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Friction

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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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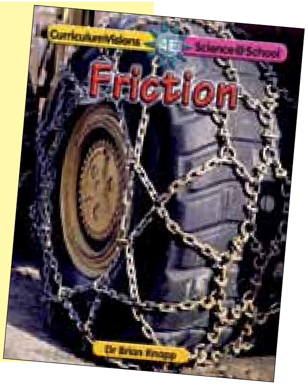
Section 1: Resources

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

1 The Friction pupil book is the full-colour paperback book that covers the scientific principles of friction and examines the way friction is used in our daily lives – all in simple, easy-to-follow units which make it accessible to a very 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.

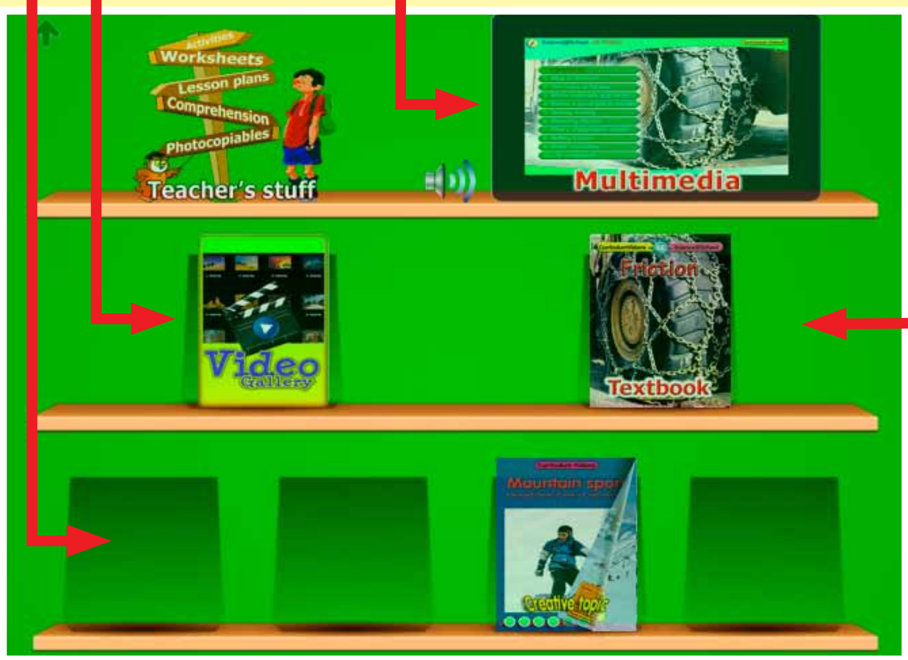
2 Our Learning Centre at

www.curriculumvisions.com

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

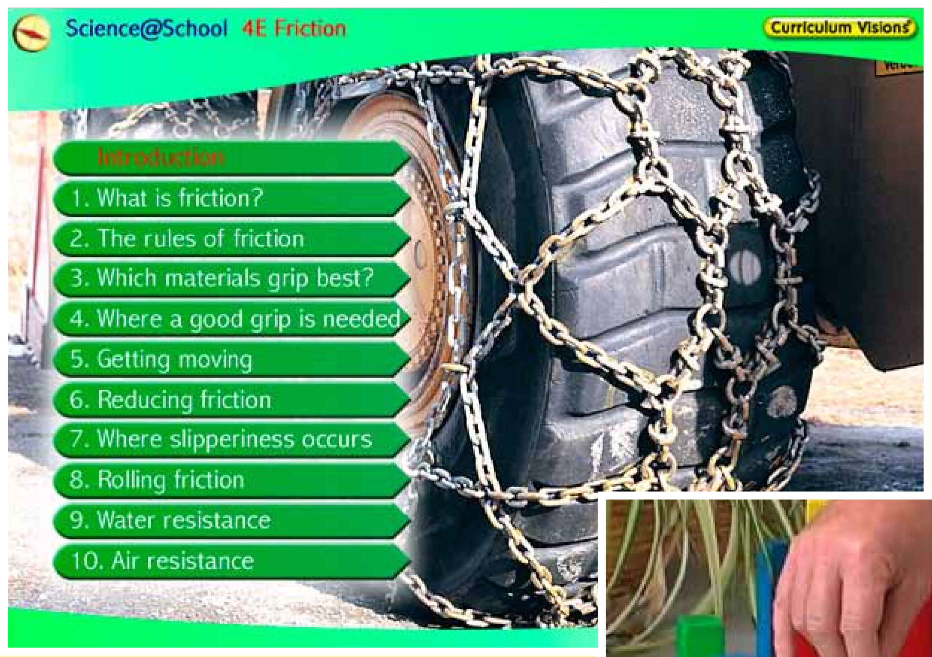
You can use support videos, e-books, picture and video galleries, plus additional Creative Topic books, graphic books called Storyboards, and workbooks. Together they cover all major curriculum areas.

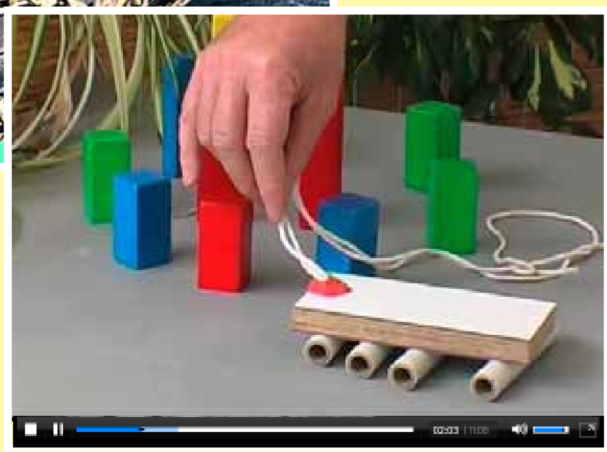
All topics are easily accessible, and there is a built-in context search across all media.



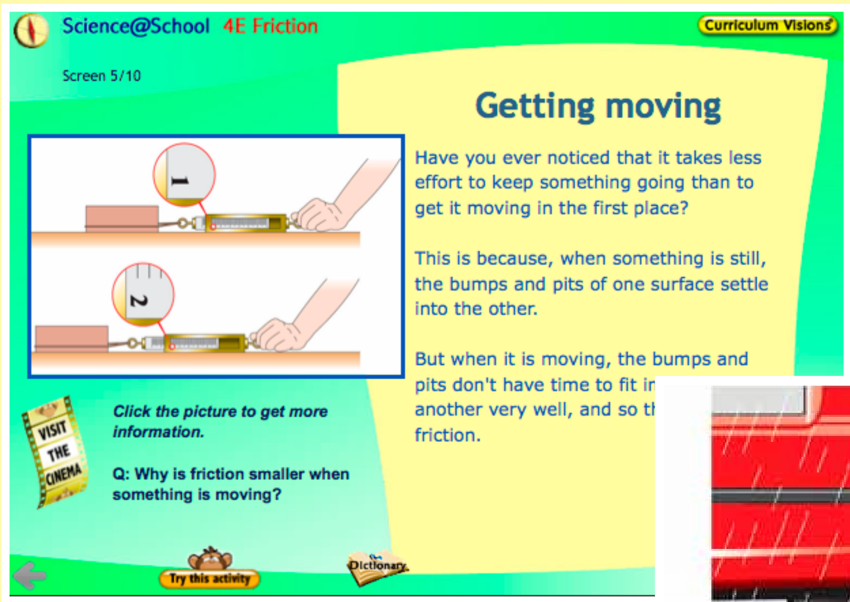
You can also use our printed student books online as part of your subscription to the Learning Centre. There page-turning versions of every printed Curriculum Visions book for use on your whiteboard.

▼ The Friction home screen





▲ 'Classroom cinema' video



▲ Web site page

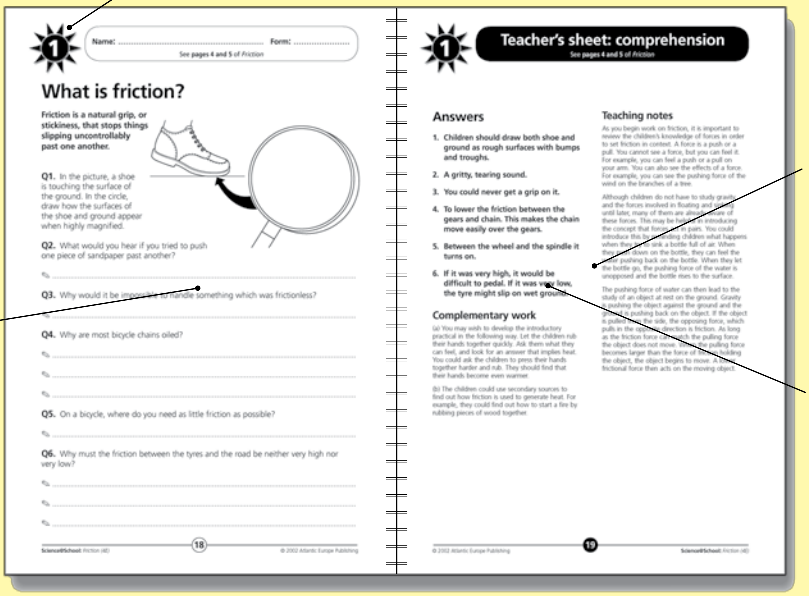
▶ Web site caption

▼ ***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.

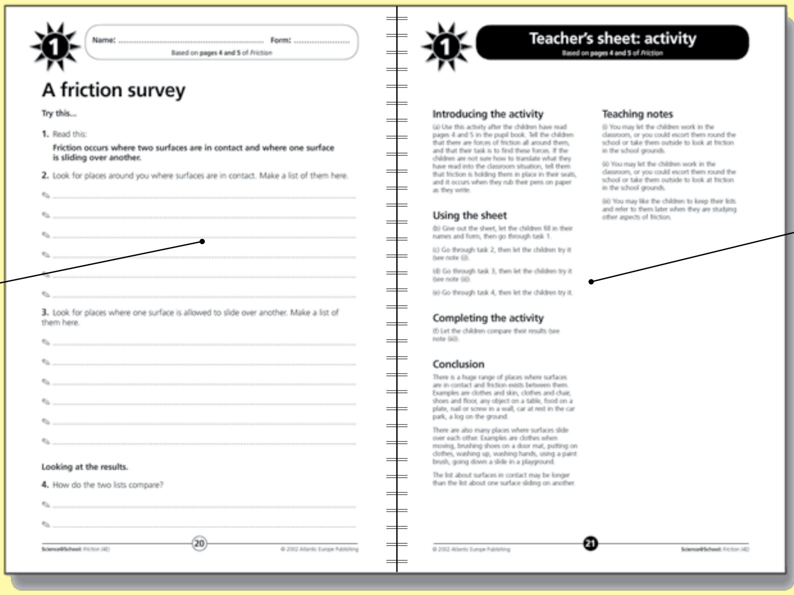


Right hand page is the teacher's sheet and provides answers, suggestions for complementary work and teaching notes.

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 friction component of the curriculum in a way that is highly relevant to work in the lower junior classes at primary school. It introduces friction as a force and shows how it can be measured with a spring. The book begins by considering grip, then shows how there are two kinds of friction – one which holds objects in place and one that occurs when an object slides. The book moves on to consider how friction can be reduced and examines friction in relation to water and air.

While covering the subject matter of the curriculum, *Friction* also facilitates the development of investigative skills both in the pupil book and the *Teacher's Guide*.

The pack is fundamentally built around the idea that friction is a force which plays a very important part in our lives – indeed we could not move nor stay still without it. From this concept different aspects of friction are investigated to show how we can control it to our advantage.

Section 2: The pupil book explained unit by unit

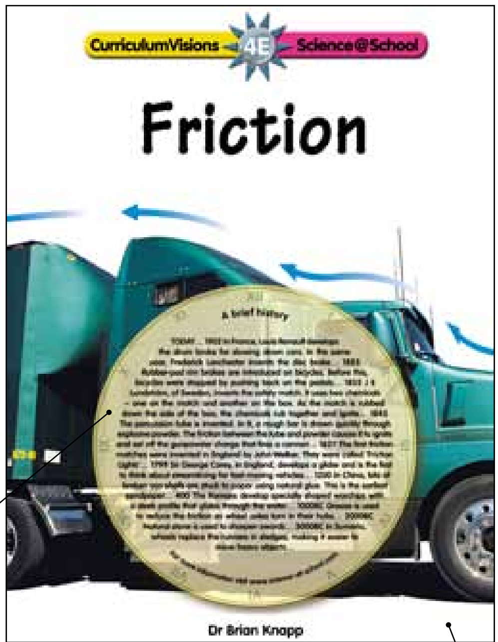
Although the pupil book – *Friction* – is clear and simple, a great deal of care and thought has been given to the structure and the content of each double page spread or unit. The worksheets and activities in this *Teacher's Guide* also link directly to the pages in *Friction*.

It is possible to use *Friction,* 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.

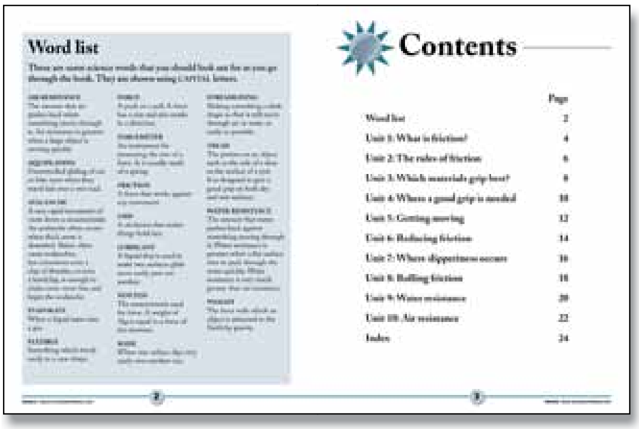
The picture shows the profile of a truck. The smoothed and streamlined shape helps reduce air resistance and is an important factor in keeping down energy costs.

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

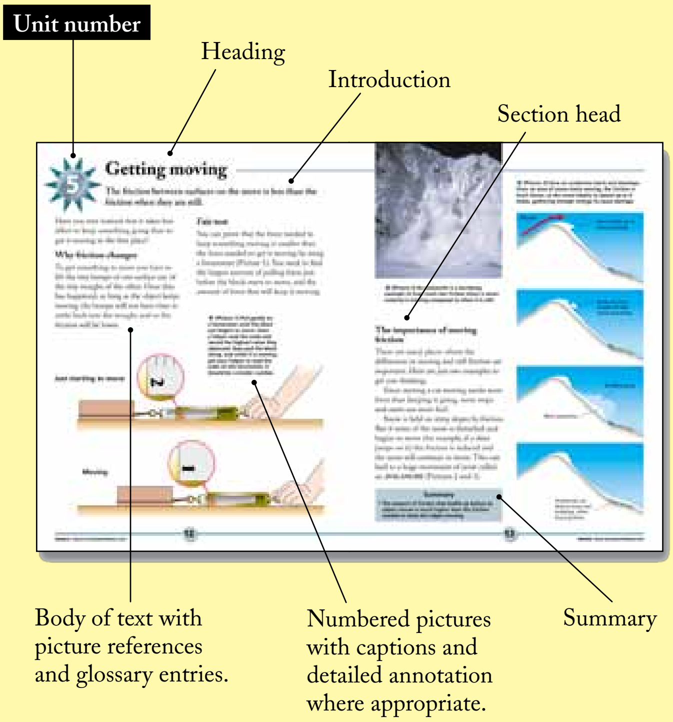
The main text of the page then follows in a straightforward, easy-to-follow, double column format.

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.

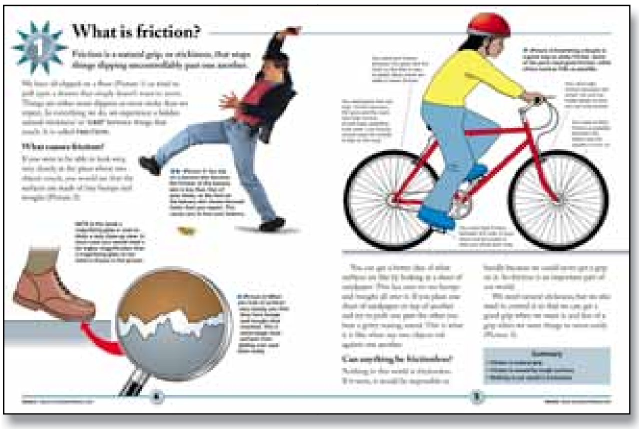
The glossary words are highlighted on the first page on which they occur. They may be highlighted again on subsequent pages if they are regarded as particularly important to that unit.

Summary

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



1 What is friction?



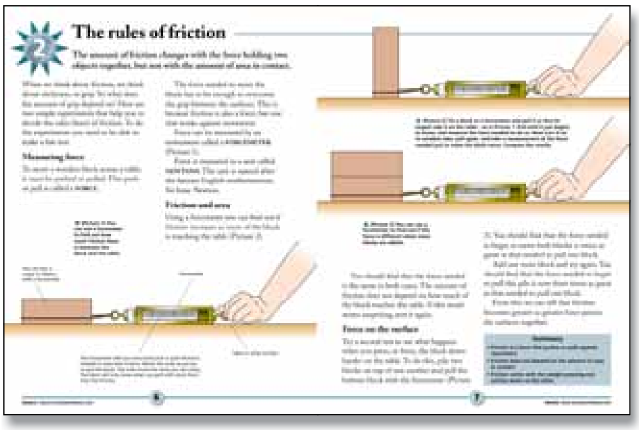
Friction is a force that opposes motion. Scientists call this a reaction. For example, there is no friction acting on a teacup placed on a flat desk. But if the desk were tilted, the mug begins to slip, and this motion causes a reaction to build up. This reaction is the force called friction. Friction occurs because surfaces are rough.

You may like to begin by giving the children magnifying glasses and asking them to look at the skin on the palms of their hands and their fingers. Ask them what they can see and look for answers which indicate that they think the surface is rough. Tell the children to open their hands and press their palms and fingers together gently. Now ask them to very gently push one hand against the other until it starts to slide. Tell the children that the force that was resisting their pushing force was the force of friction. Extend this by saying that even when the hands are sliding over each other there is a force of friction between the surfaces. When the children stop pushing their hands, the force of friction disappears because there is no longer any motion to resist.

The unit opens by describing two everyday examples of friction. A picture of the consequences of slipping on a banana skin is followed by a diagram showing how a shoe grips the ground. The unit moves on to show how different amounts of friction are needed at different places on a bicycle so it can be ridden easily and safely. The unit ends by considering frictionless conditions and concludes that friction is essential but we need to control it.

In the complementary work, the children investigate how friction produces heat in their hands and use secondary sources to find out how friction can be used to create fire. In the activity, the children make a survey of places where friction occurs.

2 The rules of friction



Show the children a forcemeter. Point out that it contains a spring. Ask the children what happens to a spring when a pulling force acts on it, and look for the answer that the spring stretches. Show the children the scale and the pointer and show them how the pointer moves when the spring is stretched. Explain to the children that the units for measuring force are called newtons and the symbol for this unit is N. Give out some forcemeters and let the children examine them. If the children have already done some work on springs, remind them of it now and show them how the forcemeter uses a spring to measure forces.

This unit follows on from Unit 1 by considering how friction can be measured, and how the amount of area in contact, and the amount of force on a surface may be investigated. The forcemeter is introduced, and the text explains that frictional forces are measured in newtons. Three clear illustrations help the children to assemble the equipment they need for investigations. The text provides guidance for carrying out the practical work, and answers to the investigations, which the children can compare with their results.

In the complementary work, the children examine how the brakes on a bicycle work. In the activity, the children explore the relationship between load and friction and surface area and friction.

3 Which materials grip best?

You may like to begin by showing the children a large picture of a rock climber with climbing shoes gripping a rocky surface. Ask the children how important it is for this rock climber to have good grip and look for an answer that suggests it might be vitally important. Tell the children that you know a simple way to test for grip, and place an object on the end of a board. Gradually raise the board to make a ramp. Continue raising the end of the ramp until the object starts to slide. Ask the children how the rock climber may fare with boots made from the material you have tested.

Having established a relationship between friction and grip in the previous unit, this unit takes the concept further. The unit opens by considering how a computer mouse moves on a mouse mat. The relationship between the materials in a shoe and a football are also considered, and instructions are given on how to test the gripping ability of different materials. The text is supported by three large, clear diagrams which help the children to try investigations.

In the complementary work, the children examine a range of footwear to find the most widely used material for making soles and heels. They can also investigate the frictional force by which rubber grips wood. In the activity, the children compare how different materials grip a surface and discover the importance of repeating experiments.

4 Where a good grip is needed

If you did the activity in the previous unit, you may like to remind the children now about the importance of repeating experiments. Ask two children to leave the room and tell them that they will be needed for an experiment in a moment. When they have left, ask one child to hold onto a dry bar of soap, squeeze it a little and show the class. Ask the child to wet the soap and repeat the experiment. This time the soap should be more difficult to hold and may slip out of the hands when squeezed. Ask one of the children who has left the room to return and try the experiment. Ask the other child who has left the room to return and try the experiment. Ask the class to draw a conclusion from what they have seen.

This unit builds on the previous one to look more closely at how materials can be used to provide grip. The unit opens by considering the slipperiness of wet soap, then moves on to explain how it may be successfully gripped by wearing rubber gloves. The tread on sports shoes and tyres are shown to disperse water to provide greater grip, and the unit ends

with a striking photograph of chained tyres which is supported by text that explains how the chains are used in snowy and icy weather conditions.

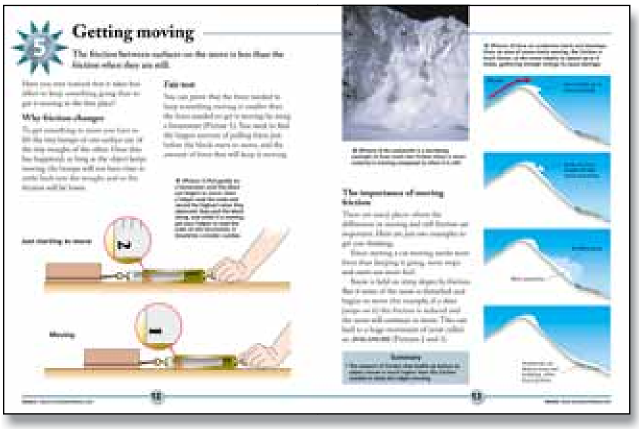
In the complementary work, the children examine the handles of sports equipment to see how they are designed to allow a good grip. Old shoes are also examined for signs of wear. In the activity, the children compare how different kinds of footwear grip a wooden board.

5 Getting moving

You may like to begin by placing a shoe on a ramp and asking the children to predict what will happen when you raise the ramp. They should say that the shoe will begin to slide. Raise the ramp to confirm their prediction. Tell the children that you wonder if the friction force now acting on the moving shoe is the same strength as the one that held it in place as the board was raised. Ask them how they could find out. The children should realise that the ramp will not help them here but the forcemeter could. Turn to page 12 in the pupil book so that they can confirm their idea and see how a test could be made.

In contrast to the previous units, which dealt mainly with overcoming friction between two stationary objects, this unit looks at how friction changes when objects are moving, that is, sliding over each other.

The unit begins by asking the children if they have noticed it is easier to keep something going than to get it moving in the first place. An explanation of this phenomenon is given, then instructions are given on how to carry out a fair test on a still object and



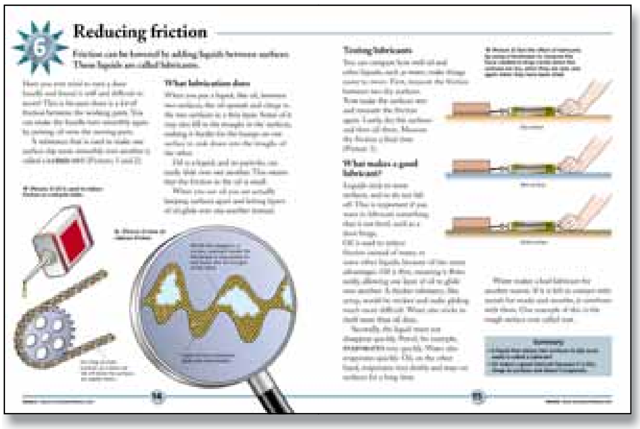
a moving object. The text is supported by a clear diagram. The text then moves on to consider the importance of moving friction and the action of an avalanche is described and illustrated.

In the complementary work, the children use secondary sources to find out about how avalanche damage is controlled. In the activity, the children test a range of surfaces to see how still (static) friction and moving friction compare.

6 Reducing friction

You could begin by asking the children to take out a pencil and paper. Ask them to rub their forefinger and thumb together, on the hand they do not use for writing. Now put a drop of vegetable oil on their thumbs and ask them to rub their finger and thumb together again. Ask them not to speak, but to write down how the rubbing action changed when the oil was added. Collect their answers and read out each one in turn. Ask the class what they conclude from the information that they have heard. Remind the children that it is important that the same experiments are carried out by different people to produce reliable results.

This unit builds on the last one to consider how friction between sliding objects can be reduced. The unit opens by considering a stiff door handle and the need for oil. The familiar activity of oiling a bicycle chain is illustrated in great detail to show how the oil slips between the touching surfaces. The action of a lubricant is explained, then the text moves on to describe how the effect of lubricants can be compared in a fair test. The text is supported by a



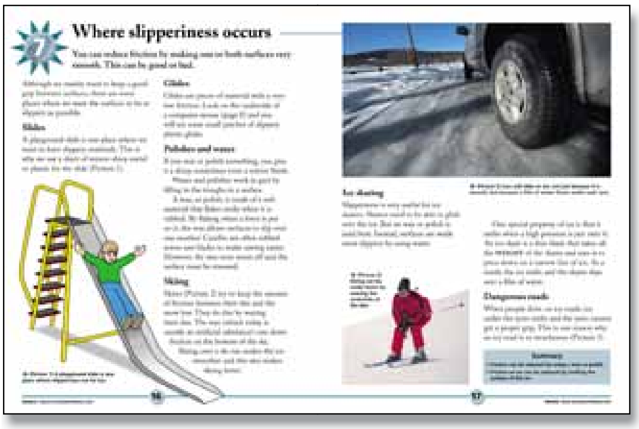
clear diagram which the children can use to help them with their investigations. The unit ends by comparing the lubricating properties of oil, syrup and water.

In the complementary work, you can demonstrate how oil improves movement. In the activity, the children compare how liquids flow and reduce friction.

7 Where slipperiness occurs

You may like to begin by asking the children about playground slides that they have been on. Some children may have even been on a helter skelter. Ask them about the best slides they have been on and what they can remember about the surface. They should conclude that the best slides had the shiniest, smoothest surface. Ask the children about slipping on ice. Some may recall accidents, while others may mention sliding on a patch of snowy ground just like on a slide. If the children have been on a sledge, ask them about the best snow (compact and smooth) for going fast. From all these anecdotes, draw conclusions about the slippiest surfaces for fun. To balance this concept, ask the children about when a slippery surface could be a danger and look for answers about slipping on wet floors, in the bath or vehicles going out of control on wet or icy roads.

This unit allows the children to contrast the properties of lubricants with other ways of obtaining a slippery surface. The unit opens by considering the materials needed to make a successful playground slide. The action of polishes and waxes in providing a slippery surface is explained, and the application



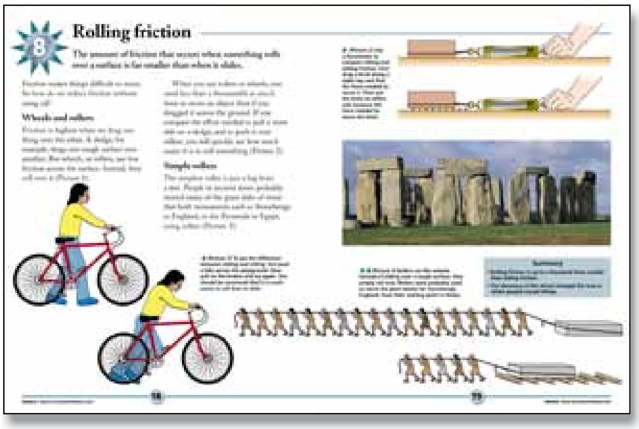
of wax to skis is described. The way that an ice skater can move on a thin film of water is carefully explained and the unit ends by considering the danger of icy roads.

In the complementary work, the children compare how objects with different surfaces move down a playground slide. In the activity, the children compare how toy cars move over different surfaces and discover the conditions which cause them to skid.

8 Rolling friction

You may like to begin by asking two children to stand up. Ask the first child to hold out their hands and try and stay in one place while the other child tries to pull him/her forwards. The class should see that the child who has to pull has some difficulty, and the child being pulled eventually has to take a step forward to keep their balance. Ask the first child now to put on a pair of roller skates or roller blades, or stand on a skateboard and ask the two children to repeat the activity. This time the children should see that the child who has to pull has much less difficulty in moving the first child, and the first child moves easily along on the rollers.

This unit builds on the two previous units by showing how friction can be reduced to make movement of large objects easier. The unit opens by comparing sliding friction with rolling friction. This comparison is made by showing that rolling friction occurs when you push a bicycle with its brakes off, and sliding friction occurs when you try to push a bicycle with its brakes on. The important point is made that the force needed to move something by

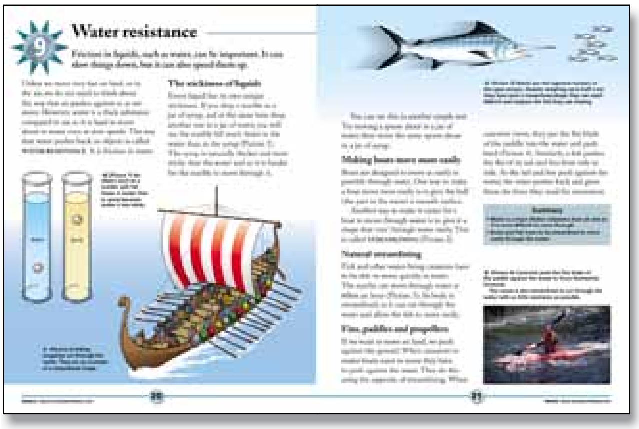


rolling friction is a thousand times less than the force needed to move it by sliding friction. A fair test for comparing sliding and rolling friction is described and illustrated. The unit ends by describing how rollers may have been used in the construction of Stonehenge in England and the Pyramids in Egypt.

In the complementary work, the children see how friction pushes a bicycle wheel forward. In the activity, the children investigate how rollers and a marble mover help to speed up movement.

9 Water resistance

Ask the children to compare walking on land with walking in water. They should answer that it is much harder to walk through the water. Ask them why they think this is, and look for an answer about the water pushing on the body. Try to relate the word ‘pushing’ with ‘resistance’, and establish the concept of water resistance. Ask the children how they could more easily move in water. Provide clues using an example such as a piece of board underwater in a swimming pool. Compare pushing the board side on as opposed to end on. Ask them why it seems easier to move the board when it is end on and look for an answer about reducing water resistance.

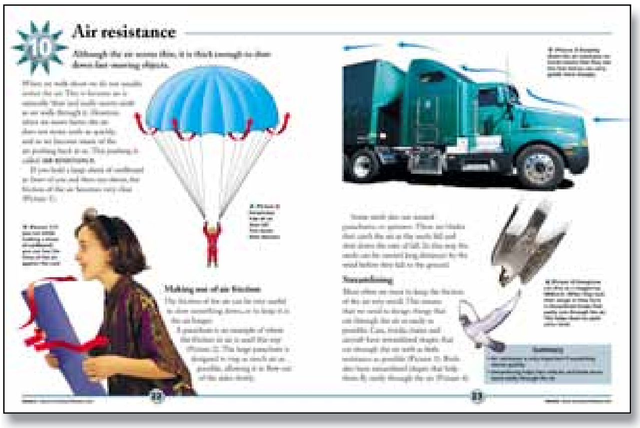


This unit begins by introducing water resistance as friction in water. This helpfully links the unit to the previous units in the book. A simple test to compare the resistance of water and syrup to a falling marble is described and illustrated. The text moves on to describe how the result of the test can be confirmed by stirring a spoon first in water and then syrup. The concept of streamlined shape is introduced and illustrated with a Viking longship and a fast swimming fish called the marlin. The unit ends by describing the use of paddles and fins to push against the water and provide propulsion.

In the complementary work, the children compare the streamlined shapes of toy boats. In the activity, the children make a range of shapes and compare how they sink through wallpaper paste.

10 Air resistance

You may like to begin by asking one child to stand up. Give the child two sheets of paper. Ask the child to screw one sheet up into a ball, then hold both pieces of paper above their head. Ask the child to let go of both sheets of paper and ask the class why the two sheets did not fall to the ground together. Look for an answer that more air was pushing on the paper with the larger surface.



This unit provides a contrast to the previous unit by describing why resistance is less when moving through air instead of liquids. A striking difference is explained – that you have to move fast before the push of air resistance takes effect, whereas when you move through a liquid you can feel its push straight away. The text then moves on to show that you can experience air resistance by running with a sheet of card. This is followed by showing how air behaves when a parachutist descends through it and by considering how some seeds are dispersed by the wind. Streamlining to aid movement through the air is considered by showing how a large truck is shaped so it can move economically at speed, and how a peregrine falcon uses streamlining to allow it to dive quickly to catch its prey.

In the complementary work, the children make a simple parachute to land a toy slowly on the ground. In the activity, the children investigate air resistance using a toy car, a ramp and a piece of card.

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 friction 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. Magnifying glasses.
2. Forcemeters.
3. Large picture of a rock climber with boots gripping a rock. A board to use as a ramp and an object, such as a block of rubber.
4. Three pieces of soap, access to a sink.
5. Shoe, ramp.
6. Oil.
7. –.
8. A pair of roller skates, roller blades or a skateboard.
9. –.
10. –.

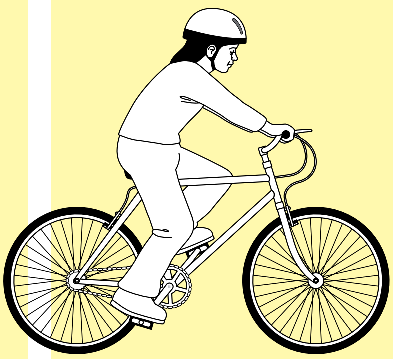
List 2 (Complementary work)

Each group will need the following items:

▼ UNIT

1. (b) Secondary sources about how friction is used to generate heat to start a fire.
2. A bicycle, to see how the brakes work.
3. A range of footwear to show how the soles and heals wear.
4. A range of clubs and bats used in sports to show how the materials used in the handles provide grip.
5. Secondary sources about avalanches and how they are controlled.
6. An object which needs oiling, a can of oil.
7. Access to a playground with a slide, wooden blocks, a range of materials to fit onto the blocks, wax, polish, stop clock (optional).
8. A bicycle.
9. Toy boats, sink, string, forcemeter (optional).
10. A piece of cloth, four pieces of string, a small toy.

▼ *Understanding how friction makes bicycle wheels go forwards in Unit 8.*



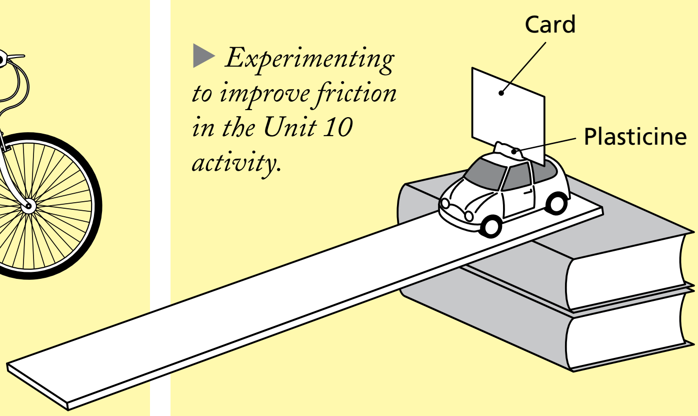
List 3 (Activity worksheets)

Each group will need the following items:

▼ UNIT

1. Escorted tour of school, access to school grounds (both optional).
2. Forcemeter, string, wood blocks, a rectangular block.
3. For introduction – a selection of mouse mats and a computer. Forcemeter, string, different kinds of carpet, corrugated cardboard, bubble wrap, cloth used to make skirts and trousers.
4. A selection of footwear all the same size, items could include Wellington boot, hiking boot, plimsoll, slipper, shoe. Forcemeter and string, or ramp and ruler.
5. A wooden block, carpet, string, forcemeter, strips of carpet, wood, card, sandpaper over which to drag the block with the carpet tied to it.
6. Three wooden boards, a wooden block, string, forcemeter, oil, syrup.
7. Three ramps – one made from highly polished wood or shiny metal, one from unpolished wood, one made from wood with sandpaper glued to it. Toy car, books or blocks, half-meter rule or meter rule, as appropriate.
8. Three or more wooden blocks, four round pencils, string, a forcemeter, a tin lid, marbles.
9. Non-allergenic wallpaper paste, two tall, clear plastic containers, a lump of Plasticine to be divided up to make small objects, ruler for measuring height of liquid (optional).
10. Toy car, books or blocks, a wooden board for a ramp, a piece of stiff card, a piece of Plasticine, metre rule or tape measure.

▶ *Experimenting to improve friction in the Unit 10 activity.*



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
- Friction is natural grip.
- Friction is caused by surfaces being rough.
- You can never make a perfectly smooth surface.

Unit 2
- Friction is a force that opposes movement.
- Friction does not depend on the amount of area in contact.
- Friction varies with the force pushing the surfaces together.

Unit 3
- The amount of friction between two surfaces depends on the materials they are made from.
- Materials with smooth surfaces have less grip.
- Materials with rough surfaces have the best grip.

Unit 4
- For a good grip, both surfaces need to be rough.
- Soft materials squash down into surfaces to give a better grip.
- The tread on tyres removes water so the tyre can grip a wet road better.

Unit 5
- There is friction between two objects that are still, and friction between objects which slide on each other.
- Friction between still objects is greater than friction between sliding objects.

Unit 6
- A lubricant is a liquid that allows two surfaces to slide more easily over each other.
- A lubricant is a thin liquid which clings to a surface and evaporates very slowly.

Unit 7
- Smooth, shiny surfaces are slippery.
- Polishes and waxes reduce friction.
- Friction on ice is reduced when the surface melts.

Unit 8
- Rolling friction is a much smaller force than sliding friction.
- Rollers are thought to have been used to move large slabs of rock in ancient times.
- Wheels reduce friction in a similar way to rollers.

Unit 9
- Water pushes on things that move through it with a force called water resistance.
- Objects which can move through water easily have streamlined shapes.

Unit 10
- When something moves through the air, a force pushes on it called air resistance.
- Air resistance can be used to slow down objects.
- Objects which move quickly and easily through the air have streamlined shapes.

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
- Make careful observations.
- Make comparisons.

Unit 2
- Use simple equipment safely.
- Construct a table and record results in it.
- Draw conclusions from results.

Unit 3
- Repeat experiments and record results in a table.
- Make comparisons.
- Draw conclusions from results.

Unit 4
- Plan a fair test.
- Carry out a fair test.
- Make a prediction.
- Compare a prediction with results.

Unit 5
- Use knowledge and understanding to plan an investigation.
- Devise a way to record results.
- Repeat experiments to test an idea.

Unit 6
- Make comparisons.
- Follow instructions.
- Use simple materials safely.

Unit 7
- Make careful measurements.
- Evaluate the results of the investigation and make suggestions for improvement.

Unit 8
- Use simple materials safely.
- Identify a pattern in results.
- Use knowledge and understanding to explain a result.

Unit 9
- Use prior knowledge in the planning of an investigation.
- Plan and carry out a fair test.
- Draw conclusions from results.

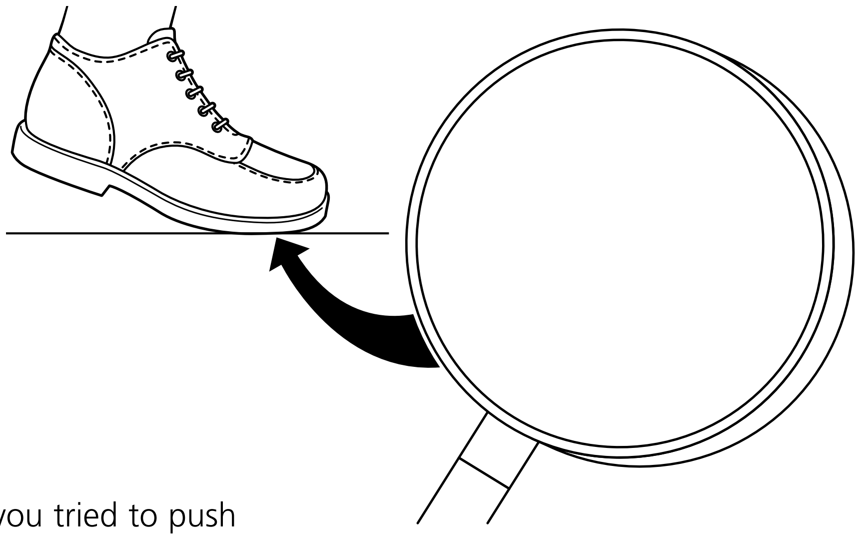
Unit 10
- Follow instructions.
- Make careful measurements.
- Repeat experiments to check the reliability of results.

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

See **pages 4 and 5** of *Friction*

What is friction?

Friction is a natural grip, or stickiness, that stops things slipping uncontrollably past one another.



Q1. In the picture, a shoe is touching the surface of the ground. In the circle, draw how the surfaces of the shoe and ground appear when highly magnified.

Q2. What would you hear if you tried to push one piece of sandpaper past another?

✎...

Q3. Why would it be impossible to handle something which was frictionless?

✎...

Q4. Why are most bicycle chains oiled?

✎...

✎...

✎...

Q5. On a bicycle, where do you need as little friction as possible?

✎...

Q6. Why must the friction between the tyres and the road be neither very high nor very low?

✎...

✎...

✎...

Teacher's sheet: comprehension

See **pages 4 and 5** of *Friction*

Answers

1. **Children should draw both shoe and ground as rough surfaces with bumps and troughs.**
2. **A gritty, tearing sound.**
3. **You could never get a grip on it.**
4. **To lower the friction between the gears and chain. This makes the chain move easily over the gears.**
5. **Between the wheel and the spindle it turns on.**
6. **If it was very high, it would be difficult to pedal. If it was very low, the tyre might slip on wet ground.**

Complementary work

(a) You may wish to develop the introductory practical in the following way. Let the children rub their hands together quickly. Ask them what they can feel, and look for an answer that implies heat. You could ask the children to press their hands together harder and rub. They should find that their hands become even warmer.

(b) The children could use secondary sources to find out how friction is used to generate heat. For example, they could find out how to start a fire by rubbing pieces of wood together.

Teaching notes

As you begin work on friction, it is important to review the children's knowledge of forces in order to set friction in context. A force is a push or a pull. You cannot see a force, but you can feel it. For example, you can feel a push or a pull on your arm. You can also see the effects of a force. For example, you can see the pushing force of the wind on the branches of a tree.

Although children do not have to study gravity, and the forces involved in floating and sinking until later, many of them are already aware of these forces. This may be helpful in introducing the concept that forces act in pairs. You could introduce this by reminding children what happens when they try to sink a bottle full of air. When they push down on the bottle, they can feel the water pushing back on the bottle. When they let the bottle go, the pushing force of the water is unopposed and the bottle rises to the surface.

The pushing force of water can then lead to the study of an object at rest on the ground. Gravity is pushing the object against the ground and the ground is pushing back on the object. If the object is pulled from the side, the opposing force, which pulls in the opposite direction is friction. As long as the friction force can match the pulling force the object does not move. When the pulling force becomes larger than the force of friction holding the object, the object begins to move. A lower frictional force then acts on the moving object.

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

Based on **pages 4 and 5** of *Friction*

A friction survey

Try this...

1. Read this:

Friction occurs where two surfaces are in contact and where one surface is sliding over another.

2. Look for places around you where surfaces are in contact. Make a list of them here.

✎...

✎...

✎...

✎...

✎...

✎...

3. Look for places where one surface is allowed to slide over another. Make a list of them here.

✎...

✎...

✎...

✎...

✎...

✎...

Looking at the results.

4. How do the two lists compare?

✎...

✎...

Teacher's sheet: activity

Based on **pages 4 and 5** of *Friction*

Introducing the activity

(a) Use this activity after the children have read pages 4 and 5 in the pupil book. Tell the children that there are forces of friction all around them, and that their task is to find these forces. If the children are not sure how to translate what they have read into the classroom situation, tell them that friction is holding them in place in their seats, and it occurs when they rub their pens on paper as they write.

Using the sheet

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

(c) Go through task 2, then let the children try it (see note (i)).

(d) Go through task 3, then let the children try it (see note (ii)).

(e) Go through task 4, then let the children try it.

Completing the activity

(f) Let the children compare their results (see note (iii)).

Conclusion

There is a huge range of places where surfaces are in contact and friction exists between them. Examples are clothes and skin, clothes and chair, shoes and floor, any object on a table, food on a plate, nail or screw in a wall, car at rest in the car park, a log on the ground.

There are also many places where surfaces slide over each other. Examples are clothes when moving, brushing shoes on a door mat, putting on clothes, washing up, washing hands, using a paint brush, going down a slide in a playground.

The list about surfaces in contact may be longer than the list about one surface sliding on another.

Teaching notes

(i) You may let the children work in the classroom, or you could escort them round the school or take them outside to look at friction in the school grounds.

(ii) You may let the children work in the classroom, or you could escort them round the school or take them outside to look at friction in the school grounds.

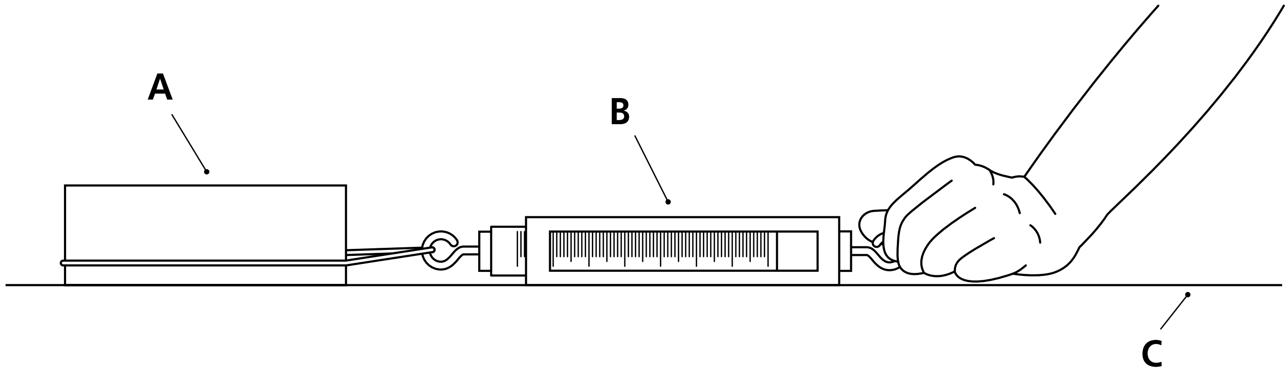
(iii) You may like the children to keep their lists and refer to them later when they are studying other aspects of friction.

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

See **pages 6 and 7** of *Friction*

The rules of friction

The amount of friction changes with the force holding two objects together, but not with the amount of area in contact.



Q1. Name the parts labelled A, B and C in the diagram.

A ✎... B ✎...

C ✎...

Q2. What is another word for a push or a pull? ✎...

Q3. (i) What is the unit called that is used to measure force?

✎...

(ii) Who is the unit named after?

✎...

Q4. If you turned A in the diagram onto its smallest side, how would the amount of area A has in contact with C change?

✎...

Q5. What could you add to the equipment in the diagram to make A push down with greater force on C?

✎...

Q6. When the force pushing two surfaces together is increased, how does the friction force between the surfaces change?

✎...

2 Teacher's sheet: comprehension

See **pages 6 and 7** of *Friction*

Answers

1. **A = block, B = forcemeter, C = table or other surface.**
2. **A force.**
3. **(i) Newton; (ii) Sir Isaac Newton, an English mathematician.**
4. **It would get smaller.**
5. **Another block.**
6. **It gets larger.**

Complementary work

You could bring a bicycle into the classroom and show the children the mechanism that pushes the brake pads hard against the wheel.

Teaching notes

The children should have studied the forces on springs earlier, and may have studied them in *3E Magnets and springs* in this series.

This unit provides a good opportunity to introduce the concept of technology. Technology can be considered as the application of scientific knowledge to solve human problems. You could use this to introduce the forcemeter in the following way. Remind the children of their work on springs and ask them what they discovered. Ask them how they could compare two pulling forces by using a spring and look for an answer about comparing the length of the stretched spring. Develop the idea by asking the children how they could use the spring to measure a range of pulls and look for the suggestion of a scale. Present the children with a forcemeter and show them how the features you have discussed have been incorporated into its design.

The rules of friction apply to clean, dry surfaces. Dirty, wet surfaces bring in other forces, such as the forces by which dirt adheres to surfaces and the way the layers of a liquid move over each other. This is far too complex for simple study, but serves to show that the study of forces is complicated and is a major part of the work of structural engineers.

2

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

Based on **pages 6 and 7** of *Friction*

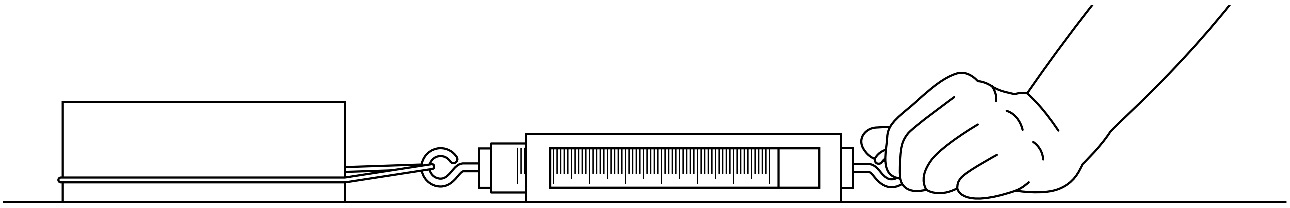
Does load and area affect friction?

Try this...

1. Read this:

The load on a surface is the force pushing down on it. You can increase the load on a block by putting more blocks on top of it.

2. Set up a block and forcemeter as the diagram shows.



3. Pull gently on the forcemeter until the block just starts to move.
Look at the force measured by the forcemeter and record it here. ✎............................

4. How does the force change if you use two, three or more blocks stacked on top of each other? Design a test to answer this question and record your results on a separate piece of paper.

5. Turn a rectangular block so that its largest surface is touching the table.

6. Pull gently on the forcemeter until the block just starts to move.
Look at the force measured by the forcemeter and record it here. ✎............................

7. Turn the rectangular block on its side so that its smallest surface is touching the table.

8. Pull gently on the forcemeter until the block just starts to move.
Look at the force measured by the forcemeter and record it here. ✎............................

Looking at the results.

9. How does friction change as you increase the load on a block?

✎..

10. How do the forces you measured in steps 6 and 8 compare?

✎..

Teacher's sheet: activity

Based on **pages 6 and 7** of *Friction*

Introducing the activity

(a) You may use this activity before the children study pages 6 and 7 in the pupil book and use the book for confirmation of their work. Alternatively, you could use the sheet after studying the unit with the whole class (see note (i)).

Using the sheet

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

(c) Go through task 2, then let the children try it.

(d) Go through task 3, then let the children try it.

(e) Go through task 4, then let the children try it (see note (ii)).

(f) Go through tasks 5 and 6, then let the children try them (see note (iii)).

(g) Go through tasks 7 and 8, then let the children try them.

(h) Let the children complete tasks 9 and 10.

Completing the activity

(i) Let the children compare their results.

Conclusion

The load does affect friction. As the load is increased, the amount of friction preventing movement increases.

The amount of area in contact does not affect the frictional resistance.

Teaching notes

(i) Another alternative would be to use this sheet and the book together for a differentiation exercise. More able pupils could use the book to help them plan and carry out an experiment, while most of the others could use this sheet. The least able could simply try to assemble the equipment as shown in the diagrams and pull the blocks.

(ii) You may ask the children to explain their plan to you orally, or to write it down on a separate piece of paper. The table should have a column headed 'Number of blocks' and a column headed 'Greatest friction force (N)'.

(iii) Remind the children that in this section of the activity they are investigating the effect of the amount of area in contact on friction.

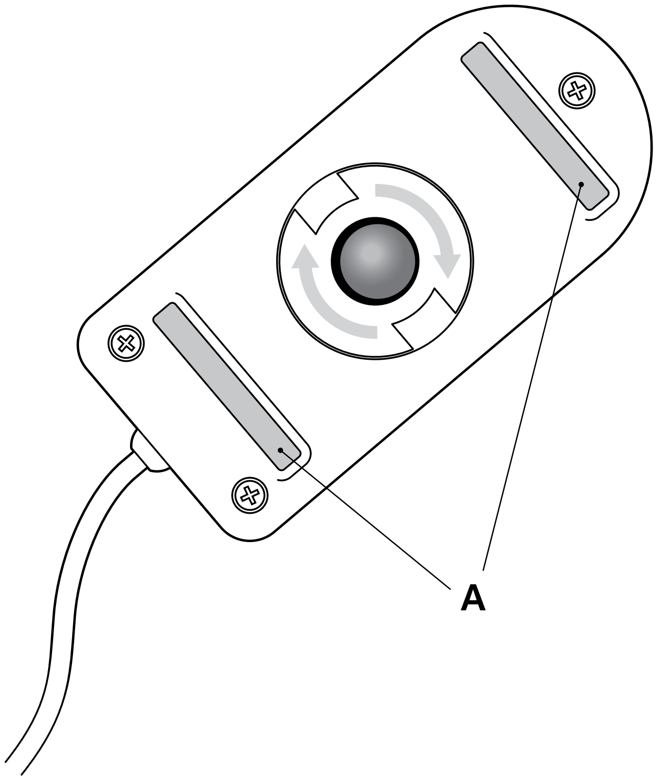
3

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

See **pages 8 and 9** of *Friction*

Which materials grip best?

Different materials grip each other by different amounts. This is what makes some materials more slippery than others.



Q1. (i) What is the object shown in the diagram?

✎...

(ii) What are the parts of the object labelled A?

✎...

(iii) What do you slide this object over?

✎...

Q2. What kind of materials grip best?

✎...

Q3. If you were to test the grip of a floor covering, what kind of object would you wrap the floor covering around – (a) a lightweight object; (b) a heavy object?

✎...

Q4. Give an example of an object you could wrap the floor covering around.

✎...

Q5. Which floor covering gives a better grip – (a) rubber or (b) plastic?

✎...

Q6. How can you change the friction between a ball and a shoe?

✎...

✎...

Teacher's sheet: comprehension

See **pages 8 and 9** of *Friction*

Answers

1. **(i) A mouse; (ii) Glides; (iii) A mouse mat.**
2. **Rough or soft, flexible materials.**
3. **(b) A heavy object.**
4. **A brick.**
5. **(a) Rubber.**
6. **Change the materials that they are made of.**

Complementary work

(a) The children could examine a range of footwear to discover the most widely used material for making soles and heels. They should discover that rubber is the most common.

(b) The children could pull a wood block over a wood surface with a forcemeter and then wrap rubber bands around the block and pull again. They should find that the block is much harder to pull when it is covered in rubber.

Teaching notes

Studies on friction allow the children to develop a range of investigative skills in a short time. During the practical work, you can reinforce this by discussing which principles of investigation they are using. For example, they could design an investigation to answer a "What if..." question, such as "What if I covered a block of wood with plastic and pulled it along the ground?"

The concept of a fair test, the need for accurate measuring and the concept of repeating experiments to establish reliable results should all be emphasised. If the children can be firmly grounded in these skills while completing this work, they could then be encouraged to apply, or discuss, these skills in other areas of the curriculum, such as in the study of materials, the body, plants and animals. In these areas of the curriculum, it is sometimes difficult to set up large numbers of tests, or measurements need to be taken over longer periods of time, so a discussion of all the skills may be more convenient than actually setting up all the experiments. The discussion can be used as part of the evaluation process, in which the children could say they could make all their results more reliable if they could repeat them, as in their studies on friction.

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

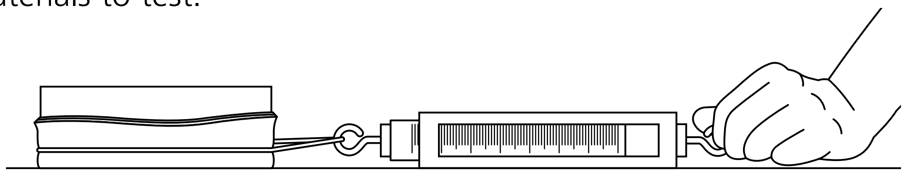
Based on **pages 8 and 9** of *Friction*

Do all materials have the same grip?

Try this...

1. Make a collection of materials to test.

2. Wrap one of the materials around a block as the diagram shows.



3. Write down the name of the first material in the 'Material' column of the table.

Material	Try 1 (N)	Try 2 (N)	Try 3 (N)	Try 4 (N)

4. Gently pull on the block until it starts to move.

5. Record the amount of force needed to make the block move in the 'Try 1' column.

6. Repeat steps 4 and 5 three more times and record your results in the 'Try 2', 'Try 3' and 'Try 4' columns.

7. Repeat steps 2 to 6 with each of the other materials in your collection. Record your results in the table.

Looking at the results.

8. Does each material need the same force each time to start it moving?

✎...

9. How do the forces needed to start the materials moving compare?

✎...

Teacher's sheet: activity

Based on **pages 8 and 9** of *Friction*

Introducing the activity

(a) Show the children a selection of mouse mats. Ask them how they could find which one is the best. Let some children try the different mouse mats at the computer. At first they may just move the mouse in a random way over the mats. Ask them how they could make their test fair. From this exercise, point out that you have to think carefully when making a scientific investigation. Tell the children that they are going to make a more thorough investigation about how different materials grip.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form, then go through task 1 and let the children try it (see note (i)).

(c) Go through task 2, then let the children try it.

(d) Go through task 3, then let the children try it.

(e) Go through tasks 4 and 5, then let the children try them.

(f) Go through task 6, then let the children try it (see note (ii)).

(g) Go through task 7, then let the children try it (see note (iii)).

(h) Go through task 8 (see note (iv)).

(i) Go through task 9, then let the children try it (see note (v)).

Completing the activity

(j) Let the children compare their results (see note (vi)).

Conclusion

Different materials grip the same surface in different ways. Some grip strongly while others only have a weak grip.

Teaching notes

(i) Let the children choose how many materials they want to test. Some may feel confident enough to test them all while some may feel more confident with just testing a few. The materials could be different kinds of carpet, corrugated cardboard, bubble wrap and materials used to make skirts and trousers.

(ii) You may like to point out here that you are making a fair test by repeating the experiment. If the children find that they obtain different results each time, they should not worry but simply record them in the table.

(iii) You may like to remind the children that they should have the same area of material in contact with the surface in each test, in order to make the test fair.

(iv) The children may like to choose a number which typifies the four results. They may use the most frequent number, or the middle value. If appropriate, you could use this exercise to introduce the concept of averages.

(v) You may like to use this exercise to introduce the children to ways of comparing data.

(vi) You may like to tell the children that when scientists perform experiments they compare them with the results of other experiments. This serves as a double check and also provides more data. The children may also discover a pattern, such as rougher materials provide a better grip.

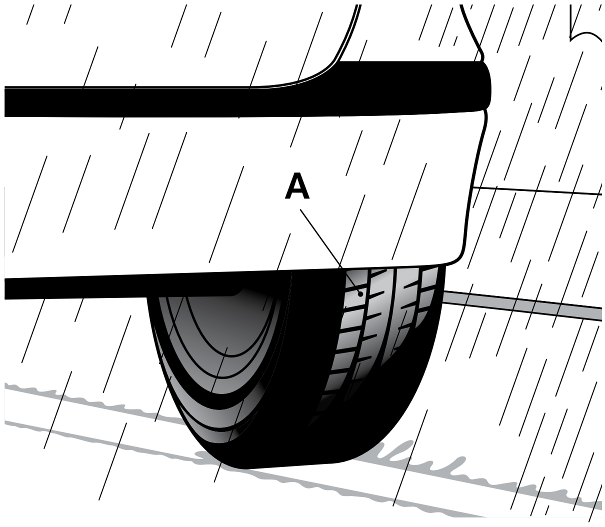
4

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

See **pages 10 and 11** of *Friction*

Where a good grip is needed

You can increase friction by using suitable materials and making surfaces rougher.



Q1. What are the zig-zag channels labelled A?

✎..

Q2. What do the channels do to the water on the road?

✎..

Q3. What could happen to a vehicle if the channels are too shallow?

✎..

Q4. (i) Why is wet soap difficult to grip?

✎..

✎..

✎..

(ii) Why can you grip soap better with rubber gloves?

✎..

✎..

✎..

Q5. (i) When are tyres often fitted with chains? ✎..

(ii) How do the chains help cars to move?

✎..

✎..

✎..

Teacher's sheet: comprehension

See **pages 10 and 11** of *Friction*

Answers

1. **Treads.**
2. **Push it out of the way.**
3. **It could aquaplane.**
4. **(i) The little troughs in the surface fill with water, so bumps in the fingers do not grip the soap so well; (ii) Rubber is a very soft material, which squashes down into the troughs and pushes the water out.**
5. **(i) In snowy and icy weather; (ii) The steel of the chains is harder than the ice and bites into it to help the tyre grip the ice.**

Complementary work

(a) The children could examine the handles on a range of sports equipment to find out about the materials and patterns used to give a good grip.

(b) Old shoes could be examined to find out which areas of the soles and heels wear down to reduce the grip.

Teaching notes

Scientists pick up ideas for experiments from other experiments they have seen. The introduction to the previous unit, and the activity in this unit, have been arranged so that some of the children may pick up on the use of the ramp in the previous unit and apply it to the investigation in this unit. If some children suggest this, point it out to the whole class that they can all get ideas for investigations from what they have learned earlier.

The tread on a tyre provides a rough surface which, in some circumstances, can provide a good grip. For example, the treads on the tyres of a mountain bike help it to grip the mud. On a flat surface, such as a road, the surface of the rubber provides the grip. The tread provides channels to remove water from wet road surfaces to allow the rubber to reach the road. This point is sometimes difficult for the children to grasp. The absence of a tread means that the water is not channelled away between the road and the tyre and so acts as a lubricant. This prevents friction between the tyre and the road, which is needed to provide movement.

As mentioned in the teaching notes in Unit 1, forces occur in pairs. The pushing force of the wheel on the road (generated by the engine) is resisted by the friction between the tyre and the road. If water on the road is not removed, the tyre loses its grip, and a skid, or aquaplaning, may occur. You may wish to discuss this in this unit and refer to it again in later units.

4

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

Based on **pages 10 and 11** of *Friction*

Testing the grip of footwear

Try this...

1. Write down the types of footwear you will test.

✎...

2. How will you make your test?

✎...

✎...

3. What equipment do you want to use to make your test?

✎...

✎...

4. How could you make the test fair?

✎...

5. Draw a table on a separate piece of paper in which to record your results.

6. Make a prediction about the results.

✎...

7. Show your teacher your plan and if it is approved, try it.

Looking at the results.

8. What do the results show?

✎...

✎...

9. How do the results compare with your prediction?

✎...

Teacher's sheet: activity

Based on **pages 10 and 11** of *Friction*

Introducing the activity

(a) Show the children a large poster of joggers and ask them how the grip of the joggers' training shoes are important. Look for answers about not letting the jogger slip, then ask the children how they could test shoes to see which gives the best grip.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form, then go through task 1 and let the children try it (see note (i)).

(c) Go through tasks 2 and 3, then let the children try them (see note (ii)).

(d) Go through task 4, then let the children try it (see note (iii)).

(e) Go through task 5, then let the children try it (see note (iv)).

(f) Go through task 6, then let the children try it.

(g) Let the children try task 7.

(h) Let the children try task 8.

(i) Let the children try task 9 (see note (v)).

Completing the activity

(j) Let the children compare their results (see note (vi)).

Conclusion

The grip of an item of footwear may be tested by placing it on a surface and pulling it with a forcemeter. It may also be tested by placing it on a ramp, raising the ramp and recording the height of the ramp at which the item began to slide.

The grip will depend on the roughness of the sole and the material from which it is made.

Teaching notes

(i) They may choose a Wellington boot, hiking boot, sports shoe, plimsoll, shoe, slipper or sandal.

(ii) Some children may wish to tie a forcemeter to each item and pull it across the same surface. Children who have seen your introduction to the previous unit may wish to raise each item on a ramp and record the height of the ramp at which the item begins to move. For both experiments, the children may like to put the same weight in each shoe.

(iii) The shoes should all be the same size. The children could provide their own shoes, or you could provide a range of shoes the same size for them to test.

(iv) The table should show that the children are going to repeat their results. The units, newtons (N) or centimetres (cm), should be shown in the column headings for each try.

(v) The children should say that there was either a good or a poor match between the prediction and the results. They should not use terms such as 'OK'.

(vi) You may like the children to present the class results using ICT. They may produce bar charts from the data.

5

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

See **pages 12 and 13** of *Friction*

Getting moving

The friction between surfaces on the move is less than the friction when they are still.

Q1. In the space, draw how you would set up the equipment to test the friction between a moving object and the surface below it.

Q2. Label the diagram you have drawn.

Q3. What are the units used to measure the force of friction? ✎...........................

Q4. Why does a car that is started and stopped many times need more fuel than one that is kept moving?

✎...

✎...

Q5. (i) How is snow held on a steep mountain side? ✎...

(ii) What may form if the snow begins to move? ✎..

Q6. Why is the force of friction on a still object more than the force of friction on a moving object?

✎...

✎...

✎...

✎...

✎...

5 Teacher's sheet: comprehension

See **pages 12 and 13** of *Friction*

Answers

1. **The diagram should have a block resting on a table. The block should be attached to a forcemeter with string. A hand could be shown holding the forcemeter.**
2. **Block, forcemeter, string, hand.**
3. **Newtons.**
4. **More force is needed to get the car moving than to keep it moving.**
5. **(i) By friction; (ii) An avalanche.**
6. **In a still object, tiny bumps on the object rest in troughs on the surface the object is resting on, so a strong force is needed to pull them out. In a moving object, the bumps are lifted out of the troughs, so the force needed to keep the object moving is less.**

Complementary work

The children can use secondary sources to find out about how people protect themselves against avalanches.

Teaching notes

It may come as a surprise to the children that there are three types of friction. The previous units have focused on the friction which holds an object in place. The correct term for this is static friction. When an object begins to move, there is still contact between the two surfaces, but the projections on the surfaces do not sink deeply into the grooves. This results in a frictional force which is less than the frictional force which held the object in place. The friction which occurs when one surface slides over another is called sliding friction. It is slightly less than static friction. In sliding friction, the objects are in contact only at their high points. When an object is rolling the friction is far less than either static or sliding friction because the projections do not have to be pulled out of the grooves, rolling simply lifts them out.

In the first unit, the point was raised about what would happen if there was no friction. At that time the discussion may have been limited to people sliding about. In this unit, it can be seen that friction also holds snowflakes together on a mountain side. When this friction is overcome by the weight of the snow mass, the snow slides away. This concept can be taken further to consider what would happen if the static friction between soil particles was lost and soil slid away.

5

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

Based on **pages 12 and 13** of *Friction*

Comparing two kinds of friction

Try this...

1. Read this.

One kind of friction holds an object in place. A second kind of friction acts when one object slides over another.

2. How could you measure the friction which holds something still?

✎..

✎..

3. How could you measure the friction which acts on something that is moving?

✎..

✎..

4. Are the still and moving friction always the same no matter what surface is used? How could you find out. Plan an investigation.

✎..

✎..

✎..

✎..

✎..

5. Make a table on a separate piece of paper to record your results.

6. Show your teacher your plan and if it is approved, try it.

Looking at the results.

7. What do the results show?

✎..

✎..

Teacher's sheet: activity

Based on **pages 12 and 13** of *Friction*

Introducing the work

(a) Use this activity after the children have studied the unit in the pupil book. Remind the children that friction is a force which holds something in place but it also occurs where one surface is sliding over another.

Tell the children that when scientists perform certain kinds of experiments, such as those related to friction, they try them out in different sets of circumstances to test their ideas. Tell the children that they are going to perform a test in different circumstances to test out an idea (see note (i)).

Using the sheet

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

(c) Go through tasks 4 to 6, then let the children try them (see note (ii)).

(d) Let the children try task 7.

Completing the activity

(e) Let the children compare their results (see note (iii)).

Conclusion

The friction which holds something in place can be measured by attaching a forcemeter to it and gently pulling the forcemeter until the object starts to move. The friction which acts on a moving object can be measured by pulling the object along and reading the scale of the forcemeter.

The static friction is always stronger than the moving friction no matter what surface the object is placed on.

Teaching notes

(i) When an investigation leads to the discovery of a relationship, such as static friction is stronger than sliding (moving) friction, the relationship is then tested in different circumstances to see if it is a general one, or one that occurs only in specific circumstances. For example, it may be found that when carpet is placed on wood, the static friction is stronger than the moving friction, but this changes when the carpet is placed on plastic. The aim of this activity is to make children think about the relationships they discover and realise that, in science, a lot of investigations are started by thinking "So we have found this relationship but what if...".

(ii) The children should suggest tying a piece of material to a wooden block, attaching a forcemeter to the block and measuring the static and moving friction on a range of different surfaces. The results may be recorded in two tables – 'Static friction' and 'Moving friction'. Each table should have a 'Material' column and four 'Try' columns with the unit N in each.

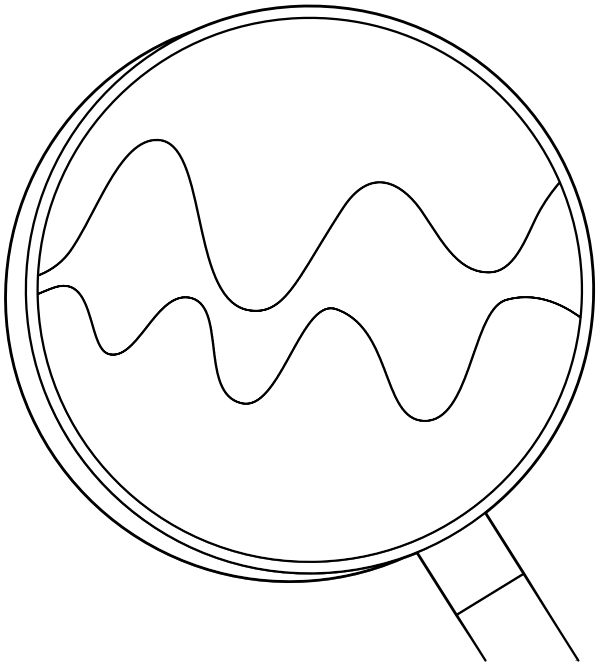
(iii) The results could be used in an ICT exercise.

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

See **pages 14 and 15** of *Friction*

Reducing friction

Friction can be lowered by adding liquids between surfaces. These liquids are called lubricants.



Q1. The diagram shows the bumps and troughs on two surfaces. Draw in how the surfaces would look after they have been oiled.

Q2. Why can a door handle be difficult to move?

✎...

✎...

Q3. When an oiled surface is turned upside down, why doesn't the oil fall off?

✎...

Q4. Why is it harder for bumps to sink into troughs on an oiled surface?

✎...

✎...

Q5. Why is oil used as a lubricant instead of syrup?

✎...

✎...

✎...

Q6. Why is oil used as a lubricant instead of water?

✎...

✎...

✎...

✎...

6 Teacher's sheet: comprehension

See **pages 14 and 15** of *Friction*

Answers

1. **Oil particles should be drawn coating the bumps and resting in the troughs.**

2. **There is a lot of friction between the working parts.**

3. **Because oil clings to most surfaces.**

4. **The oil fills in the troughs and makes it harder for the bumps to sink in.**

5. **It is thinner and flows more easily. Its layers glide much more easily over each other.**

6. **Oil sticks to itself less than water, oil evaporates much more slowly than water, oil does not combine with metals or make some metals rusty.**

Complementary work

If you can find an object which is in need of oiling, show it to the children and demonstrate how difficult it is to move the parts. Oil the object and show how oiling the parts has made them easier to move.

Teaching notes

If the children have studied book *4D Solids and liquids* in this series they will already have been introduced to the concept that solids and liquids are made from particles of matter. The word particle in this context does not refer to tiny particles such as grains of sand or specks of dust. It refers to particles which can only be seen by very powerful electron microscopes. Particles, in this sense, are made from atoms or groups of atoms called molecules. For simplicity, particles are often represented as spheres. These can be seen in the diagram of oil on page 14.

In a solid, the particles are held tightly together and cannot move. In a liquid, the particles are free to move over each other. In the evaporation process mentioned on page 15, some particles at the surface of a liquid escape into the air and form a gas.

Because it reduces friction, oil also reduces wear on surfaces which rub against each other. By reducing friction, oil also reduces the amount of heat produced when two surfaces rub against each other.

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

Based on **pages 14 and 15** of *Friction*

Looking at lubricants

Try this…

1. Make a ramp. Pour equal amounts of oil and syrup down the ramp at the same time.

2. Write down how the oil and syrup flowed down the ramp.

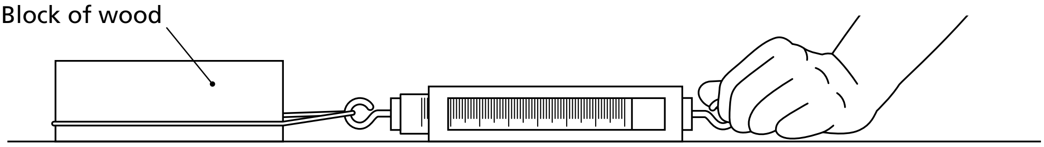
✎...

3. Use the results from step 1 to predict which liquid would be a better lubricant.

✎...

4. Take three pieces of wood. Do not pour anything on the first piece of wood, pour oil on the second and pour syrup on the third.

5. Set up a block and forcemeter on the first piece of wood as the diagram shows.



6. Gently pull the block and record the force needed to just start it moving. Record the force here. ✎............................

7. Pull the block steadily across the board and record the force that is needed to keep the block moving. Record the force here. ✎............................

8. Repeat steps 6 and 7 on each of the other two pieces of wood cleaning and drying the board between times. Record your results here.

Wood with oil: Step 6 force. ✎.......................... Step 7 force. ✎..........................

Wood with syrup: Step 6 force. ✎.......................... Step 7 force. ✎..........................

Looking at the results.

9. What do the results show?

✎...

✎...

Teacher's sheet: activity

Based on **pages 14 and 15** of *Friction*

Introducing the activity

(a) Tell the children that a lubricant is a liquid which allows surfaces to slide over each other more easily (see note (i)). If the children have done Unit 5 in *4D Solids and liquids* in this series, you may tell them that sometimes things that they learn in one area of science can have a use in other areas of science (see note (ii)).

Using the sheet

(b) Give the children the sheet, let them write their names and form on it, then go through tasks 1 and 2 with the children.

(c) Let the children try task 1 (see note (iii)).

(d) Let the children try task 2.

(e) Go through task 3, then let the children try it.

(f) Go through task 4, then let the children try it (see note (iv)).

(g) Go through tasks 5 to 7, then let the children try them.

(h) Go through task 8, then let the children try it (see note (v)).

(i) Let the children try task 9.

Completing the activity

(j) Let the children compare their results.

(k) Ask the children how the results may be more reliable, and look for the answer that each experiment should be repeated a number of times.

(l) Read about water as a lubricant on page 15 of the pupil book. Ask the children to devise a test to compare water and oil as lubricants and let them try it.

Conclusion

Syrup is less runny than oil. It is not as good a lubricant as oil.

Teaching notes

(i) You may use this activity before studying the pages in the pupil book, if you wish.

(ii) Children usually compartmentalise their knowledge and seldom use it in other contexts. This activity provides an opportunity to see how an investigation in runniness can be used to make a prediction about loss of friction.

(iii) Small amounts of the liquids should be poured down a wooden ramp. The children should find that they run at different speeds.

(iv) Make sure the children do not use too much liquid and keep their table tidy.

(v) The children only need to make one try with each lubricant at this stage.

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

See **pages 16 and 17** of *Friction*

Where slipperiness occurs

You can reduce friction by making one or both surfaces very smooth. This can be good or bad.

Q1. (i) In the space, draw a piece of playground equipment that needs to be slippery to work.

(ii) Name two materials which could be used to make this equipment.

✎.. ✎..

Q2. How does a wax or polish affect the troughs in a surface?

Q3. What happens to a wax or polish when it is rubbed?

✎...

Q4. Write down two things skiers can do to travel faster.

✎...

✎...

Q5. How does an ice skate make ice slippery?

✎...

✎...

✎...

✎...

✎...

Teacher's sheet: comprehension

See **pages 16 and 17** of *Friction*

Answers

1. **(i) The children should draw a playground slide;**
   (ii) Mirror-shiny metal and plastic.
2. **Fills them in.**
3. **It flakes easily.**
4. **Use wax on their skis, and ski over a ski-run because it is smooth.**
5. **The skate blade takes all the skater's weight and presses it on the ice. The high pressure melts some of the ice and the skater slips over a film of water.**

Complementary work

If there is a playground close by, the children could coat the bases of blocks with different materials, including waxes, and let them go down the slide. They could count, or use a stop clock, to record how fast the blocks slid, or they could let the blocks slide in pairs to work out a rank order of slippery surfaces.

Teaching notes

Sliding, or dynamic, friction provides us with an exciting but sometimes dangerous way of moving. It is exciting because of the speed of the movement. This association of sliding and moving may give the impression that this type of friction is the only one that provides movement, but this is not the case.

Most movement is due to limiting or static friction, but the way in which this provides movement is less obvious. When you take a step, your foot pushes downwards and backwards on the ground. The force pushing backwards is matched by the holding, or static, friction between your foot and the ground. When you raise your other foot, the fact that the foot on the ground is not moving allows you to move your body forwards. By comparison, when you try to walk over a slippery surface, the static friction is soon lost. It cannot provide the balancing force needed to allow you to release one foot from the ground. The sliding friction is weaker than the static friction and cannot match the force of your foot pushing backwards, so your foot moves backwards in the direction it is pushing.

When an ice skater moves on, the film of water that was created by the pressing ice skate turns back into ice. This is due to the reduction of pressure on the water.

Children may mention water chutes at swimming pools as a slippery place. Here, a slippery surface is combined with water, which acts as a lubricant to provide rapid movement.

You may use the activity in this unit to provide a link to the next unit – rolling friction.

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

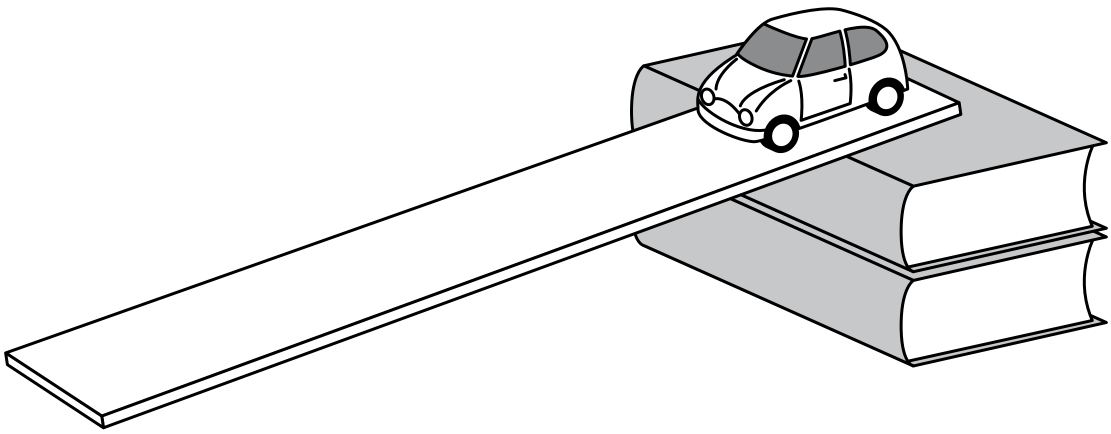
Based on **pages 16 and 17** of *Friction*

Moving over different surfaces

Try this...

1. Set up some ramps with different surfaces. At first, set the ramps so they are only a few centimetres high at one end.

2. Place a toy car at the top of one ramp, as the diagram shows, and let it go. Time how long it takes to reach the bottom of the ramp. Notice how straight the car runs and if its wheels are turning. Record your results on a separate sheet of paper.



3. Repeat step 2 with all the ramps.

4. Set up the first ramp again and raise the raised end of the ramp by a few more centimetres.

5. Repeat steps 2 and 3.

6. Set up the first ramp again and raise the raised end of the ramp by a few more centimetres.

7. Repeat steps 2 and 3.

Looking at the results.

8. What do your results show?

✎...

9. How could you make the results more reliable?

✎...

Teacher's sheet: activity

Based on **pages 16 and 17** of *Friction*

Introducing the activity

(a) Tell the children that when we walk, our feet push on the ground. A friction force between our shoes and the ground pushes back and holds our foot in place. This is what we mean by grip. Explain to the children that when someone tries to walk on an icy surface, such as frozen water on a pavement, there is little friction between the shoe and the ground, so the shoe cannot grip and the person slides around. Tell the children that the same thing happens with a wheel. It pushes on the ground, and the friction between the wheel and the ground grips the ground and allows the wheel to turn. On ice the friction is so low that the wheel spins.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form, then go through task 1 (see note (i)).

(c) Let the children try task 1.

(d) Go through task 2, then let the children try it (see note (ii)).

(e) Go through task 3, then let the children try it.

(f) Go through tasks 4 and 5, then let the children try them.

(g) Go through tasks 6 and 7, then let the children try them.

(h) Let the children try task 8.

(i) Let the children try task 9.

Completing the activity

(j) Let the children compare their results.

(k) You could let the children put water or oil on a shiny surface and see how that affects movement at all three ramp heights.

Conclusion

The car may move most quickly down the smoothest slope. It may travel in a straight line, with its wheels turning, on all but the smoothest and highest slope.

The results can be made more reliable by repeating the experiments.

Teaching notes

(i) There should be three ramps. One should be very shiny – either highly polished or shiny metal, one should be wood and the third should be covered in sandpaper. Aim to have the shiny surface so slippery, that when the ramp is set at its highest position, the car wheels do not turn and the car slides down the ramp, maybe turning as it slides.

The three height settings for the ramps could be 10cm, 20cm, and 30cm, but this will depend on the length of the ramp and how high the slippery one has to be set to make the car slide. Try this yourself before the children try it.

(ii) The children may make a table for each height setting. The table columns could be 'Ramp surface', 'Time', 'Straight direction', 'Wheels turning'. The last two columns could be filled in by writing 'yes' or 'no'.

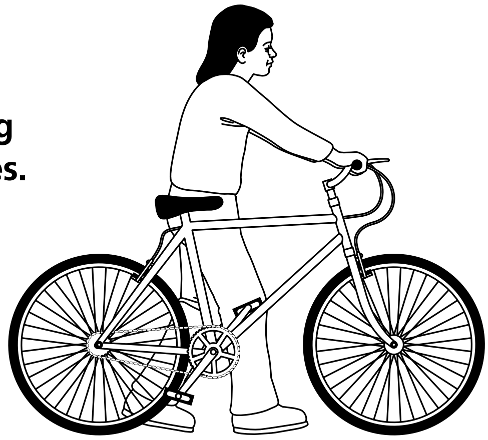
The children may use a stop watch or count quickly as a means of timing the car.

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

See **pages 18 and 19** of *Friction*

Rolling friction

The amount of friction that occurs when something rolls over a surface is far smaller than when it slides.



Q1. (i) Look at the picture. It shows a person pushing a bicycle with the brakes off. What kind of friction is occurring?

✎...

(ii) When the person puts the brakes on and pushes the bike again what kind of friction will occur?

✎...

Q2. When you use rollers instead of dragging something, do you need less than: (a) a tenth as much force; (b) a hundredth as much force; (c) a thousandth as much force?

✎...

Q3. What is the simplest roller made from?

✎...

Q4. Name two monuments which may have been made by moving stone slabs on rollers. Give the country where each monument is found.

1 ✎..

2 ✎..

Q5. How could you use a brick, a forcemeter, string and rollers to show how friction is reduced by rolling?

✎...

✎...

✎...

✎...

✎...

8 Teacher's sheet: comprehension

See **pages 18 and 19** of *Friction*

Answers

1. **(i) Rolling friction; (ii) Sliding friction.**
2. **(c) Less than a thousandth as much force.**
3. **A log from a tree.**
4. **Stonehenge – England, Pyramids – Egypt.**
5. **Tie a string around the brick and attach the string to the forcemeter. Pull the brick along a table with the forcemeter and record the force. Put rollers under the brick, pull again and record the force.**

Complementary work

The children could explore how the pushing movement on the pedals of a bicycle is transferred through the chain to the back wheel. They could first examine how the push makes the wheel turn in the air. Then they could lower the wheel to the ground and see how the friction makes the wheel roll forwards. The wheel should not be turning at great speed, so that only a slight push is experienced.

Teaching notes

When you move on roller skates, roller blades or a skateboard, you move faster, just like when you are sliding. However, the friction which occurs in rolling is not sliding friction. It is the same kind of friction, called static friction, that develops between your feet and the ground to provide the push to move you forwards when you walk.

On a wheel or ball, the speed of movement is due to the curved surface. When a wheel pushes against the ground, static friction pushes back to match it, and allows the wheel to turn. When a wheel is made to turn on a slippery surface, sliding friction occurs. This is less than the pushing force of the wheel and cannot provide a strong enough force to allow the wheel to grip. When this happens, the wheel simply spins round in a stationary position.

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

Based on **pages 18 and 19** of *Friction*

Sliding and rolling

Try this…

1. Put a block on a table and attach a forcemeter to it.

2. Pull the block along the table and record the pulling force you have to use to move it along. Record the size of the force here. ✎...............................

3. Put four, round pencils under the block.

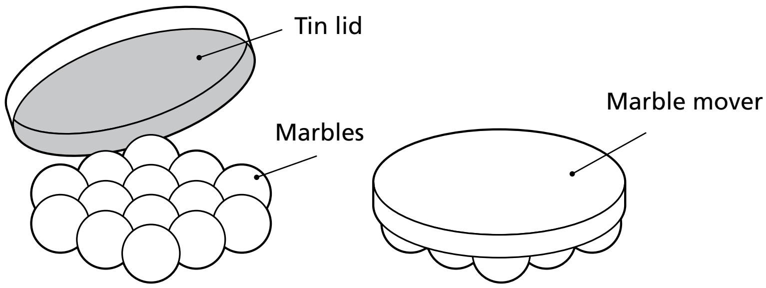
4. Pull the block along the table and record the pulling force you have to use to move it along. Record the size of the force here. ✎...............................

5. How was the force in step 2 different from the force in step 4?

✎...

6. Make a marble mover by putting marbles under a tin lid, as the diagram shows.

7. Predict what will happen when you put a block on the marble mover and pull it.



✎...

8. Pull the block on the marble mover and compare your prediction with your result.

9. What will happen to the pulling force as you add more blocks to your roller or marble mover. Make a prediction.

✎...

10. How did the pulling force change as the number of blocks increased?

✎...

11. Explain your result.

✎...

✎...

Teacher's sheet: activity

Based on **pages 18 and 19** of *Friction*

Introducing the activity

(a) If the children have tried the activity in Unit 5 you may like to remind them of how it was an example of how something can be studied in different ways. Tell the children that in this activity they are going to study rolling friction by looking at rollers and marbles (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 and 2 with the children (see note (ii)).

(c) Let the children try tasks 1 and 2.

(d) Go through tasks 3 and 4 with the children, then let the children try them.

(e) Let the children try task 5.

(f) Go through task 6, then let the children try it (see note (iii)).

(g) Go through task 7, then let the children try it.

(h) Go through task 8, then let the children try it.

(i) Go through task 9, then let the children try it.

(j) Go through tasks 10 and 11, then let the children try them (see note (iv)).

Completing the activity

(k) Let the children compare their results and the accuracies of their predictions.

Conclusion

When a block is slid along a surface, a large pulling force is needed. When rollers are used to move the block a smaller force is needed.

When a block is moved on a marble mover, a smaller pulling force is needed than when the block is slid along the surface.

When the number of blocks on the roller or marble mover is increased, the pulling force needed to move them also increases.

Teaching notes

(i) Remind the children that scientists like to study the same thing in different ways to make sure that they thoroughly understand it.

(ii) You may also like to use page 19 in the pupil book.

(iii) You may need to remind some children to use the marbles only for the tasks in this activity and not for mischief.

(iv) You may like the children to use Unit 2 in the pupils book to help them explain their result.

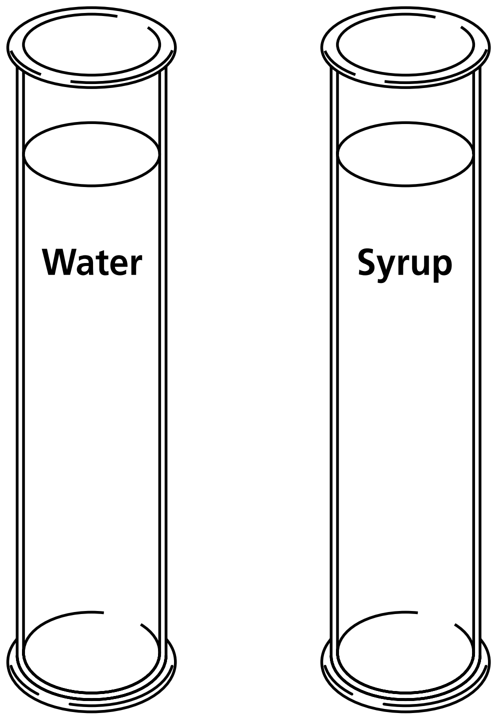
9

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

See **pages 20 and 21** of *Friction*

Water resistance

Friction in liquids, such as water, can be important. It can slow things down but it can also speed them up!



Q1. A marble is dropped into each measuring cylinder at the same time. Draw how far each one will have fallen after a moment.

Q2. Explain why you have drawn the marbles in the positions you did.

✎...

✎...

✎..

✎..

Q3. (i) What is the word that describes the shape given to a boat so that it can 'cut' through water easily?

✎..

(ii) Name a boat with this shape. ✎...

Q4. What is the name of a fish that can travel at 60km an hour through water?

✎...

Q5. What does a canoeist use to push on the water? ✎..

Q6. How does a fish swim?

✎..

✎..

✎..

✎..

Teacher's sheet: comprehension

See **pages 20 and 21** of *Friction*

Answers

1. **The marble in the water should be lower than the marble in syrup.**
2. **Syrup is thicker and stickier than water. It is harder for anything to move through it so the marble moves slower.**
3. **(i) Streamlined; (ii) Viking longship.**
4. **Marlin.**
5. **Paddle.**
6. **The fish pushes the flat of its tail and fins from side to side. They push on the water and the water pushes back to make the fish move.**

Complementary work

The children could pull toy boats across the water in a sink and compare the forces needed to move them forwards.

Teaching notes

When an object moves through water, its surface comes into contact with the water, and friction occurs between the object's surface and the water surface touching it. This force acts in the opposite direction to the pushing force of the object, and slows down the object.

Animals which need to move quickly through the water to catch prey or escape from predators have shapes which allow the water to flow over their surfaces easily. These animals have gently flowing curves, and their overall shape may be like that of a spindle or tear drop. Shapes like these reduce the push of water resistance on the body as it moves and are called streamlined shapes.

Boat hulls have a streamlined shape to reduce water resistance. Some boats have two hydrofoils attached to them. These are strong loops of metal at the front and back of the hull. As the boat moves forward, the hydrofoil lifts the hull out of the water. This reduces the area of the boat in contact with the water, and so reduces water resistance. A boat with hydrofoils is also called a hydrofoil. It can move quicker than other boats.

A hovercraft can travel over water without being slowed by water resistance. The hovercraft rides over the water on a cushion of air.

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

Based on **pages 20 and 21** of *Friction*

Looking at shapes moving through liquid

Try this…

1. Take two tall, clear plastic containers and pour water into one and wallpaper paste into the other.

2. Which liquid poured more easily?

✎...

3. Which liquid do you think will put up more resistance to objects moving through it?

✎...

4. Make two pieces of Plasticine the same size.

5. Drop one piece of Plasticine into each container at the same time and see how they fall. Write down your observation here.

✎...

✎...

6. You are going to compare how differently shaped objects fall through a liquid. The equipment and materials you will need for this investigation are: two tall clear plastic containers, a large ball of Plasticine, one of the liquids you used in step 5.

On a separate piece of paper, work out a plan to compare how differently shaped pieces of Plasticine fall through the liquid. You should use a pancake shape, a cube shape and a tear-drop shape. You can also use any other shape you can think of. You may include a diagram in your plan.

7. Show your teacher your plan and if it is approved, try it.

Looking at the results.

8. What did your results show?

✎...

✎...

Teacher's sheet: activity

Based on **pages 20 and 21** of *Friction*

Introducing the activity

(a) Ask the children if they think that all liquids behave the same way when you pour them. Look for answers that some, such as water, flow quickly while others, such as syrup or bubble bath, flow more slowly. Tell the children they are going to investigate how two liquids flow, then use this information to plan an experiment to see how differently shaped objects fall through a liquid.

Using the sheet

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

(c) Let the children try tasks 1 and 2.

(d) Go through task 3, then let the children try it (see note (ii)).

(e) Go through tasks 4 and 5, then let the children try them.

(f) Go through task 6 with the children (see note (iii)).

(g) Let the children complete task 7.

(h) Let the children complete task 8 (see note (iv)).

Completing the activity

(i) Let the children compare their results.

(j) If the children have not already made any fish shapes, let them do so now and compare how they fall.

Conclusion

Water pours more easily than wall paper paste. Wallpaper paste puts up more resistance to objects falling through it because it is thicker than water.

The sinking speed of objects can be compared by letting them fall through wallpaper paste.

A pancake-shaped object will sink slowly when its flat surface is facing down, but will sink quickly if it tips on its side. A cube may turn as it sinks. A tear-drop shape sinks faster than the other two shapes.

Teaching notes

(i) Make sure that the wallpaper paste is non-allergenic.

(ii) You may wish the children to try and explain their answer, either orally or by writing it down on the sheet. They may explain that wallpaper paste will put up more resistance because it is thicker – this is sufficient.

(iii) The children are given a list of the equipment and materials that they can use. The focus here is to see if they can relate their work in tasks 3 and 5 to the problem of observing falling objects. They should pick the thicker liquid because objects move more slowly in it, and this gives them more time to compare how they fall. All objects should be the same weight. The children do not need to produce a table for this. A report saying that one object fell faster than another is sufficient

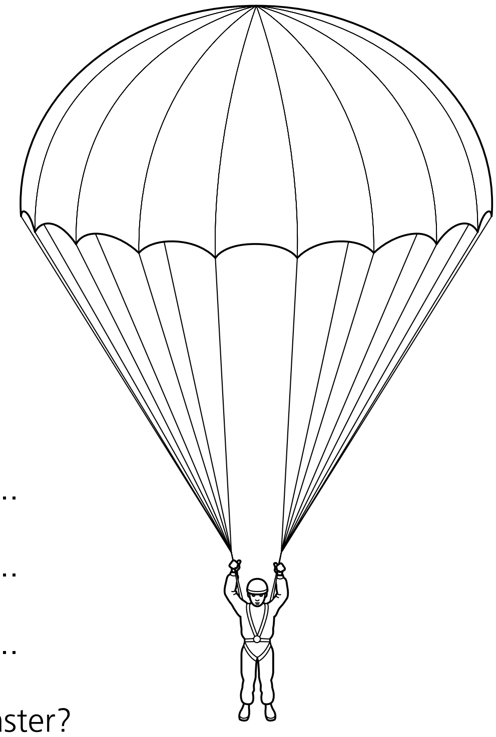
(iv) The children may place the objects in order of speed of falling, starting with the fastest.

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

See **pages 22 and 23** of *Friction*

Air resistance

Although the air seems thin, it is thick enough to slow down fast-moving objects.



Q1. (i) Draw in the path that air takes around the parachute as it falls.

(ii) How does the parachute help a parachutist?

✎...

✎...

✎...

Q2. What happens to the air around us as we move faster?

✎...

✎...

✎...

Q3. What is a spinner?

✎...

✎...

Q4. How does a streamline shape help something move through the air?

✎...

✎...

Q5. Name a bird that can dive at 440km per hour.

✎...

Q6. Why is it useful to streamline trucks?

✎...

✎...

Teacher's sheet: comprehension

See **pages 22 and 23** of *Friction*

Answers

1. **(i) The air comes from underneath the parachute and goes up;
(ii) It brings the parachutist safely to the ground by slowing down the speed of falling.**

2. **The air does not move aside fast enough, so we become aware of it pushing back.**

3. **They are blades on seeds which catch the air and slow down the rate of falling.**

4. **It 'cuts' through the air with as little resistance as possible.**

5. **Peregrine falcon.**

6. **They use less fuel and can carry goods more cheaply.**

Complementary work

The children could make a parachute out of a square piece of cloth and four pieces of string. They could attach the parachute to a small toy, throw the chute and toy up in the air and see if the toy is brought slowly back to the ground by air resistance.

Teaching notes

The children may think that air is 'nothing' and should not impede movement. You could demonstrate simply that air is 'something' by taking two balloons and balancing them on either end of a metre rule. You should then blow up one balloon and replace it on the metre rule. It will pull down the side of the metre rule, showing that it does contain 'something'. If you have talked about particles in Unit 8 you may say that the air is also made of particles, but that they can move about freely. However, when any object moves through air, the particles push on its surfaces. The power of the push only becomes noticeable when something is moving fast, or if it has a large surface pushing on the air.

Shooting stars are really pieces of rock which enter the Earth's atmosphere at high speed. The air particles rub against the rock so strongly that the friction causes the rock to become so hot that it gives out light. The space shuttle has heat resistant tiles on it so that it can enter the air from space at high speed without burning up.

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

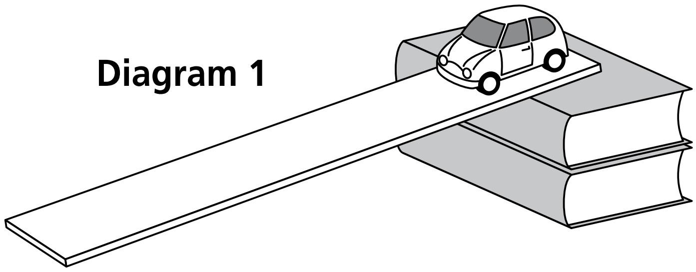
Based on **pages 22 and 23** of *Friction*

Improving friction

Try this...

1. Set up the experiment shown in Diagram 1.

Diagram 1



2. Let the car go down the ramp. Measure how far it goes across the floor? Write the distance travelled here. ✎..................................

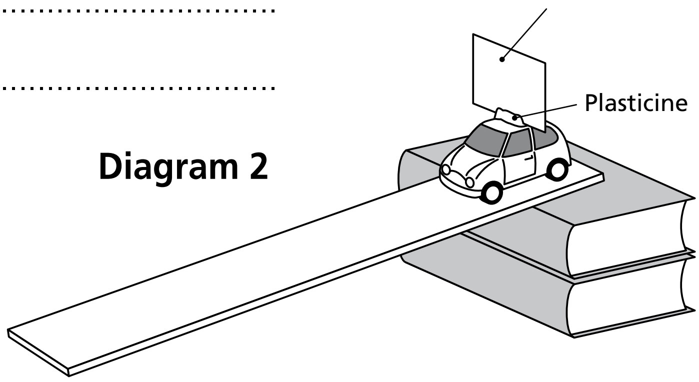
3. Will the car always travel this distance? Plan and carry out an investigation to test this idea, then write your prediction here.

✎..

✎..

4. Add a piece of stiff card to the top of the car as Diagram 2 shows.

Diagram 2



5. Predict how far down the ramp the car will travel now.

✎..

6. Plan and carry out an investigation to test your prediction.

7. How do the results of your investigation compare with your prediction?

✎..

8. Can a toy car be used to test for air resistance? Explain your answer.

✎..

✎..

✎..

✎..

Teacher's sheet: activity

Based on **pages 22 and 23** of *Friction*

Introducing the activity

(a) If the children have done the activity in Unit 7 remind them of it now and tell them that they are going to try an investigation to see if air resistance can slow down a toy car.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form, then go through task 1 (see note (i).

(c) Let the children try task 1.

(d) Go through task 2, then let the children try it (see note (ii)).

(e) Go through task 3 then let the children try it (see note (iii).

(f) Go through task 4 then let the children try it.

(g) Go through task 5 then let the children try it.

(h) Go through task 6 then let the children try it (see note (iv)).

(i) Let the children try tasks 7 and 8.

Completing the activity

(j) Let the children compare their results.

Conclusion

When testing to see how far a toy car moves across the floor, the test should be repeated several times.

When a toy car is fitted with a piece of card it does not travel as far. This is due to air resistance which pushes on the card and does not allow the car to travel so far.

Teaching notes

(i) Make sure the ramps are all facing the same way so the paths of the cars do not cross and cause collisions.

Check that all the cars to be used can travel in a straight line as some damaged ones may turn to the left or right.

(ii) Make sure the children measure the distance travelled from the bottom of the ramp to where the vehicle stops and record the unit used (eg cm).

(iii) if the children have tried some of the other activities in this book they should be thinking about repeating experiments. Some, however, may need reminding of this. From the results the middle value or the most frequent value may be used to indicate the distance travelled or if appropriate an average could be used.

You may like the children to explain their plan to you orally, or to write it down on a separate piece of paper.

(iv) You may like the children to explain their plan to you orally, or to write it down on a separate piece of paper. Their plan should have the same number of entries as the plan in task 3.

REVISION QUESTIONS

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

Q1. When you slip on a banana skin, which statement is correct?

Tick one box:

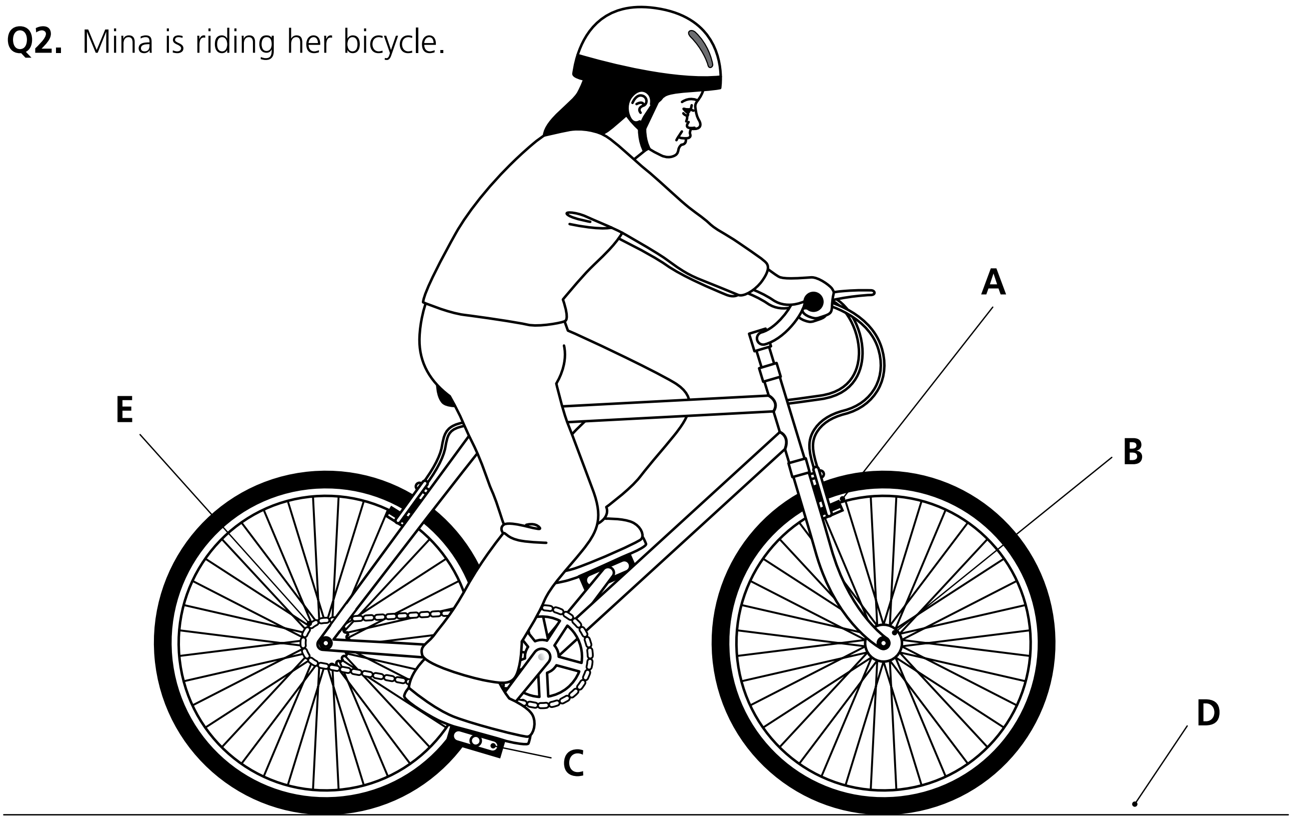
☐ The friction of the banana skin is less than that of the shoe.

☐ The friction of the banana skin is the same as that of the shoe.

☐ The friction of the banana skin is more than that of the shoe.

☐ You slip because there is no friction.

Q2. Mina is riding her bicycle.



(i) In which places does Mina need high friction? ✎..

(ii) In which place is low friction needed? ✎....................................

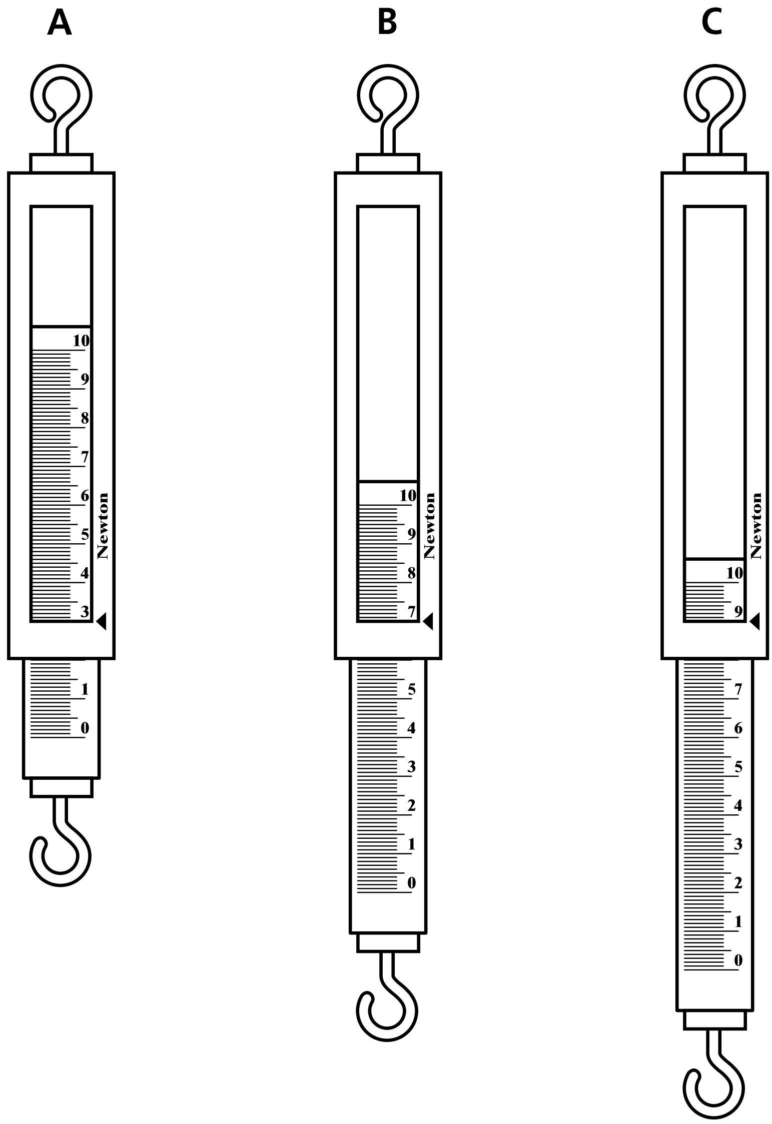
(iii) In which place is as little friction as possible needed? ✎....................................

Q3. If you looked at two touching surfaces very closely, what would you see?

✎..

✎..

Q4. Three forcemeters have objects hanging from them. The objects are pulling down on the springs in the forcemeters.



(i) What size of force is recorded by each meter?

A ✎..............................

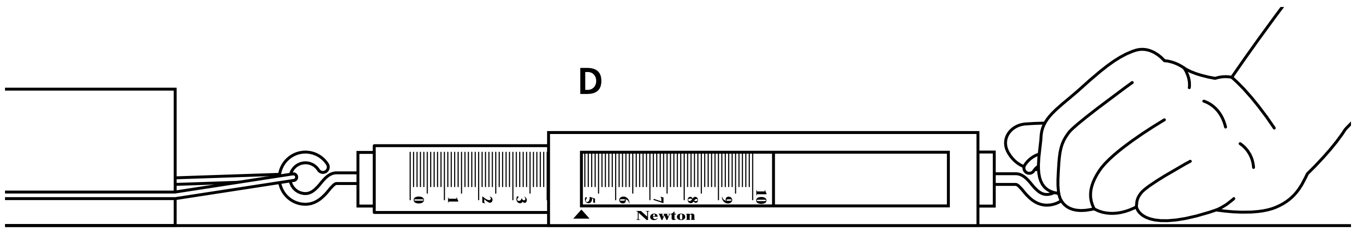
B ✎..............................

C ✎..............................

(ii) What is the difference in force between the force pulling on meter A and the force pulling on meter C?

✎.......................................

Paul is using forcemeter D to pull on a wooden block on a table.



(iii) What is the size of the pulling force shown by this meter? ✎..............................

(iv) What is the name of the force that is stopping the block from moving across the table?

✎...

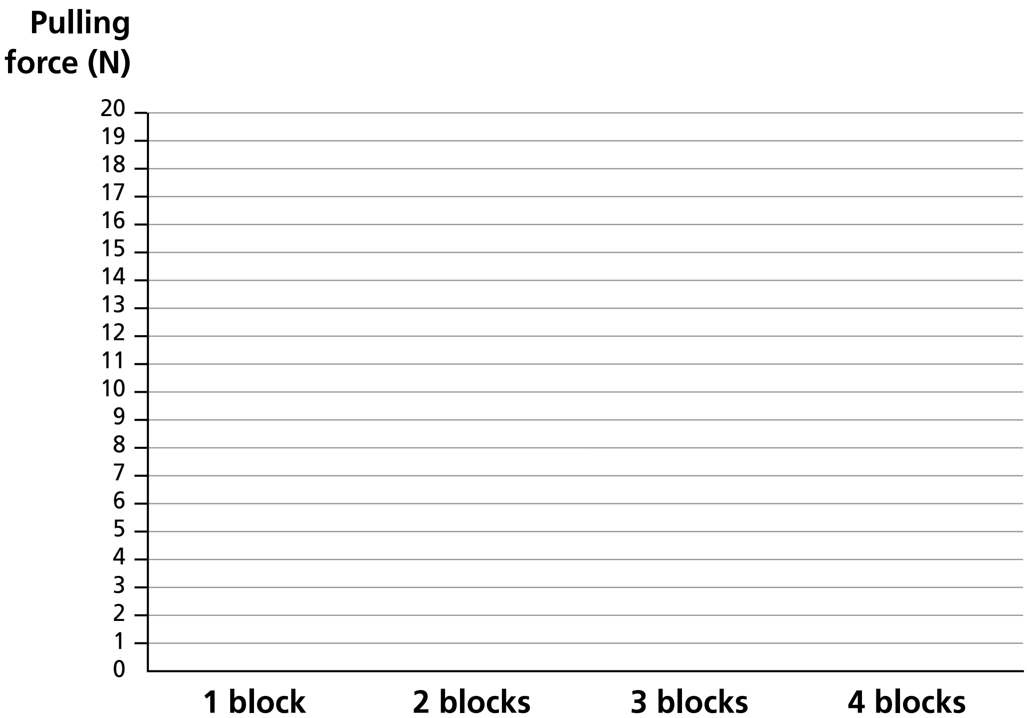
REVISION QUESTIONS

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

Q5. Jane uses a forcemeter to find out the force needed to start pulling a block across the table. She then adds more blocks and finds the force needed to start pulling the stack of blocks. Here is a table of her results.

Number of blocks	Pulling force (N)
1	4
2	8
3	12
4	16

(i) Make a bar chart of Jane's results.



(ii) How does the strength of the pulling force change as Jane adds more blocks?

✎...

✎...

(iii) Which pile of blocks was the hardest to pull? ✎...

(iv) What would happen to the pulling force if Jane took away one of the four blocks?

✎...

REVISION QUESTIONS

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

Q6. Mina pulled a block on three different surfaces. She recorded, in a table, the amount of force needed to make the block move.

Here is the table of Mina's results.

Material surface	Pulling force (N)
A	20
B	8
C	3

(i) On which surface was the block easiest to pull? ✎...............

(ii) Which surface made the spring in the forcemeter stretch the most? ✎...............

(iii) The three materials that Mina tested were polished wood, sandpaper and unpolished wood. Match each name to a letter by drawing a line between them.

Polished wood **A**

Sandpaper **B**

Unpolished wood **C**

Q7. Arif pulls on a block and records the pulling force needed to start it moving. He then continues to pull on the block to keep it moving. How did the pulling force to start moving the block compare with the pulling force to keep it moving?

Tick one box:

☐ The starting force was greater than the moving force.

☐ The moving force was greater than the starting force.

☐ The starting force and the moving force were the same.

Q8. Paul is pulling a block along a wooden board. Jane tells him the block will move faster if he puts oil on the board. Is she right? Explain your answer.

✎...

✎...

✎...

REVISION QUESTIONS

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

Q9. Jane, Paul and Mina were wearing trousers made of different materials. They went to the playground and slid down a long slide. As they slid, the children timed how long they took to reach the bottom of the slide. Here are their results:

Person	Time (secs)
Jane	4
Paul	6
Mina	3

(i) Who was wearing trousers made from the smoothest material? ✎......................

(ii) Who was wearing trousers with the roughest surface? ✎......................

(iii) Jane polished the slide. How do you think this would affect the way the children slid down it?

✎..

(iv) What happens to the friction between the children's trousers and the slide when the slide is polished?

✎..

(v) Arif wanted to ski fast down an artificial ski slope. What should he do to his skis?

✎..

Q10. Jane pulled a block along a table with a forcemeter and recorded the force needed to keep the block moving.

(i) How could she find out the force needed to pull the block when rollers are used?

✎..

✎..

(ii) What do you think Jane will find when she tries her experiment?

✎..

✎..

REVISION QUESTIONS

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

Q11. What is the name for the friction that occurs between a boat and water?

✎..

Q12. Arif wants to see how fast a lump of Plasticine sinks in wallpaper paste and in oil.

(i) Draw a shape in the box that Arif could use to make a fast-moving piece of Plasticine.

(ii) What is the name given to shapes that move quickly through water?

✎..

(iii) How could Arif perform a fair test in his investigation?

✎..

✎..

✎..

✎..

Q13. What is the name of the friction that occurs between the air and an object moving through it?

✎..

Q14. A peregrine falcon is flying slowly along. It sees a pigeon and dives quickly to try and catch it. What happens to the friction between the falcon and the air as the bird increases its speed?

✎..

Q15. Jane is sitting upright in her saddle as she pedals along on her bicycle. How should she sit if she wants to be more streamlined and travel faster? Explain your answer.

✎..

✎..

ANSWERS
REVISION QUESTIONS

1. The friction of the banana skin is less than that of the shoe. *1 mark*

2. (i) A, C. *2 marks*
(ii) E. *1 mark*
(iii) B. *1 mark*

3. Bumps and troughs that interlock. *2 marks*

4. (i) A = 3N, B = 7N, C = 9N. *3 marks*
(ii) 6N. *1 mark*
(iii) 5N. *1 mark*
(iv) Friction. *1 mark*

5. (i) Four bars drawn in the correct place and to the correct height. *4 marks*
(ii) It increases in equal increments. Two blocks double the force needed to pull one block, three blocks need treble the force and four blocks need four times the force. *2 marks*
(iii) Four blocks. *1 mark*
(iv) The pulling force would be reduced from 16N to 12N. *1 mark*

6. (i) C. *1 mark*
(ii) A. *1 mark*
(iii) Polished wood = C, sandpaper = A, unpolished wood = B. *3 marks*

7. The starting force was greater than the moving force. *1 mark*

8. Yes, she is right. The oil fills in the grooves in the wood and makes it easier for the block to slide along on top of them. *3 marks*

9. (i) Mina. *1 mark*
(ii) Paul. *1 mark*
(iii) They would slide down faster. *1 mark*
(iv) It would be reduced. *1 mark*
(v) Put wax on the underside of the skis. *1 mark*

10. (i) Put rollers under the block and pull it along the table again. *1 mark*
(ii) Much less force would be needed to pull the block when rollers are used. *1 mark*

11. Water resistance. *1 mark*

12. (i) A tear drop shape. *1 mark*
(ii) Streamlined. *1 mark*
(iii) He could fill two containers that are the same size, make two identical shapes, which are the same weight, drop them in the liquids at the same time and see which one reaches the bottom first. Alternatively, he could make just one shape, drop it in the first liquid and time how long it takes to fall, dry the object, then drop it in the second liquid and time how long it takes to fall. *4 marks*

13. Air resistance. *1 mark*

14. It increases. *1 mark*

15. If she crouches down, she will offer less surface to the air for it to push on. *2 marks*

Total marks: 48