Science@School | Book 6E

Forces in action

Teacher's Guide

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Atlantic Europe Publishing

Science@School is a series published by Atlantic Europe Publishing Company Ltd.

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The pupil book explained unit by unit

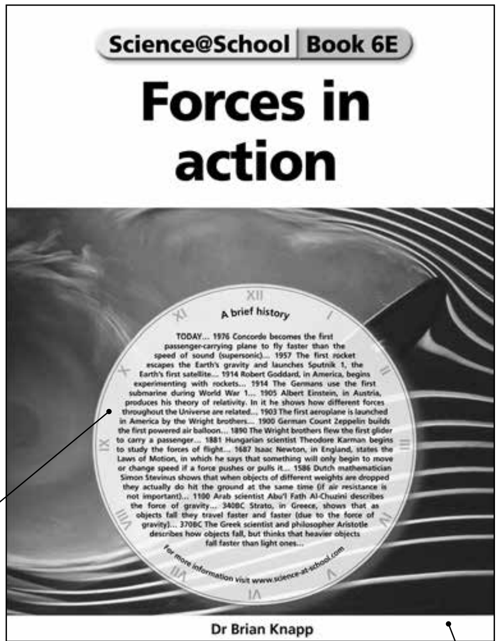
Although the pupil book – *Forces in action* – is clear and simple, a great deal of care and thought has been given to the structure and the content of each double page spread or unit. The worksheets and activities in this *Teacher's Guide* also link directly to the pages in *Forces in action*.

It is possible to use *Forces in action,* 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 12 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.

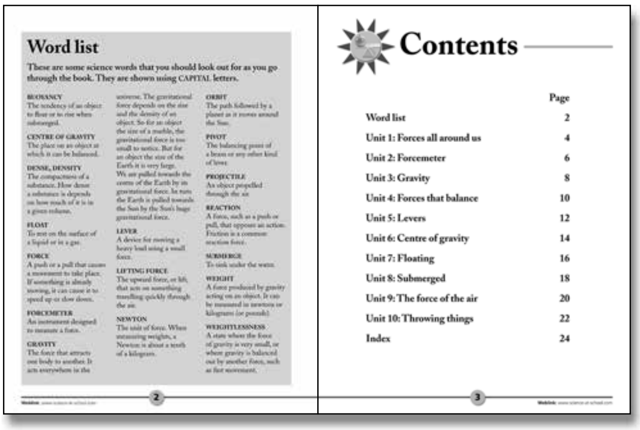
The picture shows streamlines around a model aircraft wing. The streamlines were created in smoke during a laboratory test in a wind tunnel.

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

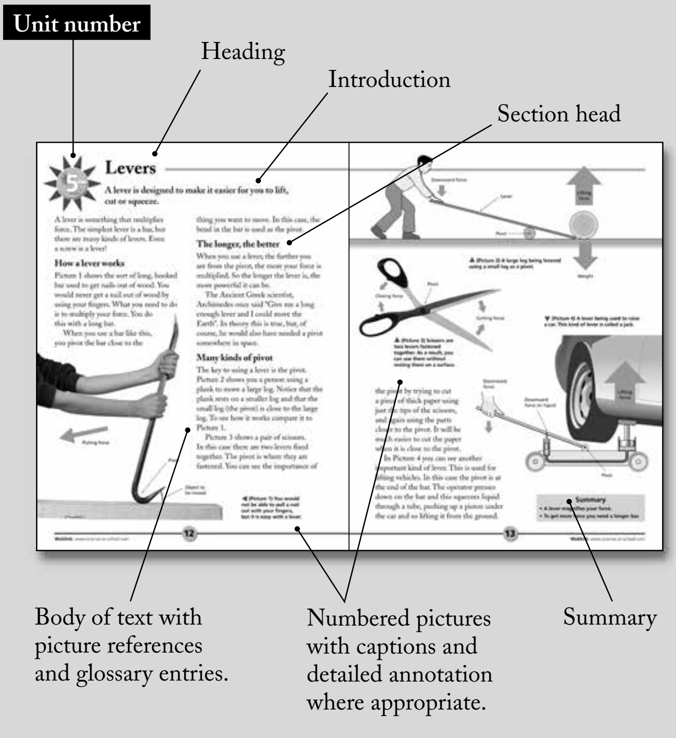
The main text of the page then follows in a straightforward, easy-to-follow, double column format.

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.

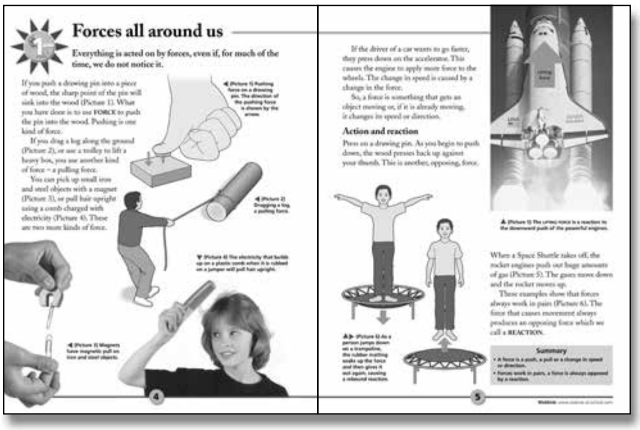
The glossary words are highlighted on the first page on which they occur. They may be highlighted again on subsequent pages if they are regarded as particularly important to that unit.

Summary

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



1 Forces all around us


Forces all around us

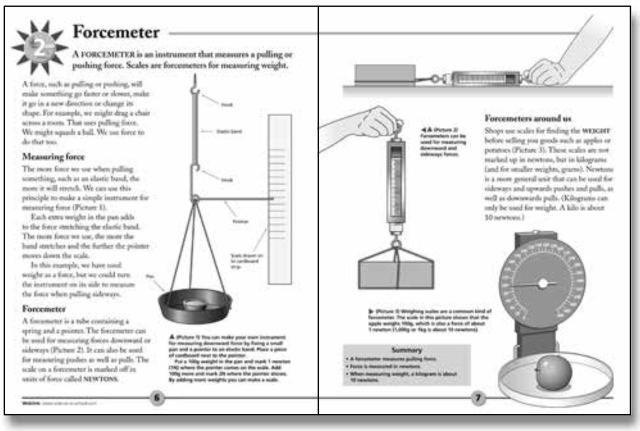
Everything is acted on by forces, even if, for much of the time, we do not notice it.

You may like to begin by blowing up a balloon, but leaving the end untied. Ask the children what would happen when you let go of the balloon. They should say that it will fly all around the room. Let the balloon go to prove them right, but remind them that this action is due to a force pushing the balloon. Ask the children for other examples of forces, and look for them mentioning friction and magnetic forces. You could finish this introduction by rubbing a sheet of polythene with a woollen cloth, then holding it above someone's head to show that static electricity can generate a force. Remind children that we cannot see forces, but we can see what they do.

The unit begins by introducing the term 'force' by reference to the simple activity of pushing in a drawing pin. This is followed by considering the pulling force used to drag a log or a trolley. The fascinating forces of magnets and static electricity are featured in support to show further examples of pushes and pulls. The notion that a force can also change the speed of something is exemplified by the use of an accelerator in a car. The unit ends by showing how forces work in pairs. This concept is built up from considering the action on a trampoline to the forces involved in launching the space shuttle.

In the complementary work, the children make a balloon rocket and send it along a string. In the activity, the children plan and carry out investigations into magnetic forces and friction.

2 Forcemeter


Forcemeter

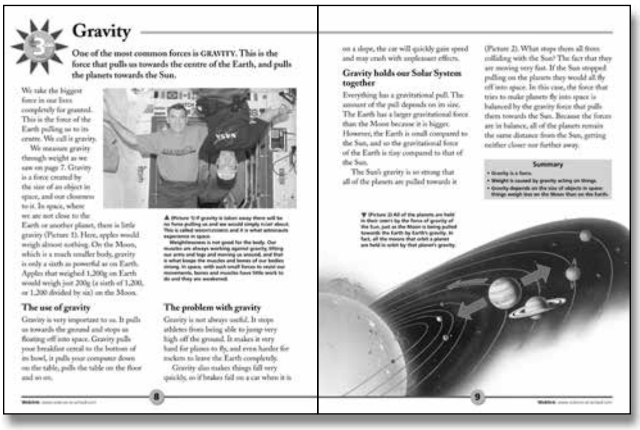
A FORCEMETER is an instrument that measures a pulling or pushing force. Scales are forcemeters for measuring weight.

You may like to begin by holding up a large elastic band. Ask the class what would happen if you added a weight to one end. Check their answers by hooking an object on the band and showing that it stretches. Show the children a slightly heavier object and ask them to predict how much this will stretch the elastic band. Try the heavier object, then ask the children to think of a way they could use the elastic band to measure forces.

This unit builds on the previous one by showing that forces can be measured. The unit begins by stating that forces not only speed things up, but are pushes and pulls which can slow things down, make them go in a new direction or even change an object's shape. The point is made that no matter what a force does, its strength can be measured by a forcemeter. A large, clear diagram of a simple forcemeter is presented, which the children can make and use. The text then moves on to describe a more complex forcemeter and the newton is introduced as the unit for measuring force. The unit ends by distinguishing between forcemeters, which measure in newtons and are used in scientific investigations, and scales used in shops to measure weight in grams and kilograms.

In the complementary work, the children make the simple forcemeter shown on page 6 and calibrate its scale by using a real forcemeter. In the activity, the children use forcemeters to measure the force needed to drag a range of objects and to open doors and drawers.

3 Gravity

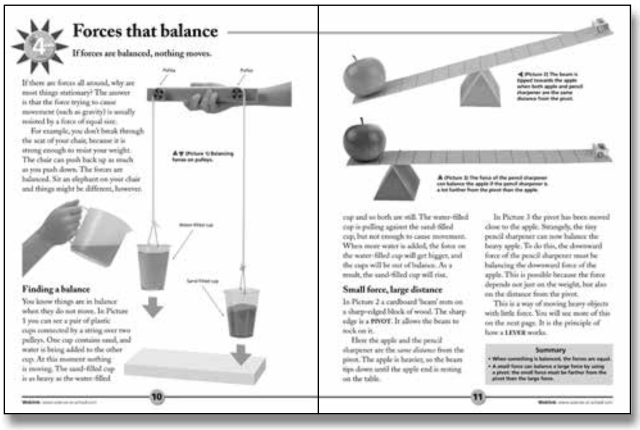


You may like to begin by asking the children if they have ever spilt coins out of their pocket and watched them go all over the floor. You may support this by letting some coins fall onto a table top. Tell the children that, like all other objects, the coins fall because of the pull of gravity. Ask the children if they think the different coins fall at the same speed, then test their ideas by asking a child to drop two different coins from the same height onto a metal tray. The children may be surprised to hear the coins land together. Tell the children that gravity pulls everything down to the centre of the Earth at the same speed.

This unit builds on the previous two by providing an in-depth look at one of the most common forces. In the introduction, the text reminds the children about the relationship between weight and gravity, and compares the weight of apples on the Earth and on the Moon. This is followed by everyday examples of gravity at work, then the text moves on to show how gravity affects movement – especially the flight of aeroplanes and spacecraft. The unit ends by considering how gravity plays a central role in holding planets around the Sun. The concept of balanced forces is introduced, to describe the movements of the planets in the Solar System, in readiness for further study of balanced forces in the next unit.

In the complementary work, the children find out about Galileo's studies on gravity. In the activity, the children investigate weight and look for a pattern in their results.

4 Forces that balance

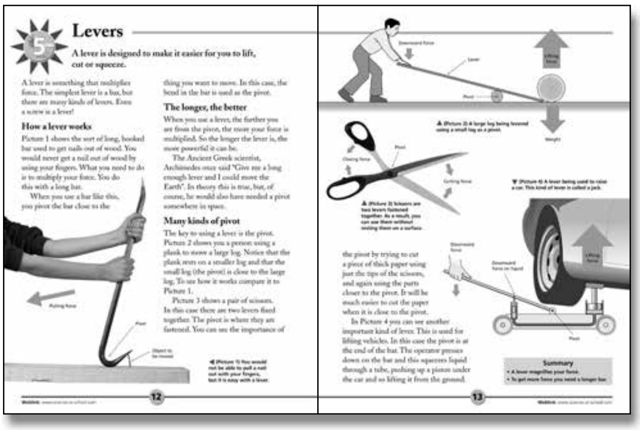


You may like to begin by asking two children who are about the same size and strength to come to the front of the class. Give them a short piece of rope and tell them that you would like them to start a tug of war. Before they get too enthusiastic about pulling each other, ask them to pull steadily on the rope so that neither moves. Tell the class that, although neither of the tuggers is moving, it does not mean that there are no forces acting on their bodies. Ask the children what they think would happen if you cut the rope, and look for the answer that the two children would fall down. Tell the children that, while they are watching the tug of war, there are forces at work holding their bodies in place.

The unit begins by asking the intriguing question, "If there are forces all around why are most things stationary?" The answer given is that the force trying to cause movement is balanced by another force. This concept is explained by reference to a person and an elephant sitting on a chair. A large, clear illustration of a device for balancing a cup of water and a cup of sand is presented to reinforce the concept of balancing forces. The unit ends by considering how an apple and a pencil sharpener can be made to balance on a simple see-saw. This work lays the foundations for the study of levers in the next unit, and the study of centre of gravity in Unit 6.

In the complementary work, the children examine the forces at work on a simple balance. In the activity, the children investigate balancing forces which hold objects in place.

5 Levers

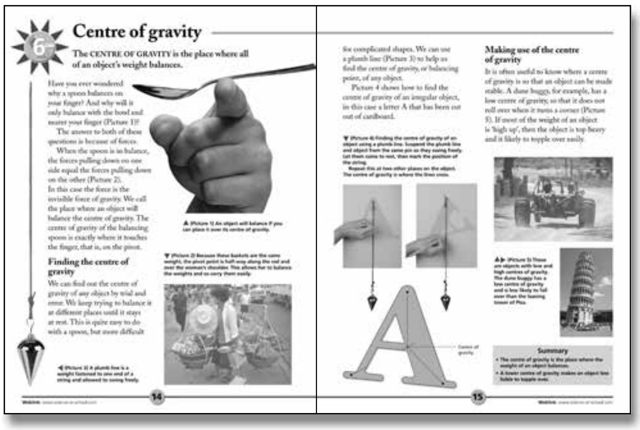


You may like to begin by trying to get the lid off a tin by using your fingers. You can make much of how difficult it is to pull the lid off, and ask the class for suggestions for easier ways to raise the lid. Look for a suggestion about putting a knife under the lip of the lid, and produce a strong screwdriver to do the job. Remove the lid using the screwdriver as a lever, then point out to the class how the lid was moved easily by a small force after all the pulling with a large force had been unsuccessful. Tell the class that the reason for this difference is that you used the screwdriver as a lever and a lever is a force multiplier – it makes a small force large.

This unit builds on the previous one by showing how the way objects balance on a see-saw can be adapted to produce a force multiplier called a lever. The way a lever works is explained by reference to a clear illustration showing how a bent bar can be used to easily pull nails out of wood. The importance of lever length is reinforced with a quotation from Aristotle – a scientist from ancient Greece. A clear diagram shows the forces involved when a lever is used to raise a log. The unit ends by explaining how a pair of scissors are really two levers fixed together, and how a car can be jacked up by using a lever.

In the complementary work, the children find out about levers in the wheelbarrow and the arm. In the activity, the children make a simple investigation on levers and use their findings to plan and carry out a more complicated experiment using a forcemeter.

6 Centre of gravity

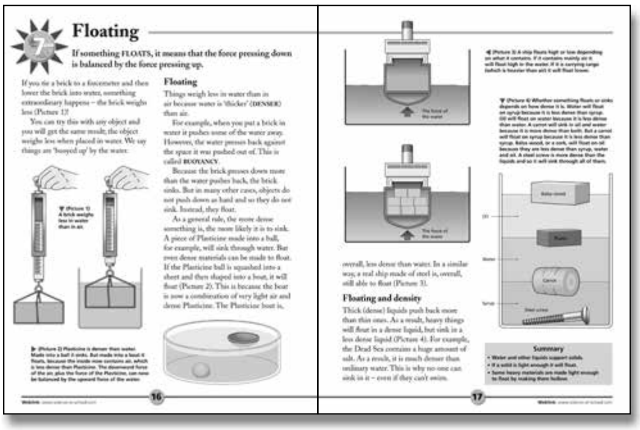


You could begin by asking the children to take a pen or pencil and try and balance it horizontally on a finger. Some children may take some time to get their pencil or pen to balance, so after a short time move them on to talk about what they did to try and make the object balance. Look for answers in which the force pulling down on one side is the same as the force pulling down on the other. Show the children an empty matchbox and place it so it overhangs the table. Push it gently, so that when more than half hangs off the table it falls. Now repeat this with a second matchbox in which you have taped a coin inside, at one end. The children should be surprised to see the box overhang quite a way without falling. Ask them to suggest how your trick is done.

This unit can be used directly after Unit 4, if you wish to provide another way of looking at balancing forces. The unit opens by considering how a spoon can balance on your finger. The observation is made that, for the spoon to balance, the bowl must be close to your finger. This builds on the action seen in the see-saw in Unit 4, but the concept of balance is taken further by introducing centre of gravity. A simple method for finding the centre of gravity, using a plumb line, is described and illustrated. The unit ends by considering how the weight of an object at its centre of gravity affects the ease with which it may topple over.

In the complementary work, the children find out how tightrope walkers keep their balance, and how buses remain stable. In the activity, the children use bottles to investigate the position of the centre of gravity, and the ease with which an object falls over.

7 Floating

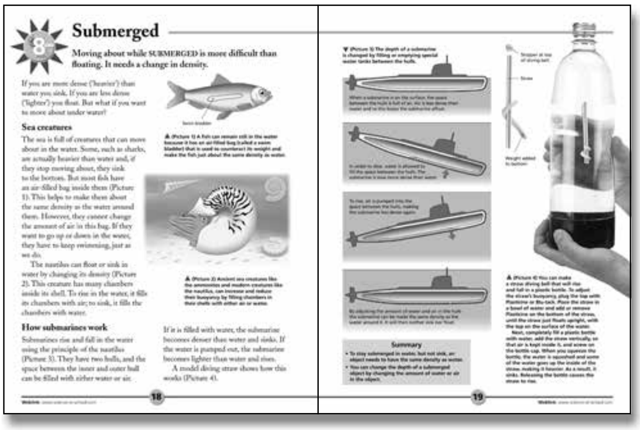


You may like to begin by asking the children how they can make themselves float in a swimming pool. When the children have shared their experiences, ask them about how they felt the water push on them. Show the children a football, and put it in a bucket of water. Ask a child to push down on the ball and explain how it feels. Ask the class to predict what will happen when the child lets go of the ball. Look for an answer about the ball being pushed back to the surface, then let the child release the ball. The children should realise that water pushes on objects that are placed in it.

This unit brings together some of the work introduced in the previous units. It opens by showing a forcemeter being used to measure the weight of a brick in air and in water. The concept of balancing forces is revisited by considering how the weight of an object in water may be balanced by the force of water pushing on it. When the forces balance in this way, the object floats. The reason why a ball of Plasticine sinks while the same weight of Plasticine made into a hollow shape floats, is explained and illustrated. The relationship between the amount of cargo on a ship and the way the ship floats is explored and the unit ends by looking at how the density of a liquid affects the things that float in it. This is supported by a clear illustration showing how different liquids float on each other, and how different objects float in the different liquids.

In the complementary work, the children find out how lifeboats keep afloat. In the activity, the children compare the weights of objects in air and water.

8 Submerged



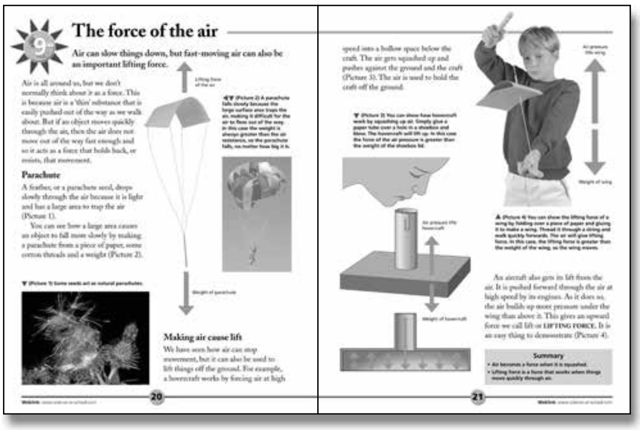
If you used the football in the introduction to the previous unit, you may like to show the children an air-filled balloon and ask them what might happen if you put it in water. They should answer that it will float. You could then push the balloon underwater and let it pop up to demonstrate the point. Now ask the children what would happen if the balloon was full of water. Some children may say that it will sink. Ask how many children agree. Fill a balloon with water and put it in a tank. The balloon should float underwater between the surface and the floor of the tank. Tell the children that the balloon is submerged but not completely sunk.

This unit builds on the previous unit by considering how things rise and sink in the water. The unit opens by asking a question about how something can move in the water without floating on top or sinking to the ocean floor. The question is first addressed to living things, where it is revealed that many fish have a balloon-like organ, which controls their density. Ancient sea creatures, related to squids, and their present day relative are shown to be able to rise and sink in the water, while the mechanism for diving and raising a submarine are thoroughly described in words and pictures. The unit ends by showing the children how they can make their own simple submarine in a large plastic bottle.

In the complementary work, the children use secondary sources to find out about deep ocean exploration. In the activity, the children make and operate a model submarine.

9 The force of the air

You could begin by taking the class outside and asking a child to run a certain distance while a second child times them. When the child has completed the run, ask him or her to try it again, but this time carrying a large sheet of cardboard in front of them. The second time should be longer than the first. Ask the children how we can make the test more accurate, and look for an answer about repeating it. Now ask two other pairs of children to try the test. They should show similar results. Check that the difference is not due to the weight of the card by having the children run with a small object that is the same weight as the card. Ask the children for their explanations, and look for an answer about the force of the push of the air.


The force of the air

Air can slow things down, but fast-moving air can also be an important lifting force.

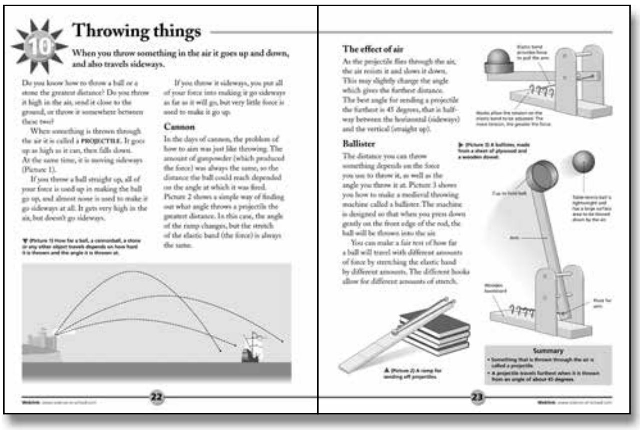
20 21

This unit builds on the previous one by showing how forces act on objects moving through the air. The unit opens by considering air as a 'thin' substance, compared to water. It then moves on to make the point that the effect of the force of air is seen when an object moves quickly through it. The role of the parachute in trapping air is described. The text then moves on to explain how a hovercraft works. This is supported by a diagram, which the children can use to make and test their own hovercraft. The unit ends by considering how a wing provides a lifting force.

In the complementary work, the children investigate the effects of holes in parachutes. In the activity, the children make a spinner and investigate how it falls through the air.

10 Throwing things

You may like to begin by taking the class outside and asking the children to arrange themselves in pairs. Give each pair a ball and ask them to stand about a metre apart. Ask the children to throw the ball to each other and take a step back after each throw. Ask them to keep doing this until you tell them to stop. Let the children get some distance from each other so that they have to throw the ball quite high in the air for it to reach their partners. Ask the children how they changed the way they threw the ball as they moved further apart, and look for an answer about throwing the ball higher to make it go further.


Throwing things

When you throw something in the air it goes up and down, and also travels sideways.

22 23

This unit follows the previous one by exploring how objects move through the air. The term 'projectile' is introduced, and an extensive study is made on how a cannonball travels when it is shot out of a cannon at different angles. The children are reminded about the importance of air resistance, and it is revealed that a cannon set at an angle of 45° will send a projectile the furthest. The unit ends with a written and illustrated account of a medieval throwing machine called a ballister. The photographs of a model of this device can be used to help the children make one, and instructions are given on how it may be used to make a fair test.

In the complementary work, the children find out how objects are thrown in sports. In the activity, the children test the power of elastic bands to throw small paper projectiles into the air.

Index

There is an index on page 24.

Using the pupil book and photocopiable worksheets

Introduction

There is a wealth of material to support the topic of forces in action 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, 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 12 and 13.

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 List 1 on page 11). 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.

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.

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 for these comprehension worksheets 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 13. 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. 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. Balloon, piece of polythene (cut from a carrier bag), woollen cloth.
2. Large elastic band, small object to hook on the band, larger object to hook on the band.
3. Coins, a metal tray.
4. A piece of rope.
5. A tin with a lid that is difficult to prise open, a tough screwdriver.
6. An empty matchbox, a matchbox with a coin taped inside, at one end, so the box can be hung a long way over a table without falling.
7. A football, a tank or a sink of water.
8. An air-filled balloon, a water-filled balloon, a tank or sink.
9. Access to an outside play area, a large piece of card, a small object which weighs the same as the card, a stopwatch.
10. Access to an outside play area, a ball for each pair of children.

List 2 (Complementary work)

Each group will need the following items:

▼ UNIT

1. A sausage-shaped balloon, a straw, sticky tape, a long piece of string, a place to tie one end of the string.
2. Materials for making the simple forcemeter shown on page 6 of the pupil book, a forcemeter which can measure up to 10N, a range of lightweight objects.
3. Secondary sources about Galileo's studies on gravity.
4. Coat hanger, two yoghurt pots, marbles or sand, forcemeter.
5. Secondary sources about the pivot and about forces acting in a wheelbarrow and on the arm.
6. (a) Secondary sources about how tightrope walkers keep their balance.
7. Secondary sources about how lifeboats keep afloat in stormy seas.
8. Secondary sources about how vessels exploring the ocean depths work.
9. Materials for making parachute canopies, cotton thread, weights which are all the same size, sticky tape.
10. Secondary sources about how the javelin, shot put, baseball and cricket ball are thrown.

List 3 (Activity worksheets)

Each group will need the following items:

▼ UNIT

1. Two magnets of different strengths, paperclips, card, scissors, a piece of carpet, cork table mat, rubber mat, ceramic tile, plank, ruler.
2. A range of forcemeters, a pencil case, string, access to doors and drawers.
3. A selection of small objects, a forcemeter, scales or a balance, graph paper.
4. An elastic band, a small object, an open coiled spring (like the ones used to make mattresses), a larger object, a box, a book, ruler, magnet, sticky tape, paperclip, thread, lump of Plasticine.
5. A ruler or similar piece of wood, a wooden block, a roll of Plasticine or a piece of chalk, a forcemeter.
6. A selection of bottles with their tops, card, scissors, plumb line, protractor or ramp with rough surface.
7. A selection of objects which do not float – some small, some large, a forcemeter, a tank or sink. You may like to wrap the objects in a polythene bag to keep them dry (optional).
8. A washing-up liquid bottle with two holes in it (you can make the holes, or the children can do it, depending on their ability and attitude), four coins, sticky tape, a piece of plastic tube, a piece of Plasticine, a tank or sink.
9. Piece of paper, ruler, scissors, paperclips, suitable equipment on which to stand to test the spinner.
10. A piece of wood with two nails driven into it as shown in the diagram on page 56. Elastic bands, paper kitchen towel for making projectiles, ruler, half metre or metre rule, eye protection if stipulated by school policy.

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

- A force is a push or a pull.
- A force can change the speed of an object.
- Forces work in pairs.

Unit 2

- A forcemeter is used to measure the strength of a force.
- The strength of a force is measured in newtons.
- Weight is measured in kilograms and grams.

Unit 3

- Weight is caused by the force of gravity.
- Everything has a gravitational pull.
- The gravitational pull of an object depends on its size.

Unit 4

- More than one force acts upon an object.
- The forces acting on an object may be balanced or unbalanced.
- If the forces are balanced, the object may remain stationary.

Unit 5

- A lever is a device which magnifies a force.
- A long lever is more powerful than a short lever.

Unit 6

- The centre of gravity is the place where the weight of an object balances.
- An object with a low centre of gravity is less liable to topple.
- An object with a high centre of gravity is more liable to topple.

Unit 7

- Water and other liquids push on objects that are immersed in them.
- A lightweight solid or liquid may float on a heavier liquid.
- When a heavy material is made into a hollow object it may float.

Unit 8

- If an object is submerged, but not sunk, its density matches the density of water.
- Some living things have ways of staying submerged.
- The diving and raising of a submarine is made possible by controlling the amount of water in the submarine's hull.

Unit 9

- A force called air resistance is generated when an object moves quickly through the air.
- Squashed air can exert a force.
- A wing moving quickly through the air generates a lifting force.

Unit 10

- The path of a projectile depends on the angle at which it is thrown into the air.
- An angle of 45° will send a projectile the greatest distance.
- A projectile may be launched from a device like a cannon or a ballister.

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
- Plan an investigation.
- Make a fair test.
- Draw conclusions from results.

Unit 2
- Use simple equipment safely.
- Construct a table and fill it in.
- Make comparisons in data.

Unit 3
- Construct a bar chart from data in a table.
- Interpret results.
- Identify a pattern in the results.

Unit 4
- Follow instructions.
- Assemble an experiment from a diagram.
- Represent forces on a diagram.

Unit 5
- Use previous knowledge to help plan an investigation.
- Make accurate measurements.
- Identify a pattern in the data.

Unit 6
- Secondary sources in carrying out a procedure.
- Make comparisons.
- Plan and carry out an investigation.

Unit 7
- Use simple equipment safely.
- Make observations.
- Record observations in written form.

Unit 8
- Make a survey.
- Interpret results.
- Draw conclusions from results.

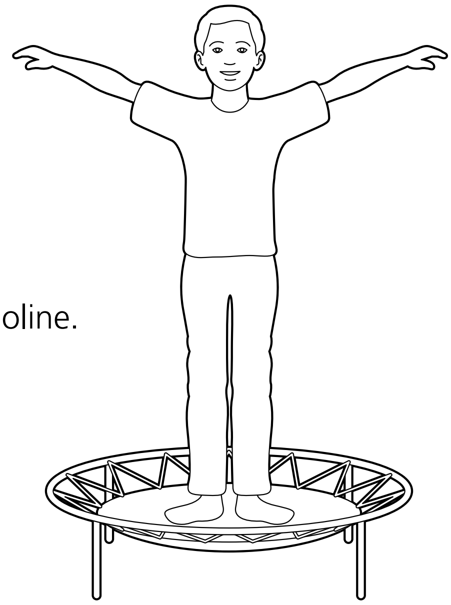
Unit 9
- Make a prediction and test it.
- Repeat measurements to investigate more thoroughly.
- Identify a pattern in the data.

Unit 10
- Plan and carry out a fair test.
- Devise safety procedures for use in an investigation.
- Draw conclusions from results.

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

See **pages 4 and 5** of *Forces in action*

Forces all around us



Everything is acted on by forces, even if, for much of the time, we do not notice it.

Q1. In the picture a person is jumping down on a trampoline.

(i) In the space below, draw a picture showing what happens a few moments later.

(ii) Draw an arrow in each picture showing the direction of the force on the person.

Q2. What kind of force is used to drive a drawing pin into a piece of wood?

✎...

Q3. What kind of force is used to drag a log along the ground?

✎...

Q4. Name two other kinds of force.

✎...

✎...

Q5. When a car driver presses on the accelerator:

(i) What does the engine do?

✎...

(ii) What happens to the car? ✎...

Q6. How does a space shuttle rise from the launch pad?

✎...

✎...

✎...

✎...

1 Teacher’s sheet: comprehension

See **pages 4 and 5** of *Forces in action*

Answers

1. **(i) A person should be rising from the trampoline. The trampoline sheet should be convex; (ii) An arrow below the person should point down in the top picture; an arrow below the person should point up in the bottom picture.**

2. **A pushing force.**

3. **A pulling force.**

4. **A force made by a magnet. A force made by electricity.**

5. **(i) Applies more force to the wheels; (ii) It goes faster/changes speed.**

6. **The rocket engine pushes a huge amount of gas downwards, and a reaction force lifts the space shuttle upwards.**

Complementary work

The children could inflate a sausage-shaped balloon, tape a straw lengthways along its top, thread a string through the straw, tie one end of the string to a door handle, pull the string tight and let the balloon go to see how the reaction force to the escaping air pushed the balloon forwards.

Teaching notes

You may like to remind the children that forces are pushes and pulls. You could perhaps begin by relating forces to their own body, and say that probably the first force they are aware of in the morning is the force exerted by muscles which open their eyes. You may then mention other muscles which pull on bones to get them out of bed.

A force cannot be seen, but the effects of a force can be seen and felt. For example, the force of the wind can be seen moving the trees, and felt pressing against our bodies.

Some forces are called contact forces. They are exerted by one object touching another. The pushing force of the thumb on the pin is an example. Friction is a contact force that the children should have studied in some detail earlier in their science course.

Some forces do not have to make contact to produce an effect. The magnetic force, electrostatic force and gravity are examples of non-contact forces. The region in which these forces work is called a force field. For example, if you put a magnet under a piece of card and sprinkle iron filings on top of the card, the filings will line up between the ends of the magnet. These lines are called lines of force and they show the extent of the force field around the magnet, called the magnetic field.

When something exerts a force, a similar force is always generated in the opposite direction. For example, when you lean against a wall, you exert a force on the wall and, at the same time, the wall pushes back on you. If it didn’t, you would fall over.

The force of the gases rushing out at the back of a rocket are balanced by a force which pushes the rocket forwards. The rocket *does not* move by the gases pushing on the air as some people believe. In space there is no air, yet the rocket engines of spacecraft still push the spacecraft along.

1

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

Based on **pages 4 and 5** of *Forces in action*

Investigating force

Try this...

1. Collect two magnets, some paperclips, a piece of card and some scissors.

2. Plan an investigation to use two tests to compare the strength of magnets.
Write down your plan here.

✎..

✎..

✎..

✎..

✎..

3. Show your teacher your plan. If your teacher approves, try your investigation.

4. What did your investigation show?

✎..

5. Collect a piece of carpet, rubber mat, cork table mat, ceramic tile, a plank and a ruler.

6. Plan an investigation to compare how slippery the carpet and the two mats are.

✎..

✎..

✎..

✎..

✎..

7. Show your teacher your plan. If your teacher approves, try your investigation.

8. What did your investigation show?

✎..

Teacher's sheet: activity

Based on **pages 4 and 5** of *Forces in action*

Introducing the activity

(a) Use this activity after the children have read pages 4 and 5 in the pupil book. Remind the children about any work they have done in previous years on magnets and friction, and tell them that they are to use this knowledge to plan and carry out some investigations.

Using the sheet

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

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

(d) Let the children try tasks 3 and 4 (see note (ii)).

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

(f) Let the children try task 6 (see note (iii)).

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

Completing the activity

(h) Let the children compare their results.

(i) If the children have all used the same materials in the second investigation, they may like to pool their results using ICT (see note (iv)).

Conclusion

The strength of a magnet may be found by hanging paperclips from its ends, or by finding the thickness of cardboard through which the magnetic forces act. The slipperiness of a surface can be found by placing the surface on a ramp and finding the height of the ramp needed to make the surface slide.

Teaching notes

(i) The plan should show two ways in which the strength of a magnet can be tested. In one part of the plan, the strength can be tested by finding out how many paperclips will hang from each end of each magnet. In the other part of the plan, the card should be cut up and pieces of card placed between the end of a magnet and a paperclip, until the paperclip is no longer held in place.

Some plans may show tables with columns labelled magnet, north pole and south pole, and indicate how many paperclips or how many cards were used at each end of each magnet.

(ii) This should be a written statement and may refer to tables constructed in the plan and filled in during the investigation.

(iii) See if the children can relate the term 'slippery' to friction, but if they do not, remind them of the link. The plan should show similarly sized pieces of material placed, in turn, at one end of the plank, and that the end is raised to form a ramp. The height of one end of the ramp is increased until the material begins to slide. When this height is reached it is measured with a ruler. A table may be produced with the column headings – 'Material sliding' and 'Height (cm)'.

(iv) You may like to remind children that whenever a scientific investigation is being made, many tests are performed and their results are gathered to try and find a pattern in the data.

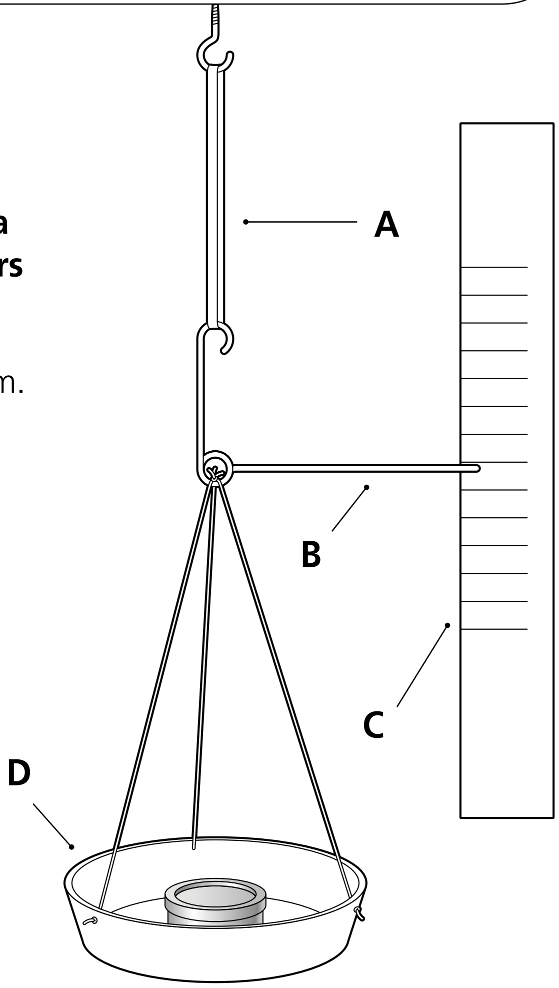
2

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

See **pages 6 and 7** of *Forces in action*

Forcemeter

A forcemeter is an instrument that measures a pulling or pushing force. Scales are forcemeters for measuring weight.



Q1. Name the parts labelled A to D in the diagram.

A ✎..

B ✎..

C ✎..

D ✎..

Q2. When a larger weight is placed in D:

(i) What happens to A?

✎..

(ii) What happens to B?

✎..

Q3. How can a pushing or pulling force affect something?

✎..

Q4. How is a forcemeter different from the equipment shown in the diagram?

✎..

Q5. What are the units on the scale of a forcemeter? ✎..

Q6. How can you use a forcemeter to measure the force needed to pull a brick sideways?

✎..

✎..

✎..

✎..

✎..

Teacher's sheet: comprehension

See **pages 6 and 7** of *Forces in action*

Answers

1. **A = elastic band, B = pointer, C = scale, D = pan.**
2. **(i) It stretches; (ii) It points to a place lower down the scale.**
3. **Force can make an object go faster, slower, go in a new direction or change its shape.**
4. **A forcemeter is a tube containing a spring and pointer.**
5. **Newtons.**
6. **Rest the brick on a table, put a string round it, hook the forcemeter to the string and pull the forcemeter. When the brick starts to move, look at the position of the pointer on the scale.**

Complementary work

The children could make a simple forcemeter as shown on page 6, then calibrate the scale in the following way. With an empty pan, mark the position of the pointer on the scale with a line and label this zero. They could then find the weight of a small object using a commercial forcemeter, then put the object in the pan of their forcemeter and record the new position of the pointer, marking the value in newtons taken from the forcemeter. They could then repeat this task with different objects to construct a scale which measures in newtons.

Teaching notes

There is a problem with the use of the word weight. In everyday language it is used to indicate a quantity of something, but in science, weight is a force. The term used in science to indicate a quantity of something is mass. It is a measure of the amount of matter in a substance. Weight is really a measure of the force of gravity on mass. Since most of us are only concerned with weight on Earth, we use the word weight to indicate mass. The scale for measuring mass is based on a unit called the gram (g). It is not a unit of force. So when you see something which is labelled – weight 10g – this is actually incorrect, it should say – mass 10g. You may wish to draw this to the children's attention, or some children may point out this confusion.

Children may also ask how grams are different from newtons. You may answer in the following way. All systems of measuring (such as for time and length) have to have units which can be used by everyone. The units are obtained by using something as a standard. For mass the standard is a lump of metal (an alloy of platinum and iridium) kept in a special room. This lump is the standard kilogram – it has a mass of exactly one kilogram. All other masses are compared with this one.

By comparison, a newton is the force needed to accelerate (or speed up) a mass of one kilogram at the rate of one metre per second per second.

You may find it useful to teach the next unit straight after this one to consolidate the children's ideas about weight and mass.

2

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

Based on **pages 6 and 7** of *Forces in action*

Using a forcemeter

Try this...

1. Use a forcemeter to find out the force needed to drag a pencil case across a table.

Record your result here. ✎..

2. Think of other things that you could pull along a table or the floor. Make a table with the headings – ‘Object’, ‘Predicted force (N)’ and ‘Actual force (N)’.

3. Fill in the table as you make your tests.

4. What do your results show?

✎..

5. Find out the forces needed to open doors and drawers. Record your results here.

6. What do your results show?

✎..

2

Teacher's sheet: activity

Based on **pages 6 and 7** of *Forces in action*

Introducing the activity

(a) Use this activity after the children have studied pages 6 and 7 in the pupil book. Show the children a number of different forcemeters and tell the children that each one is designed to measure a range of forces. Some measure small forces, and others measure larger forces. Tell the children that they may use different forcemeters to measure forces of greatly differing strengths (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 (see note (ii)).

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

(d) Go through tasks 2 and 3 (see note (iv)).

(e) Let the children try tasks 2 and 3.

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

(g) Go through tasks 5 and 6, then let the children try them.

Completing the activity

(h) Let the children compare their results.

Conclusion

A small object, such as a pencil case, may only need a small force to make it move, while a large object, like a school bag, may need a large force (see note (v)).

The force needed to open a door depends on the stiffness of the joints and weight of the door. The force needed to open a drawer depends on the amount of friction between the drawer and its support.

Teaching notes

(i) A forcemeter should have a device on it to prevent the spring being pulled too much, but make sure that the children get used to selecting forcemeters for appropriate strengths.

(ii) The children should have done some work on friction at an earlier stage in which string was tied around a block. They may need reminding of this now so that they can use the technique to test the pencil case and the other objects they choose in task 2.

(iii) Make sure the children have used N to signify the units in their answer.

(iv) The children may list the items they are to test in the first column. They should not list all their predictions at once. They should make each prediction after each test as the result of the previous test may help them to improve the accuracy of their predictions.

(v) Some children may note that the force needed to drag the object along is less than the force needed to get it moving. This is due to the two kinds of friction – holding, or static, friction (the stronger force) and sliding friction (the weaker force).

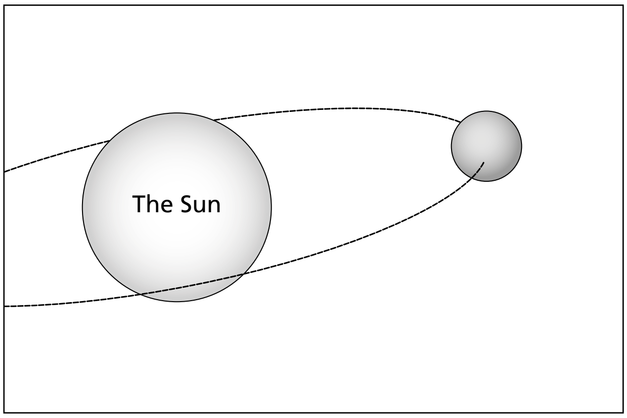
3

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

See **pages 8 and 9** of *Forces in action*

Gravity

One of the most common forces is gravity. This is the force that pulls us towards the centre of the Earth, and pulls the planets towards the Sun.



Q1. The diagram shows the planet Jupiter in its orbit around the Sun. Draw in arrows to show the forces acting on Jupiter.

Q2. (i) Which has the larger gravitational force – the Sun or the Earth? ✎..................

(ii) Explain your answer.

✎...

Q3. (i) How does the weight of an apple change when you move it from the Earth to the Moon?

✎...

(ii) Explain your answer. ✎...

✎...

Q4. Name three things that gravity pulls down to the Earth.

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

Q5. How does gravity create problems?

✎...

✎...

Q6. If you were an astronaut, how would your health change if you were in space for a long time? Explain your answer.

✎...

✎...

✎...

✎...

Teacher's sheet: comprehension

See **pages 8 and 9** of *Forces in action*

Answers

1. **One arrow pointing towards the Sun, one arrow pointing along the orbit, one arrow pointing away from the Sun.**

2. **(i) The Sun; (ii) It is larger than the Earth.**

3. **(i) The weight becomes six times smaller; (ii) Gravity on the Moon is only a sixth as powerful as gravity on the Earth.**

4. **People, breakfast cereal, computer, table.**

5. **It stops athletes jumping very high. It makes it hard for planes and rockets to fly and can make things fall quickly.**

6. **Muscles and bones would become weak. Gravity is strong on the ground and muscles and bones stay strong by working against it. In space, gravity is weaker, so muscles and bones do not have to work as hard and become weaker.**

Complementary work

The children can use secondary sources to find out about Galileo's studies on gravity.

Teaching notes

You may wish to teach this unit straight after the previous one, in order to consolidate the children's ideas about weight.

The mass of an object is the amount of matter it contains. This does not change if an object is moved from the Earth to the Moon, or anywhere else in space. The units of mass are grams and kilograms. The mass of an object is found by using scales, or a balance, calibrated to read in grams. This calibration has been made by comparing the pull or push of a spring with the standard mass mentioned on page 25.

Weight is the pulling force of gravity on an object. The unit of weight is the newton. The weight of an object can be found by using a forcemeter. This device has a scale which measures in newtons.

It seems obvious that when two objects of different weights fall to the ground, the heavier weight will fall faster than the lighter weight. But this does not happen, for the following reason. The force of gravity acts on all objects exactly the same. Two objects that are the same shape, but which weigh different amounts, will fall at exactly the same speed. Of course, on Earth, the air can slow an object down. That is why, on Earth, objects which can trap air – a feather, a parachute – do fall more slowly than objects which do not trap air – like a book, or a person.

3

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

Based on **pages 8 and 9** of *Forces in action*

Investigating weight

Try this...

1. Select eight objects.

2. Hang each one, in turn, from a forcemeter to find the object's weight.

3. Make a table and record your results in it.

4. Make a bar chart showing the weights of the objects. Arrange the objects in order of weight, starting with the object with the smallest weight.

5. Find the mass of each object using scales or a balance.

6. Make a table and record your results in it.

7. Make a bar chart showing the masses of the objects. Arrange the objects in order of mass, starting with the object with the smallest mass.

Looking at the results.

8. What do the results show?

✎...

Teacher's sheet: activity

Based on **pages 8 and 9** of *Forces in action*

Introducing the activity

(a) If you do not wish to introduce the concept of mass, simply carry out the first four steps of the activity (see note (i)). The activity in Unit 2 should be done before the children try this activity. Before you start remind the children of how a forcemeter works.

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 (ii)).

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

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

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

(f) Explain to the children that all objects have a certain amount of matter in them, and this is recorded by the units called grams and kilograms. Scales and balances are used to find mass. When a scale is used, you are comparing the mass of the object with a standard mass of a piece of special metal which is kept in a laboratory.

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

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

(i) Let the children try task 8.

Completing the activity

(j) Let the children compare their results.

Conclusion

Small objects generally have a smaller weight than larger objects. A heavy object has a greater weight than an object which feels less heavy.

As the mass of an object increases, so does its weight.

Teaching notes

(i) You could then relate the graph to features of the objects, such as the length or colour, and decide that these do not affect the weight. You could then let the children feel each object and link weight to the feeling of heaviness.

(ii) The objects should have a weight which the forcemeters can cope with. For example, if the forcemeter only records weights up to 10N, small objects must be selected.

(iii) Tell the children that they may like to make their table before they measure the weights. The table should have two columns, headed 'Object' and 'Weight (N)'.

(iv) Give the children a sheet of graph paper and let them choose the size to make their chart. The chart should be as large as possible for accuracy.

(v) Tell the children that they may like to make their table before they measure the masses. The table should have two columns, headed 'Object' and 'Mass (g)'.

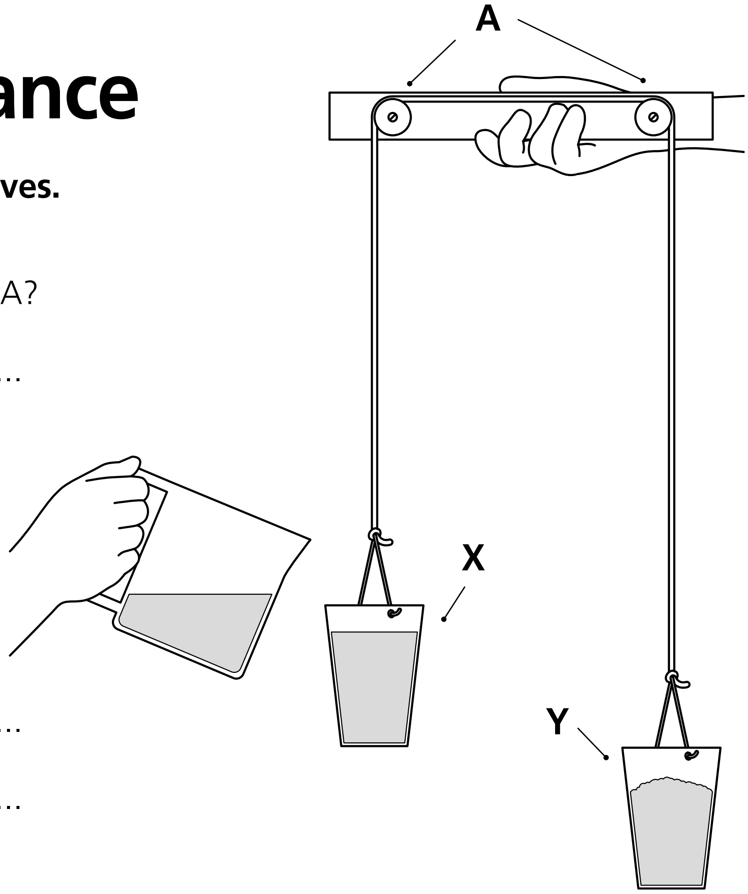
4

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

See **pages 10 and 11** of *Forces in action*

Forces that balance

If forces are balanced, nothing moves.



Q1. (i) What are the objects labelled A?

✎...

(ii) The two cups are not moving. Draw arrows to show the forces acting on them.

(iii) What will happen if more sand is added to cup Y?

✎...

✎...

(iv) Explain your answer.

✎...

✎...

Q2. Why don’t you sink through your chair when you sit down?

✎..

✎..

Q3. What is a pivot? ✎...

Q4. If an apple and a pencil sharpener are on opposite arms of a see-saw, and at the same distance from the pivot, which way does the see-saw tip?

✎..

Q5. How can the pencil sharpener be made to balance the apple on the see-saw?

✎..

✎..

✎..

4 Teacher's sheet: comprehension

See **pages 10 and 11** of *Forces in action*

Answers

1. **(i) Pulleys; (ii) There should be an arrow pointing down from each cup. The arrows should be the same size; (iii) Cup Y will go down and cup X will go up; (iv) The downward force acting on cup Y is now bigger than the downward force acting on cup X.**

2. **The chair pushes back with as much force as you push down.**

3. **A sharp-edged block of wood (or the balancing point of a beam or lever).**

4. **The arm carrying the apple tips down.**

5. **The apple should be moved close to the pivot and the pencil sharpener should be moved further away.**

Complementary work

The children could hang up a coat hanger and suspend a yogurt pot from each end. They could add objects to both pots until they balance. One pot can then be removed and its weight can be found by using a forcemeter. From the reading, they could then predict the weight acting on the second pot. The children can then test their prediction by finding the weight of the second pot using the forcemeter. They should find that both pots have the same weight.

Teaching notes

Force is usually associated with movement, but can also be associated with still objects. The basic particles of matter are held together by forces. For example, the particles (atoms) in a solid are held firmly together by forces which act between the atoms. In liquids, forces hold the particles together but also allow them to slide over each other. In a gas there are no forces which hold the particles together. The ways that forces act on substances can be taken further by realising that the inside of the atom is made from even smaller particles, and these are also held together by forces. One of these particles is the electron. This is held in place by electrostatic forces similar to the one that makes combed hair stand up.

Children may think that no force is at work when an object is at rest, so it may need pointing out that forces are acting all the time. The reason an object does not sink into a solid surface is due to the forces which hold the particles together and give the surface strength to push back against the weight of the object. This is an example of forces acting in pairs. The force of the object's weight is opposed by the force of the surface pushing back. If the force pushing back was weaker than the weight (as when an object lands in quicksand), movement occurs and the object sinks down.

4

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

Based on **pages 10 and 11** of *Forces in action*

Identifying force

Try this...

1. What happens to (a) an elastic band and (b) a coiled spring if you hang weights from them?

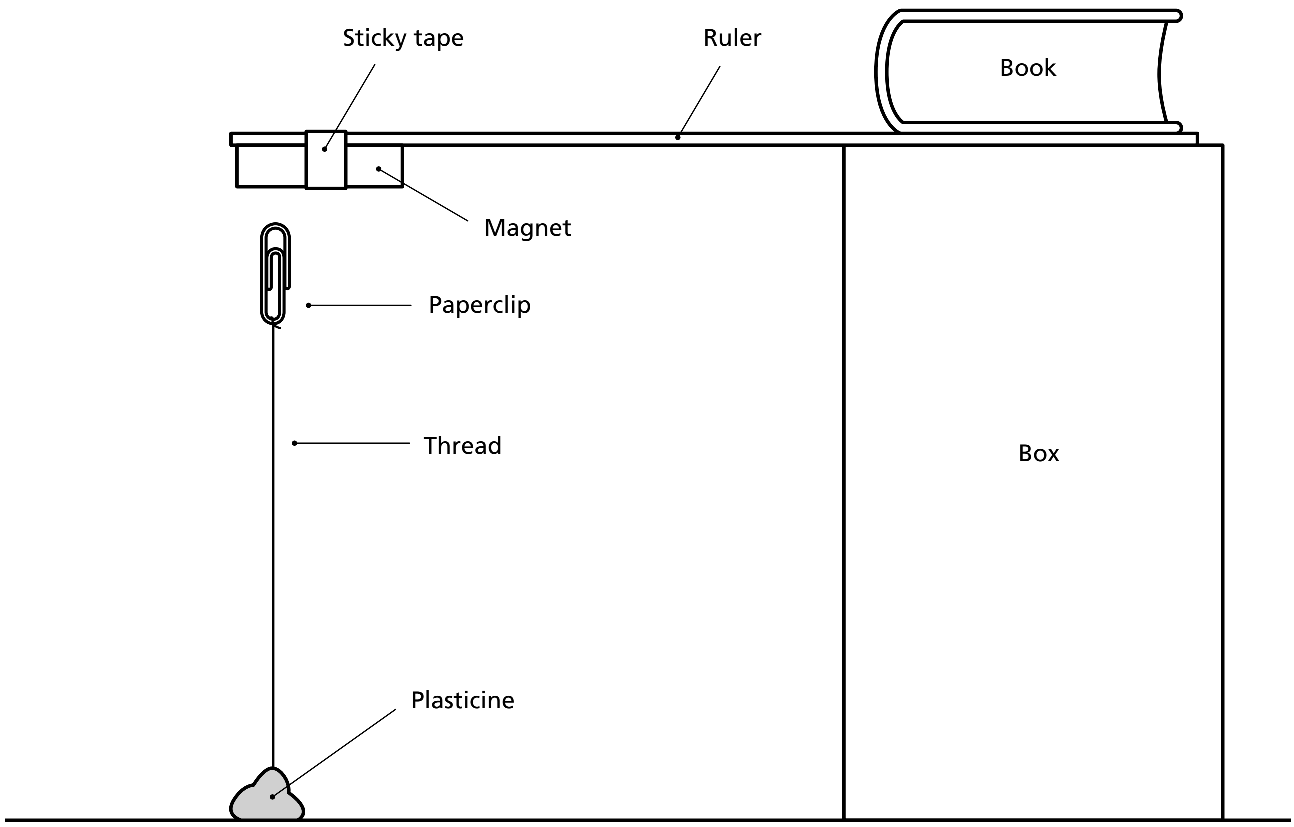
(a) ✎..

(b) ✎..

2. In the space, draw the elastic band and the weight.

3. Then draw in arrows to show the forces on the weight.

4. Set up the experiment shown in the diagram below. You need a magnet, a ruler, some sticky tape, Plasticine, a paperclip and a weight. Notice that you have to choose a length of thread so that the paperclip pulls up to the magnet but does not quite touch it.



5. Draw in arrows to show the forces at work on the paperclip.

Teacher's sheet: activity

Based on **pages 10 and 11** of *Forces in action*

Introducing the activity

(a) The forces acting on an elastic band or a coiled spring can be a difficult topic. So, you may like to begin by finding the forces on a person who is falling. The person is falling because there is only the downward force of gravity (ignoring air resistance). Draw a person on the board and put an arrow showing the direction of the weight force acting on the person. Now say that if the person is stood on the ground the person could not fall because there would be a balancing force. Draw in an arrow showing the force of the ground pushing on the person (see note (i)). Tell the children that they are now going to identify the forces acting on some objects.

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 (ii)).

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

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

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

Completing the activity

(f) Let the children compare their results. Make drawings on the board so the children can check their answers.

Conclusion

Both the elastic band and the spring stretch but then come into equilibrium. At this stage the force of the weight acting down is balanced by the pulling force of the band or spring acting up.

There should be arrows of equal size pointing down and up. This indicates balance.

When a paperclip is suspended below a magnet, a magnetic force pulls the paperclip upwards. This is balanced by the weight of the paperclip. So this is the same – one force down and one up of equal sizes.

Teaching notes

(i) The two arrows should be the same size to show that they balance.

(ii) Make sure that the spring is an open coiled spring like one used to make a mattress.

(iii) An arrow should point down to show the object's weight. An arrow should point up to show the stretching force of the elastic band.

(iv) You may like to assemble one set of the equipment to show the children how to do it. The children will have to find out the distance needed between the paperclip and the magnet by trial and error.

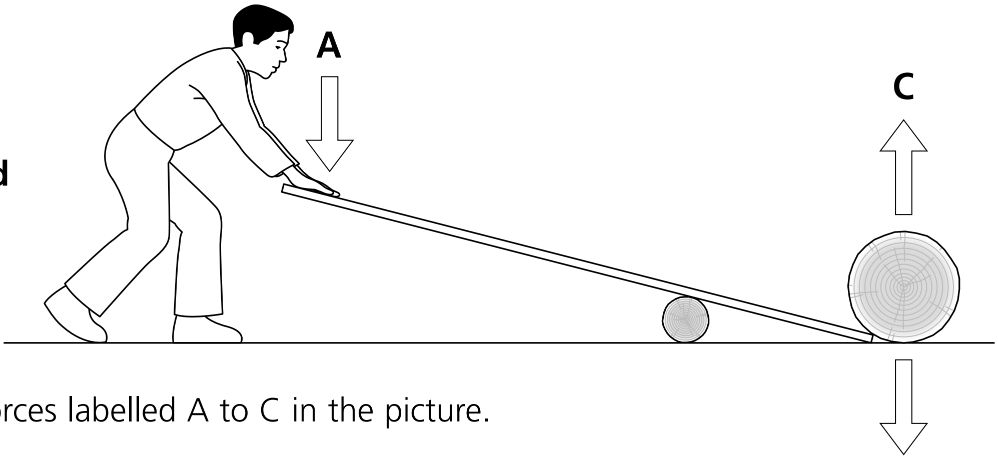
5

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

See **pages 12 and 13** of *Forces in action*

Lever

A lever is designed to make it easier for you to lift, cut or squeeze.



Q1. (i) Name the forces labelled A to C in the picture.

A ✎... B ✎..

C ✎...

(ii) Colour in the lever.

(iii) Label the pivot with an X.

Q2. What does a lever do to a force?

✎...

Q3. Which is more powerful – a short lever or a long lever? Explain your answer.

✎...

✎...

✎...

Q4. Name a device which is made from two levers fixed together.

✎...

Q5. What is a jack used for?

✎...

Q6. In the picture, if the plank snapped close to the person's hand, how would its usefulness as a lever change? Explain your answer.

✎...

✎...

✎...

Teacher's sheet: comprehension

See **pages 12 and 13** of *Forces in action*

Answers

1. (i) A = downward force, B = weight, C = lifting force; (ii) The plank is coloured in; (iii) The small log is labelled with an X.

2. It multiplies a force.

3. A long lever. The further you are from the pivot, the more the force is multiplied.

4. A pair of scissors.

5. To raise a car off the ground.

6. The snapped plank would be less powerful because it would be shorter. The hand would be closer to the pivot.

Complementary work

The wheelbarrow and the arm are examples of levers. The children should use secondary sources to find out where the pivot is in each lever and also where the load force and effort force act.

Teaching notes

A lever is a simple machine. Machines are devices that help us to do work. You can think of a lever as a bar, with a place on which the bar turns. This place is called the pivot. There are three kinds, or classes, of levers. The plank on page 13 of the pupil book is an example of a first class lever. This kind of lever has a pivot between the force that is to be overcome (called the load) and the force which is applied to the lever (called the effort). In the example in the pupil book the weight of the log is the load, and the force exerted to push down the plank is the effort. The crowbar and scissors are further examples of first class levers.

In a second class lever, the pivot is at one end of the bar, the downward force (the load) is close to the pivot and the force acting upwards against the load (the effort) is further away. The bottle opener, wheelbarrow and the car jack are examples of second class levers.

In the third class lever, the pivot is at one end of the bar with the upward force (the effort) close to it and the load further away. The arm is a third class lever. The elbow is the pivot, the bicep muscle provides the effort and the load is in the hand. Sugar tongs and chopsticks are also third class levers. The effort is applied where the hand grips the tongs or sticks and the sugar lump or food (the load) is at one end.

5

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

Based on **pages 12 and 13** of *Forces in action*

Investigating levers

Try this...

1. Set up a wooden block, ruler and roll of Plasticine, or piece of chalk, to make a lever as shown in Diagram 1.

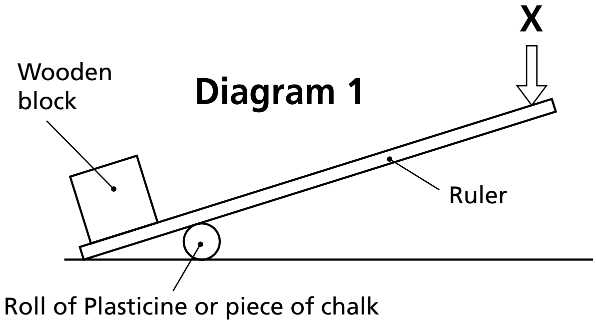
2. Push down at the point marked X.

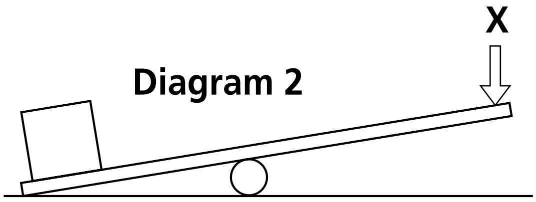
3. Set up a wooden block, ruler and roll of Plasticine, or piece of chalk, as shown in Diagram 2.

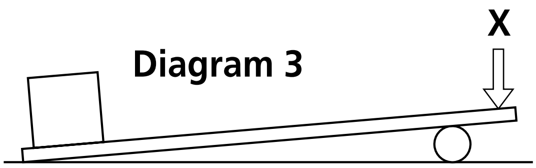
4. Push down at the point marked X.

5. Set up a wooden block, ruler and roll of Plasticine, or piece of chalk, as shown in Diagram 3.

6. Push down at the point marked X.







7. Which lever needs the least pushing force to lift the block?

✎...

8. Which lever needs the most pushing force to lift the block?

✎...

9. On a separate piece of paper, plan an investigation using a forcemeter to show how you could measure the force of the different levers shown in the diagrams, and of other levers not shown in the diagrams.

10. Show your teacher your plan. If your teacher approves, try your investigation.

Looking at the results.

11. What do your results show?

✎...

✎...

5

Teacher's sheet: activity

Based on **pages 12 and 13** of *Forces in action*

Introducing the activity

(a) Use this activity after the children have studied pages 10 to 11 and pages 12 to 13 in the pupil book. Tell the children that they are going to make a simple investigation on levers, then plan and carry out a more complicated one.

Using the sheet

(b) Give out the sheet, let the children fill in their names and form. Go through tasks 1 and 2, then let the children try them (see note (i)).

(c) Go through tasks 3 and 4, then let the children try them (see note (i)).

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

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

(f) Go through tasks 9 and 10, then let the children try them (see note (ii)).

(g) Let the children try task 11.

Completing the activity

(h) Let the children compare their results.

Conclusion

The setting which needed the least pushing force to lift the wooden block is shown in Diagram 1. The setting which needed the most pushing force to lift the wooden block is shown in Diagram 3. As the length of the lever opposite the block gets shorter, the force needed to lift the block becomes larger.

Teaching notes

(i) Tell the children to remember what it is like to push down on the lever.

(ii) The children should realise that they can assemble the lever near the end of a table and tie a piece of string at point X. They could then connect a forcemeter to the lever and pull down gently until the lever is horizontal. In their plan, they may show drawings of the three diagrams on the page and also diagrams of levers set up in different positions between Diagrams 1 and 2 and between Diagrams 2 and 3.

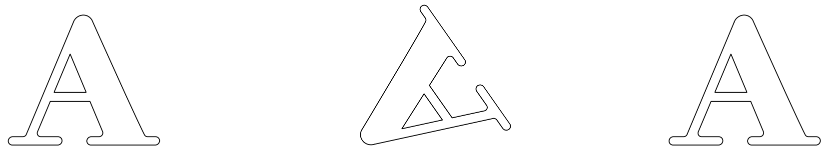
6

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

See **pages 14 and 15** of *Forces in action*

Centre of gravity

The centre of gravity is the place where all of an object's weight balances.



Q1. (i) Where would you hang a plumb line from the left hand A to help find its centre of gravity? Draw in the plumb line.

(ii) Where would you hang a plumb line from the central A to help find its centre of gravity? Draw in the plumb line.

(iii) Put an X on the right hand A to mark its centre of gravity.

Q2. An object has forces pulling down on its right and left sides. How do the forces compare if the object is in balance?

✎...

Q3. What is the name of the force that pulls down on objects? ✎..............................

Q4. How can you find the centre of gravity of a spoon?

✎...

✎...

Q5. (i) Name a vehicle with a low centre of gravity. ✎...

(ii) How is the low centre of gravity useful? ✎..

✎...

Q6. (i) A lorry is loaded so that it is top-heavy.
Is its centre of gravity high up or low down? ✎...

(ii) Would the lorry be dangerous to drive? Explain your answer.

✎...

✎...

Teacher's sheet: comprehension

See **pages 14 and 15** of *Forces in action*

Answers

1. **(i) The plumb line hangs from the top of the letter; (ii) The plumb line hangs from the top of the letter; (iii) The X is near the centre of the letter.**
2. **They are the same (equal).**
3. **Gravity.**
4. **Keep balancing the spoon at different places on your finger by trial and error until it stays at rest.**
5. **(i) A dune buggy; (ii) It stops the vehicle rolling over when it turns a corner.**
6. **(i) High up; (ii) It would be dangerous to drive because it would be in danger of toppling over easily.**

Complementary work

(a) The children can use secondary sources to find out why a tightrope walker uses a long pole to help keep their balance.

(b) If the children have done the second part of the activity about the centre of gravity of half empty bottles, they could be asked why in busy times passengers on a double decker bus may stand downstairs but not upstairs. (The extra weight of the standing bodies downstairs lowers the centre of gravity. If people stood upstairs their weight would raise the centre of gravity and the bus would be more likely to topple over.)

Teaching notes

The centre of gravity is the point in an object through which its weight seems to push downwards. Imagine a rectangular block standing on end. The surface in contact with the table is called the base. The centre of gravity is in the middle of the block and the weight acts straight down through the middle of the base. If the block is tipped a little, its weight still acts through the base, so when the block is released, the weight pulls all of the base back down to the table. If the block is tipped a long way, the weight pushing down from the centre of gravity now acts through the side of the block, not the base. This means that when you let go of the block, the weight pulls the side down to the table and the block topples over.

Objects which are short have a low centre of gravity and must be tipped a long way before the weight acts through a side and pulls them over. Objects which are tall have a high centre of gravity and need only be tipped a small amount before their weight acts through a side and pulls them over.

The centre of gravity is also called the centre of mass. The mass is the amount of matter in the object. When a bottle is half-emptied, most of its mass is concentrated in the bottom half of the bottle and its centre of gravity becomes lower. This means the bottle is less likely to topple over. It is more stable.

6

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

Based on **pages 14 and 15** of *Forces in action*

The centre of gravity of bottles

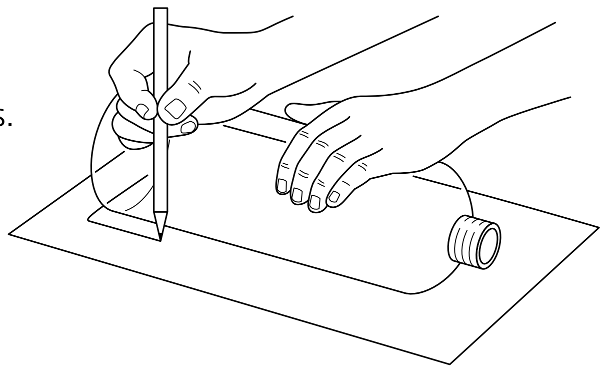
Try this…

1. Take a bottle-shaped piece of cardboard and find its centre of gravity. You may use the information on pages 14 and 15 of your book to help you.

2. Show the position of the centre of gravity of the shape to your teacher.

3. Make a collection of bottles.

4. Draw the shape of each bottle on a piece of card as the diagram shows.



5. Cut out the bottle shapes and find the centre of gravity of each shape.

6. Measure the height of each bottle.

7. Measure the height of the centre of gravity from the base of each bottle.

8. On a separate sheet of paper, make a table of your results.

9. How do the heights of the centres of gravity compare?

✎...

10. Fill the bottles with water and put their caps on.

11. On another sheet of paper, plan an investigation to find out how far the bottles must be tilted before they fall over.

12. Show your teacher your plan. If your teacher approves, try your investigation.

Looking at the results.

13. What do your results show?

✎...

6 Teacher's sheet: activity

Based on **pages 14 and 15** of *Forces in action*

Introducing the activity

(a) Use this activity after the children have studied the unit in the pupil book. Show the children some bottles and ask them which would be easiest to knock over. Ask them for an explanation (see note (i)).

Using the sheet

(b) Give the children the sheet, let them write their names and form on it, then go through task 1 (see note (ii)).

(c) Let the children try task 1.

(d) Let the children try task 2 (see note (iii)).

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

(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 tasks 6 to 8, then let the children try them.

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

(j) Go through tasks 10 to 12, then let the children try them (see note (v)).

(k) Let the children try task 13.

Completing the activity

(l) Let the children compare their results.

(m) Ask the children to predict how removing half the water from a tall bottle affects the ease with which it can be tipped over.

(n) Let the children test their predictions and offer an explanation for the result.

Conclusion

The centre of gravity of a bottle may be found by making a bottle shape on card and using a plumb line.

Tall bottles are more easily tipped over than short bottles because their centre of gravity is higher.

Removing water from a tall bottle lowers its centre of gravity.

Teaching notes

(i) The children may identify tall bottles as being easier to knock over than small, squat battles, but they may give a vague explanation. This is fine at this stage but return to it at the end of the activity and ask them to explain again. This time they should use some scientific knowledge to make a satisfactory explanation.

(ii) Give the children the option of using the pupil book if they wish. Some children may need help in adapting what they see in finding the centre of gravity of the 'A' to finding the centre of gravity of a bottle shape. Make the bottle shape easy by using a squat, almost square, small pickle jar.

(iii) This gives you an opportunity to check the children's work and see that they can locate the centre of gravity.

(iv) You may wish to use only plastic bottles with some children.

(v) The children should carefully tip the bottle to one side and use a protractor to measure the angle at which the bottle will no longer fall back and stand upright. Alternatively, the bottle could be put on a ramp, with a rough surface to prevent sliding, and the ramp raised until the bottle tips over.

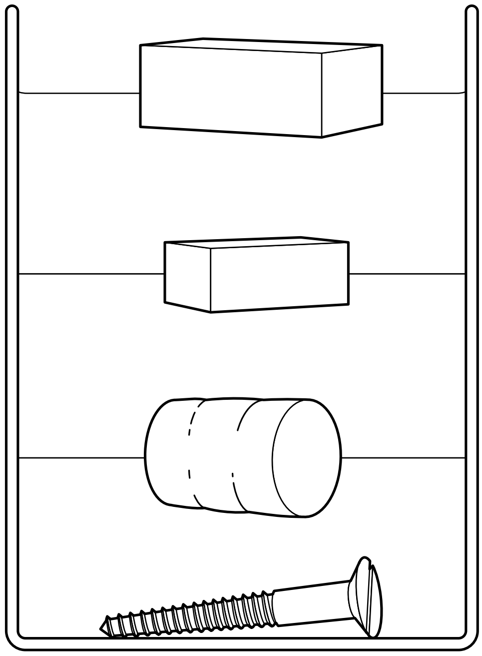
7

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

See **pages 16 and 17** of *Forces in action*

Floating

If something floats, it means that the force pressing down is balanced by the force pressing up.



Q1. There are three liquids in the beaker in the diagram. The liquids are water, syrup and oil. Label them on the diagram.

Q2. What happens to the weight of a brick when the brick is put in water?

✎...

Q3. Why does the weight of the brick change when it is put in water?

✎...

✎...

✎...

✎...

Q4. Why does a brick sink?

✎...

✎...

Q5. How do you stop a ball of Plasticine from sinking?

✎...

Q6. (i) Which liquid in the beaker is the most dense? ✎..........................

(ii) Which liquid in the beaker is the least dense? ✎..........................

(iii) Put an X on an object with is less dense than all the liquids.

(iv) Put a Y on an object which is denser than all the liquids.

(v) Put a Z on an object which is denser than one liquid but less dense than another.

Teacher's sheet: comprehension

See **pages 16 and 17** of *Forces in action*

Answers

1. **Top liquid = oil, middle liquid = water, bottom liquid = syrup.**
2. **Its weight decreases.**
3. **The brick pushes some of the water out of the way, but the water pushes back against the space it was pushed out of.**
4. **The brick pushes down more than the water pushes back.**
5. **Form it into a boat shape.**
6. **(i) Syrup; (ii) Oil; (iii) Top object; (iv) Bottom object; (v) Either of the two middle objects.**

Complementary work

The children could use secondary sources to find out how lifeboats keep afloat in stormy seas.

Teaching notes

When something is placed in water, two forces act on it. They are the weight of the object acting downwards, and the push of the water acting upwards. This push of the water is called the upthrust. The weight of an object depends on the size of the particles from which it is made, and how tightly the particles are packed together. For example, if a solid has large particles packed tightly together it is said to have a high density, and has a large weight. If the solid is made from small particles which are packed less closely it is said to have a low density, and has a small weight.

When an object is immersed in water, it pushes water out of the way to make a space for itself. The water pushes back and creates the upthrust. The size of the upthrust depends on the density of the water and the amount of water pushed away by the object. If a small object with a density higher than water is immersed, the upthrust is too small to stop the object sinking. If the object is large and has a density less than water, the upthrust is stronger than the weight and the object floats.

7

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

Based on **pages 16 and 17** of *Forces in action*

Investigating weight in air and water

Try this…

1. Select eight objects.

2. Write down the names of the objects in the first column of the table.

Object	Weight in air (N)	Weight in water (N)

3. Weigh the first object in air and record its weight in the second column of the table.

4. Weigh the first object in water and record its weight in the third column of the table.

5. Repeat steps 3 and 4 with the seven remaining objects.

Looking at the results.

6. What do the results show?

✎...

✎...

7. On the back of this sheet, draw one of the objects being weighed in water.

8. As the object is sinking, which is bigger – the weight force or the upward resisting force of the water? On your drawing, add one arrow to show the weight force and another arrow to show the force of the water (the biggest force should have a bigger arrow).

Teacher's sheet: activity

Based on **pages 16 and 17** of *Forces in action*

Introducing the activity

(a) You may use this activity before or after the children read Unit 7 in the pupil book. It may be used as an introduction to the topic or to consolidate the work in the pupil book. The children should have done the activity in Unit 4 'Identifying forces' to help them with steps 7 and 8 in this activity. Tell the children that they are going to make their own investigation about the forces at work on an object that is immersed in water.

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 task 4, then let the children try it.

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

(g) Let the children try task 6.

(h) Go through tasks 7 and 8, then let the children try them (see note (ii)).

Completing the activity

(i) Let the children compare their results and diagrams.

Conclusion

When an object is weighed in air and then in water, it is found that the weight of the object in water is less than the weight of the object in air. This can be explained by the fact that, in water, there is a force which pushes upwards on the object, and this opposes the force of gravity which is pulling down on the object. In air, there is no strong force to oppose the pull of gravity. The largest objects appear to lose the most weight in water because they have pushed the largest amount of water out of the way and this water pushes strongly upwards on the object.

Teaching notes

(i) None of the objects should float. They should all sink when placed in water.

(ii) The children may need reminding of their work in Unit 4. When something is sinking, the arrow showing the action of gravity should be pointing down and be larger than the arrow pointing upwards showing the buoyancy of the water. If the arrow pointing upwards was larger this would mean that the object would shoot out of the water! Floating, or submerged but stationary objects have arrows the same size.

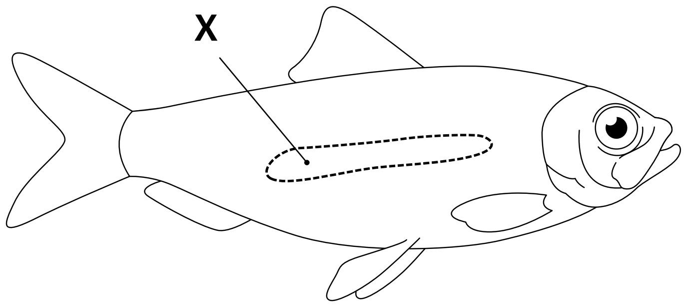
8

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

See **pages 18 and 19** of *Forces in action*

Submerged

Moving about while submerged is more difficult than floating.
It needs a change in density.



Q1. (i) What is the part of the fish's body labelled X?

✎...

(ii) What does X contain? ✎...

(iii) How does the density of this fish compare with the density of water?

✎...

Q2. (i) Name a fish that is heavier than water. ✎..

(ii) What happens to this fish when it stops swimming? ✎..

Q3. A submarine has a space between its inner and outer hull.

(i) What fills this space to make the submarine float on the water? ✎...........................

(ii) How is the submarine made to dive?

✎...

✎...

(iii) How is the submarine made to float underwater?

✎...

✎...

(iv) How is the submarine made to rise in the water?

✎...

8

Teacher's sheet: comprehension

See **pages 18 and 19** of *Forces in action*

Answers

1. **(i) A swim bladder; (ii) Air; (iii) They are about the same.**

2. **(i) Shark; (ii) It sinks.**

3. **(i) Air; (ii) Water is allowed into the space, air is allowed to escape; (iii) The amount of air and water is adjusted so the submarine has the same density as the water; (iv) Air is pumped into the space and water is pushed out.**

Complementary work

The children could use secondary sources to find out about how the vessels which explore the depths of the oceans work.

Teaching notes

A shark does not have a swim bladder. The density of a shark's body is greater than the density of water, so a shark sinks if it does not move forwards. As long as a shark moves forwards its fins can use the water flowing over them to generate an upward force. This force is greater than the shark's weight and makes the shark rise up in the water. Sharks in deep water circle round prey at the surface to gain height so they can attack.

Some fish swim to the surface and gulp air into their swim bladder. This helps their bodies attain the same density as water so they can stay submerged, but not sink all the way to the floor of the pond, lake or sea. A fish of this type can let air out of the bladder through its mouth if it wants to sink deeper.

Many fish do not gulp air. They release an air-like gas into their swim bladder from their blood when they wish to rise in the water and absorb the gas back into their blood (where it dissolves) when they want to sink.

A submarine carries tanks of compressed air. In these tanks a large amount of air is squashed into a small space under a high pressure. When a submarine needs to rise, the air is released from the tanks. The pressure of the air pushes the water out of the spaces in the submarine's hull. With its hull spaces full of air, the submarine is much less dense than the water around it and rises.

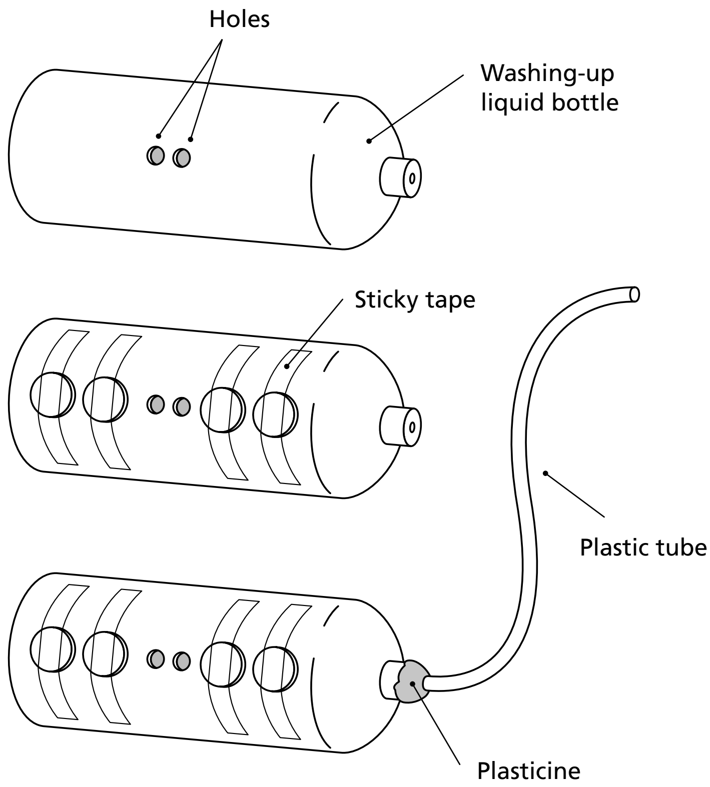
8

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

Based on **pages 18 and 19** of *Forces in action*

A model submarine

Try this…



1. Collect a plastic washing-up liquid bottle and make two holes in it.

2. Tape some coins to the plastic bottle as the diagram shows (use enough to make it sink).

3. Put one end of a plastic tube into the bottle and seal it in place with a piece of Plasticine.

4. Put the submarine in a tank or sink of water. What happens to it?

✎...

5. Blow gently down the plastic pipe. What happens?

✎...

6. Write down how you can control the submarine.

✎...

✎...

✎...

✎...

✎...

✎...

Teacher's sheet: activity

Based on **pages 18 and 19** of *Forces in action*

Introducing the activity

(a) Use this activity after the children have studied the unit in the pupil book. Tell the children that they are going to make a model submarine and make a report on how to operate it.

Using the sheet

(b) Give out the sheet and let the children fill in their names and form, then let the children perform task 1 (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 task 4, then let the children try it (see note (ii)).

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

(g) Go through task 6 with the children, then let them try it (see note (iv)).

Completing the activity

(h) Let the children compare their instructions and see if they can use someone else's instructions to operate their submarine.

Conclusion

A model submarine can be made from a washing-up liquid bottle with holes cut in its sides and with coins stuck to its outer surface. Air is supplied by a person blowing down a tube into the bottle. The submarine sinks by letting water flow in through the holes in its side. The submarine is raised by blowing air into it which pushes the water out. A strong blow can raise the submarine quickly and make it float on the surface. Some air can be trapped in the submarine by covering the end of the pipe. This can be used to allow the submarine to float just beneath the surface.

Teaching notes

(i) Depending on the ability and the attitude of the children, you may let them bring in a washing-up liquid bottle from home and make the holes in the bottle themselves.

(ii) The submarine may take a little time to sink.

(iii) The submarine should start to rise. Eventually some bubbles of air may escape too.

(iv) You may like the children to write down their account in the form of a set of instructions to sink and raise the submarine, let it float at the water surface or just below the surface.

9

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

See **pages 20 and 21** of *Forces in action*

The force of air

Air can slow things down, but fast-moving air can also be an important lifting force.

Q1. (i) In the space, draw a person hanging from a parachute.

(ii) Draw an arrow to show the direction in which the air pushes back against the falling parachute.

(iii) Draw an arrow to show the direction of the weight of the person and parachute.

(iv) Why does a parachute always sink?

✎...

✎...

Q2. What does air do as we walk about?

✎...

Q3. What does the air do if an object moves quickly through it?

✎...

✎...

Q4. What is the name of the machine that squashes air into a space beneath it so it can move? ✎...

Q5. What is the upward force on a wing as it moves through the air?

✎...

Q6. Why does a wing need to move quickly to make an aircraft fly?

✎...

✎...

Teacher's sheet: comprehension

See **pages 20 and 21** of *Forces in action*

Answers

1. **(i) A diagram of a person suspended from an open parachute; (ii) The arrow points upwards; (iii) The arrow points downwards; (iv) The weight is always greater than the air resistance.**
2. **It moves out of our way.**
3. **The air does not move out of the way fast enough and acts as a force which holds back the object.**
4. **A hovercraft.**
5. **Lift or lifting force.**
6. **Air builds up pressure under the wing to make it rise.**

Complementary work

The children could be set the task of answering the question, "What effect does a hole in a parachute have?" They should make normal parachutes and test them, then put holes of different sizes in different places and test the parachutes again.

Teaching notes

The children may have studied air resistance earlier in their course so it may be worth testing their knowledge about parachutes, and the streamlined shape of vehicles, while they study this unit.

When an object falls through the air, it may seem to the children that only one force is acting – gravity. However, air resistance also acts on all falling objects, although its effect is only easily seen with objects which offer a large surface to the air.

A wing has a special shape called an aerofoil shape. The upper surface of the wing is a convex curve and the lower surface is flat. When the wing moves through the air, a stream of air flows over both the upper surface and the lower surface. The two airstreams meet at the same time at the back of the wing (called the trailing edge). For this to happen, the stream of air over the upper surface must move faster than the stream over the lower surface, because it has a greater distance to cover due to the upper surface being curved and the lower surface flat. When a stream of air moves over a surface, it pushes on the surface. However, a faster moving stream pushes with less force than a slower moving stream. This means that the air above the wing pushes down less strongly than the air below the wing pushes up. This difference in force due to the strong pressure underneath the wing causes the wing to lift into the air.

9

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

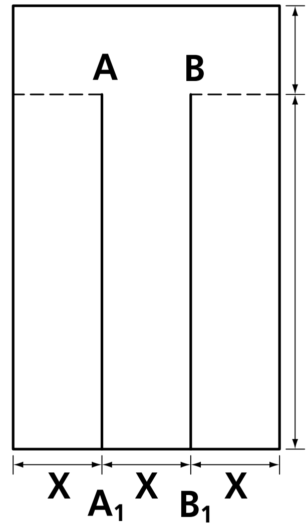
Based on **pages 20 and 21** of *Forces in action*

Investigating spinners

Try this…

1. Take a piece of paper and mark out the lines shown in Diagram 1. Measurement X should be 3cm, measurement Y should be 12cm and measurement Z should be 3cm.

Diagram 1



2. Cut along lines A to A1 and B to B1.

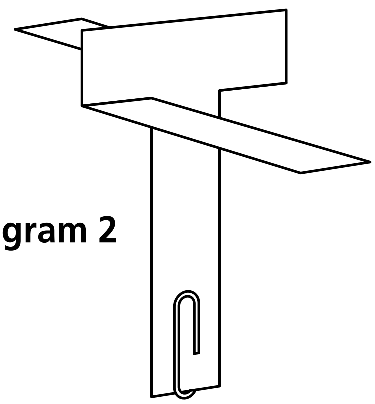
3. Bend the paper as shown in Diagram 2.

4. Attach a paperclip to the spinner as shown in Diagram 2.

5. Test your spinner to see that it spins as it falls to the ground.

6. Plan an investigation to find out how the number of paperclips attached to the spinner affects the way it falls and write it down here. In your plan, make a prediction about the results.

Diagram 2



✎...

✎...

✎...

✎...

✎...

7. Show your teacher your plan. If your teacher approves, try your investigation.

Looking at the results.

8. What did the results show?

✎...

✎...

Teacher's sheet: activity

Based on **pages 20 and 21** of *Forces in action*

Introducing the activity

(a) Use this activity after the children have studied Units 7 and 8, and pages 20 and 21, in the pupil book. Remind the children about how water pushes up on objects that sink through it, and tell the children that they are going to investigate how a simple object sinks through the air.

Using the sheet

(b) Give out the sheet and let the children write 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 (see note (ii)).

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

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

(g) Let the children try tasks 6 and 7 (see note (iv)).

(h) Let the children try task 8.

Completing the activity

(i) Let the children compare their results.

(j) Challenge the children to investigate the effect of the blades of the spinner on the time it takes the spinner to fall.

Conclusion

A spinner with a load of only one paperclip fell more slowly than a spinner with a load of many paperclips. As the load on the spinner was increased, it fell more quickly (see note (v)).

The blades of the faster-falling spinners turn more rapidly.

A spinner with large blades will take longer to fall than a spinner with small blades due there being more air pushing upwards on the larger blades.

Teaching notes

(i) You may wish to prepare some sheets already marked out for some children.

(ii) Make sure the children bend the blades of the spinner so they stick out at right angles to the rest of the spinner.

(iii) Make sure the children follow the school safety policy for dropping things from a height. For example, they may not stand on classroom furniture, but may stand on PE equipment or equipment in a playground.

(iv) The children may begin their plan with a prediction. The plan should show that the spinner will be dropped a number of times from the same height and with the same load – such as one paperclip, two paperclips etc. The time taken for each fall should be recorded. The children should produce an appropriate table on a separate piece of paper.

(v) The air pushes on all objects falling through it, but its push affects the lightest spinner most strongly and slows it down a little.

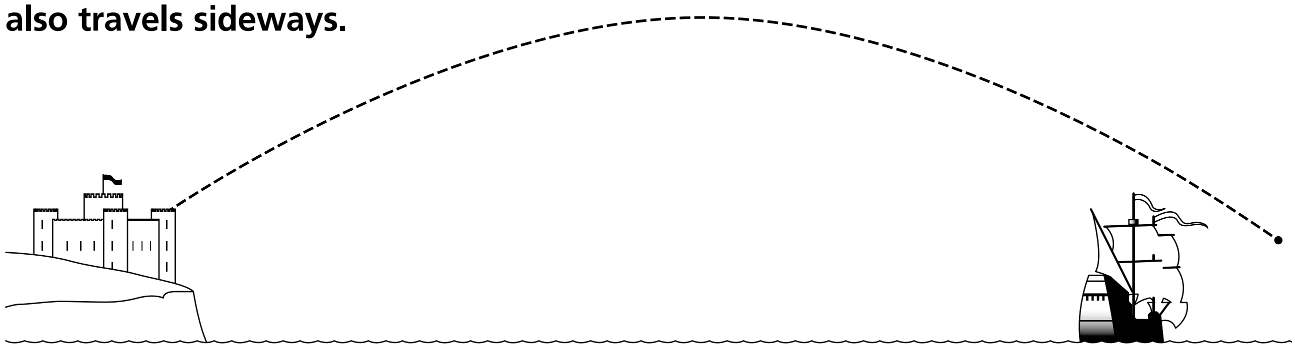
10

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

See **pages 22 and 23** of *Forces in action*

Throwing things

When you throw something in the air it goes up and down, and also travels sideways.



Q1. The diagram shows the path of a cannonball as it leaves a cannon.

(i) Draw the path of the ball if the cannon was tilted upwards a little.

(ii) Draw the path of the ball if the cannon was tilted downwards a little.

Q2. What is the name of something that is thrown through the air?

✎..

Q3. What was used to produce the force in a cannon?

✎..

Q4. What force affects a cannonball as it moves through the air?

✎..

Q5. What is the best angle for sending a cannonball furthest? ✎.................................

Q6. How could you use an elastic band and a ramp to force an object into the air?

✎..

✎..

✎..

✎..

✎..

Teacher's sheet: comprehension

See **pages 22 and 23** of *Forces in action*

Answers

1. **(i) The path should be higher at first than the path shown on the diagram and the ball should fall more vertically to the ground; (ii) The path should be lower than the first path but the ball should strike the ground farther from the cannon than the ball from the cannon tilted upwards. Both paths would be shorter than the one in the diagram.**
2. **A projectile.**
3. **Gunpowder.**
4. **Air resistance.**
5. **45°.**
6. **You could fasten the elastic band to the top of the ramp. Put an object inside the band and pull it back while resting it on the ramp. When you let go, the elastic band would shorten and push the object into the air.**

Complementary work

The children could use secondary sources to find out how athletes throw the javelin, putt the shot, throw a baseball and a cricket ball.

Teaching notes

We usually think of the natural state of an object as at rest. However, there is a second natural state – an object will move at a constant speed in a straight line if no other forces are acting on it. This may seem strange, but out in space where there is no pull of gravity or push of air pressure, a space probe or a piece of rock can keep moving in a straight line at constant speed forever unless acted on by the gravity of a star or planet.

It is important to consider this second natural state here on Earth, because when an object is given a push, it tries to maintain a constant speed in a straight line. There is no continuous force pushing it along. For example, the ancient Greeks correctly believed that a bow string gave the push to an arrow, but incorrectly believed that the air took up the push and dropped the arrow when it got tired!

As soon as a projectile begins its journey, it is tugged down by gravity and pushed against by the air. These two forces deflect the object from travelling in a straight line and moving at a constant speed, so eventually they bring it to the ground.

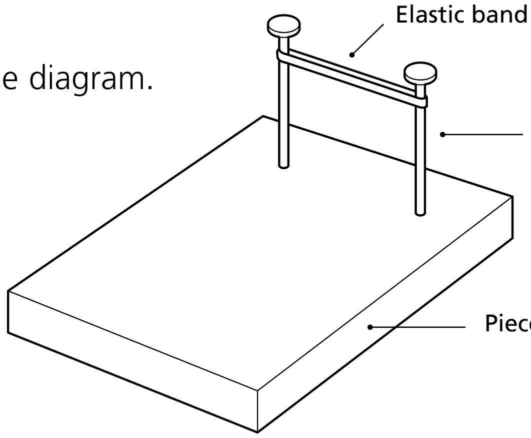
10

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

Based on **pages 22 and 23** of *Forces in action*

Testing the power of an elastic band

Try this…



1. Collect the equipment shown in the diagram.

2. Plan an investigation using the equipment in the diagram to find out how the amount an elastic band stretches affects the distance it can throw a piece of paper. Include a prediction in your plan.

✎..

✎..

✎..

✎..

✎..

✎..

3. Show your teacher your plan. If your teacher approves, try your investigation.

4. How can you compare the power of different elastic bands? Describe how you could modify your investigation in step 2 to find out.

✎..

✎..

5. Show your teacher your plan. If your teacher approves, try your investigation.

Looking at the results.

6. What do the results show?

✎..

10 Teacher's sheet: activity

Based on **pages 22 and 23** of *Forces in action*

Introducing the activity

(a) Use this activity after the children have studied pages 22 and 23 in the pupil book. Tell the children that there is a simple way to test the power of an elastic band to throw something and the children have to work out how to do it.

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

(d) Go through tasks 4 and 5, then let the children try them (see note (iii).

(e) Let the children try task 6.

Completing the activity

(f) Let the children compare their results.

Conclusion

The power of an elastic band can be tested by stretching it different amounts. A small amount of stretch will send the projectile a small distance, but a large amount of stretch will send the projectile a long distance. The distance the projectile travels increases as the amount of stretch of the elastic band increases.

The power of different elastic bands can be compared by stretching each one the same amount and measuring the distance travelled by the projectile.

Teaching notes

(i) Depending on the ability and attitude of the children, you may like them to assemble the equipment using two nails, a hammer and piece of wood. The nails must be hammered in firmly, but must not go all the way through the wood. Alternatively, you can prepare the equipment before the lesson.

(ii) The plan may start with the prediction. The plan should show that a scale is drawn on the piece of wood, or the distances the elastic band is stretched is marked and measured from a line between the two nails. The elastic band should be stretched different amounts in each trial and released. A small paper ball made from a piece of kitchen roll may be used as the projectile. The equipment must not be pointed at anyone. The distance moved by the projectile should be measured. A table should be constructed on a separate sheet of paper. The elastic band may be tested several times at each amount of stretch. The plan should show a consideration for safety and mention not stretching the elastic band too much.

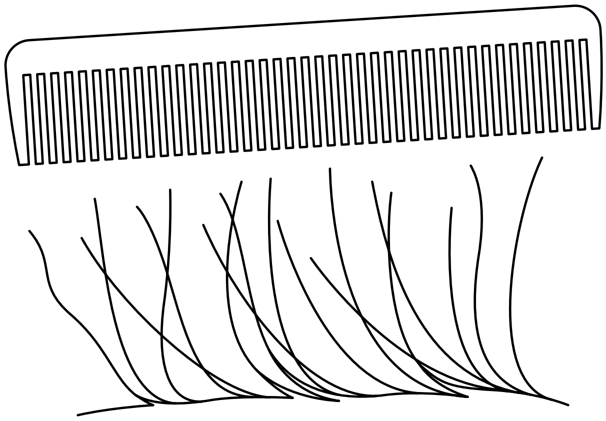
Check your school policy to see if the children should wear eye protection.

(iii) Indication of a fair test must be shown. Each band should be tested for the same amount of stretch several times.

QUESTIONS

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

Q1. Jane has combed her hair. When the comb is held above Jane's head her hair stands up as the picture shows.

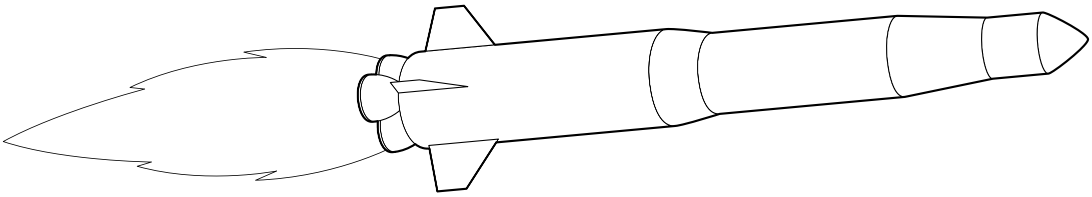


(i) Draw an arrow on the picture showing the direction of the pulling force acting on Jane's hair.

(ii) What is causing the force which is acting on Jane's hair?

✎...

Q2. The picture shows a rocket moving through space.



On the picture draw an arrow showing the direction of:

(i) The force acting on the gas.

(ii) The force acting on the rocket.

(iii) If the force acting on the gas is increased, what happens to the force acting on the rocket?

✎...

Q3. Which of these are not forces:

Tick two boxes:

Gravity ☐ Water ☐ Air ☐ Weight ☐

QUESTIONS

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

Q4. Arif uses a forcemeter to find the force needed to pull open a door.

(i) What happens to the spring in the forcemeter as Arif makes his measurement?

✎...

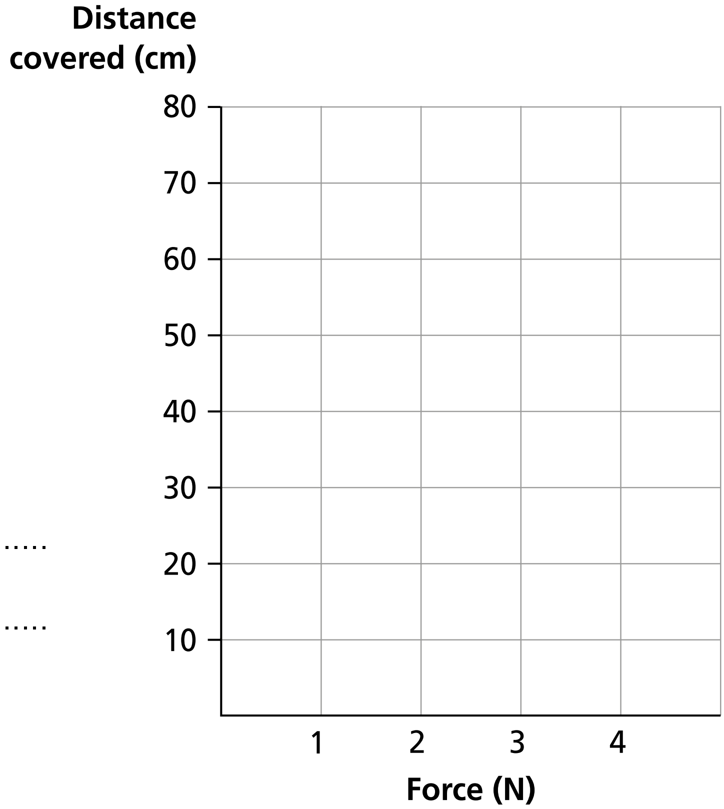
Arif records the force to open the door as 3N.

(ii) What does N stand for? ✎..

Q5. Mina has a forcemeter which she can use to measure the push on a toy car. She pushed the car with different amounts of force and measured the distance it travelled each time. She recorded her results in a table:

Force (N)	Distance covered (cm)
1	10
2	30
3	50

(i) Make a line graph of Mina's results here. Connect the points with a line.



(ii) How does the size of the force affect the distance the car travels?

✎..

✎..

(iii) From this data, predict how far the car may travel if it is pushed with a force of 4N.

✎..

QUESTIONS

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

Q6. The force of gravity on the Moon is six times less powerful than it is on the Earth. The force of gravity on Mars is three times less powerful than it is on the Earth.

(i) A bag of apples weighs 1,800g on Earth. How much does it weigh on:

(a) the Moon? ✎................................ (b) Mars? ✎................................

(ii) An astronaut weighed a bag of rocks on the Moon and found them to weigh 500g. What would the weight of the rocks be on:

(a) Earth? ✎.................................... (b) Mars? ✎....................................

Q7. Paul found the mass and weight of four different objects. He recorded his results in a table:

	Object			
	1	**2**	**3**	**4**
Mass (g)	200	400	1,000	1,400
Weight (N)	2	4	10	14

(i) Plot the results on the graph below.

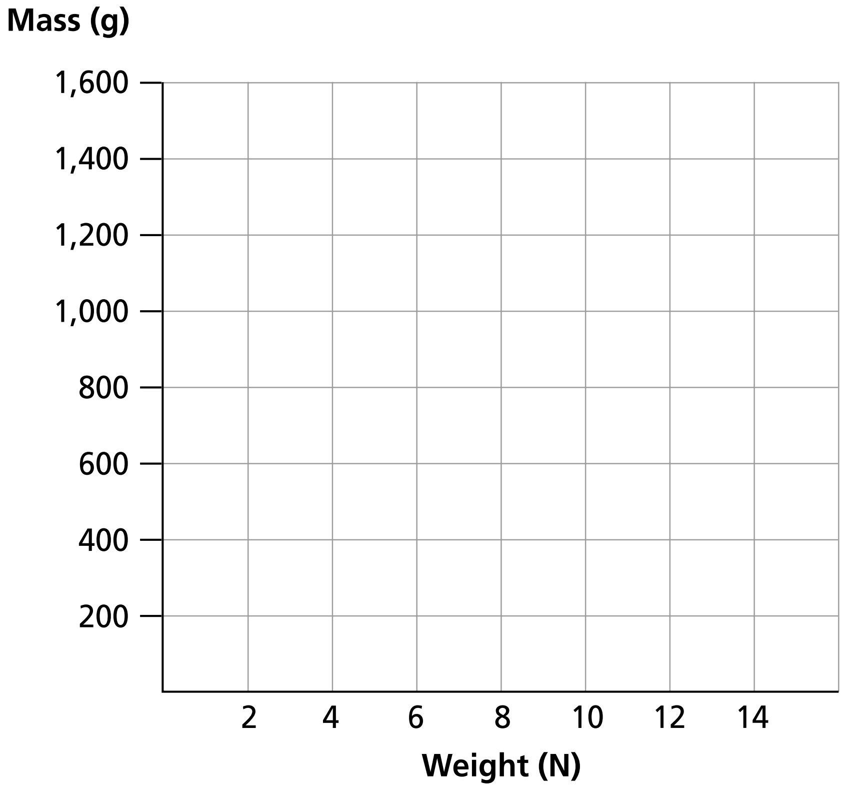
(ii) Connect the points with a line.

(iii) Paul finds an object with a mass of 600g. Predict its weight using the graph.

✎.................................

(iv) Paul finds an object with a weight of 12N. Predict its mass using the graph.

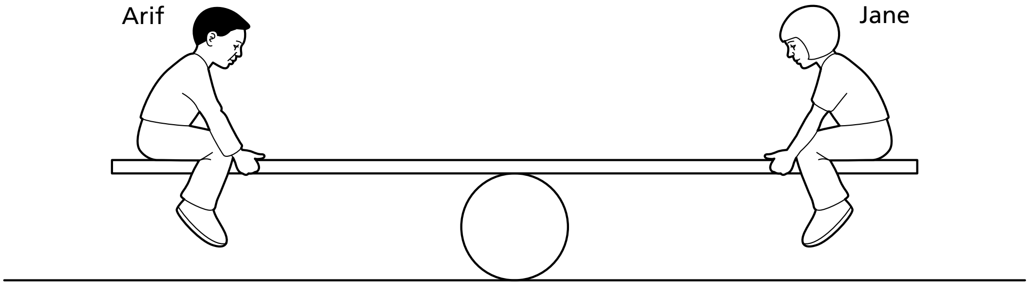
✎.................................



QUESTIONS

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

Q8. Arif and Jane are balanced on the see-saw. Draw in arrows showing the direction of the forces which are keeping the see-saw balanced.

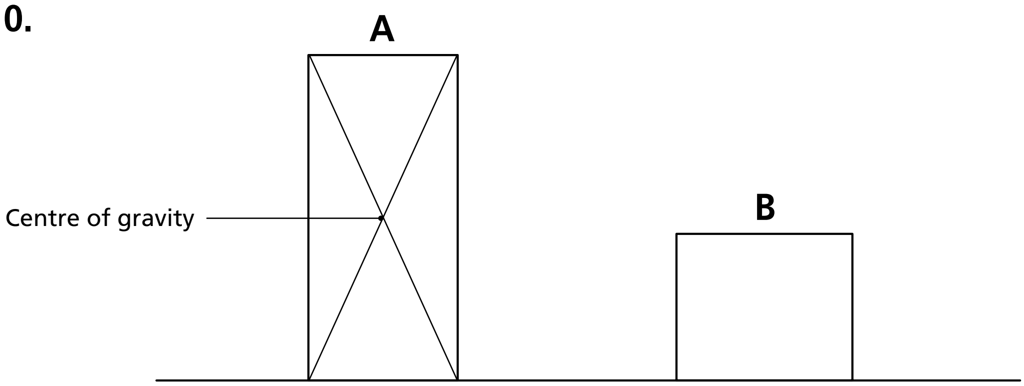


Q9. Which is a part of any lever?

Tick one box:

Point ☐ Pivot ☐ Plank ☐ Screw ☐

Q10.



(i) The left hand diagram shows you how to find the centre of gravity of rectangle A. Now draw the centre of gravity of rectangle B.

(ii) Which block is easier to knock over? ✎.....................................

(iii) Give a reason why the block is easier to knock over.

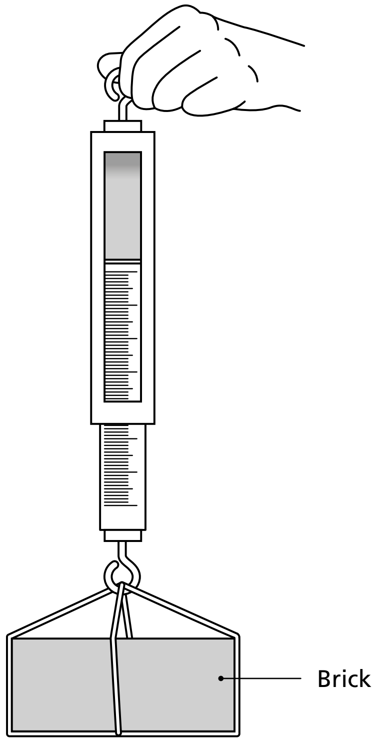
✎...

✎...

QUESTIONS

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

Q11. Mina attached a brick to a forcemeter as the picture right shows.



(i) Draw an arrow to show the direction of the brick's weight.

(ii) Draw an arrow to show the direction of the force made by the forcemeter on the brick.

Mina weighed the brick in air and in water. She found the weight of the brick to be 30N in air and 12N in water.

(iii) How did the weight of the brick change when it was moved from air to water?

✎..

(iv) What was the difference in weight between the brick in air and the brick in water?

✎..

(v) What forces acted on the brick in the water?

✎..

(vi) Why did the weight of the brick change when it was put in water?

✎..

✎..

Q12. Which part of a fish helps it to have the same density as water?

Tick one box:

Fins ☐ Gills ☐ Swim bladder ☐ Intestine ☐

QUESTIONS

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

Q13. Arif, Jane, Mina and Paul each made a different-sized parachute. They dropped their parachutes from the same height and timed how long they took to reach the ground. The table shows their results.

	Size of canopy (cm^2)	Time to fall (secs)
Arif	1,000	3.5
Jane	700	3.0
Mina	500	2.5
Paul	200	1.5

(i) Whose parachute was the smallest? ✎...

(ii) What is the difference in falling time between Arif's parachute and Mina's parachute? ✎...

(iii) How does the size of the canopy affect the time for a parachute to fall?

✎...

(iv) What is the force which slows down the fall of a parachute?

✎...

(v) In which direction does this force act?

✎...

Q14. (i) Which part of an aeroplane produces a lifting force?

✎...

(ii) What must the aeroplane be doing for the lifting force to be produced?

✎...

Q15. What is the name of the vehicle which travels on a cushion of air?

✎...

ANSWERS

1. (i) Arrow pointing from the hair to the comb. *1 mark*
(ii) Electricity on the comb. *1 mark*

2. (i) Arrow pointing to the left. *1 mark*
(ii) Arrow pointing to the right. *1 mark*
(iii) It is increased by the same amount. *1 mark*

3. Water, air. *2 marks*

4. (i) It stretches. *1 mark*
(ii) Newtons. *1 mark*

5. (i) The three points to be plotted accurately and a line drawn between them. *4 marks*
(ii) As the size of the force increases, the distance travelled by the car increases. *1 mark*
(iii) 70cm. *1 mark*

6. (i) (a) 300g (b) 600g. *2 marks*
(ii) (a) 3,000g (b) 1,000g. *2 marks*

7. (i) Four points accurately plotted. *4 mark*
(ii) A neat, straight line drawn. *1 mark*
(iii) 6N. *1 mark*
(iv) 1,200g. *1 mark*

8. There should be an arrow below each person, pointing down. The arrows should be the same size. *2 marks*

9. Pivot. *1 mark*

10. (i) The centre of gravity should be marked in the centre of the rectangle, where the diagonals cross. *1 mark*
(ii) A. *1 mark*
(iii) It has a higher centre of gravity than B. *1 mark*

11. (i) Arrow pointing down. *1 mark*
(ii) Arrow pointing up. *1 mark*
(iii) It decreased. *1 mark*
(iv) 18N. *1 mark*
(v) Weight and the push of the water upwards (upthrust). *1 mark*
(vi) The push of the water upwards opposed some of the push of the weight downwards. *1 mark*

12. Swim bladder. *1 mark*

13. (i) Paul's. *1 mark*
(ii) One second. *1 mark*
(iii) The larger the canopy, the slower the parachute falls. *1 mark*
(iv) Air resistance. *1 mark*
(v) Upwards. *1 mark*

14. (i) The wings. *1 mark*
(ii) Moving forwards. *1 mark*

15. Hovercraft. *1 mark*

Total marks: 47