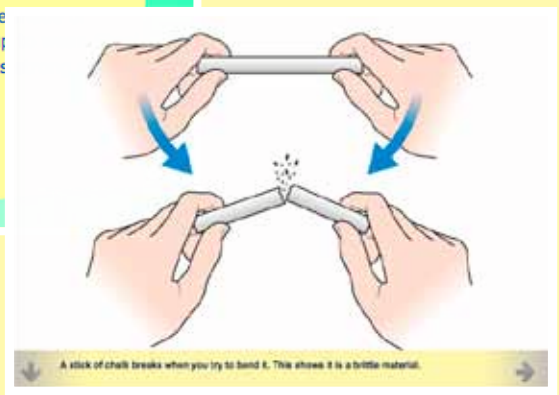
You can also use our printed student books online as part of your subscription to the Learning Centre. There page-turning versions of every printed Curriculum Visions book for use on your whiteboard.

▼ The Properties of materials home screen

▲ 'Classroom cinema' video



▲ Web site page

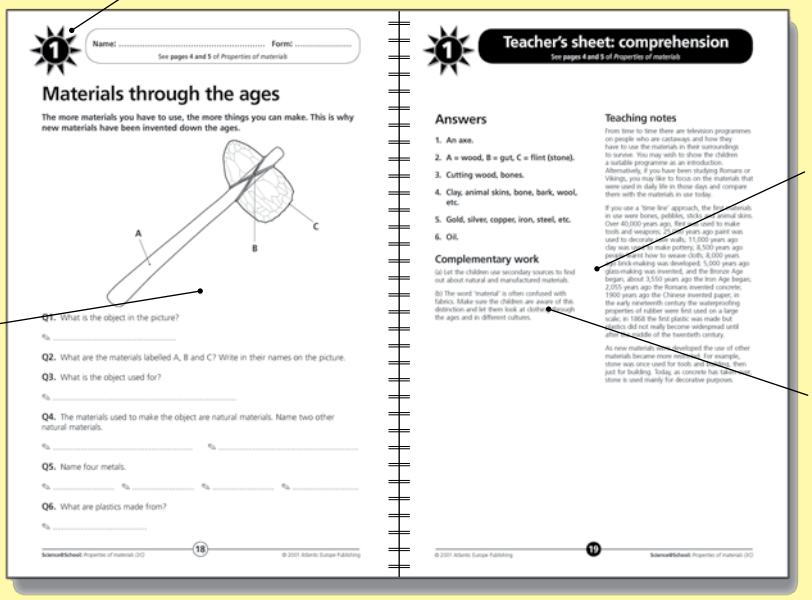


▶ Web site caption

▼ ***Each unit has one comprehension worksheet and one activity worksheet, each with a teacher's sheet.***

▶ ***The photocopiable comprehension worksheet and supporting teacher's sheet.***

Unit number.

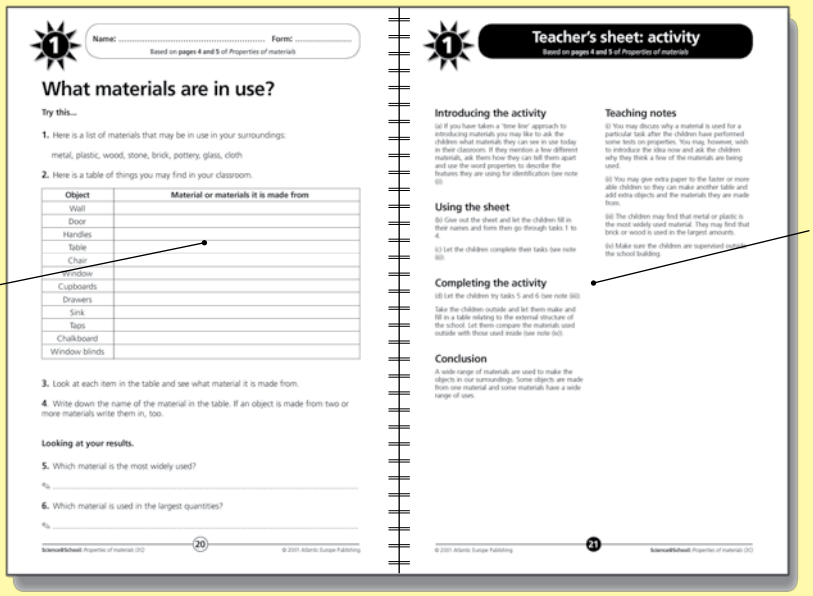


Left hand page is to photocopy and hand out to pupils.

Right hand page is the teacher's sheet and provides answers, suggestions for complementary work and teaching notes.

Resources needed to support the complementary work are shown in List 2 on page 15 of this Teacher's Guide.

▶ ***The photocopiable activity worksheet and supporting teacher's sheet.***



Left hand page is to photocopy and hand out to pupils. For some activities, pupils will also require additional sheets of paper.

Right hand page is the teacher's sheet and provides a detailed activity plan, conclusion and teaching notes. *Resources needed to support the activity worksheet are shown in List 3 on page 15 of this Teacher's Guide.*

Matching the curriculum

This book covers the materials component of the curriculum in a way that is highly relevant to work in the lower junior classes of a primary school. It consolidates earlier work by looking at the range of materials we have used throughout our history then examining key properties in detail to give the children a thorough foundation in materials science. The book ends with a study of two essential groups of materials – metals and plastics – and prepares the children for further research.

While covering the subject matter of the curriculum, *Properties of materials* also facilitates the development of investigative skills by the study of a wide range of materials. It particularly focuses on experimental design in the observing and measuring of material properties.

The pack is fundamentally built around an analysis of what is meant by the word 'properties', so that the children can gain a life-long grasp of the concept.

Section 2: The pupil book explained unit by unit

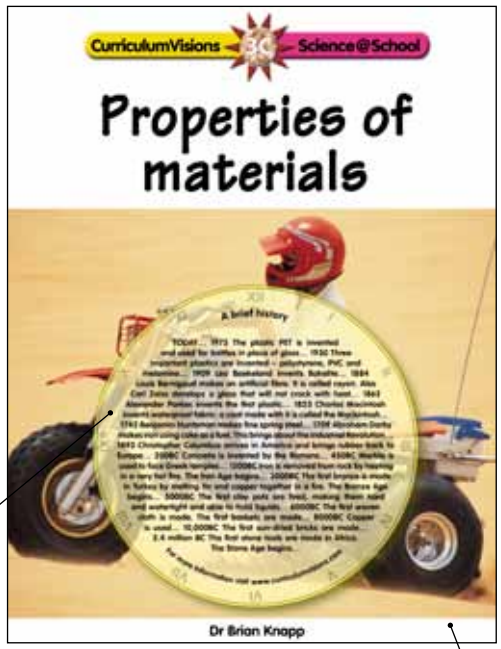
Although the pupil book – *Properties of materials* – is clear and simple, a great deal of care and thought has been given to the structure and the content of each double page spread or unit. The worksheets and activities in this *Teacher's Guide* also link directly to the pages in *Properties of materials*.

It is possible to use *Properties of materials,* and the worksheets and activities, without reading this section, but we would strongly recommend that you take a short time to familiarise yourself with the construction of the pupil book.

The units are arranged in sequence, to help you with your lesson planning. In this section, a brief description of the content of each unit is given, together with hints on how to start or support it. List 1 (Starting a unit with a demonstration) on page 15 sets out the resources that you could use to do the demonstrations where suggested. The activity associated with each unit is also briefly described to help you see how the unit and activity work together.

Title page

The book begins on the title page (page 1). Here you will find information about science and technology in the form of a clock. You may want to use this to set the scene for the study of the book's contents. You may choose to focus on an event which ties in with your work in history, before moving onto the rest of the book. Alternatively, you may wish to skip over this page and return to it later. It is not a core part of the book, but helps the children see how the work they are doing now fits in with the work of scientists and engineers in the past. It may also be used to stimulate more able pupils to research the people and events that are described here.



A time clock giving additional historical information about the topic.

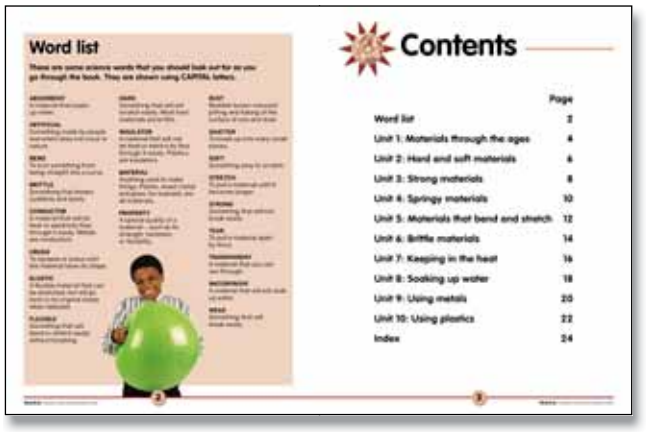
The picture shows a sand buggy made from a variety of materials.

Word list and contents

The core content of the book begins with a word list on page 2. This is a glossary, brought to the front for the pupils' attention. Pupils could be encouraged to look at the list and see how many of the words they already recognise.

One of the important things about science is the precision with which words are used. However, many scientific words are also common words, often used in a slightly different way from how they would be used in science. The word list presents the opportunity for pupils to consider the words they already know, and the meanings they are familiar with.

When your teaching unit has been completed, you may want to invite pupils to revisit this list and see if their understanding of the words has been enhanced or changed in any way. A visual dictionary is also given on the CD.



The entire contents are shown on page 3. It shows that the book is organised into double page spreads. Each double page spread covers one unit.

The units

Heading and introduction

Each unit has a heading, below which is an introductory sentence that sets the scene and draws out the most important theme of the unit.

Body

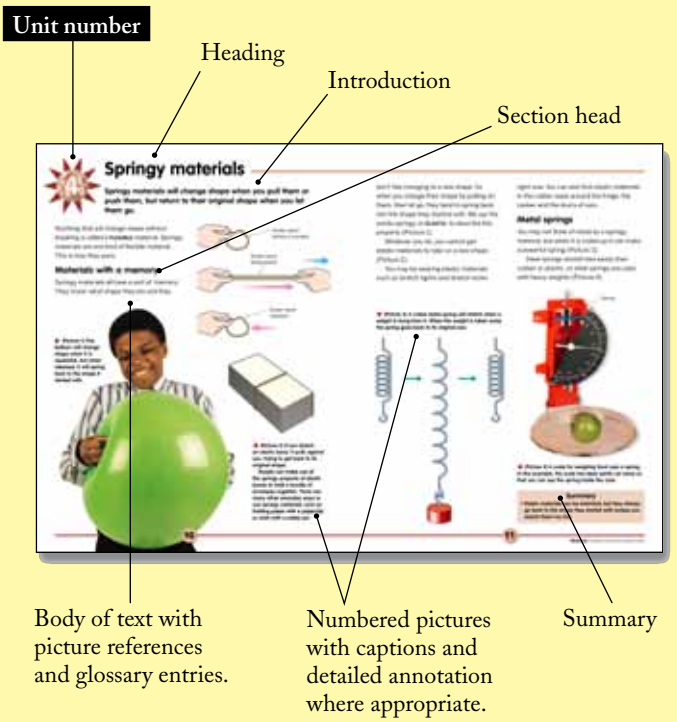
The main text of the page then follows in a straightforward, easy-to-follow, double column format.

Words highlighted in bold capitals in the pupil book are defined in the word list on page 2. A visual dictionary is also given on the CD.

The glossary words are highlighted on the first page on which they occur. They may be highlighted again on subsequent pages if they are regarded as particularly important to that unit.

Summary

Each unit concludes with a summary, highlighting and reinforcing the main teaching objectives of the unit.



1 Materials through the ages

This introductory unit begins by considering the use of materials long ago. You may like to develop a 'time line' theme and talk about materials used by stone age people, the use of clay to make pottery, brick making, the Bronze Age, glass making, the Iron Age and paper making. You may like to key this to history topics. As you move through time the children can see how the number of materials available to people increases. The children should also see that as the number of materials increases, human activity becomes more diverse, even allowing some to travel into space.

A second approach would be to consider natural versus manufactured materials. Whichever approach you use, you should finish off the introduction by showing the children samples of stone, wood, metal, plastic, paper and pottery and asking them to describe how they can recognise them. Follow this by establishing that the children look at the similarities and differences to recognise the materials and that what they are really considering about the materials are their properties.

The activity associated with this unit involves the children surveying their surroundings and noting where different materials are used and that the same materials can be used to make different objects.

2 Hard and soft materials

As the concept of materials having properties was introduced in the previous unit, this unit and those that follow focus on the properties of materials and how those properties make them useful. You may wish to begin with a demonstration using a selection of materials such as wool, metal, cotton, plastic, foam, wood, polystyrene sheet and stone, and ask the children to arrange them into order, starting with the hardest and ending with the softest. During this class discussion you might also ask them how they could test each material to support their predictions. You can return to their ideas when they try the activity or complementary work.

The unit begins by challenging the children to think about what makes a material hard or soft. It offers a description, as an example of how creative thought can be used to describe what is observed, and provides a 'scientific model' to help visualise the structure of the material. Both creative thought and scientific modelling play major roles in investigation.

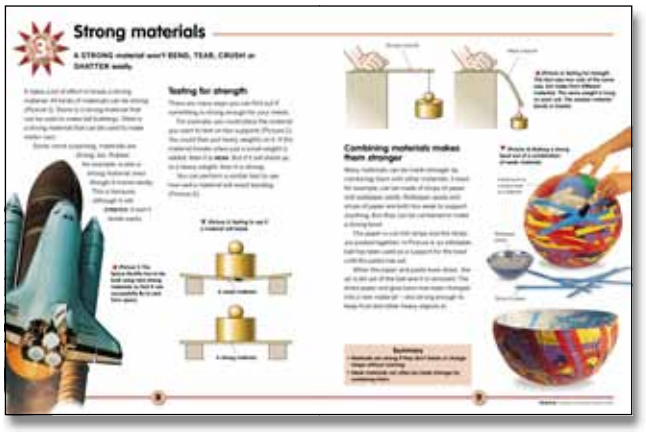
The unit introduces the rub and scratch test and describes when hardness is a useful property. The information in the unit sets the scene for moving directly in to the activity.

Ensure that pupils do not confuse soft with flexible. Wool is a hard substance, but because it has natural elasticity, its springiness is often described as 'soft' in general conversation.

Strong materials

The unit opens with the space shuttle launch and this can be used to ask the children what they think it might be like on the spacecraft as it shoots into the sky. From this you can move to more earthly surroundings and discuss materials and bridge building. This can lead to considering the dangers of weak materials.

When you have been through the unit, demonstrate the practical work relating to combining materials for extra strength. This features the pasting of paper strips around an inflated ball (or balloon), letting them dry then removing the ball (balloon) to make a papier-mâché bowl. Alternatively, you could use this activity with the children in an artwork session. The combining of materials introduces the children to the concept of composite materials. These are widely used and their use is increasing. One early composite was fibreglass – a combination of glass fibre and plastic used for making canoes



and many other things. Today, composites are used extensively in spacecraft.

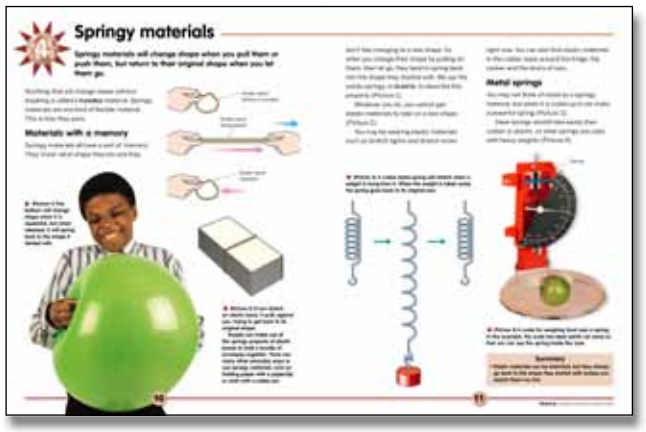
In the supporting activity, the children test rolls of different papers for strength by hanging weights from them.

Springy materials

You can begin by asking the children to squeeze their own arms and fingers and let go. They should see that the flesh springs back into its original shape. This means that they are made of springy material.

The unit opens by looking at two familiar examples – squeezing a balloon and pulling an elastic band and letting go. Both these activities could form part of your demonstration. You could also involve the children here.

The text then encourages the children to think creatively about why materials should be springy and offers the concept of 'memory' which is sometimes used in materials science. Care is taken to distinguish between the words 'flexible' and 'elastic', and the unit ends by considering applications of springy materials. You may extend the study of springy materials into the topic of sound production. If rice is placed on a tambourine skin, and the skin is tapped, the rice will vibrate. This is due to the skin being elastic.



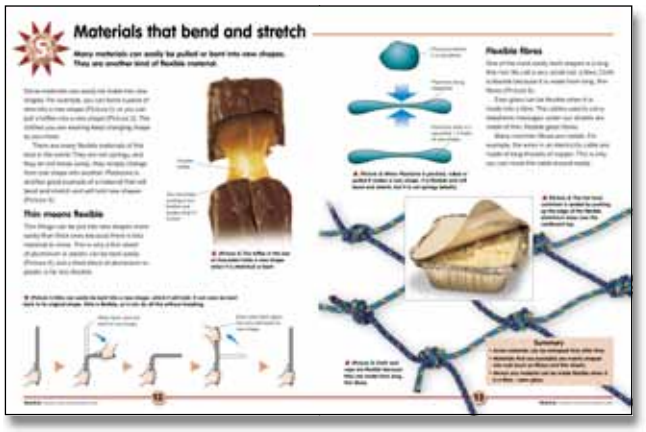
It is pushed out of position when it is tapped then springs back into place. As it vibrates it makes the rice grains dance.

In the activity, the stretchiness of a range of tights is investigated.

5 Materials that bend and stretch

This unit focuses on flexible materials and makes the distinction between these materials and the springy materials featured in the previous unit. You may like to demonstrate the difference between elastic materials and flexible materials by bending a piece of Plasticine and a piece of rubber or plastic foam. Materials are flexible because they are thin, and one of the most easily bent shapes is a long, thin rod called a fibre. A range of fibres is described here including textile fibres in cloth, metal fibres in electricity cables and glass fibres for carrying telephone messages.

In the activity, children examine fabrics to find the relationship between fabric, thread and fibres. They may be amazed at how small the fibres really are.



6 Brittle materials

You might begin the study of this unit by showing the children a large block of chocolate and asking them what happens when you try to divide it into pieces. It is easy to break because it is brittle. Read through the text with the children to discover other brittle materials, and to discover why brittleness is not a useful property even though brittle materials are still useful. The unit ends by describing how the brittleness of concrete is reduced by inserting steel rods into it and how car windscreens are really a glass sandwich with a plastic filling.

You could return to breaking up sweets when you have completed the unit, in order to consider how brittleness may be tested. Different kinds of sweets, such as seaside rock, could be placed, in turn, under a cloth for safety while a weight is dropped on them, or they could be dealt a small blow with a hammer. This demonstration could be used to illustrate a fair test. It could also be used to show that when a brittle material breaks, it always produces sharp edges. The demonstration can then lead onto the safer activity for the children, where the brittleness of twigs is tested.

7 Keeping in the heat

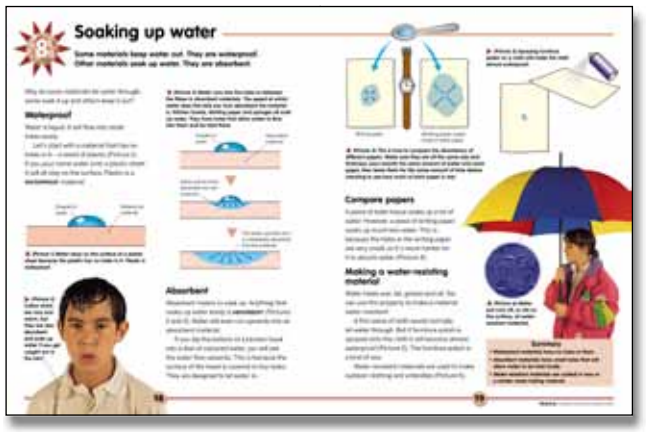
Before you work on the unit you may like to present the children with a display of clothes that are used to keep people warm. Ask the children about the common features of the materials used in the clothing. This could be followed by allowing the children to feel two hot water bottles filled with warm water, letting the children select two items of clothing in which to conceal the hot water bottles and leaving the hot water bottles there while you work through the unit. At the end of their work, the children can re-examine the hot water bottles and see which material held in the most heat.

The unit introduces the words insulator and conductor. It suggests how touch can be used to test for warmth, but builds on this by introducing the thermometer. Two fair tests are described and air is introduced as the 'invisible insulator'. You may use the points made by the unit, and the review of your work on the hot water bottles and the clothes, to focus the children's vocabulary and their awareness of the need for fair testing.

The supporting activity builds on the demonstration and allows the children to compare the insulating properties of common fabrics.

8 Soaking up water

The unit describes four activities which show how different materials behave with water. You can use them at different points in the study of the unit. You may like to relate the materials to a practical use such as keeping objects dry. You will need to make two simple water colour paintings in advance and be sure that they are dry. In the first demonstration, cover a painting with plastic and pour water onto the plastic. In the second demonstration, cover the painting with a paper towel and pour water on the paper towel. The second painting is ruined in the demonstration so the first painting is used again for your third and final demonstration. In this, a paper towel is sprayed with furniture polish and put over the painting and water is poured on it. You may also like the children to perform their own test from the unit and make a fair test comparing the absorbency of different papers. On completion of the unit, the children should be able to distinguish between waterproof materials, absorbent materials and water-resisting materials.



The supporting activity allows the children to develop the concept of a fair test into a full investigation.

9 Using metals

The last two units move from the study of the properties of materials in general to the study of two of the most widely used materials – metals and plastic. This approach is further extended by the CD, which contains a huge amount of data on different materials for project work. For example, after studying the metals in this unit, the children may like to find out how many types of metals there are and do a research project on one of them.

When many people think of metals they immediately think of cars and girder bridges, but metals are all around us. Begin by asking the children to identify six things close by them that are made from metal. Their answers could include – chair legs, table legs, pen, zip, paper clip, watch, bracelet, button, badge, coins and spectacle frames. Having established how useful metals are, work through the unit with the children. The unit builds on your introduction by featuring steel, aluminium, copper, silver and gold. It also considers rust and rust prevention.

Children often believe that all metals rust, so the activity lets them investigate this idea and leads the children to the conclusion that only iron and steel rust.

10 Using plastics

In preparation for work on this unit, ask the children to bring in small plastic items from home to make a display. Before you begin the work on the unit present your own contribution, which should feature such items as a pan with a plastic handle, a non-stick frying pan, a large plastic bowl, plastic foam and, if possible, some unusual items such as a plastic milk crate, pipe or gutter. This display will then support the introduction to the unit, which deals with the wide range and uses of plastics.

The unit begins by considering early plastics, then moves on to relate the many properties of plastics to their uses. The concept of plastics as a 'designer material' is introduced because plastics can be made with properties for almost every need. A simple way you can show this is to let the children turn back to the shop front in the Victorian store shown on Unit 1 to see that the galvanised baths are usually now replaced by acrylic baths.

Plastics are materials called polymers ('poly' meaning many and 'mers' from the name of the chemical unit from which they are built). It is worth asking the children to see just how many 'poly' plastics they can find (polystyrene, polythene, polyethane, polytetraflourethylene, polyvinyl chloride – pvc). This gives an idea of the range of plastics available (e.g. polyester on the labels of their clothes).

An everyday problem for shoppers is how much weight will their plastic bags support. The activity is a full investigation into comparing the strength of plastics used for making bags.

Index

There is an index on page 24.

Section 3: Using the pupil book and photocopiable worksheets

Introduction

There is a wealth of material to support the topic of the properties of materials in the pupil book and in the *Teacher's Guide*. On this and the following three pages, suggestions are made on how to use the worksheets and their associated teacher's sheets on pages 18 to 57, and how to integrate them for lesson planning. On the page opposite you will find the resource lists for introductory demonstrations, the complementary work and the activity worksheets. The learning objectives are shown on pages 16 and 17.

Starting a unit

Each unit in the pupil book forms the basis for a lesson. You may like to start by reading it with the class, or begin with a demonstration (see pages 7 to 13 and List 1 on page 15). Always begin the unit by reading the introductory sentences in bold type. This helps focus the class on the content of the unit and to prepare them for the work.

The first part of the main text introduces the content, which is then developed in the headed sections. The illustrations are closely keyed to the main text, and the captions of the illustrations develop the main text content (*see* 'The units' at the bottom of page 8).

With less skilled readers, you may prefer to keep to the main text and discuss the illustrations when they are mentioned. With more skilled readers, you may want to let them read the captions for themselves. Each unit ends with a summary. The children can use this for revision work. They can also use it to test their understanding by trying to explain the points made in the summary.

You can find the learning objectives for each unit on pages 16 and 17 of this *Teacher's Guide*.

The style and content of the unit also make it suitable for use in literacy work, where the needs of both English and science are met. You may wish to use the unit as a topic study in literacy work, or you may want to perform an activity in science time and follow it up with a study of the unit during literacy work.

Using the comprehension worksheets

Each unit in the pupil book has one photocopiable comprehension worksheet in this Teacher's Guide to provide a test. The learning objectives on page 16 are for these comprehension worksheets and relate directly to the knowledge and understanding component of the science curriculum.

The comprehension worksheets begin with simple questions and have harder questions towards the end.

The worksheets may be used singly, after each unit has been studied, or they may be used along with other worksheets to extend the study.

The teacher's sheet, which is opposite the comprehension worksheet, shows the answers and background information to the unit. This teacher's sheet also carries a section on work complementary to the study topic. This work may feature research using other sources. It may also have value in literacy work.

Using the activity worksheets

The activities are designed to develop skills in scientific enquiry. The learning objectives for practical skills associated with each unit are given on page 17. The activities may be small experiments, may focus on data handling or comprise a whole investigation.

Each activity section is a double page spread in this *Teacher's Guide*. On the left hand page is a photocopiable activity worksheet to help the children in practical work, or it may contain data for the children to use or interpret. The page opposite the worksheet is a teacher's sheet providing a step-by-step activity plan to help you organise your work. Each plan has a set of notes which provide hints on teaching or on the use of resources. The activity plan ends with a conclusion, which you may like to read first, to help you focus on the activity in your lesson planning.

Planning to use a unit

The materials in this pack are very flexible and can be used in a variety of ways. First, look at the unit and activity objectives on pages 16 and 17. Next, read the unit in the pupil book, and the associated worksheet and activity units in this *Teacher's Guide*. Finally, plan how you will integrate the material to make one or more lessons. You may wish to add more objectives, or replace some of the activity objectives with some of your own.

Safety

The practical activities feature equipment made from everyday materials or available from educational suppliers. However, make sure you carry out a risk assessment, following the guidelines of your employer, before you do any of the practical activities in either the pupil's book or the *Teacher's Guide*.

Resources

The three lists below show the resources needed to support the photocopiable worksheets.

- List 1 shows resources for demonstrations suggested for starting a unit.
- List 2 gives resources needed for the complementary work featured on the teacher's sheet associated with each comprehension worksheet.
- List 3 details those resources needed for the 10 activity worksheets.

List 1 (Starting a unit with a demonstration)

▼ UNIT

1. Samples of stone, wood, metal, plastic, paper, pottery.
2. Samples of wood, metal, wool, cotton, plastic, foam, polystyrene, tile, stone.
3. Strips of paper, wallpaper paste (non-allergic), balloon.
4. Balloon, elastic band.
5. Piece of Plasticine, piece of rubber or plastic foam.
6. Large block of chocolate, brittle sweets, cloth, weight or small hammer, eye protection.
7. Selection of clothes for keeping warm, two hot water bottles.
8. Two simple water colour paintings you have made, plastic sheet, paper towel, paper towel sprayed with furniture polish.
9. -
10. Pan with plastic handle, non-stick frying pan, large plastic bowl, plastic foam, plastic milk crate, pipe or gutter.

List 2 (Complementary work)

Each group will need the following items:

▼ UNIT

1. Secondary sources about natural and manufactured materials and clothes from different periods in history and/or from different cultures.
2. A mineral hardness set.
3. Thread, small bucket, weights, weighing scale or balance. Secondary sources on how materials are tested.
4. Set of balls similar in size to a tennis ball to include tennis ball, solid rubber ball, solid wood ball, solid plastic ball, hollow plastic ball. Set of similar balls, about table tennis ball size. This group can include a table tennis ball, super ball, rubber ball. Secondary sources about the sources of rubber and the manufacture of rubber objects such as Wellingtons and car tyres.
5. Secondary sources on how cloth is made, including spinning, weaving and knitting. Cotton wool, microscope and slide, sticky paper, postage stamp-sized piece of nylon tights.
6. Nuts and nut cracker (but check for allergy to nuts first). Eggshells from hens raised in different conditions, cardboard tube and small weights.
7. String vest, two hot water bottles, shirt material. Secondary sources about clothes for walking in the countryside and for mountain climbing.
8. Bulldog clips, thread, strips of different paper, tray of water. Secondary sources about clothes for a lifeboat crew and materials for diving suits.
9. Brass paper fasteners cut into small pieces, shallow dish, bowl of sand and water, large bowl. Clean and tarnished silver. Galvanised bucket or access to galvanised metal farm gate.
10. Secondary sources about how plastics are made.

List 3 (Activity worksheets)

Each group will need the following items:

▼ UNIT

1. -
2. Selection of floor coverings such as wood, plastic, tile, concrete, stone flag, linoleum, nail, Plasticine, heavy object and tube ruler.
3. Sheets of different kinds of paper, yoghurt pot, weights, weighing scale or balance.
4. Tights for people of all ages including babies, box, weights.
5. Woollen fabric, magnifying glass, cotton fabric.
6. Dead and living twigs from broadleaved and coniferous trees (not larch or yew), eye protection.
7. Three fabrics such as wool, cotton and nylon, three cans (no sharp edges), sticky paper, thermometer, scissors.
8. Squares of fabrics (about 10cm square) cut from a variety of old clothes - both indoor and outdoor wear, measuring cylinder, spoon, beaker of water (can be coloured with food colouring), white paper.
9. Steel nail, aluminium foil, copper wire, wet paper towels, board, cupboard (preferably warm).
10. Two bulldog clips, two pencils, strips of plastic from different bags, yoghurt pot, weights, weighing scale or balance.

Learning objectives

Comprehension worksheets

The table below shows the learning objectives for knowledge and understanding associated with each unit in the pupil book, using the comprehension worksheets in this *Teacher's Guide*:

Unit 1

- Materials are suitable for making a particular object because of their properties.
- New materials are constantly being invented and they allow us to do more things.

Unit 2

- Materials differ in their hardness and that hardness can be compared by scratching one material on another.

Unit 3

- Materials differ in their strength and the strengths of materials can be compared by a fair test.
- Combining materials can make a stronger composite material.

Unit 4

- Springy materials are elastic and go back to their original shape after squashing or stretching.

Unit 5

- Flexible materials can be pulled into new shapes and do not return to their original shape after the pulling force has been removed.

Unit 6

- Brittle materials break very suddenly.
- Some properties of a material are more important than others when choosing a material to use.

Unit 7

- Materials vary in their capacity to prevent heat passing though them.
- The conductance of heat through materials can be compared by a fair test.

Unit 8

- Materials can be grouped into waterproof materials, absorbent materials and water-resisting materials.

Unit 9

- There are many different kinds of metals and they differ in their properties.
- Steel rusts, but rust can be prevented by painting the metal or covering it in plastic.

Unit 10

- Plastics have many useful properties.
- Different plastics can be made to serve our needs.

Learning objectives

Activity worksheets

The table below shows the learning objectives for practical skills associated with each unit in the pupil book, using the activity worksheets in this *Teacher's Guide*:

Unit 1

- Identify a range of common materials and see that one material may be used to make different objects.

Unit 2

- Plan an investigation involving a fair test.
- Use simple equipment and materials appropriately and safely.
- Make predictions and compare them with conclusions.

Unit 3

- Use measurements to draw conclusions.
- Use tables and bar charts to communicate data.

Unit 4

- Plan an investigation involving a fair test.

Unit 5

- Make observations and comparisons.

Unit 6

- Use simple materials appropriately and safely.
- Identify a simple pattern.

Unit 7

- Plan an investigation involving a fair test.
- Construct a table.

Unit 8

- Explain results using scientific knowledge and understanding.

Unit 9

- Make observations systematically.
- Use observations to draw conclusions.

Unit 10

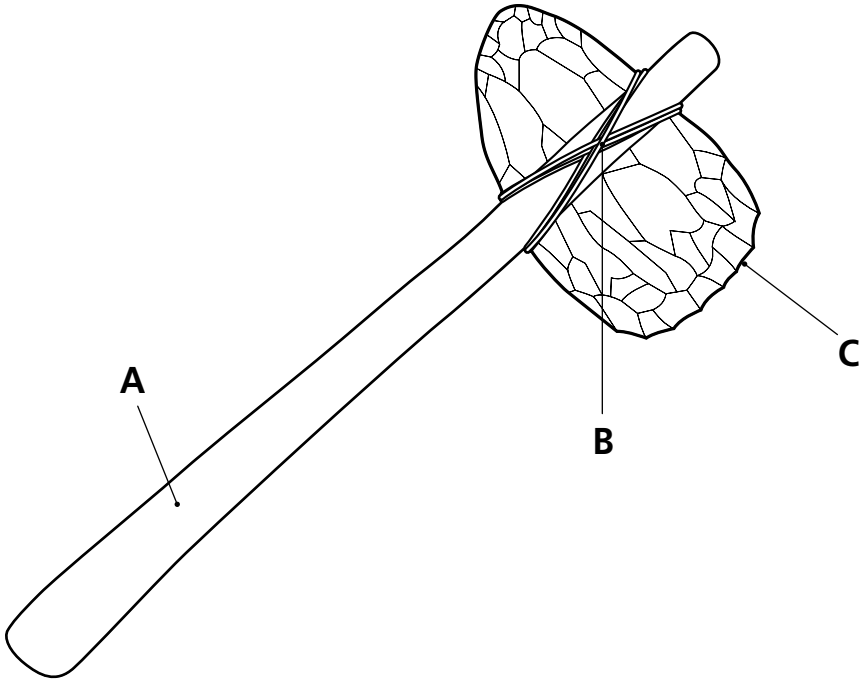
- Review work and identify and explain its limitations.

Name: ..... Form: .....

See **pages 4 and 5** of *Properties of materials*

Materials through the ages

The more materials you have to use, the more things you can make. This is why new materials have been invented down the ages.



Q1. What is the object in the picture?

✎.....

Q2. What are the materials labelled A, B and C? Write in their names on the picture.

Q3. What is the object used for?

✎.....

Q4. The materials used to make the object are natural materials. Name two other natural materials.

✎..... ✎.....

Q5. Name four metals.

✎..... ✎..... ✎..... ✎.....

Q6. What are plastics made from?

✎.....

Teacher's sheet: comprehension

See **pages 4 and 5** of *Properties of materials*

Answers

1. **An axe.**
2. **A = wood, B = gut, C = flint (stone).**
3. **Cutting wood, bones.**
4. **Clay, animal skins, bone, bark, wool, etc.**
5. **Gold, silver, copper, iron, steel, etc.**
6. **Oil.**

Complementary work

(a) Let the children use secondary sources to find out about natural and manufactured materials.

(b) The word 'material' is often confused with fabrics. Make sure the children are aware of this distinction and let them look at clothing through the ages and in different cultures.

Teaching notes

From time to time there are television programmes on people who are castaways and how they have to use the materials in their surroundings to survive. You may wish to show the children a suitable programme as an introduction. Alternatively, if you have been studying Romans or Vikings, you may like to focus on the materials that were used in daily life in those days and compare them with the materials in use today.

If you use a 'time line' approach, the first materials in use were bones, pebbles, sticks and animal skins. Over 40,000 years ago, flint was used to make tools and weapons; 25,000 years ago paint was used to decorate cave walls; 11,000 years ago clay was used to make pottery; 8,500 years ago people learnt how to weave cloth; 8,000 years ago brick-making was developed; 5,000 years ago glass-making was invented, and the Bronze Age began; about 3,550 years ago the Iron Age began; 2,055 years ago the Romans invented concrete; 1900 years ago the Chinese invented paper; in the early nineteenth century the waterproofing properties of rubber were first used on a large scale; in 1868 the first plastic was made but plastics did not really become widespread until after the middle of the twentieth century.

As new materials were developed the use of other materials became more restricted. For example, stone was once used for tools and building, then just for building. Today, as concrete has taken over, stone is used mainly for decorative purposes.

C 1

Name: ..... **Form:** .....

Based on **pages 4 and 5** of *Properties of materials*

What materials are in use?

Try this...

1. Here is a list of materials that may be in use in your surroundings:

metal, plastic, wood, stone, brick, pottery, glass, cloth

2. Here is a table of things you may find in your classroom.

Object	Material or materials it is made from
Wall	
Door	
Handles	
Table	
Chair	
Window	
Cupboards	
Drawers	
Sink	
Taps	
Chalkboard	
Window blinds	

3. Look at each item in the table and see what material it is made from.

4. Write down the name of the material in the table. If an object is made from two or more materials write them in, too.

Looking at your results.

5. Which material is the most widely used?

✎.....

6. Which material is used in the largest quantities?

✎.....

Teacher's sheet: activity

Based on **pages 4 and 5** of *Properties of materials*

Introducing the activity

(a) If you have taken a 'time line' approach to introducing materials you may like to ask the children what materials they can see in use today in their classroom. If they mention a few different materials, ask them how they can tell them apart and use the word properties to describe the features they are using for identification (see note (i)).

Using the sheet

(b) Give out the sheet and let the children fill in their names and form then go through tasks 1 to 4.

(c) Let the children complete their tasks (see note (ii)).

Completing the activity

(d) Let the children try tasks 5 and 6 (see note (iii)).

Take the children outside and let them make and fill in a table relating to the external structure of the school. Let them compare the materials used outside with those used inside (see note (iv)).

Conclusion

A wide range of materials are used to make the objects in our surroundings. Some objects are made from one material and some materials have a wide range of uses.

Teaching notes

(i) You may discuss why a material is used for a particular task after the children have performed some tests on properties. You may, however, wish to introduce the idea now and ask the children why they think a few of the materials are being used.

(ii) You may give extra paper to the faster or more able children so they can make another table and add extra objects and the materials they are made from.

(iii) The children may find that metal or plastic is the most widely used material. They may find that brick or wood is used in the largest amounts.

(iv) Make sure the children are supervised outside the school building.

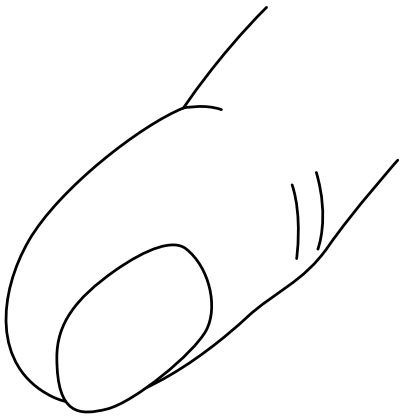
Name: ..... Form: .....

See **pages 6 and 7** of *Properties of materials*

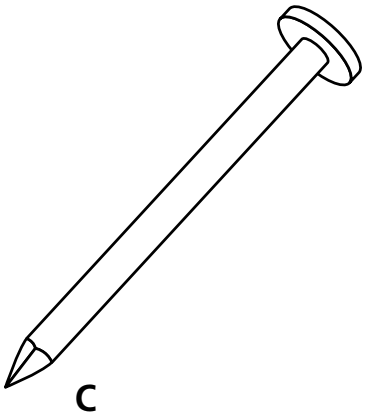
Hard and soft

Every material is different. We call these differences properties. Hardness is one important property of materials.

A



B



C

Q1. Put an H on the hardest object in the picture and an S on the softest object.

Q2. Which object can scratch A?

✎.....

Q3. Which object or objects can scratch C?

✎.....

Q4. What is the hardest natural material in the world?

✎.....

Q5. Why does a pencil lead leave a mark on paper?

✎.....

Q6. Why can rubber be used to rub out pencil marks on paper?

✎.....

✎.....

✎.....

Teacher's sheet: comprehension

See **pages 6 and 7** of *Properties of materials*

Answers

1. **H should be written on C, S should be written on B.**
2. **C.**
3. **None.**
4. **Diamond.**
5. **Because it is softer than paper and rubs off onto it.**
6. **Because it is harder than pencil lead and removes it from the paper, but is softer than the paper so it does not damage the paper.**

Complementary work

(a) You may demonstrate a Mohs Hardness Scale test set. They are available from educational suppliers.

Teaching notes

The idea that matter is made from particles is not a new one. It was first put forward in the time of the Ancient Greeks by a scholar named Democritus. He reasoned that every solid material could be divided into two, then each half divided into two, and so on many times until there came a time when the matter could no longer be divided. This indivisible particle he called an atom. It was not until the nineteenth century that the idea of atoms really took hold and today there are special microscopes that can see them. It is not necessary to tell the children about atoms, although they may discover the word from popular science. Particle theory, which describes solids, liquids and gases in terms of particles (groups of atoms), is a key stage 3 concept but sometimes teachers introduce it in upper primary school.

There is a scale of hardness used in the identification of minerals. It was devised in 1822 by Frederich Mohs, who was a German mineralogist. No mineral in the scale can be scratched by minerals lower in the scale but can be scratched by those higher in the scale. The hardness of a mineral is found by scratching it with several minerals and scratching it on several minerals until its place in the scale is found. You may use this scale in your work on rocks and soils.

People consider the property of hardness in a relative way. They select a material because its hardness meets a particular need. When several materials could provide the same hardness for a task the cost factor becomes important and the cheapest material may be selected.

2

Name: ..... Form: .....

Based on **pages 6 and 7** of *Properties of materials*

Testing floor coverings

Try this...

1. Write down what you will use in your test.

✎.....

✎.....

✎.....

2. Write down how you will make your test.

✎.....

✎.....

✎.....

✎.....

3. Write down your prediction for the order of hardness starting with the hardest.

✎.....

✎.....

4. Write down the reason for your prediction.

✎.....

✎.....

✎.....

5. Make a table for your results on a separate piece of paper and then make your tests.

6. Write down the order of hardness starting with the hardest.

✎.....

✎.....

Teacher's sheet: activity

Based on **pages 6 and 7** of *Properties of materials*

Introducing the activity

(a) You may begin the activity by letting the children try the activity on page 7 (see note (i)).

(b) Show the children the selection of floor coverings and the three items for testing their hardness (see note (ii)).

Using the sheet

(c) Give out the sheet, let the children fill in their names and form, then go through tasks 1 to 5.

(d) Let the children carry out tasks 1 to 4, then check their work (see note (iii)).

(e) Let the children construct the table in task 5 and check it before they carry out their practical work (see note (iv)).

(f) Let the children carry out the practical work.

(g) The children should carry out task 6 and evaluate their prediction with their results.

Completing the activity

(h) The children may compare their results and assess each other's skill in predictions. They could present their results as a report for the school governors advising them on the best and worst floor coverings for a particular area of the school.

Conclusion

The hardness of different materials can be compared by scratching them or by dropping things onto them.

Teaching notes

(i) Give the children some small pieces of Plasticine, a nail and a weight and let them make their test. This will help them focus on the work to be done.

(ii) The nail is used for making a scratch, the Plasticine is dropped from the same height onto different coverings and its deformation is measured. A weight, such as a ball bearing, is dropped down a cardboard tube (for safety) onto the floor covering and the size of the indentation is examined.

(iii) Look for evidence of a fair test. For example, using the same height for dropping both the Plasticine and the weight, and the same person making the scratches each time.

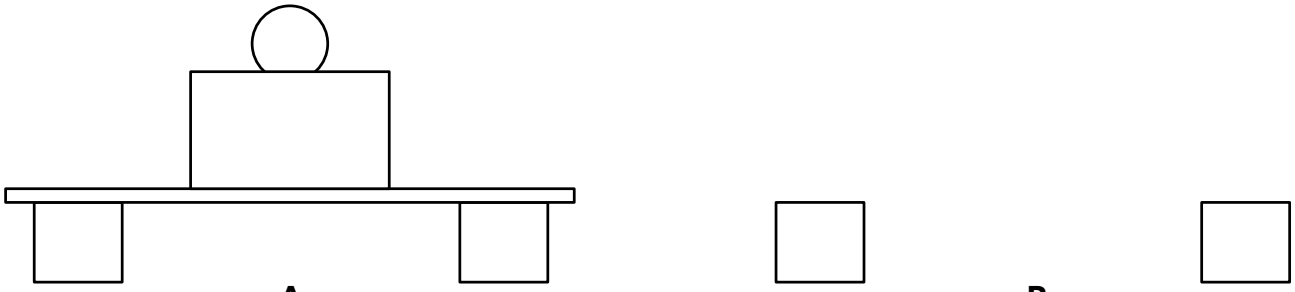
(iv) The table should have a column for listing the floor covering and a column in which to record the results. This may be a simple comparison of the depths of the scratches or indentations (10 for the deepest and one for the shallowest, for example) or it may be a measurement of the width of the Plasticine after it has hit the floor covering.

Name: ..... Form: .....

See **pages 8 and 9** of *Properties of materials*

Strong materials

A strong material won't bend, tear, crush or shatter easily.



Q1. A strong material is being tested at A. At B, draw what would happen if a weight was put on a weak material.

Q2. Name two strong materials.

✎..... ✎.....

Q3. How would you test the strength of a rod?

✎.....

✎.....

Q4. How could you tell if the rod is strong or weak?

✎.....

✎.....

Q5. How could you make strips of paper stronger?

✎.....

✎.....

✎.....

Teacher's sheet: comprehension

See **pages 8 and 9** of *Properties of materials*

Answers

1. **A bent and broken material is drawn under a weight at B.**
2. **Stone, rubber.**
3. **Hold it over the end of a table and put a weight on the end.**
4. **If it is strong it will not bend. If it is weak it will bend.**
5. **Stick them together with wallpaper paste. Use a balloon to support them. When the paper and paste have dried let the air out of the balloon.**

Complementary work

(a) The children could tie a small bucket (from the infant department) to a thread and suspend it close to the ground. Weights could be put in the bucket until the thread snapped, then the weight which caused the snap could be recorded by putting the bucket on a weighing scale or balance. Use both natural and manufactured fibres. Not all may break with the range of weights used, and this can be used as an example of the limitations of the test.

(b) Use secondary sources to find out how the strength of a material is tested.

Teaching notes

When talking about the space shuttle launch you can relate the strength of the materials to the pushing and pulling forces on the whole structure as it vibrates due to the action of the rocket engines. The children may have seen films involved with space launches and be familiar with the sight of astronauts being shaken about. This is an opportunity to talk about forces, such as gravity, and to remind children that they occur everywhere.

In discussing bridge building you may ask the children what materials they would select to make a bridge. Look for the use of branches and how they may test them before putting them over the water. You may like to show children pictures of rope bridges and ask them for their reactions if they had to use one. This could lead on to complementary work testing the strength of threads.

Name: ..... Form: .....

Based on **pages 8 and 9** of *Properties of materials*

Testing paper

Try this...

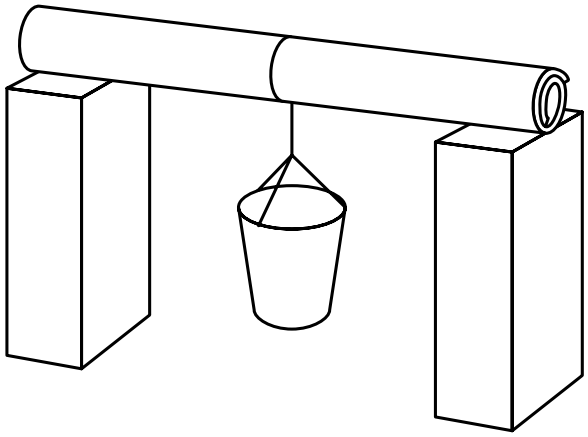
1. Collect one sheet of each kind of paper.

2. Roll up one sheet tightly and put sticky tape on each end to hold it in shape.

3. Repeat task 2 with each sheet until you have a collection of rolls of paper.

4. Fill in the first column of the table below.

5. Put a roll of paper over two supports, as the diagram shows, and hang a yoghurt pot bucket from it.



6. Add weights to the pot until the roll bends.

7. Put the yoghurt pot, with its weights, on a weighing scale or balance and record the weight.

8. Fill in the weight in the appropriate box in the table.

9. Repeat tasks 4 to 7 with each roll to complete the table.

Type of paper	Bending weight (gm)

Teacher's sheet: activity

Based on **pages 8 and 9** of *Properties of materials*

Introducing the activity

(a) Begin by reminding the children about the activity on page 9 of the pupil book, which showed how paper could be made stronger. Ask the children how the strength of paper could be measured and steer them towards the method on the sheet (see note (i)).

Using the sheet

(b) Give out the sheets and let the children fill in their names and form, then go through tasks 1 to 4.

(c) Let the children carry out tasks 1 to 4.

(d) Go through tasks 5 to 8 with the children.

(e) Let the children carry out tasks 5 to 8.

(f) Check that the children have completed tasks 1 to 8 correctly, then let them complete task 9.

Completing the activity

(g) The children can then present a report of their investigation to the rest of the class. In this, they could construct a bar chart from the data in their table.

Conclusion

The strength of paper can be tested by suspending weights from a rolled up sample. Different papers have different strengths. The strength of a paper depends on the materials that are added to it during its manufacture and also on its thickness.

Teaching notes

(i) An alternative is to spread the sheet out over the open top of a can or plastic jar and secure it to the top with a strong elastic band. The yoghurt pot is then put on the centre of the sheet and loaded with weights until the paper tears. This arrangement can also be used with wet paper, to test the effect of water on strength (see page 47 of this book).

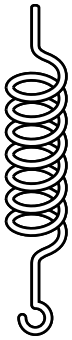
Name: ..... Form: .....

See **pages 10 and 11** of *Properties of materials*

Springy materials

Springy materials will change shape when you pull them or push them, but return to their original shape when you let them go.

A **B** **C**



Q1. A is a spring with a hook. In space B, draw how the spring would look when a weight is hung from the hook. In space C, draw how the spring would look when you remove the weight from the hook.

Q2. What happens when you squeeze a balloon and then stop squeezing it?

✎.....

Q3. What do you feel when you pull on an elastic band?

✎.....

Q4. Name two kinds of clothes that are made from elastic materials.

✎..... ✎.....

Q5. Where would you find elastic materials in a fridge?

✎.....

Q6. Name a use for a spring.

✎.....

Teacher's sheet: comprehension

See **pages 10 and 11** of *Properties of materials*

Answers

1. **In B, a spring should be drawn stretched. In C the spring should be the same length as the one in A.**
2. **It returns to its original shape.**
3. **The elastic band pulling back on you.**
4. **Tights, socks.**
5. **Making a seal around the door.**
6. **In a weighing machine or on a door to make it close automatically.**

Complementary work

(a) You could provide the children with a set of similar sized balls. One set could be similar to the size of a tennis ball and include a solid rubber ball, a solid wood ball, a solid plastic ball and a hollow plastic ball. A second set could be similar in size to a table tennis ball. Let the children perform a fair test on the bounciness of the balls, which is due to their elasticity. A sheet of paper may be stuck to a wall and each ball dropped from the same height. The height of the bounce is marked on the paper. The results may be recorded in a table and presented as a bar chart.

(b) Secondary sources can be used to find out about the sources of rubber and the manufacture of rubber objects such as Wellingtons or car tyres.

Teaching notes

The study of springy materials provides an opportunity to mention the pulling and pushing forces involved, which will reinforce the work done specifically on forces in other parts of the curriculum.

The way that rubber 'memory' works is due to the arrangement of its molecules. They form very long threads which are folded upon themselves and each other. At certain points along their length they are linked together. When rubber is stretched, the molecules straighten out and the connecting links prevent them from sliding away from each other. Tension develops in the links and when the stretching force on the rubber is removed, the tension force in the links (the 'memory') pulls the molecules back together again. Metals do not have long molecules. They have a crystalline structure, but a tension force also develops in the metal which acts as the 'memory'.

Incidentally, it is correct to call a rubber band an elastic band because it is not made of rubber but of an elastic plastic.

Name: ..... Form: .....

Based on **pages 10 and 11** of *Properties of materials*

Testing the stretchiness of tights

Try this...

1. Look at the selection of tights you have to test.

2. Write down a plan showing how you will compare how much they stretch.

✎.....

✎.....

✎.....

✎.....

3. Make a table for the results here.

4. Make the tests, following your plan, and fill in your results in the table as you go along.

5. What do the results show?

✎.....

✎.....

✎.....

✎.....

Teacher's sheet: activity

Based on **pages 10 and 11** of *Properties of materials*

Introducing the activity

(a) Ask the children what it would be like to wear socks and tights that did not stretch. Let them assess the usefulness of the property of stretchiness.

(b) Show the children the tights they are to test and ask them how they think they will do it. During the discussion, elicit from them the idea of measuring the length of the tights, then adding a weight to the tights and measuring the extension (see note (i)). This is followed by removing the weight and re-measuring the 'resting' length. This should be tried until a weight is found at which the tights will no longer stretch further (see note (ii)).

Using the sheet

(c) Give out the sheet and let the children fill in their names and form, then let them complete tasks 2 and 3.

(d) Check the children's plans and table before you let them try task 4.

(e) Let the children try task 4.

(f) Let the children try task 5 (see note (iii)).

Completing the activity

(g) The children can construct bar charts from their results and compare them. If differences are found when the same type of tights are tested, then the way the tests were carried out can be compared. Finally, you may introduce a pair of tights that are different from the ones the children have tested and ask them to predict their stretchability. You could test their prediction as a teacher demonstration, assisted by some of the children.

Conclusion

Tights vary in the amount they stretch. The stretchiness is due to the structure of the tights.

Teaching notes

(i) A box should be placed under the tights to collect any weights that fall off the tights. Alternatively, you could put the weights inside the tights. The box also keeps the children's feet away from an area where the weights may fall.

(ii) Due to the stretchiness of some tights, it may not be safe to add enough weights to find their maximum stretch. To prevent this occurrence, test the tights before the activity. Those worn by babies or toddlers may not stretch as much as tights for older people.

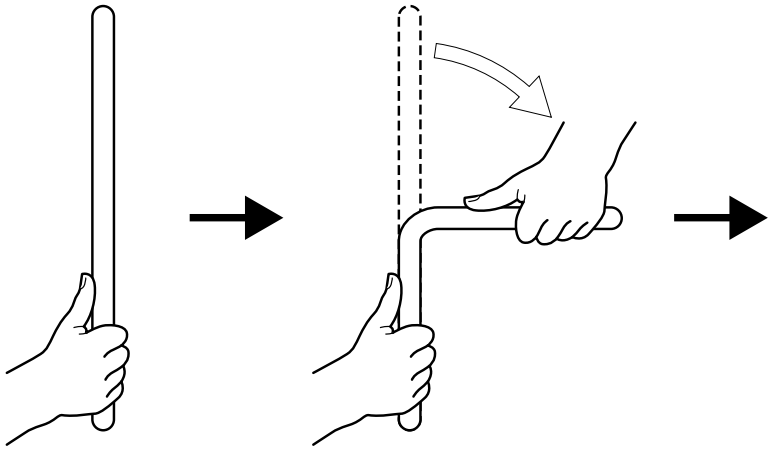
(iii) Look for the children who relate stretchiness to the thickness of the tights.

Name: ..... Form: .....

See **pages 12 and 13** of *Properties of materials*

Materials that bend and stretch

Many materials can easily be pulled or bent into new shapes. They are another kind of flexible material.



A **B** **C**

Q1. In space C, draw what happens to the wire when the top hand lets go of it.

Q2. Which is more flexible – a block of metal or a sheet of metal?

✎.....

Q3. What is a fibre?

✎.....

Q4. Why is a cloth flexible?

✎.....

✎.....

Q5. Where are glass fibres used?

✎.....

Q6. Where are copper fibres used?

✎.....

Teacher's sheet: comprehension

See **pages 12 and 13** of *Properties of materials*

Answers

1. **The rod stays bent.**
2. **The sheet.**
3. **A long thin rod.**
4. **Because it is made of long thin rods or fibres.**
5. **In cables carrying telephone messages.**
6. **In cables carrying electricity.**

Complementary work

(a) The children can use secondary sources to find out about how cloth is made. They should consider spinning, weaving and knitting.

(b) The children could consider flexible materials in their everyday life and reflect on how life would be different if items such as clothes were not flexible.

(c) The children could tease out some fibres in cotton wool and twist them or roll them together to make a short length of yarn.

(d) If a microscope is available, cut out a piece from some nylon tights that is the size of a postage stamp. Put the piece on a microscope slide and let the children look at it under the microscope. Stretch the piece and hold it down on the slide with sticky paper. Let the children look again and see how the pattern changes as the fibres and the structure is stretched.

Teaching notes

One way of thinking about the internal structure of a material is to think of it having parts hooked together. A large, thick block will have many parts, with many hooks, and the combined strength of the hooks may be too strong for a bending force to unhook them. A thinner piece of material will have fewer parts with hooks and they will have less strength against a bending force. The material can be thought of as staying in its bent position because of the parts which have not been unhooked. When a material is straightened, the unhooked parts become hooked up again.

Name: ..... Form: .....

Based on **pages 12 and 13** of *Properties of materials*

From fabrics to fibres

Try this...

1. Look at a piece of woollen fabric. Notice that it is made of thick threads called yarn.

2. How are the threads of yarn arranged?

✎.....

✎.....

3. Take one of the threads and pull it apart. Use a magnifying glass to look at the fibres in the thread.

4. Make a drawing of part of a thread of yarn and some of the fibres that make up the thread.

5. Look at a piece of cotton fabric. How is it different from the woollen fabric?

✎.....

✎.....

✎.....

Teacher's sheet: activity

Based on **pages 12 and 13** of *Properties of materials*

Introducing the activity

(a) Remind the children about the fibres that were mentioned on page 13 of the pupil book. Ask them to look at their clothes to see if they can see any threads.

(b) Tell the children that, although the threads may look small, they are actually made of even smaller threads, called fibres, which have been twisted together (see note (i)).

Using the sheet

(c) Give out the sheet, let the children fill in their names and form, then go through tasks 1 to 5 with them (see note (ii)).

(d) Let the children carry out their tasks.

Completing the activity

(e) Give the children a sample of felt and ask them to compare it with the other fabrics they have observed (see note (iii)).

Conclusion

The fibres which make up our clothes, and give them flexibility, are very small. They are twisted together to make larger, rod-like flexible structures called threads, which can be joined together to make flexible sheets of fabric.

Teaching notes

(i) Natural fibres like wool and cotton are not long and could not be used to make a width of a piece of cloth. Also, they are quite weak, so the fibres are twisted together to make a longer, stronger thread.

(ii) In task 2, it is sufficient for the children to describe the yarns as going over and under each other. They should attempt to make a scale drawing in task 4 showing the difference in width between the yarn and a fibre. In task 5 they should see that the cotton yarn is much thinner than the woollen yarn and its fibres are smaller. They should also observe that the threads are arranged over and under each other in a different pattern because they are woven together while the woollen fabric was knitted.

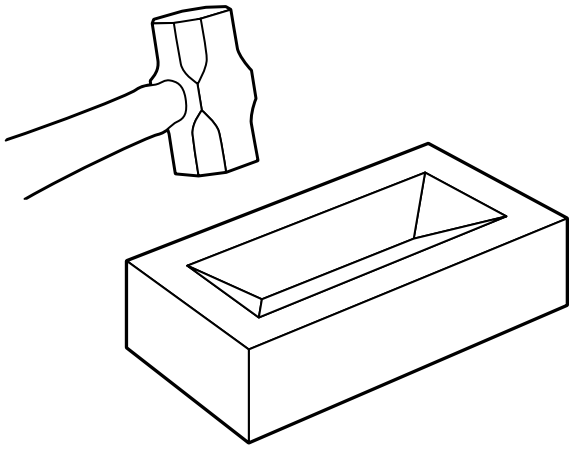
(iii) Felt is made of fibres which have been pressed together.

Name: ..... Form: .....

See **pages 14 and 15** of *Properties of materials*

Brittle materials

Some materials break very suddenly. They are brittle.



A **B**

Q1. The hammer is coming down onto the brick. In space B, draw what happens to the brick after the hammer hits it.

Q2. Why has the brick changed?

✎.....

Q3. What happens if you bend a piece of chocolate?

✎.....

Q4. Name three things that can break a brittle material.

✎..... ✎..... ✎.....

Q5. How is concrete made less brittle?

✎.....

Q6. How is a car windscreen made less brittle?

✎.....

✎.....

Teacher's sheet: comprehension

See **pages 14 and 15** of *Properties of materials*

Answers

1. **The brick should be drawn in pieces.**
2. **Because it is brittle.**
3. **It snaps.**
4. **Twisting, pulling, striking.**
5. **It has steel rods put in it.**
6. **A sheet of plastic is put between two sheets of glass.**

Complementary work

(a) If none of the children has an allergy to nuts you could demonstrate the brittleness of the casing around a nut by using a nut cracker.

(b) The children could test eggshell halves themselves by covering the eggshell with a cloth and dropping weights onto it through a cardboard tube. They may like to test eggs from hens reared in different ways.

Teaching notes

It is a mistake to think that brittle materials are weak. Many are very strong if they are given a load slowly. A brick can support a wall of bricks above it, yet shatters if it is given a sharp blow. It is the speed and size of the force delivered to a brittle material that makes it snap. Holes in the road are covered by cast iron which can support the weight of a juggernaut rolling over it, yet if it is hit with a sledge hammer it will crack.

Brittle materials are widely used because the advantages of their other properties outweigh the disadvantage of their brittleness, but economics is also important. For example, baked clay is a very cheap material which can be made to hold liquids and have a hard, easy to clean surface for using as plates. These properties, together with its cheapness, outweigh the disadvantages of its brittleness.

Brittle materials, like tiles, can be snapped by the scoring of their surface to create a line of weakness, then bending the material along this line so that it snaps cleanly. Ceramics are brittle materials, but they are shaped before firing when the clay is soft.

It may be thought that the use of sweets is at odds with the encouragement of a healthy diet, which may be a feature of your curriculum at this level. However, sweets are a feature of everyday life for many people and a good everyday example of brittleness.

6

Name: ..... **Form:** .....

Based on **pages 14 and 15** of *Properties of materials*

Twig test

Try this…

1. Look at the twigs you have been given and divide them into groups based on how they appear. Do not bend them.

2. Decide on names for the groups and write them in the left hand column of the table. Try to choose names that describe the twigs, such as long, oak twigs, etc.

Name of group	No. of twigs	Predicted No. of brittle twigs	Actual No. of brittle twigs

3. Count the number of twigs in each group, and record the numbers in the second column of the table.

4. Predict how many twigs you think are brittle in each group and record your predictions in the third column of the table.

5. Start with the group at the top of the table and bend each twig in that group in turn. When you have bent them all, record in the right hand column how many are brittle.

6. Repeat task 5 with each of the other groups.

Looking at the results.

7. How accurate were your predictions?

✎.....

8. What do your results show?

✎.....

✎.....

✎.....

Teacher's sheet: activity

Based on **pages 14 and 15** of *Properties of materials*

Introducing the activity

(a) Begin by asking the children if they have heard, in a story book or in a film or television programme, where the snapping of a twig gave away the position of the hero or the villain. Ask the children what caused the twig to snap (see note (i)) and ask them about the property that caused it to snap (see note (ii)). This observation may lead to the idea that all twigs are brittle and will snap.

(b) Show the children a collection of twigs (see note (iii)). Ask the children how they can test the twigs for brittleness and look for the answer: by bending them.

Using the sheet

(c) Give out the sheets, let the children write their names and form on them and go through tasks 1 to 2 (see note (iv)).

(d) Let the children carry out tasks 1 and 2.

(e) Go through tasks 3 and 4 with the children.

(f) Let the children carry out tasks 3 and 4.

(g) Go through task 5 (see note (v)).

(h) Let the children carry out tasks 5 and 6.

Completing the activity

(i) Let the children carry out tasks 7 and 8 and compare their results.

Conclusion

Dead twigs are brittle but live ones are flexible. Dead twigs are dry while live twigs are wet. Thin dry dead wood is brittle while thin, wet, living wood is not. The wood of conifer trees is more flexible than that of broad-leaved trees (see note (vi)).

Teaching notes

(i) The twig snapped because of the force put on it by a foot standing on it.

(ii) It was brittle.

(iii) In the collection, you should have twigs from broad-leaved trees which are alive and dead, and twigs from coniferous trees (not the larch) which are alive and dead. Check that at least some of the living twigs are not brittle.

(iv) Although this is an everyday example of brittleness, you may wish the children to use eye protection.

(v) The children should just bend each twig once. Dead twigs will snap but some of the living twigs will only bend. The children should not keep straightening and bending the twigs until they break.

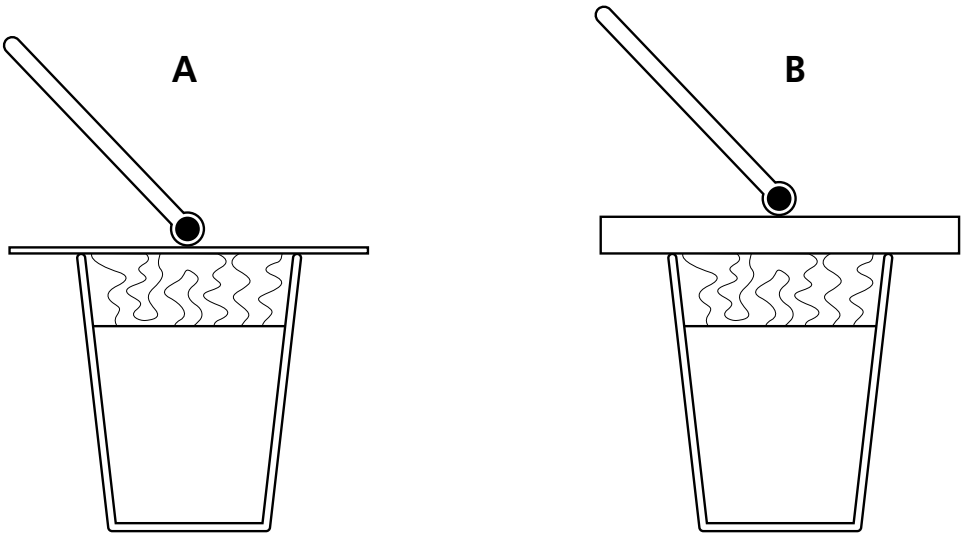
(vi) Most conifers keep their leaves all year. They have to endure snow on their leaves and strong storms, so are more flexible than broad-leaved trees which are deciduous and cannot live in the harsh conditions to which conifers are adapted.

Name: ..... Form: .....

See **pages 16 and 17** of *Properties of materials*

Keeping in the heat

To keep things warm, a material must stop heat being lost.



Q1. Which thermometer do you think will show the highest temperature?

✎.....

Q2. Why would one thermometer show a higher temperature than the other?

✎.....

✎.....

Q3. Which word is the name of a material that does not let heat get away quickly – detector, insulator, conductor? (Write your answer on the line).

✎.....

Q4. Some plastic mugs have a double wall of plastic. What is between the walls?

✎.....

Q5. Why are plastic mugs made like this?

✎.....

Q6. Which material lets heat pass through it most quickly – metal, paper or cloth?

✎.....

Teacher's sheet: comprehension

See **pages 16 and 17** of *Properties of materials*

Answers

1. **Thermometer A.**
2. **Because the material under A is thinner and heat escapes through it faster than it does through the material under B.**
3. **Insulator.**
4. **Air.**
5. **To keep drinks hot for longer.**
6. **Metal.**

Complementary work

(a) The concept of air as an insulator could be investigated by wrapping a string vest round one hot water bottle, then a cotton or nylon material around both hot water bottles, and leaving them for an hour.

(b) The children could use secondary sources to find advice for what clothing to wear when walking in the countryside.

(c) The children could use secondary sources to find out what mountaineers wear.

Teaching notes

Heat moves by conduction (passed from particle to particle inside a material), convection (passed by the movement of hot particles in liquids and gases) and by radiation (as rays of heat through air and space). At this stage the children do not need to know about these different forms of heat transfer but the use of the word conductor, as a material which conducts heat, provides an introduction for development later. It is important to emphasise that materials can be divided into two groups: those that conduct heat and those that do not. The non-conductors are insulators. The children will come across these words in the study of electricity. If they already know these words in that context then they need to be aware of the use of the word in this context, too.

Air is an insulator and is used in the design of some plastic mugs. This is an example of a composite material like the papier-mâché on page 9 of the pupil book.

Name: ..... Form: .....

Based on **pages 16 and 17** of *Properties of materials*

Which fabric stops the heat best?

Try this…

1. You have three fabrics to test, three containers with lids (such as empty water bottles), a pair of scissors, a thermometer and some sticky tape or an elastic band. Your teacher will provide you with some warm water. Use these materials to plan an investigation to answer the question: "Which fabric stops the heat best?" You may add some other items to your investigation if you wish.

2. Draw a table for your results.

Material	Water temperature at beginning (°C)	Water temperature at end (°C)

3. What do you predict?

✎.....

✎.....

Looking at your results.

4. What do your results show?

✎.....

✎.....

5. How good was your prediction?

✎.....

Teacher's sheet: activity

Based on **pages 16 and 17** of *Properties of materials*

Introducing the activity

(a) Begin by asking the children about what clothes they wear when they want to keep warm. Ask them about the properties of the materials (see note (i)).

Using the sheet

(b) Give out the sheet, let the children write their names and form, then go through tasks 1, 2 and 3 (see note (ii)).

(c) Let the children try tasks 1 and 2 and check their work before they start their investigation (see note (iii)).

(d) Let the children try out their plan (see note (iv)).

(e) Let the children try tasks 4 and 5.

Completing the activity

(f) The children should compare their results to see if they are similar. Any differences should be discussed to find out the cause. This can lead to reminding the children about the need for careful practical work.

Conclusion

The insulating properties of fabrics can be simply compared by wrapping them around the same volume of hot water for the same amount of time. Thicker fabrics are better insulators than thinner fabrics, and will keep the water hotter for longer.

Teaching notes

(i) They should mention that the materials are thick. It may be worth pointing out that the material is not solid, so air provides the extra insulation in a thick material.

(ii) The children may use a diagram to show how they would set up the apparatus.

(iii) The children will need one extra item – a clock, or they should be able to see a clock. Depending on the material you use and the ability of your class, you may wish to cut the fabrics to size before the lesson. The scissors then are only used for cutting the sticky tape to hold the fabric in place. If the children have cut their own fabric they should be sure to cover the bottom of the can. They should leave the top of the can uncovered.

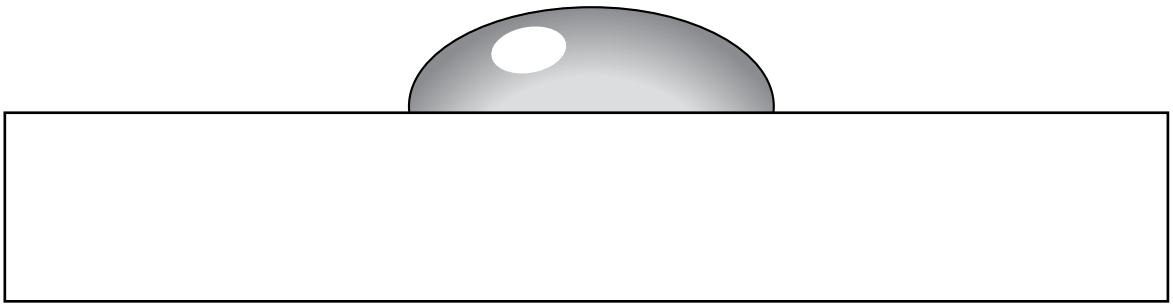
(iv) Provide them with the warm water when they are ready for it.

Name: ..... Form: .....

See **pages 18 and 19** of *Properties of materials*

Soaking up water

Some materials keep water out. They are waterproof.
Other materials soak up water. They are absorbent.



Q1. A droplet of water has just landed on the absorbent material in the diagram. Use arrows to show where the water goes next.

Q2. Name a waterproof material.

✎.....

Q3. What do absorbent materials have in them which allows them to take up the water?

✎.....

Q4. Name four absorbent materials.

1 ✎..... 2 ✎.....

3 ✎..... 4 ✎.....

Q5. What happens to paper if it is sprayed with furniture polish?

✎.....

Q6. How has the furniture polish changed the paper?

✎.....

✎.....

Teacher's sheet: comprehension

See **pages 18 and 19** of *Properties of materials*

Answers

1. **The arrows radiate downwards from below the droplet.**
2. **Plastic.**
3. **Holes.**
4. **Kitchen towel, blotting paper, sponge, cotton.**
5. **It becomes water resistant.**
6. **The paper is coated with wax which stops the water from being absorbed.**

Complementary work

(a) You may compare the water absorbing properties of different papers by setting up the following experiment: Thread bulldog clips along a string. Connect strips of different paper to the bulldog clips. Secure the string above a tray of water so that the lower edges of the paper dip into it. Compare how the water rises up the different papers. You can colour the water with a water-based paint or dye to make it easier to see it rise up the paper. This may be done as a demonstration, or provided as an extra practical activity to show that a property can be investigated in different ways.

(b) Let the children use secondary sources to find out about the clothes worn by a lifeboat crew and the materials used to make wet suits for scuba diving.

Teaching notes

Water holds itself together by cohesive forces. When water comes into contact with substances like wax or grease the cohesive forces pull the water away from the surface and make the droplets rounder. Water also moves upwards against gravity if it is presented with a tube of the correct width. This upward movement is capillary action. A water-repellent material has no holes in it, so water cannot move into it by capillary action. A water-resistant material may have holes in it, but its fibres have been sprayed with a substance that makes the cohesive forces pull the water into large droplets that cannot pass through the holes. An absorbent material has holes of the correct size to draw water in and hold it there.

The children do not need to know about this detail but you may find it useful to help explain how water moves up the paper strips in the complementary work and why water does not come though an umbrella.

8

Name: ..... Form: .....

Based on **pages 18 and 19** of *Properties of materials*

Which fabrics absorb water?

Try this…

1. You have some fabrics to test, some sheets of paper and a beaker of coloured water. Plan a test to find out which fabrics absorb water and which do not. You may add other items to your plan.

2. Make a table for your results.

3. Which materials do you predict will be absorbent?

✎.....

Looking at your results.

4. What do your results show?

✎.....

✎.....

5. How good was your prediction?

✎.....

Teacher's sheet: activity

Based on **pages 18 and 19** of *Properties of materials*

Introducing the activity

(a) Begin by telling the children that they are going to test a number of fabrics (see note (i)) to see which are absorbent and which prevent water passing through them. Remind them that they can get ideas from the spread and let them look at it again for ideas for their plan.

Using the sheet

(b) Give out the sheet, let the children fill in their names and form, then go through tasks 1 to 3.

(c) Let the children try tasks 1 to 3 (see note (ii)).

(d) Let the children try tasks 4 and 5.

Completing the activity

(e) The children can compare their results. If a wide range of materials has been used, and a few materials have been tested by different groups, all the results can be pooled to make a class result.

Conclusion

Fabrics can be tested for their absorbency by having water placed on them and left there for a period of time. If the fabric is absorbent, the water will pass through it and stain the paper underneath.

Teaching notes

(i) Show the children your collection of fabrics – they should be squares of material (about 10cm square) you have cut from old clothes, including outdoor clothes.

(ii) The test should take the form of placing each fabric on a separate sheet of white paper and pouring an equal volume of water into the centre of each fabric. The squares should each be left with the water on them for the same amount of time – perhaps 3 minutes, then the fabric removed and paper examined. If the paper is wet, this shows that the fabric has absorbed the water and it has soaked through to the paper. Some children may think about measuring the size of the stain to compare the absorbency of the fabrics. The table should have two columns headed fabric and condition of paper. This second column could be filled in by writing dry or wet or, in the case of quantifying stains, a comment such as 'stain 3cm across' could be used.

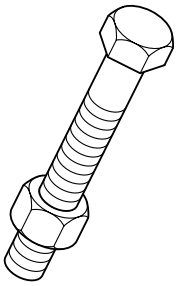
Fabric	Condition of paper

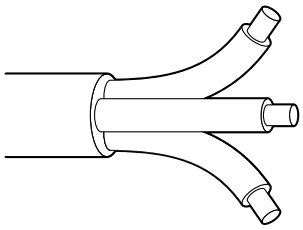
Name: ..... Form: .....

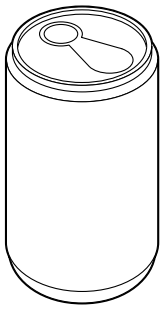
See **pages 20 and 21** of *Properties of materials*

Common metals

Weight for weight, metals are among the strongest materials. They can be made into many shapes, they will stand up to high temperatures and many of them are cheap to make.







✎..... ✎..... ✎..... ✎.....

Q1. Here are some names of metals – gold, steel, copper and aluminium. Use them to label the four metal objects in the diagram.

Q2. Which metal is used to make girders?

✎.....

Q3. Why is the metal in Q2 used to make girders?

✎.....

Q4. Which metal is used to make aeroplanes?

✎.....

Q5. Why is the metal in Q4 used to make aeroplanes?

✎.....

Q6. (a) Which metal rusts? (b) How can you tell it has rusted? (c) How can rust be stopped?

(a) ✎.....

(b) ✎.....

(c) ✎.....

Teacher's sheet: comprehension

See **pages 20 and 21** of *Properties of materials*

Answers

1. **Steel (bolt), gold (coin), copper (wire), aluminium (can).**
2. **Steel.**
3. **It is strong.**
4. **Aluminium.**
5. **It is light (and does not rust).**
6. **(a) Steel; (b) It goes brown and flaky; (c) Coat it in paint or plastic.**

Complementary work

(a) Gold forms in rocks as they cool. It is released when the rocks erode and may be found in river sand. One way of collecting it is to pan for gold. In this process a shallow pan of sand and water is swirled around until the sand is carried over the edge leaving the heavier gold in the pan. If you cut up a few brass paper fasteners, and mix them in some sandy water, the children can pan for 'gold', using a shallow dish as a pan and large bowl to collect the water and sand as it spills out. They can compare this unusual way of separating solid materials with other methods that they study later.

(b) The reactivity of metals can be demonstrated by letting the children look at clean and tarnished silver or letting a piece of old silver become tarnished.

(c) The children can use secondary sources to find out about bronze and brass.

(d) Metals are made from crystals but these are not usually seen. Zinc is unusual. When it is used as a metallic coating to protect iron (galvanised iron) it forms large crystals. These can be seen on galvanised iron buckets and farm gates.

Teaching notes

Very few metals are found naturally in metallic form. Gold, silver and copper are exceptions – they can be found as metal nuggets. Some meteorites are almost solid iron. Most metals react with other chemicals in their surroundings and form substances called compounds. A metal ore is a compound of the metal in a rocky form. Ores have to be treated in special ways to get the metal out of them. For example, iron ore has to be treated with coke in a blast furnace to release the metal.

Metals can be melted and mixed together. These mixtures are called alloys and they have properties which are different from the metals from which they are made. Alloys are widely used. For example, copper coins are made from an alloy of copper, tin and zinc, and silver coins are made from an alloy of copper and zinc.

9

Name: ..... Form: .....

Based on **pages 20 and 21** of *Properties of materials*

Which metals rust?

Try this…

1. Lay each piece of metal on a wet paper towel and make a drawing of it (use the back of this sheet or a separate piece of paper if you need to).

2. Wrap the metal pieces in the towels and leave them until you next inspect them. Add a little water to the towels every day to keep them damp.

3. Fill in the names of each metal in the first column, and record the date in the second column. Put a cross in each box in the second column to show that none of the metals had any rust when the experiment started.

Metal	Date									

4. Inspect the metals at regular intervals and make a tick on the table under the date when you first see that the metal has rusted. Make sure you write down the date in the table every time you inspect the metals. Colour in the rusty area on your drawing of the metal sample.

Looking at the results.

5. What do your results show?

✎.....

✎.....

Teacher's sheet: activity

Based on **pages 20 and 21** of *Properties of materials*

Introducing the activity

(a) Ask the children if they think that all metals rust. Whatever their response, ask them how they could make a fair test with an iron nail to see if their answers were correct (see note (i)).

Using the sheet

(b) Give out the sheet and samples of different metals. You should give them a steel nail, a piece of aluminium foil and a piece of copper wire. Let the children fill in their names and form, then go through tasks 1 to 3.

(c) Let the children carry out tasks 1 to 3 (see note (ii)).

(d) Let the children complete task 4 (see note (iii)).

(e) Let the children complete task 5.

Completing the activity

(f) The children can compare their results. Differences may occur around the time interval selected. Some children may have had to extend their table. Other children may have had a long enough time interval that they missed out on the early stages of rusting. Children who had a long time interval for inspection, but then discover rusting to be taking place, could change their inspection to a daily basis to record how the rusting proceeded. The sensible use of time can be discussed and a revised plan made which you may try if time permits.

Conclusion

Only the steel nail rusts.

Teaching notes

(i) The children should point out that samples of other metals should be the same size as the nail. This will mean that the amount of copper wire and aluminium foil used should be comparable to that of the steel in the nail.

You may have to ask them where they have seen rusty metal and elicit that rust is associated with damp surroundings. Steer the children into wrapping their metal samples in wet paper towels.

(ii) The drawings should be large enough so they will have space to record accurately where the rust occurs. The metals wrapped in towels could be put on a board or a tray and kept in a cupboard. If the conditions are warm the rusting process will be accelerated.

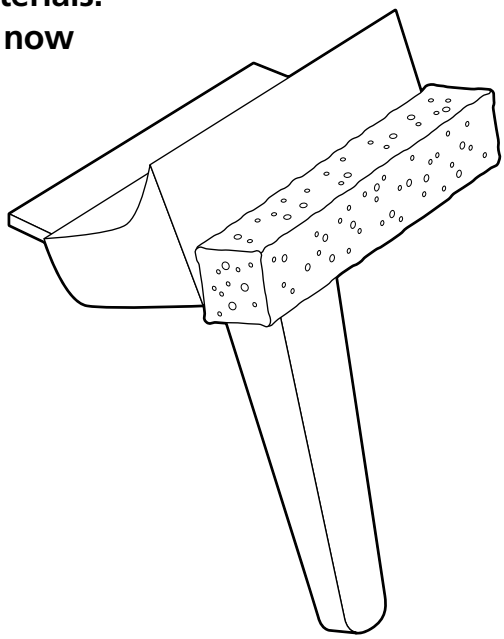
(iii) The children do not have to examine the metals every day. If some want to, then let them. They may find that they have run out of table before the steel rusts. Other children may think that rusting is a slow process and select a longer time interval. Let them follow their plan.

Name: ..... Form: .....

See **pages 22 and 23** of *Properties of materials*

Common plastics

Plastics are 'designer' materials. They are all artificial and now have millions of uses.



Q1. Here are some properties of three plastics. A is hard and shiny, B is soft and elastic, C is soft and absorbent. Label the three plastics on the squeegee. (A picture of the squeegee is on page 22 of the pupil book.)

Q2. What is the purpose of plastic C?

✎.....

Q3. What is the purpose of plastic B?

✎.....

Q4. Why can sharp detail be seen in plastic toys?

✎.....

Q5. What kind of plastic is used to make a lunchbox?

✎.....

Q6. Name four properties of plastics that make them useful for making bottles.

1 ✎..... 2 ✎.....

3 ✎..... 4 ✎.....

Teacher's sheet: comprehension

See **pages 22 and 23** of *Properties of materials*

Answers

1. **A = handle, B = scraper, C = sponge.**
2. **To add water to the window.**
3. **To scrape dirt off the window.**
4. **Because plastic is easily moulded into precise shapes.**
5. **Polythene.**
6. **Light, strong, waterproof, transparent, recyclable.**

Complementary work

(a) The children could make a survey about how many plastic items they find in the kitchen, living room, bedroom and bathroom.

(b) Use secondary sources to find out how plastic objects are made and how they can be recycled.

Teaching notes

Most plastics are made from oil. There are many substances in oil which are made from molecules that you can think of as long chains. At an oil refinery, these substances are broken up into substances which have very short, chain molecules. One of these substances is ethene. Ethene molecules can be linked together to form a long, chain molecule which does not occur in nature. As the molecule is made from many ethene molecules, it is called polythene. Other plastics prefixed by 'poly' are similarly made from many small molecules joined to make a long chain.

Plastics can be divided into two groups according to how they behave with heat. One group, called thermoplastics, become soft when warmed and hard again when cooled. Polythene belongs to this group. Plastics in the second group stay hard even when they are hot. They are called thermosets. Melamine is one example.

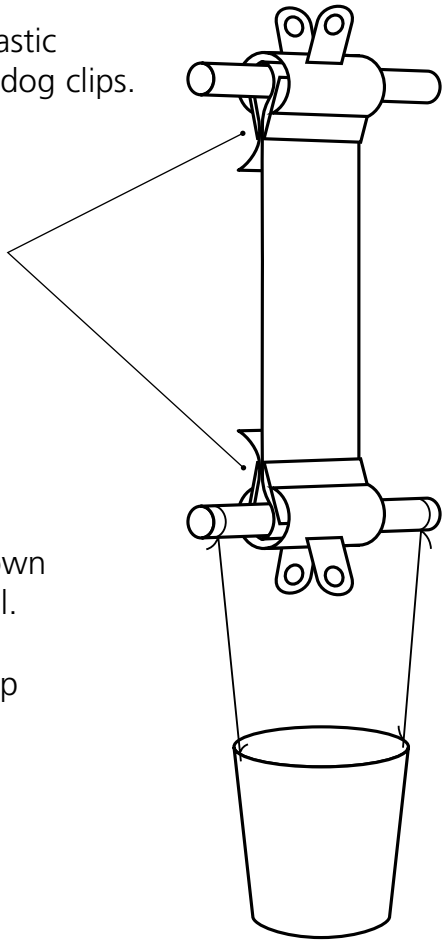
Name: ..... Form: .....

Based on **pages 22 and 23** of *Properties of materials*

The strength of plastic

Try this…

1. Look carefully at this diagram and see how the plastic strip goes over the pencils and is clamped by the bulldog clips.



2. Set up a strip like the one shown in the diagram.

3. Attach a yoghurt pot to the bottom pencil, as shown in the diagram. Have your partner hold the top pencil.

4. Put weights in the yoghurt pot until either the strip stretches or the pot is full.

5. Find the weight of the pot at the end of the test.

6. Record your result in the first line of the table.

7. Try tasks 1, 2 and 3 with the other plastic strips.

Type of plastic	Weight added (gms)

Looking at the results.

8.What do the results show?

✎.....

✎.....

Teacher's sheet: activity

Based on **pages 22 and 23** of *Properties of materials*

Introducing the activity

(a) Ask the children if they have ever been shopping with a member of the family when the plastic shopping bag broke. This should produce some anecdotes to set the investigation as relevant to an everyday problem. Ask the children how they could test the plastic in different bags. One suggestion may be just to fill different bags with weights and see when they stretch. As the weights could be considerable, you might demonstrate this to the children.

(b) Move the ideas on to a safer method and steer the children to measuring the strength of plastic strips (see note (i)).

Using the sheet

(c) Give out the sheet, let the children fill in their names and form and show them how to set up a strip as shown in the diagram (see note (ii)).

(d) Let the children try task 2 and check their work.

(e) Let the children try task 3 (see note (iii)).

(f) Let the children try tasks 4 and 5.

(g) The children should now repeat tasks 2 to 6 with the selection of plastic strips.

Completing the activity

(h) Let the children compare their results. Encourage them to offer some advice from their results such as, "Do not put heavy objects in bin liners and expect to carry them far".

Conclusion

The strength of a plastic sheet can be tested by hanging weights on a small strip of it.

Thinner sheets are weaker than thicker sheets.

Teaching notes

(i) Cut strips of plastic from a range of bags, including bin liners.

(ii) Use short strips and arrange for the bulldog clip to be suspended only a short distance above the ground, but with enough space to hang a yoghurt pot of weights and record the stretch of the material.

(iii) Some plastics may remain unstretched throughout the test, but bin liner plastic should show signs of stretching. This gives you an opportunity to show that some investigations have limitations and, provided that this is mentioned in discussing the results, this is scientifically acceptable. The weight of the pot and its weights should be found on a weighing scale or balance.

Children could measure the length of the strip both before and after stretching and add these measurements to their table.

REVISION QUESTIONS

Name: ..... **Form:** .....

Q1. Which of these materials are natural materials?

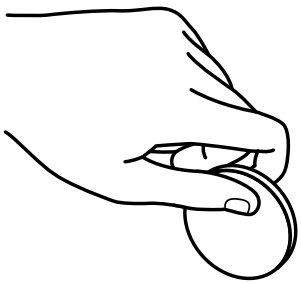
Tick the boxes:

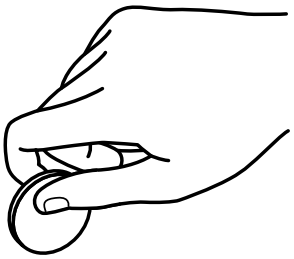
Stone ☐ Plastic ☐ Iron ☐ Clay ☐ Wood ☐

Q2. Material A is harder than material B.

If you rub A on B and B on A which one will be scratched? A ☐ B ☐

Q3. Here is a scratching test to find out which coin is harder than the other. Each coin will be scratched against a soft surface.





(i) What is wrong with the test?

✎.....

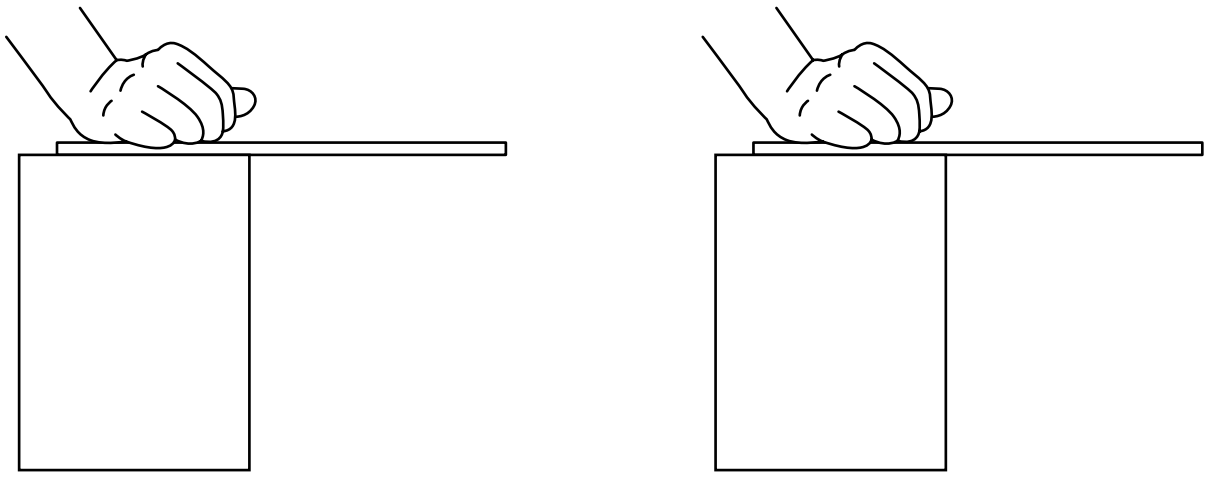
✎.....

(ii) Describe the right way of testing which coin is harder than the other?

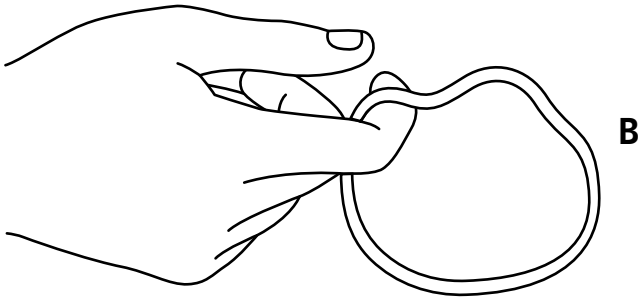
✎.....

✎.....

Q4. The strength of these two rods are to be tested at the same time. Draw where you would put the weights to test them.



Q5. Jane is holding an elastic band.



(i) What will happen if she pulls on the part marked B?

✎.....

✎.....

(ii) What will happen if she then lets go of part B?

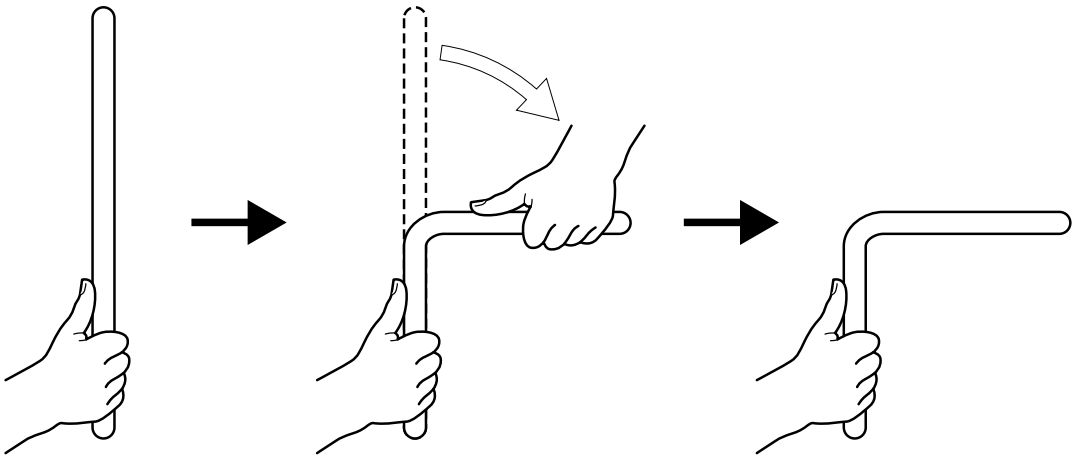
✎.....

✎.....

REVISION QUESTIONS

Name: ..... **Form:** .....

Q6. Paul bends a rod and it stays in its new shape.



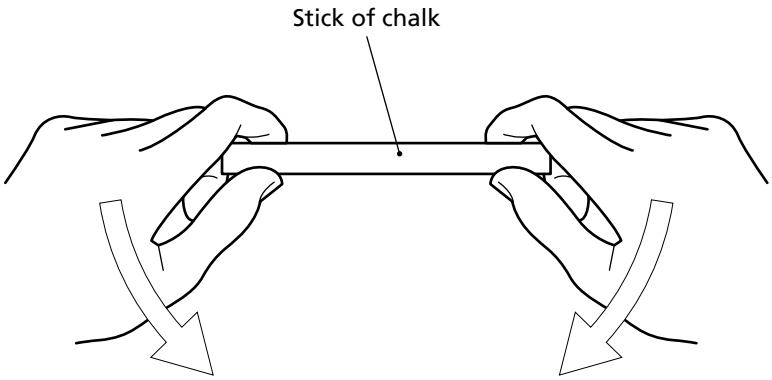
(i) Which word describes the rod's property?

Tick one box: Elastic ☐ Flexible ☐ Strong ☐

(ii) What do you think will happen when Paul bends the rod up again?

✎.....

Q7.



(i) What will happen when Sarah bends a piece of chalk?

✎.....

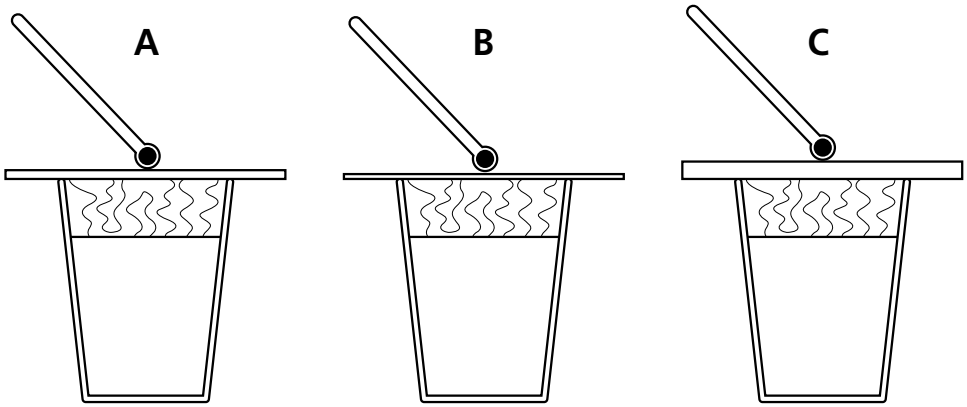
(ii) Why did this happen to the chalk?

✎.....

REVISION QUESTIONS

Name: ..... **Form:** .....

Q8. This test has been set up to see which thickness of cloth is the best insulator.



(i) Which cloth do you think is the best insulator?

Tick one box: A ☐ B ☐ C ☐

(ii) Why have you picked that cloth?

✎.....

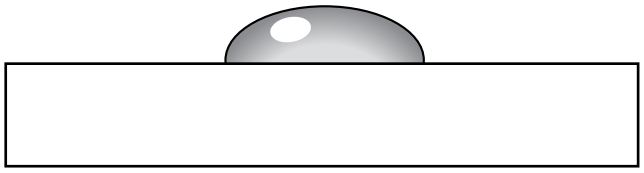
(iii) Which thermometer will show the highest temperature?

Tick one box: A ☐ B ☐ C ☐

(iv) Why have you picked that thermometer?

✎.....

Q9. This drop of water is resting on a material but cannot go into it.

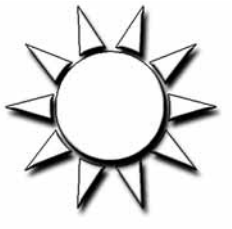


(i) What kind of material is the drop resting on?

✎.....

(ii) Why can't the drop go into the material?

✎.....



REVISION QUESTIONS

Name: ..... **Form:** .....

Q10. Fill in the table about the properties of three materials.

If you think the material has that property write **yes** in the box.

If you think it does not have that property write **no** in the box.

	Property			
Material	**Hard**	**Transparent**	**Absorbent**	**Brittle**
Glass				
Paper towel				
Steel paperclip				

Q11. Match each metal with its uses. Draw a line from the metal name to its use.

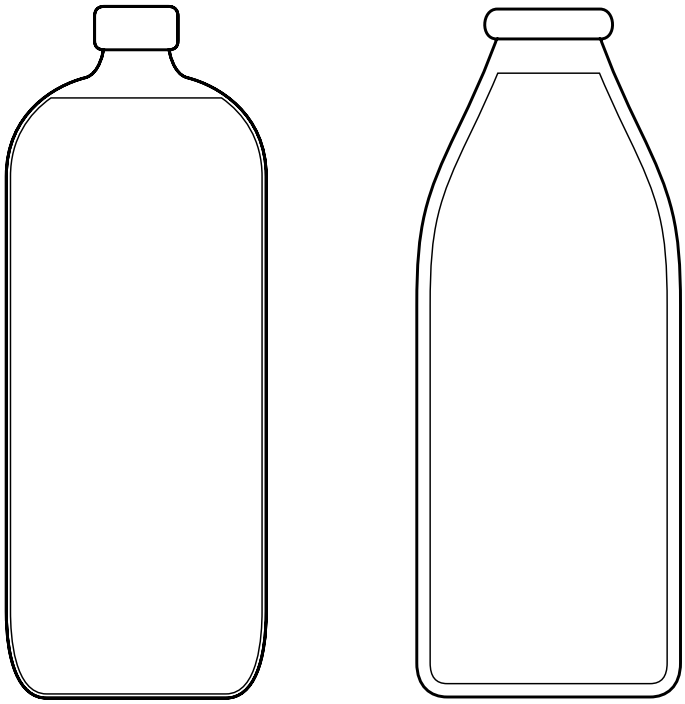
Metal	**Use**
Steel	Aircraft
Copper	Jewellery
Aluminium	Wires for electricity
Gold	Girders

Q12. Name a metal that rusts.

✎.....

Name: ..... **Form:** .....

Q13. Here is a plastic bottle and a glass bottle.



(i) How is the plastic material similar to glass?

✎.....

(ii) How is the plastic material different from glass?

✎.....

Q14. Why do electrical cables have a plastic covering?

✎.....

Q15. Why do some kinds of wire netting have a plastic covering?

✎.....

Q16. How do some plastics behave when they are heated?

✎.....

ANSWERS
SAT STYLE QUESTIONS

1. Stone, clay, wood. *3 marks*

2. B. *3 marks*

3. (i) They are both harder than the soft material and will both scratch it, so giving no result. *1 mark*
(ii) The coins should be scratched against each other. *1 mark*

4. The weights should be the same size and distance from the end of rods. *2 marks*

5. (i) It will stretch. *1 mark*
(ii) It will spring back. *1 mark*

6. (i) Flexible. *1 mark*
(ii) It will stay up straight. *1 mark*

7. (i) It will break. *1 mark*
(ii) It is brittle. *1 mark*

8. (i) C. *1 mark*
(ii) It is the thickest. *1 mark*
(iii) B. *1 mark*
(iv) The cloth is the thinnest. *1 mark*

9. (i) Waterproof material. *1 mark*
(ii) There are no holes in it. *1 mark*

10. Glass – yes, yes, no, yes. *4 marks*
Paper towel – no, no, yes, no. *4 marks*
Steel paper clip – yes, no, no, no. *4 marks*

11. Steel – girder, copper – wires for electricity, aluminium – aircraft, gold – jewellery. *4 marks*

12. Iron or steel. *1 mark*

13. (i) Transparent, waterproof. *2 marks*
(ii) Not as brittle, lighter in weight. *2 marks*

14. Plastic does not conduct electricity. *1 mark*

15. To stop them rusting. *1 mark*

16. Melt, give off poisonous fumes. *2 marks*

Total marks: 47