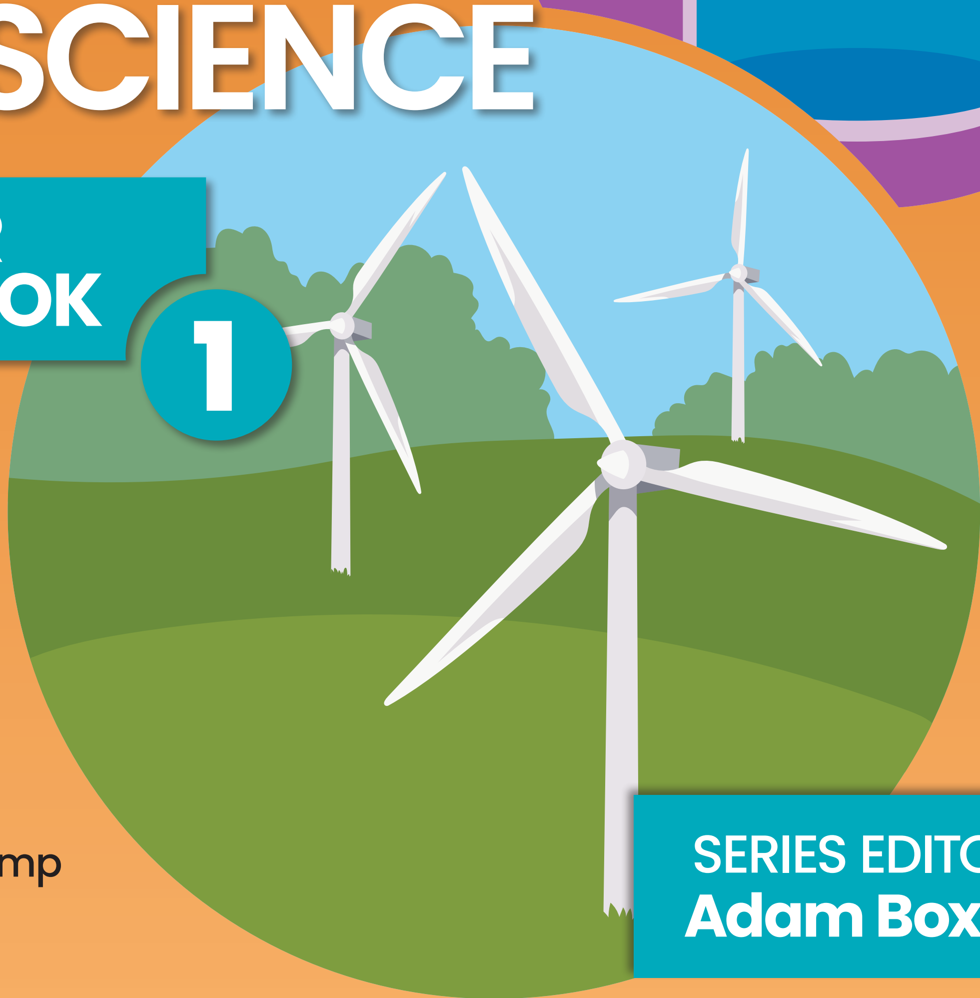
SAMPLE CHAPTER

SPRINGBOARD KS3 SCIENCE

TEACHER HANDBOOK 1



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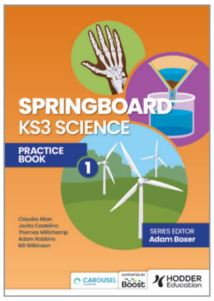

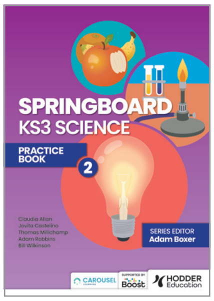

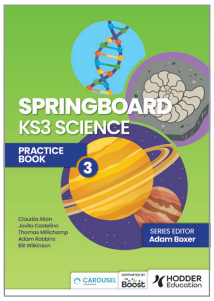

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Carousel Learning is an integrated retrieval practice platform for schools. The partnership between Carousel and Hodder Education means that all Springboard Science Boost Knowledge Tests are available in the Carousel platform as question banks.

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CONTENTS

Introduction 6

BIOLOGY

B1 Cells 9
- **B1.1** Microscopes 9
- **B1.2** Cell structure 12
- **B1.3** Animal and plant cells 15
- **B1.4** Magnification 18
- **B1.5** Unicellular organisms 22
- **B1.6** Diffusion 25
- **B1.7** Specialised cells 29

B2 Skeletal and muscular systems and organisation 34
- **B2.1** The skeleton 34
- **B2.2** Biomechanics 36
- **B2.3** Principle of organisation 44

CHEMISTRY

C1 The particle model 49
- **C1.1** Simple particle model 49
- **C1.2** Properties of different states of matter 51
- **C1.3** Changes of state 56
- **C1.4** Gas pressure 61

C2 Atoms, elements and compounds 64
- **C2.1** The atomic model 64
- **C2.2** Symbols and formulae 72
- **C2.3** Elements and compounds 76

C3 Pure and impure substances 87
- **C3.1** Diffusion 87
- **C3.2** Pure and impure 89
- **C3.3** Separation 95

PHYSICS

P1 Energy changes 103
- **P1.1** Fuels and energy stores 103
- **P1.2** Energy stores and transfers 109
- **P1.3** Power 116
- **P1.4** Energy resources 126

P2 Speed 134
- **P2.1** Speed 134
- **P2.2** Distance-time graphs 148
- **P2.3** Relative motion 156

P3 Forces 159
- **P3.1** Basic forces and diagrams 159
- **P3.2** Naming and categorising forces 162
- **P3.3** Stretching and squashing forces 168
- **P3.4** Hooke's law and work done 173
- **P3.5** Moments and simple machines 183
- **P3.6** Balanced forces 190
- **P3.7** Forces and motion 193

INTRODUCTION

Welcome to Springboard: KS3 Science!

Springboard has been developed by our expert author team with two key goals:

1. to build, develop and sustain students' knowledge and understanding of science
2. to give teachers a powerful resource to support and improve their teaching.

The course is therefore designed not just to be useful or a workload reducer, though Springboard certainly achieves these aims. The main point is to help inform and improve science teaching through evidence- and experience-based practice. In order for students to master new knowledge, teaching needs to involve explicit, narrative-driven explanations, extensive independent practice, constant checking for understanding and a coherent approach to long-term knowledge and retrieval practice. Springboard Science meets all these needs.

This is a revolutionary approach to writing textbooks and schemes of work, and Springboard is groundbreaking in its scope and ambition. Springboard won't just *help* your science teaching, it will *improve* it.

Course elements

The Springboard course is divided first into biology, chemistry and physics and then into units and topics. For example, the B1 unit is about 'Cells and organisation' and is divided into smaller topics dealing with microscopes, cell structure, diffusion and so on. Topics are not split into lessons, nor are they of uniform length. You are encouraged to teach the content according to the amount of time it takes, rather than trying to squeeze or stretch it into fixed units of time like a lesson.

While Springboard's content is not structured into fixed units of time, the curriculum plan is designed to enable you to teach through the content over three years. The Practice Books and Teacher Handbooks are organised accordingly, with a pair for each year, each containing multiple units for biology, chemistry and physics. Conceptual progression and interleaving that are built into the resources assume this teaching order is followed.

C1.2 Properties of different states of matter

	Question	Answer
1	Give two properties of gases.	Can flow; can be compressed
2	Give two properties of liquids.	Can flow; cannot be compressed
3	Give two properties of solids.	Cannot flow; cannot be compressed
4	Why can solids not flow?	There are strong forces of attraction between the particles
5	Why can liquids and gases flow?	There are weak forces of attraction between the particles
6	Why can gases be compressed?	There is space between the particles
7	Why can solids and liquids not be compressed?	The particles are already touching

The course is based on the National Curriculum for KS3 and centres around core questions: a delineation and specification of exactly what students are expected to know by the end of the course.

The elements to help deliver the course include:

- a student Knowledge Book, including core questions, key diagrams and worked examples (subject content plus working scientifically)
- student Practice Books, including extensive practice on content just taught and interleaved with topics that have been covered previously
- Teacher Handbooks, including numerous components detailed below
- additional resources on Boost, including class presentations, practical worksheets, careers worksheets, science stories, support sheets, cover work and assessment resources
- online quizzes on Boost for every topic.

For the complete curriculum experience you are encouraged to access Carousel Learning, where question banks containing all the Knowledge Book core questions are available as a flexible quizzing and retrieval resource to all Carousel users with a paid subscription.

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B1 Cells

B1.1 Microscopes

Students' learning objective: *I am learning about microscopes so I can view things too small to see with the naked eye.*

Students may have experience of using magnifying glasses in KS1 and KS2, or even in their everyday experience. By starting with microscopes we can ensure all students have a common experience, which you can continually refer to as they learn about cells.

For this topic, the following resources are available on Boost:

Knowledge check

As this is the first biology topic, there is no **General science quiz** at the start. Display the *Knowledge check slide*. The questions are best delivered one by one on mini-whiteboards (MWBs). If students do not know the answer to any of them, you should reteach the relevant concept. Answers are not on the slides because it is best to go over them together as a class.

	Question	Answer	Notes
1	What is the smallest thing you have ever seen?	May include: human hair, grain of salt	This question is to get students thinking about small objects and the limits of our eyesight. Answers will vary depending on student experiences.
2	What does the 'naked eye' mean?	Without any lenses or way of making an object appear bigger	Students may also talk about cameras, so ensure that they know these use lenses and sensors.
3	Can you name something so small you can't see it with the naked eye?	May include: germs, particles	Again, this will depend on student experiences.
4	What could you use to see it if you wanted to?	Magnifying glass, microscope, hand lens	

Guided explanation

Why do we need microscopes?

While the idea of microscopes and the experience of using them might be common to students already, this explanation aims to build a common understanding of how a microscope works and to overcome misconceptions around focusing and magnification. Students often see microscopes as devices that just magnify and ignore the concept of focusing. This leads to common errors of language like 'zooming in' that carries over from their experience with digital technology.

Draw the diagram below. Students have not yet been introduced to cells formally, so construct the diagram sequentially, with each step accompanied with a simple explanation, similar to the one that follows.

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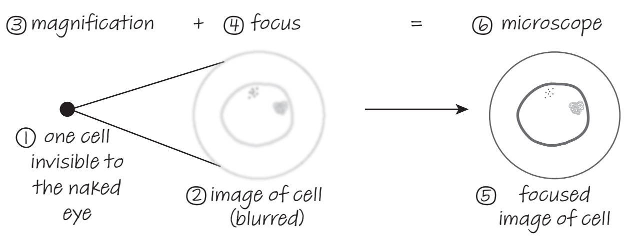

1. A cell is the building block of all living things. Cells are often very small, so are invisible to the naked eye.
2. When we look down a microscope we see what is called an 'image' – the original object, just bigger. In this case we want to look at an image of the cell.
3. This is called magnification – the image is magnified.
4. The problem we have is that when we enlarge the image it becomes fuzzy – we say it is out of focus. Luckily the microscope is designed to not only magnify but also to focus the image.
5. Once focused we have a clear image of the cell.
6. Overall, we have magnified and focused it. This is what a microscope does: magnification + focus.

The image of all the objects inside the cell now appears big and clear enough to see – the objects are magnified and focused.

Check for understanding

The Check for understanding (CFU) is best conducted using MWBs. Display the *CFU* slide and ask questions like the ones below. Tailor and adapt your questions to the class in front of you.

- What do we call it when we make something look bigger? *Look out for use of the word zooming in instead of magnifying and challenge the use of vague terms like 'make it bigger'.*
- What do we call it when we make a fuzzy, hard-to-see image clearer?
- What two functions does a microscope perform?

The independent practice for this section is included in the questions that follow the guided explanation below.

Guided explanation

How do we use a microscope?

Microscope demonstration

This demonstration is best caried out under a visualiser to ensure that all students can clearly see. If this is unavailable, it might be best to gather students around your desk. You will need a microscope and pre-prepared slide.

1. Show students each part of the microscope and discuss its purpose. Start with the eyepiece and work your way down the microscope to the focus knobs, objective lenses and stage, making sure you are clear about the role of each part.
   - Eyepiece – lens you look down; provides some magnification.
   - Focus knobs – adjust the distance between the slide and objective lens to bring the image into focus.
   - Objective lenses – a group of lenses with different magnifications, which allow you to control how magnified the image is.
   - Stage – where the slide is clipped to, so you can look through it.
2. Get a pre-made slide and go through the process of adjusting the microscope to create a focused magnified image.
3. Repeat the process, but this time use questions to get the students to tell you what to do at each stage.

Should you wish to use it, a diagram of a microscope is provided on the slide.

Check for understanding

Display the *CFU* slide and, using MWBs, ask questions like the ones below.

- What is the name of A? *Point or label different parts of the microscope for this question style.*
- What is the function of A? *Point or label different parts of the microscope for this question style.*
- What is the purpose of the mirror? *Students may not know the word reflect, so any answer that suggests directing light towards the specimen is acceptable.*
- What parts of the microscope magnify the image? *Check that students say both the eyepiece and objective lens.*

Independent practice review

Students practise independently by answering questions 1–25 from their Practice Books (page XX). Full answers can be found on the *IP answers* slide or in the answer documents on Boost. Notes are only included for questions where useful.

Q	Notes
2	Check to make sure that students move the slide to find some cells before increasing the magnification, as this is commonly missed. Ensure they can say why. Expected answers around it being easier to locate them will suffice.

Core practical

Making microscope slides

A method is provided on the *Practical Worksheet* and *Teacher and Technicians Notes* on Boost – including equipment list and safety notes – if you wish to allow your students to proceed independently. However, for most students it will ordinarily be better to take a *slow practical* approach following the guidance below.

Students should work in groups of no more than three. For each group and for yourself, provide microscopes, iodine, methylene blue, tweezers, cotton buds, slides and cover slips. You will also need an onion, knife, tiles or cutting boards and some disinfectant in a tub with a cloth.

Use a visualiser to make it easier for students to see as you model each step without leaving their workstation.

1. Assign the equipment by getting students to collect things as needed and return to their workstation. Show students how to correctly carry a microscope.
2. Set up a station at the front with the onion and the chopping board.
3. Demonstrate how to peel a single layer of onion cells and stain with iodine.
4. Set the groups to collect a sliver of onion from the cutting station and mount their own onion slide.
5. Take the students through the process of using the microscope. This would be a perfect time to use questioning, cold-calling students on the parts of the microscope and some of the key features. For example:
   - Why do we only use a thin layer of onion cells?
   - Why do we add the iodine to the onion before viewing under the microscope?
6. When the students have accurately visualised the cells under the microscope, they can record their observations by drawing a simple diagram on the *Name* worksheet on Boost.
7. Repeat the process with a cheek swab. Demonstrate the cheek swab technique and ensure that the students know to place their used cotton swabs and slides in the disinfectant. Again, this is a good chance to check understanding of the parts of the microscopes and the purpose of the methylene blue.

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- What is a molecule?
- How can you tell that carbon dioxide is a molecule?

If students have struggled with these examples, draw more similar ones and do further CFU.

Independent practice review

Student Practice Book questions 49–63 (page XX).

Q	Notes
56–60	Students work with unfamiliar substances and formulae. For the bubble diagrams the order of the bonding is not important – it is just important that the correct numbers and types of atom are in the substances.
61, 63	Students work with unfamiliar substances and formulae, drawing bubble diagrams from formulae and formulae from bubble diagrams.

C2.3 Elements and compounds

Students' learning objective: *I am learning about elements and compounds so I can explain the difference between them.*

The aim of this topic is to introduce students to compounds and the idea that they have properties that are completely different from the individual elements that form the compound.

For this topic, the following resources are available on Boost:

Knowledge check

After working through the *General science quiz*, display the *Knowledge check* slide and, using MWBs, deliver the questions one by one, reteaching concepts as necessary.

	Question	Answer	Notes
1	What is an element?	A substance made of only one type of atom	
2	How many types of atom are there?	92 (naturally occurring)	
3	Where are the different types of elements listed?	The periodic table of elements	'Periodic table' is sufficient.
4	What is the name for the one or two letters that are used to represent a type of atom?	Chemical symbol	
5	What form do chemical symbols take?	One capital letter or one capital letter and one lower-case letter	
6	What do we call the chemical symbols and numbers that tell us how many of each type of atom are in a substance?	Chemical formula	

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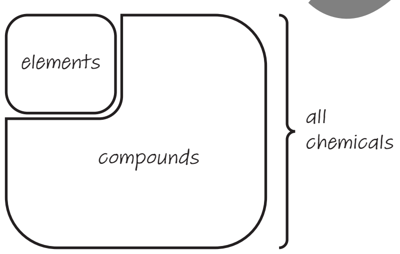
	Question	Answer	Notes
In the following questions the formulae should be displayed.			
7	How many different elements are there in are H_2?	One	These are two atoms of the same element joined in a hydrogen molecule.
8	How many different elements are there in NaF?	Two	Check that students recall that the small 'a' is part of the symbol for sodium.
9	How many different atoms are there in CO_2?	Two	Not three – the question asks how many *different* atoms.
10	How many different atoms are there in H_2SO_4?	Three	S and O are both capital letters, representing two different elements.
11	What are the three states of matter?	Solid, liquid and gas	

Guided explanation

What are elements and compounds?

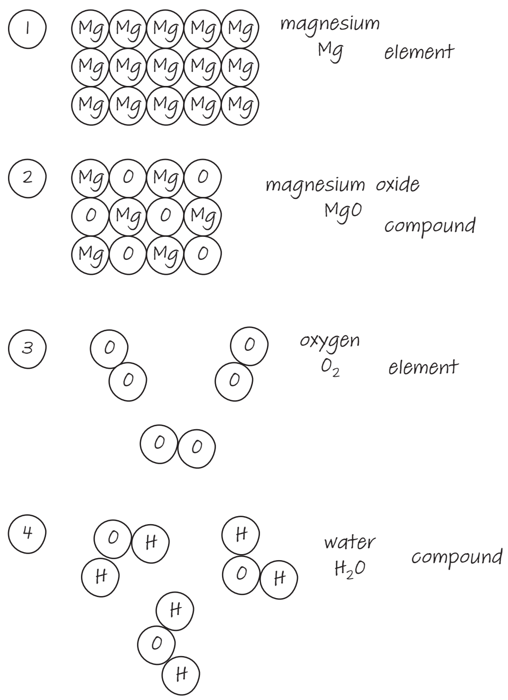
Recap that we have seen that there are 92 types of atom listed on the periodic table. If a substance is made of only one type of atom, then it is an element. When we looked at the formulae of substances, we saw that many substances, such as water, were made from more than one type of atom chemically joined together. We call these substances compounds. Whereas there are only around 100 elements, there are hundreds of thousands of combinations, which can form different compounds.

Draw the diagram below to illustrate that all chemicals are either elements or compounds, and there is no overlap.



Explain that since a compound is made of more than one type of atom chemically joined, and elements are made entirely of only one type of element, it means that all chemicals fit into one of these groups and there is no overlap at all. Say that it is usually easy to tell if a substance is an element or a compound, especially if you have its chemical formula, because compounds will have more than one chemical symbol in them.

Draw the diagram below to exemplify elements and compounds, constructing it sequentially, with each step accompanied with an explanation, similar to the one that follows.



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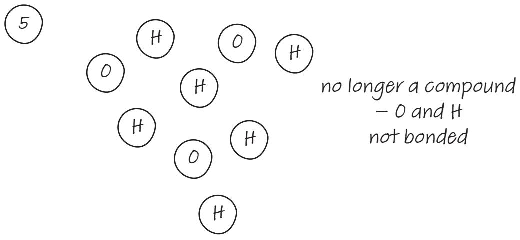

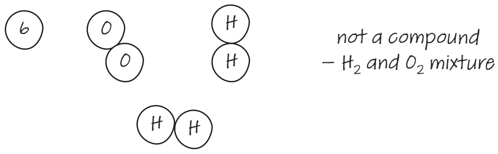

1 Taking magnesium as an example, it has the formula Mg, which only has one symbol and is therefore an element. As we can see from its bubble diagram, it is only made of Mg atoms, which again shows us that it is an element.

2 Magnesium oxide has the formula MgO, which has two symbols and is therefore a compound made from magnesium and oxygen atoms. We can also see from the bubble diagram that this substance is made from both magnesium and oxygen atoms joined together, and is therefore a compound.

3 Oxygen gas has the formula O_2, which shows us that oxygen particles are molecules made of two oxygen atoms joined together. Even when there are lots of oxygen molecules, they are all oxygen atoms and thus oxygen gas is an element made of only one type of particle.

4 Water has the formula H_2O, which shows us that water particles are molecules made of two hydrogen atoms and one oxygen atom. Even when there are lots of water molecules, this ratio is constant. Because water is made of oxygen and hydrogen atoms bonded together, it is a compound.

5 If we were to split all the H and O atoms apart from each other, is this a compound? No. This would no longer be a compound because the H and O atoms are not bonded to each other.

6 If they were to bond only to atoms the same as them, is this a compound? No. This is a mixture of H_2 and O_2 – two elements.

Check for understanding

Display the first *CFU* slide and, using MWBs, ask questions like the ones below.

- What is an element?
- What is a compound? *These two questions are vital and should be asked again in the CFU sequence if some students did not understand at the start.*

Formulae for the following questions should be written out on the board so their symbols are clear.

- Carbon dioxide has the formula CO_2; is it an element or a compound?
- Methane has the formula CH_4; is it an element or a compound? Explain why. *Since these 'element or compound?' questions could be a 50:50 guess, students should write brief explanations of their answers. Students not writing explanations should be followed up with a cold call to explain their answer.*
- Potassium has the formula K; is it an element or a compound? Explain why.
- Fluorine has the formula F_2; is it an element or a compound? Explain why.
- Hydrogen fluoride has the formula HF; is it an element or a compound? Explain why.

Display the second slide with the bubble diagrams. Ask students whether the diagrams represent elements or compounds. (You could also ask students to identify the formulae of these substances to check their skill of identifying formulae from the last topic.)

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Independent practice review

Student Practice Book questions 64–75 (page XX).

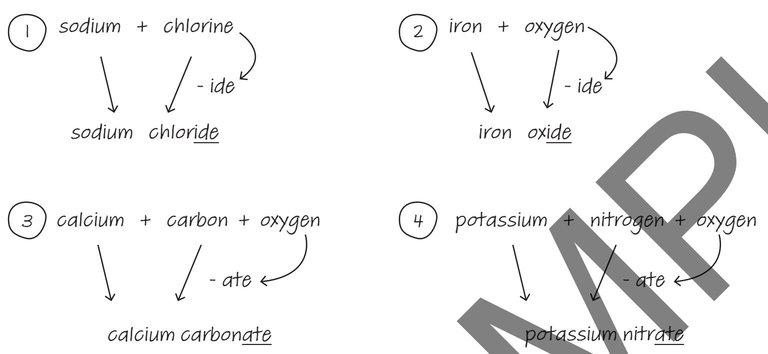
Q	Notes
66, 67	These questions confirm students' understanding of the definitions of elements and compounds.
71, 75	The questions allow students to practise classifying substances as elements or compounds, based on bubble diagrams or formulae.

Guided explanation

How do we name compounds?

Begin by explaining that a few compounds have special names, such as water (H_2O) and methane (CH_4); however, these are the only two that we need to learn at this stage. Most compounds are simply named using the elements that are combined within the compound.

Tell students that there are four simple rules that we use to name compounds systematically. Illustrate this by writing some examples on the board, step by step, as shown below.



1 **Rule 1:** The element further to the left in the periodic table (usually a metal) comes first in the name of the compound. For example, when sodium and chlorine react together, sodium is further to the left on the periodic table so comes first.
2 **Rule 2:** The second element in the name changes the end of its name to '–ide' to show that it is bound to the first element in a compound. When sodium and chlorine react together, chlorine changes to chloride. The compound is named sodium chloride.
3 Looking at the reaction of iron and oxygen, iron is further to the left on the periodic table so comes first, and oxygen changes to oxide. Therefore, the compound is iron oxide.
4 **Rule 3:** If there are three elements in the compound and one of them is oxygen, the second element in the name changes its ending to '–ate' instead of '–ide' to show that oxygen is the third element. For example, when calcium, carbon and oxygen atoms combine in a compound, calcium is the first name in the compound since it is furthest to the left, and carbon's ending is changed to '–ate' to show that oxygen is the third element within the compound. The compound's name is therefore calcium carbonate.
5 Looking at the reaction of oxygen, potassium and nitrogen combining to form a compound, potassium is the first element listed in the name because it is furthest to the left and the ending of nitrogen is changed to -ate because oxygen is also present. The compound's name is therefore potassium nitrate.

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P3.2 Naming and categorising forces

Students' learning objective: *I am learning how to name forces so I can explain how forces interact.*

Students should be comfortable drawing forces acting on an object. We will now need to introduce the 10 main forces and help students to categorise them. Students will have formal and informal knowledge of the different forces from prior education and personal experiences, but it is best to avoid the temptation to assume they know it all because they will have different gaps in their prior knowledge.

You will notice that tension is covered in this topic but is not included in the Knowledge Book. This is to ensure a focus for Year 7 on the most important and clearly defined forces. Electrostatic forces have also been omitted from this topic to reduce the number of forces that students are introduced at this stage. Unit P8 later in the course will focus on electrostatics and its importance.

For this topic, the following resources are available on Boost:

Knowledge check

After working through the *General science quiz*, display the *Knowledge check* slide and, using MWBs, deliver the questions one by one, reteaching concepts as necessary.

	Question	Answer	Notes
1	What is a force?	Push or pull	
2	What are forces measured in?	Newtons	Accept N.
3	What device is used to measure forces?	Newtonmeter	
4	What do we use to show forces acting on an object in diagrams?	Arrows	
5	What do we change to show the different sizes of forces acting on objects in diagrams?	The length of the arrow.	Make sure that students do not refer to the 'size of the arrow'.

Guided explanation

What are the main types of force?

This explanation covers the 10 main forces – it will introduce the forces and some contexts.

On the first slide, write *10 forces*. After each force is introduced, go back to this list and add the name of the force underneath. This will help show students what you have done so far, as well as provide a consistent thread through the explanation.

Explain each of the forces using stepped explanations, similar to the ones below.

You will need a magnet and an iron nail to demonstrate magnetism.

Applied force

1. *Applied force* is the name we use for any time a person applies a simple push or pull force.
2. Therefore, if we push something (demonstrate this), it is an applied push force.
3. And any time we pull something (demonstrate this), it is an applied pull force.
4. These forces do not have to be horizontal. We can push or pull things in any direction (demonstrate this).

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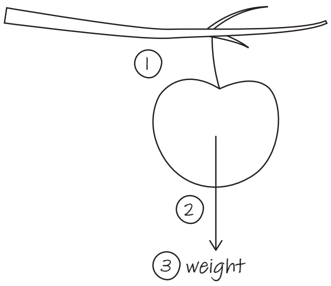
Note that this force is listed and named here in order to make examples simple to understand. It does not have as strict a definition as some of the other forces, but students will be able to get the hang of it via examples.

Weight

On the second slide, draw an apple hanging from a branch, as shown below.



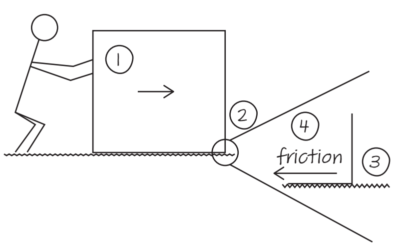
1 (Ask students) What will happen to the apple if the stem breaks?
2 The apple falls because it is being pulled towards the Earth.
3 The force that pulls the apple to the Earth is called *weight*.
4 Weight is the force that occurs when gravity pulls on an object with mass.

Thrust

1 Engines provide an applied push force that make objects move.
2 We call this force a *thrust*.

Friction

Rub your hands together. Say that when two objects move past each other, they rub. Then draw a person pushing a box, as shown below.



1 The push force is pushing to the right. The box will rub along the floor as it moves. This box will not move easily. Why is that?
2 If we zoom in, we can see the reason.
3 The surfaces are not smooth.
4 As the box moves, it gets caught on the tiny bumps and they provide a small force against the motion. All these tiny forces added together are called *friction*.

Air resistance and water resistance

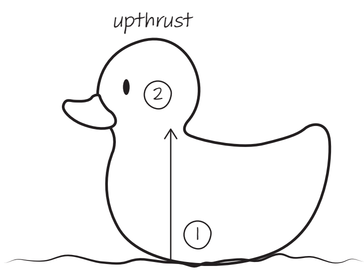
1 These two forces are very similar, so we have grouped them together. They work in the same way but in different situations.
2 When you move your hand through the air, you can feel a force of air (demonstrate this).
3 When you move your hand through water, you feel an even greater force. These are both types of friction because they push against, or resist, your movement.
4 The friction is caused by your hand trying to push the air or water particles out of the way and hitting them. We call it *air resistance* or *water resistance*.

Students often find air resistance hard to remember because they cannot see the particles, so going back to the demonstration of the hand moving through the air might provide a useful cue if they get stuck later.

When you return to your list on the board to add friction, air resistance and water resistance, point out their similarity in that they are all forces that oppose movement.

Upthrust

Draw a rubber duck on water, as shown below.

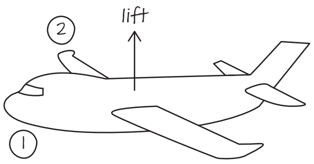


1 (Ask students) Why does it not sink? Weight must be pulling it down.
2 The water must be pushing it up. We call this force *upthrust*.

9781398385771.indb 163 31/07/23 9:21 PM

Lift

Draw a plane, as shown below.



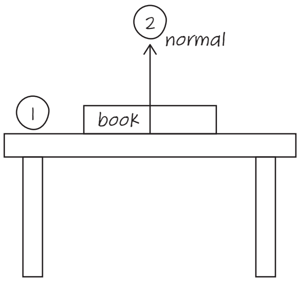
1 (Ask students) Why does the plane not fall to Earth?

2 The force that keeps flying objects from falling is called *lift*. It is a bit like upthrust, but it is not the same. A lot of students accidently call it upthrust, but it is different.

When you return to your list to add upthrust and lift, point out their similarity as forces that stop things falling down.

Normal contact

Draw a book on a table, as shown below.



1 If we put a book on a desk, the weight of the book is pulling down. However, the book does not fall. This is because the table is stopping it. It the table were made of paper it would not stop the book and it would collapse.

2 There must be a force resisting force preventing this. This force is called the *normal contact* force. It is called *normal* because that is the maths word for ninety degrees, and the force acts perpendicular to the surface of the object. It is called *contact* because the force is not there until the objects touch.

When you add normal contact force to your list, tell students it is similar to upthrust and lift in that it stops objects falling, but in this case it stops them falling through solids.

Magnetism

Using a magnet and an iron nail (under a visualiser), demonstrate magnetism.

1 The magnet attracts the iron. I can feel them pull together.

2 This is the force of *magnetism*. We will revisit this a little later in more detail.

You should now have finished your list of ten types of force. Display the list and emphasise that in every case we discuss, we are going to be using one of these forces.

Check for understanding

Display the *CFU* slide and, using MWBs, ask questions like the ones below. It is advised that you display your list of forces and explicitly show students how to use it to answer the questions.

- What force prevents planes falling to Earth?
- What force keeps a boat floating?
- What force opposes the motion of a box being pushed along a floor? *Ensure that students are clear on what the word 'opposes' means.*
- What force opposes the motion of a ball through the air?
- What force stops a shoe sinking into the mud? *Normal contact and upthrust are both legitimate, depending on the fluidity of the mud. The closer it is to a puddle, the closer it is to upthrust.*
- What force makes a rope go taut?
- What force pulls on a child sitting on a tree branch and what force stops the child falling from the branch?
- What force could I use to lift iron filings from a desk?
- What force opposes the motion of a shark swimming through the ocean?

9781398385771.indb 164 31/07/23 9:21 PM

- An object is falling and a student says that 'gravity force is acting on it'. Explain why the student is wrong.
- What force pulls an icicle off a roof?
- What force causes me to graze my knee when I fall over?
- Why is it easier to pull a box on a wood floor than on a carpet?
- Why is there no air resistance on the Moon?
- A fish is swimming straight ahead. A student says 'upthrust is slowing it down'. Explain why the student is wrong.

Independent practice review

Student Practice Book questions 13–20 (page XX).

Q	Notes
20	This question links P3 back to P2, so students should be encouraged to look back at Unit P2 of the knowledge book if needed.

Guided explanation

What are interactions?

The idea of interactions between two objects that create pairs f forces is complex, and so it is suggested that you use the information from the students' performance in prior areas of the unit to adjust the depth of your explanation and possibly simplify it if required for some students. The most important aspect of the explanation is to build an awareness of the types of force students will come across in their science education.

Explain that what we have seen so far is that forces *always act between two objects.*

1 For example, a magnet cannot be attracted or repelled without there being a second magnet. We cannot pull tight against a rope and create tension if there is nothing on the end of it.

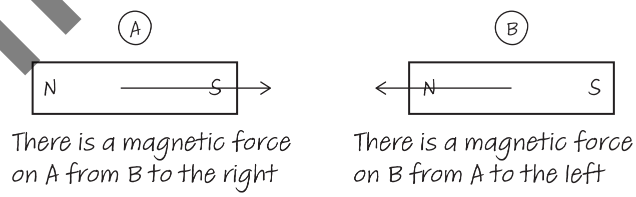
2 We call this an *interaction.* The two objects *interact* with one another.

3 The forces between the objects always come in pairs. Each object experiences a force from the other and the forces are always in the opposite direction.

4 Illustrate this by working through the following examples, using stepped explanations, similar to the ones below. You will need two bar magnets to demonstrate magnetism.

Magnetism

Take two bar magnets. Place them so that they are visible to the class (under a visualiser). Hold them a distance apart, oriented so they will attract. Draw a diagram as shown below, (possibly placing the magnets on top of it).



1 Magnets A and B will attract because the poles are opposites of one another. Therefore, they will move together. (Let the magnets go, so the students see them move together.)

2 When we say *attract*, what we mean is that there is a force *on each of the magnets from the other.* (Add arrows to show the direction of the force that each magnet experienced.)

3 There is a magnetic force *on* B *from* A to the left. But there is *also* a magnetic force *on* A *from* B to the right.

We will use this phrasing every time we look at forces – there is a (name of force) *on* (object 1) *from* (object 2) (state direction).

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