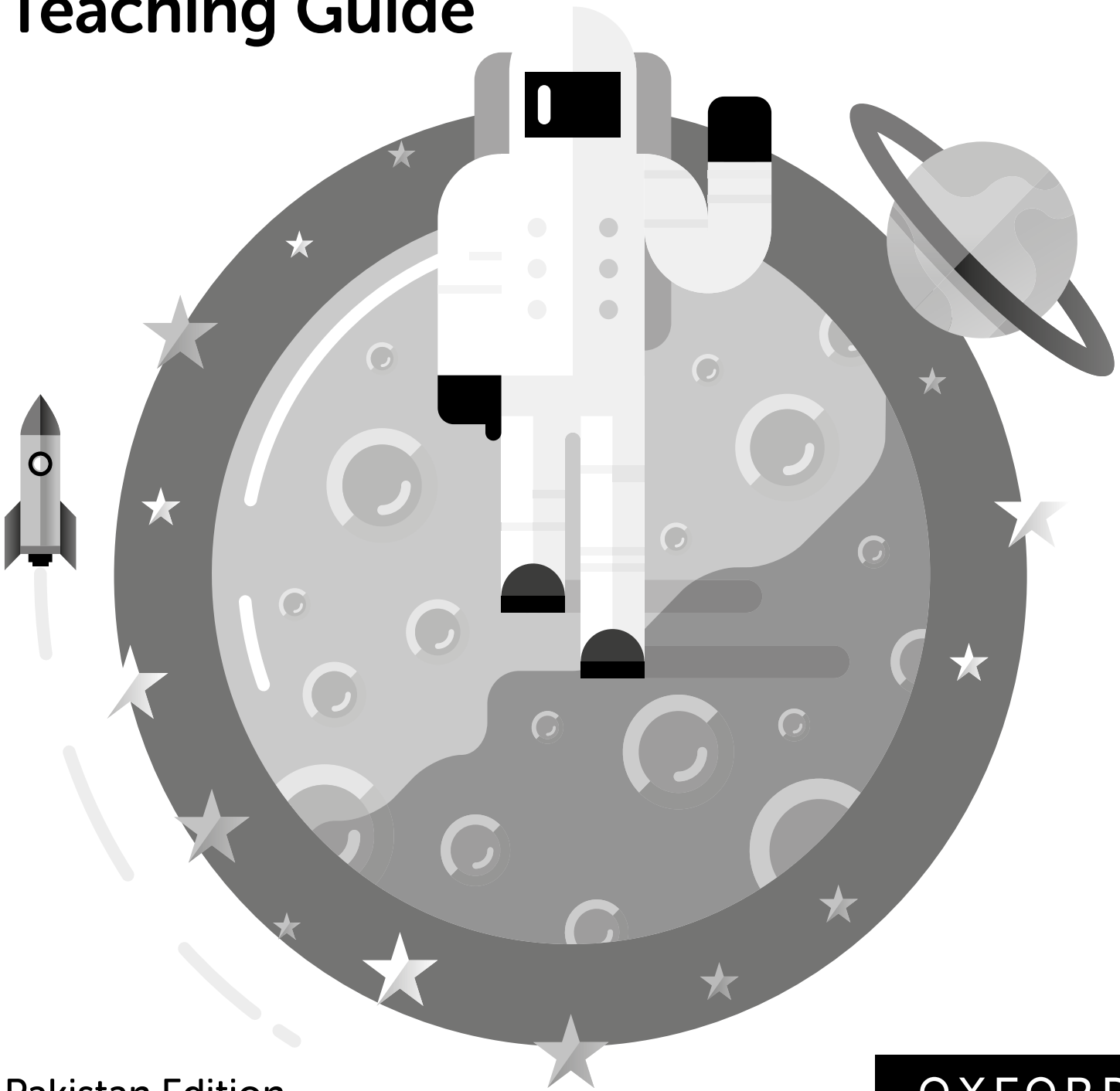
Oxford International Primary

Grade 5

Science

Teaching Guide



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Introduction

The joy of learning science

We are living in an ever-changing world, where the way we work, live, learn, communicate and relate to one another is constantly shifting. In this climate, we need to instill in our learners the skills to equip them for every eventuality so they are able to overcome challenges, adapt to change and have the best chance of success. To do this, we need to evolve beyond traditional teaching approaches and foster an environment where students can start to build lifelong learning skills for success. Students need to learn how to learn, how to problem solve, be agile and work flexibly. Going hand-in-hand with this is the development of self-awareness and mindfulness through the promotion of wellbeing to ensure students learn the socio-emotional skills to succeed.

Teaching and learning with *Oxford International Primary Science*

This series is based on the English National Curriculum Programme of Study for Primary Science. The books for each year (or stage) follow the scheme and meet all the learning objectives – including working scientifically. Each lesson includes the learning objectives from the curriculum and a summary of the key teaching points.

The teaching units in the series are flexible: they can be adapted as you see fit to meet the needs of your students. Each unit stands alone and can be taught in any order.

The books are designed for students aged 5 to 11. Underpinning the rationale for the series is the strong belief that science provides a way of thinking and working. It helps us to make sense of the world we live in and provides intellectual skills that help us in all curriculum areas and in life.

This introduction shows how to use the resources to develop your students' scientific knowledge, skills and understanding.

This series has seven main aims:

1 To deliver scientific knowledge and facts

2 To deliver scientific understanding

3 To deliver scientific methods of enquiry and working scientifically

4 To deliver scientific thinking and reasoning

5 To help students understand the development of science and its uses in context in the world around them

6 To support the wellbeing of students

7 To give students a global outlook

1 Scientific knowledge and facts

The Student Book introduces concepts in a logical sequence and ensure that new ideas are introduced sensitively. Key scientific concepts and ideas are explained. Students are then asked to discuss and apply their new knowledge.

2 Scientific understanding

Knowledge without understanding is only useful for recall. Understanding moves to a deeper intellectual level and enables students to think and apply that knowledge. Effective learning requires students to develop appropriate attitudes, skills and enthusiasm, and this can be encouraged by good teaching and exciting resources. This means students can gain an understanding of the principles and practice of science.

The knowledge, or content, in this series is based on the English National Curriculum. Each book has five units.

Though this is not a theoretical book, it is important to consider underpinning ideas that have informed good practice in the classroom:

- Teaching approach
- Cognitive style
- Active learning

Teaching approach

The kind of teaching strategies used are key to achieving understanding. Telling and giving students information is important but usually only improves students' short-term memory of scientific facts. This is often called 'passive learning' as students are not intellectually engaged in the process themselves.

Teaching and learning can either be teacher-centred (didactic) or student-centred (heuristic). Good teaching is a combination of these.

Didactic	Heuristic
Advantages • Clear learning objectives • Teacher can demonstrate a professional approach, e.g. presentations • Teacher is seen as 'expert' • Fewer problems with classroom management and behaviour	*Advantages* • Can be motivating and powerful • Develops a range of skills • Learning is relevant • Encourages creativity and problem solving • Student has a say in the learning
Disadvantages • May build on inaccurate knowledge • May not be motivating • Does not develop skills • Does not give students responsibility • Limited by the teacher	*Disadvantages* • May not deal with underlying principles – too pragmatic • If only existing skills are learned, this approach may not encourage questioning of existing approaches • Lack of structure may confuse • Classroom management may be problematic

Advantages and disadvantages of teacher-centred and student-centred approaches (Cotton, J., 1995, *The theory of learning: an introduction,* Kogan Page, London)

Cognitive style

Cognitive style is a student's personal and preferred way of organising and representing information. The cognitive style, or way of thinking, impacts on how our students see and make sense of the world.

Cognitive styles can be split into four types:

1 Wholists like to see the whole picture when learning – the big picture.

2 Analysts prefer to get down to the detail and look at only one or two details.

3 Verbalisers welcome chances to talk through problems.

4 Imagers see mental pictures when dealing with information.

Most people are a combination of all of these but have a preference for one or two. These cognitive styles may have a major impact on the processing of information.

We need to be aware of the possible cognitive styles of our learners and ensure that our approach balances all four styles.

Lev Vygotsky stressed the importance of social relationships between the teacher and learners, and amongst learners. He stressed that language and discussion are key to development.

Benjamin Bloom proposed an 'educational taxonomy' identifying different learning 'domains':

- Cognitive (knowledge)
- Affective (attitudes)
- Psychomotor (skills)

The domain can be seen as a ladder that starts with remembering and proceeds to more complex tasks such as analysing. The 'rungs' of the ladder are:

1 Recall data

2 Understand

3 Apply (use)

4 Analyse

5 Synthesise

6 Evaluate

This ladder helps teachers to devise tasks, sequences of tasks and questions appropriate to the level of thinking of their students. Considering this will help develop your students' ability to think and reason.

Active learning

Active learning approaches encourage students to engage with tasks and to develop skills that they may not develop during teacher-led, didactic lessons. Active learning combines a number of models of teaching growing out of 'discovery learning' ideas.

Whole-class instruction can be as effective as individual instruction, especially in terms of the time students spend on tasks. The key to effective teaching is the appropriate selection of approaches at any particular time and with any particular group. The table opposite summarises common teaching approaches. It does not indicate poor teaching on the left (teacher-centred) and good teaching on the right (student-centred).

Possible active learning strategies

- Group discussion (talking and listening)
- Active reading
- Active writing
- Presentation
- Role-play and drama
- Information technology
- Visits, visitors and field trips
- Data handling
- Problem solving
- Video and audio tape recording
- Games and simulations

Questioning and group work are very important. These will be dealt with in more detail on pages ix–xi.

The Student Books present ideas in a range of ways – written, diagrams, charts, tables and photographs. The lessons contain a rich variety of learning and teaching approaches, such as individual reading and writing, paired and small group discussion work, whole-class discussion and activity, problem solving, investigations, research activities, presentations, surveys and review and reflection. In addition, suggestions for other activities, such as field trips and educational visits, are included in the Teacher's Guide.

3 Scientific methods of enquiry and working scientifically

This series promotes scientific enquiry and closely follows the working scientifically objectives in the English National Curriculum. Students are encouraged to use and reflect on the different ways that scientists work and think, which have produced the knowledge, theories and laws of science over the last 1000 years. It is based on 'empiricism'; arriving at knowledge and understanding through observation and experiment.

Scientists progress by observation and questioning what they see and already know. From this, they develop hypotheses which they test by experiments and develop new knowledge. This will be further explored in the section 'How to be a Scientist: Scientific Enquiry' on pages 2–3 of this Teacher's Guide and in the student resources.

Science teaches students to think in a structured way that is good for analysing and solving problems. However, students should understand that science is also a creative human endeavour. Imagination is vital to scientific progress.

The books in this series allow students to develop their skills to work scientifically by addressing each of the appropriate scientific enquiry processes at each stage. Students are encouraged to plan and carry out full-scale investigations in the later stages and, as such, apply the skills learned earlier.

4 Scientific thinking and reasoning

It is essential to encourage students to think and reason for themselves. Thinking and reasoning are important life skills. The abilities to think, reason and research make students independent learners who can interpret and understand new ideas more quickly. Unfortunately, this aspect of education is often neglected.

In this series, the ability to think and reason will be encouraged, nurtured, practised and assessed at each level. Scientists use deductive logical thinking to make sound inferences which take them from the known to discover the unknown. They use reason and argument based on fact and evidence to prove their case. Allowing students to experience these processes promotes their curiosity and enthusiasm. 'Discovery learning' approaches allow students to experience the thrill of finding out.

Resist the temptation to provide answers, solutions and too much support for your students. We hope that the learning activities within the books, and the support provided in the Teacher's Guide, will help you to create a learning environment where at times students can plan, find out and learn new ideas themselves – with you as a guide and facilitator. Allow them time to think and discuss ideas before gently guiding those who need support.

Teacher-centred learning	**Student-centred learning**
Teacher exposition	Group work
Accent on competition	Accent on cooperation
Whole-class teaching	Resource-based learning
Teacher responsible for learning	Student more responsible for learning
Teacher providing knowledge	Teacher as guide/facilitator
Students seen as empty vessels which need filling	Students have ownership of ideas and work
Subject knowledge valued	Process skills are valued
Teacher-imposed discipline	Self-discipline
Teacher and student roles emphasised	Students seen as source of knowledge and ideas
Teacher decides the curriculum	Students involved in curriculum planning
Passive student roles	Students actively involved in learning
Limited range of learning styles and activities	Wide range of learning styles employed

Select a variety of approaches to promote active learning

5 Science in context

It is vital to link what students learn in the classroom to the real world. This makes their learning relevant and helps them to relate new ideas to their own experiences:

- Stress that science involves an ongoing process of change and improvement in ideas. Explain that our ideas about science are built on earlier ideas. Point out that people in the past could only use what they knew at the time to make sense of the world. Sometimes this meant they put forward ideas that scientists now know are not correct. For example, many people thought that the world was flat, and the Sun orbited the Earth.
- Emphasise that some early thinkers created ideas that are still remarkably similar to our modern ideas. For example, over 2200 years ago Aristarchus suggested the Earth orbits the Sun. Democritus stated that matter is made of smaller particles more than 2300 years ago. Even our understanding of forces, based on Isaac Newton's laws of motion, were proposed by Philoponus over 1500 years ago.
- Explain that science theories develop when a person or a team puts forward new ideas. If other scientists test these ideas and agree then the idea becomes a part of science theory. It might be changed later with new evidence. This is how ideas develop.
- Explain that developing new technologies and materials also helps form new science ideas. For example, until the invention of the microscope 500 years ago, scientists could not see microorganisms and did not know they existed. Improvements in telescopes have resulted in changing ideas about the stars and even our nearest planets. Modern materials have allowed spacecraft and computers to be made.

The activities in each lesson provide you with many opportunities to relate the science content and processes to the real world. Whenever possible, take students out to see examples of science being used in the real world – such as on farms, in factories or even at an airport. You can invite people in to talk about their jobs and how they use science – for example, doctors, vets, farmers, gardeners and builders.

6 Wellbeing

The Student Book provides opportunities for teachers to consider the vital importance of wellbeing and to weave this into their teaching. The enquiry-based approach encourages curiosity and helps students to think about the world around them.

Wellbeing does not mean feeling happy all of the time. Making mistakes, feeling challenged and even being confused at times can help to develop resilience.

The resources support wellbeing directly by:

- **Providing questions and science facts** to challenge and engage students. They can reflect on prior learning and apply new skills.

For example, students are encouraged to reflect on their work in earlier years on pushes and pulls when investigating balanced and unbalanced forces.

- **Encouraging active science.** This means an active brain and also an active body. Students learn better and make better progress when they are physically active in lessons.

For example, students move around to model the Earth's spin and day and night. They also build and test exploding seed pods and carry out surveys of the local area.

- **Promoting group work.** Collaborative work is used throughout the resources so that students have opportunities to develop their collaborative skills. This growth through practice develops confidence and happiness.

For example, students collaborate to investigate seed dispersal, make and test a fire extinguisher and present ideas in a variety of ways such as computer presentations, posters and information leaflets.

- **Presenting 'stretch zone' challenges** to encourage students to develop thinking skills and welcome challenge. They will become more familiar with moving away from a 'comfort' zone into the 'stretch zone' without worrying.

For example, students are asked to apply their knowledge of materials to classify soluble and insoluble substances, reflect on exothermic reactions and explore day lengths around the world.

- **Offering mindful moments.** These provide opportunities for students to pause and re-focus their attention.

For example, the end-of-unit questions in the Student Book offer ideal opportunities for students to think about their learning. There are also opportunities to encourage mindful moments during lessons and these are indicated on the lesson spreads that follow in this Teacher's Guide.

Teachers are encouraged to develop the following approaches:

- Providing praise with a growth mindset. Teachers should work to praise the process rather than the intelligence or marks. Giving positive feedback on how something is being done is highly effective. This includes praising effort, perseverance, resilience, teamwork, strategies, etc.
- Discussing and evaluating mistakes. Learning always involves making mistakes. Students should not fear or worry about mistakes. They should see them as opportunities to learn.

7 A global outlook

The *Oxford International Primary Science* resources are designed to address the idea that academic lifelong

success is the result of both academic performance and emotional wellbeing. As educators we want to prepare our students for a workplace that is unknown to us. Ideas and activities identify areas where students can develop skills while feeling safe and confident enough to apply themselves to the content of the lessons. Skills are separated into distinct categories designed to provide the opportunities to develop key lifelong skills. Students are inspired by images and information that result in curiosity and wonder. Students become confident problem solvers by taking risks that also develop creative skills. Real-world skills are encouraged through carefully designed projects and activities. Students are introduced to project management and aspects of literacy, for example financial and functional literacy. There is an emphasis on carrying out research and careful analysis of the information that they find in addition to their own findings and data. Students have opportunities to develop interpersonal skills through communication and relationship building. They are encouraged to voice their ideas through discussion activities. The projects particularly allow students to take part in leadership roles and the responsibility that comes with this. The resources address the students' self-development skills through critical thinking, ethics and motivation. There are a number of sections throughout the scheme where students are introduced to ethical and sensitive issues.

Wellbeing is an area that is emphasised in the resources with a desire to address mental health issues, supporting learners in and out of school. Students are encouraged to care for their own minds by promoting mindfulness and to manage stress more effectively. Students should become more optimistic about their lives and the world around them. They are encouraged to care for their bodies with an emphasis on being active and eating healthily. Students are encouraged through a number of activities to build and maintain relationships and friendships with family and others. They learn how to communicate confidently with a range of people and connect through kindness and thoughtful behaviours. Students are more conscious about the world beyond their immediate environment but know they have a valued role and place, resulting in becoming better and more responsible lifelong citizens from an early age.

Teaching techniques for this series

Science learning is made up of:

- Remembering science facts
- Gaining scientific knowledge
- Developing science skills
- Developing science understanding

Facts are important but being told facts does not ensure knowledge and understanding. Working out science problems and engaging with scientific processes is much more likely to help students develop understanding. This is why applying scientific skills – doing science rather than remembering it – is vital.

Think about the question below:

Question: Who was the scientist who discovered the force of gravity?

Answer: Isaac Newton.

Knowing the answer to this question takes the learner no further. It demands no higher order thinking skills and does not help with solving any other problems. However, if a student understands Newton's theory of gravity and motion, they can start to explain and predict how things move, float and fly. Understanding enables a student to apply knowledge and solve problems and furthers their learning.

This series aims to provide science facts and knowledge but also science understanding. Certain strategies are better at teaching understanding than others.

Effective questioning is the key

Students can learn to understand by listening and reading. This is only possible if they have acquired advanced learning techniques and have sufficient background knowledge and understanding in which to fit any new ideas. That is why you can enhance your understanding, for example about your teaching, through these approaches, but this is not true for young learners. For inexperienced and less skilled students, the teacher enables them to progress from memory recall to deeper understanding. This series focuses on teaching and learning approaches that promote understanding. Science facts and knowledge are covered, of course, otherwise there would be a lack of context and content, but the activities are also designed to develop thinking and learning skills.

Research tells us that teachers ask up to 400 questions per day. That can be 30 per cent of teaching time. It is clear then that time spent improving our questioning techniques will have an important impact on learning.

To give you some idea about the complexity of questioning you may wish to think about your own practice:

- Why you are asking a question
- What type of questions you are going to ask
- When you are going to ask questions
- How you are going to ask questions
- Who you are going to ask questions to
- How you expect the questions to be answered
- How you will respond if the person does not understand the question
- How you will react to an inappropriate or wrong answer
- How you will react to an appropriate answer
- How long you will wait for an answer

As teachers we ask questions for a number of reasons:

- To get attention

- To check students are paying attention
- To check understanding
- To reinforce or revise a topic
- To increase understanding
- To encourage thinking
- To develop a discussion

Bloom describes six levels of thought process:

- Knowledge
- Comprehension
- Application
- Analysis
- Synthesis
- Evaluation

We need to ask questions that encourage deeper thinking. If we only ask questions at the knowledge end of the spectrum, we will not encourage students to analyse or synthesise new ideas.

We also need to think about the nature and style of our questions. Two major categories are closed and open.

Closed questions

These tend to have only one or a limited range of correct answers. They require factual recall. They are useful for whole-group question and answer sessions, to quickly check learning or refresh memory or as a link to new work. Examples include:

Question: What is the boiling point of water at sea level?

Answer: 100°C.

Question: What are the three stages of the water cycle?

Answer: Water; clouds; rain.

These are very good for knowledge recall but are generally non-productive regarding anything else.

Open questions

These may have several possible answers and it may be difficult to decide which are correct. They are used to develop understanding and encourage students to think about issues and ideas. They encourage students to think and manipulate information and are much more complex. We are not looking for a single right answer; we are looking for what the student thinks may be the right answer. Once the teacher gets the student thinking, then the teacher can use this information to move the learning on towards the right answer, while promoting understanding at the same time.

Examples include:

Question: Where do you think the water in rain clouds comes from?

Answer: Any answer will have a little 'rightness' in it that the teacher can use. The student may answer 'From the sea.'

The teacher can then follow several further lines of enquiry to extend the learning. For example, the teacher could ask, 'Do you know of any other places the water might have come from?' Or 'How do you think that the water got into the clouds?'

These follow-up 'how' and 'why' questions encourage students to think more deeply about the science and their understanding of the key ideas and principles.

Open questions require students to make links between ideas and apply knowledge – they often require students to be logical and imaginative. They require a longer time to think and answer than closed questions, and may lead on to wider discussion and debate.

Question series

Closed and open questions can be linked together to form a series. A series must be well planned but can lead to much improved understanding. Start with a few relatively easy factual closed questions and move towards more open questions. This is known as 'agenda building'. At the same time, you can move from individual to paired and then to small group discussion as the questions become more open and demand higher-level thinking.

In this series we promote an 'enquiring classroom' where closed questions are used, but also open questions which promote enquiring minds.

Question and answer techniques – some tips

1 The 'don't lead students down dark tunnels' technique

Students need to know where they are going before they start their learning journey, so tell them. For example:

'Today we are going to learn how magnets react to each other.'

This gives students the big idea on which they can hang the information that follows and make sense of it.

2 The 'ask students what they think' technique

Students usually lack the confidence to answer questions like:

'How did the water from the sea get into the clouds?'

Unless they are confident they know the correct answer, they will probably be reluctant to answer because they are afraid of failure. However, rephrase the question and say:

'How do you think that the water might have got from the sea up into the clouds?'

Then you are giving them permission to try even if they are not sure they are correct. In this way you do not always get the same students volunteering answers and you can give other students confidence.

3 The 'praise all answers' technique

To encourage students to share their thinking and

suggestions, we have to value and thank them for their efforts. We may say, 'Good try but not quite there yet. Let me see if I can help you – do you think it could have something to do with the heat of the Sun?'

There is usually an element of correctness in most students' attempts which we can praise.

4 The 'teach from students' answers' technique

In one Student Book there is a question which asks:

'Why does a watermelon contain 600 seeds?'

As a student, I do not know the answer and I am afraid of failure.

If the teacher asks students what they think and values their answers, then this productive line of enquiry will help take a student and the rest of the class to the correct answer as well as an understanding.

Select the element of correctness from the student and then expand and explain to help all the rest of the students understand. For example:

Student: I think it is because they want to grow lots of new watermelons!

Teacher: Good answer. It is all about germination and new life. However, do you think that when one watermelon sheds its seeds, there will be 600 new watermelons springing up beside it?

Student: No, not all 600!

Teacher: Good, that's important. You have told me that not all of them survive. How many do you think survive?

The teacher leads and expands and informs the student's answers to arrive at the understanding of 'producing many, so that a few can survive to carry on the species'. Because students have been actively involved in this journey they will not only remember; they will understand.

5 The 'do not let students struggle' technique

If you find that you are asking questions and the answers are nowhere near what you are looking for, then give students the answer or suggest a choice of answers. Without this, the progress of the lesson is halted and students and teacher get frustrated; move the lesson on. Tell them and expand and explain your answer.

6 The 'right answer' technique

If you get the right answer, then all is good, or is it? Only the person who has given the answer understands why it is correct so you need to expand and explain, so that the rest of the class can share in that student's understanding.

Teacher: Good answer, what made you think of that?

Teacher: I see what you mean; you made the connection between the boiling kettle and steam and thought the Sun's heat did the same with the sea only it is invisible. Well done!

Whole-class or group work

Whole-class question and answer methods work very well and highly structured whole-class activities can help to keep students on task. However, maximum contributions and participation are usually encouraged in small groups.

Group work can help students to learn more effectively. They can learn science better and cooperative learning can help social cohesion, motivation and improvements in self-esteem. The student who is shy is more likely to contribute to a discussion with another person or one or two other people than volunteer ideas in front of the whole class. In addition, by sharing work, students can cover more ground more quickly. The small group is also a good forum for generating creativity.

Another advantage is that small group work frees the teacher from having to be at the front and leading the whole class. The teacher can move around the room and direct attention and support when and where it is most needed. Individual needs can be better met in this way.

Some specific examples of group work are described below.

1 Short, informal discussions

These are sometimes called 'Buzz groups'. They are very useful as they do not need any structure and can be used at any time. Simply ask pairs or small groups to look at a picture or think about an issue and then give them a few minutes to share their ideas. There are numerous examples of these in the resources, linked to questions for the buzz groups to consider.

2 Think-pair-share

Students think about something individually for a few minutes and work with a partner to compare their ideas. Finally, the pair present their ideas to the class.

3 Circle of voices

This works with larger groups of students (four, five or six). Students take it in turns to speak about their ideas on a topic or question. No one else is allowed to speak so this helps to develop social and listening skills.

4 1-2-4

Students think about an issue or carry out a task individually – for example, make a list of animals and plants they have seen – and then work with a partner to compare lists and discuss a slightly more complicated question – for example, which animals eat other animals. Finally, pairs join to form fours. They share ideas and then work together on a final task – for example, make some food chains.

5 Jigsaw

Students work alone to become experts on an aspect – for example, different habitats – then join back together to share their expertise and answer a larger question – for example, how are animals adapted to habitats?

Differentiation

Differentiation is closely linked to inclusion: ensuring all students have access to the curriculum. This means that learning and teaching approaches must consider individual needs. Not all learners will learn at the same pace or in the same ways.

Approaches supported by the resources are:

1 **Modifying content.** At times we can adjust the content for some learners to provide sufficient support or adequate challenge. Examples are the stretch zone tasks in the Student Book. This is often called differentiation by task.

2 **Differentiating expected outcomes.** This allows all students to tackle the same tasks but outcomes are differentiated – usually in terms of 'All students should…', 'Most students will …' and 'Some students may …'. These differentiated outcomes are given in each lesson section of this Teacher's Guide. This is often called differentiation by outcome.

3 **Differentiating the process.** This means providing more or less support as students are carrying out a task. Advice on this is in each Teacher's Guide lesson section and also there are additional support activities that can be given to some students. For example, investigation support pages.

4 **Questioning.** This is a very effective way of differentiating work. Use questions to check progress and decide when extra support or challenge is needed. Questions in the resources are designed to progress from low on Bloom's taxonomy (remember and understand) towards higher levels (analyse and evaluate).

5 **Varied approaches to assessment**. The resources include a wide range of assessment methods. These include verbal, written and drawn responses and individual and collaborative assessments. There are also differentiated questions ranging from easier introductory questions to more challenging ones.

Assessment

Assessment is an essential part of learning. Without being able to check progress, teachers and students will not be able to identify areas of strength and areas in need of development.

Assessment can be classified as either formative or summative.

Formative assessment takes place during learning and is used to address issues as they arise. This means learning and teaching can be modified during lessons to better meet the needs of learners. Feedback to students is ongoing.

Each activity within the Student Book provides opportunities for formative assessment and feedback. This can be through teachers listening to discussions or presentations, observing the outputs of investigations and through assessing outcomes such as posters, reports and leaflets. Individual questions in discussion tasks can be used to monitor understanding and identify misconceptions. These can be addressed as they are noted. Some of these are noted in the Review and reflect sections in the lesson guidance in this Teacher's Guide.

Summative assessment is used to measure or evaluate student progress at the end of a process – for example, when a unit is completed or at the end of a year. Summative assessment compares students' attainment against a standard or benchmark.

The 'What have I learned?' features at the end of each unit can be used for summative assessment. Teachers can record which questions each student is answering correctly and use this to measure individual attainment. It can also indicate how well the class is progressing through the work. In this way, the assessment can inform individual interventions (extra support for a student) or whole-class interventions (reviewing work that is not well understood).

Each activity – group and individual – can be assessed through observation and questioning and progress notes. Written or drawn responses for each activity, can be assessed/marked using the school's marking policy and unit, end-of-term and end-of-year judgements made about individual and class progress.

Feedback is a crucial aspect of assessment. This should be as positive and encouraging as possible (see the wellbeing section) and identify clear targets. Involve students in assessment and target setting. Assessment is done with learners not done to learners.

How to Support Non-English Speakers

Teaching Primary Maths and Science through English: identifying the challenges and providing the support

The challenges

Ministries of Education at both local and national level are increasingly adopting the policy of English Medium Instruction (EMI), as improving the levels of achievement in English is usually an important factor.

In international schools it is likely that students do not share a mother tongue with each other or perhaps the teacher. English is, therefore, chosen as the medium for instruction to level the playing field and to provide the opportunity to develop proficiency in an international language.

This does not mean that the maths or science teacher is now being asked to replace the English teacher, or to have the same skills or knowledge of English (though in many primary schools one teacher may indeed teach both). It does mean that the science or maths teacher needs to become more language aware.

This raises significant challenges, including:

- the teacher's knowledge of English
- students' level of English (which may vary considerably in international schools)
- resources which provide appropriate language support
- assessment tools which ensure that it is the content and not the language which is being tested
- differentiation which acknowledges different levels of proficiency in both language and content.

Meeting the challenges positively

Perhaps lack of confidence in their own English proficiency is one of the most common concerns among teachers. However, while it is a factor, success in EMI is not necessarily linked to the teachers' proficiency in the second language. Teachers who have English as their mother tongue may well lack the sensitivity to, or awareness of, the language that a non-native speaker has acquired through learning and studying the second language. Developing this awareness and demonstrating it in both materials and method is the key to effective EMI.

Classroom language/Teacher Talk

Often non-native-speaker teachers are more concerned about their ability to run and manage the whole class in English than they are about the actual teaching of the maths or science concepts. The resources or textbook should help them with the latter. However, this use of English in the class is very important as it provides exposure to the second language, which plays a valuable role in language acquisition. The Teacher Talk for purposes such as checking attendance and collecting homework does not have to be totally accurate or accessible to students.

When teaching the science concepts, however, it is essential that the Teacher Talk is comprehensible. Some basic strategies to ensure this include:

- simplify your language
- use short simple sentences and project your voice
- paraphrase as necessary
- use visuals, the board, gestures and body language to clarify meaning
- repeat as necessary
- plan before the lesson
- prepare clear simple instructions and check understanding.

Creating a language-rich environment

Primary teachers often excel at providing a colourful and engaging physical environment for students. In the EMI classroom this becomes even more important. Posters, Word walls, lists of key structures, students' work and English signs and notices all provide a backdrop which provides the opportunity for exposure and language acquisition.

Planning

When planning the teacher needs to identify what the Language Demands are. This means thinking about what language students will need to understand or produce, and deciding how best to scaffold the learning to ensure that language does not become an obstacle to understanding the concept. This involves providing Language Support and goes beyond the familiar strategy of identifying key vocabulary.

Support for listening and reading

Listening and reading are receptive skills, requiring understanding rather than production of language.

Here are some suggestions for approaching such tasks.

If you are asking your students to listen to or read texts in English, ask yourself the following questions when you are planning the unit:

1 Do I need to teach any vocabulary before they listen/read?

2 How can I prepare them for the content of the text so that they are not listening 'cold'?

3 Can I provide visual support to help them understand the key content?

4 How many times should I ask them to read/listen?

5 What simple question can I set before they listen/read for the first time to focus their attention?

6 How can I check more detailed understanding of the text? Can I use a graphic organiser (e.g. tables, charts and diagrams) or gap-fill task to reduce the Language Demands?

7 Do I need to differentiate the task for those students who find reading/listening difficult?

8 Could I make the tasks interactive (e.g. jigsaw reading i.e. when students access different information before coming together, and information share)?

9 How am I going to check their answers and give feedback?

Support for speaking and writing

Speaking and writing are productive skills and may need more language input from the teacher, who has to decide what language students will need to complete the task and how best to provide this. When you plan to use a task which requires students to produce English (speak or write), you need to think about how to help them do this.

This means that you have to think in detail about what language the task requires (Language Demands) and what strategies you will use to help them use English to perform the task (Language Support).

You need to ask yourself the following questions:

1 What vocabulary does the task require? (LD)

2 Do I need to teach this before they start? How? (LS)

3 What phrases/sentences will they need?
Think about the language for learning maths/science: e.g. predicting and comparing. What structures do they need for these language functions? (LD)

4 While I am monitoring this task, is there any way I can provide further support for their use of English (especially for the weaker students)? (LS)

5 What language will students need to use at the feedback stage (e.g. when they present their task)? Do I need to scaffold this? (LD, LS)

Teaching vocabulary and structures

Vocabulary

Learning the key maths and science vocabulary is central to EMI and 'learning' means more than simply understanding the meaning. Knowing a word also involves being able to pronounce it accurately and use it appropriately. Below is a list of strategies which could be useful:

- Avoid writing the list of vocabulary on the board at the start of the unit and 'explaining' it. The vocabulary should be introduced as and when it arises in the unit. This helps students associate the word or phrase with the concept and context.
- Record the vocabulary clearly on the board and check that you are confident with the pronunciation and spelling.
- Give students a chance to say the word once they have understood it. The most efficient way to do this is through repetition drilling.
- Use visuals whenever possible to reinforce students' understanding of the word.
- Ensure students are recording the vocabulary systematically in their glossaries and, if possible, use a Word wall which lists the vocabulary under unit/topic headings.
- Remember to recycle and revise the vocabulary.

Structures

In order for students to talk or write about their maths/science they will need to go beyond vocabulary: they will also need to use those phrases and sentence frames which a particular task requires. For example, they may need the following expressions in maths and science:

X is the same as Y.

The sides are the same length.

The next number in the sequence.

I predict that X will happen.

If X happens, then Y happens.

The next step is …

The teacher needs to build up these banks of common maths/science phrases and encourage students to record them. This is an important part of identifying the Language Demands and providing the necessary support. The teacher does not have to focus on grammar here as the language can be taught as 'chunks' rather than specific grammatical structures.

How to use the language support in the classroom

The study of science involves becoming familiar with an extensive and specific vocabulary. This is sometimes referred to as the language of science. Add to this the fact that for many students the language of instruction – English – is not their first language, and it is clear that we need to be sensitive to the use of language and language support.

The Student Book supports language development by clearly identifying key words in the Word clouds on the WOW pages and making bold the key content and enquiry words for each lesson. The interactive glossary is also of vital importance in helping students understand the language. The Student Book topic pages also combine words with pictures as this is most effective in helping students

understand the meanings of words. The linking of image to word is an essential factor in language development.

Repetition is also very important and the Student Book introduces and reinforces words by showing the words and asking students to use them in their discussions and answers.

Each section of the teaching notes linked to a particular activity or lesson also provides specific language support. Detailed and specific advice is provided for each key word and other words vital for scientific literacy. A range of strategies are suggested, including card sorts and card games, Word walls, team games to define or explain words, use of similar words to explain meaning and exploration of the origins of words.

Key principles underpinning language support in this series are:

- Words should be introduced and explained carefully.
- The word should be explained in context.
- Repetition is vital.
- Words should be linked to pictures or actions.
- Students should develop their own glossaries.
- The learning of vocabulary should be fun.
- Language should not be a barrier to learning.

Not all students will understand ideas and concepts at the same rate and there is likely to be variation in language skills. The Student Book pages are set out to be easy to follow and use, but there are also suggestions for further work and activities within each unit of this Teacher's Guide. These will help you to differentiate the learning and provide alternative learning opportunities. You should find the advice about pair and group work particularly valuable in helping you to meet individual needs.

Component Overview

The Student Books

The Student Books are textbooks for students to read and use. The Student Books include everything you need to deliver the course to your students, guide their activities and assess their progress.

Student Book	Typical student age range
Student Book 1	Age 5–6
Student Book 2	Age 6–7
Student Book 3	Age 7–8
Student Book 4	Age 8–9
Student Book 5	Age 9–10
Student Book 6	Age 10–11

The Teacher's Guides

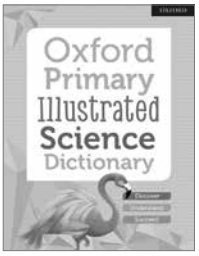
Each Teacher's Guide includes:

- An introduction with advice about delivering science and using the Student Books.
- A brief lesson plan for every lesson in each Student Books.
- Model answers to the activities and investigations; and answers to the assessment activities.

There are six Teacher's Guides:

Oxford Primary Illustrated Science Dictionary

The *Oxford Primary Illustrated Science Dictionary* gives comprehensive coverage of the key science terminology students use in the course. Each entry is in alphabetical order and, along with a clear and straightforward definition, has a fun and informative colour illustration or diagram to help explain the meaning. The dictionary is suitable for students with English as an additional language.



The curriculum

The *Oxford International Curriculum* offers a new approach to teaching and learning focused on wellbeing, which places joy at the heart of the curriculum and develops the global skills students need for their future academic, personal and career success.

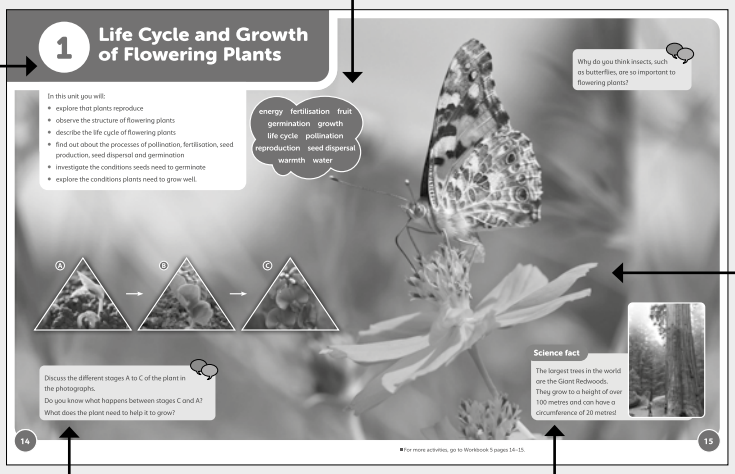
Through six subjects; English, maths, science, computing, wellbeing and global skills projects, the *Oxford International Curriculum* offers a coherent and holistic approach to ensure continuity and progression across every student's educational journey, equipping them with the skills to shape their own future. Through this approach, we can help your students discover the joy of learning and develop the global skills they need to thrive in a changing world.

Tour of a typical unit

Unit starter

Learning goals are stated clearly in every unit.

The Word cloud presents key words introduced in the unit. These are included in the write-in glossary for students to complete.



The introductory spread is bright and colourful to spark interest in young students.

Discussion activities allow students to develop communication skills.

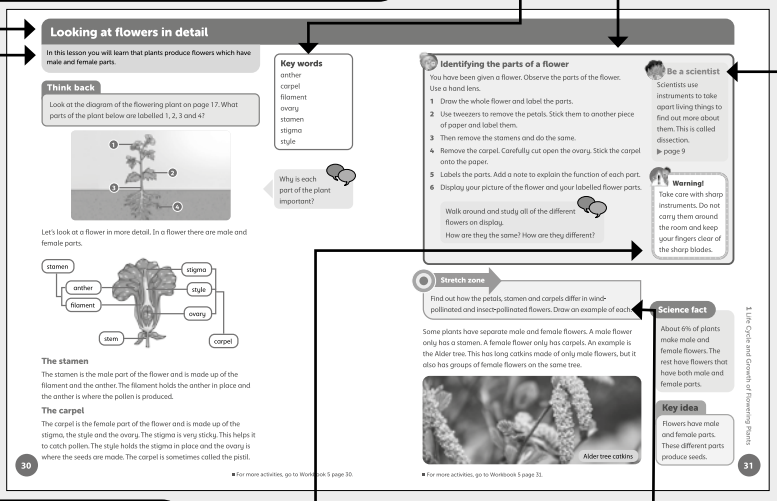
Science fact boxes engage students to think about how science has developed or is used in everyday life.

Lesson pages

Key word boxes show the main science vocabulary for the lesson.

Learning objectives for the lesson are clearly set out at the start and summarised in the Key idea box at the end.

Investigations engage students to work scientifically.



Be a scientist boxes help students to develop their skills to work scientifically.

Think back boxes remind students of prior learning.

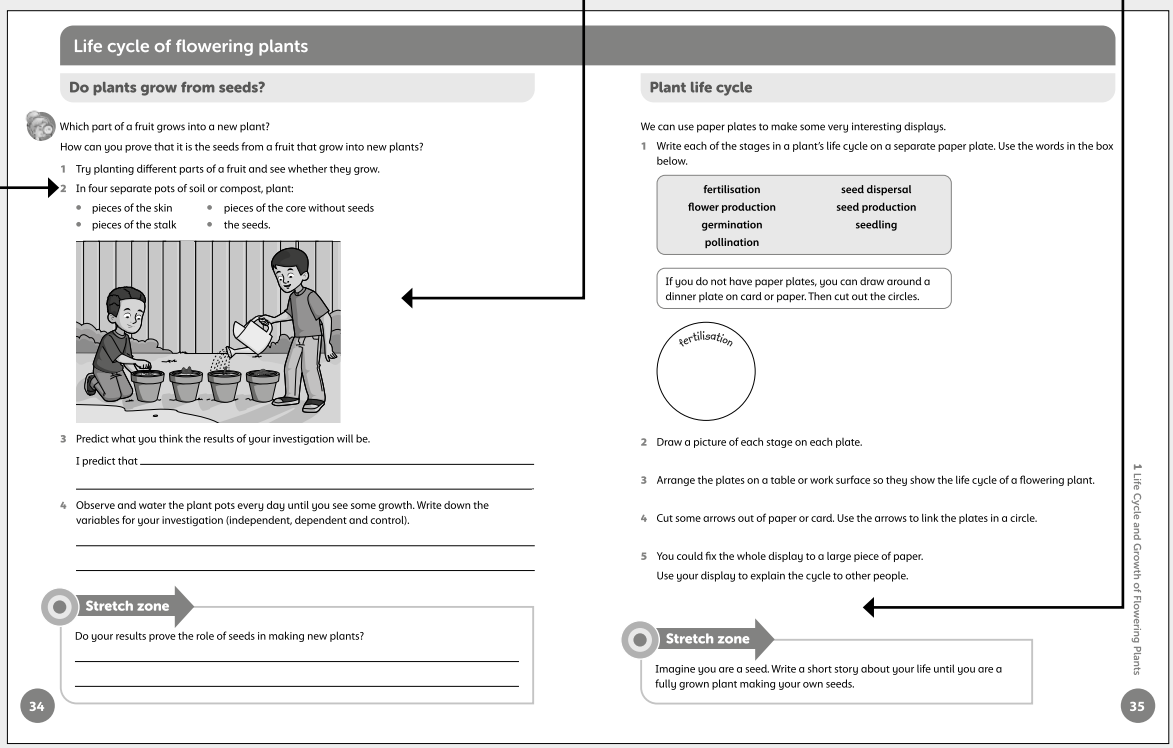
Warning boxes prompt students to identify risks and to learn how to keep themselves and others safe during practical work.

The student-friendly text is accessible for English language learners. Step-by-step instructions guide students through the activities they will undertake.

Carefully scaffolded activities promote deep learning.

Illustrations engage and support students to learn English.

Stretch zone activities challenge the most confident students.



Life cycle of flowering plants

Do plants grow from seeds?

Which part of a fruit grows into a new plant?

How can you prove that it is the seeds from a fruit that grow into new plants?

1 Try planting different parts of a fruit and see whether they grow.

2 In four separate pots of soil or compost, plant:

- pieces of the skin
- pieces of the stalk
- pieces of the core without seeds
- the seeds.

3 Predict what you think the results of your investigation will be.

I predict that _____

4 Observe and water the plant pots every day until you see some growth. Write down the variables for your investigation (independent, dependent and control).

Stretch zone

Do your results prove the role of seeds in making new plants?

Plant life cycle

We can use paper plates to make some very interesting displays.

1 Write each of the stages in a plant's life cycle on a separate paper plate. Use the words in the box below.

fertilisation, flower production, germination, pollination, seed dispersal, seed production, seedling

If you do not have paper plates, you can draw around a dinner plate on card or paper. Then cut out the circles.

fertilisation

2 Draw a picture of each stage on each plate.

3 Arrange the plates on a table or work surface so they show the life cycle of a flowering plant.

4 Cut some arrows out of paper or card. Use the arrows to link the plates in a circle.

5 You could fix the whole display to a large piece of paper.

Use your display to explain the cycle to other people.

Stretch zone

Imagine you are a seed. Write a short story about your life until you are a fully grown plant making your own seeds.

1 Life Cycle and Growth of Flowering Plants

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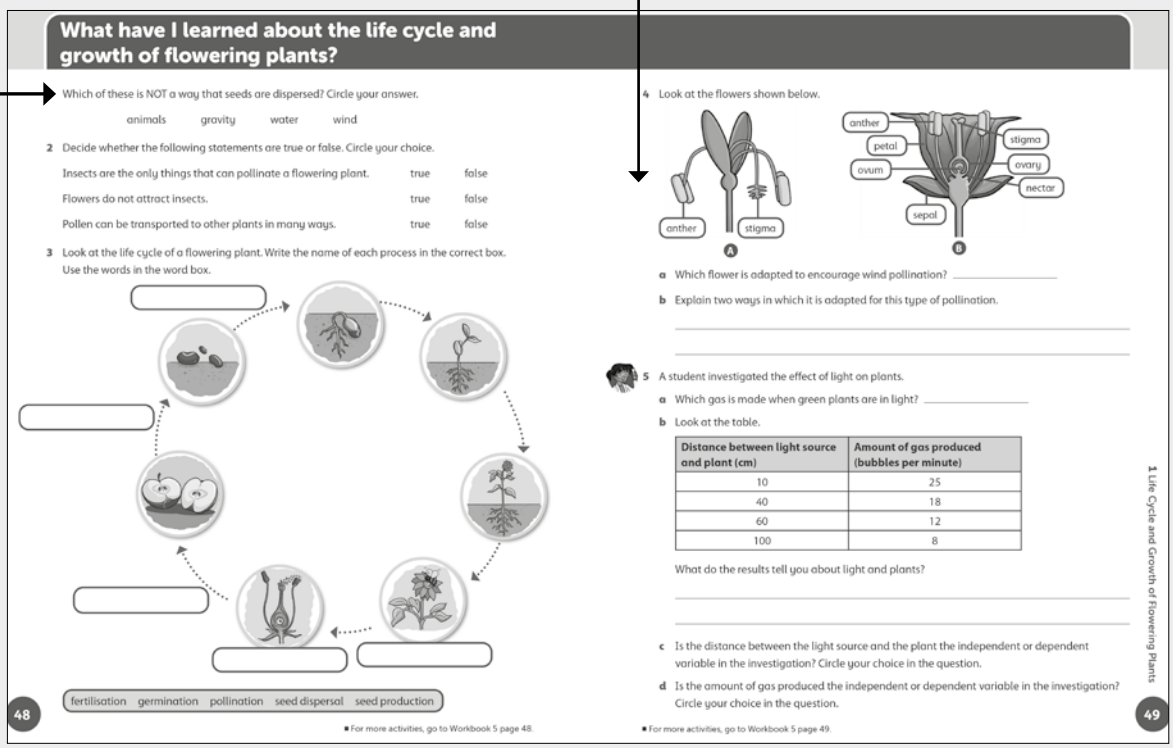
What have I learned? pages

Students' progress is assessed through the questions and tasks at the end of each unit.

Be a scientist questions encourage application of science knowledge and skills.



What have I learned about the life cycle and growth of flowering plants?

1 Which of these is NOT a way that seeds are dispersed? Circle your answer.

animals gravity water wind

2 Decide whether the following statements are true or false. Circle your choice.

Insects are the only things that can pollinate a flowering plant. true false

Flowers do not attract insects. true false

Pollen can be transported to other plants in many ways. true false

3 Look at the life cycle of a flowering plant. Write the name of each process in the correct box. Use the words in the word box.

fertilisation germination pollination seed dispersal seed production

For more activities, go to Workbook 5 page 48.

4 Look at the flowers shown below.

anther, stigma (A)

anther, petal, ovum, stigma, ovary, nectar, sepal (B)

a Which flower is adapted to encourage wind pollination? _____

b Explain two ways in which it is adapted for this type of pollination.

5 A student investigated the effect of light on plants.

a Which gas is made when green plants are in light? _____

b Look at the table.

Distance between light source and plant (cm)	Amount of gas produced (bubbles per minute)
10	25
40	18
60	12
100	8

What do the results tell you about light and plants?

c Is the distance between the light source and the plant the independent or dependent variable in the investigation? Circle your choice in the question.

d Is the amount of gas produced the independent or dependent variable in the investigation? Circle your choice in the question.

For more activities, go to Workbook 5 page 49.

1 Life Cycle and Growth of Flowering Plants

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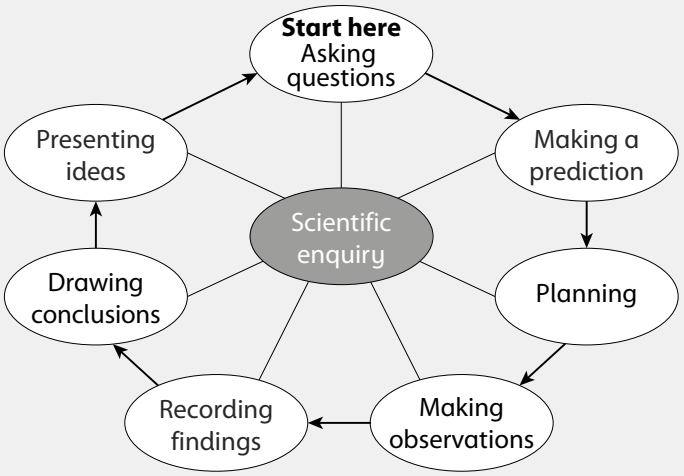
Teaching Notes

How to be a Scientist: Scientific Enquiry

These pages are designed to support you in teaching your students how to tackle scientific enquiry; that is, investigative approaches in science lessons. The structure of the pages closely follows the layout of the pages in the Student Book so you can guide students stage by stage through the process. The diagram shows the important ideas about scientific enquiry presented to students.



Teaching techniques

Students now have four years' experience of carrying out investigative tasks. They started in Years 1 and 2 and learned that being a good scientist involves careful observations, recording observations, taking measurements and trying to make sense of their results. Students will also have developed skills of prediction and simple fair testing.

In Years 3 and 4 they further developed their skills so they learned about variables and how to control them. They gained experience of planning a range of investigations and started to think about reliability and accuracy in more detail. Students will now have presented investigation findings in a range of ways, including in tables and charts, and will have worked in teams to share ideas and roles.

This year students will develop their investigation skills further by considering different types of investigation that develop out of a more sophisticated way of asking questions. They will plan in more detail, be more independent learners and take more responsibility for their safety and the safety of others.

The approach to scientific enquiry adopted throughout this scheme is to encourage students to be more responsible for identifying what should be investigated and how. Students are encouraged to reflect on the outcomes and explain what their results tell them. This can be summarised as:

- WHAT am I going to investigate?
- HOW am I going to investigate this?
- WHAT do my results tell me?

It is important to realise that students do not have to carry out full investigations all of the time. You can concentrate on one or two phases of the scientific enquiry process. For example, present students with results from secondary sources and ask them to make sense of them. Or plan an investigation and discuss this but do not actually carry out the investigation. This is a good way to develop scientific enquiry skills. However, it is also important to allow students to put these together and carry out full investigations.

Investigations are best done within the context of the science ideas being studied at the time. They should never be a bolt-on, additional activity. Students need sufficient background knowledge to make sense of the investigation. The scientific enquiry ideas within the scheme start with a suitable stimulus. It is important to set the context within which students can ask questions. They need enough information to understand the basic scientific ideas and formulate questions to be asked, but not too much so that all curiosity and discovery is removed. A misconception is that an enquiry-based approach leaves students to find out everything. This is not the case. Good enquiry-based learning allows students to take steps of discovery on their own from a basis of confident understanding of concepts. This scheme is designed to support you in achieving this.

Work through the 'Being a Good Scientist' of the Student Book with students. This is an introductory lesson or two at the start of the year. Having set the scene, you may wish to work through the planning grid on the next pages of this Teacher's Guide. Students can then use this as they work through the rest of the scientific enquiry phases.

Allow students to read through the Student Book text. Ask them to talk about the investigative process in the diagram on page 6. Ask them to think about how it is different from ones they have seen in previous years and ask them to write down any new words. Next, you can work through the sections of the process that are explained on the next few pages of the Student Book and ask students to talk about the discussion questions.

Asking questions

The key to effective scientific enquiry is to encourage students to ask questions. It is useful to suggest that students start questions with words such as 'which', 'what', 'how', 'do' and 'does' but at this stage they will realise there are other questions that start with other words, such as 'is'. They are given some questions that would fit in with the example investigation. These are split into different types.

Verification questions – such as 'Does salt dissolve in water?'

Explain that they do not need to know much about salt to find out the answer to this question. The answer to verification questions will often be yes or no.

Theory questions – such as 'Why does a large parachute fall through the air slower than a small parachute?'

Point out that students will need to know some background science to tackle this question. They will need to know something about air, air resistance, falling objects and measuring area. The answer cannot be yes or no and will require students to link their answer to some science theory. The key to this type of question is to suggest WHY something happens.

Experimental questions – such as 'Are pollinating insects attracted to one colour of petal more than others?'

These are questions that are answered through carrying out a fair test. Some prior knowledge is needed and students will need to design tests that can be repeated by other people – they are testable. The emphasis is not on why but on WHAT.

At any time when you are not focusing on investigative work you can still develop questioning skills by modelling good practice. When undertaking any sort of scientific work keep asking students questions such as 'What would happen if … ?' or 'Why does this … ?'.

Making a prediction

When students are asked to make a prediction about what will happen in an investigation, encourage them to discuss their ideas about what they think will happen. Stress that a prediction is more than a guess. Students should use what they already know and try to give reasons for their ideas. Help students to understand this and set up a number of situations when they can provide you with a prediction. Include practice in predicting at the start of any practical work in science.

Planning

Students should be able to design their own plans for investigations. Talk them through the prompt ideas and questions in the planning box on page 6 of the Student Book and emphasise the need to keep everyone safe. You can then read though the text about planning on page 8. Point out that when planning, there are two key questions.

- What will you keep the same?
- What will you change?

Write down the three types of investigation (descriptive, comparative and experimental) so that students see them in isolation. Ask them to read the description of each one.

Stress what a causal effect is. This is a new term for students, though they will have experienced it in investigations and in life. Also, remind students that the factors that are kept the same or changed are known as variables. Ask them to explain what independent, dependent and control variables are. They can check the text on page 9 to help them.

Also talk to students about the equipment they will need and remind them that it is a good idea to discuss and share plans before starting. You can also ensure that they understand that secondary sources of information include books, magazines, information leaflets and the internet.

Making observations

This phase relies on observation skills and often the accurate use of measurement. In the investigations used in the Student Book they carry out many different observations. Talk to students about the need for accuracy and repeated measurements.

Recording findings

Remind students that there are many different ways to record their results. They are now experienced in using tables and charts but point out they will be designing their own tables and producing more complicated charts and graphs. Stress that a table keeps all of their results neat and tidy. It can help them to see patterns. Students can also use their results to make a chart or graph. Point out that the independent variable is written along the X (horizontal) axis and the dependent variable is shown up the Y (vertical) axis.

Drawing conclusions

Encourage students to look at their results carefully and look for patterns. Ask students to consider whether any of their results were unusual. Discuss the value of repeating investigations to check how accurate the results are. Also encourage students to share their results to see if they are the same as the results of other groups. Ask them whether their prediction was correct.

At the end of every investigation ask students to try to think of any improvements. This is an important part of scientific enquiry. Also ask whether the investigation made them think of any other questions. Stress that good scientific enquiry always leads to other questions. These can lead to more investigations.

Presenting ideas

Encourage students to present their ideas in a variety of ways. Not only does this help them to develop a range of skills but it also models how science is communicated in real-world contexts. Point out the 'Tips for presenting ideas' section on Student Book page 13 and allow students to keep referring to it during the year.

How to be a Scientist: Investigation Master Sheet

Scientific enquiry planning grid

Asking questions: What am I trying to investigate? What is my question?

Predicting what will happen: What do I already know that will help me to decide what will happen?

I think what will happen is …

My reason is that …

Planning my investigation: Which type of test will I need to carry out?

The equipment I will need is …

What is the independent variable?

What is the dependent variable?

What I am going to measure is …

What are the control variables?

What I am going to do is …

I will be careful of …

My drawing of what I will set up

Making observations: What observations and measurements should I make?

How can I make my observations accurate?

Which measuring devices can I use?

Recording findings: What is the best way to record data?

Will I use a table, chart or graph?

Will I draw diagrams or take photographs?

Drawing conclusions: Can I see any patterns?

Are any results unusual?

Do the results support my prediction?

How could I make my investigation more accurate?

Presenting ideas: How should I present my ideas to others?

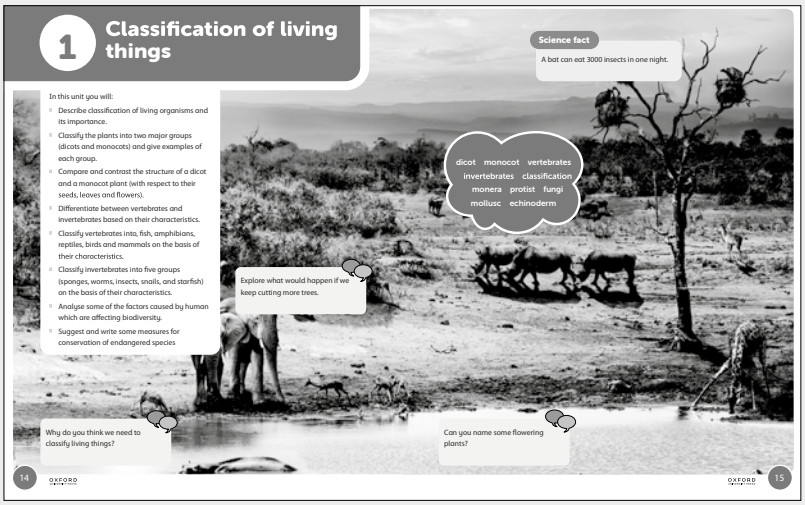
Have I used scientific language and diagrams?

Does my work lead to other questions to study?

1 Classification of living things

In this unit students will:

- Describe classification of living organisms and its importance.
- Classify the plants into two major groups (dicots and monocots) and give examples of each group.
- Compare and contrast the structure of a dicot and a monocot plant (with respect to their seeds, leaves and flowers).
- Differentiate between vertebrates and invertebrates based on their characteristics.
- Classify vertebrates into, fish, amphibians, reptiles, birds and mammals on the basis of their characteristics.



- Classify invertebrates into five groups (sponges, worms, insects, snails, and starfish) on the basis of their characteristics.
- Analyse some of the factors caused by human which are affecting biodiversity.
- Suggest and write some measures for conservation of endangered species.

Getting started

This unit explores how the characteristics of plants and animals are used to classify them. Students will review their knowledge of living and non-living things and use and design classification keys. They will learn about the classification of microorganisms and research some examples of each type. Students then move onto consider ways that human activities can have a harmful effect on the environment. They learn about air pollution, the greenhouse effect, and damage caused to the environment by deforestation. They are encouraged to investigate water pollution and waste disposal and to consider recycling and reuse as ways of reducing waste. Finally, students carry out enquiry-based studies to learn about ways to encourage others to care for the environment.

Science in context

Use the lessons in this unit to encourage students to learn more about the importance of grouping and identifying living things in real life. Allow students to survey and investigate plants and animals in their local area. Take them out to see living things in the wild, in parks and on farms. Encourage students to find out about people who use keys as part of their work and invite them into school to talk about how they use classification and identification. Students can also survey the local area to consider how human activity is damaging habitats and to look at ways that pollution and litter are being managed. You could arrange a visit to see alternative energy being used and invite a person from the local power company into school to talk about how energy is generated and used in the area.

Scientific enquiry skills

Scientific enquiry skills for this unit focus on observation skills and the setting up of fair tests. Remind students of the different variables they must consider during investigations: independent (what they change); dependent (what they measure); and control (what they keep the same). Students further develop their skills of collecting, recording and presenting data. They will consider the accuracy and validity of the observations and measurements they take and be encouraged to evaluate their work. Students are asked to present their results in a variety of ways, including drawings, bar charts, graphs and tables. Students should be encouraged to use computer technologies to help in collecting and presenting data.

You can use the Investigation master sheet to support investigative work. This provides prompts and structure to support students in planning and carrying out fair tests and recording and drawing conclusions about their findings.

Resources

Student Book: writing materials; materials to make leaflets; variety of seeds; petri dishes; rulers; sets of

different types of plastic forceps; timer; access to an outdoor area suitable for a plant and animal survey; identification keys for common species found in a local habitat; graph paper; clear plastic bottles with a section cut out; soil; twigs and sticks; grass seed; measuring jugs; water; watering cans; small cups or bottles; five water samples with different pH values; pH indicator strips; materials to make posters; access to an outdoor area suitable for survey; gloves; large sheets of paper; additional stimulus materials to capture the imagination of students; access to the internet or books on littering, saving energy, acid rain; access to specialist speakers where possible; magazines with suitable images to cut and stick on the leaflets or posters.

Key words for unit

are in the Word cloud.

dicot monocot vertebrates invertebrates classification monera protist fungi mollusc echinoderm

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Language support

At this age, students are likely to be able to read independently and look up any words they find unfamiliar, so encourage them to use scientific dictionaries. Start the unit by reading out the words in the Word cloud. Ask students to discuss each word and define those they are familiar with. This monitoring of prior knowledge is vital and can help you enormously in setting the level of work in the first few lessons. For every unit it is worth creating a Word wall so students see the words often and can become familiar with them. Students are old enough to make their own word cards for display so this could be an early task. Have daily quizzes about the words – point to one and ask, 'What does this word mean? Use it in a sentence.'

Repeat any new words regularly and use them in context. Students should listen, say, read and then write the words. They can also make a list of new non-science specific words they use in lessons. Some of these are listed in the individual lesson notes that follow.

You could create a science library in your room. Collect resources such as science books and magazines, science encyclopaedias and dictionaries. You can also collect or download specific information about topics for each lesson or activity and make a booklet of these like a class magazine. Students will enjoy helping with the production of these small information booklets and they can include some of their own work. You will find these specific booklets very valuable support for lessons and especially Stretch zone activities.

Unit at a glance

The key teaching points for students in this unit are:

- to introduce the unit objectives
- to introduce the learning outcomes
- to engage students with the content of the unit
- to review and build on prior learning and understanding of the topics.

The purpose of this introductory lesson is for students to start thinking about and reviewing prior knowledge of habitats and the characteristics of living things. These introductory pages prompt recall of earlier work and any general knowledge of plants. The photographs are used as a starting point and as a prompt for discussions.

Read through the key words and then allow students time to enjoy looking over the page before you start the sequence of discussion tasks. A suggested sequence follows below.

Arrange students into pairs or small groups of three or four for discussion work. A useful strategy is to start with students in pairs and then move pairs together to make small groups so students can share their ideas and discussions with others.

Why do you think we need to classify living things?

Ask students to look carefully at the main photograph. They can discuss it, before sharing their answer.

Possible response: *Students should identify that classification helps us understand the diversity of living things better. By classifying living things, we can learn about different kinds of plants and animals, their features, similarities and differences.*

Can you name some flowering plants?

Ask students to carefully recall their previous information. Remind them to use their observation skills and to look carefully around in their school garden.

Possible response: *Students may suggest names such as rose, jasmine, sadabahar (periwinkle), mango, tomatoes, etc.*

Explore what would happen if we keep cutting more trees.

Allow students to work with a partner or with their small group to talk about the photograph showing deforestation. Point out that they will have to use prior knowledge of habitats as well as their observation skills. Ask volunteers to share their ideas with the class.

Possible response: *The trees may be cut down to use for many possible things. Students may list some of the following: buildings; fuel; furniture; fences or making paper. This is a problem as the habitats for living things have been removed so they will lose where they live and their food supply. Some may point out that the soil can also wash or blow away.*

Science fact: A bat can eat 3000 insects in one night.

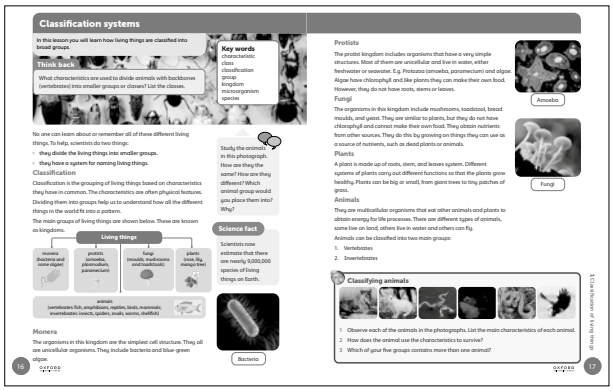
Read out the Science fact or ask a volunteer to read it out. Ask students if they have seen a bat feeding during a visit to the zoo. Remind them of the food pyramid and encourage them to think of the vast insect population which is controlled by bats.

Extra activities

1 **Computing link:** Students can research three flowering plants that are found in their region. They can download pictures or draw large versions of the plants and list some of their pollinators. They can display these in the room.

2 **Computing link:** Students can research uses of wood or stone and locate any examples of forestry or quarrying in their area. They can then design and produce a poster in class or as homework.

Classification systems


Classification systems

In this lesson you will learn how living things are classified into broad groups.

Think back

What characteristics are used to divide animals with backbones (vertebrates) into smaller groups or classes? List the classes.

Key words
characteristic
class
classification
group
kingdom
microorganism
species

No one can learn about or remember all of these different living things. To help, scientists do two things:

- they divide the living things into smaller groups.
- they have a system for naming living things.

Classification

Classification is the grouping of living things based on characteristics they have in common. The characteristics are often physical features. Dividing them into groups help us to understand how all the different things in the world fit into a pattern.

The main groups of living things are shown below. These are known as kingdoms.

Living things

monera (bacteria and some algae)
protists (amoeba, plasmodium, paramecium)
fungi (moulds, mushrooms and toadstools)
plants (rose, fig, mango tree)
animals (vertebrates: fish, amphibians, reptiles, birds, mammals; invertebrates: insects, spiders, snails, worms, shellfish)

Monera

The organisms in this kingdom are the simplest cell structure. They all are unicellular organisms. They include bacteria and blue-green algae.

Study the animals in this photograph. How are they the same? How are they different? Which animal group would you place them into? Why?

Science fact

Scientists now estimate that there are nearly 9,000,000 species of living things on Earth.

Bacteria

Protists

The protist kingdom includes organisms that have a very simple structures. Most of them are unicellular and live in water, either freshwater or seawater. E.g. Protozoa (amoeba, paramecium) and algae. Algae have chlorophyll and like plants they can make their own food. However, they do not have roots, stems or leaves.

Amoeba

Fungi

The organisms in this kingdom include mushrooms, toadstool, bread moulds, and yeast. They are similar to plants, but they do not have chlorophyll and cannot make their own food. They obtain nutrients from other sources. They do this by growing on things they can use as a source of nutrients, such as dead plants or animals.

Fungi

Plants

A plant is made up of roots, stem, and leaves system. Different systems of plants carry out different functions so that the plants grow healthy. Plants can be big or small, from giant trees to tiny patches of grass.

Animals

They are multicellular organisms that eat other animals and plants to obtain energy for life processes. There are different types of animals, some live on land, others live in water and others can fly.

Animals can be classified into two main groups:

1. Vertebrates
2. Invertebrates

Classifying animals

1 Observe each of the animals in the photographs. List the main characteristics of each animal.
2 How does the animal use the characteristics to survive?
3 Which of your five groups contains more than one animal?

Classification of living things

16 OXFORD

17

Getting started

In this lesson students will learn that living things can be classified into five kingdoms. They will learn about these groups in some detail.

Language support

To help develop language skills and review key words you can write the words that students will have heard of before (characteristic, classification, group, microorganism and species) on the board and ask students to tell their partner what each word means. They will have heard the word 'kingdom' before but in a different context. Explain that 'kingdom' is used to describe a huge group of living things. Point out that plants and animals are separate kingdoms.

Resources

Student Book: writing materials; materials to make leaflets.

Key words

characteristic class classification group kingdom microorganism species

Other words in the lesson

conifer falcon fern fungi (moulds, mushrooms, toadstools) genus moss prokaryotes (algae and bacteria) protists

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make observations

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Lesson at a glance

The key teaching points for students in this lesson are:

- living things can be classified into five kingdoms
- the living things within a kingdom can be further classified into smaller groups
- physical features, called characteristics, are used to group similar animals.

Study the animals in this photograph. How are they the same? How are they different? Which animal group would you place them into? Why?

Allow students to work with a partner to talk about the photograph showing the different insects (beetles). Encourage them to observe similarities and differences and decide which animal group they belong to.

Answer: *The animals are insects (beetles). Similarities include: many have legs, antennae, hard coverings (wing cases), eyes, and are made up of head and body. Differences include: size variation, colour variation, and length of legs and antennae.*

Ask a volunteer to read the text under the photograph to the class. Point out that classification is sorting living things into similar groups. Let them study the diagram of the five-kingdom classification system. Ask them to talk about any of the kingdoms they have heard about before.

Science fact Scientists now estimate that there are nearly 9 000 000 species of living things on Earth.

Read out the Science fact or ask a volunteer to read it out. Ask students why scientists cannot know about every type of living thing, especially when there are nine million different species (types).

Students will need support in understanding prokaryotic organisms (microorganisms). Ask them to read the text at the bottom of page 16 and explain that prokaryotic organisms have a very simple, single-celled structure. To illustrate how small they are you could point out that prokaryotic cells, such as bacteria, can be 100 times smaller than a human cell. You could also ask them to look at 1 millimetre on a ruler and imagine that they could lay 1000 cells between the graduations. Tell students that they will be studying some prokaryotes in the next unit when they learn more about diseases, but also let them know that microorganisms play a vital role in recycling materials in the environment and we use them in making many foods – such as yoghurt, cheese and vinegar.

Point out the plant key at the top of page 17. Talk through the classification questions with students. You can explain that this is a dichotomous key – each question has two possible answers or branches. Di- means two. Tell them they should always answer the question then follow the line or branch to the next question until they arrive at the answer.

Investigation: Classifying animals

Allow students to work in small groups of three or four. They will list the main characteristics of each animal and think about how the animal uses the characteristics to survive. They then divide the animals into five smaller groups based on the characteristics. Ask them to determine which of their five groups contains more than one animal and also work out which vertebrate class does not have an animal shown in the photographs.

Answer: *The characteristics should include: nature of body covering (fur, scales or feathers for example), shape, legs or not, wings or not, types of wings, and antennae or not. These various physical characteristics are used to help the animal stay alive as the coverings can protect an animal and help it to hide, the legs and wings help it to move, and the ears, antennae and eyes help it to sense the surroundings. The mammal group has two members represented.*

Review and reflect

Ask students to test a partner by saying the name of a major group of living things – starting with the five kingdoms – and their partner has to describe it. They can take it in turns until all of the kingdoms have been covered. They can then do the same for the main groups of plants.

After this you can allow some quiet time for students to reflect on what they answered well in the lesson and to think of one way they could remember better the different types of plants – algae, mosses, ferns, conifers and flowering plants.

Extra activities

1 Students can make a poster aboutliving things kingdoms by collecting samples of different plants (ferns, conifers, flowering plants, algae and mosses), pressing them, and then sticking them onto poster paper with labels.

2 **Computing link:** Ask students to work in a small group to research one of the five kingdoms in more detail. They can produce a short scientific article about the living things found in the group. They can download photographs of the living things and describe some examples of where they are found.

Differentiation

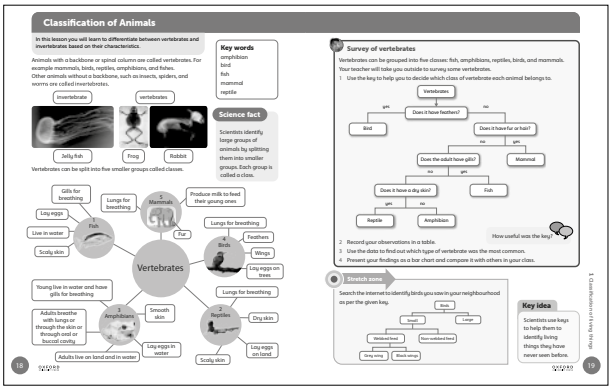
Supporting: Large versions of the five-kingdom classification key can be displayed around the room to help students become familiar with it.

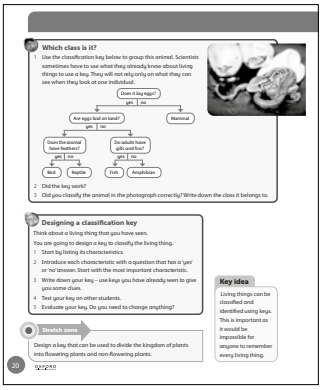
Consolidating: Display photographs of animals, flowering plants, non-flowering plants, fungi, protists and prokaryotes and regularly ask students to stand up and point to them as you say the words.

Extending: Students could research other classifications, such as the six- and seven-kingdom classifications.

Differentiated outcomes	
All students	should be able to state that living things can be classified into kingdoms using their characteristics
Most students	will be able to name and describe the five kingdoms and list some characteristics used to classify them
Some students	may be able to explain that there are other classification systems including six- and seven-kingdom systems

Classification of animals





Getting started

In this lesson students will study some of the specific physical characteristics used to classify the members of the animal kingdom into smaller groups. They will relate these characteristics to how animals are adapted to their habitats and investigate an example involving the shape and size of bird beaks.

Language support

Students will be familiar with the given key words but it is worth reviewing this. Write the words on the board and then write down the characteristics such as 'what it looks like', 'where an animal lives' and 'the grouping of living things'. Ask students to link each word to a meaning. Listen to their suggestions and then draw thick lines to show the answers.

Resources

Student Book: variety of seeds; petri dishes; rulers; sets of different types of plastic forceps; timer.

Key words

amphibian bird fish mammal reptile

Other words in the lesson

adapted climate finch forceps predators vertebrate

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- animals have physical characteristics that help them to adapt to their habitats
- these characteristics can be used to classify animals into groups.

Students can work with a partner. Ask them to list the main groups of animals. Remind them some will have a backbone and an internal skeleton and some will not. If you wish, they could divide these groups further into smaller groups or give examples.

Answer: *The two main groups are invertebrates and vertebrates. Students can further classify vertebrates into fish, amphibians, reptiles, birds and mammals. They may mention insects, spiders, snails, worms, jellyfish and shellfish as examples of invertebrates.*

Read out the definitions of vertebrates and invertebrates and ask students to discuss why these classifications are important. Next, explain the infograph on the page, detailing the classes of vertebrates.

Science fact: Scientists identify large groups of animals by splitting them into smaller groups. Each group is called a class.

Encourage the students to read out the names of the five classes of vertebrates. Discuss the main features of each class. Explain that scientists use factors to help them identify an animal. Ask students to reflect on how well the key works. Did they find it straightforward to identify the animal using these characteristics.

Investigation: Survey of vertebrates

Students can continue to work with their partner or group. Ask them to list out animals at random. Ask the students to use the classification key to decide which class of vertebrate each animal belongs to. They should look at the background as well as the animal for clues. Ask students to reflect on how well the key works. Did they find it straightforward to identify the animal? Ask them to write down the class it belongs to and record their answers in the form of a table.

This is a good example to introduce the idea of proximity bias, i.e. they will most likely list animals they encounter daily. Encourage them to think of methods to counter the bias.

Stretch zone: Search the internet to identify birds you saw in your neighbourhood as per the given key.

Key idea

Scientists use keys to help them to identify living things they have never seen before.

Summarise the lesson by asking students what they have learned. Let them share their ideas. Ask one student to read out the key idea. Ask students to write down three groups of vertebrates and, for each one, write down one adaptation that helps the animal to live in its habitat.

Investigation: Which class is it?

Students can continue to work with their partner or group. Ask them to use the classification key to group the animal in the photograph into the correct class of vertebrates. They should look at the background as well as the animal for clues. Explain that scientists also use other factors to help them identify an animal – not only what is in the key. Ask students to reflect on how well the key works. Did they find it straightforward to identify the animal? Ask them to write down the class it belongs to.

Answer: *The animal is a reptile. Students may know from prior knowledge that it is a lizard.*

Investigation: Designing a classification key

Explain that students are going to apply their knowledge and experience of using keys to help them to design their own.

Allow students to think about a living thing that they have seen and then let them design a key to classify that living thing. They can use the clues in the investigation box, but mainly they should think about the keys they have used and what made them easy to use. Their key should be easy to follow: when they show someone a drawing or photograph of the animal, they should be able to identify it by following the key. Encourage them to let someone test their key and provide feedback so they can think about any improvements. Remind them that this evaluation is an important step in science.

Answer: *Students' own answers: they should produce a simple key describing the characteristics of their animal in yes/no questions.*

Stretch zone: Design a key that can be used to divide the kingdom of plants into flowering plants and nonflowering plants.

2 **Computing link:** Allow students to have access to the internet and books to research the characteristics of flowering and non-flowering plants to help them to devise some questions for their key. Ask them to find out about one or two other characteristics, in addition to whether or not they have flowers.

> ***Possible response:*** *In addition to whether or not a plant has flowers, other differences between flowering and non-flowering plants that could be used in a key are: flowering plants make seeds that are in seed pods or fruit, non-flowering plants produce seeds in cones or have spores; flowering plants also lose leaves in winter and many non-flowering plants do not; flowering plants have tubes (veins) in the leaves and non-flowering plants do not.*

Key idea

Living things can be classified and identified using keys. This is important as it would be impossible for anyone to remember every living thing.

Read through the key idea or ask a volunteer to read it out. This will help students to review the main themes of the lesson. Ask them to list some animals and plants they have identified using keys.

Ask volunteers to tell you the name of a 'kingdom' of living things, and then a 'class' of that kingdom to make sure students have understood the distinction.

Review and reflect

Encourage students to reflect on their own learning by pausing for a few moments and thinking about the way they undertook the investigations. Talk about how they managed this and how they worked as a team. Remind them that when they are doing tricky work they are training their brain and this will help their future learning.

Extra activities

1 Print out some photographs of local animals and plants and ask students to use downloaded classification keys and identification books to identify each one.

2 Give a small group two plants and two animals to classify and ask them to make a small poster to display and show other students their classification system.

3 Show students some film of a duck-billed platypus swimming; ideally show its bill and its webbed feet, and show it laying eggs and feeding its young on milk, if possible. Ask students to make a list of the animal's characteristics. They can then debate which class of vertebrates the duck-billed platypus should be classified into. Point out that some animals are exceptions to the rule.

Differentiation

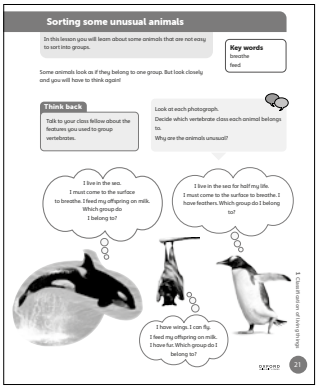
Supporting: Make cards with a photograph of an animal on each one and ask students to sort them into similar groups.

Consolidating: Create a picture wall of animals that are in the same group – for example, a group of reptiles or a group of mammals. Then ask students to make their own group to add to the wall.

Extending: Ask students to research some ways that invertebrates are split into smaller groups and ask them to list some examples.

Differentiated outcomes	
All students	should be able to describe some characteristics used to classify animals into smaller groups
Most students	will be able to classify animals into some major groups through observation of characteristics
Some students	may be able to describe how some invertebrates are classified into smaller groups

Sorting some unusual animal



Getting started

In this lesson students will study some vertebrates that have characteristics that are not typical of their vertebrate class. They will also set up a bird feeder and carry out a survey of local birds.

Language support

Explain that the word unusual means that something isn't as you might expect. Use the photograph of the bat to help you to illustrate this. It has wings and can fly, and this is unusual for a mammal.

Resources

Student Book: pieces of wood; cardboard; plastic bottles; string (materials to make bird feeders); smartphones or digital cameras; bird identification books.

Key words

breathe feed

Scientific enquiry key words

compare group/classify use secondary sources

Lesson at a glance

The key teaching point for students in this lesson is some animals are not easy to sort into groups.

Think back Talk to your partner about the features you used to group vertebrates.

Allow students to work in pairs or small groups. After a few minutes ask students to volunteer any features they have remembered – write these onto a board.

Possible response: *Students should recall features such as skin covering, gills or lungs, lay eggs or not, give birth to live young, feed young on milk, wings or not and whether the vertebrate lives in water or not.*

Discussion

Look at each photograph. Decide which vertebrate class each animal belongs to. Why are the animals unusual?

If you have written down the features from the Think back task ask students to use them to study the photographs of the whale, bat and penguin. If not, they can refer back to the photographs on page 16. Read through the text in the bubbles with students then ask them to decide which class each animal belongs to.

Answer: *Students should decide that despite some unusual features the whale is a mammal, the bat is a mammal and the penguin is a bird.*

Summarise the lesson by asking students what they have learned.

Let them share their ideas, read out and discuss the Key idea. This will remind students that some animals are difficult to sort into a group because they have unusual features not shared by other animals in the group.

Review and reflect

Encourage students to keep reviewing the features of the vertebrate classes.

Extra activities

1 You can modify the bird feeder survey to allow students to survey mammals, amphibians or fish by selecting your location. It is best not to feed these animals but just observe them in the wild.

2 **Maths link:** Students can count the birds and calculate the most common and least common in their survey. They can also produce simple bar charts of their findings.

Differentiation

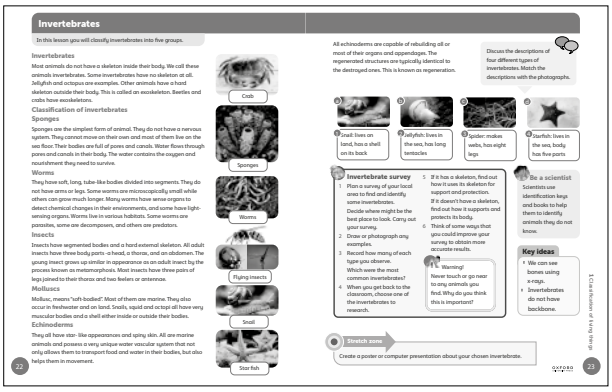
Supporting: You may have to help students to review the features used to classify vertebrates. Make a list for students.

Consolidating: You can ask students to point at and state the features they see when they look at the whale, bat and penguin that make them belong to the correct class.

Extending: Explain that animal types can have features modified over a long period of time to better adapt to where they live.

Differentiated outcomes	
All students	should be able to place the animals into their correct class.
Most students	will be able to record and identify a range of birds observed in the lesson.
Some students	may be able to explain, with examples, how birds are classified into smaller groups.

Invertebrates



Getting started

In this lesson students will learn that invertebrates can be classified into five groups. They will learn about using some major characteristics of invertebrates to help to classify them into smaller groups. They will apply their new knowledge of plant groups to carry out a survey to find and observe examples.

Language support

To help develop language skills and review key words you can write the words that students will not heard of before (exoskeleton, pores, canals, segments, antennae, metamorphosis, etc) on the board and ask students to tell their partner what they think each word means.

Resources

Student Book: writing materials; materials to make leaflets.

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make observations

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Lesson at a glance

The key teaching points for students in this lesson are:

- invertebrates can be classified into five groups.
- physical features, called characteristics, are used to group similar animals.

Allow students to work with a partner to read and discuss the text given about the different invertebrates. You can assign different group to different groups of student.

Ask a volunteer to read the text and encourage the students to notice the features in the sample animal photograph for each group. Point out that classification is sorting living things into similar groups.

Remind the students the reason why scientists cannot know about every type of living thing, especially when there are nine million different species (types).

Students will need support in understanding invertebrates. Ask them to read the text and explain the characteristic of each group carefully. An activity is given to consolidate the students' learning.

Talk through any classification related questions with students.

> ***Possible response:*** *Discuss the descriptions of four different types of invertebrates. Match the descriptions with the photographs.*

Ask students to use their observation skills to decide which description in the word boxes best matches each animal. Explain that they answer by writing down each letter and its matching number.

It is a simple exercise and a diversion for students as the description of the each animal is given right below the image.

Investigation: Invertebrate survey

Allow students to work in small groups of three or four. Explain that they are going to use the key they have just studied to help them classify some invertebrates from each major group. They can download images of invertebrates from the internet, record their findings and present their findings as an information leaflet.

Stretch zone: Create a poster or computer presentation about your chosen invertebrate.

Ask students to work with a partner and allow them access to the internet, books or wildlife magazines. They can write down the names and compare their findings with another pair.

Key ideas

- We can see bones using x-rays.
- Invertebrates do not have backbone.

Read through the key idea or ask a volunteer to read it out to the class.

Review and reflect

Ask students to test a partner by saying the name of an invertebrate – starting with the five group names – and their partner has to describe it. They can take it in turns until all of the invertebrate goups have been covered. They can then repeat it after changing partners.

After this you can allow some quiet time for students to reflect on what they answered well in the lesson and to think of one way they could remember better the different types of invertebrates.

Extra activities

1 Students can make a poster about invertebrate groups.

2 **Computing link:** Ask students to work in a small group to research one of the five groups in more detail. They can produce a short scientific article about the living things found in the group. They can download photographs of the living things and describe some examples of where they are found.

Differentiation

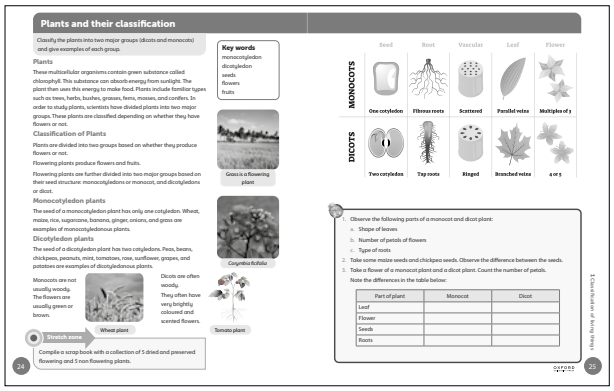
Supporting: Large versions of the five-kingdom classification key can be displayed around the room to help students become familiar with it.

Consolidating: Display photographs of animals, flowering plants, non-flowering plants, fungi, protists and prokaryotes and regularly ask students to stand up and point to them as you say the words.

Extending: Students could research other classifications, such as the six- and seven-kingdom classifications.

Differentiated outcomes	
All students	should be able to state that living things can be classified into kingdoms using their characteristics
Most students	will be able to name and describe the five kingdoms and list some characteristics used to classify them
Some students	may be able to explain that there are other classification systems including six- and seven-kingdom systems

Plants and their classification


Plants and their classification

Classify the plants into two major groups (dicots and monocots) and give examples of each group.

Key words
monocotyledon
dicotyledon
seeds
flowers
fruits

Plants

These multicellular organisms contain green substance called chlorophyll. This substance can absorb energy from sunlight. The plant then uses this energy to make food. Plants include familiar types such as trees, herbs, bushes, grasses, ferns, mosses, and conifers. In order to study plants, scientists have divided plants into two major groups. These plants are classified depending on whether they have flowers or not.

Classification of Plants

Plants are divided into two groups based on whether they produce flowers or not.

Flowering plants produce flowers and fruits.

Flowering plants are further divided into two major groups based on their seed structure: monocotyledons or monocot, and dicotyledons or dicot.

Monocotyledon plants

The seed of a monocotyledon plant has only one cotyledon. Wheat, maize, rice, sugarcane, banana, ginger, onions, and grass are examples of monocotyledonous plants.

Dicotyledon plants

The seed of a dicotyledon plant has two cotyledons. Peas, beans, chickpeas, peanuts, mint, tomatoes, rose, sunflower, grapes, and potatoes are examples of dicotyledonous plants.

Monocots are not usually woody. The flowers are usually green or brown.

Dicots are often woody. They often have very brightly coloured and scented flowers.

Grass is a flowering plant

Calyanthus floridus

Wheat plant

Tomato plant

Stretch zone

Compile a scrap book with a collection of 5 dried and preserved flowering and 5 non flowering plants.

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Seed Root Vascular Leaf Flower

MONOCOTS

One cotyledon | Fibrous roots | Scattered | Parallel veins | Multiples of 3

DICOTS

Two cotyledon | Tap roots | Ringed | Branched veins | 4 or 5

1. Observe the following parts of a monocot and dicot plant:
   a. Shape of leaves
   b. Number of petals of flowers
   c. Type of roots
2. Take some maize seeds and chickpea seeds. Observe the difference between the seeds.
3. Take a flower of a monocot plant and a dicot plant. Count the number of petals.

Note the differences in the table below:

Part of plant	Monocot	Dicot
Leaf		
Flower		
Seeds		
Roots		

1 Classification of living things

25

Getting started

In this lesson students will study the classification keys used to identify plant groups. They will learn that many scientists use keys as they cannot learn about every living thing and they will consider some of the characteristics used to classify plants. They will use a simple key to identify which group a plant belongs to and then design their own keys.

Language support

To help develop language skills you could use flashcards with the names of the plant groups discussed in the lesson. As you show a card, students have to find the word on the pages in the Student Book and then discuss with a partner any characteristic that are associated with the word. You could extend this to include science investigation and enquiry words such as discuss, identify, classify and design.

Resources

Key words

monocotyledon dicotyledon seeds flowers fruits

Scientific enquiry key words

Make observations

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Lesson at a glance

The key teaching points for students in this lesson are:

- it is impossible for anyone to remember every living thing
- plants, as other living things, can also be classified and identified using keys.

Read out in class or ask class volunteers to read the text describing the classification of plants into monocots and dicots. Encourage a class discussion on the contrasting features of monocot and dicot plants, using the infograph. Explain to students that scientists regularly check if newly discovered plants fall into either of these groups. You could show some from the internet.

Investigation

Explain that students are going to apply their knowledge and experience of using keys to help them identify and classify commonly found plants as monocots or dicots.

Allow students to think about a plant that they have seen and then let them classify it. They can use the clues in the investigation box, but mainly they should think about theclassification to use. Encourage them to check each others working and provide feedback so they can think about any improvements. Remind them that this evaluation is an important step in science.

Stretch zone: Compile a scrap book with a collection of 5 dried and preserved flowering and 5 non flowering plants.

Computing link: Allow students to have access to the internet and books to research the characteristics of flowering and non-flowering plants to help them in their stretch zone project. Ask them to find out about one or two other characteristics, in addition to whether or not they have flowers.

Possible response: *In addition to whether or not a plant has flowers, other differences between flowering and non-flowering plants that could be used in a key are: flowering plants make seeds that are in seed pods or fruit, non-flowering plants produce seeds in cones or have spores; flowering plants also lose leaves in winter and many non-flowering plants do not; flowering plants have tubes (veins) in the leaves and non-flowering plants do not.*

Review and reflect

Encourage students to display their keys and allow them to walk around to see what others have produced. They can have some quiet time to reflect on how they could modify their keys to improve them. Point out that reflecting on their work and learning from others is a very important part of learning.

Extra activities

1 Print out some photographs of local plants and ask students to use classification keys and identification books to identify each one.

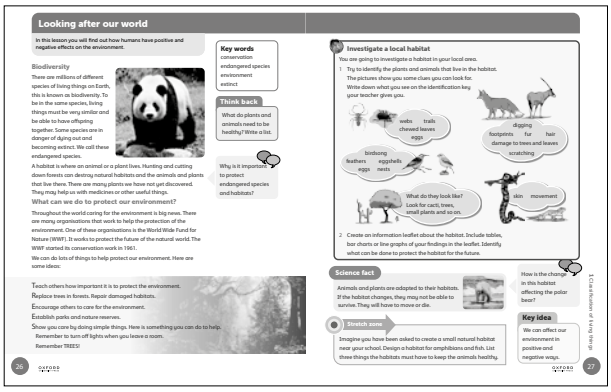
2 Give a small group two plants to classify and ask them to make a small poster to display and show other students their classification system.

Differentiation

Extending: Allow students to develop and use different types of keys to classify plants.

Differentiated outcomes	
All students	should be able to use classify some plants
Most students	will be able to design and test their own key
Some students	may be able to describe a range of different styles of key

Looking after our world



Getting started

In this lesson students will study the risk of animals becoming extinct if their habitats are damaged. They will learn about some ways to protect the environment, carry out an investigation on local habitats, and create a small sample natural habitat and what can be done to protect the living things that live there.

Language support

To support language development and to extend students' knowledge, create a class display of some extinct and currently endangered species. Ask students to help you by either drawing or bringing in pictures of endangered plants or animals. This type of activity can engage students and also extend their vocabulary as they learn the names of different plants and animals. Put up large labels identifying the 'endangered species' and the 'extinct species' so students learn these phrases.

Resources

Student Book: access to an outdoor area suitable for a plant and animal survey; identification keys for common species found in a local habitat; writing materials; graph paper; rulers; materials to make leaflets.

Key words

conservation endangered species environment extinct

Other words in the lesson

adapted affect habitat negative offspring positive protect species

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Report and present findings
Draw conclusions and give explanations
Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- humans can affect the environment in many ways
- some of these effects are positive and some are negative
- if habitats are damaged, species can become endangered and eventually extinct.

Think back: What do plants and animals need to be healthy? Write a list.

Allow students to work with a partner to discuss the Think back question and to produce a joint list. Remind them that they have studied plants and animals in earlier years. Ask volunteers to share their lists with others by reading them out.

Answer: *Animals need food, water, warmth (shelter) and air (oxygen). Plants need water, light, space, nutrients and air (carbon dioxide).*

Ask students to read the text on page about protecting the environment and to study the photograph of the panda. To test understanding, ask, 'What is a species? What do we call animals and plants that are in danger of dying out?'' What is meant by the role of Biodiversity?'.

Why is it important to protect endangered species and habitats?

Students can continue to work with their partner or join with another pair to make a larger grouping. Ask them to talk about the need to protect animals and plants and their habitats.

Possible response: *Animals and plants are part of an interlocking food web, so damaging one part can have an effect on the rest. Many plants are important for food and medicines, so we should look after them.*

After the discussion students can read through the text about what we can do to protect the environment. Point out the green box at the bottom of page and ask some students to take it in turns to read out each statement and write the acronym TREES on the board as they do this.

You can test understanding by asking, 'Name an organisation that was set up to protect the environment. When was it formed? What do the R and S stand for in TREES?'

Investigation: Investigate a local habitat

This activity needs to be planned in advance of the lesson.

Carry out a risk assessment: ensure any necessary risk assessments are completed in line with school policy and that parental permission has been given if you are organising field trips away from the school premises.

This investigation is designed to give students the opportunity to look at a local habitat and make informed decisions about how to protect it for future generations. This activity can be done in the school grounds, if there is a suitable area, or as part of a fieldwork exercise.

Provide identification keys to help students identify plants and animals. Ask students to look at the clues given in the Student Book. Instruct them to mark on their identification key if they see an example of the species and how many times they observe it.

They can share their findings by creating an information leaflet about the habitat. Remind them to include tables, bar charts or line graphs of their findings and identify what can be done to protect it for the future.

Possible response: *Students should find a wide range of habitats in the area. Remind them that habitats can be very small (microhabitats). They may find soil, pond, leaf litter, dead logs, woodland and beach, for example.*

Science fact Animals and plants are adapted to their habitats. If the habitat changes, they may not be able to survive. They will have to move or die.

Read out the Science fact or ask a volunteer to read it out. Point out that because many animals are adapted to a specific habitat, if the habitat is destroyed, it is difficult for the animals to fit in anywhere else.

How is the change in this habitat affecting the polar bear?

Allow students to work with a partner or their small team to talk about the question and reflect on their ideas about the habitat under threat. Ask some groups or pairs to share their ideas with the class and discuss any differences of opinion or interpretation – stressing that this is normal in science.

Possible response: *Students may realise that with climate change and global warming much of the Earth's ice is melting and this is reducing the habitat of the polar bear.*

Stretch zone: Imagine you have been asked to create a small natural habitat near your school. Design a habitat for amphibians and fish. List three things the habitats must have to keep the animals healthy.

Allow students to work in their small team. Point out that for this activity the emphasis is on planning and not constructing. You can ask students to use the internet to find out more about what fish and amphibians need to survive.

Possible response: *A sensible outcome would be a plan for a small pond that is deep enough for fish but has at least one shallow and sloping area for amphibians such as frogs to leave once they have hatched and grown past the tadpole stage. Check that students have added some plants because these put oxygen into the water and provide food and shade.*

Key idea

We can affect our environment in positive and negative ways.

Read out the key idea or ask a volunteer to read it out. Ask students to turn to a partner and tell them one way that they intend to help to protect the environment from now on. Remind them of the acronym from this lesson: TREES.

Review and reflect

Encourage students to identify aspects they have not completed correctly and help them to identify improvements. This will help students to develop a positive approach to learning by understanding that learning is a process that will improve with practice and reflection. For example, they can walk round and look at the information leaflets produced by others to identify what they have done well and what they can learn from others as targets to improve their work.

Extra activities

1 Allow students to construct the ponds they designed for the Stretch zone task. They can use a corner of the school grounds if one is available. They will need to dig out a circle shape that is 0.4 metres deep at its deepest and line it with sand and then a waterproof liner. The liner can be held in place by rocks around the edge and the pond filled. Plants such as reeds and water lilies can be added.

2 Invite a representative of a local conservation group to meet with your class and talk about their work. Ask them to bring in examples of scientific equipment that they use and also any photographs of the habitats and living things they are working to protect.

Differentiation

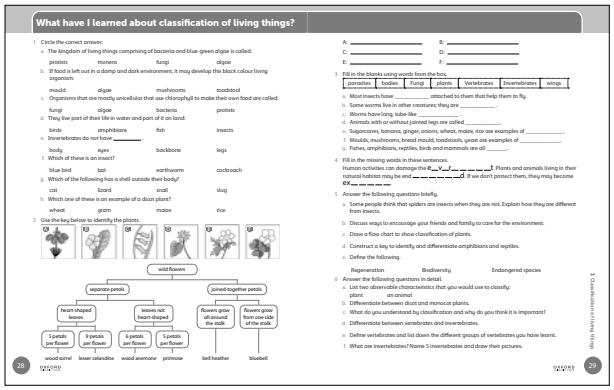
Supporting: Ask students to use the activity to help them to understand the text about protecting the environment.

Consolidating: Make a large version of the TREES box and display it in the classroom so students can become familiar with it.

Extending: Students can research an animal that has recently become extinct and find out the reasons for its demise.

Differentiated outcomes	
All students	should be able to state that damaging habitats can create problems for living things
Most students	will be able to describe what extinct and endangered plants and animals are and give some examples
Some students	may be able to explain some examples of how environmental damage has led to the extinction of a named animal

What have I learned about Classification of living things?


What have I learned about classification of living things?

Getting started

The aim of this section is to encourage students to review their learning after all of the lessons in the unit. All the lessons in the unit have questions and discussion tasks for students. You will have been using these formatively during lessons to help you assess students' knowledge and understanding of the topics.

On pages of the Student Book there are six questions related to the content of the unit. The questions are arranged in increasing order of conceptual demand and not topic order. Students can tackle these one at a time after individual lessons. The questions could also be answered as a single summative activity. This could be done by reading out the questions to the class and asking for volunteers to answer them, carrying out the activity as a group work task with students talking about each question, or as an individual written task. Whichever approach is adopted, the questions are designed to give you and the students feedback about progress and to help in identifying targets for development.

It would be very useful to do both end-of-lesson and end-of-unit reviews as you will be able to measure students' levels of confidence throughout the unit to respond quickly and also gain a measure at the end of the unit to find out if this has changed for any topics. Time to reflect may make a student more or less confident and later learning may support understanding of a topic that had been causing problems for some students. As teachers, we know that not all learning takes place at the time the teaching takes place.

What have I learned about classification and habitats? answers

1 Circle the correct phrase or word to finish each sentence.

a The kingdom of living things comprising of bacteria and blue-green algae is called:

protists monera fungi algae

b If food is left out in a damp and dark environment, it may develop this black colour living organism:

mould algae mushrooms toadstool

c Organisms that are mostly unicellular that use chlorophyll to make their own food are called:

fungi algae bacteria protists

d They live part of their life in water and part of it on land:

birds amphibians fish insects

e Invertebrates do not have .

body eyes backbone legs

f Which of these is an insect?

bluebird bat earthworm cockroach

g Which of the following has a shell outside their body?

cat lizard snail slug

h Which one of these is an example of a dicot plant?

wheat gram maize rice

Point out that one of the given four options will be correct and students must circle the answer. Stress how important it is to follow question instructions exactly.

Answer: *a. monera b. mould c. algae d. amphibians e. backbone f. cockroach g. snail h. gram*

2 Use the key below to identify the plants.

Remind students that to use a key they must answer each question and then follow that branch down to the next question until they reach the answer. Suggest they start with plant A and use its characteristics until they arrive at the name, then they can find the names of the other plants.

Answer: *A = bell heather; B = primrose; C = bluebell; D = lesser celandine; E = wood anemone; F = wood sorrel*

3 Fill in the blanks using words from the box.

a. Most insects have _____ attached to them that help them to fly.

b. Some worms live in other creatures; they are _____ .

c. Worms have long, tube-like _____ .

d. Animals with or without jointed legs are called _____.

e. Sugarcanes, banana, ginger, onions, wheat, maize, rice are examples of _____.

f. Moulds, mushrooms, bread mould, toadstools, yeast are examples of _____.

g. Fishes, amphibians, reptiles, birds and mammals are all _____.

Remind students that characteristics are what a plant or animal looks like and also remind them that some characteristics are more useful than others.

Answer: *a. wings b. parasites c. bodies d. invertebrates e. plants f. fungi g. vertebrates*

4 Fill in the missing words in these sentences.

Point out that there are three missing words and that each dash represents a missing letter of the alphabet. Explain that some letters have been added as clues.

Answer: *environment; endangered; extinct*

5 Answer the following questions briefly.

a. Some people think that spiders are insects when they are not. Explain how they are different from insects.

b. Discuss ways to encourage your friends and family to care for the environment.

c. Draw a flow chart to show classification of plants.

d. Construct a key to identify and differentiate amphibians and reptiles.

e. Define the following: Regeneration Biodiversity Endangered species

Stress that students should try to answer the questions in a brief manner, ensuring they use the key concepts.

Answer: *a. Spiders are not considered insects due to two major physical differences from insects. (i) Wheareas Spiders have 8 legs, insects have 6 legs. (ii) Spiders have 2 body parts (a combined head and thorax called a cephalothorax, and an abdomen), while insects have 3 body parts (head, thorax, and abdomen).*

b. TREES is a good way to remember how to encourage people to take care of the environment. Any two from: use posters and information leaflets to tell their friends and family about reducing energy use by using appliances for less time; walking and cycling instead of using cars; switching devices off and not leaving them on standby; not littering; disposing of waste properly; recycling and reusing materials; trying to use renewable energy sources.

c. and d. Students to attempt these questions themselves. They can take aid from the book.

e. Regeneration is a property of echinoderms to rebuild all or most of their organs and appendages. The regenerated structures are typically identical to the destroyed ones. Biodiversity is the presence of millions of different species of living things on Earth. Endangered species are the species which are in danger of dying out and becoming extinct.

6 Answer the following questions in detail.

a. List two observable characteristics that you would use to classify: a plant an animal

b. Differentiate between dicot and monocot plants.

c. What do you understand by classification and why do you think it is important?

d. Differentiate between vertebrates and invertebrates.

e. Define vertebrates and list down the different groups of vertebrates you have learnt.

f. What are invertebrates? Name 5 invertebrates and draw their pictures.

Answer: *a. A plant contains chlorophyll and is made up of roots, stem, and leaves system. An animal is a multicellular organism that eats other animals and plants. They can be either vertebrates or invertebrates.*

b. The seed of a monocotyledon plant has only one cotyledon, whereas a seed of a dicotyledon plant has two cotyledons.

c. Classification is the grouping of living things based on characteristics they have in common. The characteristics are often physical features. Classification is important as it would be otherwise impossible for anyone to remember every living thing.

d. Animals with a backbone or spinal column are called vertebrates. For example mammals, birds, reptiles, amphibians, and fishes. Other animals without a backbone, such as insects, spiders, and worms are called invertebrates.

e. and f. Answer given above but students can use their own words.

Summative assessment

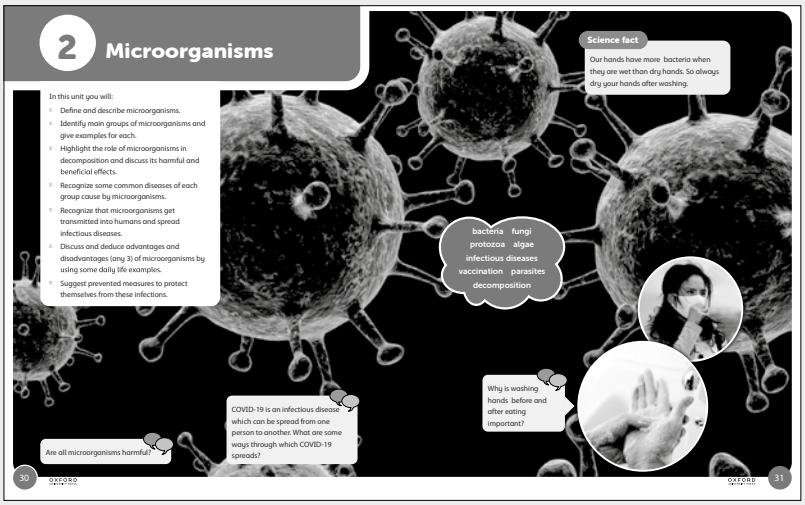
The questions in the 'What have I learned about classification and habitats?' can be used to consider the progress of each student individually. You can also use the information to create summative reports – such as end-of-term reports – for each student. If you wish to allocate a score or mark for the questions, then the total number of marks you could allocate is 30 (question 1 = 2 marks; question 2 = 2 marks; question 3 = 7 marks; question 4 = 1 mark; question 5 = 5 marks; question 6a = 4 marks; question 6b-f = 2 marks each.

By reviewing responses to the questions and the self-review of confidence levels you can tailor specific interventions to help students improve. Keep the recording and analysis of the student self-evaluations simple. A general impression of the class's self-evaluation, not individual student records, is all that is required, e.g. 'Fifty per cent of the class were not confident about ….'

2. Microorganisms

In this unit students will:

- Define and describe microorganisms.
- Identify main groups of microorganisms and give examples for each.
- Highlight the role of microorganisms in decomposition and discuss its harmful and beneficial effects.
- Recognize some common diseases of each group cause by microorganisms.
- Recognize that microorganisms get transmitted into humans and spread infectious diseases.
- Discuss and deduce advantages and disadvantages (any 3) of microorganisms by using some daily life examples.
- Suggest prevented measures to protect themselves from these infections.



Getting started

This unit explores how the characteristics of microorganisms are used to classify them. Students will review their knowledge of microorgamisms in the processes of decomposition and spread of diseases. They will learn about the classification of microorganisms and research some examples of each type.

Science in context

Use the lessons in this unit to encourage students to learn more about the importance of microorganisms in real life. Allow students to survey and investigate processes dependent on microbes in their local area. Take them out to see living things in the wild, in parks and on farms.

Scientific enquiry skills

Scientific enquiry skills for this unit focus on observation skills and the setting up of fair tests. Remind students of the different variables they must consider during investigations: independent (what they change); dependent (what they measure); and control (what they keep the same). Students further develop their skills of collecting, recording and presenting data. They will consider the accuracy and validity of the observations and measurements they take and be encouraged to evaluate their work. Students are asked to present their results in a variety of ways, including drawings, bar charts, graphs and tables. Students should be encouraged to use computer technologies to help in collecting and presenting data.

You can use the Investigation master sheet on pages 4–5 of this Teacher's Guide to support investigative work. This provides prompts and structure to support students in planning and carrying out fair tests and recording and drawing conclusions about their findings.

Key words for unit

are in the Word cloud.

bacteria fungi protozoa algae infectious diseases vaccination parasites decomposition

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Language support

At this age, students are likely to be able to read independently and look up any words they find unfamiliar, so encourage them to use scientific dictionaries. Start the unit by reading out the words in the Word cloud. Ask students to discuss each word and define those they are familiar with. This monitoring of prior knowledge is vital and can help you enormously in setting the level of work in the first few lessons. For every unit it is worth creating a Word wall so students see the words often and can become familiar with them. Students are old enough to make their own word cards for display so this could be an early task. Have daily quizzes about the words – point to one and ask, 'What does this word mean? Use it in a sentence.'

Remind students that they should add definitions of key words as they progress through the unit. This could be a regular end-of-lesson task or starter to encourage recall.

Repeat any new words regularly and use them in context. Students should listen, say, read and then write the words. They can also make a list of new non-science specific words they use in lessons. Some of these are listed in the individual lesson notes that follow.

You could create a science library in your room. Collect resources such as science books and magazines, science encyclopaedias and dictionaries. You can also collect or download specific information about topics for each lesson or activity and make a booklet of these like a class magazine. Students will enjoy helping with the production of these small information booklets and they can include some of their own work. You will find these specific booklets very valuable support for lessons and especially Stretch zone activities.

Unit at a glance

The key teaching points for students in this unit are:

- to introduce the unit objectives
- to introduce the learning outcomes
- to engage students with the content of the unit
- to review and build on prior learning and understanding of the topics.

The purpose of this introductory lesson is for students to start thinking about and reviewing prior knowledge of microorganisms. These introductory pages show an image a popularly recognised miccroorganism to prompt recall of earlier work and any general knowledge. The photographs are used as a starting point and as a prompt for discussions.

Read through the key words and then allow students time to enjoy looking over the page before you start the sequence of discussion tasks. A suggested sequence follows below.

Arrange students into pairs or small groups of three or four for discussion work. A useful strategy is to start with students in pairs and then move pairs together to make small groups so students can share their ideas and discussions with others.

Are all microorganisms harmful?

Ask students to discuss the question, make a list of any benefits they recall, and then share the answer in the class.

> ***Possible response:*** *Students should identify a range of uses of microbes, for example, in production of yoghurt and bread, and in the process of decomposition, etc.*

COVID-19 is an infectious disease which can be spread from one person to another. What are someways through which COVID-19 spreads?

Ask students to carefully recall the instructions received to prevent the spread of Covid 19.

> ***Possible response:*** *Students may share that the infection can spread through droplet, touch and sitting in proximity to the infected person.*

Why is washing hands before and after eating important?

Allow students to work with a partner or with their small group to talk about the photograph showing handwashing. Point out that they will have to use prior knowledge of good life habits as well as their observation skills. Ask volunteers to share their ideas with the class.

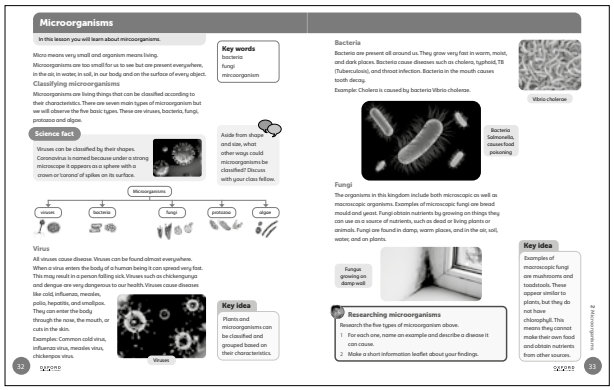
> ***Possible response:*** *The washing of hands is one of the major ways the spread of infectious diseases can be prevented.*

Science fact: Our hands have more bacteria when they are wet than dry hands. So always dry your hands after washing.

Read out the Science fact or ask a volunteer to read it out. This is a good lead on from the last discussion question and can be a good lead up to a potential stretch zone question: why are wet and moist surfaces better for bacterial growth? Encourage students to recall the structure of an average bacterial cell and relate to the need for a moist growth environment.

1 **Computing link:** Students can research any of the leading diseases (e.g. cold, flu) that are found in their region. They can download images or infographs and list some of characteristics and methods of prevention of the disease. They can display these posters in the room.

Microorganisms


Microorganisms

In this lesson you will learn about microorganisms.

Micro means very small and organism means living.
Microorganisms are too small for us to see but are present everywhere, in the air, in water, in soil, in our body, and on the surface of every object.

Classifying microorganisms

Microorganisms are living things that can be classified according to their characteristics. There are seven main types of microorganism but we will observe the five basic types. These are viruses, bacteria, fungi, protozoa and algae.

Science fact

Viruses can be classified by their shapes. Coronavirus is named because under a strong microscope it appears as a sphere with a crown or 'corona' of spikes on its surface.

Microorganisms
viruses | bacteria | fungi | protozoa | algae

Virus

All viruses cause disease. Viruses can be found almost everywhere. When a virus enters the body of a human being it can spread very fast. This may result in a person falling sick. Viruses such as chikengunya and dengue are very dangerous to our health. Viruses cause diseases like cold, influenza, measles, polio, hepatitis, and smallpox. They can enter the body through the nose, the mouth, or cuts in the skin.

Examples: Common cold virus, Influenza virus, measles virus, chickenpox virus.

Virus

Key words
bacteria
fungi
mircoorganism

Aside from shape and size, what other ways could microorganisms be classified? Discuss with your class fellow.

Key idea

Plants and microorganisms can be classified and grouped based on their characteristics.

Bacteria

Bacteria are present all around us. They grow very fast in warm, moist, and dark places. Bacteria cause diseases such as cholera, typhoid, TB (Tuberculosis), and throat infection. Bacteria in the mouth causes tooth decay.

Example: Cholera is caused by bacteria Vibrio cholerae.

Vibrio cholerae

Bacteria Salmonella, causes food poisoning

Fungi

The organisms in this kingdom include both microscopic as well as macroscopic organisms. Examples of microscopic fungi are bread mould and yeast. Fungi obtain nutrients by growing on things they can use as a source of nutrients, such as dead or living plants or animals. Fungi are found in damp, warm places, and in the air, soil, water, and on plants.

Fungus growing on damp wall

Researching microorganisms

Research the five types of microorganism above.

1 For each one, name an example and describe a disease it can cause.
2 Make a short information leaflet about your findings.

Key idea

Examples of macroscopic fungi are mushrooms and toadstools. These appear similar to plants, but they do not have chlorophyll. This means they cannot make their own food and obtain nutrients from other sources.

2 Microorganisms

32 33

Getting started

In this lesson students will explore the classification of microorganisms and characteristics of the main groups. Finally, they will carry out a research activity to find out more about groups of microorganisms.

Language support

Students are now familiar with the words 'characteristic' and 'classification' but ask them to tell you what the words mean to review them. Then ask students to try to define the word 'microorganism'. They may have heard of the word before but, if not, give them a clue by asking them to think of other words beginning with the prefix 'micro'. Then tell them it means very small.

Resources

Student Book: access to an outdoor area; writing materials; materials to make leaflets.

Key words

bacteria fungi mircoorganism

Other words in the lesson

algae bacteria protozoa virus

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make observations

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Lesson at a glance

The key teaching point for students in this lesson is that :

- microorganisms can be classified into smaller groups and this is often done based on shape.

Explain that most microorganisms are too small to be seen with the naked eye – a microscope is needed.

Science fact Viruses can be classified by their shapes. Coronavirus is named because under a strong microscope it appears as a sphere with a crown or 'corona' of spikes on its surface.

Read out the Science fact to give students some idea of the shape of one virus. Ask for volunteers to point out the corona of spikes on the surface of the virus.

Aside from shape and size, what other ways could microorganisms be classified? Discuss with your class fellow.

Students can continue to work in their groups to talk about the ways that microorganisms could be classified. Hint that animals can be classified in part by what they eat – herbivores and carnivores.

Possible response: *Microorganisms are also classified by what they grow on – such as starchy growth plates or sugary growth plates. They also form different coloured and shaped clumps when they grow and can produce different chemicals.*

Point out the microorganism classification key and ask volunteers to read out the names of the five main groups: viruses, bacteria, fungi, protozoa and algae. Work through the key with students as they trace it with their fingers. Ask them to read the text beneath the key to find out about the shapes of the bacteria. Explain that 'cocci' means 'spheres like small balls'. Point out that diplococcus means 'two cocci', streptococcus means 'chains of cocci' and staphylococcus means 'like a bunch of grapes.'

Explain that larger fungi, such as mushrooms and toadstools, are not classed as microorganisms. The classification of fungi is complicated, but students just need to know that very small fungi, such as yeast and moulds, can be classified as microorganisms.

Investigation: Researching microorganisms

Computing link: Students can work with a partner or in their group to research the five types of microorganisms shown in the key. For each one, ask them to name an example and describe a disease it can cause. They should make a short information leaflet to share their findings.

Possible response: *Examples of types of microorganisms and a disease include: virus = influenza (flu) and poliovirus (polio); bacteria = Salmonella (food poisoning), Vibrio (cholera) and Clostridium (tetanus);*

fungi = Microsporum (ringworm) and Trichophyton (athlete's foot); protozoa = Plasmodium (malaria) and Entamoeba (dysentery); algae = blue-green algae (shellfish poisoning).

Key ideas

Plants and microorganisms can be classified and grouped based on their characteristics.

Examples of macroscopic fungi are mushrooms and toadstools. These appear similar to plants, but they do not have chlorophyll. This means they cannot make their own food and obtain nutrients from other sources.

Read through the key ideas or ask a volunteer to read it out to the class. Ask students to close their books and write down the names of the five main groups of microorganisms, and then check their answers.

Review and reflect

Encourage students to reflect on their own learning by pausing for a few moments and thinking about which parts of the work they found tricky. Ask them how they tried to learn the names of the five groups of microorganisms. Talk about how well they managed this.

Extra activities

1 Students could make a 'microorganisms collage' with a large version of the key and labelled drawings of some examples of each organism. Set up a classroom display.

2 Ask students to take rubbings from large button mushroom to look at the different characteristics they have studied.

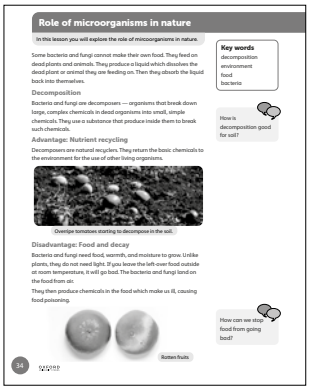
Differentiation

Consolidating: Large displays of the key for microorganisms will help students to learn the names and shapes of the five groups.

Extending: Students can study books to find out more about the detailed features microbiologists use to classify and identify microorganisms.

Differentiated outcomes	
All students	should be able to state that microorganisms can be classified based on their characteristics
Most students	will be able to identify and name the five groups of microorganisms
Some students	may be able to name specific examples of microorganisms from each group and describe a disease caused by organisms within each group

Role of microorganisms in nature


Role of microorganisms in nature

In this lesson you will explore the role of microorganisms in nature.

Some bacteria and fungi cannot make their own food. They feed on dead plants and animals. They produce a liquid which dissolves the dead plant or animal they are feeding on. Then they absorb the liquid back into themselves.

Key words
decomposition
environment
food
bacteria

Decomposition

Bacteria and fungi are decomposers — organisms that break down large, complex chemicals in dead organisms into small, simple chemicals. They use a substance that produce inside them to break such chemicals.

How is decomposition good for soil?

Advantage: Nutrient recycling

Decomposers are natural recyclers. They return the basic chemicals to the environment for the use of other living organisms.

Overripe tomatoes starting to decompose in the soil.

Disadvantage: Food and decay

Bacteria and fungi need food, warmth, and moisture to grow. Unlike plants, they do not need light. If you leave the left-over food outside at room temperature, it will go bad. The bacteria and fungi land on the food from air.

They then produce chemicals in the food which make us ill, causing food poisoning.

How can we stop food from going bad?

Rotten fruits

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Getting started

In this lesson students will study the role of microorganisms in the nature. They will specifically study about the importance of decomposition. They will discover the advantages and disadvantages of decomposition.

Language support

Students are now familiar with the words 'decomposition' and 'environment' but ask them to tell you what the words mean to review them. Then ask students to try to define the word 'microorganism'. They may have heard of the word before but, if not, give them a clue by asking them to think of other words beginning with the prefix 'micro'. Then tell them it means very small.

Resources

Student Book: access to an outdoor area; writing materials; materials to make leaflets.

Key words

decomposition environment food bacteria

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make observations

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Lesson at a glance

The key teaching point for students in this lesson is:

- microorganisms play an essential role in maintaining the nutrient levels of the environment.

Ask students to look at the photographs and text on the page. You can also ask the students to share their observations and thoughts.

How is decomposition good for soil?

Students can work in pairs or small groups. Ask them to observe the plants carefully and list some of their requirements for healthy living. Ask them where do they think the plants receive these nutrients from. They can then compare and discuss their ideas.

> ***Possible response:*** *Decomposition returns the basic chemicals to the soil for use by other plants and living organisms.*

How can we stop food from going bad?

Students can continue to work in their groups to talk about the ways that foods can go bad. Hint that when we know the ways food can go bad, we can use this information to preserve foods.

> ***Possible response:*** *Microorganisms require food, warmth, and moisture to grow. If we deprive them of the ideal temperature for growth, we can reduce the possibility of food going bad.*

Point out there are other ways to prevent spoilage of food and ask volunteers to share some. Work through the student suggestions as they discuss the use of preservatives (for example) or heating or cooling down of food. Canning and removal of moisture (drying/curing) is another method that can be discussed.

Review and reflect

Encourage students to reflect on their own learning by pausing for a few moments and thinking about which parts of the work they found tricky. Ask them how they tried to learn the names of the five groups of microorganisms. Talk about how well they managed this.

Extra activities

1 Students could make a poster reviewing the role of microorganisms in nature. Set up a classroom display.

2 Ask students to create a booklet reviewing the ways to prevent food spoilage. They can also look up ways to hasten or increase the process of decomposition.

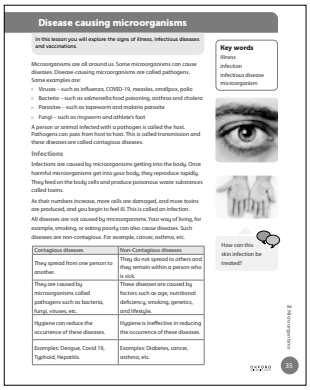
Differentiation

Consolidating: Class discussions on importance of decomposition in nature, will help students to remember the importance of microorganisms.

Extending: Students can research and discuss ways to accelerate or retard the process of decomposition.

Differentiated outcomes	
All students	should be able to state that microorganisms such as bacteria and fungi feed on dead plants and animals
Most students	will be able to discuss nutrient recycling
Some students	may be able to describe ways to increase or reduce the rate of decomposition.

Disease causing microorganisms


Disease causing microorganisms

In this lesson you will explore the signs of illness, infectious diseases and vaccinations.

Key words
illness
infection
infectious disease
microorganism

Microorganisms are all around us. Some microorganisms can cause diseases. Disease-causing microorganisms are called pathogens. Some examples are:

- Viruses – such as influenza, COVID-19, measles, smallpox, polio
- Bacteria – such as salmonella food poisoning, anthrax and cholera
- Parasites – such as tapeworm and malaria parasite
- Fungi – such as ringworm and athlete's foot

A person or animal infected with a pathogen is called the host. Pathogens can pass from host to host. This is called transmission and these diseases are called contagious diseases.

Infections

Infections are caused by microorganisms getting into the body. Once harmful microorganisms get into your body, they reproduce rapidly. They feed on the body cells and produce poisonous waste substances called toxins.

As their numbers increase, more cells are damaged, and more toxins are produced, and you begin to feel ill. This is called an infection.

All diseases are not caused by microorganisms. Your way of living, for example, smoking, or eating poorly can also cause diseases. Such diseases are non-contagious. For example, cancer, asthma, etc.

How can this skin infection be treated?

Contagious diseases	Non-Contagious diseases
They spread from one person to another.	They do not spread to others and they remain within a person who is sick.
They are caused by microorganisms called pathogens such as bacteria, fungi, viruses, etc.	These diseases are caused by factors such as age, nutritional deficiency, smoking, genetics, and lifestyle.
Hygiene can reduce the occurrence of these diseases.	Hygiene is ineffective in reducing the occurrence of these diseases.
Examples: Dengue, Covid 19, Typhoid, Hepatitis.	Examples: Diabetes, cancer, asthma, etc.

2 Disease causing microorganisms

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Getting started

In this lesson students will study some of the signs of illness, infectious diseases and vaccinations. They will learn to differentiate between contagious and non-contagious diseases and discover causes and preventive measures for both.

Language support

Students are now familiar with the words 'infection' and 'microorganism' but ask them to tell you what the words mean to review them.

Resources

Key words

illness infection infectious disease microorganism

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Report and present findings

Draw conclusions and give explanations

Lesson at a glance

The key teaching points for students in this lesson are:

- microorganisms called pathogens cause diseases
- contagious diseases can be transmitted from one host to the other.

Ask students to review the keywords. Ask them what they remember about the classification of microorganisms from the the previous class. Encourage a review discussion in class; you may divide students into groups for this activity.

Ask students to read through the text about infections. Explain that most microorganisms are too small to be seen with the naked eye – a microscope is needed.

Review in class the difference between contagious and non-contagious diseases. You should encourage the students to extract the information from the table and pose questions to each other. You can turn this into a team activity, with each team posing and answering questions alternatively. End by asking the teams to discuss among themselves and attempt to answer the discussion question.

How can this skin infection be treated?

Students can continue to work in their groups to talk about how the infection shown in photograph be treated. Hint that the first step of treating an infection lies in correctly identifying the symptoms and diseases itself, as well as understanding the mode of transmission of the infection.

Possible response: *Although it appears to be an eczema, the photo shows a fungal infection. This is due to the presence of redness, scaling, and blisters present in the fingers. Further eczema is a chronic condition, whereas the use of the word infection indicates this is a recently developed condition.*

Fungal infections require topical (and sometimes oral) medicines and good hygiene practices.

You can extend the class discussion into a stretch zone exercise. For this, you should instruct students to search up possible fungal infections, their modes of transmissions and treatments.

Review and reflect

Encourage students to reflect on their own learning by pausing for a few moments and thinking about which parts of the work they found tricky. Ask them how they tried to learn the names of the five groups of microorganisms. Talk about how well they managed this.

Extra activities

1 Students could make a 'diseases collage' with a large version of the table and relevant photographs to support some of the points. Set up a classroom display.

2 Ask students to continue the research into pathogens causing contagious diseases. They can share their findings in the form of booklets, or displays, or presentations, whichever format they prefer.

Differentiation

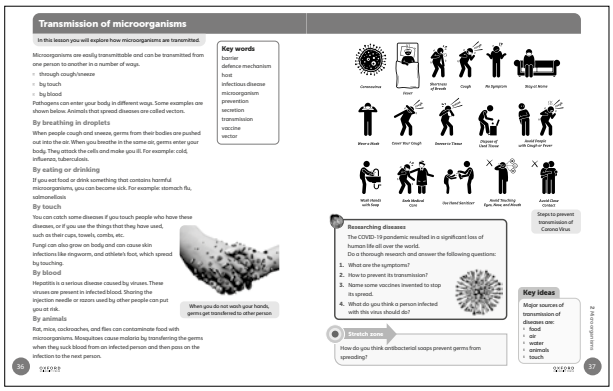
Supporting: Use the class discussions as additional support and structure for the investigations.

Consolidating: Large displays for classroom will help students to consolidate their learning.

Extending: Students can continue research into pathogens and their modes of transmissions in preparation for the next lesson.

Differentiated outcomes	
All students	should be able to state that microorganisms called pathogens cause diseases
Most students	contagious diseases can be transmitted from one host to the other
Some students	may be able to give specific examples of pathogens, the disease(s) caused and their modes of transmission.

Transmission of microorganisms



Getting started

In this lesson students will study the possible modes of transmission of infections in details. They will look into the Corona virus pandemic as an example of how infections can spread globally.

Language support

Students are now familiar many of the key words, however ask them to tell you what the words mean to review them. Especially focus on the meanings of "defence mechanism" and "secretion". They may have heard of these before but, if not, give them a clue by asking them to think of the context in which the words are used.

Resources

Student Book: access to a library archive and the internet; writing materials; materials to make posters or leaflets.

Key words

barrier defence mechanism host infectious disease microorganism prevention secretion transmission vaccine vector

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make observations

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Lesson at a glance

The key teaching points for students in this lesson are:

- pathogens can be transmitted from a person to another by touch or body fluids
- animals that spread diseases are called vectors.

Ask students to think to how pathogens cause us disease. They require access to our bodies and that can happen in a number of ways.

Ask students to read text at the top of page 36. You can also refer them to any of the posters they have created or you have provided which discuss pahtogens and their modes of transmission. Summarize that there are three main ways pathogens are able to enter our bodies: through droplets (cough or sneeze), through touch, or through blood contamination.

Remind students that not only can a visibly unwell person be contagious and infect us, but people who are not visibly unwell may also be contagious. Such people (and other animals) are known as vectors.

They can share their experiences of seeing these and other potential ways that disease-causing microorganisms (pathogens) can be spread. Ask them to recommend ways that the people could prevent the spread or transmission of pathogens. Ask volunteer pairs to share their ideas with the class.

Read out the text on page 36 and ask students if they have heard of any diseases spread by these methods. Point out that this fact is the reason why they should never touch their own faces and eyes, especially after an interaction with an unwell person. Explain that the Corona pandemic is a good example of how an infection can spread through various different modes of transmission.

Point out role of vectors and contamination in spread of infections. Encourage students to share any personal reflections they may have.

Next use the steps to prevent spread of the Corona Virus, to encourage a discussion on which of the modes of transmission are relevant to this particular infection.

You can encourage the students to discuss why some areas had a lower rate of corona mortality as compared to other areas. Hint - remind them to consider precautions against which modes of transmission worked the best.

Investigation: Researching diseases

Arrange students into groups of three or four. Explain that they are going to work in a team to produce a poster, a booklet, a presentation and a play about Covid 19.

Remind students that secondary sources are ones they have looked up rather than information that they have found out themselves through investigations. Ask them to begin their research from the student book, then expand it through secondary sources from the library. Once they have designed and completed their posters you can display them to make a disease exhibition.

Key idea

Major sources of transmission of diseases are:

- food
- air
- water
- animals
- touch

Read through the key idea or ask a volunteer to read it out to the class. Ask students to close their books and write down the names of the one disease (each) spread by these modes, and then check their answers.

Review and reflect

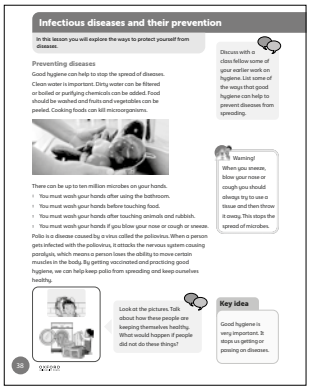
Encourage students to reflect on their own learning by pausing for a few moments and thinking about which parts of the work they found tricky. Ask them how they tried to learn the names of the five groups of microorganisms. Talk about how well they managed this.

Differentiation

Extending: Students can create similar posters/play/ leaflet, etc. for other prevalent diseases.

Differentiated outcomes	
All students	should be able to state that pathogens can be transmitted from a person to another by touch or body fluids.
Most students	will be able to state that animals that spread diseases are called vectors.
Some students	may be able to name specific examples of diseases spread by each mode of transmission and correlate them with ways to prevent the spread of said diseases.

Infectious diseases and their prevention


Infectious diseases and their prevention

In this lesson you will explore the ways to protect yourself from diseases.

Preventing diseases

Good hygiene can help to stop the spread of diseases. Clean water is important. Dirty water can be filtered or boiled or purifying chemicals can be added. Food should be washed and fruits and vegetables can be peeled. Cooking foods can kill microorganisms.

There can be up to ten million microbes on your hands.

- You must wash your hands after using the bathroom.
- You must wash your hands before touching food.
- You must wash your hands after touching animals and rubbish.
- You must wash your hands if you blow your nose or cough or sneeze.

Polio is a disease caused by a virus called the poliovirus. When a person gets infected with the poliovirus, it attacks the nervous system causing paralysis, which means a person loses the ability to move certain muscles in the body. By getting vaccinated and practicing good hygiene, we can help keep polio from spreading and keep ourselves healthy.

Discuss with a class fellow some of your earlier work on hygiene. List some of the ways that good hygiene can help to prevent diseases from spreading.

Warning!
When you sneeze, blow your nose or cough you should always try to use a tissue and then throw it away. This stops the spread of microbes.

Look at the pictures. Talk about how these people are keeping themselves healthy. What would happen if people did not do these things?

Key idea
Good hygiene is very important. It stops us getting or passing on diseases.

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Getting started

In this lesson students will consider some of the ways that infectious diseases can be prevented. They will then review the role of hygiene in preventing spread of infections.

Language support

Students will be familiar with the words microorganism, vaccine, prevention and disease, but you may need to review the words barrier, host, infectious, secretion, transmission and vector. Point out the spelling of each word and let students practise writing down the words. Don't define the new words at the start of the lesson but tell students that they will learn about them as they study the topic. When you do reach a key word in context allow them time to write down a definition.

Resources

Student Book: materials for making posters.

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Record data and results

Report and present findings

Lesson at a glance

The key teaching points for students in this lesson are:

- infectious diseases are diseases that spread from host to host in many ways.
- infectious diseases are caused by microorganisms.

Remind students about vaccines. They may also have heard of vaccines relating to the Covid 19 pandemic and may have had vaccinations to help protect them against other diseases. If they need support, allow them to spend time researching vaccines on the internet or in science books and encyclopaedias. You could produce an information page by downloading information from the internet.

Ask students to read the text on page. Ask, 'Which type of microorganism causes polio? What is a host? List two vectors.

Look at the pictures. Talk about how these people are keeping themselves healthy. What would happen if people did not do these things?

Students can continue to work with their partner. Allow them to look at the drawings and discuss the questions. They can share their experiences of seeing these and other potential ways that the spread of disease-causing microorganisms (pathogens) can be prevented. Ask them to recommend other ways that the people could prevent the spread or transmission of pathogens. Ask volunteer pairs to share their ideas with the class.

> ***Possible response:*** *The spread of diseases could be prevented by:*
>
> *maintaining regular body hygiene - taking regular baths and using soap and water regularly.*
> *Ensuring all clothing is washed properly using detergent and water- especially if it is the clothing used by a person who is unwell.*

Preventing diseases

Allow students to read the text about preventing diseases with good hygiene to help them with the discussion task alongside it.

Discuss with a class fellow some of your earlier work on hygiene. List some of the ways that good hygiene can help diseases from spreading.

Allow students time to reflect on earlier work but encourage them to draw on their own experiences and other sources of information, such as advice from parents and family, health leaflets, TV advertisements and public health films and posters.

> ***Answer:*** *Students should list some actions for good hygiene from the following: washing their body, washing their hair, brushing teeth, washing clothes, brushing hair, clipping nails, washing hands regularly and always after visiting the toilet or before handling food.*

Key ideas

- *Good hygiene is very important. It stops us getting or passing on diseases.*

Ask a student to read out the key idea. Ask students to turn to a partner and take it in turns to give an example of how a pathogen can be spread and how this spread can be prevented.

Review and reflect

Use the discussion tasks, and the research investigation tasks to encourage students to think about what they understand and what they are finding less straightforward. Discuss the outcomes of each task with students. Encourage them to identify aspects they have not completed correctly and help them to identify improvements. This will help students to develop a positive approach to learning by understanding that learning is a process that will improve with practice and reflection.

Extra activities

1 This exercise can be a preparatory step towards the next lesson. Students could make their own yoghurts to help them practise clean food handling hygiene, but also to show that many microorganisms are harmless and in fact helpful to people. They will need clean yoghurt pots, a pan, a thermos flask or a heavy pot to keep the yoghurt warm, milk and live plain yoghurt. They simply place two tablespoons of live yoghurt into a thermos flask or heavy pot. The milk is heated in a pan so it is just bubbling. You could provide pre-heated milk if you wish. Leave the milk to cool so it is still hot but can be touched with a finger (46°C if you want to give students practice in measuring temperature). The warm milk is added to the thermos or heavy pan and stirred gently to mix the milk and yoghurt. Put a lid on and leave it for at least eight hours without it being moved. The yoghurt can be placed into smaller pots and fruit can be added if you wish.

2 Ask students to work in groups of five or six to create a short play about a person who has an infectious disease. They can act out the person, family, nurses and doctors to demonstrate how the disease was caught, how it could have been prevented, and how it can be treated. You can arrange a 'show lesson' and the plays can be put on and possibly filmed.

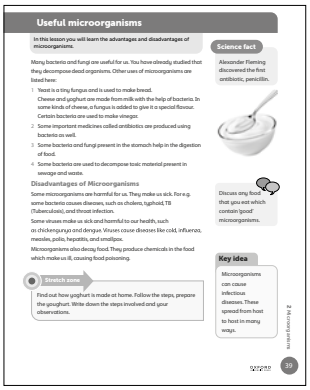
Differentiation

Consolidating: Allow students to walk through the poster exhibition to review their understanding of infectious diseases and defence mechanisms.

Extending: Students can research some of ways that insect vectors are controlled and the potential environmental impact of this.

Differentiated outcomes	
All students	should be able to name some infectious diseases and the microorganisms that cause them
Most students	will be able to state that good hygiene is essential in preventing diseases
Some students	may be able to provide examples of diseases whose spread is prevented by use of vaccines.

Useful microorganisms


Useful microorganisms

In this lesson you will learn the advantages and disadvantages of microorganisms.

Science fact

Alexander Fleming discovered the first antibiotic, penicillin.

Many bacteria and fungi are useful for us. You have already studied that they decompose dead organisms. Other uses of microorganisms are listed here:

1 Yeast is a tiny fungus and is used to make bread. Cheese and yoghurt are made from milk with the help of bacteria. In some kinds of cheese, a fungus is added to give it a special flavour. Certain bacteria are used to make vinegar.
2 Some important medicines called antibiotics are produced using bacteria as well.
3 Some bacteria and fungi present in the stomach help in the digestion of food.
4 Some bacteria are used to decompose toxic material present in sewage and waste.

Disadvantages of Microorganisms

Some microorganisms are harmful for us. They make us sick. For e.g. some bacteria causes diseases, such as cholera, typhoid, TB (Tuberculosis), and throat infection.
Some viruses make us sick and harmful to our health, such as chickenguniya and dengue. Viruses cause diseases like cold, influenza, measles, polio, hepatitis, and smallpox.
Microorganisms also decay food. They produce chemicals in the food which make us ill, causing food poisoning.

Discuss any food that you eat which contain 'good' microorganisms.

Stretch zone

Find out how yoghurt is made at home. Follow the steps, prepare the yoghurt. Write down the steps involved and your observations.

Key idea

Microorganisms can cause infectious diseases. These spread from host to host in many ways.

2.14 Useful microbes

Getting started

In this lesson students will review what they have studied so far about microorganisms and learn how some can cause infectious diseases. They will also uncover ways in which microorganisms have long been used by humans to their advantage.

Language support

Students will be familiar with the words microorganism, vaccine, prevention and disease, but you need to point out the spelling of each word and let students practise writing down the words.

Resources

Student Book: clean yoghurt pots, a pan, a thermos flask or a heavy pot to keep the yoghurt warm, milk and live plain yoghurt culture.

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Record data and results

Report and present findings

Lesson at a glance

The key teaching points for students in this lesson are:

- infectious diseases are diseases that spread from host to host in many ways
- infectious diseases are caused by microorganisms
- microorganisms are also essential in many industries and life processes providing advantage of human beings and the world.

Ask students to read the text on page. Ask, 'What is the role of decomposition in maintaining nutrient levels? What are antibiotics? What is the use of microbes in food

production?". Encourage students to use the book text to give answers.

Discuss any food that you eat which contain 'good' microorganisms.

Students can continue to work with their partner. Allow them to discuss the questions. They can share their experiences of preparing foods using yoghurt, vinegar, cheese etc.

> ***Possible response:*** *Students can list foods prepared using yoghurt, vinegar, cheese, kimchi, laban, kefir, etc. They can perhaps share if they have tried these or other probiotic foods.*

Science Fact: Alexander Fleming discovered the first antibiotic, penicillin.

Read out the Science fact or ask a volunteer to read it out. Explain to the students that a scientist named Alexander Fleming made a major discovery accidentally: He left a dish of bacteria uncovered, and sometime later he found a mold called Penicillium had grown in the dish and killed the bacteria around it. This was how he discovered the first antibiotic, which he named Penicillin.l.

Stretch zone: Find out how yoghurt is made at home. Follow the steps, prepare the youghurt. Write down the steps involved and your observations.

If you print out and distribute the yoghurt preparation steps below, you can make this activity into DART activity – so called because of the acronym Directed Activity Related to Text. It is a useful way of making reading more active and engaging and it also allows you and students to check understanding. (Other DART activities you will have used include: questions at the end of text to check comprehension; asking verbal questions during the reading of text; reading to the class and then stopping so students have to tell you what should be in the gaps; and presenting text with gaps in for students to complete.) In this example, ask students to follow the instructions to complete the activity. You might need to provide some hands-on aid, especially when using hot liquids.

Procedure: Requirements: clean yoghurt pots, a pan, a thermos flask or a heavy pot to keep the yoghurt warm, milk and live plain yoghurt.

(i) Place two tablespoons of live yoghurt into a thermos flask or heavy pot.

(ii) Heat the milk is heated in a pan so until just bubbling. You could provide pre-heated milk if you wish.

(iii) Leave the milk to cool until still hot but can be touched with a finger (46°C if you want to give students practice in measuring temperature).

(iv) Add the warm milk to the thermos or heavy pan and stir gently to mix the milk and yoghurt.

(v) Put a lid on and leave it for at least eight hours without it being moved.

(vi) Once the yoghurt is set, it can be placed into smaller pots and fruit can be added if you wish.

Key idea

- *Microorganisms can cause infectious diseases. These spread from host to host in many ways.*

Ask a student to read out the key idea. Ask students to turn to a partner and take it in turns to give an example of how a pathogen can be spread and how this spread can be prevented.

Review and reflect

Use the discussion tasks, the research investigation poster to encourage students to think about what they understand and what they are finding less straightforward. Discuss the outcomes of each task with students. Encourage them to identify aspects they have not completed correctly and help them to identify improvements. This will help students to develop a positive approach to learning by understanding that learning is a process that will improve with practice and reflection.

Extra activities

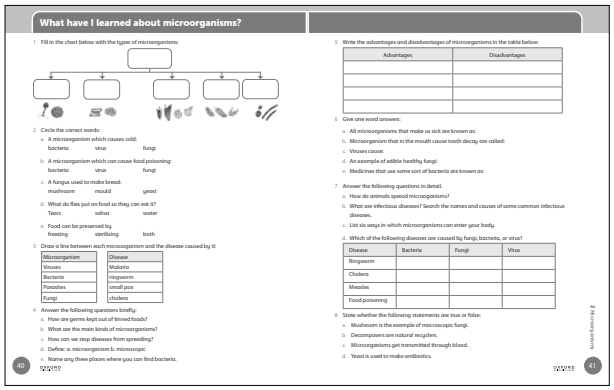
Differentiation

Supporting: Students can prepare a report on yoghurt preparation. This can be especially useful if the experiment is unsuccessful in setting yoghurt, and can provide valuable insight into doing practical research work.

Consolidating: Allow students to discuss their observations of the yoghurt making process.

Differentiated outcomes	
All students	should be able to state that there are both advantages and disadvantages from microorganisms.
Most students	will be able to describe how infectious diseases are caused by microorganisms.
Some students	may be able to explain the advantages of microorganisms, especially their uses in food production.

What have I learned about microorganisms?


What have I learned about microorganisms?

1 Fill in the chart below with the types of microorganisms:

2 Circle the correct words:
a. A microorganism which causes cold: bacteria virus fungi
b. A microorganism which can cause food poisoning: bacteria virus fungi
c. A fungus used to make bread: mushroom mould yeast
d. What do flies put on food so they can eat it? Tears saliva water
e. Food can be preserved by freezing sterilizing both

3 Draw a line between each microorganism and the disease caused by it:

Microorganism	Disease
Viruses	Malaria
Bacteria	ringworm
Parasites	small pox
Fungi	cholera

4 Answer the following questions briefly:
a. How are germs kept out of tinned foods?
b. What are the main kinds of microorganisms?
c. How can we stop diseases from spreading?
d. Define: a. microorganism b. microscopic
e. Name any three places where you can find bacteria.

5 Write the advantages and disadvantages of microorganisms in the table below:

Advantages	Disadvantages

6 Give one word answers:
a. All microorganisms that make us sick are known as:
b. Microorganism that in the mouth cause tooth decay are called:
c. Viruses cause:
d. An example of edible healthy fungi:
e. Medicines that use some sort of bacteria are known as:

7 Answer the following questions in detail.
a. How do animals spread microorganisms?
b. What are infectious diseases? Search the names and causes of some common infectious diseases.
c. List six ways in which microorganisms can enter your body.
d. Which of the following diseases are caused by fungi, bacteria, or virus?

Disease	Bacteria	Fungi	Virus
Ringworm			
Cholera			
Measles			
Food poisoning			

8 State whether the following statements are true or false:
a. Mushroom is the example of macroscopic fungi.
b. Decomposers are natural recyclers.
c. Microorganisms get transmitted through blood.
d. Yeast is used to make antibiotics.

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40 SCIENCE 41

Getting started

The aim of this section is to encourage students to review their learning after each lesson in the unit and also to undertake some end-of-unit review and reflection. On pages 40–41 of the Student Book there are questions linked to concepts and topics covered in the unit. These will assess students' knowledge and understanding of the topic. This will test longer-term understanding and recall. You can do this as an informal individual or pair activity and allow students to look information up as they work through the questions or you can set it as an individual 'closed-book' activity.

It is important that students report areas that they are not confident with. This information is useful for them in that they can think about what they need to review or ask advice about. It is also vital for you as it provides information about any topics you may wish to revisit.

What have I learned about microorganisms? answers

1 Fill in the chart below with the types of microorganisms:

Answer: *Microorganisms; viruses; bacteria; fungi; protozoa; algae.*

2 Circle the correct words:

Make sure the students understand that they have three options but they should circle only one choice - A, B or C.

Answer: *a. virus; b. bacteria; c. yeast; d. saliva; e. both.*

3 Draw a line between each microorganism and the disease caused by it:

Answer: *Viruses - small pox; Bacteria - cholera; Parasites - Malaria; Fungi - ringworm.*

4 Answer the following questions briefly:

a. How are germs kept out of tinned foods?

b. What are the main kinds of microorganisms?

c. How can we stop diseases from spreading?

d. Define: a. microorganism b. microscopic

e. Name any three places where you can find bacteria.

Answer:*a. Since bacteria and fungi need food, warmth, and moisture to grow, the process of tinning (canning of foods) removes air and warmth. In some cases the moisture is also removed. And many times preservatives which inhibit the growth of microbes are also added.*

b. Microorganisms are of following main types: viruses, bacteria, fungi, protozoa, algae.

c. by practicing good hygiene and preventing pathogens from entering our bodies.

d. microorganism: living things which are too small for us to see but are present everywhere b. microscopic: a tool used to see microorganisms.

e. any of the following: our guts, skin, soil, air, water bodies.

5 Write the advantages and disadvantages of microorganisms**:**

Explain that in this question they have three smaller questions to answer. Only one of the choices they are given in each section will be correct so they have to match only one word or phrase to each description and underline their choices. They should have three underlined choices at the end.

Answer: *Encourage students to list down the advantages and disadvantages listed in the student book, in form of a table.*

6 Give one word answers:

Answer: *a. pathogens; b. bacteria; c. disease; d. mushrooms; e. antibiotics.*

7 Answer the following questions in detail.

Answer: *a. by acting as vectors. Rat, mice, cockroaches, and flies can contaminate food with microorganisms. Mosquitoes cause malaria by*

transferring the germs when they suck blood from an infected person and then pass on the infection to the next person.

b. infectious diseases are diseases which can spread from one person to the other. These include Common cold, flu, Covid 19 (all caused by viruses) Typhoid, tuberculosis (both caused by bacteria).

c. through the nose, the mouth, or cuts in the skin, through touch, through contaminated blood, food or water, or by bites of vectors.

d. fungi: Ringworm; bacteria: Cholera, Food poisoning; virus: Measles.

8 State whether the following statements are true or false.

Answer: *a. true, b. true, c. true, d. false..*

Summative assessment

You can read out the answers to the 'What have I learned about the microorganisms?' section in the Student Book for students to self-assess or you can take in the pages and mark them to award an overall score. You could allocate marks as follows: question 1 = 1; question 2 = 5; question 3 = 2; question 4 = 5; question 5 = 2; question 6 = 5; question 7 = 8 (2 marks each); question 8 = 2. This makes a total of 30 marks.

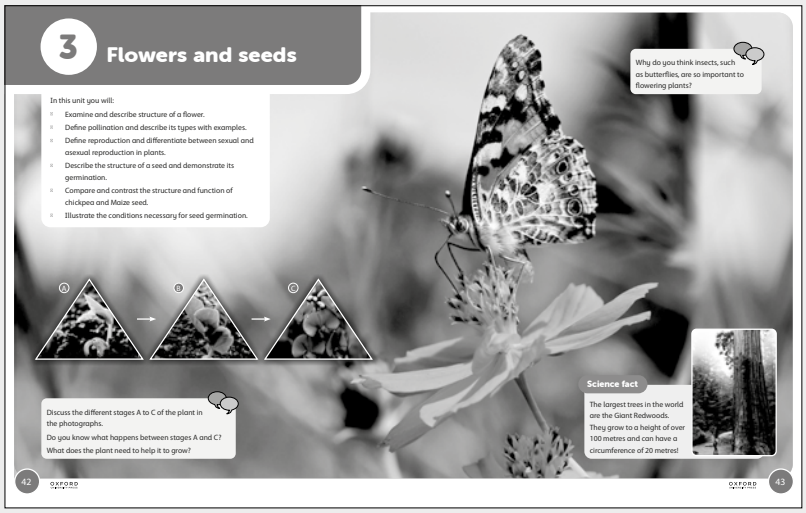
If necessary, ask students to revisit topics and questions to help them to learn more about any they did not score well on. In this way the questions are both summative and formative. All assessments should be linked to enhancing learning and in this way the 'What have I learned about?' pages will support this as well as providing data to report back to students, parents and/or other significant adults.

This feedback can then be used to form support strategies to help students improve. Keep the recording and analysis of students' self-evaluations simple. A general impression of the self-evaluation of the class is all that is required, for example: 50% of the class were not confident about … .

3 Flowers and seeds

In this unit students will:

- Examine and describe structure of a flower.
- Define pollination and describe its types with examples.
- Define reproduction and differentiate between sexual and asexual reproduction in plants.
- Describe the structure of a seed and demonstrate its germination.
- Compare and contrast the structure and function of chickpea and Maize seed.
- Illustrate the conditions necessary for seed germination.



Getting started

This unit explores in detail the structure and life cycle of flowering plants. Students review their knowledge of the main parts of a plant and the structure of flowers and go on to consider how flowering plants reproduce. They learn about the processes of pollination and fertilisation and the importance of seeds. Students are encouraged to compare and contrast monocot and dicot seeds. This leads to investigations and discussions about how seeds are spread and the conditions needed for seed germination. Finally, students carry out enquiry-based study to learn about the conditions needed for seed germination and for plants to grow well.

Science in context

Use the lessons in this unit to encourage students to learn more about the importance of flowering plants in everyday life. Allow students to survey and investigate the uses of flowering plants in their local area. Take them out to see flowering plants growing in the wild and in parks and visit a local market to survey the types of plants and seeds on sale. Visits to horticultural centres, farms and possibly even a research centre may be possible. Students have studied plants in earlier years, so remember to find out about any previous visits they have made and add to the experience rather than duplicating it.

Encourage students to find out about how parts of flowering plants are used for food and decoration and show them foods linked to the life cycle of flowering plants such as seeds and fruits in local shops and markets. Invite people into school who use flowering plants as part of their work – gardeners, local environmentalists, farmers, naturalists and other scientists, for example.

Scientific enquiry skills

Scientific enquiry skills for this unit focus on observation skills and the setting up of fair tests. Remind students of the different variables they must consider during investigations: independent (what they change); dependent (what they measure); and control (what they keep the same). Students also further develop their skills of collecting, recording and presenting data. They consider the accuracy and validity of the observations and measurements they take and are encouraged to evaluate their work. They are asked to present their results in a variety of ways, including in drawings, bar charts, graphs and tables. Students should be encouraged to use computer technologies to help them collect and present data.

Resources

Student Book: plastic cups or pots; eggshells (optional); compost or soil; water; plant labels or lollipop sticks; a variety of seeds including chick pea and maize seeds, batches of identical seeds, small smooth seeds, grass seeds; burrs and seeds with hooks (optional); different varieties of small plants in pots, including flowering plants and identical plants; flowers including cut flowers from a shop and those growing outside; a cactus or photographs of different cacti (optional); jars; timers or stopwatches; balloons; funnels; large pieces of cloth or paper; tape measures; cameras (optional); tweezers; sugar or honey; rulers; lamps; glass tubes; glass jars; hand lenses; thermometers; paper towels; scissors; glue; A4 and larger sheets of paper; writing materials including sharp pencils; brightly coloured card; cardboard; sticky tape; cardboard boxes; materials to make posters and information leaflets; access to the internet or to books on seed dispersal, plant reproduction, the life cycle of plants and germination;

access to a printer; a video clip of seeds exploding from pods (optional); access to a fridge; access to an outdoor area where various flowers grow.

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results using diagrams and labels, tables, keys and graphs

Make predictions

Report and present findings in a variety of ways

Draw conclusions and give explanations

Identify causal relationships

Use scientific evidence to support or refute ideas

Language support

It is useful to start any new unit by encouraging students to discuss each new word and define those they are familiar with. This monitoring of prior knowledge is vital and can help you enormously in setting the level of work in the first few lessons. Create a Word wall for the unit so students see the words often and become familiar with them. This will help with accurate usage and spelling of scientific words and terms. You can have daily quizzes about the words – point to one and ask: What does this word mean? Use it in a sentence.

To develop good practice throughout the year, remind students that their Student Book has a glossary at the back.

When learning new words, especially specific science words and terms, it is vital that they are repeated regularly and used in context. Ask students to listen, say, read and then write the words. Students can also make a list of other words that are not science-specific but are used in lessons and are not familiar. Some of these are listed in the individual lesson notes that follow. Students could write these words down in a notebook.

Consider creating a science library in your room. Add some general resources such as science books and magazines, science encyclopaedias and dictionaries.

You can also collect or download specific information about topics for each lesson or make an information booklet of these. Students can help with the production of these information booklets and they can include some of their own work. You will find these booklets very valuable support for lessons and especially for Stretch zone activities.

Unit at a glance

The key teaching points for students in this unit are:

- to introduce the unit objectives
- to introduce the learning outcomes
- to engage students with the content of the unit
- to review and build on prior learning and understanding of the topics
- to start the first unit of the book.

The purpose of this lesson is for students to start thinking about flowering plants and how they reproduce and develop. The introductory pages show a range of photographs of flowering plants and a butterfly to prompt recall of earlier work and any general knowledge of plants. Read through the key words and give students time to enjoy looking over the page before you start the sequence of discussion tasks.

Ask students to look closely at the photographs on the pages, and then ask them to talk about the discussion questions.

Discuss the different stages A to C of the plant in the photographs. Do you know what happens between stages C and A? What does the plant need to help it to grow?

Arrange students into pairs or small groups. A useful strategy is to start with students in pairs and then move pairs together to make groups of four so students can share their ideas and discussions with others.

Ask students to look carefully at the triangular photographs and talk about each stage. Point out that the process does not stop at C – otherwise plants would die out. Ask students to think about what would fill the gap to link to stage A. This will elicit prior knowledge of the life cycle of flowering plants. They can then talk about what plants need to grow.

Possible response: *Students could suggest that between stages C and A the plant will produce seeds that pass into the soil and start to grow. They should recall that plants need light, water, air and space to grow. Some may mention warmth as a factor.*

Why do you think insects, such as butterflies, are so important to flowering plants?

Ask students to look carefully at the main photograph on the page. They can talk about what the butterfly is doing and why this is important for the plant. This question is designed to check their understanding of pollination.

Possible response: *Students should recall that the butterfly spreads pollen from one plant to another or to different parts of the same plant. Some may recall the word 'pollination' and suggest the flower provides nectar for the insect.*

Science fact: The largest trees in the world are the Giant Redwoods. They grow to a height of over 100 metres and can have a circumference of 20 metres!

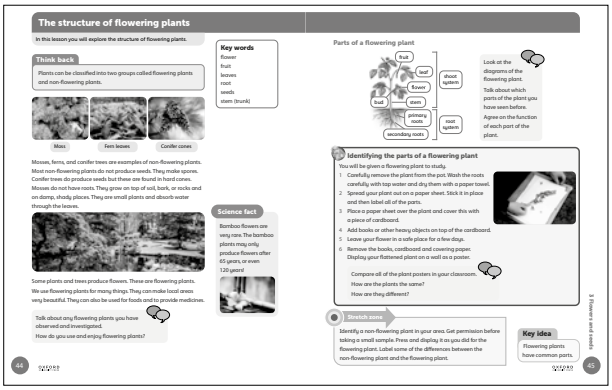
Read out the Science fact or ask a volunteer to read it out. You could explain that Giant Redwoods are examples of a type of plant called conifers. Strictly speaking these are not flowering plants but Giant Redwoods do produce flowers and seeds. You could measure out a circle with a circumference of 20 metres and stand your class inside it to give some idea of the scale of these huge trees.

Extra activities

1 It is useful to have a wide range of flowering plants at different stages available throughout the unit. You can ensure a ready supply by asking students to plant seeds in small pots – yoghurt pots or egg boxes work well – and to look after them and observe them over the next few days and weeks.

2 Consider starting a class garden, using a spare section of the school grounds. Dig squares to act as planting plots or beds. Arrange for students to plant a range of flowering plants, including vegetables and fruits, such as tomatoes. If you do not have any available ground, use a range of pots and containers to make an effective garden. You could extend this to make a community garden and use expertise from the local area.

The structure of flowering plants


The structure of flowering plants

In this lesson you will explore the structure of flowering plants.

Think back

Plants can be classified into two groups called flowering plants and non-flowering plants.

Moss | Fern leaves | Conifer cones

Mosses, ferns, and conifer trees are examples of non-flowering plants. Most non-flowering plants do not produce seeds. They make spores. Conifer trees do produce seeds but these are found in hard cones. Mosses do not have roots. They grow on top of soil, bark, or rocks and on damp, shady places. They are small plants and absorb water through the leaves.

Some plants and trees produce flowers. These are flowering plants. We use flowering plants for many things. They can make local areas very beautiful. They can also be used for foods and to provide medicines.

Talk about any flowering plants you have observed and investigated.
How do you use and enjoy flowering plants?

44

Key words
flower
fruit
leaves
root
seeds
stem (trunk)

Science fact

Bamboo flowers are very rare. The bamboo plants may only produce flowers after 65 years, or even 120 years!

Parts of a flowering plant

fruit
leaf
flower
stem
primary roots
secondary roots
bud
shoot system
root system

Look at the diagrams of the flowering plant.
Talk about which parts of the plant you have seen before.
Agree on the function of each part of the plant.

Identifying the parts of a flowering plant

You will be given a flowering plant to study.
1 Carefully remove the plant from the pot. Wash the roots carefully with tap water and dry them with a paper towel.
2 Spread your plant out on a paper sheet. Stick it in place and then label all of the parts.
3 Place a paper sheet over the plant and cover this with a piece of cardboard.
4 Add books or other heavy objects on top of the cardboard.
5 Leave your flower in a safe place for a few days.
6 Remove the books, cardboard and covering paper. Display your flattened plant on a wall as a poster.

Compare all of the plant posters in your classroom.
How are the plants the same?
How are they different?

Stretch zone

Identify a non-flowering plant in your area. Get permission before taking a small sample. Press and display it as you did for the flowering plant. Label some of the differences between the non-flowering plant and the flowering plant.

Key idea

Flowering plants have common parts.

3 Flowers and seeds

45

Getting started

In this lesson students look at some examples of non-flowering plants and then review their understanding of the structure of flowering plants. They learn about the uses of flowering plants and then look at their structure in detail. They build on work from earlier years. Students then study a flowering plant and create a labelled display.

Language support

To help develop language skills and review key words you can write these words on the board: 'fruit', 'flower', 'seeds', 'leaf/leaves', 'stem (trunk)', 'roots'. Ask students to tell their partner what each of the words mean. They could even be challenged to draw an example of each.

Resources

Student Book: different varieties of flowering plants in pots; water; paper towels; large sheets of paper; cardboard; glue; objects to use as weights, e.g. large books; materials to make posters.

Key words

flower fruit leaves root seeds stem (trunk)

Other words in the lesson

bud cone conifer fern moss
non-flowering plant primary roots root system
shoot system spore

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make observations

Record data and results using diagrams and labels,

tables, keys and graphs

Report and present findings in a variety of ways

Lesson at a glance

The key teaching points for students in this lesson are:

- there are flowering and non-flowering plants
- flowering plants have common parts
- flowering plants have many uses.

Think back: Plants can be classified into two groups called flowering plants and non-flowering plants.

Ask students to think back to their work in earlier years about flowering and non-flowering plants. Remind them that this doesn't mean a plant doesn't have flowers for part of the year. A non-flowering plant will never be able to produce flowers. You can point out the photographs of moss, ferns and conifer cones to help students to remember their work from Year 4 when they used keys to identify some plants.

Read out the text beneath the photographs or ask a volunteer to read it out. Point out that flowers are the part of a flowering plant that help it to reproduce and make seeds, and non-flowering plants do not make seeds. Many make spores. You could mention that some conifers, such as the Giant Redwoods discussed in the introductory lesson, do have flower-like structures and have seeds in cones but they are not flowering plants.

Allow students to study the photograph of flowering plants and trees on page 45 of the Student Book. You could also use this opportunity to take students out to an area near the school to observe flowering plants. This could include a market or shop selling flowers and plant products. This will help with the discussion task below.

Talk about any flowering plants you have observed and investigated. How do you use and enjoy flowering plants?

Allow students to work with a partner to talk about any flowering plants they have seen and then to discuss the questions. If you have taken them out to see flowers and other plant products, they can apply this knowledge, or you can rely on prior experiences. Students will have studied the uses of plants in Years 1 and 2 and should be aware of how important flowering plants are to people and within habitats.

Possible response: *Students should suggest uses such as decoration, food and medicines. Some may also suggest shade and for building materials.*

Science fact: Bamboo flowers are very rare. The bamboo plants may only produce flowers after 65 years, or even 120 years!

Read out the Science fact or ask a volunteer to read it out. Ask students what animal is known to feed only on bamboo plants. Encourage them to think about what it would be like if a flowering plant they planted in a garden only flowered every 120 years.

Point out the labelled diagram at the top of page 45 of the Student Book. Remind students that they have studied the structure of flowering plants before but stress that reviewing work helps them to understand and they will now be looking at the flowers in more detail.

Look at the diagrams of the flowering plant. Talk about which parts of the plant you have seen before. Agree on the function of each part of the plant.

Arrange students into pairs or groups of three or four. Ask them to look at the diagrams and read through the labels. They then talk about which parts of the plant they have seen before. They can play a game by asking their partner to look away and then they cover one of the labels and ask their partner to name the label they are hiding and the function of this part of the plant. Explain that they should try to recall as much as possible, but they should not worry if they cannot recall everything – they will be investigating flowering plants in the next few lessons and they can fill any gaps in their memory.

Possible response: *Students should suggest that the leaf uses energy from sunlight to help the plant to make food (sugars); roots take up water and minerals from soil; flowers help plants to reproduce and make seeds; fruits help the seeds to be dispersed; stems hold the flowers and leaves off the ground and have tubes to allow water and food to move around the plant; a bud is where a new leaf or flower is developing.*

With the structure of the flower students may recall that: filament holds the anther up and the anther produces pollen; petals attract insects and other pollinators; sepals once covered the bud to protect the young flower; the receptacle is where the flower joins the stem; stigma is where pollen lands on the female part of the flower; the style links the stigma to the ovary and the ovary is where ovules are formed.

Investigation: Identifying the parts of a flowering plant

Allow students to work in groups of three or four. Explain that they are going to cut up or dissect a flowering plant and make a labelled display.

Give each group a potted plant. Try to give a range of three or four different types. Ask them to follow the instructions. They can use gently running tap water to wash roots but block plugholes with paper or cloth so soil does not block the sink. Once the roots are clean, tell students to dry them with a paper towel and spread the plant out on a paper sheet. Explain that by placing a paper sheet over the plant and covering this with a piece of cardboard they are starting to make a pressed flower, which is dried and keeps its shape.

Stretch zone: Identify a non-flowering plant in your area. Get permission before taking a small sample. Press and display it as you did for the flowering plant. Label some of the differences between the non-flowering plant and the flowering plant.

Ask students to think about why they need to get permission before cutting or removing plants. Remind them that we all need to be responsible for protecting habitats. In many countries it is legal to take small parts of some wild plants but students should never dig up a plant or take too much of it. Once they have made their pressed plant poster they can display it next to their flowering plant version.

Computing link: Ask students to research some of the differences between flowering plants and non-flowering plants and label these on their posters.

> ***Possible response:*** *Students should suggest that non-flowering plants do not have buds or flowers so there will be no petal, stamens, stigmas, etc. and these plants do not produce seeds or fruit. They may also suggest that non-flowering plants may produce spores and/or cones.*

Key idea

Flowering plants have common parts.

Read out the Key idea or ask a volunteer to read it out. Ask students to use a blank piece of paper to list the parts of a flowering plant without looking them up in their books or notes. They can then work with a partner to draw and label a picture of a flower from memory. When they have completed as much as they can, ask them to look at the diagram in the Student Book, check their picture and add any missing labels.

Review and reflect

Ask students to test a partner by saying the name of a part of a flowering plant and asking them to name it and describe its function. They can take it in turns until all of the parts have been covered. You can allow some quiet time after this for students to reflect on what they answered well in the lesson and to think of one method they could use to remember the parts of a flowering plant and flower better.

Extra activities

1 **Computing link:** Ask students to research the uses of flowering plants in more detail. Give them one of the following topics: food; medicines; fuel; dyes; fibres; ornaments and timber. They can download examples and share their ideas by giving a short talk to the class.

2 Students make and label a 3D model of a flowering plant using paper, card, dry pasta or modelling clay and display these as a plant exhibition.

Differentiation

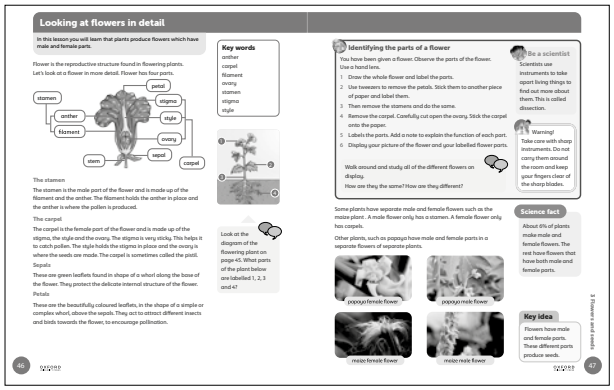
Supporting: Show students a range of flowering and non-flowering plants to help them to learn the difference.

Consolidating: Allow students to download and display a wide range of flowering plants to consolidate what the plants have in common and how they can vary.

Extending: Encourage students to find out more about how non-flowering plants reproduce.

Differentiated outcomes	
All students	should be able to classify a plant as flowering or non-flowering
Most students	will be able to label the parts of a flower and describe the function of each
Some students	may be able to compare and contrast flowering and non-flowering plants

Looking at flowers in detail


Looking at flowers in detail

In this lesson you will learn that plants produce flowers which have male and female parts.

Flower is the reproductive structure found in flowering plants. Let's look at a flower in more detail. Flower has four parts.

stamen, petal, stigma, style, anther, filament, ovary, sepal, stem, carpel

The stamen

The stamen is the male part of the flower and is made up of the filament and the anther. The filament holds the anther in place and the anther is where the pollen is produced.

The carpel

The carpel is the female part of the flower and is made up of the stigma, the style and the ovary. The stigma is very sticky. This helps it to catch pollen. The style holds the stigma in place and the ovary is where the seeds are made. The carpel is sometimes called the pistil.

Sepals

These are green leaflets found in shape of a whorl along the base of the flower. They protect the delicate internal structure of the flower.

Petals

These are the beautifully coloured leaflets, in the shape of a simple or complex whorl, above the sepals. They act to attract different insects and birds towards the flower, to encourage pollination.

Key words

anther
carpel
filament
ovary
stamen
stigma
style

Look at the diagram of the flowering plant on page 45. What parts of the plant below are labelled 1, 2, 3 and 4?

Identifying the parts of a flower

You have been given a flower. Observe the parts of the flower. Use a hand lens.

1. Draw the whole flower and label the parts.
2. Use tweezers to remove the petals. Stick them to another piece of paper and label them.
3. Then remove the stamens and do the same.
4. Remove the carpel. Carefully cut open the ovary. Stick the carpel onto the paper.
5. Label the parts. Add a note to explain the function of each part.
6. Display your picture of the flower and your labelled flower parts.

Walk around and study all of the different flowers on display.

How are they the same? How are they different?

Be a scientist

Scientists use instruments to take apart living things to find out more about them. This is called dissection.

Warning!

Take care with sharp instruments. Do not carry them around the room and keep your fingers clear of the sharp blades.

Some plants have separate male and female flowers such as the maize plant. A male flower only has a stamen. A female flower only has carpels.

Other plants, such as papaya have male and female parts in a separate flowers of separate plants.

papaya female flower, papaya male flower, maize female flower, maize male flower

Science fact

About 6% of plants make male and female flowers. The rest have flowers that have both male and female parts.

Key idea

Flowers have male and female parts. These different parts produce seeds.

3 Flowers and seeds

46 STUDENT BOOK

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Getting started

This lesson looks at the parts of the flower. The lesson starts with a review of learning where students identify the parts of a plant and discuss the function of each part. They then look at the detailed parts of a flower and the function of each and then apply this knowledge by completing an investigation to identify and label the parts of a real flower.

Language support

Students are formally introduced to several key words in this lesson. Most of them have been covered before but they are now expected to use the terms. It is important that they are able to recognise these words and understand their meanings. As new words are introduced, allow students time to add definitions to their glossaries. Display a large version of the flower diagram and keep this on display so students become familiar with the names of the parts of the flower.

Resources

Student Book: variety of different-shaped flowers; tweezers; hand lenses; small sharp knives; sheets of paper; glue.

Key words

anther carpel filament ovary stamen stigma style

Other words in the lesson

dissect female male pistil

Scientific enquiry key words

Make observations
Record data and results using diagrams and labels, tables, keys and graphs

Lesson at a glance

The key teaching points for students in this lesson are:

- flowers have male and female parts
- these parts are vital in the production of seeds.

In the next lesson, students will learn about how the ovules in a flowering plant are fertilised by pollen.

Look at the diagram of the flowering plant on page 45. What parts of the plant below are labelled 1, 2, 3 and 4?

Start by asking students to look at the parts of the plant shown in the diagram in the previous spread of the Student Book. Allow them to discuss the plant with a partner and then try to remember the parts they studied in an earlier lesson ('The structure of flowering plants').

Remind students that thinking back over their previous work is an important way to help them to understand it.

Answer: *1 = flower; 2 = leaf; 3 = stem; 4 = roots.*

Investigation: Identifying the parts of a flower

Point out that the purpose of this investigation is to allow students to apply their knowledge of flower structure by dissecting and displaying the various parts.

Warning! Take care with sharp instruments. Do not carry them around the room and keep your fingers clear of the sharp blades.

Start by stressing the warning and ask students to talk about why they need to take care with sharp instruments. Ask them to suggest other rules for working safely.

Students can work in a pair or group of three or four. Hand out a variety of different-shaped flowers so students can compare their final displays and see that although flowers may vary in size and shape, most contain the same main parts.

Note: Check that the flowers are bisexual – they have stamens and carpels on the same flowers. Some plants have male only and female only flowers and other plants have male plants and female plants. Check visually to avoid confusing students. Plants such as roses, lilies, daffodils, gladioli and tulips work well.

Encourage students to use a hand lens to see fine detail and to draw the whole flower and then the dissected parts. They can then make their display.

Be a scientist: Scientists use instruments to take apart living things to find out more about them. This is called dissection.

Point out the Be a scientist feature and explain that taking things apart to look at how they work is a common activity in science. Explain that dissect means to cut something up carefully in a methodical way – not just to break something apart. Scientists are very careful about what they collect and dissect and they make sure they do not damage a habitat.

Walk around and study all of the different flowers on display. How are they the same? How are they different?

Once the displays are exhibited, allow students to move between each one. They should discuss how the plants are the same and how they vary. After this you can ask volunteer students to share their ideas with the class.

> ***Possible response:*** *Students should notice that the flowers vary in colour, shape and size but they should all contain the same main parts.*

Ask students to read the text about male and female flowers. Ask whether they have seen any catkins. You can also let students know that some plant species have male and female plants. This can cause a problem for hay fever sufferers as if all male trees are planted in a town or city, the pollen level can be very high.

Science fact: About 6% of plants make male and female flowers. The rest have flowers that have both male and female parts.

Read out the Science fact or ask a volunteer to read it out. Ask students to suggest why it might be useful for a plant to make only male or female flowers. Explain that if pollen from the same plant lands on the stigma there will be no chance of mixing characteristics in the offspring. It is important for plants to get pollen from another plant of the same species.

Key idea

Flowers have male and female parts. These different parts produce seeds.

Read out the Key idea or ask a volunteer to read it out. Ask students to work with a partner and take it in turns to name a part of a flower with the partner saying its function.

Review and reflect

You can use the answers during the Key idea task to help you to gauge students' level of understanding. You can also use the dissected flower displays to ask students to reflect on how well they have completed the work and how well they worked together.

Extra activities

1 Students examine the stamen and carpel using microscopes. They will be able to see much more detail and even individual pollen grains and the rough and sticky surface of the stigma. If you do not have access to microscopes, you could download and display magnified photographs of pollen and the parts of a flower.

2 Ask students to use flowers to make perfume. They should select a flower with a strong scent – or mix flowers together – and preferably use the petals. These can be washed, cut up or crushed and then left in a small amount of water for 24 hours. Students then sieve or filter the mixture to remove the petals and to obtain just the liquid. This will contain dissolved substances that make the liquid smell pleasant.

Differentiation

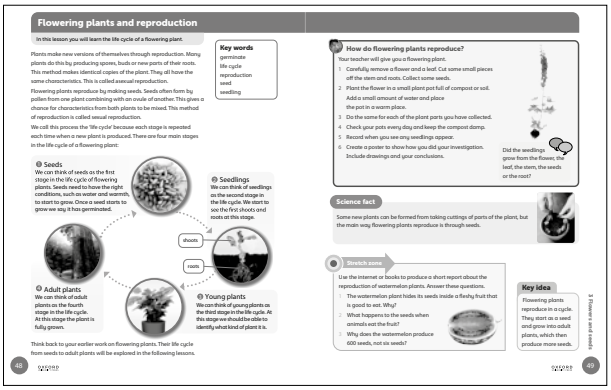
Supporting: Use the activity from the book to support students in learning the parts of a flower.

Consolidating: Display numerous pictures of flowers and occasionally ask a student to volunteer to stand up and point to a stamen, a stigma, a petal, etc.

Extending: Allow students to dissect a male-only and a female-only flower.

Differentiated outcomes	
All students	should be able to name the parts of a flower
Most students	will be able to describe the functions of each part of a flower
Some students	may be able to explain why some plants have male and female flowers

Flowering plants and reproduction


Flowering plants and reproduction

In this lesson you will learn the life cycle of a flowering plant.

Plants make new versions of themselves through reproduction. Many plants do this by producing spores, buds or new parts of their roots. This method makes identical copies of the plant. They all have the same characteristics. This is called asexual reproduction.

Flowering plants reproduce by making seeds. Seeds often form by pollen from one plant combining with an ovule of another. This gives a chance for characteristics from both plants to be mixed. This method of reproduction is called sexual reproduction.

We call this process the 'life cycle' because each stage is repeated each time when a new plant is produced. There are four main stages in the life cycle of a flowering plant:

Key words
germinate
life cycle
reproduction
seed
seedling

1 Seeds
We can think of seeds as the first stage in the life cycle of flowering plants. Seeds need to have the right conditions, such as water and warmth, to start to grow. Once a seed starts to grow we say it has germinated.

2 Seedlings
We can think of seedlings as the second stage in the life cycle. We start to see the first shoots and roots at this stage.

shoots
roots

3 Young plants
We can think of young plants as the third stage in the life cycle. At this stage we should be able to identify what kind of plant it is.

4 Adult plants
We can think of adult plants as the fourth stage in the life cycle. At this stage the plant is fully grown.

Think back to your earlier work on flowering plants. Their life cycle from seeds to adult plants will be explored in the following lessons.

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How do flowering plants reproduce?

Your teacher will give you a flowering plant.

1 Carefully remove a flower and a leaf. Cut some small pieces off the stem and roots. Collect some seeds.
2 Plant the flower in a small plant pot full of compost or soil. Add a small amount of water and place the pot in a warm place.
3 Do the same for each of the plant parts you have collected.
4 Check your pots every day and keep the compost damp.
5 Record when you see any seedlings appear.
6 Create a poster to show how you did your investigation. Include drawings and your conclusions.

Did the seedlings grow from the flower, the leaf, the stem, the seeds or the root?

Science fact

Some new plants can be formed from taking cuttings of parts of the plant, but the main way flowering plants reproduce is through seeds.

Stretch zone

Use the internet or books to produce a short report about the reproduction of watermelon plants. Answer these questions.

1 The watermelon plant hides its seeds inside a fleshy fruit that is good to eat. Why?
2 What happens to the seeds when animals eat the fruit?
3 Why does the watermelon produce 600 seeds, not six seeds?

Key idea

Flowering plants reproduce in a cycle. They start as a seed and grow into adult plants, which then produce more seeds.

3 Flowers and seeds

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Getting started

This lesson looks at how flowering plants reproduce. Students find out about the different stages in the life cycle and the processes involved. They investigate whether plants can be propagated from different plant parts.

Language support

As you work through the lesson, check students' understanding of the terms 'germinate', 'reproduction' and 'life cycle'. Remind them that they have used these terms before and ask for volunteers to explain what they mean and put them in a sentence.

Resources

Student Book: flowering plants; scissors; pots containing compost or soil; water; materials to make posters; access to the internet or books about watermelon plants.

Key words

germinate life cycle reproduction seed seedling

Other words in the lesson

asexual reproduction characteristic identical sexual reproduction

Scientific enquiry key words

Plan and/or carry out enquiries to answer question

Make observations

Record data and results using diagrams and labels, tables, keys and graphs

Make predictions

Draw conclusions and give explanations

Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- flowering plants reproduce in a cycle
- the cycle starts with a seed and this develops into an adult plant
- adult flowering plants produce seeds to continue the cycle.

Tell students that they are going to think about how flowering plants make new flowering plants. Ask: Have you seen any flowering plants? Where? What happens to the flowers over time?

Read through the text at the top of page of the Student Book. Do this one paragraph at a time. After the first paragraph emphasise that making new plants from spores, cuttings, runners or bulbs only makes identical copies of the parent plant. No new and possibly valuable characteristics can appear. Explain that this is known as asexual reproduction.

After the second paragraph emphasise that because pollen and ovules from different plants combine, a new, unique plant is made from the seeds that are produced. This combination of characteristics allows offspring to develop new characteristics that might help them to survive. Explain that this is known as sexual reproduction.

After the third paragraph, ask: Why is the life cycle of a flowering plant called a cycle? How many stages are there in the life cycle?

Allow students to work with a partner and to follow the life cycle shown in the Student Book. Read through each stage with students and encourage them to study the photographs for each stage. Ask: What overall shape is the picture of the life cycle of a flowering plant? Why is it circular? What happens to the adult flowering plant after it has made seeds?

These questions are designed to get students to think about the life cycle of a flowering plant as being a continuous process and, further, to encourage them to predict what might happen at the latter stages of the life cycle.

Investigation: How do flowering plants reproduce?

The purpose of this investigation is to show students that new flowering plants grow from seeds and usually not from other parts of the plant. You may wish to discuss with students propagating plants using methods such as cuttings, but remember to emphasise that the offspring will be an identical copy of the parent. You can use the Science fact (see below) to help with this.

Give each group a flowering plant that has been removed from its pot. Ask students to carefully remove a flower and a leaf. They should also cut some small pieces off the stem and roots. Tell them that they should remove a small side stem and not cut into the main stem. Remind students to be careful when cutting the plant.

Hand out some seeds from the same plant type. Students plant the seeds, flower, leaf and the other small pieces of the plant they have removed into separate small plant pots full of compost or soil. They add a small amount of water and place the pot in a warm place. They will check their pots every day. Remind them to keep the compost damp. They should record when they see any seedlings appear. Students can share their ideas by creating a poster to show how they did their investigation. Ask them to include drawings and their conclusions.

Did the seedlings grow from the flower, the leaf, the stem, the seeds or the root?

Ask students to discuss their results within the group and also to look at the posters produced by other groups and then decide which plant parts resulted in new seedlings.

Possible response: *Students should observe that the seeds grow and develop into a new plant but the other parts of the flowering plant do not produce new plants.*

Science fact: Some new plants can be formed from taking cuttings of parts of the plant, but the main way flowering plants reproduce is through seeds.

Read out the Science fact or ask a volunteer to read it out. Ask students to tell you if they have seen cuttings being taken or even used this technique themselves. You could use this opportunity to explain that cuttings only give identical copies of the parent plant and they need special treatment to grow.

Stretch zone: Use the internet or books to produce a short report about the reproduction of watermelon plants. Answer these questions.

1 The watermelon plant hides its seeds inside a fleshy fruit that is good to eat. Why?

2 What happens to the seeds when animals eat the fruit?

3 Why does the watermelon produce 600 seeds, not six seeds?

Computing link: Ask students to work with a partner to think about the Stretch zone task. Allow them to use the internet to find out answers to the facts about watermelon seeds. Ask them to discuss the facts and decide the answers. They should then create a short report – this can be as an information leaflet or computer presentation.

Possible response: *Students should find out that the fleshy fruit attracts animals that eat it and then the seeds pass through the animal and are spread. Watermelons produce so many seeds so that at least some will pass through an animal and into fertile soil. Many seeds will not reach fertile ground, so producing lots of seeds increases the watermelon plant's chances of producing offspring.*

Key idea

Flowering plants reproduce in a cycle. They start as a seed and grow into adult plants, which then produce more seeds.

Read out the Key idea or ask a volunteer to read it out. Ask students to draw the stages of the life cycle from memory. Then they check with page 18 of the Student Book and correct any errors and fill in any gaps on their diagrams.

Review and reflect

Ask students to sit opposite a partner. Ask them to think about what they have learned and then take it in turns to tell their partner about two examples. They should start by saying 'One thing I have learned in this lesson is …' and the second time they say 'Another thing I have learned is …'.

Extra activities

1 Ask students to work in groups to produce large posters showing the life cycle of plants. They could download photographs to show the different stages or draw them. Display the posters in the classroom.

2 You could invite a local farmer or gardener in to talk about how they use seeds. They could describe the types of seeds they use, how the seeds are planted and why the final crop is so important.

Differentiation

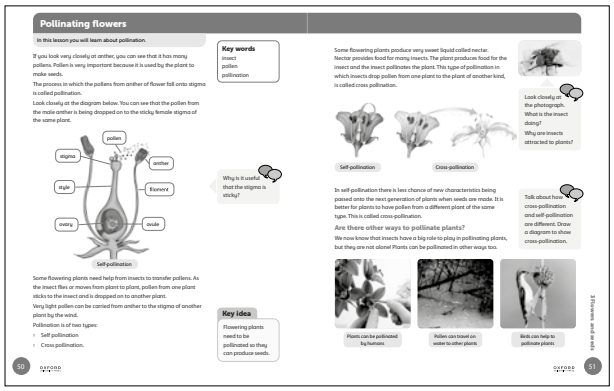
Supporting: Copy the life cycle from the Student Book and make it a cut and paste activity by cutting it into eight pieces (pictures and text), mixing the pieces up and asking students to put them into the correct order.

Consolidating: Display seed packets or download pictures of seed packets. These show the seeds and the plants that grow from them.

Extending: Students could research more about the advantages and disadvantages of asexual and sexual reproduction in plants.

Differentiated outcomes	
All students	should be able to recall the four stages of a flowering plant's life cycle
Most students	will be able to describe what happens at each stage of the life cycle
Some students	may be able to explain some advantages and disadvantages of asexual and sexual reproduction in flowering plants

Pollinating flowers


Pollinating flowers

In this lesson you will learn about pollination.

If you look very closely at anther, you can see that it has many pollens. Pollen is very important because it is used by the plant to make seeds.
The process in which the pollens from anther of flower fall onto stigma is called pollination.
Look closely at the diagram below. You can see that the pollen from the male anther is being dropped on to the sticky female stigma of the same plant.

pollen
stigma
anther
style
filament
ovary
ovule
Self-pollination

Some flowering plants need help from insects to transfer pollens. As the insect flies or moves from plant to plant, pollen from one plant sticks to the insect and is dropped on to another plant.
Very light pollen can be carried from anther to the stigma of another plant by the wind.
Pollination is of two types:
- Self pollination
- Cross pollination.

Key words
insect
pollen
pollination

Why is it useful that the stigma is sticky?

Key idea
Flowering plants need to be pollinated so they can produce seeds.

Some flowering plants produce very sweet liquid called nectar. Nectar provides food for many insects. The plant produces food for the insect and the insect pollinates the plant. This type of pollination in which insects drop pollen from one plant to the plant of another kind, is called cross pollination.

Look closely at the photograph. What is the insect doing? Why are insects attracted to plants?

Self-pollination
Cross-pollination

In self-pollination there is less chance of new characteristics being passed onto the next generation of plants when seeds are made. It is better for plants to have pollen from a different plant of the same type. This is called cross-pollination.

Are there other ways to pollinate plants?
We now know that insects have a big role to play in pollinating plants, but they are not alone! Plants can be pollinated in other ways too.

Talk about how cross-pollination and self-pollination are different. Draw a diagram to show cross-pollination.

Plants can be pollinated by humans
Pollen can travel on water to other plants
Birds can help to pollinate plants

3 Flowers and seeds

50 OXFORD
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Getting started

This lesson looks at two different ways flowers are pollinated: by insects and by the wind. Students learn how pollen is carried by insects that have been attracted to flowers and that flowers that are pollinated by wind are often specially adapted. They also consider how people, birds and water can help to pollinate flowers.

Language support

Ensure that students understand the word 'pollen'. Explain that the movement of pollen onto the female part of a flower is called pollination. Then ask students to complete their glossaries to reinforce the words 'insect' and 'pollination' for this lesson.

Resources

Student Book: access to an outside area where a range of flowers grow; cameras (optional); materials to make information leaflets.

Key words

insect pollen pollination

Other words in the lesson

anther flowers nectar ovary ovule petal seeds sepal stigma wind-pollinated

Scientific enquiry key words

Make observations

Record data and results using diagrams and labels, tables, keys and graphs

Report and present findings in a variety of ways

Draw conclusions and give explanations

Lesson at a glance

The key teaching points for students in this lesson are:

- flowering plants need to be pollinated so they can produce seeds
- pollen can be moved in a variety of ways.

Read through the text in of the Student Book or ask volunteers to read a paragraph each. Ask students to explain what pollen is and how insects can move it from place to place. It is important that students realise that pollination can only occur with plants of the same species. This can be a point of confusion that needs to be addressed at this stage.

Why is it useful that the stigma is sticky?

Remind students to recall what they have learned earlier about the shape and role(s) of flowers.

Encourage students to discuss hay fever: do they or someone they know ever have itchy eyes or a runny nose when outside? Explain that this is possibly due to pollen grains blowing around in the wind.

Explain that flowers that use the wind to help them to spread pollen are specially adapted to make this more efficient. Remind students that pollen is made in the anther and sticks to the stigma.

Possible response: *Students may suggest that the stickiness of the stigma helps the pollen grains stick to stigma and not get blown or shaken off.*

Explain that the process of pollination comes before fertilisation and can be thought of as a journey that the pollen makes. Point out the diagram and explain that it shows the journey pollen can make from the anther to the stigma within the same plant. Write 'self-pollination' on the board and stress that this will make seeds, but the seeds will produce plants that are identical to the parent plant.

Explain that students will be carrying out a survey of flowers in the school grounds or a local park. Take students to an area that has many different types of flowers. Remind them that many trees produce flowers so they should not only concentrate on the smaller, low flowers. Ask them to observe the different types of flowers and use the shape of the flowers to decide whether they are likely to be self or cross pollinated and whether they are wind pollinated or animal pollinated. Students can record their ideas by drawing or photographing one example of each. Finally, they can make an information leaflet about pollination using findings from their survey.

Look closely at the photograph. What is the insect doing? Why are insects attracted to plants?

Students can work with a partner to study the photograph and discuss the questions. Ask students to

think about why insects are attracted to flowering plants. It is useful to bring into the discussion that insects use flowers for food, and that they are attracted by the colour and the smell of flowers, for example. Students can then share their ideas with the class.

Possible response: *Students may suggest the insect is feeding on the flower. Some may say the insect is obtaining a sugary liquid and some may even recall this is called nectar. Elicit that flowers also may have bright colours and scent.*

Ask: Are there other ways to pollinate plants? Ask students to look at the photographs at the bottom of page 51 of the Student Book and discuss what they see. Point out that people, water and animals such as birds and bats can also pollinate flowers.

Possible response: *Students may suggest that by adding pollen they can make sure each flower is pollinated. Some may know that by adding pollen from specific plants a person can try to make new plants with specific characteristics. For example, pollen from a tall plant added to a plant that makes large fruit may give offspring that are tall and have large fruit.*

Ask students to work with a partner to study the diagrams. Ask them to look for clues in the flowers – for example, which has anthers and stigma that are open to the air? Which has the anthers and stigma hidden inside the petals?

Possible response: *Students should conclude that the one of the plants is self pollinated, whereas the other is cross pollinated.*

Talk about how cross-pollination and self-pollination are different. Draw a diagram to show cross-pollination.

Use the discussion task to encourage students to talk to others in their small group about the evidence they are using to decide how the flowers might be pollinated.

Possible response: *Students should suggest that flowers with both anthers and stigma of the same size and open to the air are possibly wind and self pollinated. Flowers with anthers and stigma on separate flowers or of different sizes are likely to be cross pollinated. Students should suggest that by having anthers and stigma sticking above the flower the pollen is more easily blown off the anthers by the wind and taken to the stigma by the wind. They might also suggest that the presence of bright colours, nectar and scent may indicate animal assisted cross pollination. Students should realise that in self-pollination the flower is pollinated by pollen from the same flower or plant. This makes seeds that will produce plants identical to the parent plant. In cross pollination the flower is pollinated by pollen from a different plant. Point out that this would have to be the same type (species) of plant. Cross-pollination gives a chance for new characteristics to appear so the offspring is a unique plant – not identical to the parents.*

Ask students to work with a partner and review their knowledge of flower adaptation by creating creative diagrams showing cross pollinations.

Key idea

Flowering plants need to be pollinated so they can produce seeds.

Read out the Key idea or ask a volunteer to read it out. Ask students to think about what life would be like if flowering plants could not produce seeds. Remind them that lots of the foods we eat come from flowering plants.

Review and reflect

Discuss the outcomes of the lesson with students. Encourage them to think about their work, such as the flower survey, to think of any improvements they could make if they did this type of work again. This will help students to develop a positive approach to learning, by understanding that learning is a process that will improve with practice and reflection.

Extra activities

1 **Computing link:** Students create a poster illustrating different pollination methods to display in the classroom. They should include information labels and could download diagrams and photographs from the internet.

2 You could arrange a visit to a local horticultural centre, market garden, garden centre or plant research centre to see people working to pollinate and tend flowers. If this is not possible, invite a plant scientist, farmer or gardener into school to talk about the importance of pollen and pollination and why we should look after pollinating animals such as bees.

Differentiation

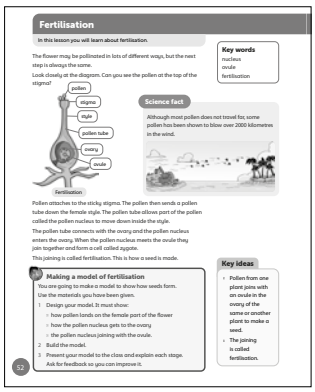
Supporting: Explain adaptations for wind pollination by placing chalk dust on top of a pencil and inside a small tube. Ask students to blow away the dust and they will see the dust on the pencil is more easily blown away.

Consolidating: When growing flowering plants throughout the unit, use a variety of wind and insect pollinated varieties so that students can observe their characteristics.

Extending: Ask students to research some examples of water- and bird-pollinated plants.

Differentiated outcomes	
All students	should be able to state that flowers can be pollinated by wind, animals, people and water.
Most students	will be able to describe the difference between self and cross pollination.
Some students	may be able to describe examples of other ways to pollinate flowers.

Fertilisation


Fertilisation

In this lesson you will learn about fertilisation.

The flower may be pollinated in lots of different ways, but the next step is always the same.

Look closely at the diagram. Can you see the pollen at the top of the stigma?

pollen
stigma
style
pollen tube
ovary
ovule

Fertilisation

Science fact

Although most pollen does not travel far, some pollen has been shown to blow over 2000 kilometres in the wind.

Pollen attaches to the sticky stigma. The pollen then sends a pollen tube down the female style. The pollen tube allows part of the pollen called the pollen nucleus to move down inside the style.

The pollen tube connects with the ovary and the pollen nucleus enters the ovary. When the pollen nucleus meets the ovule they join together and form a cell called zygote.

This joining is called fertilisation. This is how a seed is made.

Making a model of fertilisation

You are going to make a model to show how seeds form.

Use the materials you have been given.

1 Design your model. It must show:
- how pollen lands on the female part of the flower
- how the pollen nucleus gets to the ovary
- the pollen nucleus joining with the ovule.

2 Build the model.

3 Present your model to the class and explain each stage. Ask for feedback so you can improve it.

Key words
nucleus
ovule
fertilisation

Key ideas
- Pollen from one plant joins with an ovule in the ovary of the same or another plant to make a seed.
- The joining is called fertilisation.

52

Getting started

This lesson builds upon the previous lessons and considers what happens after pollination has occurred. Students are introduced to the idea that pollen is used to fertilise a flowering plant and the lesson examines how this process happens. Students are given an opportunity to review what is meant by fertilisation and they model the process.

Language support

Explain that a pollen tube is a hollow tube that develops from a pollen grain when it is deposited on to the stigma of a flower. You could show them some cardboard tubes, such as from paper towel holders. The pollen nucleus is the inside part of the pollen that carries part of the information needed to make a seed.

Emphasise that 'fertilisation' is used to describe the joining together of the male pollen and female ovule. Remind students that an ovule is the part of a plant that develops into a seed.

Resources

Student Book: materials to make a model of fertilisation, such as card, paper, coloured modelling material.

Key words

fertilisation ovule nucleus

Other words in the lesson

anther carpel cross-pollination filament ovary pollen tube self-pollination stigma style

Scientific enquiry key words

Make observations

Record data and results using diagrams and labels, tables, keys and graphs

Report and present findings in a variety of ways

Draw conclusions and give explanations

Lesson at a glance

The key teaching points for students in this lesson are:

- pollen from one plant joins with an ovule in the ovary to make seeds
- this joining is called fertilisation.

Ask students to work with a partner to review the mechanisms of pollination they have studied. They make a list to share with the class.

Ask students to look at the diagram at the top of page 52 of the Student Book and read the first paragraph so they can review their knowledge of the parts of a flower and locate the anther and stigma, in particular, as central to pollination.

Ask students to work with a partner to discuss and recall the learning from the previous lesson. You could ask them what problems plants would face if pollen and the stigma were both slippery.

Possible response: *Students should recall that the sticky stigma will catch and hold more pollen than if it was slippery.*

Explain that the process of pollination comes before fertilisation and can be thought of as a journey that the pollen makes. Point out the lower diagram and explain that it shows the journey pollen can make from the anther to the stigma within the same plant.

Science fact: Although most pollen does not travel far, some pollen has been shown to blow over 2000 kilometres in the wind.

Read out the Science fact or ask a volunteer to read it out. Ask students to suggest why it would be useful to plants to have pollen that can travel large distances. Remind them that cross-fertilisation gives the chance for new characteristics.

Point out the diagram showing fertilisation and ask students to study it carefully. Ask them to read through the text beneath the diagram and as they do this they can follow the path of the pollen and growing pollen tube on the diagram. Explain that the pollen nucleus contains half of the information needed to make a new plant. Stress that the ovule also contains half of the information needed to make a new plant. At fertilisation these two halves come together so the future seed has all of the information needed to make a new plant.

Seed formation is very complex and does not need to be covered at this stage but avoid stating that a seed is made at fertilisation. Tell students that fertilisation is the first stage in seed production.

Investigation: Making a model of fertilisation

Explain that students are going to make a model to show how seeds form. Again, stress that after fertilisation a seed is not made but fertilisation is the start of seed formation. Allow students to use the materials you have provided. Ask them to work with their team to design their model. It must show how pollen lands on the female part of the flower and how the pollen nucleus gets to the ovary and joins with the ovule. It is possible to show this in one model or students could make three to show different phases. They present their model to the class and explain each stage.

As pre-work you can encourage students to survey and observe different types of flowers. Hand out three different types of flowers and ask students to observe them carefully. They then draw the carpel of each flower and label the parts. Next, they draw the stamen of each flower and label the parts. Finally, they can use modelling clay to make a model carpel and some pollen grains. They should slowly change their model to show how the pollen grain grows a pollen tube and reaches the ovule. (Note regarding the word 'ovule': the terms 'ovum' or 'egg' are sometimes used but are more commonly used to refer to animal snot plants.)

Students should ask the other groups for feedback so they can reflect on their model and think of ways to improve it.

Key ideas

- *Pollen from one plant joins with an ovule in the ovary of the same or another plant to make a seed.*
- *The joining is called fertilisation.*

Ask a volunteer to read out the Key ideas. Then ask students to use a blank piece of paper to draw a diagram to show self-pollination and cross-pollination. They can also try to reproduce from memory the diagram on page 52 showing fertilisation. After 5 minutes, check to see what they have remembered and what they have forgotten or not understood.

Hand out three different types of flowers and ask students to observe them carefully. They then draw the carpel of each flower and label the parts. Next, they draw the stamen of each flower and label the parts.

Finally, they can use modelling clay to make a model carpel and some pollen grains. They should slowly change their model to show how the pollen grain grows a pollen tube and reaches the ovule. (Note regarding the word 'ovule': the terms 'ovum' or 'egg' are sometimes used but are more commonly used to refer to animals not plants.)

Review and reflect

You can use the fertilisation models as an opportunity to encourage self-reflection and target setting. Ask students to move around the models and leave a note on each one that contains two pieces of praise and one idea for improvement. Students can then return to their own model and read the comments. They then think of one improvement they could make and, more generally, a way of doing this type of work better.

Extra activities

1 Ask students to create an information leaflet about how a plant is pollinated and fertilised. They could include photographs and diagrams downloaded from the internet.

2 **Maths link:** Students model the sticky stigma by throwing small pieces of rolled up paper onto different surfaces. They count how many small balls of paper stick to smooth and sticky surfaces (sticky tape for example), work out percentages, carry out some data analysis and produce a bar chart.

3 Students research the difference between a carpel and a pistil. Both are often used interchangeably but there are differences in the definitions.

Differentiation

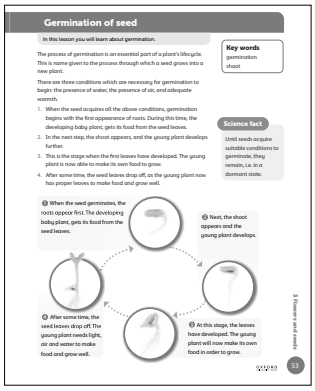
Supporting: Trace the movement of the pollen, pollen tube and pollen nucleus on a diagram on the board to help students to follow the process.

Consolidating: Keep a large, labelled diagram or poster of the fertilisation process, so students can keep referring to it.

Extending: Ask students to research how seeds form after fertilisation and to find out the differences between fruit and seed pods.

Differentiated outcomes	
All students	should be able to state that pollination can be self-pollination or cross-pollination
Most students	will be able to describe the process of fertilisation in words and drawings
Some students	may be able to explain how fertilisation after cross-pollination leads to offspring that are not identical to the parent plants

Germination of seed


Germination of seed

In this lesson you will learn about germination.

The process of germination is an essential part of a plant's lifecycle. This is name given to the process through which a seed grows into a new plant.

There are three conditions which are necessary for germination to begin: the presence of water, the presence of air, and adequate warmth.

1. When the seed acquires all the above conditions, germination begins with the first appearance of roots. During this time, the developing baby plant, gets its food from the seed leaves.
2. In the next step, the shoot appears, and the young plant develops further.
3. This is the stage when the first leaves have developed. The young plant is now able to make its own food to grow.
4. After some time, the seed leaves drop off, as the young plant now has proper leaves to make food and grow well.

Key words
germination
shoot

Science fact
Until seeds acquire suitable conditions to germinate, they remain, i.e. in a dormant state.

1 When the seed germinates, the roots appear first. The developing baby plant, gets its food from the seed leaves.

2 Next, the shoot appears and the young plant develops.

3 At this stage, the leaves have developed. The young plant will now make its own food in order to grow.

4 After some time, the seed leaves drop off. The young plant needs light, air and water to make food and grow well.

3 Flowers and seeds

53

Getting started

This lesson looks at the conditions needed for seeds to germinate. Students learn that a growth medium such as soil is needed by seeds and that soil contains water and nutrients. They investigate the growth of seeds to find out whether they need light to germinate.

Language support

Remind students of the different types of variables (independent, dependent and control). Write them on the board and ask them for examples of each type from investigations students have carried out before. A display of the three types of variables on word cards would be useful.

Resources

Student Book: pots (or eggshells) with compost; identical seeds; water; labels; access to the internet or books on germination.

Key words

germination shoot

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Recognise and control variables

Record data and results using diagrams and labels, tables, keys and graphs

Make predictions

Report and present findings in a variety of ways

Lesson at a glance

The key teaching points for students in this lesson are:

- seeds need a growth medium to grow in
- germination does not need light.

In the next lesson, students will explore whether seeds need water and warmth to germinate.

Ask students to read the text in the Student Book. Explain to them that when a seed germinates small shoots grow upwards and small roots grow downwards.

Encourage them to think back to all of their past work on growing plants and ask them why they would not plant vegetable seeds on a concrete or tarmac surface.

Encourage students to investigate whether seeds need light to help them to germinate. Ask them to make a prediction, as this will encourage them to think back to their work on the structure of seeds. Allow them to work in a group of three or four and to follow the instructions independently or you can take them through the instructions step by step.

Students can set up the pots with seeds and compare those grown in the light with those grown in the dark. Discuss with them that it is difficult to isolate presence or absence of light as the only independent variables because the pots left in the light may get warmer or dry out quicker. Students will have to try to limit these problems. Keeping a thermometer near all the pots will at least help them to check on any temperature variations.

Ask students to check their pots every day and remind them to keep the compost moist. They then design a table and record their observations. Ask them to write down their conclusion and decide whether the seeds needed light to help them to germinate.

Ask groups to think about the fair testing aspect of the investigation and to list the variables. Ask volunteers to share their answers with the class.

Possible response: *Students should list light/dark as the independent variable; whether they observe germination or not as the dependent variable; and the amount (volume) of water added, temperature, types of seeds used, number of seeds used, growth medium and type of container as the control variables.*

Science fact: Until seeds acquire suitable conditions to germinate, they remain, i.e. in a dormant state.

Read out the Science fact or ask a volunteer to read it out. Ask students if they have ever read the instructions on a seed packet and seen information about the conditions required for the seeds to germinate. You could hand out some seed packets for them to conduct some examples.

Students can carry out this activity as an internet or book research project or investigate by planting a variety of fruit seeds and determining how long each took to germinate. If you allow them to carry out the investigation, warn them that the season (warm or cold) also has an impact on whether the seeds germinate and whether they survive further. You will need to let them check their seeds after every lesson.

Ask students to think about whether seeds need light to germinate. Elicit that planted seeds are underground in the dark so they must be able to germinate without light.

Examples of plant growth

Use this activity to review students' knowledge of plant growth and to provide an opportunity for students to survey a range of plants in your area. Let them think about the largest plants they have seen, then they discuss two things that these plants needed to help them to grow.

They can look outside in the school grounds or in a local park for young and old plants of the same type and draw them.

Encourage students to talk about how any small plants they find could have got to where they are growing. This will help them to link what they see to the life cycle of flowering plants.

Ask students to discuss and write down what the plants need to help them to grow. They should recall from earlier that plants need space, light and water.

Possible response: *Students should discover that the seeds will germinate in warm and damp places. They will explore this further next lesson.*

Review and reflect

Ask students to produce a scientific report of their Student Book investigation. This can include a prediction, method, results and their conclusions. As you read through these, look for evidence of sensible predictions and an understanding of variables.

Encourage students to celebrate success during the lesson as this raises confidence and engagement but also remind them that learning is a process: they can learn from the things that did not go as well as they hoped.

Extra activities

1 Students use the internet to find the vegetables grown in your area that have the slowest and quickest germinating seeds.

2 Students carefully cut up a large seed, such as a bean seed.

Warning! Make sure students can use sharp tools carefully. Alternatively, cut up the seeds for them.

Students can remove the embryo and plant this underground and compare its growth with a full seed. This will show the embryo (small future plant) needs the cotyledon as a food supply to help it to start to grow.

3 Ask students to think about why scientists plant many seeds, not just one seed, when carrying out investigations.

Differentiation

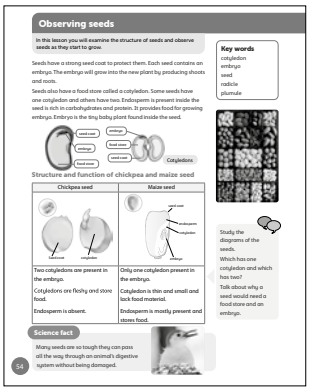
Supporting: Place some seeds in a pot of compost and some other seeds on the top of a wooden table. Ask students to predict which are most likely to grow. This will help them to think about what seeds and plants need for healthy growth.

Consolidating: Hand out or display a wide range of seed packets, or download photographs of seed packets, so that students can see the information about growth conditions.

Extending: Ask students to link the structure of a seed with the reason seeds do not need light to germinate.

Differentiated outcomes	
All students	should be able to state the conditions seeds need to germinate
Most students	will be able to describe an investigation to show that seeds do not need light to germinate
Some students	may be able to explain how the structure of seeds explains why seeds do not need light to germinate

Observing seeds


Observing seeds

In this lesson you will examine the structure of seeds and observe seeds as they start to grow.

Key words
cotyledon
embryo
seed
radicle
plumule

Seeds have a strong seed coat to protect them. Each seed contains an embryo. The embryo will grow into the new plant by producing shoots and roots.
Seeds also have a food store called a cotyledon. Some seeds have one cotyledon and others have two. Endosperm is present inside the seed is rich in carbohydrates and protein. It provides food for growing embryo. Embryo is the tiny baby plant found inside the seed.

Cotyledons

Structure and function of chickpea and maize seed

Chickpea seed	Maize seed
Two cotyledons are present in the embryo. Cotyledons are fleshy and store food. Endosperm is absent.	Only one cotyledon present in the embryo. Cotyledon is thin and small and lack food material. Endosperm is mostly present and stores food.

Study the diagrams of the seeds.
Which has one cotyledon and which has two?
Talk about why a seed would need a food store and an embryo.

Science fact
Many seeds are so tough they can pass all the way through an animal's digestive system without being damaged.

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Getting started

In this lesson students study the structure of seeds and find out about the functions of each part. They learn to compare and contrast sample monocot and dicot seeds.

Language support

Students will be familiar with the word 'seed' but may not have heard of the words 'cotyledon' and 'embryo'. Write the words on the board and then write down 'food store' and 'tiny young plant' and ask them to link each word to a meaning. Then draw a thick line between 'cotyledon' and 'food store' and 'embryo' to 'tiny young plant'.

Resources

Student Book: a variety of seeds (optional); access to water; bean seeds; jars; paper towels; access to the internet.

Key words

cotyledon embryo seed radicle plumule

Other words in the lesson

germinates roots seed coat shoots store

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results using diagrams and labels, tables, keys and graphs

Report and present findings in a variety of ways

Lesson at a glance

The key teaching points for students in this lesson are:

- seeds contain an embryo that will develop into a new plant
- seeds also have a food store called a cotyledon
- seeds are protected by tough outer covering called the seed coat.

Ask students to look at the photograph and text at the top of page 54 of the Student Book. You can also hand out a variety of seeds for students to handle. Ask students to feel the strong seed coat. At this stage you could ask students to look inside the seeds to examine the structure, but you may prefer to use this as a summary task.

Show students the diagrams of the seeds in the Student Book.

Study the diagrams of the seeds. Which has one cotyledon and which has two? Talk about why a seed would need a food store and an embryo.

Students can work with a partner or in a group of three or four. If you choose the latter, they could stay in their group for the investigation that follows. Point out the labels for the parts of a seed and allow them to think about the differences between the seed with one cotyledon (monocotyledonous) and two cotyledons (dicotyledonous). They can then talk about the need for a food store and an embryo.

Possible response: *Students should notice that the right-hand diagram shows a seed with one cotyledon and the left-hand diagram shows a seed with two cotyledons. They should suggest that a food store is needed as the germinating plant will need energy and raw materials to grow but cannot get them from any other source as it doesn't have leaves and fully formed roots and is underground. The embryo is the tiny new plant that will grow and develop so without this the seed would not produce a new plant.*

Science fact: Many seeds are so tough they can pass all the way through an animal's digestive system without being damaged.

Read out the Science fact or ask a volunteer to read it out. Ask students to suggest why it is important from the plant's perspective that seeds pass all the way through an animal and are not digested. Elicit that this allows them to be spread when the animal gets rid of waste.

Review and reflect

Encourage students to reflect on their learning throughout the lesson. Use the discussion task to encourage students to think about what they understand about seed structure. Discuss the outcomes of each task with students. Encourage them to identify aspects they have not completed correctly and help them to identify improvements. This will help students to develop a positive approach to learning, by understanding that learning is a process that will improve with practice and reflection.

Extra activities

1 **Computing link:** Students research how monocots and dicots vary when they grow. They produce a poster with monocots on one side and dicots on the other. They could download pictures to give examples.

2 Students carry out a survey of fruits found in the local area. You provide three different local fruits and students collect some seeds from them and plant them out in compost or soil. They observe which produce seedlings.

Differentiation

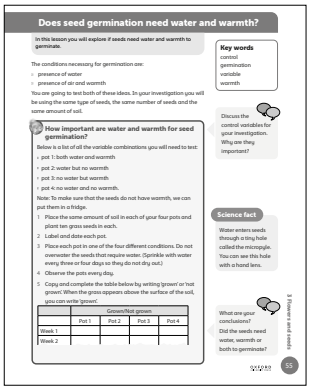
Supporting: Allow students to use the term 'food store' rather than 'cotyledon'.

Consolidating: Allow students to cut open a range of different seeds to locate the embryo and cotyledons.

Extending: Students could research the role of the micropyle in seeds. This is the tiny hole in the seed coat.

Differentiated outcomes	
All students	should be able to draw and label a monocot seed
Most students	will be able to draw and label monocot and dicot seeds and investigate how they germinate
Some students	may be able to describe how monocot and dicot plants develop differently

Does seed germination need water and warmth?


Does seed germination need water and warmth?

In this lesson you will explore if seeds need water and warmth to germinate.

The conditions necessary for germination are:
- presence of water
- presence of air and warmth

You are going to test both of these ideas. In your investigation you will be using the same type of seeds, the same number of seeds and the same amount of soil.

Key words
control
germination
variable
warmth

Discuss the control variables for your investigation. Why are they important?

How important are water and warmth for seed germination?

Below is a list of all the variable combinations you will need to test:
- pot 1: both water and warmth
- pot 2: water but no warmth
- pot 3: no water but warmth
- pot 4: no water and no warmth.

Note: To make sure that the seeds do not have warmth, we can put them in a fridge.

1. Place the same amount of soil in each of your four pots and plant ten grass seeds in each.
2. Label and date each pot.
3. Place each pot in one of the four different conditions. Do not overwater the seeds that require water. (Sprinkle with water every three or four days so they do not dry out.)
4. Observe the pots every day.
5. Copy and complete the table below by writing 'grown' or 'not grown'. When the grass appears above the surface of the soil, you can write 'grown'.

	Grown/Not grown			
	Pot 1	Pot 2	Pot 3	Pot 4
Week 1				
Week 2				

Science fact
Water enters seeds through a tiny hole called the micropyle. You can see this hole with a hand lens.

What are your conclusions? Did the seeds need water, warmth or both to germinate?

3 Flowers and seeds

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Getting started

The aim of this lesson is to show students how scientists plan an investigation from what they know and observe. Students learn that scientists can look at more than one factor or variable at a time, but they still need to control their investigations. Students explore the need for water and warmth for seed germination.

Language support

Read out the key words and tell students that after each one they should write a number from 1 to 5 to estimate how well they know the word. Explain that if they can define the word and put it into a sentence, they should score it 5; if they have not heard of the word before, they should score it 1. Tell students an aim of the lesson is to get all of their scores to 5 so they should check at the end of the lesson and score the words again.

Resources

Student Book: plastic cups or pots; soil; grass seeds; access to a fridge; lollipop stick labels; materials to make information leaflets; hand lenses and large seeds such as beans (optional).

Key words

control germination variable warmth

Other words in the lesson

micropyle seeds soak warmth water

Scientific enquiry key words

Recognise and control variables

Make observations

Record data and results using diagrams and labels, tables, keys and graphs

Report and present findings in a variety of ways

Draw conclusions and give explanations

Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- seeds need both water and warmth to germinate
- investigations can look at more than one factor (variable).

Ask students to sit quietly and think back to their last lesson about germination. This will help them to prepare for the more complex investigation they will carry out this lesson by asking them questions about fair testing and variables. For example, ask: Did you make a prediction? What did you deliberately alter? What type of variable is this? What did you keep the same? What type of variable is this? What did you measure? What do we call this variable?

Read out the text at the top of the page and explain that they are going to test scientists' ideas about warmth and water.

Discuss the control variables for your investigation. Why are they important?

Ask students to discuss the text with a partner and to think about the control variables mentioned. They can then share their ideas with the class.

Answer: *Students should know that control variables make an investigation a fair test. By using control variables, scientists can measure the impact one factor (variable) has because other things are controlled.*

Investigation: How important are water and warmth for seed germination? What are your conclusions? Did the seeds need water, warmth or both to germinate?

Ask students to work in groups of three or four. Explain that they will set up four small investigations in order to find out about the conditions needed for germination.

Students should be able to follow the instructions independently and set up the test pots but you can also read the instructions out to take students through the investigation step by step. If they cannot decide what to do with each pot of planted seeds, you could put the following summary on the board.

Pot 1: this is kept in the classroom and watered regularly (water and warmth).

Pot 2: this is kept in the fridge and watered regularly (water but no warmth).

Pot 3: this is kept in the classroom but not watered (no water but warmth).

Pot 4: this is kept in the fridge but not watered (no water and no warmth).

Remind students to observe the pots every day and record any observations. They will also need to avoid watering some pots and adding a small volume of water to the others. They need to copy and complete the table from the Student Book to record any growth. To report and share their findings, ask them to produce an information leaflet for gardeners about seed germination. They can use the example on page 39 of the Student Book as a guide. Remind them to include a description of their investigation and their conclusions and advice about germinating seeds.

Answer: *Students should discover that the seeds that have water and warmth germinate better than any of the others.*

Science fact: Water enters seeds through a tiny hole called the micropyle. You can see this hole with a hand lens.

Read out the Science fact or ask a volunteer to read it out. Ask students to suggest why a seed needs a small hole. Remind them that the seed coat is tough and waterproof. You could hand out hand lenses and let students look at some larger seeds such as beans to find the micropyle. Elicit that the micropyle helps the seed to absorb water during germination.

Review and reflect

Remember to praise the process of learning as much as, if not more than, the outcomes. The Student Book investigation is complex – this is the first investigation students will have carried out using more than one independent variable. Use every opportunity to allow them to work together to check understanding and share ideas.

After the investigation, allow students to sit for a few minutes to think about how they worked together and how they could work even better as a team.

Extra activities

1 Students set up the equipment they used for bean germination to investigate what happens if seeds have no water and/or no warmth. They can see the germination process, or lack of it, using this method.

2 Now that students know the conditions seeds need in order to germinate, ask them to try growing some plants from seed at home. You can send some seeds home in small packets. Ask students to take a photograph of any seeds that germinate and challenge them to improve on the germination times given on the seed packets.

Differentiation

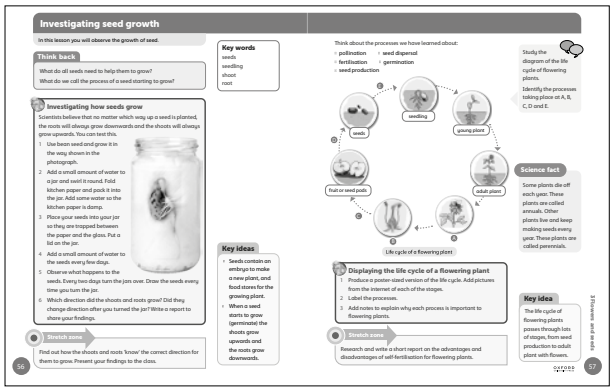
Supporting: Hand out blank copies of the results table for the investigation for students to complete.

Consolidating: Display a range of information leaflets around the room so students can look through them for layout ideas for their own leaflet.

Extending: Ask students to research how water starts the process of germination.

Differentiated outcomes	
All students	should be able to state that water and warmth are both needed for seed germination
Most students	will be able to describe a controlled investigation to prove that both water and warmth are needed for germination
Some students	may be able to explain that water enters the seed and starts the enzymes that help the embryo obtain energy

Investigating seed growth


Investigating seed growth

In this lesson you will observe the growth of seed.

Think back

What do all seeds need to help them to grow?
What do we call the process of a seed starting to grow?

Investigating how seeds grow

Scientists believe that no matter which way up a seed is planted, the roots will always grow downwards and the shoots will always grow upwards. You can test this.

1. Use bean seed and grow it in the way shown in the photograph.
2. Add a small amount of water to a jar and swirl it round. Fold kitchen paper and pack it into the jar. Add some water so the kitchen paper is damp.
3. Place your seeds into your jar so they are trapped between the paper and the glass. Put a lid on the jar.
4. Add a small amount of water to the seeds every few days.
5. Observe what happens to the seeds. Every two days turn the jars over. Draw the seeds every time you turn the jar.
6. Which direction did the shoots and roots grow? Did they change direction after you turned the jar? Write a report to share your findings.

Stretch zone

Find out how the shoots and roots 'know' the correct direction for them to grow. Present your findings to the class.

Key words

seeds
seedling
shoot
root

Key ideas

- Seeds contain an embryo to make a new plant, and food stores for the growing plant.
- When a seed starts to grow (germinate) the shoots grow upwards and the roots grow downwards.

Think about the processes we have learned about:

- pollination
- fertilisation
- seed production
- seed dispersal
- germination

seed
seedling
young plant
adult plant
fruit or seed pods

Life cycle of a flowering plant

Study the diagram of the life cycle of flowering plants.

Identify the processes taking place at A, B, C, D and E.

Science fact

Some plants die off each year. These plants are called annuals. Other plants live and keep making seeds every year. These plants are called perennials.

Displaying the life cycle of a flowering plant

1. Produce a poster-sized version of the life cycle. Add pictures from the internet of each of the stages.
2. Label the processes.
3. Add notes to explain why each process is important to flowering plants.

Stretch zone

Research and write a short report on the advantages and disadvantages of self-fertilisation for flowering plants.

Key idea

The life cycle of flowering plants passes through lots of stages, from seed production to adult plant with flowers.

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3 Flowers and seeds

Getting started

In this lesson students study the structure of seeds and find out about the functions of each part. They set up an investigation using a bean seed to observe the stages of germination. They determine whether the shoot or roots appear first as the seed germinates. Further, the lesson is an opportunity for students to review and extend their knowledge of the life cycle of flowering plants. They will add the processes of pollination, fertilisation, seed production, seed dispersal and germination into the overall cycle they covered previously.

Language support

Students will be familiar with the word 'seed' but may not have heard of the words 'cotyledon' and 'embryo'. Write the words on the board and then write down 'food store' and 'tiny young plant' and ask them to link each word to a meaning. Then draw a thick line between 'cotyledon' and 'food store' and 'embryo' to 'tiny young plant'. These words are also pronounced and explained in the eBook so students can use this to help them to become familiar with the terms.

Resources

Student Book: a variety of seeds (optional); access to water; bean seeds; jars; paper towels; materials to make posters; access to the internet and a printer to obtain pictures of the life cycle of plants.

Key words

seeds seedling shoot roots

Other words in the lesson

germinates seed coat

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results using diagrams and labels, tables, keys and graphs

Report and present findings in a variety of ways

Lesson at a glance

The key teaching points for students in this lesson are:

- seeds contain an embryo that will develop into a new plant
- seeds also have a food store called a cotyledon
- when seeds germinate the shoots grow upwards and the roots grow downwards.
- the life cycle of flowering plants passes through lots of stages
- important processes in the life cycle are pollination, fertilisation, seed production, seed dispersal and germination.

Ask students to attempt the think back questions at the top of the page as an active recall task. You should encourage them to look back into the units they have previously studied to look up the answers.

Think back: What do all seeds need to help them to grow? What do we call the process of a seed starting to grow?

Possible response: *Students may suggest that all seeds need a food store and an embryo to help them to grow but encourage them to think back to planting investigations they have carried out and elicit that they also need water, warmth and soil. They should recall that the process is germination.*

Investigation: Investigating how seeds grow

The purpose of this investigation is to show students the germination process and to allow them to investigate whether shoots always grow upwards and roots always grow downwards. Explain that scientists believe that no matter which way up a seed is planted, the roots will always grow downwards and the shoots will always grow upwards, so students are going to test this.

Ask students to follow the instructions. Water must not be allowed to collect in the bottom, as when the jar is turned it will spill. Remind students to add a small amount of water to the seeds every few days and observe what happens to the seeds.

Possible response: *Students should find that shoots do always grow upwards and roots always grow downwards. With constant turning this can give both a corkscrew shape.*

Stretch zone: Find out how the shoots and roots 'know' the correct direction for them to grow. Present your findings to the class.

Possible response: *Students should find that the shoots always grow upwards and the roots grow downwards – although there will be a period of transition as the plant responds and this can result in a corkscrewing growth. The independent variable is the direction the jar faced; the dependent variable is the direction the roots and shoots grew and the control variables were type of seeds, temperature, watering amount and light.*

Computing link: Allow students to work individually or with a partner and allow them access to the internet to research how shoots and roots can have a direction. They will find that it is due to the effect of gravity. Somehow the germinating seed senses which way is up and which way is down.

Key ideas

- *Seeds contain an embryo to make a new plant, and food stores for the growing plant*.
- *When a seed starts to grow (germinate) the shoots grow upwards and the roots grow downwards*.

Read out the Key ideas or ask a volunteer to read them out. Ask students to write the words 'embryo', 'seed coat' and 'cotyledon' onto separate pieces of paper and fold them over. Their partner picks one up, reads it out and must then explain the function of the part.

Allow the students to read the text and study the lifecycle of a flowering plant as shown on the page. Ask students how many stages they notice in the life cycle of a flowering plant. Ask them to write the stages down and share their ideas with a partner.

Possible response: *Students should state that there are four stages in a flowering plant's life cycle, or five stages if they remember that they can add fruit production to the life cycle.*

Once students have talked about the life cycle with a partner ask them to talk about the discussion question. Encourage them to think back to what pollination is and how it happens. Some pairs could share their ideas with the class.

Possible response: *Students should suggest that pollination takes place after the adult plant produces flowers and before seeds are made and dispersed.*

Study the diagram of the life cycle of flowering plants. Identify the processes taking place at A, B, C, D and E.

Allow students to work with a partner or you could arrange them into groups of three or four then let them continue to work in these groups for the investigation. Point out the pictures and arrows but especially the letters. They can then talk about which process each letter represents.

Answer: *A = pollination; B = fertilisation (there is a pollen tube growing down to the ovary); C = seed production; D = seed dispersal; E = germination.*

Investigation: Displaying the life cycle of a flowering plant

Ask students to work with their group to plan and produce a poster-sized version of the life cycle and refer them to the other instructions in the investigation. They can use the example in of the Student Book as a guide but tell them to make their version much larger. Display the posters in the classroom. This will help consolidation as students will see them throughout the unit.

Science fact: Some plants die off each year. These plants are called annuals. Other plants live and keep making seeds every year. These plants are called perennials.

Read out the Science fact or ask a volunteer to read it out. Ask students if they have seen or planted any annuals. Ask them why being able to make seeds is so important to annual plants.

Stretch zone: Research and write a short report on the advantages and disadvantages of self-fertilisation for flowering plants.

Computing link: Allow students to work with a partner so they can discuss their ideas. Give them access to the internet to find out more about self-fertilisation. They could report their findings in the form of a table in a presentation.

Possible response: *Students should find out that the advantages of self-fertilisation include the need for fewer pollen grains and increased chance of fertilisation as the pollen does not have far to travel. Self-fertilisation also produces identical plants, which might be useful if the plant is successful. Disadvantages include lack of opportunity for variation and inability to remove weaker characteristics.*

The Stretch zone task encourages creative writing as students imagine they are a seed and then write about the plant's life story.

Key idea

The life cycle of flowering plants passes through lots of stages, from seed production to adult plant with flowers.

Read out the Key idea or ask a volunteer to read it out. Ask students to draw the life cycle from memory but let them look at the diagram in the Student Book for 10 seconds every minute until they have completed their drawings.

Review and reflect

The posters and plate displays created in the lesson can be used for you and the students to evaluate learning because they show evidence of understanding and creativity. You can give feedback about each one – verbally or in writing – and also encourage students to pass on positive comments and suggestions for improvements.

Let students sit quietly for a few minutes and think about what they believe they have done well and what single thing they could take as a learning target into the next lessons.

Extra activities

1 Arrange a survey of the local area to allow students to observe as many parts of the plant life cycle as possible. They may find seeds; seeds being dispersed by wind, water or another method; seedlings appearing above the soil; flowers forming; insects visiting plants to pollinate them; and some young plants.

2 Show a video clip from the internet of pollen and pollen tubes growing. Consider a classroom demonstration: place a 10% sugar solution onto a microscope slide that has a depression or well in it and tap the anthers of a flower so pollen falls into the sugar solution. Add a coverslip, then pollen can be observed over the next 10–20 minutes. You will need a ×10 or possibly a ×40 microscope as pollen is difficult to see, but students may enjoy trying.

Differentiation

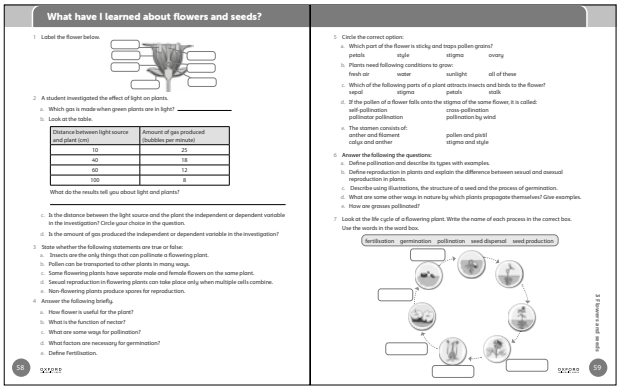
Supporting: Copy the life cycle diagram from the Student Book and cut it up so the stages are separate and the words are separate. Then ask students to reassemble the diagram by gluing it onto paper and placing the words in the correct place.

Consolidating: Display the large posters of the life cycle in your room for the rest of the unit and refer to it often to remind students and help recall.

Extending: Students could make a summary table to show the advantages and disadvantages of self- and cross-pollination.

Differentiated outcomes	
All students	should be able to describe the four-stage life cycle of a flowering plant from previous lessons
Most students	will be able to add pollination, fertilisation, seed production, seed dispersal and germination to the life cycle of a flowering plant
Some students	may be able to explain the advantages and disadvantages of self- and cross-pollination

What have I learned about flowers and seeds?



Getting started

The aim of this section is to encourage students to review their learning. Some topics have consolidation questions in the Student Book for students to answer. These will assess students' knowledge and understanding of the topic.

It is important that students report areas that they are not confident with. This information is vital for you to provide remediation in the end-of-unit summative assessment.

You may ask students to complete them in this lesson. This can be done as an individual challenge, a pair activity or a whole-class question and answer session. After students have completed the questions read out the expected answers and let them check their progress.

What have I learned about the life cycle and growth of flowering plants? answers

1 Label the flower below.

Remind students they can refer back to the student book unit if they are unsure.

Answer: *from top right: stigma, style, ovary, sepal, ovule, petal, anther.*

2 A student investigated the effect of light on plants.

a. Which gas is made when green plants are in light?

b. Look at the table. What do the results tell you about light and plants?

c. Is the distance between the light source and the plant the independent or dependent variable in the investigation? Circle your choice in the question.

d. Is the amount of gas produced the independent or dependent variable in the investigation? Circle your choice in the question.

Answer: *a = oxygen; b = as light level (intensity) increases the number of bubbles increases and this means plants make food faster in brighter light; c = independent; d = dependent.*

3 Decide whether the following statements are true or false. Circle your choice.

Insects are the only things that can pollinate a flowering plant. true false

Flowers do not attract insects. true false

PSome flowering plants have separate male and female flowers on the same plant. true false

Sexual reproduction in flowering plants can take place only when multiple cells combine. true false

Non-flowering plants produce spores for reproduction. true false

Explain that students should decide whether each statement is true or false – a statement cannot be both. Again, make sure students circle the answers. Point out that in an examination or test if they crossed out or underlined it they would not get a mark.

Answer: *False; false; true; false; true.*

4 Answer the following briefly.

Answer: *a. it is the reproductive organ of the plant.*

b. the plant produces Nectar as food for many insects which pollinate the plant.

c. self pollination; cross pollination; pollination using birds or insects as help; pollination aided by humans or even by water.

d. presence of water, air and warmth are necessary for germination.

e. When the pollen nucleus joins the ovule to form a cell called zygote, the process of joining is called fertilisation.

5 Circle the correct option.

Answer: *a. stigma b. all of these c. petals d. self-pollination e. anther and filament*

6 Answer the following the questions.

Answer: *a. Pollination is the process by which pollen from the male part of a flower (anther) is transferred to the female part of a flower (stigma), resulting in fertilization and the production of seeds. There are two types of pollination:*

self-pollination and cross-pollination. Self-pollination happens when pollen from the anther of a flower lands on the stigma of the same flower or another flower on the same plant. This type of pollination occurs in plants that have tiny flowers, such as wheat and peas.

Cross-pollination occurs when pollen from the anther of a flower lands on the stigma of a different flower on another plant of the same species. This type of pollination is common in plants with large, bright flowers, such as roses and sunflowers.

Pollinators such as bees, butterflies, moths, birds, and bats play an important role in cross-pollination by carrying pollen from one flower to another. Wind and water can also carry pollen from one plant to another.

b. Reproduction is the process by which plants produce new individuals and it is of two possible types: asexual and sexual.

Asexual reproduction involves only one parent plant and produces offspring that are completely identical to the parent plant. Examples of asexual reproduction in plants include vegetative propagation, budding, and fragmentation.

Sexual reproduction involves two parent plants and in the process, the male gamete (pollen) from one plant fertilizes the female gamete (ovule) of another plant. This results in the production of seeds that contain genetic information from both parent plants. Examples of sexual reproduction in plants include pollination and fertilization.

c. Encourage students to reproduce the content in their own from the unit.

d. Plant cuttings, grafting and budding.

e. Grasses are wind pollinated, as they have many tiny flowers which are unable to attract animal or insect pollinators.

7 Look at the life cycle of a flowering plant. Write the name of each process in the correct box. Use the words in the word box.

Suggest that students start looking at the cycle at the picture of the seeds. Remind them to use only the words from the word box at the bottom of the page. They could cross out each word as they use it.

Answer: *Students should label the cycle as follows (starting at the top and working clockwise around the cycle): germination; pollination; fertilisation; seed production; seed dispersal.*

Summative assessment

The review questions in the Student Book are a useful contribution when discussing the progress of each student individually. This information may also be used to create end-of-term reports for each student. You can score the questions as a summative test by awarding a mark for each answer. There are 16 marks in total question 1 = 2; question 2 = 2; question 3 = 5; question 4 = 5; question 5 = 5; question 6 = 11 (a-d = 2 marks each; e = 1mark); question 7 = 5.

Investigate like a scientist

The Investigate like a scientist activity is designed to encourage students to apply their investigative and creative skills and review key aspects of the content of the unit.

Design a research greenhouse

Resources: seeds, seedlings, pots and compost.

You can carry out this activity as an end-of-topic research project. Explain that students are going to design and make their own greenhouse. Let them look at the drawings to get ideas for some possible designs and allow them to search the internet for ideas. Point out that greenhouses can be very large and some can be as small and as simple as a plastic bottle. The size they design will depend on the resources you have given them.

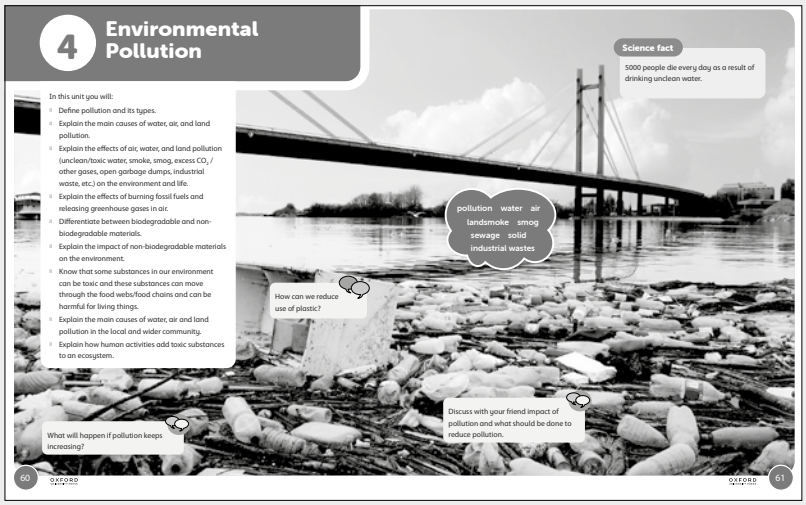
Insist that students start with a design for their greenhouse. This should be a drawing with details of materials, shape and measurements for the greenhouse and how it will be constructed. Encourage students to read through the points in the Think about section and also the research questions they could explore.

Hand out seeds, seedlings, pots and compost and allow students to plan and carry out their greenhouse research project. They should then write a scientific report to explain their method and findings to others. Remind them to include how they designed and carried out a fair test.

4 Environmental Pollution

In this unit students will:

- Define pollution and its types.
- Explain the main causes of water, air, and land pollution.
- Explain the effects of air, water, and land pollution (unclean/toxic water, smoke, smog, excess CO_2/other gases, open garbage dumps, industrial waste, etc.) on the environment and life.
- Explain the effects of burning fossil fuels and releasing greenhouse gases in air.
- Differentiate between biodegradable and nonbiodegradable materials.
- Explain the impact of non-biodegradable materials on the environment.



- Know that some substances in our environment can be toxic and these substances can move through the food webs/food chains and can be harmful for living things.
- Explain the main causes of water, air and land pollution in the local and wider community.
- Explain how human activities add toxic substances to an ecosystem.

Getting started

This unit helps students understand the meaning and impact of pollution and all its types on our world. Students will review their knowledge of how pollution can be harmful to all living things and how its effects accumulate through the native food chains in an ecosystem. Students then move onto consider ways that human activities can have a harmful effect on the environment. They learn about air pollution, the greenhouse effect, and damage caused by non-biodegradable substances. They are encouraged to investigate water pollution and waste disposal and to consider recycling and reuse as ways of reducing waste. They will consider ways of reducing litter. Students learn about renewable and non-renewable sources of energy. Additionally, students carry out enquiry-based studies to learn about ways to encourage others to care for the environment.

Science in context

Use the lessons in this unit to encourage students to learn more about the importance of taking responsibility of caring for our environment. Students can also survey the local area to consider how human activity is damaging habitats and to look at ways that pollution and litter are being managed. You could arrange a visit to see alternative energy being used and invite a person from the local power company into school to talk about how energy is generated and used in the area.

Scientific enquiry skills

Scientific enquiry skills for this unit focus on observation skills and the setting up of fair tests. Remind students of the different variables they must consider during investigations: independent (what they change); dependent (what they measure); and control (what they keep the same). Students further develop their skills of collecting, recording and presenting data. They will consider the accuracy and validity of the observations and measurements they take and be encouraged to evaluate their work. Students are asked to present their results in a variety of ways, including drawings, bar charts, graphs and tables. Students should be encouraged to use computer technologies to help in collecting and presenting data.

Resources

Student Book: writing materials; materials to make leaflets; access to an outdoor area suitable for a litter survey; gloves; large sheets of paper; access to the internet or books on littering, saving energy, acid rain; access to specialist speakers where possible; magazines with suitable images to cut and stick on the leaflets or posters.

Key words for unit

are in the Word cloud

pollution water air landsmoke smog sewage solid industrial wastes

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Language support

At this age, students are likely to be able to read independently and look up any words they find unfamiliar, so encourage them to use scientific dictionaries. Start the unit by reading out the words in the Word cloud. Ask students to discuss each word and define those they are familiar with. This monitoring of prior knowledge is vital and can help you enormously in setting the level of work in the first few lessons. For every unit it is worth creating a Word wall so students see the words often and can become familiar with them. Students are old enough to make their own word cards for display so this could be an early task. Have daily quizzes about the words – point to one and ask, 'What does this word mean? Use it in a sentence.'

Remind students they should note down the definitions of key words as they progress through the unit. This could be a regular end-of-lesson task or starter to encourage recall.

Repeat any new words regularly and use them in context. Students should listen, say, read and then write the words. They can also make a list of new non-science specific words they use in lessons. Some of these are listed in the individual lesson notes that follow.

You could create a science library in your room. Collect resources such as science books and magazines, science encyclopaedias and dictionaries. You can also collect or download specific information about topics for each lesson or activity and make a booklet of these like a class magazine. Students will enjoy helping with the production of these small information booklets and they can include some of their own work. You will find these specific booklets very valuable support for lessons and especially Stretch zone activities.

Unit at a glance

The key teaching points for students in this unit are:

- to introduce the unit objectives
- to introduce the learning outcomes
- to engage students with the content of the unit
- to review and build on prior learning and understanding of the topics.

The purpose of this introductory lesson is for students to start thinking about and reviewing prior knowledge of habitats and living environments of living things. These introductory pages show a photo of a polluted environment. The photographs are used as a starting point and as a prompt for discussions.

Read through the key words and then allow students time to look over the page before you start the sequence of discussion tasks. A suggested sequence follows below.

Arrange students into pairs or small groups of three or four for discussion work. A useful strategy is to start with students in pairs and then move pairs together to make small groups so students can share their ideas and discussions with others.

What will happen if pollution keeps increasing?

Ask students to look carefully at the main photograph. They can discuss it, make a list of any habitats they see, and then decide if the habitats look healthy.

Possible response: *Students should identify that if pollution keeps increasing, it will have a negative impact on the environment and as a result on the living creatures. Polluted air can cause breathing problems and illnesses like asthma. Polluted water can make people sick if they drink it or swim in it. It can also harm fish and other aquatic animals. Polluted soil can make it difficult for plants to grow and can harm animals that eat those plants. If pollution continues at its current rate, it could lead to the extinction of various species of animals and insects.*

How can we reduce use of plastic?

Ask students to use their observation skills and tshare their thoughts.

Possible response: *Students may share that some of the ways we can reduce the use of plastics include using reusable bags, instead of using plastic bags; Using a refillable water bottle instead of buying bottled water; Avoiding single-use plastics; following the 3R's: reduce, reuse, recycle.*

Discuss with your friend impact of pollution and what should be done to reduce pollution.

Allow students to work with a partner or with their small group to talk about the photograph. Point out that they

will have to use prior knowledge of habitats as well as their observation skills. Ask volunteers to share their ideas with the class.

Possible response: *Students may share different ideas about the impact of increasing Pollution. Some of these ideas may include: breathing problems and illnesses like asthma, harm to fish and other aquatic animals, difficult for plant growith and can harm to animals that eat those plants, extinction of various species of animals and insects, global warming, rising sea levels, coral bleaching, and other environmental problems that could impact human populations.*

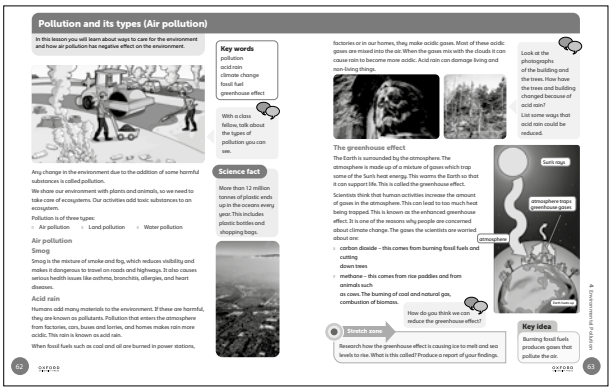
Science fact: 5000 people die every day as a result of drinking unclean water.

Read out the Science fact or ask a volunteer to read it out. Ask students if they have seen or used unclean source of water. Remind them that there are ways to clean water but the best way forward is to ensure that water sources are not polluted.

Extra activities

1 **Computing link:** Students can research uses of wood or stone and locate any examples of forestry or quarrying in their area. They can then design and produce a poster in class or as homework.

Pollution and its types (Air pollution)


Pollution and its types (Air pollution)

In this lesson you will learn about ways to care for the environment and how air pollution has negative effect on the environment.

Key words
pollution
acid rain
climate change
fossil fuel
greenhouse effect

With a class fellow, talk about the types of pollution you can see.

Science fact
More than 12 million tonnes of plastic ends up in the oceans every year. This includes plastic bottles and shopping bags.

Any change in the environment due to the addition of some harmful substances is called pollution.
We share our environment with plants and animals, so we need to take care of ecosystems. Our activities add toxic substances to an ecosystem.
Pollution is of three types:
- Air pollution
- Land pollution
- Water pollution

Air pollution
Smog
Smog is the mixture of smoke and fog, which reduces visibility and makes it dangerous to travel on roads and highways. It also causes serious health issues like asthma, bronchitis, allergies, and heart diseases.

Acid rain
Humans add many materials to the environment. If these are harmful, they are known as pollutants. Pollution that enters the atmosphere from factories, cars, buses and lorries, and homes makes rain more acidic. This rain is known as acid rain.
When fossil fuels such as coal and oil are burned in power stations, factories or in our homes, they make acidic gases. Most of these acidic gases are mixed into the air. When the gases mix with the clouds it can cause rain to become more acidic. Acid rain can damage living and non-living things.

Look at the photographs of the building and the trees. How have the trees and building changed because of acid rain?
List some ways that acid rain could be reduced.

The greenhouse effect
The Earth is surrounded by the atmosphere. The atmosphere is made up of a mixture of gases which trap some of the Sun's heat energy. This warms the Earth so that it can support life. This is called the greenhouse effect.
Scientists think that human activities increase the amount of gases in the atmosphere. This can lead to too much heat being trapped. This is known as the enhanced greenhouse effect. It is one of the reasons why people are concerned about climate change. The gases the scientists are worried about are:
- carbon dioxide – this comes from burning fossil fuels and cutting down trees
- methane – this comes from rice paddies and from animals such as cows. The burning of coal and natural gas, combustion of biomass.

Earth's rays
atmosphere traps greenhouse gases
atmosphere
Earth's surface

How do you think we can reduce the greenhouse effect?

Stretch zone
Research how the greenhouse effect is causing ice to melt and sea levels to rise. What is this called? Produce a report of your findings.

Key idea
Burning fossil fuels produces gases that pollute the air.

4 Environmental Pollution

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Getting started

This lesson considers the negative effects of human activities on the environment and focuses upon air pollution and how this leads to acid rain and the greenhouse effect. Students study examples of air pollution from vehicles and other sources and consider the link between carbon dioxide and methane and the greenhouse effect.

Language support

To support language development refer to this unit's Word wall covering some of the more difficult vocabulary in this unit. You could also ask students to add new words and definitions to their glossaries. A large-scale diagram of the greenhouse effect on Student Book page 63 will help students to place the key words in context.

Resources

Key words

acid rain atmosphere climate change
fossil fuel greenhouse effect pollution

Other words in the lesson

carbon dioxide enhanced greenhouse effect
factory methane power station trapped

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- burning fossil fuels produces gases that pollute the air
- some of these gases cause acid rain and this can damage plants, animals and buildings
- other pollutants in the air are called greenhouse gases and these trap heat and warm up the Earth.

Science fact: More than 12 million tonnes of plastic ends up in the oceans every year. This includes plastic bottles and shopping bags.

Read out the Science fact or ask a volunteer to read it out. Ask students to talk about any times they have observed plastic pollution in action – in magazines or books, on TV or the radio, or near to where they live. Elicit their responses to what can be done to counter this pollution.

With a class fellow, talk about the types of pollution you can see.

Students can work with their partner to study the photograph and talk about what is coming out of the vehicle's exhaust pipe. They can think about some ways of reducing this emission and share their ideas by moving to join another pair. You can ask volunteer groups to stand up and tell the class about their ideas.

Answer: *Car fumes – some students may have heard of carbon monoxide and particles. Car fumes can be reduced by using public transport, walking or cycling, or using electric cars. They should also identify that burning of trash and cutting of trees is increasing the level of pollution.*

Students can read through the text about smog and acid rain on and you can check understanding by asking them the questions below. Get them to discuss the questions with their partner: Why do you think rain is important to life? How do you think acid rain is formed? Why do you think that acid rain is a problem?

Look at the photographs of the building and the trees. How have the trees and building changed because of acid rain? List some ways that acid rain could be reduced.

Students can continue to work with their partner to study the photographs and talk about the discussion questions. They can pin their lists up on the wall and students can move around to compare the lists.

Answer: *They have been damaged because the acid attacked the wood and stone. Acid rain can be reduced by cutting down on the use of fossil fuels (using less energy and limiting use of cars and aeroplanes).*

Students can read through the text about the greenhouse effect and you can ask them to examine the diagram showing the greenhouse effect. Explain that the greenhouse effect is a natural process that keeps the Earth warm enough to support life. Point out that the diagram shows what is called the *enhanced* greenhouse effect: this results from human activities and is leading to climate change.

You can also check understanding by asking the following questions: What do you think we mean by the 'greenhouse effect'? What are the main greenhouse gases? What may happen if human activities continue to increase the amount of greenhouse gases in the atmosphere? What do you think we mean by the 'enhanced greenhouse effect'? What gas is released from burning fossil fuels and cutting down trees?

How do you think we can reduce the greenhouse effect?

Initiate a class discussion about how we can reduce the enhanced greenhouse effect. This can be used to reinforce the idea that we need to be proactive in reducing exhaust fumes and burning fossil fuels and in reducing deforestation (limiting cutting down trees to areas where trees are farmed for timber products). You could talk in simple terms about global agreements, for example the Kyoto Protocol, that aim to reduce global emissions of greenhouse gases.

Possible response: *The release of carbon dioxide and methane into the atmosphere can be reduced by using fuels and energy sources other than fossil fuels and by eating more plant-based proteins, so fewer cows are needed. Planting or conserving trees can help carbon dioxide to be reduced.*

Stretch zone: Research how the greenhouse effect is causing ice to melt and sea levels to rise. What is this called? Produce a report of your findings.

Computing link: Students can work independently or in pairs or small groups. Allow them access to the internet to gather the information needed to produce a report. They can download or print out diagrams and photographs to add to their report.

Answer: *The greenhouse effect is causing a warming of the Earth. This is called global warming.*

Key idea

Burning fossil fuels produces gases that pollute the air.

Read out the key idea or ask a volunteer to read it out. Ask students to name one of the gases produced when coal, petrol or wood is burned.

Review and reflect

Hold up word cards for the key words in the lesson: acid rain, atmosphere, climate change, fossil fuel, greenhouse effect, pollution. Each time you hold up a word, ask students to turn to a partner and use the word in a sentence. They should write down any of the words they are unsure of and look these up.

Extra activities

Investigate the greenhouse effect

Explain that students are going to make a model to show the greenhouse effect. They make a polythene greenhouse by following the instructions and then investigate to find out if the temperature is warmer inside or outside the greenhouse.

Maths link: Once they have measured and recorded their results five times on day one and five times on day two, ask students if they can see any patterns. They can use the prompt questions to help them to think about this. Ask them why they should take the temperatures at the same time every day.

Point out that there isn't a large greenhouse covering the Earth, but their greenhouse is trapping air inside and this represents carbon dioxide and methane being trapped in the atmosphere.

> ***Answer:*** *Students should find that the temperature inside increases in line with the temperature outside. The temperature inside the greenhouse is higher than the temperature outside. This tells us that trapped gases become warmer and warmer. This is what is happening on Earth.*

Differentiation

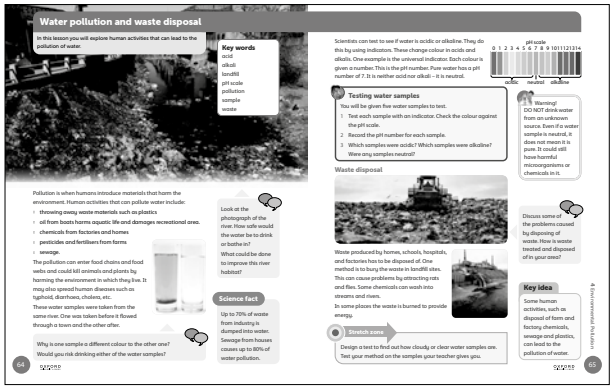
Supporting: Students will benefit from having large-scale posters of the greenhouse effect diagram on display.

Consolidating: Ask students to look around the local area for buildings and statues damaged by pollution in the air. They can also download some examples.

Extending: Students could research predictions about how the world will warm up if greenhouse gases are not reduced.

Differentiated outcomes	
All students	should be able to state that air pollution causes damage to the environment and suggest some ways to reduce this pollution
Most students	will be able to describe how acid rain forms and state that the greenhouse effect warms the Earth's atmosphere
Some students	may be able to describe examples of scientific predictions about global warming

Water pollution and waste disposal


Water pollution and waste disposal

In this lesson you will explore human activities that can lead to the pollution of water.

Key words
acid
alkali
landfill
pH scale
pollution
sample
waste

Pollution is when humans introduce materials that harm the environment. Human activities that can pollute water include:
- throwing away waste materials such as plastics
- oil from boats harms aquatic life and damages recreational areas.
- chemicals from factories and homes
- pesticides and fertilisers from farms
- sewage.

The pollution can enter food chains and food webs and could kill animals and plants by harming the environment in which they live. It may also spread human diseases such as typhoid, diarrhoea, cholera, etc.

These water samples were taken from the same river. One was taken before it flowed through a town and the other after.

Why is one sample a different colour to the other one? Would you risk drinking either of the water samples?

Look at the photograph of the river. How safe would the water be to drink or bathe in? What could be done to improve this river habitat?

Science fact
Up to 70% of waste from industry is dumped into water. Sewage from houses causes up to 80% of water pollution.

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Scientists can test to see if water is acidic or alkaline. They do this by using indicators. These change colour in acids and alkalis. One example is the universal indicator. Each colour is given a number. This is the pH number. Pure water has a pH number of 7. It is neither acid nor alkali – it is neutral.

pH scale
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
acidic | neutral | alkaline

Testing water samples
You will be given five water samples to test.
1 Test each sample with an indicator. Check the colour against the pH scale.
2 Record the pH number for each sample.
3 Which samples were acidic? Which samples were alkaline? Were any samples neutral?

Warning!
DO NOT drink water from an unknown source. Even if a water sample is neutral, it does not mean it is pure. It could still have harmful microorganisms or chemicals in it.

Waste disposal

Waste produced by, homes, schools, hospitals, and factories has to be disposed of. One method is to bury the waste in landfill sites. This can cause problems by attracting rats and flies. Some chemicals can wash into streams and rivers.
In some places the waste is burned to provide energy.

Discuss some of the problems caused by disposing of waste. How is waste treated and disposed of in your area?

Key idea
Some human activities, such as disposal of farm and factory chemicals, sewage and plastics, can lead to the pollution of water.

Stretch zone
Design a test to find out how cloudy or clear water samples are. Test your method on the samples your teacher gives you.

© Environmental Pollution

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Getting started

Students now look at two further types of human activity that can affect the environment – water pollution and waste disposal. In both cases, students are asked to consider what the environmental impacts are. They investigate water samples and discuss the problems associated with disposing of waste.

Language support

Ensure that students are confident with the words and concepts covered in the lesson. Explain to students what is meant by, for example, 'waste disposal' and 'water pollution'. Ask students to identify any words or ideas that they are unfamiliar with and explain what they mean. Ask them to use the photographs to give them clues as to the meaning of the words.

Resources

Student Book: five water samples with different pH values; pH indicator strips.

Key words

acid alkali landfill pH scale pollution sample waste

Other words in the lesson

chemical disease disposal fertiliser indicator neutral oil pesticide plastic sewage

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- some human activities can lead to water pollution
- examples of human activities include sewage, disposal of plastics, and farm chemicals leaching into waterways.

Ask students to work in pairs to look at the image of the water pollution and describe what they can see. Start a class discussion about the possible impacts of these activities on the environment. During the discussion ensure that you identify enough impacts to enable students to answer the questions.

Look at the photograph of the river. How safe would the water be to drink or bathe in? What could be done to improve this river habitat?

Students can work in pairs or small groups. Ask them to discuss if they think it is safe to drink the water or swim in it. You can ask them to think about the problems that living things such as fish would have in the water. Once they have thought up some ideas to improve the river allow them to share ideas with the class.

Possible response: *The river water would not be safe to drink or bathe in. The litter could be removed and people could stop adding substances to the river.*

Ask students to read the text and look carefully at the photograph of the glasses of water.

Why is one sample a different colour to the other one? Would you risk drinking either of the water samples?

Ask students which sample looks to be the cleanest. Ask them to share ideas about why one could be clear and the other one cloudy.

Possible response: *The water in the glass on the right looks the safest to drink, but point out that it could still contain harmful substances and microorganisms that cannot be seen. The one on the left could have soil and other chemicals added.*

Science fact Up to 70% of waste from industry is dumped into water. Sewage from houses causes up to 80% of water pollution.

Read out the Science fact and ask students to think about why dumping waste into water can cause problems for humans and other living things. Ask for volunteers to share their ideas with the class.

Point out the text at the top of page 65, read through it with students, and study the drawing of the pH scale. Explain that this is one way of testing water samples and students are going to use it in their investigation.

Students do not need to know the background science of pH at this stage but tell them that indicators are natural substances that can be extracted from plants. You could add some acidic substances to cabbage juice to illustrate this. Point out that the numbers are used because colours are not easy to describe. Hand out a paint colour guide to make this point – the colours are given names so people can ask for them without having to describe the colour.

Investigation: Testing water samples

Warning! DO NOT drink water from an unknown source. Even if a water sample is neutral, it does not mean it is pure. It could still have harmful microorganisms or chemicals in it.

Read out the warning and ask students to discuss why they should not drink water from an unknown source.

Explain that they will be given five water samples to test. Ask them to test each sample with an indicator. If you cannot obtain commercial universal indicator paper or solution, then you can make your own indicator using red cabbage or other plants with pigments. Students dip indicator paper into the sample or pour a small amount of indicator solution into each sample and check the colour against the pH scale. Remind students to record the pH number for each sample and decide which samples are acidic, alkaline or neutral.

Stretch zone: Design a test to find out how cloudy or clear water samples are. Test your method on the samples your teacher gives you.

Students can work with a partner to plan and carry out their test. Hand out three water samples – one clear, one very cloudy (made by adding soil to water), and one slightly cloudy (made by adding fruit to water).

Answer: *Students should find that using cloudiness (turbidity) is a useful way of finding out if water contains pollutants.*

Show students the photograph and text about waste disposal. Ask them to study it carefully and then talk about the discussion task.

Discuss some of the problems caused by disposing of waste. How is waste treated and disposed of in your area?

Ask students to write down two effects of waste disposal on the environment. They can then research how waste is disposed of in their area. You can provide access to the internet or obtain information from the local government or company that disposes of the waste.

Possible response: *Problems include attracting rats and other animals and the leaching of chemicals into water, rivers and streams. Landfill sites are also unsightly, they take up land that may have important habitats, and they can smell.*

Key idea

Some human activities, such as disposal of farm and factory chemicals, sewage and plastics, can lead to the pollution of water.

Read out the key idea or ask a volunteer to read it out to the class. Ask students to talk to a partner about any examples of pollution they have seen in their area and to write down a list of ideas about how each could be reduced.

Review and reflect

Use the discussion tasks to encourage students to think about what they understand and what they are finding less straightforward. Discuss the outcomes of each task with students. Encourage them to identify aspects they have not completed correctly and help them to identify improvements. This will help students to develop a positive approach to learning by understanding that learning is a process that will improve with practice and reflection.

Extra activities

1 **Computing link:** Ask students to create an information leaflet about one of the issues covered in the unit so far. You could allocate groups a different topic – such as TREES, acid rain, greenhouse effect, quarrying, deforestation, water pollution, or waste disposal. Let them have access to the internet to find out more information about the topic and to download pictures to make a computer-generated leaflet.

2 **Maths link:** Students could research the types and amounts of pollution that are sent into the ocean, rivers and streams or buried or burned in your area. They can produce tables of the amounts and present these as bar charts or line graphs showing the trends over time. For example, has the amount of waste going to landfill fallen or risen over the last ten years in the local area?

Differentiation

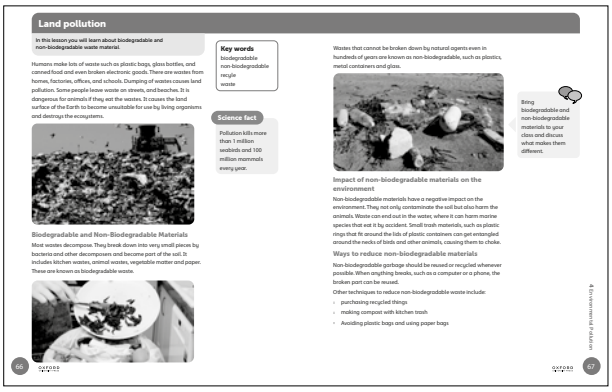
Supporting: Introduce turbidity tests by asking students to write their name on a piece of paper and then try to read it through the different water samples.

Consolidating: Arrange a visit to a local waste disposal site or invite a visitor into the classroom so students can see and hear about waste disposal.

Extending: Students can research some of the most common chemicals that cause pollution in rivers, streams, lakes and the oceans.

Differentiated outcomes	
All students	should be able to state that water becomes polluted when chemicals and waste materials are thrown away into rivers and streams
Most students	will be able to describe how water can be tested for acidity and turbidity
Some students	may be able to list some specific chemicals that pollute water

Land pollution


Land pollution

In this lesson you will learn about biodegradable and non-biodegradable waste material.

Humans make lots of waste such as plastic bags, glass bottles, and canned food and even broken electronic goods. There are wastes from homes, factories, offices, and schools. Dumping of wastes causes land pollution. Some people leave waste on streets, and beaches. It is dangerous for animals if they eat the wastes. It causes the land surface of the Earth to become unsuitable for use by living organisms and destroys the ecosystems.

Key words
biodegradable
non-biodegradable
recycle
waste

Science fact
Pollution kills more than 1 million seabirds and 100 million mammals every year.

Biodegradable and Non-Biodegradable Materials
Most wastes decompose. They break down into very small pieces by bacteria and other decomposers and become part of the soil. It includes kitchen wastes, animal wastes, vegetable matter and paper. These are known as biodegradable waste.

Wastes that cannot be broken down by natural agents even in hundreds of years are known as non-biodegradable, such as plastics, metal containers and glass.

Bring biodegradable and non-biodegradable materials to your class and discuss what makes them different.

Impact of non-biodegradable materials on the environment
Non-biodegradable materials have a negative impact on the environment. They not only contaminate the soil but also harm the animals. Waste can end out in the water, where it can harm marine species that eat it by accident. Small trash materials, such as plastic rings that fit around the lids of plastic containers can get entangled around the necks of birds and other animals, causing them to choke.

Ways to reduce non-biodegradable materials
Non-biodegradable garbage should be reused or recycled whenever possible. When anything breaks, such as a computer or a phone, the broken part can be reused.
Other techniques to reduce non-biodegradable waste include:
- purchasing recycled things
- making compost with kitchen trash
- Avoiding plastic bags and using paper bags

4 Environmental Pollution

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Getting started

In this lesson students will study the environmental problems associated with litter. They will learn to define and classify litter and will investigate litter in their area through the planning and carrying out of a litter survey. Students will study some of the effects of litter on wildlife.

Language support

Use this opportunity to clarify the relationship between litter (which is thrown away carelessly) and waste (which may be disposed of correctly but can still cause problems). You could walk around the room and if you drop paper on the floor, students shout 'litter' and, as you put some in the waste basket, they shout 'waste'. Ask them why you should pick up the litter that you dropped.

Resources

Student Book: access to an outdoor area suitable for a litter survey; gloves; graph paper; large sheets of paper.

Key words

biodegradable non-biodegradable recycle waste

Scientific enquiry key words

Make predictions

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- litter is waste material that people throw away carelessly
- litter can damage habitats and endanger wildlife.

Ask students to work with a partner. They should look at the photo on top of the page and then talk about how they handle litter. Remind them that if they put something in the bin, then it isn't litter – it is waste. To prompt discussion, as this will set the tone for the lesson, you could ask questions around a scenario. Tell and ask students, 'You are walking down the street drinking a bottle of water. You finish the water. Where do you put the empty bottle? Do you throw it on the ground, throw it in a litter bin, take it home to throw away, or take it home for recycling?' Ask volunteer pairs to share their answers with the class.

Possible response: *Students should state that they never drop litter and always put waste in the bin or take it home for recycling.*

What sort of things do we think of as litter? Think about the food and drink you have. Think about the sort of packaging it comes in.

You can ask pairs to discuss this next question or, for variety, ask the whole class for suggestions. As they suggest items and materials that they believe are litter, you can make a class list on the board.

Possible response: *Elicit that litter includes many objects and materials such as paper, cardboard, plastic items, glass containers, wooden objects, waste food and even metal objects.*

Students can carry out the next discussion with a partner. Ask them to read the text about 'What is litter?' and then talk about the discussion question.

Where can we find litter? Write down three places where we can find litter.

Allow students to sit quietly for a few minutes and imagine walking around their village, town or city and consider where they are most likely to find litter. They can then share ideas with their partner and some pairs can read out ideas to the class.

Possible response: *Students may suggest that litter gathers near fast-food outlets, where people have gathered for picnics or barbeques, and where it might have been blown by wind and caught on fences and hedges.*

Science fact Pollution kills more than 1 million seabirds and 100 million mammals every year.

Ask a volunteer to read out the Science fact. Ask students if they have ever seen litter in the sea. They can share ideas about how it might have got there. Point out that litter can harm all living things.

Explain in class that litter can usually be classified into two types: biodegradable and non-biodegradable. Ask the students to read through the text and then discuss the differences between the two types. You could ask question such as "which type of litter is more commonly found?" , "which type of litter causes more pollutions?". Finish by discussing ways to reduce the amount of non-biodegradable wastes produced.

You could send off for information from local waste management companies or the government or community department that oversees waste disposal. They should be able to send you details of what is collected, how much is collected, where it is sent and how it is handled. If not, you can ask students to search for this information on the internet and download information sheets about it. Alternatively, students can draw on their own observations of where household waste is taken and what happens to it afterwards.

Possible response: *Students will discover that the waste is either buried in landfill, composted (only some waste), burned, burned to provide energy, or recycled.*

Investigation: Is littering each person's responsibility? Or is littering the responsibility of the community?

Initiate a discussion within small groups about whose responsibility it is to deal with littering. Ask students to decide whether it is the responsibility of the individual or the community. Then ask students to raise their hands if they think littering is the responsibility of the individual, and again to raise their hands if they think it is the responsibility of the community. It is anticipated that students put up their hands on both occasions. Explain that a spider diagram shows the ideas put forward linked by lines, a bit like a spider web. Encourage groups to have at least four or five ideas in their spider diagram.

Possible response: *Students may share a variety of ideas and these may include: it is an individual's responsibility as they use the materials; it is the responsibility of the community as there is too much litter for individuals to deal with; it is the individual's responsibility because money will be saved as people would not have to be paid to pick up litter; it is the responsibility of the community as people pay tax for this to be done; it is both the responsibility of the community and the responsibility of the individual because we all have to work together.*

Review and reflect

Use the outcomes during the lesson (feedback from discussion tasks, the litter survey investigation activity, the

spider diagrams and the poster design task) to encourage students to think about this topic. Encourage students to identify aspects they have not completed correctly and help them to identify improvements. They should also recognise things they are proud of and celebrate this. This will help students to develop a positive approach to learning by understanding that learning is a process which improves with practice and reflection.

Extra activities

1 **Computing link:** Ask students to produce a 'press release' about the problems of littering. They can use the findings from their investigation or any internet research. Students can also include drawings or photographs to help their press release have impact.

2 Allow students to make a 'litter collage' by using washed items of litter to create some artwork. The pieces of litter could be labelled with the type of material and how it could endanger living things.

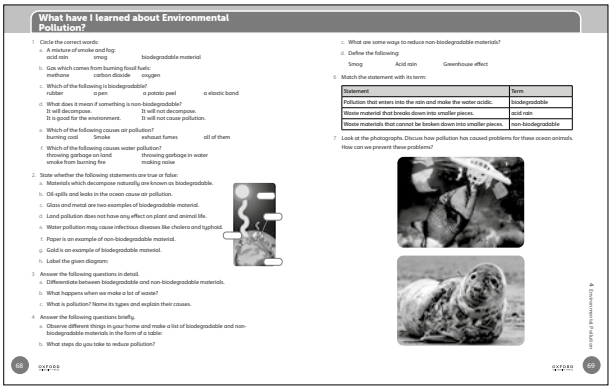
Differentiation

Consolidating: Students could carry out a daily check of items placed into the class waste basket and keep a litter diary for a week to show the range and quantity of what is being thrown away.

Extending: Students could evaluate the environmental impact of the different ways that waste is managed.

Differentiated outcomes	
All students	should be able to state that litter can be harmful for living things
Most students	will be able to describe difference between types of litter and their impact on the environment
Some students	may be able to explain the different ways waste material is handled and what the environmental impact of each is

What have I learned about Environmental Pollution?


What have I learned about Environmental Pollution?

1 Circle the correct words:
a. A mixture of smoke and fog: acid rain smog biodegradable material
b. Gas which comes from burning fossil fuels: methane carbon dioxide oxygen
c. Which of the following is biodegradable? rubber a pen a potato peel a elastic band
d. What does it mean if something is non-biodegradable? It will decompose. It will not decompose. It is good for the environment. It will not cause pollution.
e. Which of the following causes air pollution? burning coal Smoke exhaust fumes all of them
f. Which of the following causes water pollution? throwing garbage on land throwing garbage in water smoke from burning fire making noise
2 State whether the following statements are true or false:
a. Materials which decompose naturally, are known as biodegradable.
b. Oil-spills and leaks in the ocean cause air pollution.
c. Glass and metal are two examples of biodegradable material.
d. Land pollution does not have any effect on plant and animal life.
e. Water pollution may cause infectious diseases like cholera and typhoid.
f. Paper is an example of non-biodegradable material.
g. Gold is an example of biodegradable material.
h. Label the given diagram:
3 Answer the following questions in detail.
a. Differentiate between biodegradable and non-biodegradable materials.
b. What happens when we make a lot of waste?
c. What is pollution? Name its types and explain their causes.
4 Answer the following questions briefly.
a. Observe different things in your home and make a list of biodegradable and non-biodegradable materials in the form of a table:
b. What steps do you take to reduce pollution?
c. What are some ways to reduce non-biodegradable materials?
d. Define the following: Smog Acid rain Greenhouse effect
6 Match the statement with its term:

Statement	Term
Pollution that enters into the rain and make the water acidic.	biodegradable
Waste material that breaks down into smaller pieces.	acid rain
Waste materials that cannot be broken down into smaller pieces.	non-biodegradable

7 Look at the photographs. Discuss how pollution has caused problems for these ocean animals. How can we prevent these problems?
4 Environmental Pollution
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Getting started

The aim of this section is to encourage students to review their learning after each lesson in the unit and also to undertake some end-of-unit review and reflection. These will assess students' knowledge and understanding of the topic. However, it is also worth allowing students to answer all of the questions at the end of the unit. This will test longer-term understanding and recall. You can do this as an informal individual or pair activity and allow students to look information up as they work through the questions or you can set it as an individual 'closed-book' activity.

It is important that students report areas that they are not confident with. This information is useful for them in that they can think about what they need to review or ask advice about. It is also vital for you as it provides information about any topics you may wish to revisit.

'What have I learned about the Environmental Pollution?' answers

1 Circle **the correct words:**

Make sure students understand that they have multiple options but they should only circle one choice – A, B or D.

Answer: a. smog b. carbon dioxide c. a potato peel d. It will not decompose. e. all of them f. throwing garbage in water.

2 State whether the following statements are true or false:

Remind students to notice that option h is a labelling question and needs to be worked accordingly.

Answer: *a, e: true; b, c, d, f, g: false*
h. starting from top right: Sun's rays, atmosphere traps greenhouse gases, Earth heats up, atmosphere.

3 a Answer the following questions in detail.

Answer: *a. Biodegradable materials are those that can be broken down by natural processes into simpler substances, which are then taken up by the environment without causing any harm. Examples of biodegradable materials include food waste, paper, and wood.*

Non-biodegradable materials are those that cannot be broken down by natural processes. These materials remain in the environment for a long time and can cause harm to living organisms. Examples of non-biodegradable materials include plastic, glass, and metal.

b. Increase in wastes causes increase in land and water pollution, depending on where they are improperly disposed. Burning of wastes results in increased air pollution. All the three types of pollution cause harm to health and life of living creatures and the food chains they are part of.

c. Any change in the environment due to the addition of some harmful substances is called pollution, which can be of three types: Air pollution, Land pollution, Water pollution.

Students can then explain about the three types of pollutions in their own words.

4 Answer the following questions briefly.

Answer: *a. Encourage students to work in pairs to answer this part. You can assign this as a homework assignment.*

b. Encourage students to share their lived experiences in answer.

c. Non-biodegradable garbage should be reused or recycled whenever possible. Other ways to to reduce non-biodegradable waste include:

- purchasing recycled things
- making compost with kitchen trash
- Avoiding plastic bags and using paper bags

d. Smog is mixture of smoke and fog, which reduces visibility and makes it dangerous to travel on roads and highways. It also causes serious health issues like asthma, bronchitis, allergies, and heart diseases. Acid rain occurs when pollution that enters the atmosphere from factories, cars, buses and lorries, and homes makes rain more

acidic. Greenhouse effect is result of a mixture of gases which trap some of the Sun's heat energy. This warms the Earth so that it can support life. However, human activities increase the amount

of gases in the atmosphere. This can lead to too much heat being trapped and is known as the enhanced greenhouse effect.

5 Match the statement with its term.

Explain that in this question they have to match three statements with the word that is described by them.

Answer: *acid rain; biodegradable; non-biodegradable.*

6 Look at the photographs. Discuss how pollution has caused problems for these ocean animals.

How can we prevent these problems?

Suggest that students start by looking at the given photographs so they know wwhich animals and pollutants are being considered. If they need extra support explain that though both photos show water pollution, the impact shown in both photos is different. Encourage analytical thinking by asking them to think through what the photos are showing and what that means for the creature.

Answer: *Students may identify that both photos are showing effects of water pollution, specially of garbage in water. The fish is shown eating soft plastic, mistaking it for seaweed. This plastic provides no nutrition and can end up starving the fish(es), causing a decline in their population. The second photo shows a sea lion with plastic tangled around its neck. This can lead to strangulation and again result in death of the animal.*

Summative assessment

You can read out the answers to the 'What have I learned about the Ecosystems?' section in the Student Book for students to self-assess or you can take in the pages and mark them to award an overall score. You could allocate marks as follows: question 1 = 3; question 2 = 4, 2h = 1; question 3 = 6; question 4 = 4; question 5 = 3; question 6 = 4. This makes a total of 25 marks.

If necessary, ask students to revisit topics and questions to help them to learn more about any they did not score well on. In this way the questions are both summative and formative. All assessments should be linked to enhancing learning and in this way the 'What have I learned about?' pages will support this as well as providing data to report back to students, parents and/or other significant adults.

The self-review is excellent starting point when discussing the progress of each student individually. This information may also be used to create end-of-term reports for each student. It may also be useful to keep a record of overall confidence levels for the whole class to identify areas that may need revision later.

This feedback can then be used to form support strategies to help students improve. Keep the recording

and analysis of students' self-evaluations simple. A general impression of the self-evaluation of the class is all that is required, for example: 50% of the class were not confident about … .

Investigate like a scientist

Building a wildlife pond

Resources: string or hose pipe; spade; pond liner; spirit level; plank; sand; large stones; water (rain water is best); pond plants; materials to make a poster.

Explain that students are going to build a wildlife pond. The size will depend on many factors, such as space available, resources available and the time you wish to allocate to this project. Whatever the size, the process is the same. Work through the instructions with students and make sure you use a sunny place outside. You can help them to allocate roles. Some can mark out the pond with string or a hosepipe and others can help to dig out the pond. Make sure the pond has some deep areas so animals and plants can obtain the correct temperature and level of sunlight. It will also need to have some shallow areas near the edges so animals such as frogs can get out of the water. Help students to use a plank and spirit level to make sure the sides and bottom are flat. They must remove any sharp stones and then cover the bottom with a 5 cm layer of sand. They will need to work together to spread out the liner into the hole and get rid of any creases. They can hold the liner down at the edges with large stones.

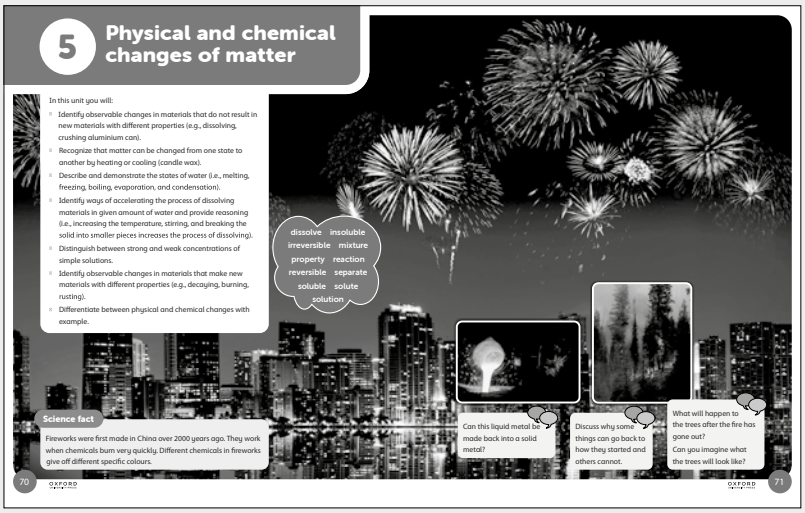
Students then add sand to the bottom of the liner and carefully fill the pond with water. They should let the water settle for a week and then they can add the pond plants. Suggest they add soil and plants around the edge of the pond as well as in the middle. They can observe the pond regularly and record any insects or amphibians they see there. Ask them to identify any eggs, young or adult animals. They can use the pond for many investigations, for example to find out which animal life cycles they see in the pond. Students can review what they have learned in the unit by making a poster showing one of the life cycles they have observed in or near the pond.

Note: if standing water is likely to attract insects such as mosquitoes then instead of creating a pond you can use an existing damp area, plant a range of marsh plants and keep the soil moist, or you can make a flower bed or similar.

5 Physical and chemical changes of matter

In this unit students will:

- *Identify observable changes in materials that do not result in new materials with different properties (e.g., dissolving, crushing aluminium can).
- Recognize that matter can be changed from one state to another by heating or cooling (candle wax).
- Describe and demonstrate the states of water (i.e., melting, freezing, boiling, evaporation, and condensation).
- Identify ways of accelerating the process of dissolving materials in given amount of water and provide reasoning (i.e., increasing the temperature, stirring, and breaking the solid into smaller pieces increases the process of dissolving).
- Distinguish between strong and weak concentrations of simple solutions.
- Identify observable changes in materials that make new materials with different properties (e.g., decaying, burning, rusting).
- Differentiate between physical and chemical changes with example.



Getting started

This unit introduces students to the idea that there are different materials that are selected to make objects based on their properties. Students become aware of the similarities and differences between reversible and irreversible reactions. They explore how a solid can be mixed with other materials and that sometimes it can be separated using different techniques. They also investigate how some solids dissolve in water but some do not. Students are also introduced to the energy changes in some reactions.

The content of this unit can be observed and experienced in everyday life, including during cooking and preparing drinks. Students will undertake various investigations to explore the properties of everyday materials and how these affect the way they behave.

Science in context

Use the lessons in this unit to demonstrate to students the importance of materials on a global and more local scale. They should gain an understanding of why materials are used in particular ways in everyday life, and the science behind this. They will be able to link the properties of materials to their use for a specific purpose. They will also learn that materials can be changed, mixed, dissolved and separated, and will be able to relate this to many examples in their own lives and the lives of people such as scientists, gardeners and cooks.

Provide opportunities for students to observe how changed, mixed, dissolved and separated materials are used in everyday life.

Scientific enquiry skills

An Investigation master sheet is given in this Teacher's Guide on pages 4–5 to help students plan their scientific enquiries. Throughout this unit students try to answer questions by collecting evidence through observation and measuring, and recording results in a variety of ways. They make predictions about the properties and changes of materials, such as thermal and electrical conductivity, and follow scientific methods to test their predictions. Students draw conclusions about whether fuels burn with a flame, for example, and plan investigations such as separating out colours in pen ink. They collaborate with others to problem solve and communicate their ideas in a variety of ways including in tables of results, presentations and leaflets.

Resources

Student Book: batteries, bulbs and connectors to make test circuits; magnets; selection of objects made from different materials (e.g. wood, metal, cloth, glass, stone, brick); wooden spoons; metal spoons; plastic spoons; thermometers or thermometer strips; glass beakers; boiling water; a cake and cake ingredients (optional); salt; water; hot water; dirty water; cups; saucers; teaspoons; tongs; metal or ceramic plates; matches; paper and other

types of fuel that can be lit with matches (e.g. twigs, cardboard); acetic acid (vinegar); bicarbonate of soda; fire (e.g. a lit candle) and other sources of heat; plastic bottles with lids; modelling clay or tape; straws; a jar of mixed sweets; mixture of solids; sugar; talcum powder; sand mixed with water; sieves; filter paper; filter funnels; materials to design, make and test a filter bed (such as large plastic bottles, scissors, cotton wool, charcoal, fine sand, pebbles and sand, rocks); pen ink in different colours; samples of drinks containing varying amounts of sugar; Bunsen burners (optional); scales; cement; small stones; protective gloves; eye glasses; materials to make information leaflets and magazine articles; access to the internet; information sheets about newly developed materials; books or information sheets about the use of magnets for recycling.

Key words for the unit

Bold words are in the Word cloud

Boil **dissolve** evaporate **insoluble** liquid **irreversible** freeze **mixture** **property** temperature reaction **thermometer** **reversible** decaying separate **soluble** steam **solute** **solution**

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results using diagrams and labels, tables, keys and graphs

Make predictions

Report and present findings in a variety of ways

Draw conclusions and give explanations

Identify causal relationships

Use scientific evidence to support or refute ideas

Language support

Introduce the key words at the start of the unit. Ask students to work with a class fellow. Read all the key words. Students could create a miniature Word wall in the back of their notebooks. They can add pictures and simple definitions that are meaningful to them as they become more confident with each of the words. Discuss each word and explain that students will learn and use them throughout the learning of the unit. Encourage students to say the words out loud to support them with pronunciation. Do not correct their pronunciation if it is incorrect, but model the correct pronunciation while repeating back what they say. For example, 'so you are saying that dissolve means …'. At the start of the learning in this unit you could set up a classroom library including books, magazines and leaflets that include content about modern materials and their uses.

Unit at a glance

The key teaching points for students in this unit are:

- to introduce the unit objectives
- to introduce the learning outcomes
- to engage students with the content of the unit
- to review and build on prior learning and understanding of the topics.

The purpose of this introductory lesson is for students to start thinking about different materials and how they can be changed. The Discussions prompt students to talk about a range of different ways in which materials can be changed, with photographs used as a starting point. Ask students to look at the main photograph first and then the Science fact.

Science fact: Fireworks were first made in China over 2000 years ago. They work when chemicals burn very quickly. Different chemicals give the fireworks the different colours.

Read out the Science fact or ask a volunteer to read it out. Ask students to suggest how we get different coloured fireworks. Ask students to discuss any experiences of fireworks. You could use this opportunity to highlight that once a firework has been burned and used it can no longer be used again.

Can this liquid metal be made back into a solid metal?

Point out the photograph of the liquid metal and ask students to discuss this question with a partner then encourage them to share their ideas with the class. Explain that the metal has to be heated to high temperatures for it to change from a solid to a liquid. Ask what they think would happen if it cooled down. Ask what would happen to an ice cube if it melted and then cooled. Elicit the idea that the metal melts at a much higher temperature but, like some other solids that are melted, it can change back to a solid when it is cooled.

Possible response: *Students should suggest that the metal can change back into a solid when it is cooled down.*

Discuss why some things can go back to how they started and others cannot.

Ask students to work with a partner. Ask them to read the discussion task and talk about how some things can return to their original state but other things cannot. Ask them if they can explain why. The pairs could then join with others to form small discussion groups.

Possible response: *Students should suggest that changes to certain materials, such as heating or combining them with other materials, mean that they cannot change back. They may suggest an example, such as cooking an egg, which cannot then be changed back to a raw egg. However, changes to other materials, such as water which can be cooled to form ice, don't stop them from being changed back.*

What will happen to the trees after the fire has gone out? Can you imagine what the trees will look like?

Students work with their partner again. Point out the photograph of the burning trees and ask students to read through and answer the discussion questions. They discuss how the trees turn to ash when they have burned. Ask if it would be possible, once the tree has turned to ash, to change the tree back to how it was before the fire started. Tell them that some things cannot go back to how they started.

Possible response: *Students should suggest that the trees will not look the same. They will turn to ash – a greyish coloured powder that is not like the tree.*

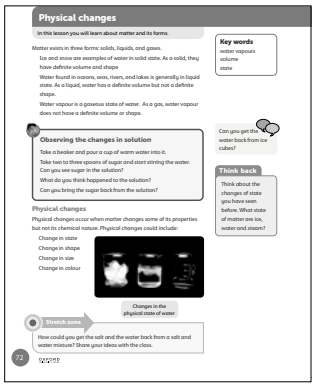
Extra activities

1 Ask students to list all of the materials they can see in the photographs on pages 70–71.

2 Ask students to suggest any liquid they have seen cooled down to form a solid. What was the liquid? What happened to make it solid?

3 **Computing link:** Allow students to use the internet to find out what fireworks are made of and whether setting a firework off is a reversible or irreversible change.

Physical changes


Physical changes

In this lesson you will learn about matter and its forms.

Key words
water vapours
volume
state

Matter exists in three forms: solids, liquids, and gases.
Ice and snow are examples of water in solid state. As a solid, they have definite volume and shape
Water found in oceans, seas, rivers, and lakes is generally in liquid state. As a liquid, water has a definite volume but not a definite shape.
Water vapour is a gaseous state of water. As a gas, water vapour does not have a definite volume or shape.

Observing the changes in solution
Take a beaker and pour a cup of warm water into it.
Take two to three spoons of sugar and start stirring the water.
Can you see sugar in the solution?
What do you think happened to the solution?
Can you bring the sugar back from the solution?

Can you get the water back from ice cubes?

Think back
Think about the changes of state you have seen before. What state of matter are ice, water and steam?

Physical changes
Physical changes occur when matter changes some of its properties but not its chemical nature. Physical changes could include:
Change in state
Change in shape
Change in size
Change in colour

Changes in the physical state of water

Stretch zone
How could you get the salt and the water back from a salt and water mixture? Share your ideas with the class.

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Getting started

In this lesson, students explore what happens to solids when they are heated. They consider the arrangement of particles in solids and what happens when the energy of the particles increases due to heating.

Language support

Throughout the lesson, use the word 'state' frequently to reinforce its meaning and encourage students to use the word in their answers. For example ask, 'What is the state of the chocolate before it melts? What is its state after it has melted?' Another key word is 'melting'. This means changing from the solid state to the liquid state.

Resources

Student Book:

Key words

water vapours volume state

Other words in the lesson

matter

Scientific enquiry key words

ask questions use equipment observe measure compare notice patterns record carry out tests group/classify communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- materials change state when they are heated
- solids can melt when they are heated.

Can you get the water back from ice cubes?

Possible response: *Yes, ice cubes can be heated to get back to liquid state i.e. water.*

Explain that when we heat materials we add energy to them. The particles start to move faster and move further apart. You could ask students to draw what they think happens to particles in a solid as it is heated. You might need to remind them of the regular packed particles of a solid before they start their drawing.

The particles in a solid move further apart and are only loosely linked when it becomes a liquid. The structure and shape of the solid breaks down and the liquid takes on the shape of the bottom part of its container.

Investigation: Observing the changes in solution

Tell students that no new substance is formed during the dissolution of sugar in water, the change is only physical. This is a reversible transformation because crystallization allow the sugar and water to be recovered from the solution.

Think Back: Think about the changes of state you have seen before. What state of matter are ice, water and steam?

Possible response: *Ask students to recall their background knowledge or use the internet or other available resources to find more examples. Students could suggest butter melting during cooking, ice caps melting or a wax candle melting when it is lit.*

Stretch zone: How could you get the salt and the water back from a salt and water mixture? Share your ideas with the class.

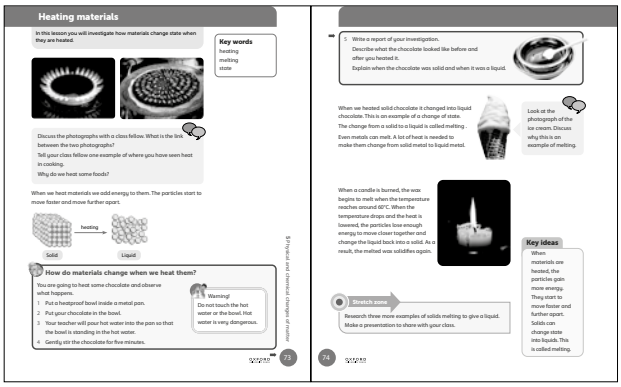
Possible response: *Ask the students to define evaporation. What happens when the water evaporates?*

Demonstrate the process of water evaporating and leaving behind the salt.

Review and reflect

Students can discuss in small groups the process of physical changes in the state of matter. They should reflect on how the heat from a source provides energy to the particles and this makes them move apart. Encourage them to discuss their ideas about how melting can be useful as it changes solids into liquids. Students should listen to the ideas of others as they share their ideas and understanding.

Heating materials



Getting started

In this lesson, students explore what happens to solids when they are heated. They consider the arrangement of particles in solids and what happens when the energy of the particles increases due to heating.

Language support

Throughout the lesson, use the word 'state' frequently to reinforce its meaning and encourage students to use the word in their answers. For example ask, 'What is the state of the chocolate before it melts? What is its state after it has melted?' Another key word is 'melting'. This means changing from the solid state to the liquid state.

Resources

Student Book: squares of chocolate; heatproof bowl; large saucepan; spoon; very hot water (only the teacher should handle this).

Key words

heating melting state

Other words in the lesson

cooking

Scientific enquiry key words

ask questions use equipment observe measure compare notice patterns record carry out tests group/classify communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- materials change state when they are heated
- solids can melt when they are heated.

In the next lesson, students will learn about how liquids change when they are heated.

Start the lesson by letting students know the learning objective and then asking them to work in pairs to discuss the discussion activity at the top of Student Book page 73.

Discuss the photographs with a partner. What is the link between the two photographs? Tell your partner one example of where you have seen heat in cooking. Why do we heat some foods?

> ***Possible response:*** *Students may suggest that the heat from the cooker can be used to cook food such as the cake in the photograph.*

Explain that when we heat materials we add energy to them. The particles start to move faster and move further apart. You could ask students to draw what they think happens to particles in a solid as it is heated. You might need to remind them of the regular packed particles of a solid before they start their drawing.

The particles in a solid move further apart and are only loosely linked when it becomes a liquid. The structure and shape of the solid breaks down and the liquid takes on the shape of the bottom part of its container.

Investigation: How do materials change when we heat them?

Warning! Do not touch the hot water or the bowl. Hot water is very dangerous.

Ask a student to read out the warning information. Allow students to talk about it with their partner or in a small group and then ask volunteers to tell you why hot water can be so dangerous. You can ask for examples of when students have seen hot water and how people at home made sure no one was harmed.

Students investigate heating chocolate as an example of melting. They observe that the structure of the solid chocolate breaks down and becomes a liquid that can be poured.

Organise students into groups. Tell them they are going to heat some chocolate to observe what happens. Once each group has their chocolate ready in the bowl inside the pan you can move around the room and add hot water to each pan.

Ask students why they need to gently stir the chocolate for five minutes. Discuss how the heat is being transferred from the hot water to the bowl. This is how the solid chocolate particles are getting energy to move apart – this is how melting happens.

Ask students to describe and explain as requested in their investigation report.

Next read out the text beneath the investigation box on page 74. This defines the change from a solid to a liquid as melting. Ask a student to say the word out loud after you read it and then write the word on the board.

Explain that even metals can melt but that a lot of heat is needed to make them change from solid metal to liquid metal. You can then point out the two photographs and ask students to work with a partner to talk about the discussion questions.

Look at the photograph of the ice cream. Discuss why this is an example of melting.

Ask students to draw the particles in the ice cream when it is frozen. Then they can draw the particles in the ice cream after it has melted.

> ***Possible response:*** *Students may say that the ice cream is changing from a solid into a liquid as heat is applied from the Sun. The particles should be close together in an orderly manner in the solid ice cream and further apart as it melts and becomes a liquid.*

Stretch zone: Research three more examples of solids melting to give a liquid. Make a presentation to share with your class.

Students could use the internet or other available resources to find more examples to write a short presentation for the Stretch zone activity.

> ***Possible response:*** *Students could suggest butter melting during cooking, ice caps melting or a wax candle melting when it is lit.*

Key ideas

- *When materials are heated, the particles gain more energy. They start to move faster and further apart.*
- *Solids can change state into liquids. This is called melting.*

Ask for two volunteers to read out the key ideas. You can ask students to stand up and cluster in small groups to model the particles in a solid; when you shout 'melting' they should model the process of melting and arrange themselves into the arrangement of particles in a liquid. Remind them that the particles are still close together and touching but are able to move more than in a solid.

Review and reflect

Students can discuss in small groups the process of melting. They should reflect on how the heat from a source provides energy to the particles and this makes them move apart. Encourage them to discuss their ideas about how melting can be useful as it changes solids into liquids. Students should listen to the ideas of others as they share their ideas and understanding.

Extra activities

1 Ask students to search for recipes that include melting or boiling as part of the process.

2 Organise a cake-decorating activity. Allow students to be imaginative in how they cover the cakes using melted chocolate. They can design their own patterns. They can then advertise and sell their cakes.

Differentiation

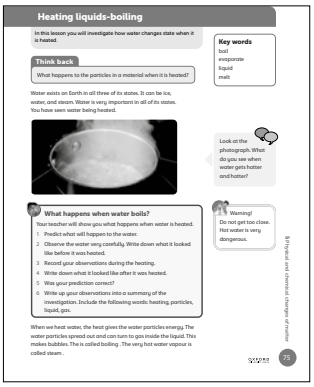
Supporting: Students should be given opportunities to observe different solids melting to become liquids.

Consolidating: Allow students to observe closely and describe how solids change during melting.

Extending: Students can give examples of a number of solids that melt when they are heated and suggest some uses for them.

Differentiated outcomes	
All students	should be able to recognise when a solid melts
Most students	will be able to draw particle models of the change of state during melting
Some students	may be able to describe at least one use of melting solids

Heating liquids-boiling


Heating liquids-boiling

In this lesson you will investigate how water changes state when it is heated.

Think back

What happens to the particles in a material when it is heated?

Key words
boil
evaporate
liquid
melt

Water exists on Earth in all three of its states. It can be ice, water, and steam. Water is very important in all of its states. You have seen water being heated.

Look at the photograph. What do you see when water gets hotter and hotter?

What happens when water boils?

Your teacher will show you what happens when water is heated.

1 Predict what will happen to the water.
2 Observe the water very carefully. Write down what it looked like before it was heated.
3 Record your observations during the heating.
4 Write down what it looked like after it was heated.
5 Was your prediction correct?
6 Write up your observations into a summary of the investigation. Include the following words: heating, particles, liquid, gas.

Warning!
Do not get too close. Hot water is very dangerous.

When we heat water, the heat gives the water particles energy. The water particles spread out and can turn to gas inside the liquid. This makes bubbles. The is called boiling . The very hot water vapour is called steam .

75

Getting started

Students begin the lesson by reviewing their work on melting. They then observe boiling water. The lesson then moves on to explain the differences between evaporation at low temperatures to make water vapour and boiling at high temperatures to make steam.

Language support

It is important to keep using words such as 'boiling' and 'evaporation'. During the lesson, stop and ask students what the words mean. Regular and frequent practice is better than occasional heavy study sessions. Use this opportunity to once again distinguish between steam that is made when water boils and water vapour that is produced when water evaporates. It might help to stress that steam will scald them and water vapour will not.

Resources

Student Book: a kettle or pan of water; electric hotplate; water.

Key words

boil evaporate liquid melt

Other words in the lesson

boiling evaporation

Scientific enquiry key words

use equipment observe use secondary sources

Lesson at a glance

The key teaching points in this lesson are:

- water changes state when it is heated
- evaporation is the process where water changes state into water vapour.

In the next lesson, students will learn more about how materials change when they are heated.

Think back: What happens to the particles in a material when it is heated?

Ask students to discuss with a partner some examples of melting that they have seen. Suggest that they think about any cooking they have done or seen in the last few days. Ask some pairs to share their examples with the rest of the class.

Then review students' understanding of how particles in a solid change when it melts to become a liquid. Ask a volunteer to draw the particles on the board and check that the class understands the concept of the particle model.

Look at the photograph. What do you see when water gets hotter and hotter?

Ask students to discuss the question in pairs.

> ***Possible response:*** *Students may say that they see bubbles in the water as it gets hotter. The bubbles of gas eventually escape as water vapour from the surface of the water.*

Investigation: What happens when water boils?

Warning! Do not get too close. Hot water is very dangerous.

Read out the warning information to students and ask them to tell you why hot water can be harmful. Remind them that they have learned about the dangers of hot water before. Stress that boiling water and steam can scald (damage) skin and this is very painful.

The aim of this investigation is for students to observe that when water is heated to boiling point it gives off steam and bubbles from within the liquid itself and not just at the surface.

Organise students around the front bench to create the atmosphere of an arena. Set up a pan of water on an electric hotplate. Heat the water and ask students to observe what happens. Encourage them to report any slight changes they see.

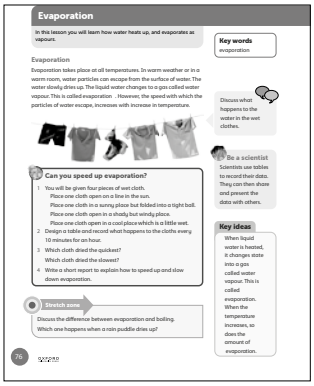
Ask students to write down their observations by answering parts 1–6 of the investigation. In a plenary session, ask students to read out what they have written to check understanding.

Read out the last paragraph on page 75 – this summarises the key points to learn from the demonstration.

Review and reflect

Ask students to write down what they have enjoyed learning about the most in this lesson. They might have enjoyed one of the activities or identifying evaporation in everyday life. Then ask them to write down the most challenging part of this lesson. Ask them to note why they found it difficult and what they did to solve this. Remind them that they know how to deal with a challenge and that this is a skill to be used in all parts of life.

Evaporation


Evaporation

In this lesson you will learn how water heats up, and evaporates as vapours.

Key words
evaporation

Evaporation

Evaporation takes place at all temperatures. In warm weather or in a warm room, water particles can escape from the surface of water. The water slowly dries up. The liquid water changes to a gas called water vapour. This is called evaporation . However, the speed with which the particles of water escape, increases with increase in temperature.

Discuss what happens to the water in the wet clothes.

Be a scientist
Scientists use tables to record their data. They can then share and present the data with others.

Can you speed up evaporation?
1 You will be given four pieces of wet cloth.
Place one cloth open on a line in the sun.
Place one cloth in a sunny place but folded into a tight ball.
Place one cloth open in a shady, but windy, place.
Place one cloth open in a cool place which is a little wet.
2 Design a table and record what happens to the cloths every 10 minutes for an hour.
3 Which cloth dried the quickest?
Which cloth dried the slowest?
4 Write a short report to explain how to speed up and slow down evaporation.

Key ideas
When liquid water is heated, it changes state into a gas called water vapour. This is called evaporation. When the temperature increases, so does the amount of evaporation.

Stretch zone
Discuss the difference between evaporation and boiling.
Which one happens when a rain puddle dries up?

76

Getting started

The lesson explains the differences between evaporation at low temperatures to make water vapour and boiling at high temperatures to make steam.

Language support

Ask students to keep using the word evaporation and water vapour. Ask them to differentiate between water vapours and steam.

Resources

Student Book: pieces of cloth; water.

Key words

evaporation

Other words in the lesson

boiling

Scientific enquiry key words

use equipment observe use secondary sources

Lesson at a glance

The key teaching point in this lesson is:

- evaporation is the process where water changes state into water vapour.

In the next lesson, students will learn more about how materials change when they are heated.

Evaporation

Ask students to read the passage about evaporation at the top of page 76 silently. Then ask the general question, 'Tell me what happens during evaporation.'

Ask each student to tell the answer to their partner. The partner can then correct the student if necessary. Take feedback and check students' understanding by asking them to tell their partner where the water goes when the clothes are drying on the washing line in the next discussion activity.

Discuss what happens to the water in the wet clothes.

> ***Possible response:*** *Students may suggest that water in the wet clothes changes state into water vapour and leaves the clothing. This change of state is called evaporation.*

It is important that students understand that the change of state is from a liquid to a gas.

Investigation: Can you speed up evaporation?

This activity is intended to test students' understanding of evaporation. Students are given four identical pieces of wet cloth that they will investigate. They follow the method so that they have different situations to explore.

Students should practise designing a table to record their observations clearly. They should observe each piece of cloth every 10 minutes for an hour.

They should find that the cloth on the line dried quickest using the energy from the Sun. The cloth in the cool and wet place should have dried slowly but the scrunched up one could also be equally slow.

Ask students to write a short report to share their findings with others. This can be in the form of a short scientific report or a computer presentation. Remind them to include how they carried out their tests (their method), how they made it a fair test and any observations and conclusions.

Be a scientist: Scientists use tables to record their data. They can then share and present the data with others. (Student Book, page 11)

Use the Be a scientist information to stress the importance of recording accurate results in a neat table so that the results can be shared and compared with other students (scientists) in the class.

Stretch zone: Discuss the difference between evaporation and boiling. Which one happens when a rain puddle dries up?

Encourage students to say that when a liquid boils the particles become energised and move apart and the liquid changes state to a gas. In evaporation, the particles of gas escape from the surface of the water. Evaporation is what happens when the water in a rain puddle dries up.

Key ideas

- *When liquid water is heated, it changes state into a gas called water vapour. This is called evaporation.*

- *When the temperature increases, so does the amount of evaporation.*

Summarise the lesson by asking students what they have learned. Let them share their ideas, and read out and discuss the key ideas. Ask them to name the changes of state when water is heated. They should be able to describe the process of evaporation and identify this in everyday situations.

Review and reflect

Ask students to write down what they have enjoyed learning about the most in this lesson. They might have enjoyed one of the activities or identifying evaporation in everyday life. Then ask them to write down the most challenging part of this lesson. Ask them to note why they found it difficult and what they did to solve this. Remind them that they know how to deal with a challenge and that this is a skill to be used in all parts of life.

Extra activities

1 Ask students to suggest examples of evaporation, such as drying clothes and hair and using electric hand dryers. Ask them how they think these processes work.

2 Students could produce a large wall display showing what happens to the particles when a liquid evaporates. The particles could be represented by paper plates painted in bright colours.

Differentiation

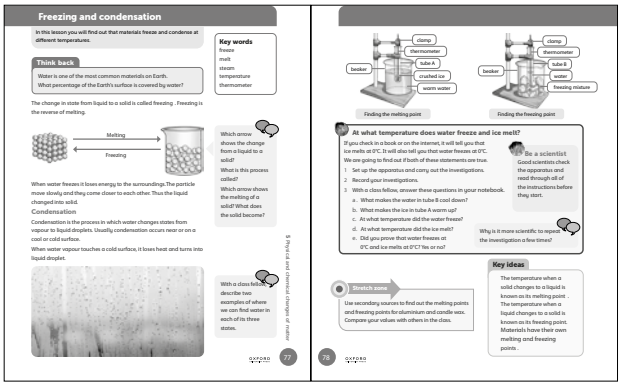
Supporting: Students can be supported to recognise the bubbles of a gas escaping from water as it is heated.

Consolidating: Students can be given a chance to practise drawing particle diagrams to show the processes of boiling and evaporation.

Extending: Students can identify situations in real life where evaporation happens and can be encouraged to talk about them in terms of particles.

Differentiated outcomes	
All students	should be able to describe what happens when water boils
Most students	will be able to identify the changes of state when liquids are heated
Some students	will be able to describe the process of evaporation

Freezing and condensation



Getting started

In this lesson students review melting. Students then learn about what happens to the particles in solids as they melt and in liquids as they freeze. They learn that freezing is the reverse of melting and carry out an experimental investigation to record freezing and melting temperatures of water.

Language support

The word 'reverse' is important in this lesson. Explain that it means 'in the opposite direction'. Demonstrate this by asking students to walk in one direction and then in the reverse direction.

Resources

Student Book: beakers; clamps; thermometers; test tubes; warm water; ice.

Key words

freeze melt steam temperature thermometer

Other words in the lesson

reverse

Scientific enquiry key words

use equipment observe compare record carry out tests group/classify communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- materials melt and freeze at different temperatures
- water can exist in three states and has its own melting and freezing temperature.

In the next lesson, students will learn about condensation as the reverse of evaporation.

Think back: Water is one of the most common materials on Earth. What percentage of the Earth's surface is covered by water?

Discuss the Think back question and remind students of their prior learning from the unit's introductory lesson. Students should recall that 70% of the Earth's surface is covered by water.

Read through the text at the top of page 77 of the Student Book. This reminds students that when a solid such as ice is heated it changes into a liquid. Ask, 'What is this process called?' They should recall that the process is called melting. Ask students what happens when water is placed into a freezer. Elicit that it freezes – it changes from liquid water to solid ice. Point out the diagram on page 77 and explain that it shows that when water is cooled, it freezes to solid ice and when ice is warmed it changes to liquid water. Stress that this makes freezing and melting opposite processes. Explain that the word 'reverse' means opposite – like a car going forwards and then going in reverse.

You could model this by asking students to stand up and model the particles in solids and liquids and to change from one to the other when you say 'melting' or 'freezing'.

Which arrow shows the change from a liquid to a solid? What is this process called? Which arrow shows the melting of a solid? What does the solid become?

Answer: *Arrow 2 shows the change from a liquid to a solid. The process is called freezing. Arrow 1 shows the melting of a solid. The solid becomes a liquid.*

Water

Ask students to think about what happens when water is heated or cooled. Ask them which states of water they have seen. Point out that water exists on Earth in three states. Write down ice, water and steam. Ask students to study the photograph at the bottom of page 77 and decide which states of water they can observe. Stress that water is very important in all of its states and ask them where they might travel to in order to see a lot of solid water – ice. Ask, 'What would you wear? Why?'

With a partner, describe two examples of where we can find water in each of its three states.

Possible response: *Students may suggest: in the kitchen when water is boiling in a pan and freezing in the freezer; in a cold country where there is snow/ice on the ground, a river flowing and sunshine drying up puddles.*

Investigation: At what temperature does water freeze and ice melt?

The aim of this investigation is for students to realise that melting and freezing are opposite processes. Read the opening information in the investigation about how water freezes and melts at 0°C. Discuss this statement and ask students if they think it is correct. Tell them that they will investigate this to test it. You could explain that scientists often carry out a test to check if something is true or not. Show them the diagrams of the apparatus they will need and allow them to set it up – if you do not have enough equipment, then you can a) ask them to carry out the freezing point test followed by the melting point test or b) have half of the groups carrying out the freezing point test and the other half carrying out the melting point test and then share the findings or c) carry out a teacher demonstration with some students helping.

Explain that to find a melting point they are warming ice and measuring the temperature when it turns to liquid water. For the freezing point they are cooling water until it turns to solid ice. Show students how to take an accurate temperature reading using the thermometers and encourage them to write down their measurements as soon as they are obtained.

Students should understand that the water in tube B is cooled by the ice cubes in the beaker and that the ice in tube A is warmed by the warm water in the beaker.

Elicit that the water will have frozen and melted at the same temperature of 0°C.

Be a scientist: Good scientists check the apparatus and read through all of the instructions before they start. (Student Book, pages 8–9)

Read through the Be a scientist information. Ask students to think about why it is important to read through instructions before they start any investigations. Elicit that they will need to plan what is needed and any timings – for example, they may have to wait a few minutes or hours or days with some investigations. Ask, 'What might happen if you did not check apparatus before and during an investigation?' Students should suggest that some apparatus might be missing or broken so the investigation would not work or it might be inaccurate.

Why is it more scientific to repeat the investigation a few times?

Answer: *Humans make mistakes, especially when they are measuring. Experimental methods can also go wrong. If an investigation is repeated and the results are about the same, we can be more confident that these are the correct results.*

Stretch zone: Use secondary sources to find out the melting points and freezing points for aluminium and candle wax. Compare your values with others in the class.

The Stretch zone activity is an opportunity for students to extend their learning of melting and freezing points

beyond that of water to other materials. They should realise that different materials have different melting and freezing points.

> ***Answer:*** *Students will need to use the internet; they should find out that aluminium is about 660°C and candle wax is usually between 46°C and 68°C.*

Key ideas

- *The temperature when a solid changes to a liquid is known as its melting point. The temperature when a liquid changes to a solid is known as its freezing point.*
- *Materials have their own melting and freezing points.*

Summarise the lesson by asking students what they have learned. Let them share their ideas, and read out and discuss the key ideas. Encourage them to share their ideas about how materials can melt or freeze but both temperatures are the same. Remind students that this means that the materials change from a solid to a liquid when they melt and from a liquid to a solid when they freeze.

Review and reflect

Encourage students to take time out to think about what they have learned. Ask them to share their understanding with a partner and discuss the key points. Ask them which parts of the lesson they are confident about. Then ask them to discuss anything they found challenging. Ask them to discuss these with their partner and ask for help if they need to.

Extra activities

1 Students can start their own ice-lolly and iced-drink factory. They can use plastic containers or cooking foil to make moulds and fill them with flavoured drinks. The drinks can then be placed in a kitchen (not laboratory) freezer or the freezer compartment of a refrigerator.

2 Ask students to research other examples of liquids being frozen. They will find out that most liquids will freeze if they are cooled. It might amaze them to realise that even carbon dioxide gas can be a solid. You might be able to obtain some to drop into warm water. You get a classic stage effect as the gas reforms and sweeps towards the ground carrying with it cooled water vapour.

Differentiation

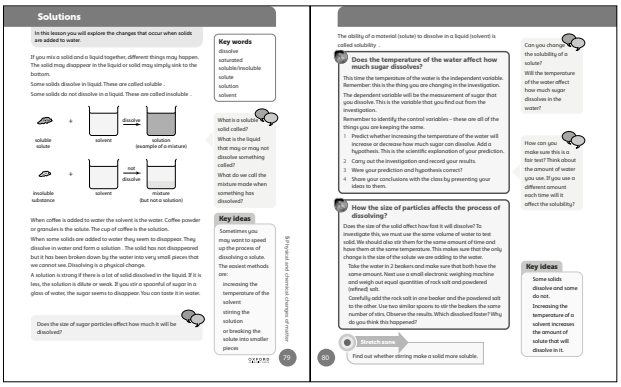
Supporting: Allow students opportunities to observe and to take the temperature of water freezing and melting.

Consolidating: Demonstrate the freezing and melting points of other materials, for example chocolate and candles.

Extending: Students could research the freezing and melting point of other materials.

Differentiated outcomes	
All students	should be able to recognise when a material is melting or freezing
Most students	will be able to measure the temperatures of materials when they melt and freeze
Some students	may be able to compare the freezing and melting temperature of water with other materials

Solutions



Getting started

The focus of this lesson is making solutions by adding solids to water. Students explore how some solids dissolve in water but others do not. They explore some of the key ideas associated with making solutions, including saturation, and how solubility can be affected by changing some factors, including the temperature of the solvent.

Language support

Ask students to read out the key words and discuss them with a partner. There are some unusual words in this lesson that students might not have experienced before. Some students might have heard the words 'dissolve' and 'saturated' before. Discuss their experiences – they might recall dissolving sugar or coffee and being saturated in the rain or when playing with water. Explain that we dissolve solids in water and if we add too much it becomes saturated in the same way as we might get soaked with water if there is a lot of rain.

Resources

Student Book: sugar; water; hot water; cups; teaspoons; thermometers; materials such as talcum powder, salt or sand.

Key words

dissolve saturated soluble/insoluble solute solution solvent

Other word in the lesson
temperature

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Recognise and control variables

Take measurements, using equipment accurately

Record data and results using diagrams and labels, tables, keys and graphs

Make predictions

Draw conclusions and give explanations

Lesson at a glance

The key teaching points for students in this lesson are:

- some solids dissolve in water to make a solution
- the temperature of the water can affect how much solute will dissolve.

Ask students to read the text at the top of page and study the diagrams. You could tell students that water is known as the universal solvent because most solutes dissolve in it. Ask students to give examples of solutes being dissolved in a solvent to produce a solution. For example, they might say that salt is a solute, water is a solvent and dissolving the salt produces a saltwater solution.

What is a soluble solid called? What is the liquid that may or may not dissolve something called? What do we call the mixture made when something has dissolved?

Students read and discuss the questions with a classmate. Encourage them to refer to the diagrams and the information on page 79. They should collaborate and problem solve.

Possible response: *Students should state that the soluble solid is called a solute, the liquid is called a solvent and the mixture of something that has dissolved is called a solution.*

Explain that students are going to work in small groups to investigate how much sugar dissolves in a fixed amount of water.

Investigation: Does the size of sugar particles affect how much it will be dissolved?

Students should read through the investigation method then, in their groups, predicthow the size of sugar they think will dissolve in of water. At this point they should prepare a table of results to be used to record their observations.

Possible response: *When a solute is crushed into tiny particles instead of big chunks, more surface area is exposed, which causes the solute to dissolve more quickly. Granulated sugar dissolves more quickly than sugar cubes because it exposes a larger surface area to the solvent.*

Can you change the solubility of a solute? Will the temperature of the water affect how much sugar dissolves in the water?

Ask groups to discuss the questions and encourage them to use their knowledge and understanding to answer them.

Possible response: *Students should suggest that the solubility of a solute can be changed. Temperature is a key factor that changes solubility. The warmer the water the more solute will dissolve. Students might arrive at this idea when thinking about dissolving sugar in drinks or when cooking.*

Investigation: Does the temperature of the water affect how much sugar dissolves?

At the start of the investigation, discuss the warning. Ask students why they should take care using hot water and point out the importance of reporting spills. Students should say that hot water can scald the skin and spills of water can be a slip hazard so they need to be cleaned up immediately.

Students continue to work in their groups for this investigation. Explain that they are going to plan an investigation to find out how the temperature affects the solubility of sugar. They should read all of the investigation information first. You could prepare bowls of water at three different temperatures – cold from a refrigerator, room temperature, and room temperature mixed with hot water so it is much warmer but safe to touch. You can encourage students to use a thermometer to record and monitor the temperatures, as they will change during the investigation. Ideal water temperatures would be between 5°C and 10°C, between 20°C and 30°C and between 40°C and 50°C. After reading the method students recognise that the temperature of the water is the independent variable. The dependent variable is the amount of sugar they record that dissolves in the water at different temperatures. They could control how many times they stir the solution as this might affect the solubility of the sugar. They should also wash the equipment thoroughly between each test to make sure that there isn't any sugar residue. Students will make their own predictions but they should link the increase in temperature with the increase in the amount of sugar that dissolves. They should record their observations in a suitable table and analyse the data to decide whether it supports or refutes their predictions. Encourage students to write and share their conclusions based on the results they have collected.

Possible response: *Students should suggest that the hotter the water, the more sugar will dissolve.*

How can you make sure this is a fair test? Think about the amount of water you use. If you use a different amount each time, will it affect the solubility?

Possible response: *Students should suggest that they should use the same amount of water each time. The more water used, the more solute will dissolve, so it is important to keep the same amount to make this a fair test. They should also stir the sugar the same number of times.*

Stretch zone: Find out whether stirring make a solid more soluble.

Allow students to work in groups of three or four to discuss their ideas. Hand out a range of solids for them to test and then classify into the ones that dissolve faster..

Possible response: *Students should suggest that stirring speeds up the process of dissolving.*

Key ideas

- *Some solids dissolve and some do not.*
- *Increasing the temperature of a solvent increases the amount of solute that will dissolve in it.*

Read out the Key ideas. Ask students to write word cards for: 'soluble', 'insoluble', 'solvent', 'solute', 'solution' and to hold up the correct one when you read out the sentences 'blank' for the missing words. Students have to hold up the correct word card in each case.

Some solids dissolve in liquid. These are called [soluble]. Some solids do not dissolve in a liquid. These are called [insoluble].

When coffee is added to water the [solvent] is the water. Coffee powder or granules is the [solute]. The cup of coffee is the [solution].

How the size of particles affects the process of dissolving?

Gather the students in groups and conduct this experiment. As the students to observe the changes carefully. Teacher should aware the students that they keep the amount of water same for both the powdered salt and the rock salt.

Possible response: *Students will note that the powdered salt dissolved quickly in the water.*

Review and reflect

Ask students to reflect quietly on their learning of this lesson. Ask them to think about the key words as there are quite a few and most are likely to be new to them. Ask them to think about how they would use each of them in a sentence. Ask students whether they are confident using the scientific words and whether they understand the concept of making solutions. Students should write a note to themselves to remind them how

they overcame some of the challenges in this lesson so that they can refer to them when they are challenged in future lessons.

Extra activities

1 Ask students to demonstrate to people at home how to make a solution. They should ask the people to predict which solids will dissolve and which will not. Students test the predictions and show their audience the results. The idea is that it is more difficult to show people a concept and this means that the 'teacher' has to be more knowledgeable. Students could video their demonstrations and share them with the class.

2 Ask students to construct a list of soluble and insoluble substances. They write what would happen if each were the opposite. For example, sand is insoluble. If it was soluble, we would not have beaches.

3 **Maths link:** Students could extend the temperature investigation by recording the amount of sugar that will dissolve at a range of temperatures. They could plot their results on a graph to see if there is a relationship between the two.

Differentiation

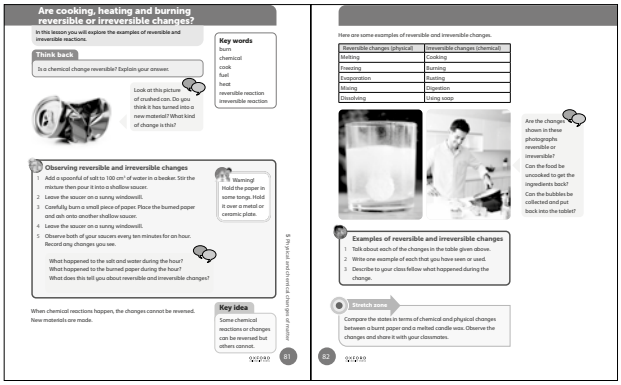
Supporting: Encourage students to repeat the investigation dissolving sugar to make sure they are confident with making solutions and with their results.

Consolidating: Write 'solute', 'solvent', 'solution', 'mixture' and 'insoluble substance' on cards or sticky notes.

Extending: Ask students to test solids other than sugar to find out how much will dissolve and compare this to sugar.

Differentiated outcomes	
All students	should be able to make a sugar solution
Most students	will be able to understand that the higher the temperature, the quicker the solute will dissolve
Some students	may be able to make solutions using different solutes and predict the best temperature to use

Are cooking, heating and burning reversible or irreversible changes?



Getting started

This lesson introduces students to the idea that cooking, heating and burning are irreversible changes. Students become aware of the idea that it is not possible to get back the reactants from these changes. They consider examples of reversible and irreversible changes. They begin to think about evidence such as a change in colour or bubbles of gas as an indicator that a change is irreversible.

Language support

Read through the key words with the class. Ask students to define some of the words based on their experience such as 'burn', 'cook', 'heat', 'reversible' and 'irreversible'. Discuss what a chemical is and ask for examples. Discuss what fuel is and, again, ask for any examples. Explain that a fuel is anything that burns and provides energy. This might include gasoline for vehicles or candles for light. The word chemical is another name given to a substance, especially one that has been made in a laboratory or factory. They can have common and scientific names. Examples include salt (sodium chloride), vinegar (ethanoic acid) and baking soda (sodium hydrogen carbonate).

Resources

Student Book: various types of fuel to burn (e.g. twigs, paper, cardboard); access to the internet.

Key words

burn chemical cook fuel heat reaction reversible/irreversible

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make observations

Record data and results using diagrams and labels, tables, keys and graphs

Make predictions

Draw conclusions and give explanations

Lesson at a glance

The key teaching points for students in this lesson are:

- some reactions are irreversible
- cooking, heating and burning are examples of irreversible reactions.

Think back: Is a chemical change reversible? Explain your answer.

Possible response: *Students should recall that when a chemical reaction takes place, a new product is made, and so a chemical reaction is not reversible.*

Look at this picture of crushed can. Do you think it has turned into a new material? What kind of change is this?

Ask the students to recall the differences between reversible and irreversible reactions. Once they give the differences, ask them to look at the picture of the can and ask if the crushed can is something new formed. This will help them understand the type of change the can has gone through.

Possible response: *Students may respond that since there is no new material formed, therefore the can went through a physical change.*

Investigation: Observing reversible and irreversible changes

Warning! Hold the paper in some tongs. Hold it over a metal or ceramic plate. What could happen if you did not do this?

Start by reading out the warning. Allow students to discuss what could happen if they did not use tongs to hold paper that is burning. This will help to support their risk-analysis skills.

Students should work in small groups to collaborate and communicate using scientific vocabulary and skills, and to record their observations. They mix salt into water and leave the solution in a saucer on a sunny windowsill. To make this a fair test they should count how many times or for how long they stir the mixture – this will enable groups to compare their results. The solution should be saturated so that it cannot dissolve any more salt, and make sure that students pour a thin layer into the saucer or it will take a long time for the water to evaporate completely. Next, students should place a piece of burned paper and ash in a similar saucer on the same windowsill. They should observe both saucers every 10 minutes for an hour and record any changes they see. After about 10 minutes they should begin to observesolid salt crystals forming in one saucer, while nothing will change in the saucer with the paper and ash. Encourage students to discuss their observations with the class. Use the discussion questions to lead this.

What happened to the salt and water during the hour? What happened to the burned paper during the hour? What does this tell you about reversible and irreversible changes?

Students continue to work in their groups to discuss the questions, which support them in reviewing their investigation.

Possible response: *Students should suggest they observed the water decreasing in amount and the solid salt becoming more visible over the hour. Eventually they will see the salt as a solid with the water evaporated away. The paper will have burned and changed to ash almost immediately. When left on the plate it would remain as burned ashes. Students should say that dissolving the salt in water is a reversible change because the end product returned to being solid salt again. The ash did not return to being paper. This is an example of an irreversible. change.*

Key idea

Some chemical reactions or changes can be reversed but others cannot.

Read out the Key idea and ask students, in pairs, to share ideas and summarise what they have learned. This will remind them of the terms 'reversible' and 'irreversible' and the reactions they have investigated and observed. Ask each pair to suggest one reversible change and one irreversible change.

Are the changes shown in these photographs reversible or irreversible? Can the food be uncooked to get the ingredients back? Can the bubbles be collected and put back into the tablet?

To give students clues about the answers you could: point to the fizzing water in the photograph on the left and ask students what causes the fizzing (bubbles); for the question about cooking, ask them to think about the example of the cake and the egg from the earlier lesson.

Possible response: *Students should suggest that the photographs show irreversible changes. The food cannot be uncooked to get the ingredients back. It would not be possible to collect the bubbles and get them back into the tablet.*

Investigation: Examples of reversible and irreversible changes

Students work with a partner to discuss the examples of changes displayed in the table on page 82. They think about each type of change and then add an example of each that they have experienced or they know about. There are many examples that they can suggest – just ensure that they are sensible examples. They could copy the table in their notebooks and add a column to record their examples. The completed table would make a good tool for 'Review and reflect' or for revision.

> ***Possible response:*** *Students should suggest examples such as: ice cream melting and turning to liquid; ice cream freezing and becoming a solid; evaporation of water when making salt crystals; mixing a salad where the chopped vegetables can be separated; dissolving sugar into a drink; cooking a cake; burning charcoal; rusting of a bike frame; digesting food; washing hands using soap.*

Stretch zone: Compare the states in terms of chemical and physical changes between a burnt paper and a melted candle wax. Observe the changes and share it with your classmates.

For the Stretch zone task, demonstrate this experiment in the class making sure to take precautionary measures. Show them the paper and the candle burning, and ask if they can have both of the objects back again. On their response, ask them to recall the differences between reversible and irreversible reactions. Note down which experiment falls into the respective categories.

Review and reflect

Ask students to sit opposite a partner. Ask them to think about what they have learned and then take it in turns to tell their partner about two examples. They should start by saying 'One thing I have learned this lesson is …' and, for the second example, 'Another thing I have learned is … '. They could write these anonymously in large speech bubbles, that you could collect and display around the room so the class can share examples of learning successes. Students could also review their completed tables from the investigation on page 76 of the Student Book as a review activity.

Extra activities

1 Ask students to find out about other fuels that we use and what we use them for.

2 Ask students to identify fuels that are burned at home and make a poster to show these.

3 **Computing link:** Allow students to use the internet to research what problems are caused when fuel burns and makes carbon dioxide.

Differentiation

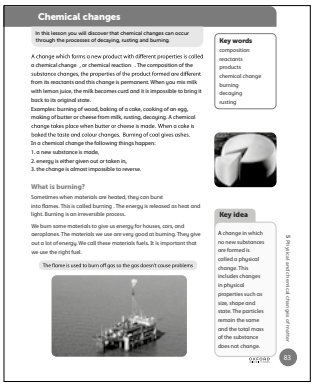
Supporting: Provide magazines with relevant content and ask students to cut out pictures that show an example of each of the changes in the table on page 76 of the Student Book.

Consolidating: Ask students to observe paper burning and to compare other fuels to this. They could practise writing a hypothesis for one of the fuels they will test.

Extending: Based on their findings from the investigation, ask students to find examples of other fuels and predict whether they will burn with a flame.

Differentiated outcomes	
All students	should be able to name examples of some irreversible and reversible changes
Most students	will be able to give a number of examples of reversible and irreversible changes
Some students	may be able to predict whether a material change is reversible

Chemical changes


Chemical changes

In this lesson you will discover that chemical changes can occur through the processes of decaying, rusting and burning.

A change which forms a new product with different properties is called a chemical change , or chemical reaction . The composition of the substance changes, the properties of the product formed are different from its reactants and this change is permanent. When you mix milk with lemon juice, the milk becomes curd and it is impossible to bring it back to its original state.

Examples: burning of wood, baking of a cake, cooking of an egg, making of butter or cheese from milk, rusting, decaying. A chemical change takes place when butter or cheese is made. When a cake is baked the taste and colour changes. Burning of coal gives ashes.

In a chemical change the following things happen:

1. a new substance is made,
2. energy is either given out or taken in,
3. the change is almost impossible to reverse.

What is burning?

Sometimes when materials are heated, they can burst into flames. This is called burning . The energy is released as heat and light. Burning is an irreversible process.

We burn some materials to give us energy for houses, cars, and aeroplanes. The materials we use are very good at burning. They give out a lot of energy. We call these materials fuels. It is important that we use the right fuel.

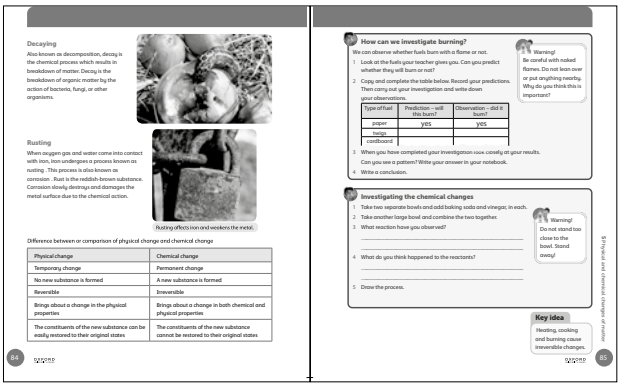
The flame is used to burn off gas so the gas doesn't cause problems.

Key words
composition
reactants
products
chemical change
burning
decaying
rusting

Key idea
A change in which no new substances are formed is called a physical change. This includes changes in physical properties such as size, shape and state. The particles remain the same and the total mass of the substance does not change.

Science and Investigation Skills

83


Decaying

Also known as decomposition, decay is the chemical process which results in breakdown of matter. Decay is the breakdown of organic matter by the action of bacteria, fungi, or other organisms.

Rusting

When oxygen gas and water come into contact with iron, iron undergoes a process known as rusting . This process is also known as corrosion . Rust is the reddish-brown substance. Corrosion slowly destroys and damages the metal surface due to the chemical action.

Rusting affects iron and weakens the metal.

Difference between or comparison of physical change and chemical change

Physical change	Chemical change
Temporary change	Permanent change
No new substance is formed	A new substance is formed
Reversible	Irreversible
Brings about a change in the physical properties	Brings about a change in both chemical and physical properties
The constituents of the new substance can be easily restored to their original states	The constituents of the new substance cannot be restored to their original states

84

How can we investigate burning?

We can observe whether fuels burn with a flame or not.

1. Look at the fuels your teacher gives you. Can you predict whether they will burn or not?
2. Copy and complete the table below. Record your predictions. Then carry out your investigation and write down your observations.

Type of fuel	Prediction – will this burn?	Observation – did it burn?
paper	yes	yes
twigs		
cardboard		

3. When you have completed your investigation look carefully at your results. Can you see a pattern? Write your answer in your notebook.
4. Write a conclusion.

Warning!
Be careful with naked flames. Do not lean over or put anything nearby. Why do you think this is important?

Investigating the chemical changes

1. Take two separate bowls and add baking soda and vinegar, in each.
2. Take another large bowl and combine the two together.
3. What reaction have you observed?
4. What do you think happened to the reactants?
5. Draw the process.

Warning!
Do not stand too close to the bowl. Stand away!

Key idea
Heating, cooking and burning cause irreversible changes.

Physical and Chemical Changes of Matter

85

Getting started

This lesson introduces students to the idea that cooking, heating and burning are irreversible changes. Students become aware of the idea that it is not possible to get back the reactants from these changes. They consider examples of reversible and irreversible changes. They begin to think about evidence such as a change in colour or bubbles of gas as an indicator that a change is irreversible. They will get to know that the irreversible reactions are also called chemical changes. Chemical change results in the formation of a new product.

Language support

Read through the key words with the class. Ask students to define some of the words based on their experience such as 'burn', 'cook', 'heat', 'reversible' and 'irreversible'. . Discuss the term chemical change. Ask them to give examples of chemical changes. Describe them burning and decomposition.

Resources

Student Book: various types of fuel to burn (e.g. twigs, paper, cardboard); access to the internet.

Key words

composition reactants products
chemical change burning decaying rusting

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make observations

Record data and results using diagrams and labels, tables, keys and graphs

Make predictions

Draw conclusions and give explanations

Lesson at a glance

The key teaching points for students in this lesson is:

- cooking, heating and burning are examples of irreversible reactions.

Read out the text on page 83 and 84 of the Student Book or ask students to read out a sentence each. This explains burning as the irreversible process when materials are heated and burst into flames, releasing heat and light. It explains that materials we burn to give us energy are called fuels. Ask students if they know what the photograph shows (an oil platform; the excess gas is being burned off).

Ask students how decaying and rusting are the examples of irreversible reactions. Ask students if they have seen foods rotting and if they think they can get back the food from rotten state its original fresh state.

Investigation: How can we investigate burning?

Warning! Be careful with naked flames. Do not lean over or put anything nearby. Why do you think this is important?

Read out the warning and ask students how they could keep themselves and others safe near naked flames. Students should copy the table of results at the start of the investigation to allow them to organise their observations. The fuels should be studied and discussed in small groups. Based on their experience, students predict whether the fuels will burn. They then burn each fuel and record their observations. They should find that not all the fuels burn with a flame but the majority do. They link their predictions back to the results and write a concluding sentence about the investigation.

Possible response: *Students should suggest that most of the fuels they investigate will burn.*

Investigation: Investigating the chemical changes

Warning! Do not stand too close to the bowl. Stand away!

Ask the students to observe the experiment carefully and note the changes happening. Let students observe first and then ask them to answer the questions.

Possible response: *Students should suggest using lime water as an indicator of the presence of carbon dioxide.*

Key idea

Heating, cooking and burning cause irreversible changes.

Summarise the lesson by reading out the Key idea then asking students what they have learned. Ask them to share ideas. This will remind students that some changes are irreversible but others are reversible. Ask volunteers to give a definition of the terms 'reversible' and 'irreversible'. Ask students to name some examples of reversible and irreversible changes.

Review and reflect

Ask students to sit opposite a partner. Ask them to think about what they have learned and then take it in turns to tell their partner about two examples. They should start by saying 'One thing I have learned this lesson is …' and, for the second example, 'Another thing I have learned is … '. They could write these anonymously in large speech bubbles, that you could collect and display around the room so the class can share examples of learning successes. Students could also review their completed tables from the investigation on page 76 of the Student Book as a review activity.

Extra activities

1 Ask students to find out about other fuels that we use and what we use them for.

2 Ask students to identify fuels that are burned at home and make a poster to show these.

3 **Computing link:** Allow students to use the internet to research what problems are caused when fuel burns and makes carbon dioxide.

Differentiation

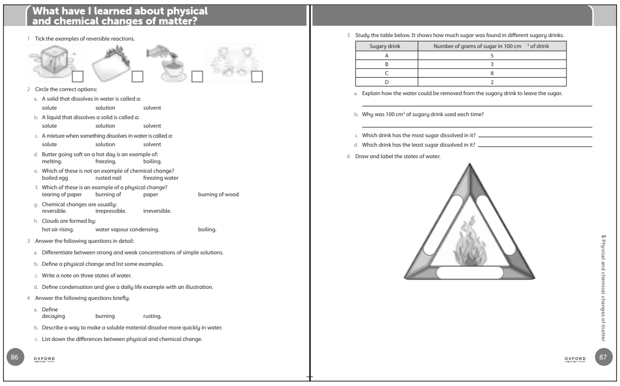
Supporting: Provide magazines with relevant content and ask students to cut out pictures that show an example of each of the changes in the table on page 82 of the Student Book.

Consolidating: Ask students to observe paper burning and to compare other fuels to this. They could practise writing a hypothesis for one of the fuels they will test.

Extending: Based on their findings from the investigation, ask students to find examples of other fuels and predict whether they will burn with a flame.

Differentiated outcomes	
All students	should be able to name examples of some irreversible and reversible changes
Most students	will be able to give a number of examples of reversible and irreversible changes
Some students	may be able to predict whether a material change is reversible

What have I learned about physical and chemical changes of matter?



started

The aim of this section is to encourage students to review their learning after each topic in the unit. On pages 86-87 of the Student Book there are some consolidation questions for students to answer. These will assess students' knowledge and understanding of the topic.

You may have been asking students to tackle questions and review statements after some lessons – links to appropriate ones have been pointed out in the lesson sections of this Teacher's Guide. If this is the case it is worth considering asking students to revisit them as a single activity so they can think back over the whole unit. If you have been saving up the questions and statements for an end-of-unit review session, you can ask students to complete them in this lesson. This can be done as an individual challenge, a pair activity or a whole-class question and answer session. After students have completed the questions read out the expected answers and let them check their progress.

'What have I learned about physical and chemical changes of matter?' answers

1 Tick the examples of reversible reactions.

Students can tick as many boxes as they think are correct.

Answer: *Students should tick the ice cube melting and dissolving sugar in a drink.*

2 Circle the correct options:

a. A solid that dissolves in water is called a:
solute solution solvent.

b. A liquid that dissolves a solid is called a:
solute solution solvent.

c. A mixture when something dissolves in water is called a:
solute solution solvent.

d. Butter going soft on a hot day is an example of:
melting. freezing. boiling.

e. Which of these is not an example of chemical change?
boiled egg rusted nail freezing water.

f. Which of these is an example of a physical change?
tearing of paper burning of paper burning of wood.

g. Chemical changes are usually:
reversible. irrepressible. irreversible.

h. Clouds are formed by:
hot air rising. water vapour condensing boiling.

Answer: *a= solute b= solvent c= solution*
d= melting e= freezing water f= tearing of paper
g= irreversible h= hot air rising

3 Answer the following questions in detail:

a. Differentiate between strong and weak concentrations of simple solutions.

b. Define a physical change and list some examples.

c. Write a note on three states of water.

d. Define condensation and give a daily life example with an illustration.

Answer: *a. If there is a large amount of solid dissolved in the liquid, the solution is strong. If it is lower, the fluid is weak or diluted. Weak concentrations are more dilute, and the strong concentrations are less dilute.*

b. When matter changes its observable properties, we can say it has undergone a physical change. For example, melting ice.

c. Matter exists in three states that are:
- *Solid*
- *Liquid*
- *Gas*

d.The process by which water transforms from vapor to liquid droplets is called condensation. Condensation typically happens on or next to a cold, chilly surface.
For example: dew in the morning on the grass.

4 Answer the following questions briefly.

a. Define decaying burning rusting.

b. Describe a way to make a soluble material dissolve more quickly in water.

c. List down the differences between physical and chemical change.

Answer: *a.* ***Decaying***
The breakdown of organic materials caused by bacteria, fungi, or other organisms is known as decay.

Burning
Sometimes when materials are heated, they can burst into flames. This is called burning.

Rusting
Rusting is the process that occurs to iron when it comes into contact with oxygen gas and water.

b. A solute dissolve more quickly when it is stirred into a solvent because it helps disperse the solute particles throughout the solvent.

c. Answer on page # 84 of OIPS book 5

5 Study the table below. It shows how much sugar was found in different sugary drinks.

Sugary drink	Number of grams of sugar in 100 cm3 of drink
A	5
B	3
C	8
D	2

a. Explain how the water could be removed from the sugary drink to leave the sugar.

_____

b. Why was 100 cm3 of sugary drink used each time?

_____

c. Which drink has the most sugar dissolved in it?

_____

d. Which drink has the least sugar dissolved in it?

_____

Students write one process on each line given.

Answer: *a. Explain how the water could be removed from the sugary drink to leave the sugar.*
(evaporation)

b. Why was 100 cm3 of sugary drink used each time?
(to keep the results fair)

c. Which drink has the most sugar dissolved in it?
(drink c)

d. Which drink has the least sugar dissolved in it?
(drink d)

6 Draw and label the states of water.

Answer: *Students should suggest oxygen on the left, ignition on the right, fuel along the bottom*

Summative assessment

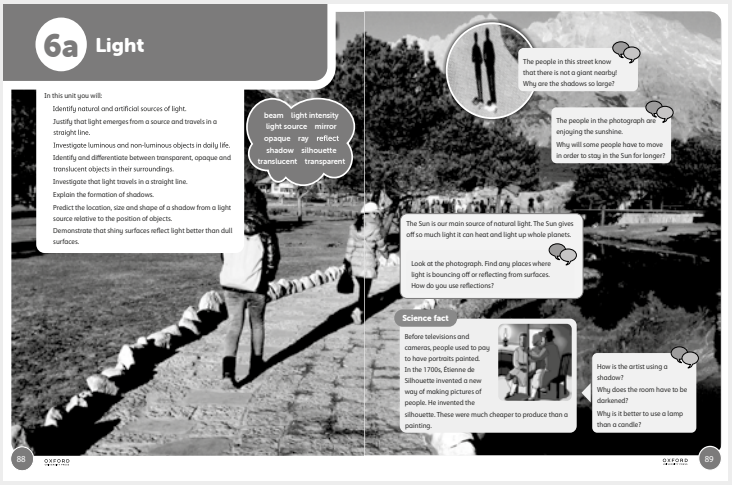
The questions in the 'What have I learned about materials?' section on pages 86-87 of the Student Book can be used to consider the progress of each student individually. You can also use the information to create summative reports – such as end-of-term reports – for each student. As with all of the units this year, you can allocate scores based on the number of questions answered correctly or by splitting the questions into smaller sections. You could allocate marks as follows: question 1 = 2; question 2 = 7; question 3 = 8; question 4 = 3; question 5 = 4; question 6 = 3. This makes a total of 27 marks.

This feedback can then be used to form support strategies to help students improve. Keep the recording and analysis of the student self-evaluations simple. A general impression of the class's self-evaluation is all that is required, for example: 50% of the class were not confident about … .

6a Light

In this unit students will:

- Identify natural and artificial sources of light.
- Justify that light emerges from a source and travels in a straight line.
- Investigate luminous and non-luminous objects in daily life.
- Identify and differentiate between transparent, opaque and translucent objects in their surroundings.
- Investigate that light travels in a straight line.
- Explain the formation of shadows.
- Predict the location, size and shape of a shadow from a light source relative to the position of objects.
- Demonstrate that shiny surfaces reflect light better than dull surfaces.



Getting started

This unit allows students to review that we see things because light enters our eyes from a light source. Students become aware of the properties of light such as reflection and refraction and how a beam or ray of light travels in a straight line. They will explore how light can be reflected from surfaces including mirrors. Students investigate and measure light. They also investigate how light travels through some materials better than others but is blocked by opaque materials. Students investigate how shadows are cast and how they can change the shape and size of a shadow. The content of this unit can be observed and experienced in everyday life.

Science in context

Use the lessons in this unit to demonstrate how we use different light sources. The properties of light allow scientists and engineers to select the most appropriate material to use for a specific purpose. For example, students can observe local buildings to see how light can travel through some materials to get light into dark spaces, and apply this to building designs. Provide opportunities for students to observe how light travels and how the intensity of sources can be measured. Students need to understand that light can be reflected from surfaces, but these are not sources of light, so show them examples of mirrors being used in buildings and on vehicles. Provide opportunities for students to observe how shadows are formed naturally with light from the Sun. They can observe shadows being cast and know how the size and shape of them change by changing an object's position in front of the source of light. Take students out to see examples of sundials to show how ways of telling the time have changed over time and you can also let them survey examples of people creating shade – such as with umbrellas and awnings. You can also encourage students to consider ways that science helps people who are not able to see.

Scientific enquiry skills

Throughout this unit, students will try to answer questions by collecting evidence through observation, contributing to discussions, and making predictions about the properties of light. They will follow scientific enquiry methods and will collect and make observations to test their predictions. They will make comparisons and decide whether their predictions are supported or refuted by their results. Students will collaborate with others to problem solve and communicate their ideas through tables of results and presentations.

You can use the Investigation master sheet on pages 4–5 of this Teacher's Guide to support investigative work. This provides prompts and structure to support students in planning and carrying out fair tests and recording and drawing conclusions about their findings.

Resources

Student Book: pencils; rulers or tape measures; paper cups; paperclips; pieces of cardboard; writing materials; materials to make posters; torches; small mirrors; large mirrors; small cardboard boxes; pieces of thin card; scissors; sticky tape; foil; dark card; materials to make

leaflets; rulers; large sheets of paper; ray boxes made previously; protractors or other angle measurers; circular pieces of card; pieces of dowelling or pencils; samples of materials that are opaque, transparent and translucent; selection of small objects; cardboard or other material to use as a screen; materials to make shadow puppets; sheets or blinds (optional); coloured filters; large screens or a blank wall; small opaque objects such as building blocks; access to outdoors at various sunny times; drawing materials; 1-metre sticks; compasses; chalk; bright light sources; solar-powered calculators; tissue paper; access to the internet or books with information on the brightness of stars.

Key words for unit

Bold words are in the Word cloud

angle of incidence angle of reflection **beam** blind spot colour direction eyes horizon incident ray **light intensity** **light source** lumen lux midday **mirror** normal **opaque** optical illusion periscope **ray** ray diagram **reflect** reflected ray refraction sense **shadow** shadow stick sight **silhouette** sundial **translucent** **transparent**

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Language support

Introduce the key words to students at the start of the unit. Read all of the words out loud to allow students to hear their pronunciation.

Students could create a miniature Word wall in the back of their books. They can add pictures and simple definitions that are meaningful to them as they become more confident with each of the words. Discuss each word and explain that students will learn and use them throughout the learning of the unit. Encourage students to say the words out loud to support them with pronunciation. Do not correct their pronunciation but model the correct ones by repeating back what they say. For example, 'So you are saying that reflection means . . .'.

At the start of the learning in this unit, try to add resources to a classroom library including books, magazines and leaflets that include content about light, and in particular shadows, reflection and refraction.

Unit at a glance

The key teaching points for students in this unit are:

- to introduce the unit objectives
- to introduce the learning outcomes
- to engage students with the content of the unit
- to review and build on prior learning and understanding of the topics.

The purpose of this introductory lesson is for students to start thinking about different sources of light and how shadows are cast. The introductory pages show a range of different ways that light is used and the images are used as a starting point. Ask students to look closely at the photographs on the pages and to read the text about how the Sun is our main source of natural light and heat. Then ask them to engage with the discussion questions.

Look at the photograph. Find any places where light is bouncing off or reflecting from surfaces. How do you use reflections?

Ask students to discuss this with a partner then encourage them to share their ideas with the class. Explain that light bounces off some shiny surfaces, like the water, into our eyes.

Possible response: *Students should suggest that light is being reflected from the water, the white stones alongside the path, the snow on the mountain, the light parts of the person's dark jacket and the windows in the distant building. Some will realise that in order to see an object light must bounce or reflect from it so every object could be listed. They may suggest they use reflections when they use a mirror and also to see any objects.*

Science fact: Before televisions and cameras, people used to pay to have portraits painted. In the 1700s, Étienne de Silhouette invented a new way of making pictures of people. He invented the silhouette. These were much cheaper to produce than a painting.

Read out the Science fact or ask a volunteer to read it out. Ask students to imagine making a portrait of someone using this technique. Ask them how they would take a picture today. They will probably suggest using a camera or a smartphone. Point out that these devices need light to enter them in order to take a photograph but they work in a different way to the silhouette.

How is the artist using a shadow? Why does the room have to be darkened? Why is it better to use a lamp than a candle?

Students can work with their partner again. Point out the drawing of the person creating a silhouette and ask them to work through the questions in turn. Ask volunteers to tell you what they discussed about each question and ask the rest of the class to evaluate and come to a conclusion about each question.

Possible response: *Students should suggest that the artist is using light to cast a shadow of the person onto the canvas or paper. The room has to be darkened so that the source of light casts a good shadow when it is blocked by the person being drawn. A lamp would make more light and is less likely to flicker so the shadow would be darker and clearer to draw around.*

Point out the photograph in the circle at the top of page 89. Ask students to look at the photograph of the people and their shadows on the ground, and to discuss the question with their partner.

The people in this street know that there is not a giant nearby! Why are the shadows so large?

Encourage students to think about why the shadows look much larger than the people who are casting them.

Possible response: *Students should suggest that the light from the Sun is being blocked by the people. This is casting a large shadow on the ground. Elicit that the shadows are longer than the people because the light source (probably the Sun in this case) is low in the sky.*

The people in the photograph are enjoying the sunshine. Why will some people have to move in order to stay in the Sun for longer?

You could approach this discussion with the whole class and ask for volunteers to tell you what they think. Remind them that they have learned about how the Earth moves around the Sun in the solar system.

Possible response: *Students should suggest that as the Earth moves on its axis the amount of light from the Sun changes. The shadows cast by the trees will move position so some people who are currently in sunlight will be in shadow.*

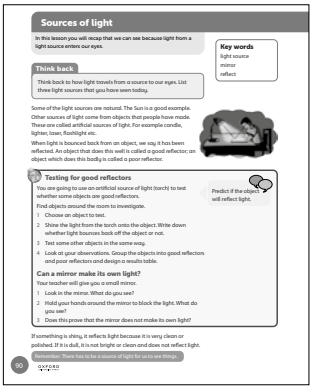
Extra activities

1 Students can keep a diary of every time they use a source of light over a full day.

2 **Maths link:** Students can count how many shadows they see in one hour when they are outside.

3 Ask students to draw a silhouette of a partner. Allow them to set up a light source so they can cast a shadow. Display the silhouettes and see if people can guess who they represent.

Sources of light


Sources of light

In this lesson you will recap that we can see because light from a light source enters our eyes.

Key words
light source
mirror
reflect

Think back

Think back to how light travels from a source to our eyes. List three light sources that you have seen today.

Some of the light sources are natural. The Sun is a good example. Other sources of light come from objects that people have made. These are called artificial sources of light. For example candle, lighter, lcwer, flashlight etc.
When light is bounced back from an object, we say it has been reflected. An object that does this well is called a good reflector; an object which does this badly is called a poor reflector.

Testing for good reflectors

You are going to use an artificial source of light (torch) to test whether some objects are good reflectors.
Find objects around the room to investigate.
1 Choose an object to test.
2 Shine the light from the torch onto the object. Write down whether light bounces back off the object or not.
3 Test some other objects in the same way.
4 Look at your observations. Group the objects into good reflectors and poor reflectors and design a results table.

Predict if the object will reflect light.

Can a mirror make its own light?

Your teacher will give you a small mirror.
1 Look in the mirror. What do you see?
2 Hold your hands around the mirror to block the light. What do you see?
3 Does this prove that the mirror does not make its own light?

If something is shiny, it reflects light because it is very clean or polished. If it is dull, it is not bright or clean and does not reflect light.

Remember: There has to be a source of light for us to see things.

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Getting started

This lesson reminds students what a source of light is. They have covered this already in previous years. Students will observe natural sources of light – using the Sun as a good example – and human-made sources, for example a lamp. Students become aware that when light is reflected from an object, we see it. Students explore and observe sources of light and how some materials can reflect them better than others. They are reminded that mirrors are not a source of light but are just good at reflecting it. They compare this to the Moon, which reflects the light from the Sun.

Language support

Read through the key words with the class. Ask students to define some of the words based on their previous learning. Discuss examples of light sources that they are familiar with, for example the Sun, a candle or lamps. Discuss how some materials are not a source of light but reflect it. Ask them to give any examples that they might know. Explain that a mirror is a good reflector of light and that is how we can use them to see ourselves.

Resources

Student Book: torches; small mirrors.

Key words

light source mirror reflect

Other words in the lesson

artificial Moon natural reflector

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Recognise and control variables

Make observations

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- some sources of light are natural and others are artificial
- a mirror is not a source of light, it just reflects it.

In the next lesson, students will learn about how beams or rays of light can be reflected by surfaces.

Think back: Think back to how light travels from a source to our eyes. List three light sources that you have seen today.

Ask students to discuss how light travels from a source to our eyes. They can refer back to the previous lesson if they need to. Ask them to look around the room to remind them of all of the sources of light that they might have seen.

Possible response: *Students should suggest lamps, bulbs, the Sun, candles, streetlights, car headlights or the light from a smartphone.*

Ask students to read the text. After they have read the text, ask them to list two examples of natural light sources and two examples of artificial light sources. Explain that when light is bounced back from an object, we say it has been reflected. Ask them to study the picture and tell a partner how reflected light helps them to read a book.

Investigation: Testing for good reflectors

Students work with a partner for this investigation. They will use an artificial source of light – a torch – to test whether some objects are good reflectors. They are asked to find objects around the room to investigate and follow the instructions given.

Predict if the object will reflect light.

Remind students that it is important that they record their predictions because this is what they are testing in the investigation.

Possible response: *Students should use their ideas to make predictions. They should suggest that good*

reflectors have a shiny and smooth surface like a mirror. The ones that are poor reflectors are rough and dull, for example a rug or a brick wall.

Investigation: Can a mirror make its own light?

Give a group of students a small mirror. They will look in the mirror and explain what they see. Then they will hold their hands around the mirror to block the light and then explain what they see. Ask them to use their observations to explain how this proves the mirror does not make its own light.

Be a scientist: Remember that scientists do not just guess when they make a prediction. They use their scientific knowledge to work out what they think is most likely to happen. (Student Book, page 8)

Remind students how to make a prediction. Use examples such as: I predict I am having an apple at lunch time. This is not a guess. Perhaps they have an apple everyday so the prediction they made is based on their experience. Remind them to make their predictions at the start of the investigation, and to record their observations and compare them with others in the class.

Predict if the object will reflect light.

Remind students that it is important that they record their predictions because this is what they are testing in the investigation.

Possible response: *Students should use their ideas to make predictions. They should suggest that good reflectors have a shiny and smooth surface like a mirror. The ones that are poor reflectors are rough and dull, for example a rug or a brick wall.*

Extra activities

1 Students investigate different coloured mirrors to find out if they reflect the light in the same way. They can colour plastic mirror strips with felt pens or use tissue paper as a filter.

2 Students record how many mirrors there are at home. They should comment on how the mirrors are used. Sometimes they are used to reflect light into a dark space.

Differentiation

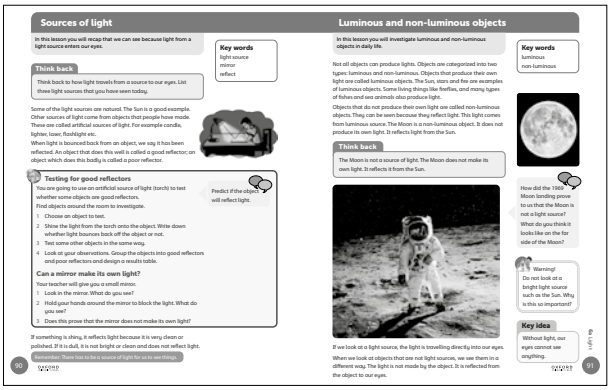
Supporting: Provide photographs or cut-outs of pictures from magazines to help students identify natural and artificial light sources.

Consolidating: Give students a wide range of materials to find out whether or not they reflect light.

Extending: Ask students to find out how we use reflection apart from seeing ourselves in a mirror.

Differentiated outcomes	
All students	should be able to identify natural and artificial sources of light
Most students	will be able to predict and identify materials that reflect light
Some students	may be able to list ways that reflection of light is used

Luminous and non-luminous objects


Sources of light

In this lesson you will recap that we can see because light from a light source enters our eyes.

Think back

Think back to how light travels from a source to our eyes. List three light sources that you have seen today.

Key words
light source
mirror
reflect

Some of the light sources are natural. The Sun is a good example. Other sources of light come from objects that people have made. These are called artificial sources of light. For example candle, lighter, laser, flashlight etc.
When light is bounced back from an object, we say it has been reflected. An object that does this well is called a good reflector; an object which does this badly is called a poor reflector.

Testing for good reflectors

You are going to use an artificial source of light (torch) to test whether some objects are good reflectors.
Find objects around the room to investigate.

1 Choose an object to test.
2 Shine the light from the torch onto the object. Write down whether light bounces back off the object or not.
3 Test some other objects in the same way.
4 Look at your observations. Group the objects into good reflectors and poor reflectors and design a results table.

Predict if the object will reflect light.

Can a mirror make its own light?

Your teacher will give you a small mirror.

1 Look in the mirror. What do you see?
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3 Does this prove that the mirror does not make its own light?

If something is shiny, it reflects light because it is very clean or polished. If it is dull, it is not bright or clean and does not reflect light.

Remember: There has to be a source of light for us to see things.

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Luminous and non-luminous objects

In this lesson you will investigate luminous and non-luminous objects in daily life.

Key words
luminous
non-luminous

Not all objects can produce lights. Objects are categorised into two types: luminous and non-luminous. Objects that produce their own light are called luminous objects. The Sun, stars and fire are examples of luminous objects. Some living things like fireflies, and many types of fishes and sea animals also produce light.
Objects that do not produce their own light are called non-luminous objects. They can be seen because they reflect light. This light comes from luminous source. The Moon is a non-luminous object. It does not produce its own light. It reflects light from the Sun.

Think back

The Moon is not a source of light. The Moon does not make its own light. It reflects it from the Sun.

How did the 1969 Moon landing prove to us that the Moon is not a light source? What do you think it looks like on the far side of the Moon?

Warning!
Do not look at a bright light source such as the Sun. Why is this so important?

Key idea
Without light, our eyes cannot see anything.

If we look at a light source, the light is travelling directly into our eyes.
When we look at objects that are not light sources, we see them in a different way. The light is not made by the object. It is reflected from the object to our eyes.

91

Getting started

This lesson reminds students what a source of light is. They have covered this already in previous years. Students will observe natural sources of light – using the Sun as a good example – and human-made sources, for example a lamp. Students become aware that when light is reflected from an object, we see it. Students explore and observe sources of light and how some materials can reflect them better than others. They are reminded that mirrors are not a source of light but are just good at reflecting it. They compare this to the Moon, which reflects the light from the Sun.

Language support

Read through the key words with the class. Ask students to define some of the words based on their previous learning. Discuss examples of light sources that they are familiar with, for example the Sun, a candle or lamps. Discuss how some materials are not a source of light but reflect it. Ask them to give any examples that they might know. Explain that a mirror is a good reflector of light and that is how we can use them to see ourselves.

Resources

Student Book: torches; small mirrors.

Key words

luminous non-luminous

Other words in the lesson

artificial Moon natural reflector

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Recognise and control variables

Make observations

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- some sources of light are natural and others are artificial
- a mirror is not a source of light, it just reflects it.

Think back: Think back to how light travels from a source to our eyes. List three light sources that you have seen today.

Ask students to discuss how light travels from a source to our eyes. They can refer back to the previous lesson if they need to. Ask them to look around the room to remind them of all of the sources of light that they might have seen.

Possible response: *Students should suggest lamps, bulbs, the Sun, candles, streetlights, car headlights or the light from a smartphone.*

Ask students to read the text. After they have read the text, ask them to list two examples of natural light sources and two examples of artificial light sources. Explain that when light is bounced back from an object, we say it has been reflected. Ask them to study the picture and tell a partner how reflected light helps them to read a book.

Ask students to read the information about the Moon at the top of page 91 and to look at the photograph. They might recall learning about the Moon in previous years.

Think back: The Moon is not a source of light. It is like a giant mirror in the sky. The Moon does not make its own light. It reflects it from the Sun.

Make sure students realise that the Moon is acting like a huge mirror and does not produce its own light. Explain that they are going to collect some evidence to prove this in the next investigation.

Ask students to look at the photograph of the astronaut on the Moon on page 91. In pairs, they should discuss the questions in the discussion box. As prompts before they start, you can ask, 'What planet can you see in the distance? What do you think the 'far side of the Moon' means?' Elicit that this is the side that is further away from the Sun. Does the background of the photograph look light or dark?

How did the 1969 Moon landing prove to us that the Moon is not a light source? What do you think it looks like on the far side of the Moon?

> ***Possible response:*** *Students should suggest that the fact there was a Moon landing at all is evidence, but photographs, film footage and reports from astronauts of the 1969 Moon landings are also evidence that the Moon must not be a source of light. It is dark on the far side of the Moon because the Sun would not be visible. This is further evidence that the Moon is not a source of light.*

Warning! Do not look at a bright light source such as the Sun. Why is this so important?

Ask students to think back to their prior learning about how to stay safe when looking at the sky. Ensure they recall that the Sun emits huge amounts of heat and light energy. This could damage the eyes or even result in blindness.

Ask students to read the text at the bottom of page 91. Ask for volunteers to share their ideas with the class about the difference between seeing a star, a streetlight or a lit candle and seeing a book or the Moon. Elicit that the former are light sources and the book and Moon are only seen as they reflect light from another source. The book and Moon do not make their own light.

Key idea

Without light, our eyes cannot see anything.

Read through the key idea or ask a volunteer to read it out to the class. Ask students to summarise what they have learned in the lesson with a partner. Let them share their ideas, and read out and discuss the key idea.

Artificial light (page 75)

Remind students that sources of light can be natural or artificial. Ask them to write down one example of a natural light source and some examples of artificial light sources. They can use their own experiences and also ideas in the photograph. Next, ask them to look at the artificial sources of light they listed and ask them to explain why a natural source of light cannot be used. Elicit that at night the main natural light source (the Sun) is not visible in the sky and others, such as volcanoes and lightning, are neither safe nor reliable sources.

Computing link: Finally, allow students access to the internet so they can research the development of lamps and torches over the past 200 years. They can download pictures and present these in a timeline.

Review and reflect

Use the discussion tasks, the research investigation activities to encourage students to think about what they understand and what they are finding less straightforward. Discuss the outcomes of each task with students to correct misconceptions and identify improvements.

Extra activities

1 Students investigate different coloured mirrors to find out if they reflect the light in the same way. They can colour plastic mirror strips with felt pens or use tissue paper as a filter.

2 Students record how many mirrors there are at home. They should comment on how the mirrors are used. Sometimes they are used to reflect light into a dark space.

Differentiation

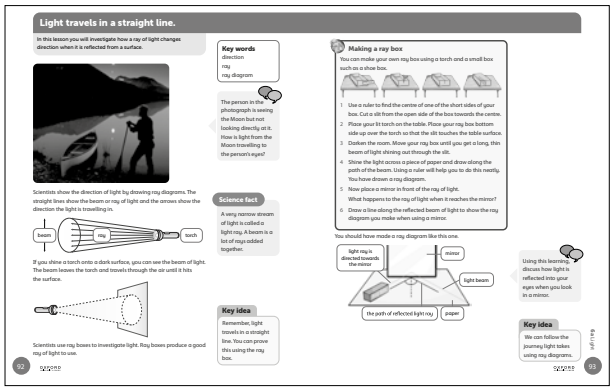
Supporting: Provide photographs or cut-outs of pictures from magazines to help students identify natural and artificial light sources.

Consolidating: Give students a wide range of materials to find out whether or not they reflect light.

Extending: Ask students to find out how we use reflection apart from seeing ourselves in a mirror.

Differentiated outcomes	
All students	should be able to identify natural and artificial sources of light
Most students	will be able to predict and identify materials that reflect light
Some students	may be able to list ways that reflection of light is used

Light travels in a straight line.



Getting started

The focus of this lesson is to observe how light travels in beams or rays of light. Students will construct a ray box and observe how the light behaves when it leaves it. They will explore how ray diagrams can be drawn to represent the way that light is directed. They will also explore how the rays can be changed by using mirrors. Finally, they represent reflected light from a mirror using ray diagrams.

Language support

Ask students to read out the key words and discuss them with a partner. There are some unusual words in this lesson (ray and ray diagram), which students might not have experienced before. Use the diagrams on page 92 to explain 'ray' and 'beam'. Explain that a beam is made up of many rays but we can split a beam into smaller (narrower) rays. Encourage students to use the correct key words throughout the lesson.

Resources

Student Book: torches, small boxes such as shoe boxes; rulers; scissors; mirrors; large sheets of paper.

Key words

direction ray ray diagram

Other words in the lesson

design interior pinhole camera

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make observations

Analyse data, notice patterns and group or classify things

Report and present findings

Lesson at a glance

The key teaching points for students in this lesson are:

- observe how rays can change direction when they are reflected from a mirror
- use ray diagrams to show the journey of light.

In the next lesson, students will investigate the angle of incidence and the angle of reflection.

The person in the photograph is seeing the Moon but not looking directly at it. How is light from the Moon travelling to the person's eyes?

Ask students to study the photograph showing the person at night and discuss the question in small groups.

> ***Possible response:*** *Students should suggest that the light from the Moon is being reflected by the smooth surface of the water.*

Ask students to read the information on page 92. They should use the diagrams to help them understand the information about how scientists show the direction of light using ray diagrams. The text also introduces the ray box. This is a piece of equipment that directs a ray of light.

Science fact: A very narrow stream of light is called a light ray. A beam is a lot of rays added together.

Ask students to observe the diagram that clearly shows the beam and rays of light. To check understanding, you could draw a simple version on the board and ask students to guide you on labelling a ray and a beam.

Key idea

Remember, light travels in a straight line. You can prove this using the ray box you make next.

Ask students to tell you how light travels. They should recall that it travels in straight lines. Ask them to tell you how they know this. Ask, 'What scientific evidence do you have to support your ideas?'

Investigation: Making a ray box

This investigation guides students on making their own ray box using a torch and a small box. You might want to show a scientific ray box or a picture of one from the internet to show what they are constructing.

Ask small groups to work together. They can follow the instructions independently, and you can support if needed. When all groups have prepared their ray box, darken the room. They need to move each ray box until they get a long, thin beam of light shining out through the slit.

Next, they shine the light across a piece of paper and draw along the path of the beam – this is a ray diagram. Encourage them to use a ruler.

Now they will place a mirror in front of the ray of light and observe what happens to the ray before drawing the reflected beam of light.

> ***Possible response:*** *Students should see the ray of light leaving the ray box in a straight line. They should observe the ray of light being reflected back in a straight line but at an angle from the mirror.*

Ask students to study the diagram at the bottom of page 93 showing the light leaving the ray box and how it is reflected from the mirror. Ask them if this represents their observations. They can label their own diagrams using the labels in the book.

Using this learning, discuss how light is reflected into your eyes when you look in a mirror.

Ask students to continue to work in their small groups. Encourage them to use the key words from the lesson in their discussion.

> ***Possible response:*** *Students should suggest that the light is directed towards the mirror, where the light rays are reflected and the path of the reflected light ray enters the person's eyes.*

Key idea

We can follow the journey light takes using ray diagrams.

Read out the key idea or ask a volunteer to read it out. Ask another volunteer to describe how they used a ray box in the lesson. They should describe how the light behaves when it leaves the ray box and meets the surface of a mirror.

Review and reflect

Ask students to write a note to themselves to remind them how they overcame some of the challenges in this lesson so that they can refer to this when they are challenged in future lessons.

Extra activities

1. Students draw two ray diagrams to show the direction of a ray of light from objects in the room.
2. Students take their ray box home and show people how it works. They record the rays of light leaving the ray box and how they react to a mirror and one other object.

Differentiation

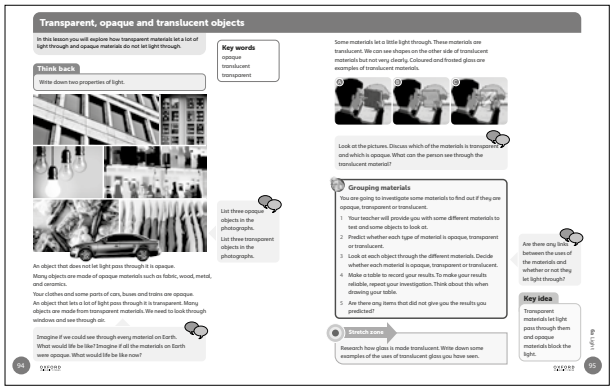
Supporting: You can provide students with pre-made ray boxes that shine a very thin beam of light to make observations easier.

Consolidating: Students can practise drawing ray diagrams and label the rays that enter the mirror and the rays that leave the mirror.

Extending: Students could explore what happens to light that hits mirrors that are not flat.

Differentiated outcomes	
All students	should be able to state that light changes direction when reflected from a surface
Most students	will be able to show reflection of light as a ray diagram
Some students	may be able to label ray diagrams including the path of reflected light

Transparent, opaque and translucent objects


Transparent, opaque and translucent objects

In this lesson you will explore how transparent materials let a lot of light through and opaque materials do not let light through.

Think back

Write down two properties of light.

Key words
opaque
translucent
transparent

An object that does not let light pass through it is opaque.
Many objects are made of opaque materials such as fabric, wood, metal, and ceramics.
Your clothes and some parts of cars, buses and trains are opaque.
An object that lets a lot of light pass through it is transparent. Many objects are made from transparent materials. We need to look through windows and see through air.

Imagine if we could see through every material on Earth. What would life be like? Imagine if all the materials on Earth were opaque. What would life be like now?

List three opaque objects in the photographs.
List three transparent objects in the photographs.

Some materials let a little light through. These materials are translucent. We can see shapes on the other side of translucent materials but not very clearly. Coloured and frosted glass are examples of translucent materials.

Look at the pictures. Discuss which of the materials is transparent and which is opaque. What can the person see through the translucent material?

Grouping materials

You are going to investigate some materials to find out if they are opaque, transparent or translucent.

1 Your teacher will provide you with some different materials to test and some objects to look at.
2 Predict whether each type of material is opaque, transparent or translucent.
3 Look at each object through the different materials. Decide whether each material is opaque, transparent or translucent.
4 Make a table to record your results. To make your results reliable, repeat your investigation. Think about this when drawing your table.
5 Are there any items that did not give you the results you predicted?

Are there any links between the uses of the materials and whether or not they let light through?

Key idea
Transparent materials let light pass through them and opaque materials block the light.

Stretch zone
Research how glass is made translucent. Write down some examples of the uses of translucent glass you have seen.

94 Light 95

Getting started

This lesson introduces students to the idea that some materials allow light to pass through them and others block light. Materials are described as transparent if they allow light to pass through them and opaque if they block it completely. Students also investigate materials that allow some light to pass through – these are described as translucent. Students group or classify materials into these categories and begin to consider how these properties are used.

Language support

The key word 'translucent' might be unknown to most students. They might have heard of 'transparent' and they studied opaque materials in Year 3 but check they fully understand what they mean. These words are not easy to spell. A strategy you can use is to write the words on the board but leave some gaps so letters are missing. Students can copy the words and then discuss which letters are missing. They can self-check by referring to the key words box on page 94 of the Student Book.

Resources

Student Book: samples of materials that are opaque, transparent and translucent; selection of small objects.

Key words

opaque translucent transparent

Other words in the lesson

frosted

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Make observations

Record data and results

Analyse data, notice patterns and group or classify things

Draw conclusions and give explanations

Lesson at a glance

The key teaching points for students in this lesson are:

- materials let different amounts of light pass through them
- materials can be classified or grouped as transparent, translucent or opaque.

In the next lesson, students will investigate shadows.

Think back: Write down two properties of light.

Ask students to write down their thoughts. This activity can be used to support them to recall prior learning about light.

Possible response: *Students should suggest that light travels in a straight line, it can be reflected or refracted, and white light is made up of a spectrum of colour.*

List three opaque objects in the photographs. List three transparent objects in the photographs.

Arrange students into pairs or groups of three or four for discussion work. A useful strategy is to start with students in pairs and then move pairs together to make small groups so students can share their ideas and discussions with others. Ask students to study the photographs and then discuss the questions.

Possible response: *Students may suggest: opaque = clothing, fruit, metal and rubber on the car, concrete in the building; transparent = windows in the buildings, bottles, light bulbs, plastic food bags, the car windscreen.*

Ask students to read through the text beneath the photographs on page 86. Volunteers could read out a sentence each. Ask them to use the information in the text to answer the discussion questions that follow.

Imagine if we could see through every material on Earth. What would life be like? Imagine if all the materials on Earth were opaque. What would life be like now?

Allow students to work with a partner to talk about the questions.

Possible response: *Students should suggest we wouldn't have any privacy if all of the materials were transparent. If they were all opaque, we wouldn't see outside or be able to drive in a car.*

Students can continue to work with their partner or in their group to read the information at the top of page 95 about translucent materials. If possible, show students some real examples of coloured and frosted glass. Ask them where they have seen examples before. Elicit that translucent materials are useful because they allow light through but still provide some privacy.

Look at the pictures. Discuss which of the materials is transparent and which is opaque. What can the person see through the translucent material?

Point out the drawings on page 95 and ask students to discuss the questions to review their understanding of these properties of materials.

Answer: *A opaque; B translucent; C transparent. The person can see the outline of the tree but not all its detail through the translucent material.*

Investigation: Grouping materials

Ask students to work in pairs or groups of three of four. Explain that they are going to investigate some materials to find out if they are opaque, transparent or translucent. You should provide them with some different materials to test and some objects to look at. They should predict whether each type of material is opaque, transparent or translucent. Then they look at each object through the different materials to decide whether each material is opaque, transparent or translucent. Encourage them to record their results in a table. Ask them how they can make their results more reliable. Elicit that they should repeat the investigation. Finally, they analyse their results to assess whether any items did not give the results they predicted. Check their answers and discuss any misunderstandings.

Are there any links between the uses of the materials and whether or not they let light through?

Ask students to read through the discussion question and work with their group to consider their investigation results. Ask them to link the property of the material to its use.

Possible response: *Students should suggest uses of the materials they investigate. For example, it is important that the windscreen in a car lets lots of light through, while a bathroom window doesn't need to let as much light through and should not allow people to see in; curtains or blinds in a bedroom should not let any light through.*

Stretch zone: Research how glass is made translucent. Write down some examples of the uses of translucent glass you have seen.

Allow pairs access to the internet and any other suitable resources, such as catalogues, to research how glass is made translucent. Remind them that they don't need to write down the process, but they should write down examples of the uses of translucent glass. Encourage them to share their findings with other pairs.

Possible response: *Students should suggest any sensible response. Examples could be bathroom windows, glass panels in doors, side windows in vehicles, drinking vessels and vases.*

Key idea

Transparent materials let light through and opaque materials block the light.

Read through the key idea or ask a volunteer to read it out to the class. Ask students to describe how we can group materials according to the amount of light they allow through. Ask them to give one example of each use of the three properties of material they have learned about in the lesson.

Review and reflect

Discuss the outcomes of the grouping materials task with students during and at the end of the process. Encourage them to identify improvements that they can make to their testing and point out that this process of testing and redesigning is a normal part of the way that scientists and engineers work. This will help students to develop a positive approach to learning by understanding that learning is a process that will improve with practice and reflection.

Extra activities

1 Students survey their homes for the different categories of materials. They find the most unusual example for each category.

2 **Computing link:** Students find out if there are any buildings that are completely made out of transparent materials. They make a computer presentation including pictures and facts.

Differentiation

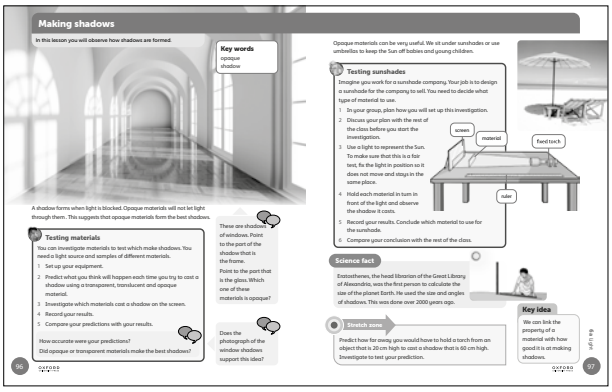
Supporting: Give students lots of different objects to practise grouping into transparent, translucent and opaque materials.

Consolidating: Encourage students to look for examples of the different categories of materials when they are in the playground.

Extending: Give students photographs or cut-outs of magazines and ask them to identify why materials with one of these properties were selected for use.

Differentiated outcomes	
All students	should be able to group materials into transparent, translucent and opaque
Most students	will be able to identify materials with transparent, translucent and opaque properties
Some students	may be able to explain why the property of the material is useful in specific examples

Making shadows



Getting started

This lesson builds upon the previous lesson and considers what happens when objects block light. Students review work from last year and investigate the shadows cast by transparent, translucent and opaque objects. Students are given an opportunity to apply their knowledge of shadows in designing and testing sunshades.

Language support

Create a set of matching cards with words and definitions to ensure that students are confident in the use of the main ideas covered in this lesson. Words should include opaque, translucent, transparent and shadow.

Resources

Student Book: torches; cardboard or other material to use as a screen; samples of materials that are opaque, transparent or translucent; rulers.

Key words

opaque shadow

Other words in the lesson

translucent transparent

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Make observations

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- when light is blocked a shadow is formed
- opaque materials make shadows.

In the next lesson, students will apply their knowledge of shadows to develop shadow games.

These are shadows of windows. Point to the part of the shadow that is the frame. Point to the part that is the glass. Which one of these materials is opaque?

Arrange students into pairs or groups of three or four. Ask them to study the photograph at the top of page 96 and read the information about how opaque materials block light and form shadows.

Answer: *Students should suggest the shadow is the opaque window frame and the white part is the transparent glass.*

Investigation: Testing materials

Ask students to work with their group to investigate materials to test which make shadows. They will need a light source and samples of different materials.

They will need to plan and set up their equipment. Allow independent working here and prompt only if needed. Students should predict what they think will happen each time they try to cast a shadow using a transparent, translucent and opaque material, and then carry out the investigation. Remind students to record their predictions after they have observed the equipment set up and the samples they will investigate so they can compare their predictions with their results.

Answer: *Students should predict and find that the opaque materials will make the best shadows. Their results should support their predictions.*

How accurate were your predictions? Did opaque or transparent materials make the best shadows?

Ask students to discuss these questions with their investigation group to assess their skills at making predictions based on their scientific knowledge.

Possible response: *Students should suggest their predictions were quite accurate. However, some translucent materials might have made shadows and students may have predicted that they wouldn't.*

Does the photograph of the window shadows support this idea?

Students can work with their investigation group to talk about the shadows formed in the photograph of the windows.

Possible response: *Students should suggest that this supports their predictions and ideas. Some parts of the window frame have not made shadows as well as others.*

Read to students the top two lines of text on page 97. Tell them they are now going to apply their learning and become product designers: they are going to test the best material to make a sunshade.

Investigation: Testing sunshades

Students should imagine their job is to design a sunshade for a company to sell. They need to decide what type of material to use. In their group, they will plan how to set up this investigation, and will communicate, collaborate and problem solve as a group.

They should follow the instructions given. Make sure they discuss their plan with the rest of the class before they start the investigation. They could use the diagram to help them set up the investigation. Give them prompts to make sure that they plan a fair test. Ask them to make sure they record their results clearly so they can conclude which is the best material to use for the sunshade. Compare the conclusions as a class discussion.

Possible response: *Students should suggest that an opaque material that is thick and dark in colour would make the best shadow on the screen and will therefore make the best sunshade.*

Science fact: Eratosthenes, the head librarian of the Great Library of Alexandria, was the first person to calculate the size of the planet Earth. He used the size and angles of shadows. This was done over 2000 years ago.

Read out the Science fact or ask a volunteer to read it out. Ask students if they think it would be possible to find the shadow of the Earth. Then ask them to look at the diagram which shows how Eratosthenes used the shadows cast by a stick on the ground.

Stretch zone: Predict how far away you would have to hold a torch from an object that is 20 cm high to cast a shadow that is 60 cm high. Investigate to test your prediction.This Stretch zone activity is pre-learning for the next few lessons on shadows in this unit. Students can work with their investigation group to plan and carry out this activity. Ask them to measure the distance from the source of light and the size of the shadow to help investigate their predictions.

Possible response: *Students should suggest the object would need to be quite close to the torch. The shadow would be larger than the object but fuzzy around the edges and not very clear.*

Key idea

We can link the property of a material with how good it is at making shadows.

Read out the key idea and ask students to turn to a partner and take it in turns to describe how we can make shadows using opaque materials. Elicit that the shadow is cast when the object blocks the light. Light cannot go around corners, so a shadow is cast as the light stops at the boundary of the opaque materials.

Review and reflect

You can ask students to produce a scientific report of their investigation. This can include a prediction, method, results and their conclusions. You can read through these and look for evidence of sensible predictions and an understanding of variables.

Encourage students to celebrate success during the lesson as this raises confidence and engagement. It also reminds them that learning is a process and they can learn from the things that did not go as well as they hoped.

Extra activities

1 Students stand outside in sunlight. They investigate how to make their shadows smaller and bigger. They make a poster to show how they did this. Also tell students they will get a chance to study this in more detail in a forthcoming lesson.

2 Students make a collage of pictures cut out from magazines to show what materials make the best shadows.

Differentiation

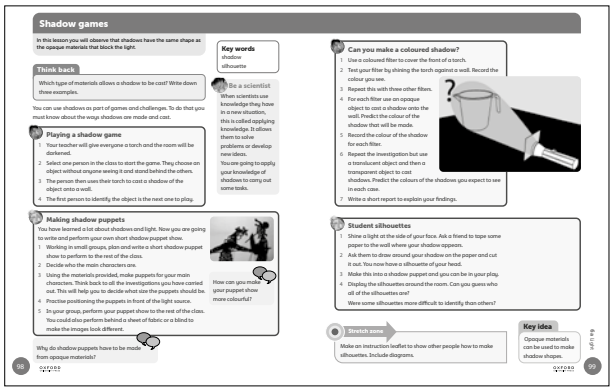
Supporting: Display photographs of sunshades, blinds and curtains being used to create shade to show students some examples in context.

Consolidating: Students can make sketches of areas of shadow around the school and label the materials that are casting the shadows.

Extending: Students can research the uses of translucent materials based on their property of letting some light through.

Differentiated outcomes	
All students	should be able to predict which objects will cast shadows
Most students	will be able to state that opaque materials cast the best shadows as they block light
Some students	may be able to relate the properties of transparent, translucent and opaque materials to the type of shadow they will cast

Shadow games


Shadow games

In this lesson you will observe that shadows have the same shape as the opaque materials that block the light.

Key words
shadow
silhouette

Think back
Which type of materials allows a shadow to be cast? Write down three examples.

You can use shadows as part of games and challenges. To do that you must know about the ways shadows are made and cast.

Playing a shadow game
1 Your teacher will give everyone a torch and the room will be darkened.
2 Select one person in the class to start the game. They choose an object without anyone seeing it and stand behind the others.
3 The person then uses their torch to cast a shadow of the object onto a wall.
4 The first person to identify the object is the next one to play.

Making shadow puppets
You have learned a lot about shadows and light. Now you are going to write and perform your own short shadow puppet show.
1 Working in small groups, plan and write a short shadow puppet show to perform to the rest of the class.
2 Decide who the main characters are.
3 Using the materials provided, make puppets for your main characters. Think back to all the investigations you have carried out. This will help you to decide what size the puppets should be.
4 Practise positioning the puppets in front of the light source.
5 In your group, perform your puppet show to the rest of the class. You could also perform behind a sheet of fabric or a blind to make the images look different.

How can you make your puppet show more colourful?

Why do shadow puppets have to be made from opaque materials?

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Be a scientist
When scientists use knowledge they have in a new situation, this is called applying knowledge. It allows them to solve problems or develop new ideas.
You are going to apply your knowledge of shadows to carry out some tasks.

Can you make a coloured shadow?
1 Use a coloured filter to cover the front of a torch.
2 Test your filter by shining the torch against a wall. Record the colour you see.
3 Repeat this with three other filters.
4 For each filter use an opaque object to cast a shadow onto the wall. Predict the colour of the shadow that will be made.
5 Record the colour of the shadow for each filter.
6 Repeat the investigation but use a translucent object to cast shadows. Predict the colours of the shadows you expect to see in each case.
7 Write a short report to explain your findings.

Student silhouettes
1 Shine a light at the side of your face. Ask a friend to tape some paper to the wall where your shadow appears.
2 Ask them to draw around your shadow on the paper and cut it out. You now have a silhouette of your head.
3 Make this into a shadow puppet and you can be in your play.
4 Display the silhouettes around the room. Can you guess who all of the silhouettes are?
Were some silhouettes more difficult to identify than others?

Stretch zone
Make an instruction leaflet to show other people how to make silhouettes. Include diagrams.

Key idea
Opaque materials can be used to make shadow shapes.

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Getting started

The aim of this lesson is to show students how scientists plan an investigation from what they know and observe. Students will learn that scientists can look at more than one factor or variable at a time but they still need to control their investigations. Students will explore how shadows can be used to make games, puppet shows and silhouettes.

Language support

Students are familiar with the word 'shadow', but write the word 'silhouette' on the board and point out that they saw an example of this in the unit's introductory lesson. Remind them it is named after the artist who invented it and let them practise saying the word out loud.

Resources

Student Book: torches; materials to make puppets for a shadow puppet show; sheets or blinds (optional); coloured filters; selection of opaque, transparent and translucent objects; large sheets of paper.

Key words

shadow silhouette

Other words in the lesson

filter opaque puppet

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Make observations

Record data and results Report and present findings

Lesson at a glance

The key teaching points for students in this lesson are:

- shadows have many different uses
- coloured shadows can be made using filters.

In the next lesson, students will investigate how the size of a shadow changes when it is nearer or further away from the light source.

Think back: Which type of materials allows a shadow to be cast? Write down three examples.

Ask students to work with a partner to recall the properties of materials that allow shadows to form. Prompt them to recall their investigations in previous lessons.

Answer: *Students should suggest that opaque materials cast shadows. They can give any three examples that are made from opaque materials, for example a plastic toy, wooden block or stone.*

This lesson is made up of four investigations and a final challenge activity.

Be a scientist: When scientists use knowledge they have in a new situation, this is called applying knowledge. It allows them to solve problems or develop new ideas. You are going to apply your knowledge of shadows to carry out some tasks.

Read out the Be a scientist feature to let students understand that they are going to use what they have learned in the previous lessons. They are going to use or apply their learning to play some games with shadows.

Investigation: Playing a shadow game

Students should work in large groups, or as a whole class. Provide torches and objects for students to make shadows with. Make sure you have cleared the floor of any objects that could be a trip risk. Students take turns to cast a shadow while the others guess the object.

Select one person in the class to start the game. The first person to identify the object is the next one to play.

Investigation: Making shadow puppets

Students work with a group to make up a shadow puppet show. This is an opportunity for students to work as a team and respect the decisions of others as they plan, write and perform together.

Encourage them to use the materials provided to make puppets for the main characters. They should think back to all the investigations they have carried out to help them to decide what size the puppets should be. They will need to practise positioning the puppets in front of the light source and will then perform the puppet show to the rest of the class. If you have a sheet of fabric or a blind available, they can perform the show behind it to make the images look different.

How can you make your puppet show more colourful?

Ask students to work with their group to reflect on their puppet show and discuss if they observed any other colours. Ask how they could introduce colour into their show.

Possible response: *Students should suggest the only colours they observed were shades of black because all of the light was blocked by the puppet. They may suggest using a colour filter or a coloured sheet or blind to make the show more colourful.*

Why do shadow puppets have to be made from opaque materials?

This discussion can be led by you with the whole class as a quick recap before moving onto the next investigation. Encourage students to think back to their earlier work on shadows and the materials they tested.

Possible response: *Students should suggest that the material has to be opaque to cast a good shadow. Light travels in straight lines so it cannot curve around the puppet. The opaque material stops the light rays and so a shadow is formed.*

Investigation: Can you make a coloured shadow?

This investigation challenges students to try to make a coloured shadow. The only way to make a coloured shadow would be to block some of the spectrum of colour. This would be a very difficult task. The principle of making a shadow is that the light is blocked completely. Students will find that they cannot successfully make a coloured shadow.

They will use four coloured filters to cover the front of a torch and test their filters by shining the torch against a wall. They need to record the colour.

For each filter, they will use an opaque object to cast a shadow onto the wall. They should predict the colour of the shadow that will be made then test it and record the actual colour of the shadow for each filter. Remind students that an opaque object forms a shadow by blocking all of the light and this should act as a powerful clue.

They will repeat the investigations using a translucent object and then a transparent object to cast shadows. Again, they should predict the colours of the shadows they expect to see in each case. Remind students that transparent materials allow all of the light to pass through and ask them if they expect to see a shadow. You can also ask, 'How much light does a translucent material allow through? If this casts a weak shadow, what colour might it be?'

Students are asked to write a short report to explain their findings. This is a tricky concept, so you may need to discuss the challenges of this activity as a class before they write a report.

Investigation: Student silhouettes

Students will work with a partner to produce their own silhouettes. Some students find this very tricky and resilience plays a huge part in producing a good silhouette. You may need to support pairs in following the instructions.

Students might find it difficult to create a true likeness using a silhouette. Encourage them to use other clues to support them in identifying their classmates.

Display some silhouettes around the room and discuss the technique. Concentrate on the process and principle of forming shadows rather than the quality of the silhouette.

Stretch zone: Make an instruction leaflet to show other people how to make silhouettes. Include diagrams.

Ask students to work with their group to carry out this task. Remind them of the steps they took in the investigation. This activity should help them to consolidate their understanding of this technique.

Key idea

Opaque materials can be used to make shadow shapes.

Ask students to close their books and count to 10. Then you can ask them to turn to a partner and tell them what they predict the Key idea for the lesson should be. After this, they can open the book and read the Key idea to check if their prediction was correct.

Review and reflect

Remember to praise the process of learning as much as, if not more than, the outcomes. Encourage students to ask questions and to look back through prior work on light and shadows to review and revise. Use every opportunity to allow students to work together to check understanding and share ideas. This can take place after each of the investigations on shadows and silhouettes and also after the Stretch zone task.

Extra activities

1 Students can make a silhouette of a person at home. They explain to the person each part of the method and why they are doing this.

2 Students research Étienne de Silhouette and make a poster about his work. They should include some of the silhouettes that he made.

Differentiation

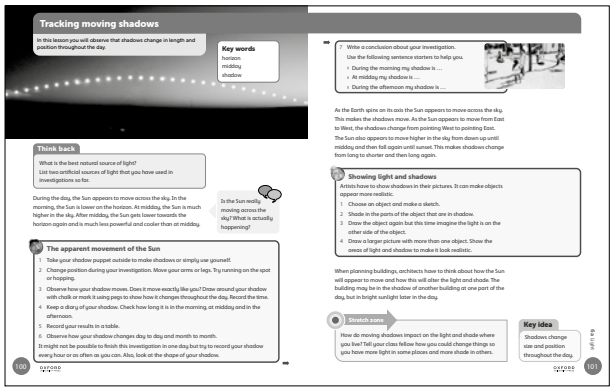
Supporting: Use the activities to help students to make their shadow puppets and silhouettes.

Consolidating: Students could make their own hand-shadow shapes and explain to their classmates how to make them.

Extending: Encourage students to explore how to change the size and shape of their shadows.

Differentiated outcomes	
All students	should be able to make a shadow of a character using one technique
Most students	will be able to use different techniques to make a shadow character
Some students	may be able to explain how shadows are used to make puppets and silhouettes

Tracking moving shadows


Tracking moving shadows

In this lesson you will observe that shadows change in length and position throughout the day.

Key words
horizon
midday
shadow

Think back
What is the best natural source of light?
List two artificial sources of light that you have used in investigations so far.

During the day, the Sun appears to move across the sky. In the morning, the Sun is lower on the horizon. At midday, the Sun is much higher in the sky. After midday, the Sun gets lower towards the horizon again and is much less powerful and cooler than at midday.

Is the Sun really moving across the sky? What is actually happening?

The apparent movement of the Sun
1 Take your shadow puppet outside to make shadows or simply use yourself.
2 Change position during your investigation. Move your arms or legs. Try running on the spot or hopping.
3 Observe how your shadow moves. Does it move exactly like you? Draw around your shadow with chalk or mark it using pegs to show how it changes throughout the day. Record the time.
4 Keep a diary of your shadow. Check how long it is in the morning, at midday and in the afternoon.
5 Record your results in a table.
6 Observe how your shadow changes day to day and month to month.
It might not be possible to finish this investigation in one day, but try to record your shadow every hour or as often as you can. Also, look at the shape of your shadow.

7 Write a conclusion about your investigation.
Use the following sentence starters to help you.
› During the morning my shadow is ...
› At midday my shadow is ...
› During the afternoon my shadow is ...

As the Earth spins on its axis the Sun appears to move across the sky. This makes the shadows move. As the Sun appears to move from East to West, the shadows change from pointing West to pointing East.
The Sun also appears to move higher in the sky from dawn up until midday and then fall again until sunset. This makes shadows change from long to shorter and then long again.

Showing light and shadows
Artists have to show shadows in their pictures. It can make objects appear more realistic.
1 Choose an object and make a sketch.
2 Shade in the parts of the object that are in shadow.
3 Draw the object again but this time imagine the light is on the other side of the object.
4 Draw a larger picture with more than one object. Show the areas of light and shadow to make it look realistic.

When planning buildings, architects have to think about how the Sun will appear to move and how this will alter the light and shade. The building may be in the shadow of another building at one part of the day, but in bright sunlight later in the day.

Stretch zone
How do moving shadows impact on the light and shade where you live? Tell your class fellow how you could change things so you have more light in some places and more shade in others.

Key idea
Shadows change size and position throughout the day.

100 OXFORD 101 OXFORD

Getting started

This lesson looks at how shadows cast by the Sun change in length and intensity throughout the day. The Sun appears to move across the sky but this is not the case;. In the morning, the Sun is low on the horizon and is not as bright as at midday. At midday, it is at its highest and brightest. Students investigate and track the Sun and observe how shadows change throughout the day.

Language support

Ask students to discuss the key words. They can say a sentence to their partner using each of the words. Remind them that midday is at 1200 hours. Ask them what they do at midday. This will help them to understand the word. Then ask them to look at the horizon and use this word in a sentence to their partner. They might say 'I can see a tree on the horizon.'

Resources

Student Book: access to outdoors at various sunny times (perhaps over more than one day); shadow puppets made previously; selection of small opaque objects; drawing materials.

Key words

horizon midday shadow

Other words in the lesson

architect artificial axis east/west natural spin

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Recognise and control variables

Make observations

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Lesson at a glance

The key teaching points for students in this lesson are:

- shadows change in length and position during the day
- the Sun is highest in the sky at midday.

In the next lesson, students will investigate more about the changes in the length and position of shadows.

Think back: What is the best natural source of light? List two artificial sources of light that you have used in investigations so far.

Start by asking students to discuss what a source of light is and which ones are natural. Then ask them if the Sun is a natural source of light. They should discuss what artificial sources of light are and why we need them.

Possible response: *Students should suggest that the Sun is the best natural source of light. We use many sources of artificial light including lamps and light bulbs.*

Ask students to read the first paragraph of text on page 100. It explains about the different positions of the Sun during a day. Ask them the time of day when the Sun is most powerful. Students then discuss the questions alongside the paragraphs and share their answers as a whole class. This is a revision of prior learning.

Is the Sun really moving across the sky? What is actually happening?

Possible response: *Students should suggest that the Sun does not move across the sky. The Earth is spinning on its axis which changes its position in front of the Sun. This makes the Sun appear to move across the sky.*

Investigation: The apparent movement of the Sun

Ask students to work in a small group to carry out this investigation. They are asked to observe how their shadow changes day to day and month to month so it would be useful to plan this activity over a few weeks.

They will use the shadow puppet they made before, or their own shadow, to investigate how shadows move position, shape and size during a day: in the morning, at midday and in the afternoon.

Students can follow the instructions, and you can support when needed. Remind them to record their results in a table.

Ask them to discuss the questions in the discussion box to help them review their investigation results and to write a conclusion. They can use the sentence starters given to help them.

Read out the information under the investigation on page 101. Explain how in the morning the Sun reaches the Earth at an angle which makes shadows look long and thin. At midday, it is directly above so shadows are shorter. Ask them to look at the photograph at the top of page 101 and to suggest whether the children are playing in the morning/afternoon or at midday. Ask them to explain why they reached their conclusion.

Explain that a shadow is created because of the absence of light. This means the darkness of it does not change. The amount of light surrounding an object, however, can make the shadow appear darker. So, when the light is brighter at midday the contrast will be greater so the shadow could appear darker.

Investigation: Showing light and shadows

This investigation gives students a chance to be creative and use their artistic skills. Artists often show shadows in their pictures. It can make objects appear more realistic. Students choose an object and make a sketch by shading in the parts of the object that are in shadow. Then they draw the object again but this time with the light on the other side of the object. Ask them if the shadow changed. Ask them why they think the shadow changed.

Possible response: *Students should suggest that the shadow will be in line with the source of light but at the other side of the object.*

Point out the text below the investigation box and ask students to read it and then discuss how architects need to think about the Sun and shadows. Ask, 'Why might an architect want to let a lot of light into a building? Why is shade so important in buildings?' You could ask students if they would like to use their science knowledge to help them to design buildings in the future.

Stretch zone: How do moving shadows impact on the light and shade where you live? Tell your partner how you could change things so you have more light in some places and more shade in others.

Students can read the question in the Stretch zone and discuss with a partner how to change the light and shadows where they live.

Possible response: *Students should suggest that they can move opaque objects that block the light from places where they want more light, and put them into places where shade is needed.*

Key idea

Shadows change size and position throughout the day.

Read out the key idea or ask a volunteer to read it out. Ask students to turn to a partner and tell them how we can track the movement of the Sun using shadows. Ask students to suggest why we think the Sun moves across the sky during the day and what scientific evidence we know about that refutes this idea.

Review and reflect

The pictures and written responses created in the lesson can be used for you and your students to evaluate learning. These show evidence of understanding and creativity. You can give feedback about each one – verbally or in writing – and also encourage students to pass on positive comments and suggestions for improvements.

Let students sit quietly for a few minutes and think about what they believe they have done well and what single thing they could take as a learning target into the next lessons.

Extra activities

1 Students observe the position of the Sun at a specific time in the morning, midday and afternoon for two days. They compare the position of the shadows on both days. Are they always the same? Remember to tell students never to look directly at the Sun.

2 Students draw their shadows on the ground with chalk in the morning, midday and afternoon. They take a picture of the shadows and compare them.

Differentiation

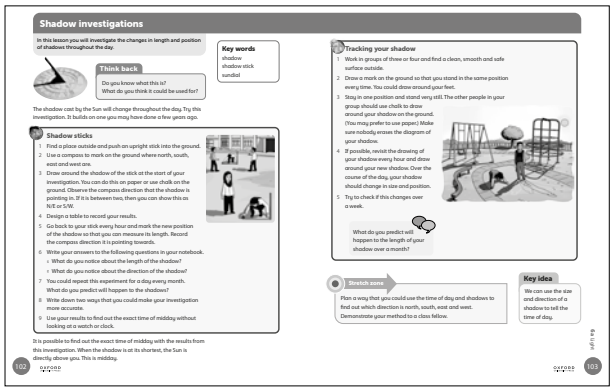
Supporting: Allow students to model the apparent movement of the Sun and its effects on shadows by using a torch as the Sun and a football as the Earth.

Consolidating: Ask students to track the movement of a shadow across the room by adding a string outline every 30 minutes to show how it changes.

Extending: Students could research the difference in shadow length in summer, spring, autumn and winter in a northern hemisphere country such as Sweden or Canada.

Differentiated outcomes	
All students	should be able to observe the apparent movement of the Sun and how shadows change during the day
Most students	will be able to use shadows to show how the position of the Sun appears to move
Some students	may be able to predict the time of day shadows were made

Shadow investigations


Shadow investigations

In this lesson you will investigate the changes in length and position of shadows throughout the day.

Think back

Do you know what this is?
What do you think it could be used for?

Key words
shadow
shadow stick
sundial

The shadow cast by the Sun will change throughout the day. Try this investigation. It builds on one you may have done a few years ago.

Shadow sticks

1 Find a place outside and push an upright stick into the ground.
2 Use a compass to mark on the ground where north, south, east and west are.
3 Draw around the shadow of the stick at the start of your investigation. You can do this on paper or use chalk on the ground. Observe the compass direction that the shadow is pointing in. If it is between two, then you can show this as N/E or S/W.
4 Design a table to record your results.
5 Go back to your stick every hour and mark the new position of the shadow so that you can measure its length. Record the compass direction it is pointing towards.
6 Write your answers to the following questions in your notebook.
- What do you notice about the length of the shadow?
- What do you notice about the direction of the shadow?
7 You could repeat this experiment for a day every month. What do you predict will happen to the shadows?
8 Write down two ways that you could make your investigation more accurate.
9 Use your results to find out the exact time of midday without looking at a watch or clock.

It is possible to find out the exact time of midday with the results from this investigation. When the shadow is at its shortest, the Sun is directly above you. This is midday.

Tracking your shadow

1 Work in groups of three or four and find a clean, smooth and safe surface outside.
2 Draw a mark on the ground so that you stand in the same position every time. You could draw around your feet.
3 Stay in one position and stand very still. The other people in your group should use chalk to draw around your shadow on the ground. (You may prefer to use paper.) Make sure nobody erases the diagram of your shadow.
4 If possible, revisit the drawing of your shadow every hour and draw around your new shadow. Over the course of the day, your shadow should change in size and position.
5 Try to check if this changes over a week.

What do you predict will happen to the length of your shadow over a month?

Stretch zone

Plan a way that you could use the time of day and shadows to find out which direction is north, south, east and west. Demonstrate your method to a class fellow.

Key idea

We can use the size and direction of a shadow to tell the time of day.

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Getting started

This lesson explores how we can investigate shadow sticks. These can be used to track the changes in the sunlight throughout the day. The shadows can be used to tell us the time of day and this is how sundials work. Shadows are investigated over the course of a day and students try to find midday using their investigations.

Language support

Students are introduced to two new key terms within this lesson – 'sundial' and 'shadow stick'. It is important that they are able to recognise these words and understand their meanings. As new words are introduced, allow students time to practise the spelling and pronunciation. Remind them that they have already learned the word 'shadow'.

Resources

Student Book: 1-metre sticks; compasses; chalk; writing materials; paper; access to outdoor area with clean, hard surface.

Key words

shadow shadow stick sundial

Other words in the lesson

midday

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Lesson at a glance

The key teaching points for students in this lesson are:

- shadow sticks can be used to track the Sun
- sundials use shadows to tell the time.

Think back: Do you know what this is? What do you think it could be used for?

Ask students to look carefully at the photograph at the top of page 102. Ask them if they have ever seen one of these. It is a sundial. Encourage a discussion about their experiences of them.

Possible response: *Students should suggest that the picture is a sundial that uses shadows cast by the Sun to tell the time of day.*

Investigation: Shadow sticks

This investigation builds on learning. It would be useful to plan to do this activity over the course of a month.

Students can work in pairs or small groups. They can follow the instructions in the Student Book independently. They will use a compass and measuring tape to record the direction and size of shadows every hour during the day. They will need to design a suitable table to record their results. Check the design of their table and make sure students are confident using a compass and a tape measure.

Students are asked to repeat this experiment for a day every month and predict what will happen to the shadows. They are also asked to evaluate their work and write down two ways to make their investigation more accurate.

Finally, they use their results to find out the exact time of midday without looking at a watch or clock.

Possible response: *Students should be able to estimate the time of day using the position of the shadow cast. They could check the accuracy using a clock or watch.*

Read out the text at the bottom of page 102 or ask a volunteer to read it. Ask students if they were certain about finding the time of midday using their results.

Investigation: Tracking your shadow

Students can work in groups of three or four. This investigation will need to be carried out over a week. Ask students to read through the steps and ask you to explain if they have any questions about the task.

Students can then follow the instructions to produce the marking point for their investigation. The picture on page 103 explains the process. If possible, they should revisit the drawing of the shadow every hour and draw around the new shadow. Over the course of the day, their

shadow should change in size and position. Students are asked to try to check if this changes over a week.

Possible response: *Students should suggest that the size and position of the shadow changes throughout the day. It should be short at midday and longer earlier in the morning and later in the afternoon.*

After they have carried out the investigation over a week, ask each group to make a prediction about what will happen over a whole month.

What do you predict will happen to the length of your shadow over a month?

Possible response: *Students should suggest that their shadow will change a little because of the changes in sunlight between seasons.*

Look at the picture. Decide with a partner where you would place a sticky note to label the shadow drawn at midday. Share your reasons with the class.

Students should study the picture before deciding where the sticky note should go. Remind them what the shape of the shadow should be like at midday. Direct them to the information at the bottom of page 102 as a reminder.

Answer: *Students should suggest that the sticky note should be added to the blue shadow as it is the shortest.*

Ask volunteers to read out the text beneath the investigation box. They could read a sentence each. Explain that 'apparent' means 'seems to be' and stress that the Sun does not move across the sky. You could demonstrate using a ball or even a globe as the Earth – ask a student to slowly turn it round and round. Ask another student to be the Sun – they stand still and shine a torch on the model Earth. You can stop the Earth once or twice to point out which parts are in sunlight and which are in shade, and ask students to imagine what shadows would look like in different places. You can fix small pieces of modelling clay to the surface to cast shadows and test students' predictions.

Stretch zone: Plan a way that you could use the time of day and shadows to find out which direction is north, south, east and west. Demonstrate your method to a partner.

Unless you are going to carry out the investigation as an extra activity (see below) then tell students this Stretch zone will challenge their planning skills. Ask them to discuss how they would find out the positions and show their partner how they will carry out the method.

Possible response: *Students should suggest that a shadow always points in the opposite direction to where the Sun appears to be in the sky. They should write into their plan that in the morning the Sun appears to rise in the east so shadows will point west. In an evening, the Sun sets in the west so shadows point east. With these two compass points they can find the points between them to locate north and south. They can then use a compass to check their ideas.*

Key idea

We can use the size and direction of a shadow to tell the time of day.

Read through the key idea or ask a volunteer to read it out to the class. Ask students to describe how a sundial works to tell us the time. They should comment on the accuracy of using a sundial.

Review and reflect

Use the activities in the Student Book to encourage students to identify aspects they have not completed correctly and help them to identify improvements. For example, they can walk around and look at the sundials made by other students to identify what they have done well and what they can learn from others as targets to improve their work.

Extra activities

1 Students can write an advertising leaflet for sundials. They discuss the benefits and pitfalls of using them instead of a watch.

Differentiation

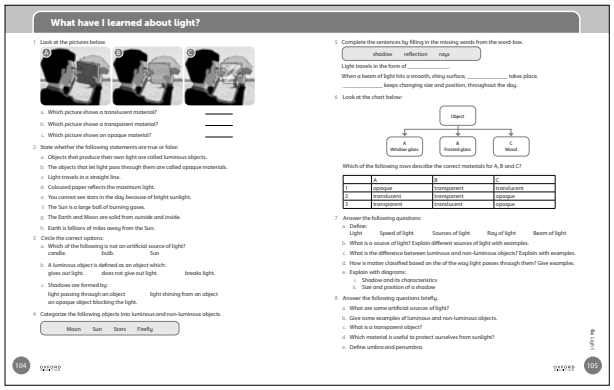
Supporting: Allow students time to practise using shadow sticks and recording the position of the shadow.

Consolidating: Allow students time to practise recording the position of the shadow and comparing this to the time on a clock.

Extending: Students can determine midday by observing shadows on a sundial.

Differentiated outcomes	
All students	should be able to use changes in the position of shadows through the day to estimate the time
Most students	will be able to investigate the shadows at different times of the day
Some students	may be able to predict the time using the position of a shadow

What have I learned about the way we see things?


What have I learned about light?

1 Look at the pictures below.

a. Which picture shows a translucent material? ____

b. Which picture shows a transparent material? ____

c. Which picture shows an opaque material? ____

2 State whether the following statements are true or false:

a. Objects that produce their own light are called luminous objects.

b. The objects that let light pass through them are called opaque materials.

c. Light travels in a straight line.

d. Coloured paper reflects the maximum light.

e. You cannot see stars in the day because of bright sunlight.

f. The Sun is a large ball of burning gases.

g. The Earth and Moon are solid from outside and inside.

h. Earth is billions of miles away from the Sun.

3 Circle the correct options:

a. Which of the following is not an artificial source of light? candle. bulb. Sun

b. A luminous object is defined as an object which: gives out light. does not give out light. breaks light.

c. Shadows are formed by: light passing through an object light shining from an object an opaque object blocking the light.

4 Categorise the following objects into luminous and non-luminous objects.

Moon Sun Stars Firefly

5 Complete the sentences by filling in the missing words from the word-box.

shadow reflection rays

Light travels in the form of _____.

When a beam of light hits a smooth, shiny surface, _____ takes place.

_____ keeps changing size and position, throughout the day.

6 Look at the chart below:

Object

A Window glass | B Frosted glass | C Wood

Which of the following rows describe the correct materials for A, B and C?

	A	B	C
1	opaque	transparent	translucent
2	translucent	transparent	opaque
3	transparent	translucent	opaque

7 Answer the following questions:

a. Define:
Light Speed of light Sources of light Ray of light Beam of light

b. What is a source of light? Explain different sources of light with examples.

c. What is the difference between luminous and non-luminous objects? Explain with examples.

d. How is matter classified based on the of the way light passes through them? Give examples.

e. Explain with diagrams:
i. Shadow and its characteristics
ii. Size and position of a shadow

8 Answer the following questions briefly.

a. What are some artificial sources of light?

b. Give some examples of luminous and non-luminous objects.

c. What is a transparent object?

d. Which material is useful to protect ourselves from sunlight?

e. Define umbra and penumbra.

6a LIGHT

104 SCIENCE WORLD

SCIENCE WORLD 105

Getting started

The aim of this section is to encourage students to review their learning after all of the lessons in the unit. All the lessons in the unit have questions and discussion tasks for students. You will have been using these formatively during lessons to help you assess students' knowledge and understanding of the topics.

On pages 104-105 of the Student Book there are eight questions related to the content of the unit. These will assess students' knowledge and understanding of the topics. The questions are arranged in increasing order of conceptual demand and not topic order. Students can tackle these one at a time after relevant lessons – the questions could also be answered as a single summative activity. This could be done by reading out the questions to the class and asking for volunteers to answer them, carrying out the activity as a group work task with students talking about each question, or as an individual written task. Whichever approach is adopted, the questions are designed to give you and the students feedback about progress and to help in identifying targets for development.

It is important that students report areas that they are not confident with. This information is vital for you to provide support strategies in the end-of-unit summative assessment.

What have I learned about the way we see things? answers

1 Look at the pictures below.

a. Which picture shows a translucent material?

b. Which picture shows a transparent material?

c. Which picture shows an opaque material?

Point out the three pictures of the person holding up the object. Explain that students need to decide which object matches each statement and then answer by writing in the most appropriate letter.

Answer: *a B; b C; c A*

2 State whether the following statements are true or false:

a. Objects that produce their own light are called luminous objects.

b. The objects that let light pass through them are called opaque materials.

c. Light travels in a straight line.

d. Coloured paper reflects the maximum light.

e. You cannot see stars in the day because of bright sunlight.

f. The Sun is a large ball of burning gases.

g. The Earth and Moon are solid from outside and inside.

h. Earth is billions of miles away from the Sun.

Answer: *a true b false c true d true e true f true g false h true*

3 Circle the correct options:

a. Which of the following is not an artificial source of light? candle. bulb. Sun

b. A luminous object is defined as an object which: gives out light. does not give out light. breaks light.

c. Shadows are formed by: light passing through an object light shining from an object an opaque object blocking the light.

Explain that these questions are multiple-choice questions so they are looking for only one of the three choices offered in each case. Suggest that if students are unsure, they could start by eliminating any obviously wrong choices.

Answer: *a. Sun b. Gives out light c. an opaque object blocking the light*

4 Categorize the following objects into luminous and non-luminous objects.

Answer: *Moon Sun Stars Firefly*
Luminous
Sun Firefly
Non luminous
Moon Stars

5 Complete the sentences by filling in the missing words from the word-box.

Light travels in the form of _____.

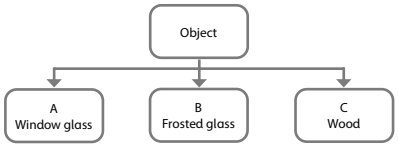
When a beam of light hits a smooth, shiny surface, _____ takes place.

_____ keeps changing size and position, throughout the day.

Point out the word box and remind students to use words from here. Each word will only be used once so suggest students cross them out as they use them.

Answer: *shadow reflection rays*

6



Which of the following rows describe the correct materials for A, B and C?

	A	B	C
1	opaque	transparent	translucent
2	translucent	transparent	opaque
3	transparent	translucent	opaque

Ask students to recall what are transparent, translucent and opaque objects. Ask them to suggest some examples.

Answer: *Answer is the row 3.*

7 Answer the following questions:

a. Define: Light

Speed of light

Sources of light

Ray of light

Beam of light

b. What is a source of light? Explain different sources of light with examples.

c. What is the difference between luminous and non-luminous objects? Explain with examples.

d. How is matter classified based on the of the way light passes through them? Give examples.

e. Explain with diagrams:

i. Shadow and its characteristics

ii. Size and position of a shadow

Answer: *7.a*
Light : The energy from the sun, lamp, etc, that makes us see things.
speed of light: the speed at which light travel in a vacuum.
Source of light: Light comes from different sources, which are known as sources of light.
Ray of light: The light traveling in any one direction in a straight line is called a ray of light.
Beam of light: A group of light rays given out from a source is called a beam of light.
b. A body which emits light in all directions is said to be the source of light. Examples include: Sun, stars, jellyfish, fireflies, glowworms are natural sources of light.
Candle, lighter, laser, flashlight are artificial sources of light.
c. Objects that produce their own light are called luminous objects. The Sun, stars and fire are examples of luminous objects.
Objects that do not produce their own light are called non-luminous objects. They can be seen because they reflect light. This light comes from luminous source. The Moon is a non-luminous object. It does not produce its own light. It reflects light from the Sun.
d. Matter can be classified as transparent, translucent, or opaque depending on how it interacts with light. Materials such as fabric, wood, metal, and ceramics are opaque.
Examples of transparent objects are air, water, diamond and clear glass.
Examples of translucent objects are coloured and frosted glass.

8 Answer the following questions briefly.

a. What are some artificial sources of light?

b. Give some examples of luminous and non-luminous objects.

c. What is a transparent object?

d. Which material is useful to protect ourselves from sunlight?

e. Define umbra and penumbra

Summative assessment

The review questions in the Student Book are a useful contribution when discussing the progress of each student individually. This information may also be used to create end-of-term reports for each student. You can score the questions as a summative test by awarding a mark for each answer. There are 42 marks in total (question 1 = 3; question 2 = 8 question 3 = 3; question 4 = 4 question 5 = 3 question 6 = 1 question 7 = 10 question 8= 10).

6b Sounds

In this unit students will:

- Describe and demonstrate how sound is produced by a vibrating body.
- Identify a variety of materials through which sound can travel. Identify that speed of sound differs in solids, liquids and gaseous mediums.
- Define and describe the intensity of sound with examples.
- Define noise and its harmful effects on human health.
- Appreciate the role of human beings in reducing noise pollution.

Getting started

In this unit students are introduced to the fact that sounds are produced by vibrations that travel from their source through a range of materials before they reach the ear. This unit lends itself to many investigations into volume, pitch and how sound travels through different materials. Students make a variety of musical instruments and use these to explore different ways of producing sounds and how to change pitch and volume.

Hearing-impaired students will need particular support throughout this unit. Give visual demonstrations of the properties of musical instruments and encourage students to feel the vibrations of a drum skin and tuning fork. The lips pick up vibrations from a tuning fork if you hold it at a safe distance. Demonstrate rice vibrating on a drum to see the vibrations. Help other students to be sensitive to the needs of hearing-impaired students.

Emphasise to all students that loud sounds can hurt our ears!

Science in context

Students have opportunities to develop their awareness of science in context in this unit. Students learn the content by hands-on experiences including predicting, observing, testing and investigating. They look at some ideas that have developed over time, for example how sound travels in vibrations and how we interpret these into sounds. Students learn that scientists have used their imaginations to question the world around them. Students consider how current science knowledge has emerged over extensive time to provide us with theories and laws in science.

Provide students with opportunities to experience how people use science such as sound energy in their daily work. This will help students to see the science they are learning about in everyday and important contexts. It might be possible to invite audiologists or other specialists into school to talk about their work and put it into context.

Encourage students to observe how we use sound in the natural world around us. They could research specialists who work with sound including technicians and musicians. Show students video clips of sound technicians at work and how they monitor and regulate sounds that we hear. Allow them to observe sound amplification using different equipment.

Scientific enquiry skills

An Investigation master sheet is given in this Teacher's Guide on pages 4–5 to help students plan their scientific enquiries. In this unit students collect evidence in a variety of contexts. They make predictions about how things will sound and how they can change the sound. Students test these predictions by carrying out investigations and collecting evidence. Students select equipment and resources to make musical instruments and change the pitch and loudness of them. They measure sound in decibels and make observations about sound. Students present the evidence they have collected in a variety of ways, drawing conclusions from looking at trends and patterns. They share their findings with the rest of the group.

Resources

Student Book: plastic rulers; large bowls; cling film; sticky tape (to make drums); sticks; rice; tuning forks; containers

of water; empty tissue boxes; pencils or short pieces of dowel; elastic bands or string; cardboard tubes; glue or sticky tape; selection of musical instruments; sound-level meters; access to books giving examples of decibel levels of different sounds or access to the internet; access to areas/materials where sound can travel through (for example, walls, windows, doors, curtains, benches); range of materials to test how sound transmits; glass bottles; water; paper cups; long pieces of string; radios; boxes with lids; materials such as different thicknesses of cloth and paper or rolls of cotton wool; sound-level meters; guitars previously made; recording of a piece of music; paper plates or card cut into circles; bells; shells; dry pasta or anything that will make a sound when shaken; balloons; A3 sheets of thick paper or thin card; clean empty bottles (sterilised at the neck); short sticks; drinking straws.

Key words for unit

Bold words are in the Word cloud

amplify **decibel** ear defender insulator **loud** material **music** **pattern** **pitch** quiet sound **transmit** travel **vacuum** vibrate **vibration** volume **tuning fork**

Scientific enquiry key words

ask questions use equipment observe measure compare notice patterns record carry out tests group/classify use secondary sources communicate findings

Language support

Write on the board the key words from this unit that you think students might already know. Ask them to work in small groups to explain or give examples of each word, then take feedback from the class. Make a note of the words that will need teaching as students encounter them in the lessons.

Unit at a glance

The key teaching points for students in this unit are:

- to introduce the unit objectives
- to introduce the learning outcomes
- to engage students with the content of the unit
- to review and build on prior learning and understanding of the topics.

This introductory lesson aims to enthuse and engage students and allow them to discuss their previous learning. It introduces sound and how sounds vary in loudness. It also encourages students to think about how we hear. Students will have some understanding of sound from earlier units and their everyday experiences. This lesson gives you the opportunity to assess prior learning and any misconceptions.

Science fact The study of sound waves is known as acoustics.

Read the science fact or ask the volunteer to read the text. Ask the students what is acoustic./ Describe them that acoustic is the characteristic of a space or building that affect how sound travels through it.

Can we hear while sleeping?

Ask students if they hear anything when they are asleep. Explain them that sleep is defined as the period of rest with the eyes closed and, mind and body not active. Which means that you cannot hear while sleeping.

Ask students to read the Science fact and ask them what they know about acoustics.

Define them that acoustics is the science concerned with the production, control, transmission, reception, and effects of sound.

Does a car horn sound louder or a baby's cry?

Students Ask the students if they have heard a baby's cry. Discuss with them that a baby cry sounds different depending on the situation. Four types were observed in the study: hunger, pain, illness, and alarm cries. Tell them it varies with the age as well.

Ask them if they have felt the need to cover their ears with their hands when hearing a baby crying? Or hearing the car's horn. Discuss with them the factors on which loudness depends. Discuss the role of distance in the loudness of sound.

Possible response: *Students should suggest that the baby's cry is louder than the car's horn.*

The intensity of a baby's cry is 120 dB and a typical car horn is 110 decibels.

Will sound travel in space?

Encourage students to discuss this with a partner. Ask for volunteers to share their ideas about how sound travels. Discuss that sound is a type of energy made by vibrations. These vibrations create sound waves which move through mediums such as air, water and wood.

Answer: *No, sound cannot travel in space. Sound travels through the vibration of atoms and molecules in a medium (such as air or water).*

How sounds are made

Getting started

In this lesson students learn that sound is made when objects vibrate. The vibrations travel through the air. These vibrations are picked up by the ear and the hearing system makes sense of the vibrations. Students investigate the vibrations and the sounds that they can hear. They also use tuning forks and strings to observe the vibrations they make.

Language support

Ask students to write definitions of the key words. You will need to revisit these and remind students of the meanings. There are many opportunities in this unit to demonstrate the meaning of the word 'vibrate'. Demonstrate how a tuning fork vibrates. Students should be able to feel the vibrations if they put the fork close to but not touching their lips.

Resources

Student Book: plastic rulers; large bowls; cling film; sticky tape (to make drums); sticks; rice; tuning forks; containers of water; empty tissue boxes; pencils or short pieces of dowel; elastic bands or string; cardboard tubes; glue or sticky tape.

Key words

sound vibrate

Other words in the lesson

loud quiet

Scientific enquiry key words

ask questions use equipment observe measure compare notice patterns record carry out tests use secondary sources communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- sounds are made when objects vibrate
- we can see vibrations and can link these to the sounds being made.

Students should look at the photograph of the busy street and discuss the question with a partner.

What is sound?

Encourage students to think about their prior learning on senses and to think about what sound is and why it is important.

Ask students to read the text beneath the photograph. Students are introduced to the idea that there are many sounds around us all of the time. These sounds can come from many different sources, including vehicles and phones. We are also capable of making different sounds. Discuss how sounds are made as a result of vibrations. These vibrations move across air and other materials to the ear, where our brain makes sense of them. Ask students to discuss as a class what vibrations are. Explain that they are the backwards and forwards motion of an object or material.

Investigation: How can we investigate the vibrations that cause sound?

Ask students to discuss how they can investigate this. Ask them to think about the equipment they will need.

Students should hit a drum with a stick, then put rice on the drum and hit it again. They should recognise that the rice is vibrating on the skin of the drum.

What causes this?

Ask students to share their ideas with a partner and then discuss this as a class. Some students could feel the surface of the drum vibrating when it has been hit to help them understand what is happening.

> ***Answer:*** *The rice vibrates because when the drum is hit it vibrates and these vibrations pass onto the rice.*

Ask students to read how musicians and singers use tuning forks. The vibrations can be seen and observed. Then they can discuss with a partner the discussion questions.

How can we hear a sound from the tuning fork? How does the sound reach our ears?

Encourage students to observe how the forks vibrate when they are struck. Elicit that the vibrating forks disturb the air around them and it is these vibrations that our ears process. Our ears connect to our brain, which tells us what the sound is and other information about it.

Investigation: Exploring tuning forks

Ask students to work in small groups. Give one tuning fork to each group. Alternatively, demonstrate the activity or try to find household forks that make a good sound.

Give each group a container with water in it. Ask students to strike the tuning fork and place it on the rim of the container. They should be able to see ripples forming on the surface of the water. These are caused by the vibrations from the tuning fork.

Show students the photographs of the guitar and the string vibrating and ask, 'How can we hear a guitar being played?' Elicit that the string is vibrating, which makes a sound.

How can we investigate this?

Ask a volunteer to read out the information on page 119 about how we hear the sound from a guitar. Ask students to work in a small group to discuss how they could investigate how the vibration of the strings results in sound being heard. They then make a guitar in the next investigation.

Key idea

We hear sound when something vibrates.

Read out the key idea, or ask a volunteer to read it out. This will remind students that some materials vibrate and sounds are made. Remind students that the vibrations disturb the air and the vibrations are carried to the ear. This is how we hear sounds. Twang an elastic band to illustrate this. Ask students to share some of their investigations where they have observed vibrations.

Review and reflect

Encourage students to reflect on their own learning by pausing for a few moments and thinking about which parts of the work they found a challenge. Talk about how they managed this and suggest that next time they stop for a short while and take a few deep breaths. Also remind them that when they are doing tricky work, they are training their brain and this will help their future learning.

Some students might find that identifying the trends in their observations difficult. Encourage them to repeat their observations and to discuss these with other students. As they collaborate, they will understand the concept to a deeper level and their confidence levels will increase.

Extra activities

1 Students can change the vibrations on a drum by hitting it differently: lighter or harder or in different places on the drum.

Differentiation

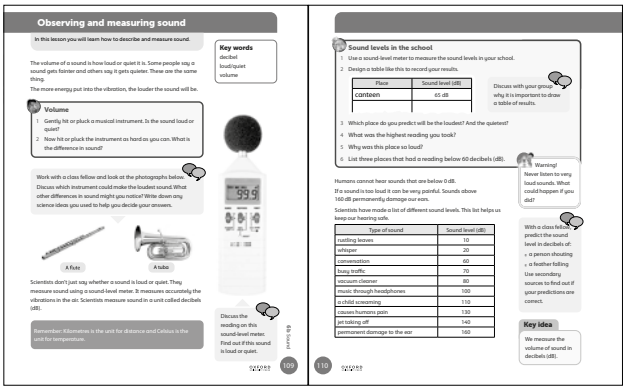
Supporting: Allow students many opportunities to observe the vibrations made by different objects.

Consolidating: Students can repeat the investigations observing the vibrations and the sound produced.

Extending: Students can explore how changing the vibration affects the sound made.

Differentiated outcomes	
All students	should be able to observe sounds being made by vibrations
Most students	will be able to make sounds using different materials that vibrate
Some students	may be able to change the sound made by changing the vibrations

Observing and measuring sound



Getting started

Students investigate how sound can be loud or quiet using musical instruments. They make predictions about the loudness or quietness of different sounds and measure sound levels in the school. Secondary data is used to demonstrate how loud or quiet everyday sounds are. Encourage students to analyse the data collected with the secondary data.

Language support

Show students the volume buttons on a TV remote control or the volume dial on a radio and ask, 'What does this button/dial do?' Reinforce the term 'sound-level meter' as students use it in their investigation. Encourage students to use the unit of measurement decibels when they talk about their sound readings.

Resources

Student Book: selection of musical instruments; sound-level meters; access to books giving examples of decibel levels of different sounds or access to the internet.

Key words

decibel loud/quiet volume

Other words in the lesson

sound-level meter

Scientific enquiry key words

use equipment observe compare
notice patterns record group/classify
use secondary sources communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- we can describe the volume of a sound
- sound can be measured using a sound-level meter
- sound is measured in decibels.

In the next lesson, students will learn how sound travels into our ears.

Students should read through the information at the top of page 109. Ask them to describe what we mean by the volume of a sound. Encourage them to describe this in their own words. Make sure that students understand the different words used to describe the volume of a sound. The important point is that the more energy there is in a vibration, the louder the sound will be made.

Organise students into small groups and provide them with a musical instrument such as a drum or a guitar. Explain that they are going to investigate how to change the volume of sound made by the instrument.

Investigation: Volume

Students work in small groups to investigate the instrument they are given. Allow them time to discuss the two questions. Students will understand that some sounds are loud and some are quiet. They will try to make a very loud sound by hitting or plucking the instruments as hard as they can.

Ask students to give their conclusions orally first. Then write the words 'quiet' and 'loud' on the board for them to use in their written conclusions in their notebooks. For example: When I play the instrument gently, it makes a quiet sound. When I play the instrument hard, it makes a loud sound. In conclusion, it takes more energy to make a loud sound. This is because more energy makes bigger vibrations.

Work with a class-fellow and look at the photographs below. Discuss which instrument could make the loudest sound. What other differences in sound might you notice? Write down any science ideas you used to help you decide your answers.

Ask students to look at the photographs. Ask if they have ever seen these instruments, and if they know whether they make a loud or a quiet sound. If they are unfamiliar with these instruments, can they work out which would make the loudest sound by looking at the shapes?

Possible response: *Students may suggest that the flute makes a quieter sound than the tuba. This is because there are different amounts of vibrations produced when the instruments are blown into. The differences in the sound could be louder or quieter, or higher or lower pitch. The science ideas used were that the instrument that needs more energy to blow into it would produce a louder sound, and the vibrations made by the instruments might be different.*

Ask a volunteer to read the text under the photographs of the instruments. Summarise by telling the class that scientists don't just say that a sound is loud or quiet – they need a more scientific way of measuring sound. Scientists use an instrument called a sound-level meter. Sound is measured in units called decibels (dB).

Discuss the reading on this sound-level meter. Find out if this sound is loud or quiet.

Ask students to look at the photograph of the sound-level meter and to write down the reading shown on the meter. They are then asked to research whether this is a loud or a quiet level of sound. They can use the table on page 110 or the internet for this research.

> ***Answer:*** *The value is 99.9 dB and this is an average sound – louder than a vacuum cleaner but quieter than music through headphones.*

Think back: Remember the other units of measurement that you have used. Kilometres is the unit for distance and Celsius is the unit for temperature.

Ask students to discuss with a partner all of the units of measurement that they have used. As a class, construct a shared list of units which could include grams, kilograms, metres and kilometres.

Introduce the investigation and tell students that they are going to measure sound like a scientist would.

Investigation: Sound levels in the school

The aim of this investigation is for students to predict and then measure the sound levels at different locations around the school, and to record their measurements in a table. The follow-up questions encourage students to analyse their results.

Encourage students to design a suitable table of results to record the sound-level readings. You could provide some students with a table like the one on page 110 to complete.

Ask students to work with a partner to think about the different places they might visit around the school. Ask them to predict which would have the loudest and quietest sounds. You could visit the places that students have discussed and measure the sound levels there. Take readings and encourage students to record them in their table of results.

At the end of the investigation ask students to analyse their readings and highlight the highest reading. They should discuss why the sound was so loud there. It could be a busy area, for example a kitchen or a music room. Low readings could be the library or quiet break-out areas. Students should try to identify three areas with sound-level readings below 60 dB.

Discuss with your group why it is important to draw a table of results.

You could show students a series of numbers scribbled on some paper and ask them what they mean. This could demonstrate the importance of keeping results neat in a table. Or ask them about a recent investigation. Ask them to recall the exact readings or results from memory to enforce the importance of recording results.

Show students the table of secondary data at the bottom of page 110 and read the warning with them.

Warning! Never listen to very loud sounds. What could happen if you did?

Remind students that our ears pick up vibrations from our surroundings. If there are many vibrations, from very loud sounds, they could damage our ears. Discuss the importance of good hearing and how it would affect students' lives if their hearing was damaged. Be sensitive to those who could have hearing problems.

With a class fellow, predict the sound level in decibels of: a person shouting; a feather falling. Use secondary sources to find out if your predictions are correct.

Students work with a partner to use the readings in the table to make predictions. Explain that scientists make predictions based on evidence from themselves or other scientists.

> ***Possible response:*** *Students could suggest that conversation is 60 dB and a child screaming is 110 dB, so shouting would be somewhere in between this. A feather falling would probably be the same or less than leaves rustling. Explain that secondary sources are any data collected and shared by other scientists. Students could suggest using the internet or books to find out if their predictions are correct.*

Key idea

We measure the volume of sound in decibels (dB).

Summarise the lesson by asking students what they have learned. Let them share their ideas, and read out and discuss the key idea. This will remind students of the units of measurement for sound. Ask them to close their books and describe the instrument used to measure sound.

Review and reflect

Encourage students to reflect on their own learning by pausing for a few moments and thinking about which parts of the work they found tricky. Talk about how they managed this and suggest that next time they stop for a short while and take a few deep breaths. Also remind them that when they are doing tricky work, they are training their brain and this will help their future learning.

Extra activities

1 Ask questions about the sound-level table in the Student Book on page 110 such as: 'How loud is a child screaming?' (110 decibels); 'How many more decibels will cause permanent damage?' (50 decibels).

2 **Maths link:** Students can include their predictions for a person shouting and a feather falling alongside the table of secondary data to create a bar chart.

3 Ask students to compare the data they collected around the school to that in the table. Did they find any places that were getting close to the pain threshold? Did they find any places where readings were close to 0 dB?

Differentiation

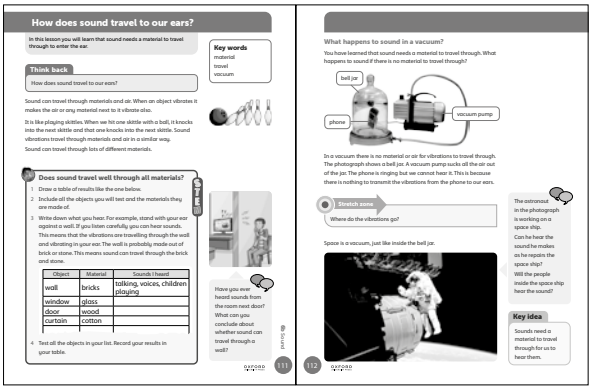
Supporting: You may need to allow students to observe many times how the sound-level meter works.

Consolidating: Students can practise recording sounds in decibels (dB) on the sound-level meter.

Extending: Students could be asked to predict the level of sound recorded after listening to sounds.

Differentiated outcomes	
All students	should be able to describe a sound
Most students	will be able to measure a sound in decibels
Some students	may be able to compare sound-level data to secondary data

How does sound travel to our ears?



Getting started

In this lesson students explore how sound travels through materials. Students listen to sounds being transmitted through various materials to see if they can hear them. Students are introduced to the fact that there must be a material for sound to be transmitted. The fact that sound cannot be transmitted if there is not a material is proved by the bell jar demonstration.

Language support

Students should now be familiar with all the key words except 'vacuum'. This is the first time that this word has been introduced. Ask students to write definitions for any new words in their glossary after they have experienced them and have their own ideas about what they mean to them. Provide several opportunities for students to write the word 'vacuum' to reinforce the spelling.

Resources

Student Book: access to areas/materials where sound can travel through (for example, walls, windows, doors, curtains, benches).

Key words

material travel vacuum

Other words in the lesson

bell jar vibrate

Scientific enquiry key words

observe compare notice patterns record carry out tests group/classify

Lesson at a glance

The key teaching points in this lesson are:

- sounds need materials to travel through
- sounds cannot travel through a vacuum.

In the next lesson, students will learn more about how different materials change sound.

Think back: How does sound travel to our ears?

Ask students to work in pairs to discuss the Think back question. Ask them to write a sentence to explain to other students learning about sound how it travels to our ears. They should include vibrations and how these travel through the air and other materials to our ears.

Students could demonstrate the skittle model using plastic bottles and a ball. Line the skittles up and roll a ball at the first one. As it falls it knocks over the next one. This is how sound vibrations knock into materials and the air as the sound moves through them.

Ask, 'Can sound travel through a wall?' Encourage students to start thinking about the investigation by discussing this question in pairs.

Investigation: Does sound travel well through all materials?

The aim of this investigation is for students to explore which materials transmit sound better than others. Organise students into pairs. Ask them to copy the table and write a list of the objects and materials they will test. You could ask them to make predictions about whether sound travels well through each of the materials they will be testing.

Start by asking students to stand with their ear against a wall. If students can hear a sound, this means the material is transmitting vibrations from the source of the sound.

Remind students that if they can hear sound clearly, the material is a good transmitter of sound. If the sound is not very clear, it is not a good transmitter of sound.

Students should write down what they hear in the table to record their findings. Encourage students to share their observations. They might be surprised that most materials allow sound vibrations to move through them. The sound might sound quieter or not as clear, but the vibrations are still travelling through them.

Have you ever heard sounds from the room next door? What can you conclude about whether sound can travel through a wall?

Ask students to discuss the questions with a partner. They will probably say they have heard children in the next classroom talking, for example. Ask students to discuss what this tells them about how the sound travels. If they can hear noise from next door, then the sound has travelled through the materials that make the wall.

What happens to sound in a vacuum?

If a bell jar is available, you can use it to demonstrate that sound cannot travel through a vacuum. If not, there are good videos of demonstrations available on the internet. Alternatively, you can use the photograph at the top of page 112 to explain the key ideas.

Go through the equipment. Show that the phone is ringing before you put it in the jar. Explain that the vacuum pump sucks out all the air. Ensure that all students understand that there is now nothing in the bell jar (apart from the phone). If you are demonstrating with a real bell jar, it should be clear that the ringing sound can no longer be heard.

Ask students to read the text below the photograph. Then ask questions to elicit that in a vacuum there is no material or air to carry the vibrations.

Stretch zone: Where do the vibrations go?

Ask students to discuss this question in pairs. You could prompt them by reminding them that there is no air inside the bell jar – it is a vacuum – and to think about how sound travels. They should arrive at the idea that there is nothing for the vibrations to travel along so they do not go anywhere.

The astronaut in the photograph is working on a space ship. Can he hear the sound he makes as he repairs the space ship? Will the people inside the space ship hear the sound?

Ask students to look at the photograph of the astronaut. Remind students that many male and female astronauts have worked in space. Ask questions to elicit that the astronaut is repairing the space ship and that he will be producing some sound. Refer them to the sentence above the photo: Space is a vacuum, just like inside a bell jar.

Possible response: *The astronaut would not hear the sounds he makes as there is no air in space – it is a vacuum. This means that the sound vibrations have nothing to knock into or vibrate against. The people inside might hear the sounds as there is air inside the space ship, so the vibrations can travel through the air to their ears.*

Key idea

Sounds need a material to travel through for us to hear them.

Read out the key idea, or ask a volunteer to read it out. This will remind students of how materials are needed to transmit sound vibrations. Ask students to turn to a partner and describe them the process of how sound reaches the ear from a source.

Review and reflect

Encourage students to reflect on their own learning by pausing for a few moments and thinking about which

parts of the work they found tricky. Talk about how they managed this and suggest that next time they stop for a short while and take a few deep breaths. Also remind them that when they are doing tricky work they are training their brain and this will help their future learning

Extra activities

1 Ask students to extend their learning about sound vibrations in a vacuum by asking them to research if there is sound in space.

2 Students draw a diagram to show the journey of sound from a source to their ear.

Differentiation

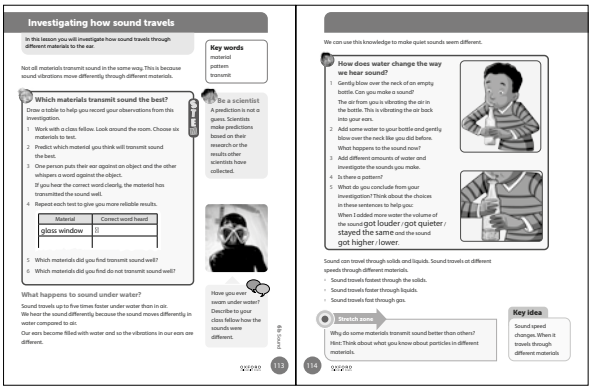
Supporting: Students can practise talking to their partner through a wall and a window to learn how sounds travel through different materials.

Consolidating: Students can be encouraged to explore that some materials are better than others at transferring vibrations through investigations.

Extending: Students could try to describe what happens to vibrations in a vacuum.

Differentiated outcomes	
All students	should be able to describe how materials are needed to hear sound
Most students	will be able to understand that materials transmit vibrations differently
Some students	may be able to explain what happens to vibrations in a vacuum

Investigating how sound travels



Getting started

In this lesson students continue to explore how sound travels through materials. Students first carry out a whispering investigation using a variety of materials. They then focus on how sound changes when travelling through water. Students explore how the amount of water in a bottle changes sound. This builds on the idea that sound travels differently through different materials.

Language support

Most of the key words have been covered in detail. Randomly pick some of the words that have been completed and ask students to use them in a sentence. Use this information to support students who have not used some words correctly.

Resources

Student Book: range of materials to test how sound transmits; glass bottles; water.

Key words

material pattern transmit

Other words in the lesson

water

Scientific enquiry key words

ask questions use equipment observe measure compare notice patterns carry out tests group/classify communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- materials change the way that sound vibrations travel

- sounds are different in some materials.

Ask students to read the opening information at the top of page 113. Ask them to think about how materials transmit sound. Explain that materials transmit sound differently because of the way that the vibrations move through them. Explain to students they are going to investigate how some materials transmit sound better than others.

The aim of this first investigation is for students to use their knowledge from the previous lesson to make and test predictions about which materials transmit sound the best.

Investigation: Which materials transmit sound the best?

Students should work with a class-fellow for this investigation. Explain that they will investigate six materials to test which ones transmit sound the best. Encourage students to make predictions for each material. They should identify the material that they predict will transmit sound the best at the start of the investigation.

A bench is a good place to demonstrate the investigation. One student puts their ear against the bench and the other whispers a word into the bench. When students hear the word they say it to their partner. They record with a tick in the table of results if they heard the correct word.

Students will analyse their results to decide which material transmitted sound the best and which did not transmit sound so well.

Be a scientist: A prediction is not a guess. Scientists make predictions based on their research or the results other scientists have collected.

Read the Be a scientist information and discuss with students what a good prediction is. In earlier years students might have understood this to be a guess – but now they should know it is an educated guess based on experience or the results and ideas of other scientists.

What happens to sound under water?

Ask students to read the text about sounds under water. Point out that water is a good transmitter of sound because the vibrations travel five times faster than in air. The sound we hear is different because of the way the particles are arranged in a liquid. Vibrations travel through them differently compared to air.

Have you ever swum under water? Describe to your partner how the sounds were different.

Students should discuss if they have heard sound when they have been swimming under water, and how the sound was different. Explain that they will continue to work in small groups or with a partner to investigate how water changes the way that we hear sounds.

Investigation: How does water change the way we hear sound?

The aim is for students to investigate how different amounts of water affect the sound made by blowing over a glass bottle. The more water in the bottle the less air there is to carry the vibrations.

Sterilise the necks of the bottles. Demonstrate how to blow over a bottle to make a sound. Ask students to try it. Ask questions to elicit that the air from them is vibrating the air in the bottle. This is then vibrating the air around the bottle and back into their ears.

Students could explore blowing harder and more gently to see if this affects the sound they make. If students find it difficult to make a sound, they can gently tap the bottle with a pencil. Ask what happens to the sound as they tap with varying amounts of energy.

Students then add some water to the bottle and gently blow over the neck again. They should notice that the sound has a higher pitch as there is less space for the air above the water to vibrate. Provide students with a jug of water and allow them to investigate with different water levels in the bottles.

Students should be able to identify a pattern in their observations. As the level of water changes, the sound changes. With less water there is more space for the air particles to vibrate and this makes a lower sound. Students should conclude the investigation by choosing the correct phrases in the sentences given.

Answer: *When I added more water the volume of the sound got louder and the sound got higher.*

Stretch zone: Why do some materials transmit sound better than others? Hint: Think about what you know about particles in different materials.

Students could review their learning about particle arrangements and support this by researching using the internet. Discuss how the particles are arranged differently in solids, liquids and gases. This actually means that solids transmit sounds better because the vibrations do not have to move between the particles.

Key idea

Sound speed changes when it travels through different materials.

Summarise the lesson by asking students what they have learned. Let them share their ideas, and read out and discuss the key idea. This will remind students of the way that sound travels through different materials. Ask students to share the results from their investigations and suggest which materials transmit sound the best and the worst.

Review and reflect

Remember to praise the process of learning as much as, if not more than, the outcomes. Encourage students to ask questions and to look back through prior work to review and revise. Use every opportunity to allow students to work together to check understanding and share ideas. Discuss the Stretch zone question. Remind students of the particle models of solids, liquids and gases. Ask them to think about how this would affect the way that sound travels.

Extra activities

1 Students use their knowledge about the arrangement of particles in solids, liquids and gases to draw a diagram to show how sound travels through air (gas) better than through a wall (solid).

2 Students use the bottles to play a tune together.

Differentiation

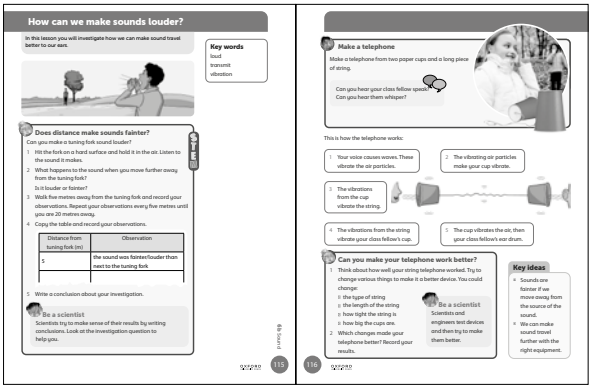
Supporting: Give students the opportunity to test lots of different materials for transmitting sounds.

Consolidating: Allow students to compare how sound travels in all three states of matter.

Extending: Help students to link how sounds are transmitted through materials with particle diagrams.

Differentiated outcomes	
All students	should be able to investigate how sounds travel through materials
Most students	will be able to observe which materials transmit sound better
Some students	may be able to link the particle diagrams of materials and how the sound travels

How can we make sounds louder?



Getting started

Students continue to investigate how sound changes because of the way the vibrations are transmitted in different materials. They also explore how the volume of sound depends on the amount of energy in the vibrations. Students then design and make a device to explore how sounds can be made louder.

Language support

Students have had opportunities to use language such as 'quieter' and 'louder'. Continue to encourage them to use the key words by questioning throughout the activities. They will have experienced the word 'transmit' but review their understanding. Model the correct use of the word in your teaching: sound is transmitted; the guitar string transmits the sound; I transmit vibrations from my vocal cords when I sing.

Resources

Student Book: tuning forks; paper cups; long pieces of string.

Key words

loud transmit vibration

Other words in the lesson

distance

Scientific enquiry key words

ask questions use equipment observe measure compare notice patterns
record carry out tests group/classify
communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- when sounds are transmitted well, we can hear them better
- the more vibrations that are transmitted into our ears, the more sound we hear.

Start the lesson by asking, 'Can sound travel through all materials?' Remind students that sound needs a material, such as a solid or air or water, to travel through. We can use our understanding of sound to make sounds change. Inform students that they are going to investigate if a sound changes if it is further away.

Investigation: Does distance make sounds fainter?

Students investigate what happens to the sound when they move further away from a vibrating tuning fork.

If enough tuning forks are available, hand one to pairs of students. If there is only one, you can demonstrate this activity.

Students should hit the fork on a hard surface and hold it in the air. Their partner listens to the sound it makes. Then they move increasingly further away from the tuning fork and observe what happens to the sound, noting if it gets louder or fainter. Students copy the table and record their observations, then write a conclusion.

Elicit from students that this investigation shows that the further away from a source they are the fainter the sound they hear.

Be a scientist: Scientists try to make sense of their results by writing conclusions. Look at the investigation question to help you. (Student Book, page 13)

Writing a conclusion is a key skill that some students find difficult. Explain that a conclusion is a sentence or a few sentences that sum up the results collected and the patterns in the results.

Remind the class that to make a sound louder we must increase the amount of energy in the vibrations.

Investigation: Make a telephone

Students investigate the idea that certain materials can keep vibrations together and direct them over a distance.

Before handing out the paper cups, make a hole in the base of each cup for students to thread the string through.

In pairs, students securely attach each end of the string to the two cups. They each take one of the cups and move away from each other until the string is stretched tight. One person puts their cup to their ear and the other talks into their cup.

Can you hear your partner speak? Can you hear them whisper?

To prove that the telephones are carrying the vibrations to the ear, ask students to try speaking and whispering to each other without the telephones. Make sure that they stay at the same distance from each other. Ask students to record their conclusions.

> ***Possible response:*** *Students should note that they can hear their partner speak, and possibly even whisper, through the telephones.*

Read together through the steps explaining how the string telephone works. Ask questions to check students' understanding. Elicit that it works as a result of the vibrations being concentrated inside the cup. The vibrations are directed along the string, into the other cup and into the ear. This makes the sound louder than it would be without the telephone.

For this investigation, it is enough for students to know that the cup is good at keeping the vibrations together.

Investigation: Can you make your telephone work better?

Students use their knowledge of the investigation to plan how to change the factors that they think will affect the sound transmitted.

They can follow the suggestions in the investigation box or find some of their own. They could use bowls or tubes, for example, in the place of cups.

When the string is tighter, the vibrations can move more easily. When the string is shorter, the vibrations do not have to travel as far. Students shouldn't be able to hear the sound differently with plastic or paper cups as they are both a solid. The bigger the cup the more vibrations are collected and transmitted.

Be a scientist: Scientists and engineers test devices and then try to make them better.

Remind students how scientists have an idea and then test it. They then make amendments and changes until they have the best result that they can achieve. Ask students how they could improve their string telephone. Encourage them to share their improvements and try to explain why they think it would work better. They could suggest different materials for the cup or the string, for example. The idea is that they suggest improvements and test them like a scientist.

Key ideas

- *Sounds are fainter if we move away from the source of the sound.*
- *We can make sound travel further with the right equipment.*

Summarise the lesson by asking students what they have learned. Let them share their ideas, and read out and discuss the key ideas. This will remind students that they can make sounds louder by changing things.

Review and reflect

Encourage students to reflect on their learning throughout the lesson. Use the discussion tasks, the investigations to encourage students to think about what they understand and what they are finding less straightforward. Discuss the outcomes of each task with students. Encourage them to identify aspects they have not completed correctly and help them to identify improvements. This will help students to develop a positive approach to learning by understanding that learning is a process that will improve with practice and reflection.

Extra activities

1 Tell students that some blind people can use sound to 'see'. They make a clicking sound with their tongue and can tell what is around them by the vibrations that travel back to their ears. Demonstrate how to make a clicking sound. With students in pairs, one person closes their eyes and the other guides them around the room. Ask students to stop and predict if they are near a wall or an open space based on the echoes of their clicks. The clicking sound should sound louder when they are near a material such as a wall or a door as the vibrations bounce back to them.

2 Give each pair of students an empty cardboard tube. Allow them to explore how their voice sounds through the tube. Ensure students know not to shout into each other's ears as this could damage them. Ask if their partner's voice changes when they talk through the tube.

Differentiation

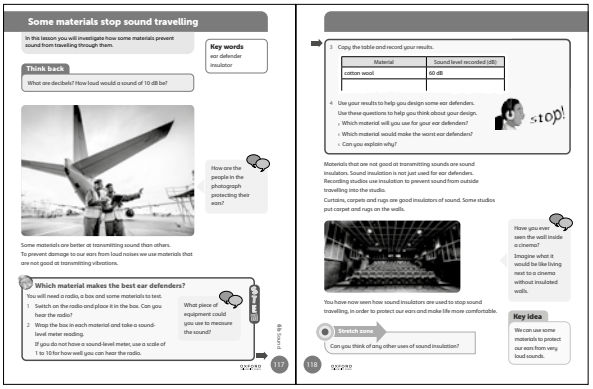
Supporting: Work with students to support them in measuring the distance accurately in the first investigation.

Consolidating: Support students by providing tables of results to record their observations accurately.

Extending: Allow students to suggest improvements to their telephone and to justify their ideas.

Differentiated outcomes	
All students	should be able to follow instructions on how to make sounds louder
Most students	will be able to design their own investigation to make sounds louder
Some students	may be able to continue changing variables until they have the best result to make sounds louder

Some materials stop sound travelling



Getting started

In this lesson students explore sound insulators by investigating which materials reduce the sound vibrations entering our ears. Students find out about the importance of ear defenders. The secondary data from the earlier lesson on measuring sound is used to demonstrate when we must protect our ears. Students explore how sound insulation is used in familiar places including the home and school.

Language support

Show images of people wearing ear defenders. Ask students what they are for, and if they have seen people wearing them. Model good use of the key words when you are working with students.

Resources

Student Book: radios; boxes with lids; materials such as different thicknesses of cloth and paper or rolls of cotton wool; sound-level meters.

Key words

ear defender insulator

Other words in the lesson

protect

Scientific enquiry key words

use equipment observe compare record carry out tests

Lesson at a glance

The key teaching points in this lesson are:

- some materials insulate sound
- ears are protected by wearing ear defenders.

In the next lesson, students will learn about the wave patterns of sound.

Think back: What are decibels? How loud would a sound of 10 dB be?

Students should recall from an earlier lesson that decibels are the units that sound is measured in, and that a very quiet sound such as rustling leaves would be about 10 dB.

Read through the text at the top of page 117 and ask students to look at the photograph.

How are the people in the photograph protecting their ears?

Elicit that without ear defenders, the people working at the airport would be in pain every time an aeroplane took off, since most people feel pain in their ears at 130 dB and an aeroplane taking off is around 140 dB.

> ***Answer:*** *They are wearing ear defenders. This is to protect their ears from the sound of the aeroplane engines.*

Ask students to read the text under the photograph. Discuss how some materials are better than others at transmitting sounds. Ask students if they can recall from their learning so far any materials that are good at transmitting sounds. Explain that some materials are not very good at transmitting sounds and we can use these to protect our ears from loud sounds. Tell students that they will investigate these materials next.

Investigation: Which material makes the best ear defenders?

The aim of this investigation is to explore how some materials are better than others at stopping sound vibrations travelling to the ear.

What piece of equipment could you use to measure the sound?

You could show students a sound-level meter or remind them of the picture on page 117 of the Student Book. This question tests if students remember their earlier learning.

> ***Answer:*** *Students should suggest using a sound-level meter to measure the sound.*

Students should switch on the radio and place it inside the box. Then they wrap the box in each type of material and take a sound-level meter reading. They should copy the table and record their results. If no sound-level meter is available, students could use a scale of 1 to 10.

Ask the class to be very quiet during the investigation. Otherwise, this will not be a fair test, as the reading will include the noise of the class.

Students then use their results to help them design some ear defenders. They should use the prompt question to help them think about their design.

Explain to students that the material with the lowest sound-level recording does not transmit sound very well. These materials would make the best ear defenders to protect our ears. They should select the one with the lowest reading. The one with the highest reading would allow too much sound to travel to the ear and would make the worst ear defenders.

Ask one or two volunteers to read out the text on page 118 beneath the investigation. It explains that materials which are not good at transmitting sounds are good sound insulators. It then gives some examples of good sound insulators and where they are used. Students should also look at the photograph of the cinema.

Have you ever seen the wall inside a cinema? Imagine what it would be like living next to a cinema without insulated walls.

Ask students why they think cinemas need to be insulated. The insulating material in cinemas is usually carpet, which is not normally applied to walls.

> ***Possible response:*** *Students might have seen that the walls in a cinema are usually covered in a thick fabric or carpet to prevent the sound being transmitted to the cinema or space next to it. Living next to a cinema that is not insulated would be very noisy and probably annoying.*

Stretch zone: Can you think of any other uses of sound insulation?

Students could research the uses of sound insulation using the internet.

> ***Possible response:*** *Students might suggest that headphones insulate against the sound travelling away from the ears. Sound insulation is also used in recording studios or radio stations, and inside the bonnet or hood of a vehicle to insulate against the sound of the engine.*

Key idea

We can use some materials to protect our ears from very loud sounds.

Read out the key idea or ask a volunteer to read it out. This will help students to review the main theme of the lesson, and will remind students of how sound needs to travel through the particles in a material. The structure or type of material can reduce the transmission of sound. These materials are called insulators. Ask students to list the materials that act well as sound insulators.

Review and reflect

Encourage students to reflect on their own learning by pausing for a few moments and thinking about which parts of the work they found challenging. Talk about

how they managed this and suggest that next time they stop for a short while and take a few deep breaths. Also remind them that when they are doing more challenging work, they are training their brain and this will help their future learning.

Extra activities

1 Students can carry out research to find out other uses of sound insulation, for example in factories with machinery. They could construct an information board about sound insulation.

2 Students find out why egg boxes are used in studios to line the walls and floors. They present their findings as a poster showing this with an explanation of how it works.

Differentiation

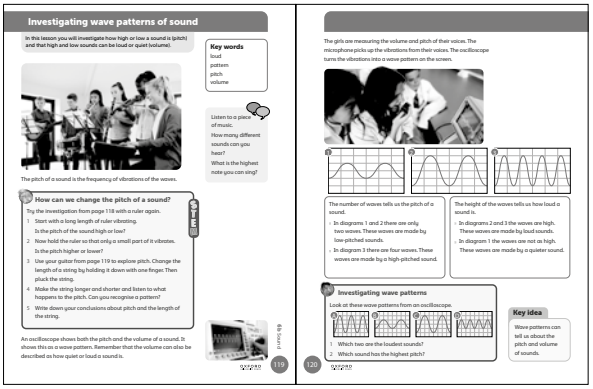
Supporting: Help students to test different materials for their insulation properties.

Consolidating: Allow students to repeat investigations to make sure they get accurate results.

Extending: Students could use a mixture of materials to find the best outcome for insulating sounds.

Differentiated outcomes	
All students	should be able to investigate sound insulation
Most students	will be able to predict materials that will insulate sound
Some students	may be able to describe a range of materials that are used to insulate sound in different applications

Investigating wave patterns of sound


Investigating wave patterns of sound

In this lesson you will investigate how high or low a sound is (pitch) and that high and low sounds can be loud or quiet (volume).

Key words
loud
pattern
pitch
volume

Listen to a piece of music.
How many different sounds can you hear?
What is the highest note you can sing?

The pitch of a sound is the frequency of vibrations of the waves.

How can we change the pitch of a sound?

Try the investigation from page 118 with a ruler again.

1 Start with a long length of ruler vibrating.
Is the pitch of the sound high or low?
2 Now hold the ruler so that only a small part of it vibrates.
Is the pitch higher or lower?
3 Use your guitar from page 119 to explore pitch. Change the length of a string by holding it down with one finger. Then pluck the string.
4 Make the string longer and shorter and listen to what happens to the pitch. Can you recognise a pattern?
5 Write down your conclusions about pitch and the length of the string.

An oscilloscope shows both the pitch and the volume of a sound. It shows this as a wave pattern. Remember that the volume can also be described as how quiet or loud a sound is.

6b Sound

119

The girls are measuring the volume and pitch of their voices. The microphone picks up the vibrations from their voices. The oscilloscope turns the vibrations into a wave pattern on the screen.

The number of waves tells us the pitch of a sound.
- In diagrams 1 and 2 there are only two waves. These waves are made by low pitched sounds.
- In diagram 3 there are four waves. These waves are made by a high pitched sound.

The height of the waves tells us how loud a sound is.
- In diagrams 2 and 3 the waves are high. These waves are made by loud sounds.
- In diagram 1 the waves are not as high. These waves are made by a quieter sound.

Investigating wave patterns

Look at these wave patterns from an oscilloscope.

1 Which two are the loudest sounds?
2 Which sound has the highest pitch?

Key idea
Wave patterns can tell us about the pitch and volume of sounds.

120

Getting started

In this lesson students investigate pitch as being a high or a low sound. Students learn that the size of the vibrating object determines the pitch of the sound. Students can explore this using rulers and the guitars they made earlier. Sound-wave patterns are introduced and oscilloscope readings are used to predict the volume and pitch of sound. Students analyse wave patterns to determine if sounds are loud or high pitched.

Lesson at a glance

Reinforce key words to do with pitch and volume by recording a collection of sounds to play to students. Ask them to identify whether the sounds are loud, quiet, high or low and to say whether the word they have given refers to pitch or volume. Also encourage students to use the comparatives 'louder', 'quieter', 'higher' and 'lower' when describing sounds.

Resources

Student Book: plastic rulers; recording of a piece of music.

Key words

loud pattern pitch volume

Other words in the lesson

microphone oscilloscope wave

Scientific enquiry key words

use equipment observe compare
notice patterns use secondary source

Lesson at a glance

The key teaching points in this lesson are:

- a sound can be described as having pitch and volume
- we can change the pitch of a sound.

In the next lesson, students will investigate the volume of sounds.

Ask students to observe the photograph of students playing different instruments. Ask them to think about what they are doing and what the audience would hear. Would it be loud or quiet?

Listen to a piece of music. How many different sounds can you hear? What is the highest note you can sing?

Play a piece of music and ask students to listen quietly. Ask them to listen out for the different sounds they can hear. After this, ask students to discuss with the person next to them the sounds they heard. Encourage them to use language like 'high', 'low', 'loud' and 'quiet' to describe the sounds. Ask students to use their voice to make high and low sounds.

Investigation: How can we change the pitch of a sound?

Students use plastic rulers and their guitars to investigate how changing the length of the vibrating part affects the pitch. Students should work in pairs and discuss the questions with their partner as they go through the investigation.

Students begin with the length of the ruler vibrating as long as possible. Ask them to describe the sound this makes when they make it vibrate. Elicit from students that the part of the ruler extending over the edge of the desk is the vibrating part. They should report that the pitch is low when there is a long piece of ruler vibrating.

Students then hold the ruler so that there is a smaller part vibrating. They should observe that the sound is a higher pitch when the length of the ruler vibrating is shorter.

Now students investigate changing the pitch of the strings on their guitars. Ask them to discuss with students around them how they can make high and low notes with the guitar.

Ask students how they made the notes higher or lower pitched. The shorter the string that is vibrating, the higher the pitch. Ask students if they can see a pattern in their results from the guitar string and the length of the ruler vibrating. They should conclude that the shorter the vibrating string or ruler the higher the pitch.

Read the text at the bottom of page 119 and ask students to look at the photograph of the oscilloscope. A sound is displayed as a wave on the oscilloscope screen. If you have an oscilloscope available, you can demonstrate how it works. Alternatively, there are lots of videos of oscilloscopes on the internet.

Explain that this piece of equipment is a bit like the sound-level meter because it transfers sound vibrations into a reading. But instead of giving a numerical reading, the oscilloscope displays the sound as a wave pattern. This illustrates both volume and pitch.

Read the text at the top of page 120 and ask students to look at the photograph of students using an oscilloscope. The three numbered diagrams below the photograph show three different oscilloscope recordings. The number of waves (or frequency) shows the pitch of the sound. The height of the wave shows the volume. Students can carefully read the information in the boxes about the number of waves (the pitch) and the height of waves (the volume) in each of the three recordings.

Investigation: Investigating wave patterns

Students look at the four oscilloscope recordings and use the information about wave numbers and wave heights to determine which two show the loudest sounds and which one shows the highest pitch. You could explain that the oscilloscope converts the sound vibrations into an electrical output that shows a pattern on the screen. The number of waves informs the pitch of the sound – fewer waves result in a lower-pitched sound. The height of the wave informs how loud the sound is – the higher the wave the louder the sound.

Answer: *A and C are the loudest as they have the highest waves. D has 4 waves and has the highest pitch.*

Key idea

Wave patterns can tell us about the pitch and volume of sounds.

Summarise the lesson by asking students what they have learned. Let them share their ideas. Ask a volunteer to read out and discuss the key idea. This will remind students of how wave patterns can be used to show different sounds. Hold up some wave patterns and ask students to describe the sound that would have generated them.

Review and reflect

Encourage students to reflect on their learning throughout the lesson. Use the discussion tasks, the investigation activity to encourage students to think about what they understand and what they are finding less straightforward. Discuss the outcomes of each task with students. Encourage them to identify aspects they have not completed correctly and help them to identify improvements. This will help students to develop a positive approach to learning by understanding that learning is a process that will improve with practice and reflection.

Extra activities

1 Students draw wave patterns for the people at home. They annotate them to show how to read them accurately. This is a good method of consolidating students' understanding of wave patterns and how they describe a sound.

2 Students work in groups to make a game. They draw sound-wave patterns and play sounds. They have to match the sound to the wave pattern.

Differentiation

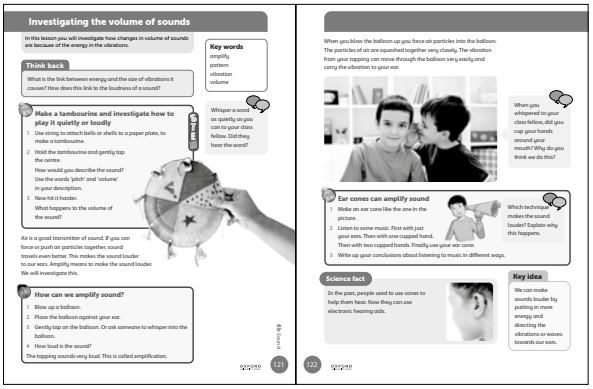
Supporting: You may need to show a number of oscilloscope readings with the sounds alongside to help with understanding.

Consolidating: Allow students to sort different patterns into the lowest or highest pitch and the loudest or quietest volume.

Extending: Provide students with more oscilloscope patterns for them to interpret.

Differentiated outcomes	
All students	should be able to describe a sound pattern according to pitch and volume
Most students	will be able to interpret some wave patterns
Some students	may be able to identify the pitch and volume of a sound using a wave pattern

Investigating the volume of sounds



Getting started

In this lesson students explore amplification. They begin by varying the volume of a tambourine, then they make an amplifier with a blown-up balloon. Students can model air particles by playing a whispering game. To end the lesson, students make an ear cone. They test whether cupped hands or the cone amplify sound the best.

Language support

Reinforce key words to do with pitch and volume by recording a collection of sounds to play to students. Ask them to identify whether the sounds are loud or quiet, and high or low pitched. Also encourage students to use the comparatives 'louder', 'quieter', 'higher' and 'lower'. Write the word 'amplify' on the board and ask students if they have heard this word before. You could model what the word means by saying the start of the word in a quiet voice and raising your voice towards the end of the word.

Resources

Student Book: paper plates or card cut into circles; bells; shells; dry pasta or anything that will make a sound when shaken; string; balloons; A3 sheets of thick paper or thin card; sticky tape or glue; recording of some music.

Key words

amplify pattern vibration volume

Other words in the lesson

transmitter

Scientific enquiry key words

use equipment compare record group/classify communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- sound can change volume from low to high through amplification
- the volume of a sound is determined by the energy in the vibrations.

In the next lesson, students will learn more about how pitch is used to make musical instruments.

Think back: What is the link between energy and the size of vibrations it causes? How does this link to the loudness of a sound?

Ask students how they made their guitar or drum sound louder. They should recall that they hit the drum harder or pulled harder on the guitar string.

> ***Possible response:*** *Students might suggest that the more energy in a sound the greater the vibration, and this results in louder sounds.*

Whisper a word as quietly as you can to your partner. Did they hear the word?

Ask students to remind you how they can make their voice loud or quiet. Ask students what is needed in a vibration to make it loud. They should recall that the more energy there is in a vibration the louder the sound it makes. Elicit that a whisper will have less energy.

Ask the class to sit in a circle. Choose one student to think of a word. They whisper this to the person next to them. This whisper continues around the group until it comes back to the original student. Ask the person if it is the same word that they started off with. If not, then ask the class to discuss why the word has changed.

Elicit that as students are sitting in the circle, they are modelling particles. When they are close together, they are like the particles in a solid. When they are far apart, they are like the particles in a gas. The closer they are the easier it is to transmit the correct whisper. Ask students if they remember the investigations in which they discovered that sound travels better through some solids than through air.

Tell students that they are going to make a tambourine and investigate how to change the volume of the sound it makes.

Investigation: Make a tambourine and investigate how to play it quietly or loudly

Students make a tambourine out of card or paper plates. Allow them to attach any items that will make a noise when they strike or shake the tambourine. Students could work with a partner for this activity to help secure the items to the plate.

Students hold the tambourine and gently tap the centre. They discuss the sound that they hear with their partner. They should observe that the sound is quiet. Ask them to write a sentence to describe the sound using the words 'pitch' and 'volume'. They could say that the tambourine made a high pitch, low volume sound when it was tapped gently.

Students hit the tambourine harder for the second part of the investigation. Encourage them to repeat this several times and compare the sounds that are made.

Encourage students to discuss with their partner the sound they hear when the tambourine is hit harder. Ask them to record their observations in a sentence again using volume.

> ***Possible response:*** *Students should report that when they hit the tambourine harder the sound was higher in volume.*

Students continue to read the information below the investigation. Remind students that air is a very good transmitter of sound vibrations. If the particles can be pushed closer together, it is even better. Keep referring back to the model of air particles to help students understand this concept.

Explain to students that they will continue to work with their partner to investigate how to amplify sound. Make sure that they understand that to amplify means to make the sound louder.

Investigation: How can we amplify sound?

This investigation reinforces the idea that when air particles are pushed together, the air transmits sound better and makes the sound louder.

Students should follow the method for the investigation. They begin by inflating the balloon. Remind them not to over-inflate it or it might burst, which can be dangerous. Students place the balloon over their ear and observe how tapping or whispering sounds can be amplified by the balloon. Ask students to compare the whisper or tapping with and without the balloon to show how the air inside the balloon amplifies the sound that they hear.

> ***Possible response:*** *Students should report that the sound is louder using the balloon as the air amplifies the sound they hear.*

Students read the information about amplification at the top of page 121. Remind students that air is made up of tiny particles. When air is blown into a small space like a balloon the particles are forced together which makes it easy for the vibrations to move through them.

When you whispered to your partner, did you cup your hands around your mouth? Why do you think we do this?

Ask students to continue to work with their partner to discuss the questions. Students may make the link back to the cardboard tube in an earlier lesson.

Possible response: *Students may suggest that cupping their hands concentrates the vibrations into a smaller area. This makes them easier to hear as the squashed together particles amplify the sound.*

Explain to students that they will make another device to amplify sound.

Investigation: Ear cones can amplify sound

Students continue to work with their partner to make an ear cone out of a sheet of A3 paper or card. They can stick on a strip of card to use as a handle, as in the picture in the Student Book. They can investigate which helps them to hear a piece of music better: cupping one ear with a hand, cupping both ears with both hands, or using the ear cone. Encourage students to conclude their investigation by writing a sentence about their observations.

Possible response: *Students should conclude that cupping or using a cone forces the air particles together which makes it easier for sound to travel through the air to them. The result is that the sound is amplified or sounds louder.*

Which technique makes the sound louder? Explain why this happens.

Students continue to work with their partner to discuss the question. Encourage students to share their responses with the class and focus on their explanations to assess their understanding of the concept of amplification.

Possible response: *Students may suggest that the ear cone will make the sound louder than the cupped hands as it is larger and forms a complete shape for the vibrations to travel through.*

Science fact In the past, people used to use cones to help them hear. Now they can use electronic hearing aids.

Students read out the Science fact and discuss what this means. Encourage students to share their responses as a class. Be sensitive to any students who wear hearing aids. Discuss how the devices help people to hear better. These devices work in many different ways but they all can increase sound vibrations.

Key idea

We can make sounds louder by putting in more energy and directing the vibrations or waves towards our ears.

Summarise the lesson by asking students what they have learned. Let them share their ideas, and read out and discuss the key idea. This will remind students that some sounds are louder than others. Remind students of the different ways that they have amplified sounds. Ask them to share one technique that they used and evaluate how well it worked.

Review and reflect

Ask students to sit down for a few minutes and think about what they have learned from the lesson. They can then think of one idea from the lesson that they would like to investigate and find out more about. Ask them to make a plan about how they would do this. This planning time will allow students to think up some imaginative and original things to do and you could let them carry out these projects. They are highly motivating and reinforce learning.

Extra activities

1 Ask students how they could make the amplification investigations more accurate. What piece of equipment could they use? Students could make a sound and measure it using a sound-level meter. They could then place the meter at the end of a cone or balloon to check if the sound measured is amplified.

2 **Computing link:** Students can research hearing aids and how they work. They design a poster to present their findings.

Differentiation

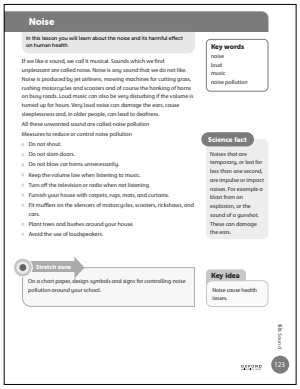
Supporting: Allow students more opportunities to change the volume of the sounds they make.

Consolidating: Students can be allowed to amplify the sounds made using different techniques.

Extending: Students could measure the sounds made using the different techniques using a sound-level meter.

Differentiated outcomes	
All students	should be able to recognise changes in the volume of a sound
Most students	will be able to amplify the volume of a sound
Some students	may be able to evaluate the efficiency of techniques in amplifying sound

Noise


Noise

In this lesson you will learn about the noise and its harmful effect on human health.

If we like a sound, we call it musical. Sounds which we find unpleasant are called noise. Noise is any sound that we do not like. Noise is produced by jet airliners, moving machines for cutting grass, rushing motorcycles and scooters and of course the honking of horns on busy roads. Loud music can also be very disturbing if the volume is turned up for hours. Very loud noise can damage the ears, cause sleeplessness and, in older people, can lead to deafness.

All these unwanted sound are called noise pollution

Measures to reduce or control noise pollution

- Do not shout.
- Do not slam doors.
- Do not blow car horns unnecessarily.
- Keep the volume low when listening to music.
- Turn off the television or radio when not listening.
- Furnish your house with carpets, rugs, mats, and curtains.
- Fit mufflers on the silencers of motorcycles, scooters, rickshaws, and cars.
- Plant trees and bushes around your house.
- Avoid the use of loudspeakers.

Key words
noise
loud
music
noise pollution

Science fact
Noises that are temporary, or last for less than one second, are impulse or impact noises. For example a blast from an explosion, or the sound of a gunshot. These can damage the ears.

Stretch zone
On a chart paper, design symbols and signs for controlling noise pollution around your school.

Key idea
Noise cause health issues.

123

Getting started

The final lesson before the summative assessment consolidates previous learning of pitch and sound and the difference between a pleasant sound and an unpleasant sound. Students will get to know the difference between the musical sound and noise,and the preventive measures to take in order to protect the ears from noise.

Language support

Play a piece of music and say the word 'music'. Use the word in a sentence. Play a high-pitched and low-pitched sound until students are confident what music and noise means. Ask them to use the words 'music' and 'noise' in a sentence.

Resources

Student Book: chart paper.

Key words

music noise loud noise pollution

Other words in the lesson

volume unwanted sounds

Scientific enquiry key words

use equipment measure compare

notice patterns record

Lesson at a glance

The key teaching points in this lesson are:

- noise is an unpleasant sound, but music is a sound that makes you feel good.
- turning up the volume of music for hours at a time can be unpleasant and cause harmful effects.

Ask students to read the information on page 123. Make sure students learn the causes of noise pollution and the ways to control the pollution.

Ask students which sounds seem unpleasant to them and what steps they take to overcome the effects.

Key idea

Summarise the lesson by asking students what they have learned. Let them share their ideas. Ask a volunteer to read out the key idea. A low pitched sound using their voices. Ask for volunteers to share their ideas about how they feel when they hear loud sound. Ask them to list down the hazards of noise pollution.

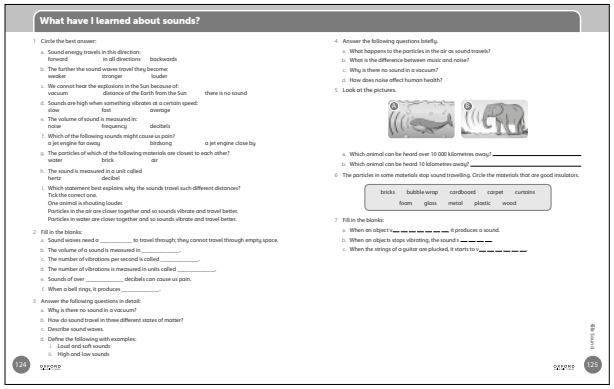
Stretch zone: On a chart paper, design symbols and signs for controlling noise pollution around your school.

Encourage students to share what they think can be the symbols showing ways to control the noise pollution. Help the students to craft their ideas on a chart paper.

Review and reflect

Encourage students to reflect on their own learning by pausing for a few moments and thinking about which parts of the work they found more challenging. Talk about how they managed this and suggest that next time they stop for a short while and take a few deep breaths.

What have I learned about sounds?


What have I learned about sounds?

1 Circle the best answer:
a. Sound energy travels in this direction: forward in all directions backwards
b. The further the sound waves travel they become: weaker stronger louder
c. We cannot hear the explosions in the Sun because of: vacuum distance of the Earth from the Sun there is no sound
d. Sounds are high when something vibrates at a certain speed: slow fast average
e. The volume of sound is measured in: noise frequency decibels
f. Which of the following sounds might cause us pain? a jet engine far away birdsong a jet engine close by
g. The particles of which of the following materials are closest to each other? water brick air
h. The sound is measured in a unit called hertz decibel
i. Which statement best explains why the sounds travel such different distances? Tick the correct one.
One animal is shouting louder.
Particles in the air are closer together and so sounds vibrate and travel better.
Particles in water are closer together and so sounds vibrate and travel better.

2 Fill in the blanks:
a. Sound waves need a _____ to travel through; they cannot travel through empty space.
b. The volume of a sound is measured in _____.
c. The number of vibrations per second is called _____.
d. The number of vibrations is measured in units called _____.
e. Sounds of over _____ decibels can cause us pain.
f. When a bell rings, it produces _____.

3 Answer the following questions in detail:
a. Why is there no sound in a vacuum?
b. How do sound travel in three different states of matter?
c. Describe sound waves.
d. Define the following with examples:
i. Loud and soft sounds
ii. High and low sounds

4 Answer the following questions briefly.
a. What happens to the particles in the air as sound travels?
b. What is the difference between music and noise?
c. Why is there no sound in a vacuum?
d. How does noise affect human health?

5 Look at the pictures.

a. Which animal can be heard over 10 000 kilometres away? _____
b. Which animal can be heard 10 kilometres away? _____

6 The particles in some materials stop sound travelling. Circle the materials that are good insulators.
brick bubble wrap cardboard carpet curtains foam glass metal plastic wood

7 Fill in the blanks:
a. When an object v_____ it produces a sound.
b. When an objects stops vibrating, the sound s_____
c. When the strings of a guitar are plucked, it starts to v_____

Getting started

The aim of this section is to encourage students to review their learning after each topic in the unit. Each topic has some consolidation questions in the Student Book for students to answer. These will assess students' knowledge and understanding of the topic.

It is important that students report areas they are not confident with. This information is vital for you in providing support strategies in the end-of-unit summative assessment.

What I have learned about sounds? answers

1 Circle the best answer:

a. Sound energy travels in this direction: forward in all directions backwards

b. The further the sound waves travel they become: weaker stronger louder

c. We cannot hear the explosions in the Sun because of: vacuum distance of the Earth from the Sun there is no sound

d. Sounds are high when something vibrates at a certain speed: slow fast average

e. The volume of sound is measured in: noise frequency decibels

f. Which of the following sounds might cause us pain? a jet engine far away birdsong a jet engine close by

g. The particles of which of the following materials are closest to each other? water brick air

h. The sound is measured in a unit called hertz decibel

i. Which statement best explains why the sounds travel such different distances? Tick the correct one. One animal is shouting louder. Particles in the air are closer together and so sounds vibrate and travel better. Particles in water are closer together and so sounds vibrate and travel better.

Answer: *a. in all directions b. weaker c. vacuum d. fast e. decibels f. a jet engine close by g. brick h. decibel i. particles in the water are closer together and so sounds vibrate and travel better.*

2 Fill in the blanks:

a. Sound waves need a _____ to travel through; they cannot travel through empty space.

b. The volume of a sound is measured in _____.

c. The number of vibrations per second is called _____.

d. The number of vibrations is measured in units called _____.

e. Sounds of over _____ decibels can cause us pain.

f. When a bell rings, it produces _____.

Answer: *a. Medium b. decibel c. frequency d. hertz e. 130 f. vibrations*

3 Answer the following questions in detail:

a. Why is there no sound in a vacuum?

b. How do sound travel in three different states of matter?

c. Describe sound waves.

d. Define the following with examples: i. Loud and soft sounds ii. High and low sounds

Answer: *3a. Sound needs a medium, e.g water, air to travel. Since there are no particles in the vacuum therefore, there sound cannot travel in the vacuum.*

b. Three states of matter are: solid, liquid and gas.

Sound travels differently through each matter.

In solids, the molecules are packed, therefore the sound travels fastest. In liquids, the sounds travel faster and in the air, it travels fast.

c. Sound waves are defined as the pattern of disturbance brought about by energy moving through a medium.

d. i. loud sound:

Sound travels as waves. The bigger the wave, the more energy it carries, and the louder it sounds. For example: Fire alarm, food blender.

Soft sounds: Soft sound has a low volume. For example: sound of blowing wind.

ii. We define low sounds as having a low pitch and high sounds as having a high pitch.

For e.g. hitting a drum creates a low pitch sound, whereas blowing a whistle makes a high pitch sound high.

4 Answer the following questions briefly.

a. What happens to the particles in the air as sound travels?

b. What is the difference between music and noise?

c. Why is there no sound in a vacuum?

d. How does noise affect human health?

Answer: *4a. Sound waves are longitudinal waves. They cause particles to vibrate parallel to the direction of wave travel.*

b. Music is ordered sound. Noise is disordered sound. Noise is an unwelcome and unpleasant sound, but music is a sound that makes you feel good.

c. Due to lack of medium (air, water) in a vacuum, there is no sound in the vacuum.

d. Every day, millions of individuals are impacted by noise pollution. Noise Induced Hearing Loss is the most frequent health issue. In addition, stress, heart disease, elevated blood pressure, and disturbed sleep are all linked to loud noise exposure.

5 Look at the pictures.

Ask students to study the animals in the pictures. Ask them to think about their habitat. Remind them about how the particles are arranged in solids, liquids and gases and how this affects how sound travels.

a. Which animal can be heard over 10 000 kilometres away?

Answer: *A: whale*

b. Which animal can be heard 10 kilometres away?

Answer: *B: elephant*

6 The particles in some materials stop sound travelling. Circle the materials that are good insulators.

Students read the question carefully. They should discuss each material. Remind them which materials sound travels best in: a solid then a liquid and then a gas. An insulator prevents sound travelling.

Answer: *bubble wrap; carpet; curtains; foam.*

7 Fill in the blanks:

a. When an object v _ _ _ _ _ _ _, it produces a sound.

b. When an objects stops vibrating, the sound s _ _ _ _ .

c. When the strings of a guitar are plucked, it starts to v _ _ _ _ _ _ .

Answer: *a= vibrate b=stops c= vibrate*

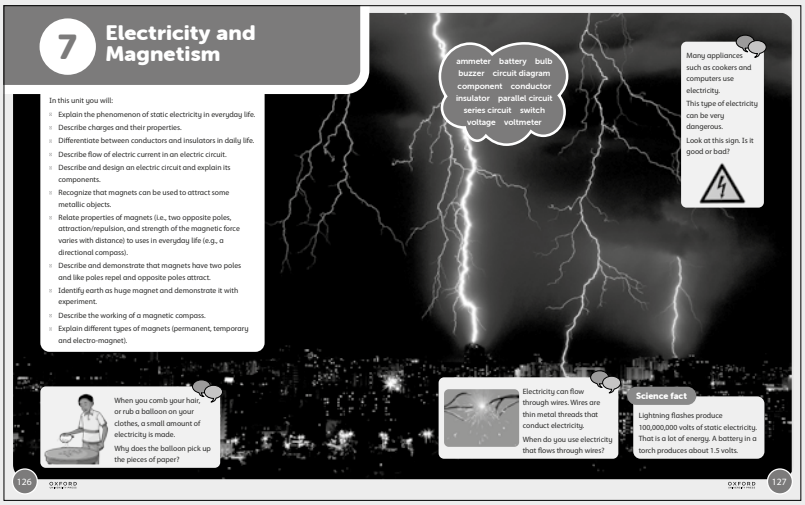
Summative assessment

The questions in the 'What have I learned about sounds?' section on pages 124-125 of the Student Book can be used to consider the progress of each student individually. You can also use the information to create summative reports – such as end-of-term reports – for each student. As with all of the units this year, you can allocate scores based on the number of questions answered correctly or by splitting the questions into smaller sections. You could allocate marks as follows: question 1 has 9 marks; question 2 has 6 marks; question 3 has 8 marks; question 4 has 4 marks; question 5 has 2 marks; question 6 has 4 marks; question 7 has 3 marks. This makes a total of 36 marks.

7 Electricity and magnetism

In this unit students will:

- Explain the phenomenon of static electricity in everyday life.
- Describe charges and their properties.
- Differentiate between conductors and insulators in daily life.
- Describe flow of electric current in an electric circuit.
- Describe and design an electric circuit and explain its components.
- Recognize that magnets can be used to attract some metallic objects.
- Relate properties of magnets (i.e., two opposite poles, attraction/repulsion, and strength of the magnetic force varies with distance) to uses in everyday life (e.g., a directional compass).



- Describe and demonstrate that magnets have two poles and like poles repel and opposite poles attract.
- Identify earth as huge magnet and demonstrate it with experiment.
- Describe the working of a magnetic compass.
- Explain different types of magnets (permanent, temporary and electro-magnet).

Getting started

In this unit students review prior learning of electricity and then look in more detail at conductors and insulators.

The introductory lesson is designed to engage and inspire students. It reminds them of any prior learning and also introduces the ideas and concepts of electricity. In subsequent lessons, students investigate electrical conductors and insulators and move onto consider electrical circuits and building a test circuit. Students learn how to increase the number of components in a circuit and observe the effects. They learn the conventional symbols for drawing circuit diagrams. Finally, they measure the flow of electricity and link this to the brightness of bulbs and the number of batteries. They also understand the structure of wires. Circuit diagrams are drawn and interpreted.

Science in context

Use the lessons in this unit to encourage students to learn more about the importance of electricity in everyday life. Allow students to survey electrical appliances and other uses of electricity in school and their local area. Take them out to see important uses of electricity such as streetlights, traffic lights, shop and hospital lights and appliances such as refrigerators, computers and cookers. Students have studied electricity in earlier years, so remember to find out where they have visited in previous years to add to this experience rather than duplicate it. Encourage students to find out about how electricity is used to enhance life. Discuss the dangers of electricity and use examples of safety signs and notices from the area. Invite people into school who use electricity as part of their work – such as electricians, electrical engineers, farmers and people who use portable lights such as climbers and cavers. Encourage students to keep a diary of electrical appliances and devices they use and to imagine what life would be like without electricity. Allow students to consider the development of our understanding of electricity and how appliances such as torches have changed over time. Also ensure that students are aware that electricity is very important but has negative impacts on the environment. Take them to see a power station, if possible, and discuss the fuels it uses; and visit a recycling plant to observe how appliances, devices and batteries are recycled.

Scientific enquiry skills

Students plan and carry out a range of investigations to help them test their ideas about electricity. They make predictions and write conclusions. They are expected to evaluate their enquiry work and ensure that they set up and carry out fair tests.

Prompt questions and discussions are included to support students as they plan and evaluate their investigations. Students also have opportunities to record findings in different ways and to interpret results. You can use the Investigation master sheet on pages 4–5 to support investigative work. This provides prompts and

structure to support students in planning and carrying out fair tests and in recording and drawing conclusions about their findings.

Resources

Student Book: batteries; wires; connectors; bulbs; range of everyday objects of varying conductivity to test (e.g. plastic and wooden rulers, paper, card, fabric, spoons, scissors); ammeters; nichrome wire in pieces of different thickness and length; switches; materials to make information sheets; voltmeters; writing materials; buzzers.

Key words for unit

Bold words are in the Word cloud.

ammeter appliance **battery** bulb

buzzer cable cell circuit circuit breaker

circuit diagram circuit symbol **component**

conductor current fuse gauge **insulator**

mains electricity metal **parallel circuit** plastic

plug **series circuit**

switch symbol **voltage**

voltmeter wire

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Language support

The introductory lesson contains a Word cloud of the key words to be covered in the unit. These words could be placed on a Word wall in the classroom.

Students should recall that a circuit in electricity ishow all of the components join together. It has to be a complete circuit like a running track or the components will not work. A component is anything that is includedin the circuit. Even a wire is a component. 'Voltage' is a more recent addition to the electricity vocabulary. Remind students that this is the push in a circuit. Some people think of it as the pressure pushing the current around the circuit. You could collect science books and encyclopaedias to form a small class library as a resource for students to research definitions and also act as support for 'finding out' tasks. Consider downloading information sheets about the concepts to be covered in the unit, as well as allowing students access to the internet to help develop their computer skills.

Unit at a glance

The key teaching points for students in this unit are:

- to introduce the unit objectives
- to introduce the learning outcomes
- to engage students with the content of the unit
- to review and build on prior learning and understanding of the topics.

When you comb your hair, or rub a balloon on your clothes, a small amount of electricity is made. Why does the balloon pick up the pieces of paper?

Ask students to work with a partner. Allow them to study the picture showing how the person is using a balloon to pick up small pieces of paper. They might recall investigations like this from their prior learning. Ask them to share examples of using this technique and then pairs can share their ideas with the class.

Possible response: *Students might suggest that static electricity is causing the balloon to pick up the pieces of paper. This is different from the electricity that is used when we plug in an appliance. The charged particles attract oppositely charged particles.*

Science fact Lightning flashes produce 100 000 000 volts of static electricity. That is a lot of energy. A battery in a torch produces about 1.5 volts.

Read out the Science fact or ask a volunteer to read it out. Ask students to consider the electricity that is produced during a storm. Say the number out loud – one hundred million – and ask students why lightning can be so dangerous. Elicit that if a person is struck by lightning, the shock can kill that person, and if a building is struck by lightning, it can start a fire.

Electricity can flow through wires. Wires are thin metal threads that conduct electricity. When do you use electricity that flows through wires?

Ask students to share their ideas about when they have used electrical devices with wires. Allow students to work in pairs or small groups. Elicit that many of the machines that help us at home, such as vacuum cleaners and refrigerators, use electricity that flows through wires. Ask

Unit 7 Electricity and magnetism

if they can name any other appliances. Ask if they have seen wires connecting appliances to the mains supply. Use this opportunity to tell students to never touch wires, especially if the covering is broken.

Possible response: *Students might suggest any appliances, for example computers, smartphone chargers or a games console.*

Many appliances such as cookers and computers use electricity. This type of electricity can be very dangerous. Look at this sign. Is it good or bad?

Ask students to continue to work with their partner or small group. Ask students to look at the sign. Find out if any of them have seen this sign. You could ask if they have seen similar danger signs. Ask, 'Where will you see a sign like this? What does the sign tell you? What happens if we ignore the sign?'

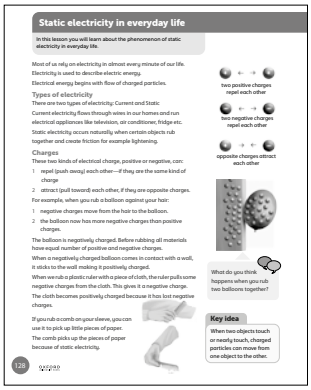
Possible response: *Students should suggest that the sign is a warning and they should stay away from the area.*

Extra activities

1 **Maths link:** Students could compare different materials by rubbing the comb with each material and counting which one can pick up the most pieces of paper. They should tear the pieces of paper into the same size so that it is a fair test. Ask them what else they should keep the same to make their investigation a fair test. Elicit that the material is the independent variable so will be changing, but the type of paper should be the same and they must try to keep the same distance between the paper and the comb.

2 Students make a small summary poster about everything they know about the uses of electricity. They can survey the room or the school and also download photographs of appliances and add them to their poster.

Static electricity in everyday life


Static electricity in everyday life

In this lesson you will learn about the phenomenon of static electricity in everyday life.

Most of us rely on electricity in almost every minute of our life. Electricity is used to describe electric energy.

Electrical energy begins with flow of charged particles.

Types of electricity

There are two types of electricity: Current and Static.

Current electricity flows through wires in our homes and run electrical appliances like television, air conditioner, fridge etc.

Static electricity occurs naturally, when certain objects rub together and create friction for example lightening.

Charges

These two kinds of electrical charge, positive or negative, can:

1 repel (push away) each other—if they are the same kind of charge

2 attract (pull toward) each other, if they are opposite charges.

For example, when you rub a balloon against your hair:

1 negative charges move from the hair to the balloon.

2 the balloon now has more negative charges than positive charges.

The balloon is negatively charged. Before rubbing all materials have equal number of positive and negative charges.

When a negatively charged balloon comes in contact with a wall, it sticks to the wall making it positively charged.

When we rub a plastic ruler with a piece of cloth, the ruler pulls some negative charges from the cloth. This gives it a negative charge.

The cloth becomes positively charged because it has lost negative charges.

If you rub a comb on your sleeve, you can use it to pick up little pieces of paper.

The comb picks up the pieces of paper because of static electricity.

two positive charges repel each other

two negative charges repel each other

opposite charges attract each other

What do you think happens when you rub two balloons together?

Key idea

When two objects touch or nearly touch, charged particles can move from one object to the other.

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Getting started

This lesson introduces students to two different types of electricity and the nature of charges- attraction and repulsion. The lesson further explains the nature of charges with examples from everyday life.

Language support

Explain to the students that the flow of charges is called current. Ask them to discuss what attraction and repulsion is. Explain to them the concept of Opposite attracts and likes repel. The lesson will apply this concept of charge interactions to describe the wide range of phenomena related to static electricity.

Resources

Student book, balloons, comb

Scientific enquiry key words

use equipment observe compare
group/classify communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- there are two types of electricity: current electricity and static electricity.
- any charged object can exert electric force upon other objects - both charged and uncharged objects.
- like charges cause repulsion and unlike charges cause attraction.

Think back: Can you remember any parts of a circuit from your earlier learning? Make a list.

Students should read the text on page 128 and focus on the image at the upper right corner of the page. Explain to them that the two kinds of electrical charges—positive and negative—are opposite forms of charge. Furthermore, in line with the basic idea of charge interaction, a positively charged object will attract a negatively charged object. Objects with opposite charges will be drawn to one another. Like-charges repel one another, in contrast to the attractive force between two objects with opposing charges.

Use the hair comb experiment to demonstrate to the students the idea of static electricity by rubbing it on a woolen fabric and seeing what happens to the pieces of paper.

What do you think happens when you rub two balloons together?

Ask students what they think would happen when the balloons are rubbed together. Refer them to read the text on the page again to clear the concept. Upon their answers, conduct the experiment to show them what happens when the balloons are rubbed together.

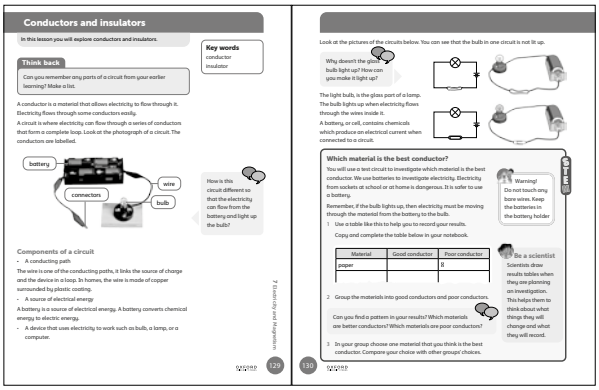
Answer: *Students will answer that the balloons will repel each other when rubbed together.*

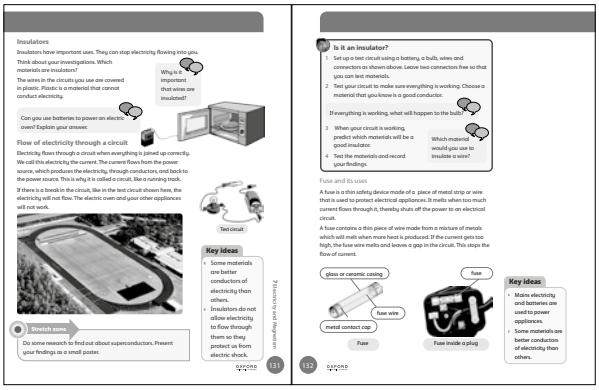
Key idea

- *When two objects touch or nearly touch, charged particles can move from one object to the other.*

Summarise the lesson by explaining the concept that rubbing materials together can help move charge more quickly because more surface area is being contacted.

Conductors and insulators





Getting started

This lesson introduces students to the idea that materials work differently in a circuit. Students become aware of the similarities and differences between materials that conduct (allow electricity to pass through) and those that insulate (don't allow electricity to pass through). They will explore and investigate conductors and insulators in an electrical circuit. They will also consider the importance of conductors and insulators in everyday life.

Language support

Ask students to discuss the two key words: conductor and insulator. Use a length of wire to explain how the insulator covering prevents or stops the electricity flowing into people and the conductor helps the electricity to flow in the wire. Hold up materials and allow students to say insulator or conductor. Discuss their ideas.

Resources

Student Book: wires; bulbs; batteries; connectors (crocodile clips); selection of materials to test; access to books about superconductors or to the internet; materials to make posters.

Key words

conductor insulator

Other words in the lesson

material

Scientific enquiry key words

use equipment observe compare
notice patterns record carry out tests
group/classify communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- materials can be electrical conductors or insulators
- materials can be tested to find out if they are insulators or conductors.

Think back: Can you remember any parts of a circuit from your earlier learning? Make a list.

This can be a plenary session where you write what students say on a board. Students should recall the components of a simple circuit including wires, battery, connectors, bulbs, switches and buzzers.

Conductors

Ask students to work with a partner to read the information under the heading. Ask them to look at all of the conductors labelled in the circuit. Ask students to then read the information about the drawings of the two circuits and the bulbs. Explain that bulbs are the glass parts of lamps that light up when electricity flows through them.

How is this circuit different so that the electricity can flow from the battery and light up the bulb?

Refer students to the circuit drawing on the right and ask pairs of students to discuss the question.

Answer: *Students should recognise that the circuit is completed with the metal paperclip. This is conducting the electricity to the other wire and around the circuit.*

Why doesn't the glass bulb light up? How can you make it light up?

Refer students to the circuit drawing on page 130 and ask them to discuss why the bulb doesn't light up in this circuit. Here there is an elastic band connecting the wires. Ask students to think about whether or not the elastic band is a conductor.

Answer: *Students should state that the elastic band is not a good conductor of electricity. This means that the electricity cannot flow around the circuit and the bulb does not light up. They should suggest replacing the elastic band with something metal that will conduct electricity and allow the bulb to light up.*

Ask students to continue to work together to read the text about how a battery works. This is quite complex and some students will need support to understand the principle. Tell them that batteries are known as cells by scientists because they contain different compartments that release chemicals. When batteries are connected in a circuit, they produce an electrical current. Ask students to share their experience of conductors from earlier lessons. Explain that not all conductors are the same and some are better than others. Explain that students will investigate this.

Investigation: Which material is the best conductor?

Organise students into small groups for this activity.

Warning! Do not touch any bare wires. Keep the batteries in the battery holder.

Remind students of the safety warning at the start of the investigation. Ask them to share why they should not touch bare wires to remind them how to keep safe.

Students will need to set up a test circuit and some materials to investigate. They will need to construct a table of results to help them record their findings like the example shown. After the investigation students group the materials into good and poor conductors. They also select the best conductor and compare this to other groups' choices. Encouarge students to share their findings and discuss any differences or similarities.

Can you find a pattern in your results? Which materials are better conductors? Which materials are poor conductors?

Possible response: *Students might see that metals are good conductors of electricity. Some metals, for example copper, are good conductors of electricity. Other materials, for example plastic or wood, are not good conductors of electricity.*

Be a scientist: Scientists draw results tables when they are planning an investigation. This helps them to think about what things they will change and what they will record.

Ask students to read the Be a scientist information about how good scientists work. Remind them that drawing and recording in tables helps all scientists, including students, to keep their results neat and tidy, and organised to allow them to share them with other scientists. Some students find drawing tables difficult but this should show them why it is important.

Insulators

Ask students to continue to work together to read the information about insulators. Discuss how an insulator works in the opposite way to a conductor: it stops the flow of electricity. Some materials are good insulators and some are not so good in the same way that some conductors can be better than others. Ask students to remind you why we cover wires in plastic. Then ask them to work on the discussion question.

Why is it important that wires are insulated?

Answer: *Students should know that insulated wires keep users safe by preventing the electricity flowing into them. Humans are very good conductors of electricity but this is very dangerous, so we need to stop electricity from flowing through us.*

Stretch zone: Do some research to find out about superconductors. Present your findings as a small poster.

For the Stretch zone activity, some students might like to work independently; others with a partner for support and collaboration. They could use the internet to find out about superconductors. You could help them by telling them that superconductors have very little resistance. This means that almost all of the electricity flows through the superconductor. Unlike the bulb, very little is converted to heat or light.

Key ideas

- *Some materials are better conductors of electricity than others.*
- *Insulators do not allow electricity to flow through them so they protect us from electricity.*

Summarise the lesson by asking students what they have learned. Let them share their ideas. Ask two volunteers to read out one key idea each. This will remind students that some materials are good conductors of electricity and others are not. Ask students to name some examples of good conductor materials and some examples of good insulator materials.

Extra activities

1 Students draw diagrams of objects that use conductors and insulators of electricity. They share their drawings and discuss why the materials have been used.

2 **Computing link:** Students find out what other devices and equipment use materials that need to insulate electricity. They could extend this to a survey of their home.

Differentiation

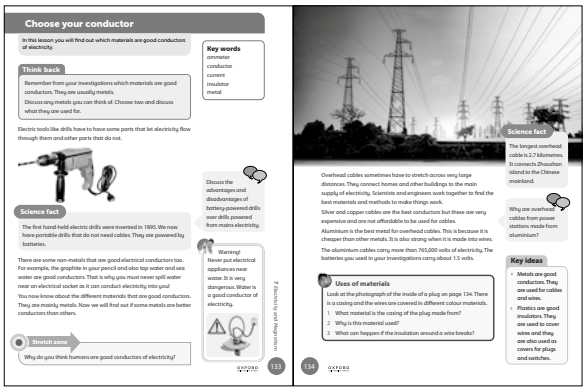
Supporting: Support students to carry out the investigation using a range of materials.

Consolidating: Students could organise the materials into groups of good and poor conductors based on their repeated investigations.

Extending: Students could be asked to predict if a material is a good conductor or a good insulator.

Differentiated outcomes	
All students	should be able to state that some materials are conductors and others are insulators of electricity
Most students	will be able to test different materials to identify if they are conductors or insulators
Some students	may be able to predict if a material is a good or poor conductor

Choose your conductor


Choose your conductor

In this lesson you will find out which materials are good conductors of electricity.

Key words
ammeter
conductor
current
insulator
metal

Think back
Remember from your investigations which materials are good conductors. They are usually metals.
Discuss any metals you can think of. Choose two and discuss what they are used for.

Electric tools like drills have to have some parts that let electricity flow through them and other parts that do not.

Discuss the advantages and disadvantages of battery-powered drills over drills powered from mains electricity.

Science fact
The first hand-held electric drills were invented in 1895. We now have portable drills that do not need cables. They are powered by batteries.

Warning!
Never put electrical appliances near water. It is very dangerous. Water is a good conductor of electricity.

There are some non-metals that are good electrical conductors too. For example, the graphite in your pencil and also tap water and sea water are good conductors. That is why you must never spill water near an electrical socket as it can conduct electricity into you!
You now know about the different materials that are good conductors. They are mainly metals. Now we will find out if some metals are better conductors than others.

Stretch zone
Why do you think humans are good conductors of electricity?

7 Science in my daily life

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Overhead cables sometimes have to stretch across very large distances. They connect homes and other buildings to the main supply of electricity. Scientists and engineers work together to find the best materials and methods to make things work.
Silver and copper cables are the best conductors but these are very expensive and are not affordable to be used for cables.
Aluminium is the best metal for overhead cables. This is because it is cheaper than other metals. It is also strong when it is made into wires.
The aluminium cables carry more than 765,000 volts of electricity. The batteries you used in your investigations carry about 1.5 volts.

Science fact
The longest overhead cable is 2.7 kilometres. It connects Zhoushan island to the Chinese mainland.

Why are overhead cables from power stations made from aluminium?

Key ideas
- Metals are good conductors. They are used for cables and wires.
- Plastics are good insulators. They are used to cover wires and they are also used as covers for plugs and switches.

Uses of materials
Look at the photograph of the inside of a plug on page 134. There is a casing and the wires are covered in different colour materials.
1 What material is the casing of the plug made from?
2 Why is this material used?
3 What can happen if the insulation around a wire breaks?

134

Getting started

In this lesson students investigate conductors of electricity. The focus of this lesson is on the conductivity of a variety of metals. Students are introduced to the ammeter as a piece of equipment that measures current.

Language support

The Word cloud at the beginning of the unit could be used throughout to check students' understanding of concepts and introduce any unfamiliar words. Most students should be familiar with the key words in this topic, although 'ammeter' may be unfamiliar. Remind students that the word 'meter' is used for a device that measures something.

Resources

Student Book: batteries; wires; connectors; bulbs; range of metals to test for conductivity;.

Key words

conductor current insulator metal

Other words in the lesson

conductivity copper drill graphite portable powered socket tools

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- some materials are good conductors and others are not
- metals and some non-metals are good conductors
- a test circuit can be used to test if a material is a conductor.

Think back: Remember from your investigations which materials are good conductors. They are usually metals. Discuss any metals you can think of. Choose two and discuss what they are used for.

Ask students to list as many different metals that they know of. They can do this individually and then compare their list with a partner and make a joint list. Let them choose two of the metals on their list. Ask, 'What do you think they are used for?' Elicit from students the materials they remember to be good conductors from their investigations. Write their answers on the board.

Discuss the advantages and disadvantages of battery-powered drills over drills powered from mains electricity.

Ask students to read the text and look at the photograph of the drill on page 133. Encourage them to look at the materials used in the construction of the drill.

> ***Answer:*** *Battery-powered drills are not connected to mains electricity so they are more portable. The power stored in the battery will be used up so it will need to be recharged. Those powered by mains electricity carry on without needing to be recharged.*

Science fact: The first hand-held electric drills were invented in 1895. We now have portable drills that do not need cables. They are powered by batteries.

Read out the Science fact or ask a volunteer to read it out. Ask students to think about the first drill that was invented. Ask them to think about what it might have been like. They might suggest that is was bigger and heavier as it was probably constructed out of metals and possibly wood.

Warning! Never put electrical appliances near water. It is very dangerous. Water is a good conductor of electricity.

Read out the safety warning and ask students why this is an important safety rule. Ask students to discuss why they should not have an electric heater above a bath or a socket very near to a shower.

Stretch zone: Why do you think humans are good conductors of electricity?

Ask students to talk about the Stretch zone question with a partner. Ask them to decide on a reason and then you can ask volunteers to share their ideas with the class.

Answer: *Humans are made up of about 60% water, which is a good conductor of electricity. Salt water is an even better conductor of water and we also contain salts.*

Investigation: Uses of materials

The purpose of this investigation is to encourage students to consider how insulators are used in real-life objects to shield us from electricity.

Encourage them to think about their investigationson insulators and to consider the other properties of materials used to cover plugs and wires. For example, is it easy to shape? Is it expensive? Does it catch fire easily? You could explain that before plastic was invented, plugs and wires were covered in other insulators. Rubber and sometimes wood were used. Take the opportunity to reinforce that students must never touch a broken wire, even if the appliance is not plugged in. Explain that electricity can still flow. Show them a computer laptop or a phone charger. Some have a light near the plug which stays illuminated for some time after it has been unplugged.

Possible response: *The plug casing is made from plastic because it is a good insulator of electricity. If the insulation breaks, it is dangerous to use. The electricity could be conducted into a person and cause an electric shock or even electrocution.*

Science fact: Ask students to continue to work with their partner to read the text on page 134 and look at the photograph. Read out the Science fact or ask a volunteer to read it out. Science fact The longest overhead cable is 2.7kilometres. It connects Zhoushan island to theChinese mainland.

Why are overhead cables from power stations made from aluminium?

Discuss the difference between wires and cables (a cable is much thicker and may comprise many wires). Ask students to think about the distances cables need to stretch across. Ask them to look at the table on page 134 in pairs and decide which metal they would choose for an overhead cable. Use the Science fact to demonstrate that some cables need to cross very long distances.

Possible response: *Aluminium is a very goodconductor of electricity. It is easily pulled into wires and it is much cheaper than other metals.*

Key ideas

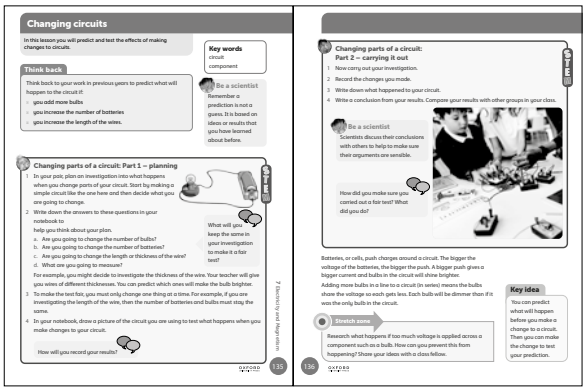
- *Metals are good conductors. They are used for cables and wires.*
- *Plastics are good insulators. They are used to cover wires and they are also used as covers for plugs and switches. Summarise the lesson by asking students to close their books and count to 20. After that they should turn to a partner and between them write down what they think the key ideas for the lesson should be. They can share their ideas with the class and then open up their books to check if they were correct. Once they have completed this you can ask students to tell their partner the types of materials that are used to cover wires and sockets, and to explain why. Ask them to say why we should never use cables where the insulation is damaged.*

Extra activities

1 **Computing link:** Ask students to research other scientists who have helped our understanding of electricity – for example the Ancient Greeks, Alessandro Volta, Edith Clarke, Maria Telkes. They can use books, the internet or printed information sheets you provide. They can find out who the scientists were, where they lived, and when and what they studied and found out. Ask, 'Did they invent or research anything else?'

2 **Computing link:** Students study their chart showing the order of conductivity and then select one metal from the list. They find out about the metal using books or by carrying out an internet search and they create an information card about it. They draw or download pictures of the metal being used and include any uses that depend on it being a conductor of electricity.

Changing circuits



Getting started

This lesson introduces students to the idea that when the components in a circuit are changed the circuit behaves differently. Students make predictions about the changes if more bulbs or batteries are added to a circuit. They also investigate if the thickness of a wire has any impact on a circuit. Students test their predictions. They practise using their results to draw conclusions. They also explore how in a series circuit the voltage from a battery or mains electricity is shared across all of the components.

Language support

Read through the key words with the class. Ask students to define 'circuit' and 'component' based on their prior learning. 'Component' is a difficult word – it has been covered in previous lessons but make sure you use the word interchangeably with 'electrical part'. Discuss the circuits they have used. Ask students to give examples of the components they have used, for example bulbs, batteries and switches. They can complete any glossaries or Word walls that they might have started as they experience the words and use them.

Resources

Student Book: batteries; wires; connectors; bulbs; nichrome wire in pieces of different thickness and length.

Key words

circuit component

Other words in the lesson

batteries bulbs gauge series voltage wire

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- changing the components in a circuit has an effect on the other components
- the changes in a circuit can be predicted.

In the next lesson, students will learn about the uses of circuit breakers such as switches.

Think back: Think back to your work in previous years to predict what will happen to the circuit if:

- you add more bulbs
- you increase the number of batteries
- you increase the length of the wires.

Ask students to work with a partner to discuss each of the Think back points. Ask them to recall the investigations they have carried out in prior learning. They could draw any diagrams to help them recall or list the components they used.

Possible response: *Students should predict that when more bulbs are added, they will be dimmer. When the number of batteries is increased, the bulbs will be brighter. When the length of a wire is increased, the bulbs will be dimmer.*

Be a scientist: Remember a prediction is not a guess. It is based on ideas or results that you have learned about before.

Read out the Be a scientist information and ask students to think about what a prediction is before they carry out the investigations. Remind them that this is not a guess. It is based on knowledge and experience.

Ask students to work in pairs for the duration of the investigations in this lesson.

Investigation: Changing parts of a circuit: Part 1 – planning

The purpose of this investigation is to help students explore what happens when changes are made to a circuit. Stress that in this first part they are only going

to carry out the planning phase. Arrange students into pairs and ask them to follow the instructions to plan an investigation into what will happen if they change a simple circuit by altering the: number of bulbs; number of batteries; length of wire or thickness of wire. Ask the pairs to decide what they will change and what they will measure. If ammeters are available, the results will be easier to record.

Allow students to work independently and only step in if they need support. This will help them to develop perseverance and will help to increase their confidence and problem-solving skills. Also explain that to make the test fair, they should only change one thing at a time. Each time they should draw a picture of the circuit they are using to test what happens.

Tell students that when the components (bulb, ammeter) are connected one after another in a row it is called a series circuit.

Possible response: *Students will follow steps 1–4 to plan their investigation using all the prompts provided.*

Ask students to talk about the discussion questions in their investigation groups before moving onto Part 2 of the investigation.

What will you keep the same in your investigation to make it a fair test?

Ask students to discuss what makes a fair test and then to evaluate their investigation. Remind them that a fair test will have an independent variable (what they are changing), a dependent variable (what they are measuring) and control variables (what they are keeping the same).

Possible response: *Students should recognise that to run a fair test they can only change one variable at a time. This is called the independent variable. They measure the outcome of the dependent variable.*

How will you record your results?

Ask students to think about how they will record their results. They should set up a table in their notebook. Ensure that they prepare this prior to the investigation.

Possible response: *Students should design their investigation and record their results so that the investigation can accurately be repeated by others.*

Investigation: Changing parts of a circuit: Part 2 – carrying it out

Students should now carry out their planned investigation. Remind them to record the changes they make and write down what happens in their circuit. Remind them to test their circuit and that all the components are working before beginning the investigation. Ask the pairs to carry out their investigation, changing either the number of bulbs or batteries or the length/thickness of the wire.

Ask the groups to discuss if there was any pattern in their results, for example as the length of wire increased what happened to the bulb? After analysing the results, they should write a conclusion and compare their results with other groups in the class.

Possible response: *Students should use their results to write a conclusion. They should find that as more bulbs were added or the length of wire was increased the brightness of the bulb decreased. If they added more batteries, the brightness increased. They should be able to identify these patterns using their data.*

Be a scientist: Scientists discuss their conclusions with others to help to make sure their arguments are sensible.

Ask students why it is so important to talk about their conclusions with other people. Elicit that by doing this they can check if their ideas make sense and also consider other people's ideas. Point out that this is why a good investigation plan has to be detailed enough so that other people can repeat it. This means they can share their data and see if they come up with the same conclusions.

How did you make sure you carried out a fair test? What did you do?

Ask students to talk about the questions to encourage them to think about their findings and how they carried out the investigation. Ask them to compare their methods and suggest any improvements to it.

Possible response: *Students should have only changed one variable and controlled any others that could affect the dependent variable.*

Ask students to work independently to read through the summary text under the investigation on page 136.

Stretch zone: Research what happens if too much voltage flows through a component such as a bulb. How can you prevent this from happening? Share your ideas with a partner.

Allow students to use the internet to find out about voltage and bulbs. Ask them to find different bulbs and record the voltage stated on them.

Possible response: *If too much voltage flows through some filament bulbs, the wire heats up and breaks. Students should use the correct voltage recommended for all components to avoid breakages or even electrical fires.*

Key idea

You can predict what will happen before you make a change to a circuit. Then you can make the change to test your prediction.

Ask a volunteer to read out the key idea. This will remind students of what happens to a circuit when components are changed. Ask them to explain to a partner what happens when more bulbs or batteries are added to a circuit. Ask them what they observed. You could draw a circuit on the board with three bulbs and two batteries and ask students to suggest one way of making the bulbs brighter and one way of making the bulbs less bright.

Review and reflect

Use the discussion tasks, the Stretch zone activity tasks to encourage students to think about what they understand and what they are finding less straightforward. Discuss the outcomes of each task with students. Encourage them to identify aspects they have not completed correctly and help them to identify improvements. This will help students to develop a positive approach to learning by understanding that learning is a process that will improve with practice and reflection.

Extra activities

1 Students take pictures of their investigation and describe how they made this a fair test.

2 Students research the different thicknesses of wires and explain in a leaflet how they are used.

Differentiation

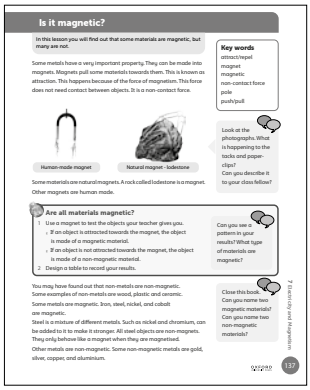
Supporting: Demonstrate a circuit so students can observe an example of what happens when one of the components in a circuit is changed.

Consolidating: Students can continue to add bulbs to a circuit until they no longer light to illustrate how the bulbs have to share the electricity and so each has less and less.

Extending: Students predict and test the effect of the thickness of a wire on a bulb. They repeat their observations.

Differentiated outcomes	
All students	should be able to observe what happens to a circuit when more bulbs are added
Most students	will be able to predict what will happen when more batteries are added to a circuit
Some students	may be able to make a number of predictions based on changes to a circuit

Is it magnetic?


Is it magnetic?

In this lesson you will find out that some materials are magnetic, but many are not.

Some metals have a very important property. They can be made into magnets. Magnets pull some materials towards them. This is known as attraction. This happens because of the force of magnetism. This force does not need contact between objects. It is a non-contact force.

Key words
attract/repel
magnet
magnetic
non-contact force
pole
push/pull

Look at the photographs. What is happening to the tacks and paper-clips?
Can you describe it to your class fellow?

Human-made magnet

Natural magnet - lodestone

Some materials are natural magnets. A rock called lodestone is a magnet. Other magnets are human made.

Are all materials magnetic?

1 Use a magnet to test the objects your teacher gives you.
- If an object is attracted towards the magnet, the object is made of a magnetic material.
- If an object is not attracted towards the magnet, the object is made of a non-magnetic material.

2 Design a table to record your results.

Can you see a pattern in your results? What type of materials are magnetic?

You may have found out that non-metals are non-magnetic. Some examples of non-metals are wood, plastic and ceramic.
Some metals are magnetic. Iron, steel, nickel, and cobalt are magnetic.
Steel is a mixture of different metals. Such as nickel and chromium, can be added to it to make it stronger. All steel objects are non-magnets. They only behave like a magnet when they are magnetised.
Other metals are non-magnetic. Some non-magnetic metals are gold, silver, copper, and aluminium.

Close this book.
Can you name two magnetic materials?
Can you name two non-magnetic materials?

7 Electricity and Magnetism

137

Getting started

In this lesson students are introduced to the non-contact force of magnetism. They will investigate magnetic and non-magnetic materials, and the properties of magnets.

Language support

Introduce the key words and read them out to the class. Ask them if they know what any of them mean or if they have heard of them before. Discuss how 'attract' means to move towards and 'repel' means to move away. You could ask students to volunteer to act out 'attract' – they should move towards each other; 'repel' – they should move away from each other. Explain that they are being non-contact forces – so they should not touch each other.

Write the word 'magnet' on the board and ask students to volunteer definitions. Then change the word from magnet to magnetic. Ask a volunteer to use the word 'magnetic' in a sentence.

Resources

Student Book: magnets; selection of magnetic and non-magnetic objects.

Key words

attract/repel magnet magnetic
non-contact force pole push/pull

Other words in the lesson

North South

Scientific enquiry key words

use equipment observe notice patterns
record data group/classify
use secondary sources

Lesson at a glance

The key teaching points in this lesson are:

- some materials are magnetic and are attracted to a magnet
- a magnet has a North-seeking pole and a South-seeking pole.

Read the text at the top of page 88 and demonstrate a magnet attracting material towards it but without touching it, to reinforce the idea of a non-contact force.

Discussion

Look at the photographs. What is happening to the tacks and paperclips? Can you describe it to your partner?

Possible response: *Students should recognise that the tacks and paperclips are attracted to the magnets.*

Investigation: Are all materials magnetic?

The aim of this investigation is for students to explore magnetic and non-magnetic materials. Each group will need a small bar magnet and a range of magnetic and non-magnetic materials or objects to test. Students should design a table to record their results in, and should record that if the materials are attracted to the bar magnet, they are magnetic. If they are not attracted, they are non-magnetic.

Discussion

Can you see a pattern in your results? What type of materials are magnetic?

Possible response: *Students should begin to see that non-metals are non-magnetic, and that some metals are magnetic.*

Discussion

Close this book. Can you name two magnetic materials? Can you name two non-magnetic materials?

Possible response: *Students may know that only iron, steel, nickel and cobalt are magnetic materials. All other materials are non-magnetic, including metals such as gold, silver and copper.*

Read the text at the top of page 89 and discuss the word 'poles' with students. Ask them if they know that the Earth has poles – and if they can name these parts of the Earth. This will help them to make the link to the poles of a magnet.

Investigation: What happens when we bring two magnets together?

The aim of this investigation is for students to explore the rules of attraction and repulsion of magnets. Each group will need two bar magnets. Point out that it is easy for magnets to be damaged if they are banged, dropped on the floor or stored incorrectly. For each test, ask students what they feel between the magnets when two like poles are pushed together and two opposite ones. Two like poles will push apart or repel, and two opposite poles are attracted or pull together. This is the law of magnetism, as shown in the diagram below the investigation.

Key ideas

Magnetism is a non-contact force.

Magnets can pull or attract some materials towards them. They can also push or repel some materials away from them.

Summarise the lesson by asking students what they have learned. Let them share their ideas, read out and discuss the key ideas. This will remind students that forces are invisible but that we can see the effect of them on objects, including magnets.

Review and reflect

Use the discussion questions to evaluate the learning taking place during the lesson. You could also use the Workbook activities to assess the understanding of the content so far. Ask questions in the lesson and address any misunderstandings throughout.

Encourage students to identify aspects they have not completed correctly and help them to identify improvements. This will help students to develop a positive approach to learning by understanding that learning is a process that will improve with practice and reflection.

Conclude the lesson by asking students to try question 2 and question 3 of the 'What have I learned about forces and magnets?'

Extra activities

1 Extend the first investigation by asking students to find out how close an object has to be to the magnet before it is attracted to the magnet.

2 **Maths link:** Students could find out if bigger magnets are stronger. Provide students with a range of different magnets and count how many pins each one can pick up. Encourage them to review their findings and conclude whether bigger magnets are stronger. They should find that they are not always stronger (neodymium magnets, for example, are small but very strong).

Differentiation

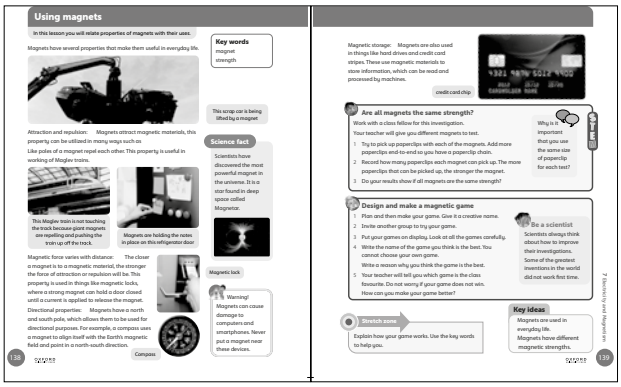
Supporting: Provide students with a magnet and a magnetic material. Ensure they understand what magnetic attraction feels and looks like.

Consolidating: Students could start to predict which of the materials they have been provided with will be magnetic based on their initial findings in the investigation on page 88.

Extending: Students could explore the non-contact nature of magnetism by trying to move magnetic objects using a magnet below a sheet of paper.

Differentiated outcomes	
All students	should be able to recognise if a magnet repels or attracts a material.
Most students	will be able to test materials using a magnet.
Some students	may be able to understand the law of magnetism.

Using magnets



Getting started

In this lesson students will consider some of the many uses of magnets in everyday life. They will discover that magnets can have different strengths of magnetism.

Language support

Students should be familiar with the term 'magnet'. Reinforce this by asking students to use the word in a sentence, which also includes the word 'magnetism'. Ask students to look at the photographs on page 138, and to compare the strength of the magnet picking up the car and the one holding a piece of paper to the fridge. Ask which one is the strongest.

Resources

Student Book: materials to make fridge magnets (magnetic strips, photographs, glue); scissors; various magnets; paperclips; items to make a magnetic game (such as card, small magnets, ball bearings, sticky tape, glue, coloured pens, small wooden sticks).

Key words

magnet strength

Other words in the lesson

fridge

Scientific enquiry key words

use equipment

Lesson at a glance

The key teaching points in this lesson are:

- magnets can be different strengths
- magnets have many different uses.

Read through the text at the top of page 90 and ask students to look at the photographs. Ask a volunteer to choose a photograph that shows a strong magnet, and one that shows a weaker magnet.

Science fact Scientists have discovered the most powerful magnet in the universe. It is a star found in deep space called Magnetar.

Discuss the Science fact and talk about how some things like stars can be magnets.

Warning! Magnets can cause damage to computers and smartphones. Never put a magnet near these devices.

Read out the warning and remind students to use magnets carefully.

Investigation: Are all magnets the same strength?

Ask students to compare the strengths of different magnets by counting how many paperclips they can attract. Provide students with a variety of sizes and types of magnets and some paperclips. They should record the number of paperclips that each one picks up. Encourage students to compare their results. This should show that not all magnets are the same strength as some will pick up more paperclips than others.

Discussion

Why is it important that you use the same size of paperclip for each test?

> ***Possible response:*** *Students should recognise that this would be a fair test. If the paperclips were different sizes it would not be fair.*

Investigation: Design and make a magnetic game

The aim of this investigation is for students to apply their knowledge of magnets to design a game. They are encouraged to investigate and decide what type of game will work best. Each group will need items such as card, small magnets, ball bearings, sticky tape, glue, coloured pens and small wooden sticks, for example. Students can work in groups or with a partner. Students could make a target game, a game that uses magnets to pick up objects, or a game to move a counter along a path using a magnet above or underneath a board. Use the photographs at the top of page 91 to give students some ideas. Students construct and test the games, then they choose a favourite. Compile their favourite choices and report this back to the class. Ask students to consider how they could improve their game after experiencing the games that others have made.

Be a scientist Scientists always think about how to improve their investigations. Some of the greatest inventions in the world did not work first time.

Read out the Be a scientist information to encourage students whose games may not work out as they had hoped.

Stretch zone: Explain how your game works. Use the key words to help you.

Encourage students to use the vocabulary from this unit so far in their explanations.

Key ideas

Magnets are used in everyday life.

Magnets have different magnetic strengths.

Summarise the lesson by asking students what they have learned. Let them share their ideas, read out and discuss the key ideas. This will remind students that different magnets can have different uses depending on their strength. Ask students to recall examples of magnets in everyday life.

Review and reflect

Use the discussion points throughout the lesson to assess students' understanding of the objectives for this lesson. Encourage students to talk to each other using the key words correctly.

Ask students to sit down for a few minutes and think about what they have learned from the lesson. They can then think of one idea from the lesson that they would like to investigate and find out more about.

Extra activities

1 **Computing link:** Students could carry out internet research to find out other uses of magnets and present their findings.

2 Students could make a leaflet about their game to encourage people to buy it.

Differentiation

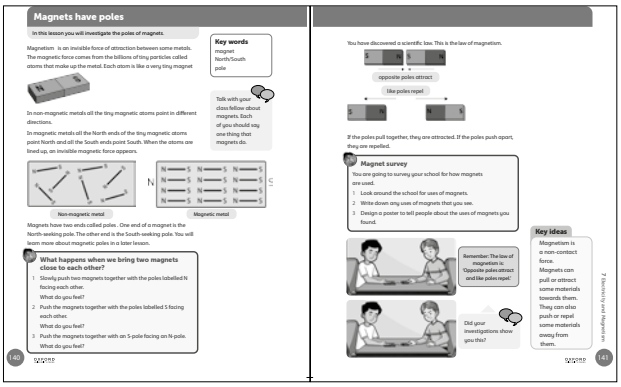
Supporting: Display as many of the different types of magnets used in the lesson around the room as you can. Ask students to count how many different magnets they can see.

Consolidating: Ask students to list five uses of magnets that they have learned about. They could list these in order of strongest to weakest magnet.

Extending: Students could research how magnets were used in the past, and make a poster to show their findings.

Differentiated outcomes	
All students	should be able to describe different uses of magnets.
Most students	will be able to explain why magnets are different strengths.
Some students	may be able to explain how a magnetic game works.

Magnets have poles


Magnets have poles

In this lesson you will investigate the poles of magnets.

Key words
magnet
North/South
pole

Magnetism is an invisible force of attraction between some metals. The magnetic force comes from the billions of tiny particles called atoms that make up the metal. Each atom is like a very tiny magnet

Talk with your class fellow about magnets. Each of you should say one thing that magnets do.

In non-magnetic metals all the tiny magnetic atoms point in different directions.

In magnetic metals all the North ends of the tiny magnetic atoms point North and all the South ends point South. When the atoms are lined up, an invisible magnetic force appears.

Non-magnetic metal

Magnetic metal

Magnets have two ends called poles. One end of a magnet is the North-seeking pole. The other end is the South-seeking pole. You will learn more about magnetic poles in a later lesson.

What happens when we bring two magnets close to each other?

1 Slowly push two magnets together with the poles labelled N facing each other.
What do you feel?
2 Push the magnets together with the poles labelled S facing each other.
What do you feel?
3 Push the magnets together with an S-pole facing an N-pole.
What do you feel?

140

You have discovered a scientific law. This is the law of magnetism.

opposite poles attract

like poles repel

If the poles pull together, they are attracted. If the poles push apart, they are repelled.

Magnet survey

You are going to survey your school for how magnets are used.

1 Look around the school for uses of magnets.
2 Write down any uses of magnets that you see.
3 Design a poster to tell people about the uses of magnets you found.

Remember: The law of magnetism is: Opposite poles attract and like poles repel.

Did your investigations show you this?

Key ideas

Magnetism is a non-contact force.
Magnets can pull or attract some materials towards them. They can also push or repel some materials away from them.

141

Getting started

The aim of this lesson is to explain what causes the force of magnetism. Students probably already know that the Earth has a North Pole and a South Pole. They also know that magnets have a North-seeking pole and a South-seeking pole. They consider how Earth's poles and a magnet's poles are linked.

Language support

Carry out an activity to act as an analogy for magnetic forces. Tell students that they are all 'particles' in a magnet. Half of the students should stand in a line on one side of a rope placed on the floor. They should face towards one end of the rope. The other half should stand facing the other direction on the other side of the rope. Then all students should pick up the rope. Ask them to pull the rope in the direction they are facing. This will cause chaos! The idea is that this demonstrates that the particles in a magnet all need to be lined up facing the same direction in order to work. Students should have felt a strong pulling force when they were facing and pulling in the same direction.

Ask students if they have heard the word 'atoms' before. Explain that this is the name for the tiny particles inside magnets. Write the word on the board and ask students to say it out loud.

Resources

Student Book: writing materials; clipboards; large sheets of paper.

Key words

magnet North/South pole

Other words in the lesson

atoms particles

Scientific enquiry key words

use equipment observe record data

Lesson at a glance

The key teaching points in this lesson are:

- magnets have two poles
- atoms in a magnet are lined up.

Discussion

Talk with your partner about magnets. Each of you should say one thing that magnets do.

Possible response: *Students might say that magnets attract magnetic materials or that two of the same poles will repel each other.*

Read through the text on page 140 and look at the diagrams of atoms in a non-magnetic metal and in a magnetic metal. If you have a large open area available, ask students to lie on the ground modelling the alignment of atoms in each diagram.

Investigation: What happens when we bring two magnets together?

The aim of this investigation is for students to explore the rules of attraction and repulsion of magnets. Each group will need two bar magnets. Point out that it is easy for magnets to be damaged if they are banged, dropped on the floor or stored incorrectly. For each test, ask students what they feel between the magnets when two like poles are pushed together and two opposite ones. Two like poles will push apart or repel, and two opposite poles are attracted or pull together.

Investigation: Magnet survey

Organise places to visit around the school where magnets can be seen in use. Provide students with a clipboard or some way of recording their observations. Students use their observations of the survey to design a poster. This should show people the uses of magnets that they found.

Read out the information on page 141 about the poles of the Earth and how the molten metal core creates a massive magnetic pull. Discuss the diagram and the magnetic fields. Explain that the North end of a bar magnet is attracted to the North pole on Earth and the South end to the South pole. Explain that this determines how a magnet works. This can be seen in a compass which has a magnetised part with one end that always points North.

Key ideas

- *Magnetism is a non-contact force.*
- *Magnets can pull or attract some materialstowards them. They can alsopush or repel some materials away from them.*

Summarise the lesson by asking students what they have learned. Let them share their ideas, read out and discuss the key ideas.

Did your investigations show you this?

Possible response: *Students should find that the law of magnetism worked in their investigation. Theopposite poles attracted or were pulled to each other; the like poles repelled or pushed away from each other*

Review and reflect

Encourage students to reflect on their learning throughout the lesson. Use the discussion tasks tasks to encourage students to think about what they understand and what they are finding less straightforward. Encourage them to identify any areas of difficulty and help them to identify questions they would like to ask.

This will help students to develop a positive approach to learning by understanding that learning is a process that will improve with practice and reflection. They should reflect on how well they understand the tricky concepts of magnetism and magnetic fields and decide if they need any further support before moving on to the next lesson.

Extra activities

1 Hold a treasure hunt with hidden materials around the room. Give students directions and compass bearings to help them find them.

2 **Computing link:** Students could use the internet to find out how animals use magnetism during migration.

Differentiation

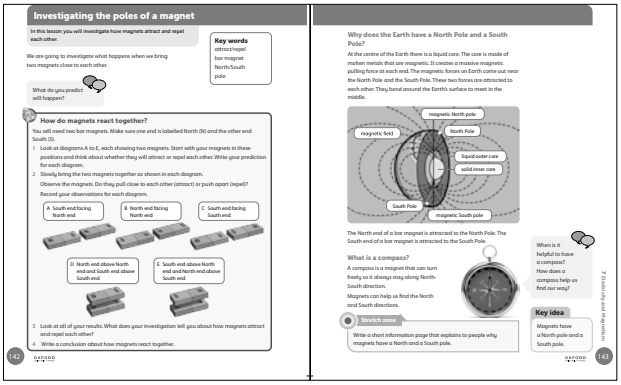
Supporting: Revise the key concepts 'attract' and 'repel' by demonstrating which position two magnets need to be placed in to repel or attract the other one. Relate this to the magnet's poles.

Consolidating: Provide students with a bar magnet and ask them to do a drawing of how the atoms would be lined up.

Extending: Ask students if they can write a sentence that links the poles of a magnet to the magnetic poles on Earth.

Differentiated outcomes	
All students	should be able to investigate the poles of a magnet.
Most students	will be able to recognise from the organisation of atoms if a material is magnetic or not.
Some students	may be able to use a compass to navigate.

Investigating the poles of a magnet


Investigating the poles of a magnet

In this lesson you will investigate how magnets attract and repel each other.

Key words
attract/repel
bar magnet
North/South
pole

We are going to investigate what happens when we bring two magnets close to each other.

What do you predict will happen?

How do magnets react together?

You will need two bar magnets. Make sure one end is labelled North (N) and the other end South (S).

1 Look at diagrams A to E, each showing two magnets. Start with your magnets in these positions and think about whether they will attract or repel each other. Write your prediction for each diagram.
2 Slowly bring the two magnets together as shown in each diagram.
Observe the magnets. Do they pull close to each other (attract) or push apart (repel)?
Record your observations for each diagram.

A South end facing North end
B North end facing North end
C South end facing South end
D North end above North end and South end above South end
E South end above North end and North end above South end

3 Look at all of your results. What does your investigation tell you about how magnets attract and repel each other?
4 Write a conclusion about how magnets react together.

142 OXFORD

Why does the Earth have a North Pole and a South Pole?

At the centre of the Earth there is a liquid core. The core is made of molten metals that are magnetic. It creates a massive magnetic pulling force at each end. The magnetic forces on Earth come out near the North Pole and the South Pole. These two forces are attracted to each other. They bend around the Earth's surface to meet in the middle.

magnetic North pole
magnetic field
North Pole
liquid outer core
solid inner core
South Pole
magnetic South pole

The North end of a bar magnet is attracted to the North Pole. The South end of a bar magnet is attracted to the South Pole.

What is a compass?

A compass is a magnet that can turn freely, so it always stay along North-South direction.
Magnets can help us find the North and South directions.

When is it helpful to have a compass?
How does a compass help us find our way?

Stretch zone

Write a short information page that explains to people why magnets have a North and a South pole.

Key idea

Magnets have a North pole and a South pole.

7 Electricity and magnetism

143 OXFORD

Getting started

In this lesson students will investigate how magnets react together. They have already learned how magnets have a South-seeking and a North-seeking pole, and they expand upon this learning to make magnets attract and repel each other. They will also learn how the Earth has magnetic forces which form a magnetic field pattern around the Earth.

Language support

Students can review their understanding of what it means to attract and to repel. You could ask students to make their own crossword puzzles for other students to complete using the words covered in this magnetism topic so far: attract; repel; magnet; magnetic; non-contact force; pole; push; pull; strength; North; South.

Resources

Student Book: bar magnets with one end labelled North (or N), the other labelled South (or S).

Key words

attract/repel bar magnet North/South pole

Other words in the lesson

magnetic field

Scientific enquiry key words

use equipment observe notice patterns
carry out tests communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- magnets have two opposite ends or poles
- opposite poles attract or pull together; like poles repel each other.

Tell students they are going to investigate what happens when they bring two magnets together.

Discussion

What do you predict will happen?

> ***Possible response:*** *Students may recall from previous lessons that the magnets will attract or repel each other depending on the poles that are brought together.*

Investigation: How do magnets react together?

Provide students with two bar magnets. Ask them to set them up as in each of the diagrams on page 142. They should test their predictions and decide how the magnets react in each situation.

When is it helpful to have a compass? How does a compass help us find our way?

> ***Possible response:*** *Students should know that a compass helps us to find our way around because it can tell us which direction is North and which is South.*

Stretch zone: Write a short information page that explains to people why magnets have a North and a South pole.

> ***Possible response:*** *Read the Stretch zone challenge. Remind students to think about the poles of magnets and the poles of the Earth. Students should include information about the poles of the Earth and how the Earth's metal core creates the magnetic field.*

Key ideas

Magnets have a North pole and a South pole.

Summarise the lesson by asking students what they have learned. Let them share their ideas, read out and discuss the key ideas. This will remind studentsthe features of a magnet. Ask students to draw two magnets that would repel each other and two that would attract each other.

Extra activities

1 Students could draw diagrams to show their results from the investigation into how magnets react together.

2 Students could make a quiz by designing questions about what they have learned about magnets and magnetism so far. They could try them out on another group or you could consolidate them and hold a class quiz.

Differentiation

Supporting: You could help students to draw on a wipe board the position of two bar magnets when they repel and attract.

Consolidating: Students could describe the experience of the pull of attracting bar magnets and the push of repelling ones.

Extending: Students could identify the poles of the Earth on a basic drawing of the Earth as a sphere, and could draw Earth's magnetic field lines, showing them getting stronger and closer together at the poles.

Differentiated outcomes	
All students	should be able to investigate the poles on a bar magnet.
Most students	will be able to predict whether the bar magnets will repel or attract.
Some students	may be able to understand the magnetic field patterns around Earth.

Which materials are magnetic?

Getting started

In this lesson students find out which materials are magnetic and which are not.

Language support

Students should be familiar with the terms 'magnetic' and 'non-magnetic'. Ask them to suggest an example of each. Ask students to read out loud the word 'alloy'. Ask them what they think this could mean. Explain that some materials are made from mixtures of metals, and in science we call a mixture of metals an alloy.

Resources

Student Book: magnets; nails; range of objects made from different metals, including paperclips, and other materials.

Key words

alloy magnetic/non-magnetic metal

Other words in the lesson

aluminium copper steel

Scientific enquiry key words

use equipment observe notice patterns
group/classify communicate findings

Lesson at a glance

The key teaching point in this lesson is:

- only some metals magnetic
- some alloys, such as steel, can be magnetised.

Read through the text and write all the names of the metals on the board. Circle the ones that are magnetic.

Point out that steel – an alloy containing iron – can be magnetised if all the atoms line up the same way. Ask students to recall magnetism from an earlier lesson and see if they can remember how they modelled being magnets when they all faced the same direction and pulled on a rope.

Discussion

Agree with your partner about which of these metals is magnetic: aluminium, brass, copper, gold, iron, lead, nickel, silver, steel, tin.

Students should discuss the list of metals and using their knowledge and experience they decide which of the metals are magnetic.

> ***Answer:*** *Students should recall that iron, nickel and steel are magnetic.*

Discussion

Which of these things do you think is magnetic? Can you explain your answer?

Look at the photographs with students and ask for volunteers to read out the labels. Ask students how they would test if each item is magnetic.

> ***Possible response:*** *Students might suggest that some of the metals are magnetic because they contain iron – so the chair leg, the pan and the food can may be magnetic. They should be confident in knowing that most of the items are not magnetic. Students should suggest using a magnet to test if each item is magnetic.*

Review and reflect

Listen to the discussions during this lesson. Encourage students to use the key words appropriately. To support language development, you could ask each student to tell you one new word they have learned in this unit so far, and to write it on the board. You can then ask students to create a mind map of these words to show how they are linked.

Remind students that learning is a journey. It does not matter if they answer a question incorrectly. It is what they do about this knowledge gap that is important. Discuss with students how much they learn when they try to work out why they got an answer to a question wrong.

Extra activities

1 **Maths link:** Ask students to test if the nail magnet becomes stronger if they stroke it with a magnet for a longer time. They could design an investigation to test this. They could also time how long it takes to make different objects magnetic.

2 Students could try to make a magnet out of a non-magnetic material. Does this prove that magnets can only be made from magnetic materials?

Differentiation

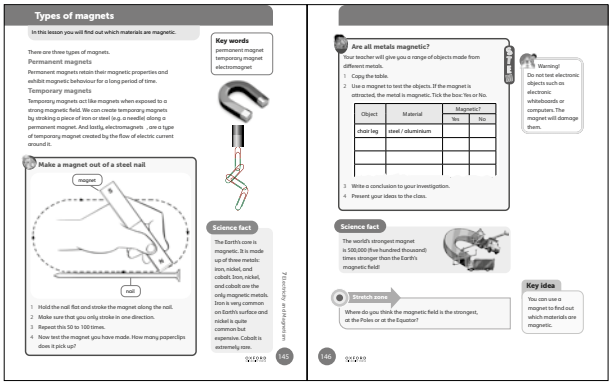
Supporting: Students could work with a partner and test various materials around the room to find out if they are magnetic or not.

Consolidating: Students could predict which materials around the room will be magnetic. They could then test their predictions using a magnet.

Extending: Students could select an object that they think will make a good magnet. They test it at the start with a bar magnet. They then carry out the method to make it into a magnet. They test their magnet with the same bar magnet to find out if it now acts as a magnet.

Differentiated outcomes	
All students	should be able to identify magnetic and non-magnetic materials.
Most students	will be able to sort objects into magnetic and non-magnetic using the materials they are made from.
Some students	may be able to make a magnet and test it.

Types of magnet



Getting started

In this lesson students will learn different types of magnets. They make a magnet out of a magnetic material. They then use their knowledge to work out which materials are magnetic before testing them.

Language support

Students should be familiar with the terms 'magnetic' and 'non-magnetic'. Ask them to suggest an example of each.

Resources

Student Book: magnets; nails; range of objects made from different metals, including paperclips, and other materials.

Key words

permanent magnet

temporary magnet

electromagnet

Scientific enquiry key words

use equipment observe notice patterns

group/classify communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- some alloys, such as steel, can be magnetised.

Read through the text at the top. Ask students to recall magnetism from an earlier lesson and see if they can remember how they modelled being magnets when they all faced the same direction and pulled on a rope.

Investigation: Make a magnet out of a steel nail

Provide students with a steel nail and a bar magnet. Remind students how the atoms have to be in a straight line, all facing the same direction, for the material to be a magnet. They should follow the instructions and then test their magnets. You could explain that mechanics and engineers use this technique to make screwdrivers into a magnet to help them retrieve nuts and bolts from inside machinery. Ask students to test how many paperclips they can pick up using their magnets.

Investigation: Are all metals magnetic?

Warning! Do not test electronic objects such as whiteboards or computers. The magnet will damage them.

Read out the warning information at the start of the investigation and ensure that all students are aware of this.

Provide pairs or small groups with a range of objects to test, and a magnet. Ask them to copy the table or provide a table for students. Students record the name of each object and the material that it is made from. You might need to support some with this. Most materials that are magnetic will be made of iron or an alloy containing iron. Students test and record their findings. Ask students to compare their results with other groups and discuss any differences they have. Explain that humans make mistakes so scientists always try to compare their results.

Key idea

You can use a magnet to find out which materials are magnetic.

Summarise the lesson by asking students what they have learned. Let them share their ideas, read out and discuss the key idea. This will remind students that magnets are only attracted to magnetic material. Ask students to list the magnetic materials that we know about. Are they metals or non-metals? Ask students if the majority of the materials they tested were magnetic or non-magnetic.

Stretch zone: Where do you think the magnetic field is the strongest, at the Poles or at the Equator?

Possible response: *Students should say that the magnetic field is stronger at the Poles than at the Equator.*

Review and reflect

Listen to the discussions during this lesson. Encourage students to use the key words appropriately. To support language development, you could ask each student to tell you one new word they have learned in this unit so far, and to write it on the board. You can then ask students to create a mind map of these words to show how they are linked.

Remind students that learning is a journey. It does not matter if they answer a question incorrectly. It is what they do about this knowledge gap that is important. Discuss with students how much they learn when they try to work out why they got an answer to a question wrong.

Extra activities

1 **Maths link:** Ask students to test if the nail magnet becomes stronger if they stroke it with a magnet for a longer time. They could design an investigation to test this. They could also time how long it takes to make different objects magnetic.

2 Students could try to make a magnet out of a non-magnetic material. Does this prove that magnets can only be made from magnetic materials?

Differentiation

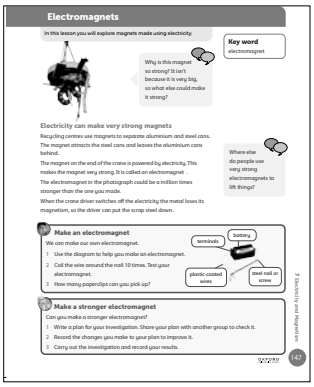
Supporting: Students could work with a partner and test various materials around the room to find out if they are magnetic or not.

Consolidating: Students could predict which materials around the room will be magnetic. They could then test their predictions using a magnet.

Extending: Students could select an object that they think will make a good magnet. They test it at the start with a bar magnet. They then carry out the method to make it into a magnet. They test their magnet with the same bar magnet to find out if it now acts as a magnet.

Differentiated outcomes	
All students	should be able to identify magnetic and non-magnetic materials.
Most students	will be able to sort objects into magnetic and non-magnetic using the materials they are made from.
Some students	may be able to make a magnet and test it.

Electromagnets


Electromagnets

In this lesson you will explore magnets made using electricity.

Key word
electromagnet

Why is this magnet so strong? It isn't because it is very big, so what else could make it strong?

Electricity can make very strong magnets

Recycling centres use magnets to separate aluminium and steel cans. The magnet attracts the steel cans and leaves the aluminium cans behind.

The magnet on the end of the crane is powered by electricity. This makes the magnet very strong. It is called an electromagnet.

The electromagnet in the photograph could be a million times stronger than the one you made.

When the crane driver switches off the electricity the metal loses its magnetism, so the driver can put the scrap steel down.

Where else do people use very strong electromagnets to lift things?

Make an electromagnet

We can make our own electromagnet.

1 Use the diagram to help you make an electromagnet.
2 Coil the wire around the nail 10 times. Test your electromagnet.
3 How many paperclips can you pick up?

terminals
battery
plastic-coated wires
steel nail or screw

Make a stronger electromagnet

Can you make a stronger electromagnet?

1 Write a plan for your investigation. Share your plan with another group to check it.
2 Record the changes you make to your plan to improve it.
3 Carry out the investigation and record your results.

7 Electricity and Magnetism

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Getting started

In this lesson students find out about the connection between magnets and electricity. Students learn that we can use electricity to create very strong magnets. Students consider everyday objects that use electricity and magnetism.

Language support

As this stage in the unit it would be useful to check through the glossary at the back of the Student Book to ensure that all students have completed their definitions for this unit. You can then check their understanding by asking quick fire questions, for example, 'What does 'attract' mean? What is the word that means the opposite?' Explain that the key word 'electromagnet' is made from joining two words: electricity and magnet.

Resources

Student Book: batteries; plastic-coated wires; steel nails or screws; paperclips.

Key words

electromagnet

Other words in the lesson

coil electricity

Scientific enquiry key words

use equipment observe measure
notice patterns record data carry out tests
communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- electricity can make magnets called electromagnets
- electromagnets can be very strong.

Discussion

Why is this magnet so strong? It isn't because it is very big, so what else could make it strong?

Look at the photograph showing an electromagnet picking up scrap metal. Say that it is called an electromagnet. This may give students clues about what makes it a strong magnet.

> ***Possible response:*** *Students might suggest that this magnet is strong because it uses electricity.*

Read through the text below the photograph. You could demonstrate the ability of the electromagnet to be switched off and no longer be magnetic by simply picking something up with your hand, saying the electricity is switched on. Ask a student to decide when to say, 'Off!' – and when they do you simply drop the object you were holding.

Discussion

Where else do people use very strong electromagnets to lift things?

> ***Possible response:*** *Students might recall the photograph of a car in a scrap yard being picked up by a magnet and may suggest that this was an electromagnet.*

Investigation: Make an electromagnet

Demonstrate how to set up a circuit using a steel nail or screw, plastic-coated wires, terminals and a battery. Students coil the wire around the nail and connect it to the battery. They try to pick up paperclips using the nail when it is connected.

Investigation: Make a stronger electromagnet

Students explore how to make their electromagnet stronger. They will test this by counting the number of paperclips that it can pick up. There are three ways to make the electromagnet stronger: by using an iron core, by making more coils of wire, or by adding batteries. Students could record how many paperclips they pick up for every five extra coils they make, for example. Encourage students to plan their method and record their results.

Review and reflect

Encourage students to review and reflect on their learning about electromagnets. Students should discuss any areas of the learning that they are not confident about and draw up a list of how they can solve this. Encourage them to talk to other students, look at displays of work or ask the teacher for help. Ask students if they are ready to move onto the next lesson or if they need more time to work on this content. Use this to inform your planning.

Extra activities

1. Show students a portable appliance that uses an electric motor, such as a hair dryer. You could also show them an old electric motor, opened up to show the magnets and wires. This will provide stimulus for students. Ask them to look for other electric appliances with motors at home.
2. Students could use photographs from brochures or catalogues selling appliances to make a collage of items that use magnets.

Differentiation

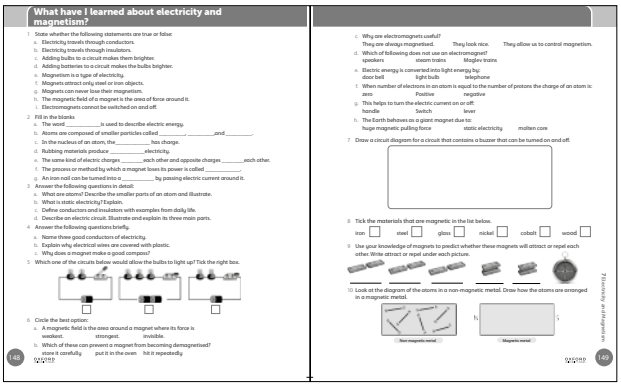
Supporting: Provide students with the equipment and mixed-up bullet points of instructions to make an electromagnet. Ask them to arrange the bullets in the correct order.

Consolidating: Students could write a method for making an electromagnet. They could also add steps to explain how to make it stronger.

Extending: Students could suggest why the ability to switch electromagnets on and off is useful. They could list two cases or devices where this would be useful – one should be in the home and one in industry.

Differentiated outcomes	
All students	should be able to make a magnet using electricity.
Most students	will be able to make an electromagnet stronger.
Some students	may be able to understand how a magnet can make electricity.

What have I learned about Electricity and Magnetism?



Getting started

The aim of this section is to encourage students to review their learning after each topic in the unit. Most topics have some consolidation questions for students to answer. These will assess student knowledge and understanding of the topic. As with the previous units you can ask students to think about individual questions after each lesson. Another strategy is to ask students to think about all of the questions as a summative task at the end of the unit. This can be as an individual, pair or small group discussion, or a written task. A combination of end-of-lesson work on specific questions and end-of-unit attempts at them as one activity is recommended. Box to show how confident they are about each topic.

Encourage students to spend some time quietly thinking about their learning for the whole unit. This is a long unit so you might want to display the learning objectives and key words to help them think back. Ask them what they have learned well and feel confident about. Then ask them to think about the parts that they have felt challenging but have overcome. Students should be praised for this as this develops a growth mindset. Finally ask students if there are any parts of this unit that they have found very difficult and would need further support with. Discuss these as a whole class or in small groups.

What have I learned about Electricity and Magnetism? answers

1 State whether the following statements are true or false:

a. Electricity travels through conductors.

b. Electricity travels through insulators.

c. Adding bulbs to a circuit makes them brighter.

d. Adding batteries to a circuit makes the bulbs brighter.

e. Magnetism is a type of electricity.

f. Magnets attract only steel or iron objects.

g. Magnets can never lose their magnetism.

h. The magnetic field of a magnet is the area of force around it.

i. Electromagnets cannot be switched on and off.

Answer: *a.true b. false c. false d. true e. false f. true g. false h. true i. false*

2 Fill in the blanks

a. The word _____is used to describe electric energy.

b. Atoms are composed of smaller particles called _____, _____,and _____.

c. In the nucleus of an atom, the_____ has charge.

d. Rubbing materials produce _____ electricity.

e. The same kind of electric charges _____each other and opposite charges _____each other.

f. The process or method by which a magnet loses its power is called _____.

g. An iron nail can be turned into a _____ by passing electric current around it.

Answer: *a. Electricity b. Protons, electrons, neutrons c. Proton d. Static e. Repel, attract f. Demagnetization g. magnet*

3 Answer the following questions in detail:

a. What are atoms? Describe the smaller parts of an atom and illustrate.

b. What is static electricity? Explain.

c. Define conductors and insulators with examples from daily life.

d. Describe an electric circuit. Illustrate and explain its three main parts.

Ask student to recall their previous knowledge and answer the questions.

Answer: *a. Atom is the smallest particle. Atom comprises of sub-atomic particles called protons, electrons, and neutrons.Protons: These particles are positively charged particles. Electrons: These are negatively charged particles. Neutrons: These are neutral particles.*
b. When electrons accumulate on something and give it an electric charge, this is known as static electricity.

Subsequently, the electrons will gravitate toward an object with a lower electric charge and will jump to it.
c. Conductors
Materials or substances that permit the passage of electricity through them are known as conductors. Because they make it easy for electrons to move from atom to atom inside of them, they conduct electricity. For example, humans, animals, metals.
Insulators
Materials or substances that hinder or avoid electricity flow through them are known as insulators. For example, wood, and rubber.
d. A circuit is where electricity can flow through a series of conductors that form a complete loop. (diagram on page # 129 of student's book)

4 Answer the following questions briefly

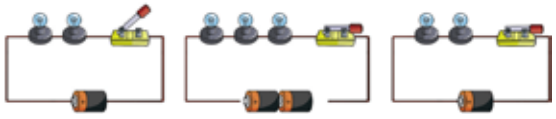
a. Name three good conductors of electricity.

b. Explain why electrical wires are covered with plastic.

c. Why does a magnet make a good compass?

Answer: *a. Iron, silver, copper*
b. Plastics are good insulators. They are used to cover wires and they are also used as covers for plugs and switches.
c. Magnetic fields align with the compass needles. A compass will typically align with Earth's magnetic field since Earth is a magnet.

5 Which one of the circuits below would allow the bulbs to light up? Tick the right box.



Remind students to read the question carefully and point out that an important word in the question is the word 'one' so they know only one of the three choices is correct. Hint that they can follow the circuits with their finger to check for any breaks.

Answer: *corner right*

6 Circle the best option:

a. A magnetic field is the area around a magnet where its force is
weakest. strongest. invisible.

b. Which of these can prevent a magnet from becoming demagnetised? store it carefully put it in the oven hit it repeatedly
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c. Why are electromagnets useful?
They are always magnetised. They look nice.
They allow us to control magnetism.

d. Which of following does not use an electromagnet?
speakers steam trains Maglev trains

e. Electric energy is converted into light energy by:
door bell light bulb telephone

f. When number of electrons in an atom is equal to the number of protons the charge of an atom is:
zero Positive negative

g. This helps to turn the electric current on or off:
handle Switch lever

h. The Earth behaves as a giant magnet due to:
huge magnetic pulling force static electricity
molten core

Answer: *a. Strongest b. Store it carefully*
c. They allow us to control magnetism
d. Steam trains e. light bulb f. zero
g. switch h. huge magnetic pulling force

7 Draw a circuit diagram for a circuit that contains a buzzer that can be turned on and off. How can you make something stop?

8 Tick the materials that are magnetic in the list below.

Answer: *iron steel*

9 Use your knowledge of magnets to predict whether these magnets will attract or repel each other. Write attract or repel under each picture.

Ask students what they see in the pictures. Explain that these are bar magnets which show the different poles with an N for North and S for South. Ask if they can recall what would happen if an N end of a magnet came close to another N end of a magnet, and then to an S end of a magnet. Remind them that like poles repel and unlike poles attract. Then ask them to study each diagram and write under each if it would repel or attract.

Answer: *From left to right top row: repel, repel, attract; from left to right bottom row: attract, repel.*

10 Look at the diagram of the atoms in a non-magnetic metal. Draw how the atoms are arranged in a magnetic metal.

Ask students to work with a partner to discuss the diagrams. Then ask them to share as a group their review of the atoms in a magnet. Remind them that in a magnetic material all of the atoms are neatly lined up. They can then use the other diagram to help them draw the atoms in a magnetic metal.

Answer: *Students should draw the atoms as in the magnetic metal diagram*

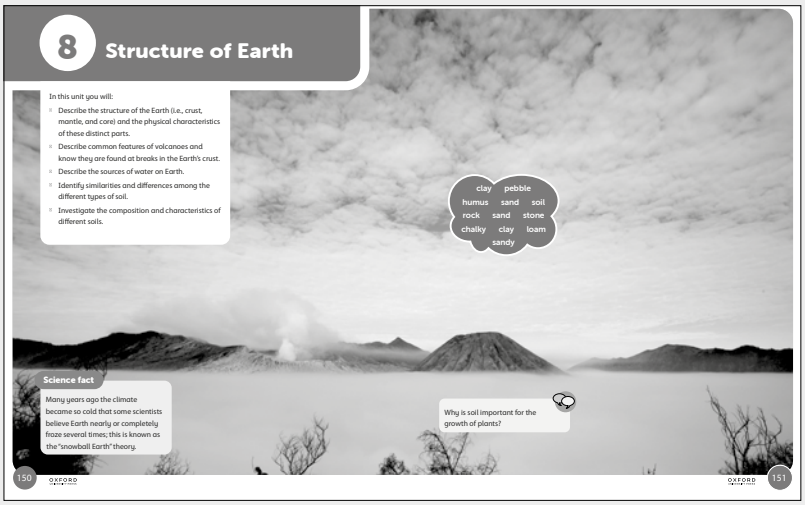
Summative assessment

The answers to the 'What have I learned about electricity and magnetism?' questions in the Student Book are a useful starting point when discussing the progress of each student individually. You can also use this information to add to students' reports. An overview of whole-class scores can point to topics and concepts that might need more work and this can also inform your practice the next time you teach this and similar topics. As with all of the units this year, you can allocate scores based on the number of questions answered correctly or by splitting the questions into smaller sections. A way to do this is to allocate as follows: question nine has five marks, question 2 has seven marks, question 3 has 12 marks, question 4 has 6 mark, question 5 has 1 mark, question 6 has 8 marks, question 7 has 2 marks, question 8 has 2 marks, question 9 has 2 marks, question 10 has 2 marks. mark. This gives 51 marks.

8 Structure of Earth

In this unit students will:

- Describe the structure of the Earth (i.e., crust, mantle, and core) and the physical characteristics of these distinct parts.
- Describe common features of volcanoes and know they are found at breaks in the Earth's crust.
- Describe the sources of water on Earth.
- Identify similarities and differences among the different types of soil.
- Investigate the composition and characteristics of different soils.



Getting started

In this unit students discover what rocks are and where they are found. They are asked to think about where they have seen rocks and are shown worldwide examples. They learn that fossils are formed when things that lived long ago become trapped within rock. They observe and make models of them. The unit moves on to a consideration of soil. Students learn that soil is a mixture of materials, including dead plant and animal matter and broken-down rocks. They investigate soils by looking at different types and consider the vital importance of soil in agriculture. Finally, students will discover the sources of water and how water recycles.

Science in context

This unit will allow you to discuss with students the work of people who use knowledge of rocks and soil in their work. These include geologists, structural engineers, builders, gardeners, farmers, conservationists and environmental scientists. Students can talk about how some of these people need to know about the rocks and structure of the ground and how others need to know about and understand different soils. You can relate this to students' lives by asking them to share examples of when they have experienced rocks and soil in their everyday life. Encourage students to question why it is important to know about the rocks in the ground, and why soil is important. Also ask why fossils are important and what they can tell us.

Scientific enquiry skills

An Investigation master sheet is given in this Teacher's Guide on pages 4–5 to help students plan their scientific enquiries. In this unit, students can use their firsthand experiences of rocks to help them to carry out observations and measurements to classify rocks and test their properties. They will be using simple information sources to help them to explore the different types of rock and their uses. Students are encouraged to make and record observations as they study rocks and soil, and to make comparisons of the different rocks. They also apply this knowledge to link the properties of the rocks to their uses. The unit encourages students to identify simple patterns and associations.

Resources

Student Book: different coloured modelling clay; selection of interesting rock samples including hard and soft rocks – as many of the following as possible: sandstone, mudstone, shale, limestone, chalk, marble, granite; hand lenses; magnifying glasses; digital cameras Unit 2 Looking at Rocks and Soil 23 (optional); samples of fossils in rocks; dough; models of small animals; leaves; wax or chocolate; clay; water; tall glasses or plastic containers such as water bottles with the tops cut off; long spoons; four different soil samples; plastic bottles cut to make funnels; spoons; cotton wool; jars or beakers.

Key words for unit

Bold words are in the Word cloud.

clay **pebble** **humus** **sand** **soil** **rock** **stone** **chalky** **loam** **sandy**

oceans rivers

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Language support

At this age, students are likely to be able to read independently and look up any words they find unfamiliar, so encourage them to use scientific dictionaries. Start the unit by reading out the words in the Word cloud. Ask students to discuss each word and define those they are familiar with. This monitoring of prior knowledge is vital and can help you enormously in setting the level of work in the first few lessons. For every unit it is worth creating a Word wall so students see the words often and can become familiar with them. Students are old enough to make their own word cards for display so this could be an early task. Have daily quizzes about the words – point to one and ask, 'What does this word mean? Use it in a sentence.'

Repeat any new words regularly and use them in context. Students should listen, say, read and then write the words. They can also make a list of new non-science specific words they use in lessons. Some of these are listed in the individual lesson notes that follow.

Unit at a glance

The key teaching points for students in this unit are:

- to introduce the unit objectives
- to introduce the learning outcomes
- to engage students with the content of the unit
- to review and build on prior learning and understanding of the topics.

Why is soil important for the growth of plants?

Ask students what are the requirements to grow a plant. Allow students to discuss in a group. Ask what they think the role of soil is in the growth of plants and then share their ideas.

Answer: *Soil serves as a source of nutrients and water for plants as well as providing structural support.*

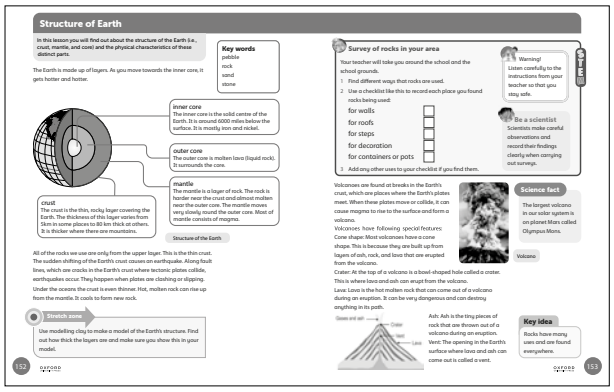
Science fact: Many years ago the climatebecame so cold that some scientists believe Earth nearly or completely froze several times; this is known as the "snowball Earth" theory.

Read out the information in the Science fact and ask them to search on snowball Earth theory.

Extra activities

1 **Computing link:** Ask students to use the internet to research some large-scale rock formations. These can be local to your region or worldwide, such as the Grand Canyon, the Himalayas or New Zealand.

Structure of Earth



Getting started

In this lesson students explore the idea that rocks are under the surface of the Earth even if we cannot see them. They review where they have seen rocks and what they are used for. They think about specific examples of rock and learn that pebbles, stones and sand are broken-down rock.

Language support

Show examples of different rocks and explain that the word 'rock' includes stones, pebbles and even particles of sand. Ask them to share their experience of rocks that they have seen in everyday life.

Resources

Student Book: different coloured modelling clay.

Key words

pebble rock sand stone

Other words in the lesson

volcanoes lava earthquake

Scientific enquiry key words

observe record data notice patterns
group/classify use secondary sources
communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- rocks can have different properties
- rocks are found all over the Earth.

Ask students to look at the diagram of the Earth's layers. Read out the information about the structure of the Earth and where rocks are found.

Stretch zone: Use modelling clay to make a model of the Earth's structure. Find out how thick the layers are and make sure you show this in your model.

Ensure students understand the cross-section diagram of the Earth and the different layers inside. Ask them to base their models on this.

Direct students to the photographs of the two different buildings and the text underneath. If possible, show some examples of stones, pebbles and sand so students can see the differences. Stress that they are all rock.

Investigation: Survey of rocks in your area

Warning! Listen carefully to the instructions from your teacher so that you stay safe.

Make sure all students understand the warning information. Explain to students that they are going to survey the school to find out the different ways that rocks have been used. Provide students with a checklist to record their observations. They could practise drawing this or you could provide this before the survey. Discuss as a whole group the findings from the survey. Use this to express the many ways that we use rocks.

Be a scientist Scientists make careful observations and record their findings clearly when carrying out surveys.

Use the Be a scientist information as students are carrying out their surveys. Remind them to look carefully at the different buildings and what they are made from.

Ask students to look at the photographs of the canyon and the underwater caves. Ask them where else they might see rocks in the natural environment.

Key idea

Rocks have many uses and are found everywhere.

Summarise the lesson by asking students what they have learned. Let them share their ideas, read out and discuss the key idea. Encourage students to discuss the pictures and information from this lesson and ask them to discuss with a partner what they have learned about rocks so far. Ask students what they think they will learn about in the rest of this unit. They could list these in the back of their notebooks. Students compare their lists with other students.

Review and reflect

Encourage students to discuss the content that they have learned in this lesson. This is an introductory lesson so students should have many questions about the topic. Students write these questions and review them as they learn more throughout this unit.

Extra activities

1 Ask students to draw a map of their local area and mark on it any places where rocks occur naturally and where they are used for buildings and bridges.

2 Students could draw a diagram of the Earth's structure and explain this to the people at home.

Differentiation

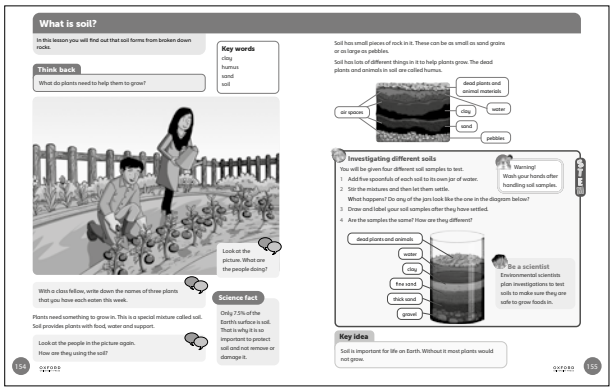
Supporting: You may need to provide students with many pictures and samples of different rocks. Students should begin to recognise the many different types that are all categorised as rocks.

Consolidating: Provide students with opportunities to handle rocks and begin to recognise their useful properties, and link this to the uses of rock in construction.

Extending: Ask students to suggest why we have so many rocks on Earth.

Differentiated outcomes	
All students	should be able to observe differences in rock samples.
Most students	will be able to identify the use of rocks in some buildings.
Some students	may be able to relate the properties of rocks to their uses.

What is soil?



Getting started

In this lesson students learn about the composition and uses of soil. They study the different things contained in soil and investigate how the amounts of these things vary in different soils.

Language support

Read out the key words and ask students if they are familiar with any of them. Have examples of clay, humus, sand and soil to hand if possible. Hold them up and ask students if they can identify any of them. Focus on clay and humus as these will be less familiar. Explain that humus is the part of soil that is made from decaying leaves and plants and is very good to grow plants in. You could explain that it is an old word that means 'earth' or 'ground' to help them. Show students clay and explain that this is part of the soil. You could give them a sample to squeeze and squash as they say the word 'clay'.

Resources

Student Book: water; tall glasses or plastic containers such as water bottles with the tops cut off; long spoons; four different soil samples.

Key words

clay humus sand soil

Other words in the lesson

gravel pebbles

Scientific enquiry key words

use equipment observe notice patterns
carry out tests group/classify
communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- soil is formed from broken down rocks
- soil is made up of different things.

Think back What do plants need to help them to grow?

Possible response: *Students may suggest soil as well as water and sunlight.*

Discussion

Look at the picture. What are the people doing?

Possible response: *Students might say that the people are tending to the garden plants.*

Discussion

With a partner, write down the names of three plants that you have both eaten this week.

Possible response: *Students might suggest any edible plants eaten in local homes; these might be lettuce, cucumber, cabbage or tomatoes, for example.*

Discussion

Look at the people in the picture again. How are they using the soil?

Read the text at the bottom of page 154 which explains that plants grow in soil and that it gives them food, water and support.

Possible response: *Students might say that the people are using the soil to grow plants.*

Science fact Only 7.5% of the Earth's surface is soil. That is why it is so important to protect soil and not remove it or damage it.

Read out the Science fact and ask students to suggest different things that cover the remaining 92.5% of the Earth's surface. Are they surprised to read that soil covers only 7.5%?

Read through the information at the top of page 155 about what is found in soil. Ask students to look at the soil profile diagram and make sure they understand what the different layers show. Point out that the air spaces in each layer will vary according to the type of soil.

Investigation: Investigating different soils

Warning! Wash your hands after handling soil samples.

Make sure you have read out the warning before students begin the investigation. Ask students to suggest why it is important to wash their hands after handling soil.

The aim of this investigation is to encourage students to test a range of different soils and make comparisons. This will help students to practise their scientific enquiry skills of finding information, testing and comparing.

Ideally the water in each jar will be at least 20 centimetres high to allow for the soil to be mixed and settle into layers. It is important that students stir the mixtures well and leave them to settle. Ask them to observe what they see as the mixtures settle and then leave them overnight for best results.

Ask students to look at the diagram of the beaker in the Student Book, and to compare their results with this. Point out that clay particles are so small that they can take days to settle. They may form a thin grey layer on top of the sand.

Be a scientist Environmental scientists plan investigations to test soils to make sure they are safe to grow foods in.

Read out the information in the Be a scientist feature and explain that some soils may contain pollutants or toxins and would not be safe for growing food in.

Key idea

Soil is important for life on Earth. Without it most plants would not grow.

Summarise the lesson by asking students what they have learned. Let them share their ideas, read out and discuss the key idea. This will remind students that it is important that we look after soil. Ask students to discuss why soil is important for life on Earth. Ask them to consider what they would no longer have if we ran out of soil.

Extra activities

1 **Computing link:** Encourage students to research other uses of rocks using the internet. If there is a local factory that works with rocks, you could arrange a tour to see how the rock is worked.

2 Carry out a field trip to a local area where rocks are exposed. Ask students to look for uses of this stone in buildings and walls, for example.

Differentiation

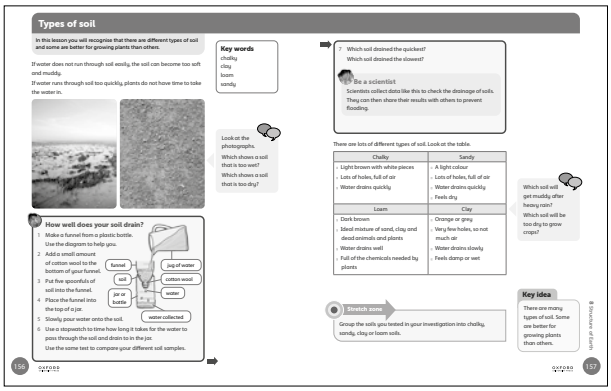
Supporting: Ask students to describe the properties of different rock samples.

Consolidating: Students could observe the uses of rocks in pictures and suggest why the rocks were selected for each use.

Extending: Students could describe where rocks and other materials come from and how they have to be extracted.

Differentiated outcomes	
All students	should be able to understand that rocks have many uses.
Most students	will be able to describe how rocks also provide us with other materials including oil and gas.
Some students	may be able to describe how metals are also found in the Earth's crust and that we use these as materials.

Types of soil


Types of soil

In this lesson you will recognise that there are different types of soil and some are better for growing plants than others.

If water does not run through soil easily, the soil can become too soft and muddy.
If water runs through soil too quickly, plants do not have time to take the water in.

Key words
chalky
clay
loam
sandy

Look at the photographs.
Which shows a soil that is too wet?
Which shows a soil that is too dry?

How well does your soil drain?
1 Make a funnel from a plastic bottle. Use the diagram to help you.
2 Add a small amount of cotton wool to the bottom of your funnel.
3 Put five spoonfuls of soil into the funnel.
4 Place the funnel into the top of a jar.
5 Slowly pour water onto the soil.
6 Use a stopwatch to time how long it takes for the water to pass through the soil and drain to in the jar.
Use the same test to compare your different soil samples.

funnel
soil
jar or bottle
jug of water
cotton wool
water
water collected

7 Which soil drained the quickest?
Which soil drained the slowest?

Be a scientist
Scientists collect data like this to check the drainage of soils. They can then share their results with others to prevent flooding.

There are lots of different types of soil. Look at the table.

Chalky	Sandy
• Light brown with white pieces • Lots of holes, full of air • Water drains quickly	• A light colour • Lots of holes, full of air • Water drains quickly • Feels dry
Loam	**Clay**
• Dark brown • Ideal mixture of sand, clay, and dead animals and plants • Water drains well • Full of the chemicals needed by plants	• Orange or grey • Very few holes, so not much air • Water drains slowly • Feels damp or wet

Which soil will get muddy after heavy rain?
Which soil will be too dry to grow crops?

Stretch zone
Group the soils you tested in your investigation into chalky, sandy, clay or loam soils.

Key idea
There are many types of soil. Some are better for growing plants than others.

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Getting started

In this lesson students carry out investigations into soil drainage and consider the composition of different soil types. They consider how different soil types can affect plants.

Language support

It is important to ensure that students understand the names of the different soils. Most are obvious – sandy soils contain a lot of sand and clay soils contain a lot of clay. Explain that the latter is made up of lots of tiny flat minerals that stick together in water. Loam is the name given to a rich soil that is ideal for growing plants.

Resources

Student Book: soil samples; plastic bottles cut to make funnels; spoons; cotton wool; jars or beakers; water.

Key words

chalky clay loam sandy

Scientific enquiry key words

use equipment observe measure record data
carry out tests group/classify

Lesson at a glance

The key teaching points in this lesson are:

- there are different types of soil
- some soil types are better for growing plants in than others.

Read out the introductory text and ask students to look at the photographs of wet and dry soil.

Discussion

Look at the photographs. Which shows a soil that is too wet? Which shows a soil that is too dry?

Ask students to assess which soil is very wet and which is very dry. Try to elicit that if soil is too wet, plants that are not used to wet soil will die. But if soil is too dry, there will not be enough water for plants and they will also die.

Answer: *Students should identify that the first photograph shows soil that is too wet and the second is too dry.*

Investigation: How well does your soil drain?

The aim of this investigation is to encourage students to find out how quickly or slowly water drains through different soils. This will help students to practise their scientific enquiry skills of observation, testing and comparing.

Organise students into small groups. Adding the wool to the bottom of the funnel will prevent the soil running out of the funnel. Check that the funnels are set up correctly before students pour in the water.

Ask students to pour 100 cubic centimetres of water into the soil and see how long the water takes to pass through the soil sample. Ask students to compare their results with those of other groups in the class. You could record the times on the board and they can identify the best soils for drainage.

Be a scientist Scientists collect data like this to check the drainage of soils. They can then share their results with others to prevent flooding.

Read out the information in the Be a scientist feature and discuss with students why it is important to prevent flooding.

Ask students to look at the table describing the four common types of soil. These are loam, sandy soil, chalky soil and clay soil. Point these out and ask students to read out the properties of each type. Ask them to think about a soil that allows water through it too quickly. Can they work out why this would be a problem?

Discussion

Which soil will get muddy after heavy rain? Which soil will be too dry to grow crops?

Elicit that soils that do not allow water to pass through them are most likely to become muddy. The water cannot escape anywhere. Soils that allow water to pass through quickly are most likely to be too dry to grow crops.

Possible response: *Students might suggest that clay would become muddy after heavy rain as it does not drain very well. Sandy soil drains quickly and feels dry so this would be too dry to grow crops.*

Stretch zone: Group the soils you tested in your investigation into chalky, sandy, clay or loam soils.

Ask students to think about how well their soils drained and what they looked like. Elicit from students that soils that keep some water but let most of it pass through are good for growing crops. Loam will not be too muddy or too dry.

Key idea

There are many types of soil. Some are better for growing plants than others.

Summarise the lesson by asking students what they have learned. Let them share their ideas, read out and discuss the key idea. Ask students why soil is important. Provide students with the names of types of soil and ask them to organise them into soils that will drain well and soils that will drain less well. Ask them why this property of a soil is important when growing plants.

Review and reflect

Encourage students to reflect on their learning throughout the lesson. Use the discussion tasks, the research investigation activity to encourage students to think about what they understand and what they are finding less straightforward. Discuss the outcomes of each task with students.

Encourage students to identify aspects they have not completed correctly and help them to identify improvements. This will help them to develop a positive approach to learning by understanding that learning is a process that will improve with practice and reflection.

Extra activities

1 A useful way to extend work on the different types of soil is to allow students to grow seedlings. You could give them a sandy soil and a loam-type soil. Alternatively have one soil in its natural state and compare it with one with added fertilisers. Students can monitor the growth of the seedlings.

2 **Computing link:** Students could find out about what could be added to sandy soil to make it better for growing crops. They need to think about what they know about soil and then work out how soils can be improved. You could show them examples of peat and fertilisers, which can be added to soil. You could also discuss adding animal waste (manure) to soils to add nutrients.

Differentiation

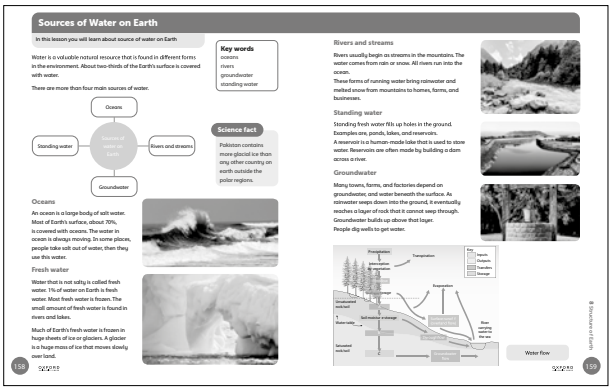
Supporting: Copy out the soil type bullet points from page 157 of the Student Book onto four different cards, without including the soil type name. Hand these out to students as a card sort to help them understand the soil type differences.

Consolidating: Hand out the same card sort activity but with one or two bullet points missing from each; ask students to name each type and fill in the blanks.

Extending: Ask students to construct the soil types table from memory. They can check their completed table and add or amend where they need to.

Differentiated outcomes	
All students	should be able to recognise different soil types.
Most students	will be able to describe the properties of some soils.
Some students	may be able to explain the properties of some soils.

Sources of Water on Earth



Getting started

In this lesson students will know about different of sources of water and its flow.

Language support

It is important to ensure that students understand the names of the different sources of water and their proportion.

Resources

Student Book:

Key words

oceans rivers groundwater

standing water

Lesson at a glance

The key teaching point in this lesson is:

- there are different sources of water

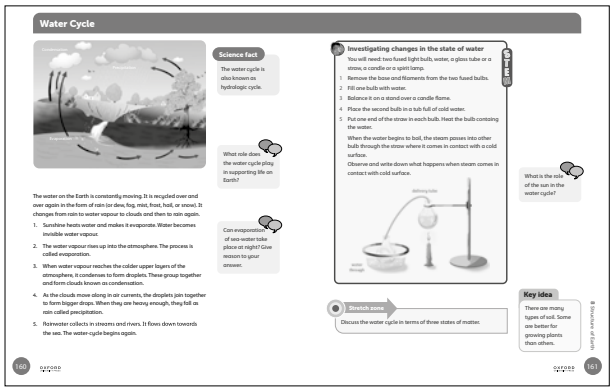
Science fact Pakistan contains more glacial ice than any other country on earth outside the polar regions.

Read the information given in the science fact and tell them that most of the glaciers are found in the northern regions of Gilgit-Baltistan and Khyber Pakhtunkhwa. Ask them if they can name some glaciers found in Pakistan.

Review and reflect

Encourage students to reflect on their learning throughout the lesson. Read the text on pages 158 and 159. Ask them if they have seen or visited any of the sources mentioned on the pages. Assign them the task to find out three sources of water in their surrounding and paste the pictures in the notebook.

Water Cycle



Getting started

This lesson introduces students to the importance of the water cycle and how it uses evaporation and condensation to recycle water on Earth. Water is a valuable commodity and it has to be recycled so that wecan use it to sustain life.

Language support

The key words linked to the water cycle have been used and experienced in earlier lessons. Explain that water is recycled. Talk about other materials that are recycled, for example paper or glass. Explain that a cycle means going around like the wheels on a bicycle. Demonstrate using your hand how the water moves around the circle you draw in the air.

Resources

Student Book: writing materials; paper, card or blank flip books.

Lesson at a glance

The key teaching points in this lesson are:

- the water cycle recycles water
- the water cycle involves a number of processes.

Read out the the text with students. Explain that although 70% of the surface of the Earth is covered in water, only 5% of it is pure. Remind students that when water, including sea water, evaporates, the dissolved substances are left behind.

Science fact The water cycle is also known as **hydrologic cycle.**

Read out the science fact and ask students what do they know about water cycle. Elicit the example of melting ice and ask them what they observe. Relate the stages of changes in matter with the water cycle.

Discussion

What role does the water cycle play in supporting life on Earth?

Ask students to recall what water cycle is and what are the processes involved in this cycle.

> ***Answer:*** *Due to its power to control weather patterns on Earth and make water available to all living things, the water cycle is a vital activity. We would run out of clean water, which is necessary for life, if water didn't naturally recycle itself.*

Investigation: Investigating changes in the state of water

The aim of this investigation is for students to observe that when water is heated to boiling point it gives off steam and bubbles from within the liquid itself and not just at the surface. Organise students around the front bench to create the atmosphere of an arena. Set up the equipments as shown on page 161. Heat the water and ask students to observe what happens. Encourage them to report any slight changes they see.

As they see the steam emerging and converting into droplets, ask them what happens to steam when it cools down, then you can allow them to look at the second bulb placed in the cold water. Encourage students to use their observation skills to notice any droplets of water. Use this opportunity to explain that condensation is the process where gases are cooled and change to liquids. Ask the students if they can then share examples of when they have seen condensation.

Discussion

What is the roleof the sun in the water cycle?

Ask students what do we get from Sun.

> ***Possible response:*** *The role of Sun is to provide heat energy. Heat energy from the Sun helps in the evaporation of water hence, changing the state from liquid to gas.*

Remind students that the air in the atmosphere contains water vapour. Explain that if the air is cooled, the water vapour condenses. This water can fall as rain. Write the words 'evaporation' and 'condensation' on the board and tell students they are going to study how these two processes drive the recycling of water around the whole world.

Discussion

Can evaporation of sea-water take place at night? Give reason to your answer.

Ask students to recall what evaporation is. What are the conditions for evaporation? Clear them that there is a difference between evaporation and boiling. Evaporation in water takes place at all temperatures.

Possible response: *Although very slowly, the evaporation process also occurs at night. The reason for this is that heat persists in the atmosphere long after the sun sets. To complete the evaporation process, this tiny amount of heat is enough.*

Stretch zone: Discuss the water cycle in terms of three states of matter.

Ask a volunteer to read out the text at the on page 160.

Point out the bullet opposite to each step/ process of the water cycle. For e.g. :

*evaporation- to make water vapour.

*condensation - to make liquid water.

This is the central part of the water cycle students are going to study.

Explain that 'precipitation' is a general name for rain, hail and snow. It is the water falling to the ground after water vapour is cooled.

Key idea

Students take some time to reflect on their learning. They review the learning objectives and the key words that are used in this lesson. Students should take time to consider what would happen if we did not have clean and fresh water to drink. Students might want to reflect on the importance of nature and how it provides for us in the water cycle

Extra activities

1 Students could build a model of the water cycle.

2 Students could design a poster to show the importance of the water cycle including all of the changes of state

Differentiation

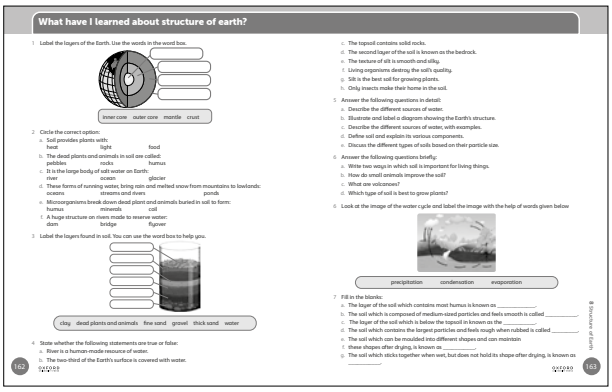
Supporting: Students can trace the water cycle using the diagram on page 160

Consolidating: Students can practise writing the relevant words and drawing arrows between them to show the processes of the water cycle.

Extending: Students can practise drawing the water cycle diagram from memory, labelling each part correctly.

Differentiated outcomes	
All students	should be able to recognise some changes of state in the water cycle
Most students	will be able to describe each of the changes of state in the water cycle
Some students	may be able to discuss the importance of the water cycle.

What have I learned about structure of earth?


What have I learned about structure of earth?

1 Label the layers of the Earth. Use the words in the word box.

inner core outer core mantle crust

2 Circle the correct option:
a. Soil provides plants with: heat light food
b. The dead plants and animals in soil are called: pebbles rocks humus
c. It is the large body of salt water on Earth: river ocean glacier
d. These forms of running water, bring rain and melted snow from mountains to lowlands: oceans streams and rivers ponds
e. Microorganisms break down dead plant and animals buried in soil to form: humus minerals coil
f. A huge structure on rivers made to reserve water: dam bridge flyover

3 Label the layers found in soil. You can use the word box to help you.

clay dead plants and animals fine sand gravel thick sand water

4 State whether the following statements are true or false:
a. River is a human-made resource of water.
b. The two-third of the Earth's surface is covered with water.

5 Answer the following questions in detail:
a. Describe the different sources of water.
b. Illustrate and label a diagram showing the Earth's structure.
c. Describe the different sources of water, with examples.
d. Define soil and explain its various components.
e. Discuss the different types of soils based on their particle size.

6 Answer the following questions briefly:
a. Write two ways in which soil is important for living things.
b. How do small animals improve the soil?
c. What are volcanoes?
d. Which type of soil is best to grow plants?

7 Fill in the blanks:
a. The layer of the soil which contains most humus is known as _____.
b. The soil which is composed of medium-sized particles and feels smooth is called _____.
c. The layer of the soil which is below the topsoil in known as the _____.
d. The soil which contains the largest particles and feels rough when rubbed is called _____.
e. The soil which can be moulded into different shapes and can maintain these shapes after drying, is known as _____.
f. The soil which sticks together when wet, but does not hold its shape after drying, is known as _____.

6 Look at the image of the water cycle and label the image with the help of words given below

precipitation condensation evaporation

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Getting started

The aim of this section is to encourage students to review their learning after each lesson in the unit and also to undertake some end-of-unit review and reflection. On pages 162–163 of the Student Book there are questions linked to concepts and topics covered in the unit. These will assess students' knowledge and understanding of the topic. You may have been using questions after each lesson where provided; there are links to relevant questions in the lesson sections in this Teacher's Guide. However, it is also worth allowing students to answer all of the questions at the end of the unit. This will test longer-term understanding and recall. You can do this as an informal individual or pair activity and allow students to look information up as they work through the questions or you can set it as an individual 'closed-book' activity.

It is important that students report areas that they are not confident with. This information is useful for them in that they can think about what they need to review or ask advice about. It is also vital for you as it provides information about any topics you may wish to revisit.

'What have I learned about the structure of Earth?' answers

1 Label the layers of the Earth. Use the words in the word box.

Remind students of the model of the layers of the Earth. Talk about the different layers in the model. Then read out the words in the word box and ask them where they think they are in the model. Students can then copy the words into the appropriate labels.

Answer: *The labels from top to bottom are: inner core, outer core, mantle, crust.*

2 Circle the correct option:

a. Soil provides plants with:
heat light food

b. The dead plants and animals in soil are called:
pebbles rocks humus

c. It is the large body of salt water on Earth:
river ocean glacier

d. These forms of running water, bring rain and melted snow from mountains to lowlands:
oceans streams and rivers ponds

e. Microorganisms break down dead plant and animals buried in soil to form:
humus minerals coi

f. A huge structure on rivers made to reserve water:
dam bridge flyover

Remind students to read through all of the options and point out that there can be more than one answer so they can tick as many of the boxes as they need to. Remind them that there are some questions as extensions where they need to do some research and recall their background knowledge.

Answer: *a: food b: humus c: ocean : streams and rivers e: humus f: dam*

3 a Label the layers found in soil. You can use the word box to help you.

Ask students to recall the work they did in the investigation on this topic. If you have any of the equipment they used to hand, show and discuss this to act as a stimulus to their recollection. Talk about how the soil separated into different layers when it settled. Ask if they can recall any of the layers that they observed in their investigation. Read out the words in the word box and link them to the discussion you have just had. Students can then copy thewords into the appropriate blank label boxes.

Answer: *From top to bottom the labels are: dead plants and animals, water, clay, fine sand, thick sand, gravel*

4 State whether the following statements are true or false:

a. River is a human-made resource of water.

b. The two-third of the Earth's surface is covered with water.

c. The topsoil contains solid rocks.

d. The second layer of the soil is known as the bedrock.

e. The texture of silt is smooth and silky.

f. Living organisms destroy the soil's quality.

g. Silt is the best soil for growing plants.

h. Only insects make their home in the soil.

Remind students to recall their background knowledge and answer the questions as true or false.

Answer: *a. false b. true c. false d. false e. false f. true g. true h. false*

5 Answer the following questions in detail:

a. Describe the different sources of water.

b. Illustrate and label a diagram showing the Earth's structure.

c. Describe the different sources of water, with examples.

d. Define soil and explain its various components.

e. Discuss the different types of soils based on their particle size.

Ask students to recall the lessons learned in the unit, and their background knowledge.

Answer: *a. Describe the different sources of water. Water is an important natural resource that the environment contains in a variety of forms. Water covers about two thirds of the Earth's surface. Ground water, rivers and streams, the ocean, and standing water are the four primary sources of water.*

b.Illustrate and label a diagram showing the Earth's structure.

Page 152 of the student book

c. Describe the different sources of water, with examples.

Different sources of the water include:

Oceans

Large bodies of salt water are referred to be oceans. The oceans cover over 70% of the Earth's surface. In an ocean, the water is always moving.
Example: Pacific Ocean, Atlantic Ocean

Fresh water

Fresh water refers to water that is not salty. Freshwater makes up 1% of all water on Earth. Most freshwater is in the frozen state. Much of Earth's fresh water is frozen in huge sheets of ice or glaciers.
Example: Siachen Glacier

Rivers and streams

Streams in the highlands are often where rivers start. The water comes from snow or rain. Every river empty into the sea. These types of flowing water supply houses, farms, and businesses with rainwater and melted snow from the mountains.
Examples: Indus River, Sutlej River

Standing water
Holes in the earth fill with standing fresh water. Ponds, and reservoirs are a few examples. A lake created by humans and utilized for water storage is called a reservoir. Often, to create a reservoir, a dam is constructed over a river.
Examples: Tarbela Dam, Rawal Dam

d. Define soil and explain its various components.

The organic and inorganic elements that make up the earth's surface and act as a growing medium for plants are referred to as soil. The five elements that make up soil are minerals, organic stuff found in the soil, gas, water, and living things. There are three size classifications of soil minerals: sand, silt, and clay.

e. Discuss the different types of soils based on their particle size.
(page 157 of the student book)

6 Answer the following questions briefly:

a. Write two ways in which soil is important for living things.

b. How do small animals improve the soil?

c. What are volcanoes?

d. Which type of soil is best to grow plants?

Encourage the students to conduct research in order to provide answers to the questions and ask them to recall the lecture or notes the teacher gave during the class. Tell students to read the questions carefully and answer the questions carefully.

Answer: *a. Write two ways in which soil is important for living things.*
Soil is important because:
- *Soil provides plants with food and water*
- *Soil provides the supp*ort to the plants.

b. How do small animals improve the soil?
Tiny creatures stir the soil and create openings for water and air to permeate. They breakdown decaying plants to tiny fragments for easier breakdown by bacteria and fungi.

c. What are volcanoes?
A volcano is an opening in the crust of the earth through which gasses, ash, and lava are released.

d. Which type of soil is best to grow plants?
The most suitable soil for plant growth is loamy soil because of its high water retention capacity, which allows it to hold onto water for extended periods of time and keep nutrients needed for plant growth.

7 Look at the image of the water cycle and label the image with the help of words given below.

Answer: *(page 160 of student book)*

8 Fill in the blanks:

a. The layer of the soil which contains most humus is known as _____.

b. The soil which is composed of medium-sized particles and feels smooth is called _____.

c. The layer of the soil which is below the topsoil in known as the _____.

d. The soil which contains the largest particles and feels rough when rubbed is called _____.

e. The soil which can be moulded into different shapes and can maintain

f. these shapes after drying, is known as _____.

g. The soil which sticks together when wet, but does not hold its shape after drying, is known as _____.

Answer: *a) Topsoil b) Silt soil c) Sub soil d) Sandy soil e/f) Clay g) Silt*

Summative assessment

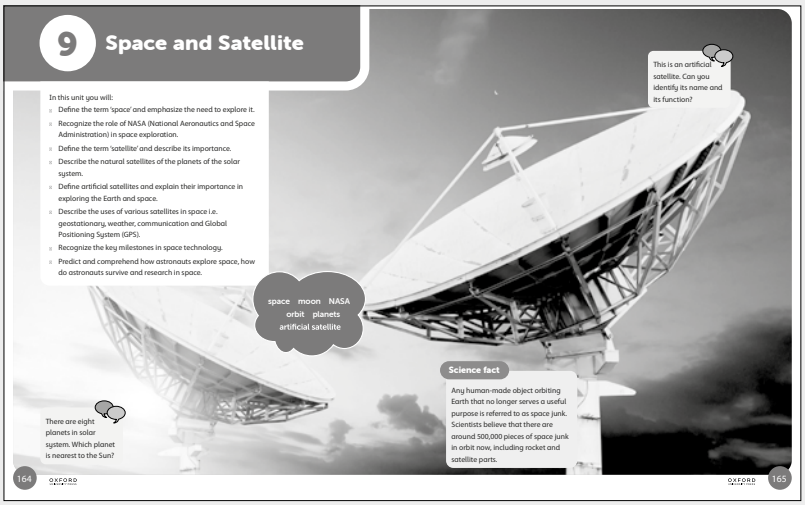
You can read out the answers to the 'What have I learned about the structure of Earth?' section in the Student Book on pages 162–163 for students to self-assess or you can take in the pages and mark them to award an overall score. You could allocate marks as follows: question 1 = 4 question 2 = 6 question 3 = 6 question 4 = 8; question 5 = 10 question 6 = 4; question 7 = 3; quetion 8 = 6. This makes a total of 47 marks.

If necessary, ask students to revisit topics and questions to help them to learn more about any they did not score well on. In this way the questions are both summative and formative. All assessments should be linked to enhancing learning and in this way the 'What have I learned about?' pages will support this as well as providing data to report back to students, parents and/or other significant adults.

9 Space and Satellite

In this unit students will:

- Define the term 'space' and emphasize the need to explore it.
- Recognize the role of NASA (National Aeronautics and Space Administration) in space exploration.
- Define the term 'satellite' and describe its importance.
- Describe the natural satellites of the planets of the solar system.
- Define artificial satellites and explain their importance in exploring the Earth and space.
- Describe the uses of various satellites in space i.e. geostationary, weather, communication and Global Positioning System (GPS).
- Recognize the key milestones in space technology.
- Predict and comprehend how astronauts explore space, how do astronauts survive and research in space.



Getting started

In this unit students will explore the solar system and satellites.

They will learn the role of NASA in space exploration. Students will get to know the difference between natural and artificial satellites and the role they play in our lives.

Science in context

Encourage students to understand more about the significance of NASA and satellites for space exploration by using the lessons in this unit.

Students should be encouraged to research the moon's phases and its orbit around the Earth. Instruct the students to watch the astronomers' interviews in order to gain insight into their experiences. Request that they investigate various hypotheses on natural satellites.

Resources

Student Book:

Key words for unit

Bold words are in the Word cloud.

space explore
moon asteroids **NASA**
orbit GPS **planets**
tides **artificial satellite**

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Language support

At this age, students are likely to be able to read independently and look up any words they find unfamiliar, so encourage them to use scientific dictionaries. Start the unit by reading out the words in the Word cloud. Ask students to discuss each word and define those they are familiar with. This monitoring of prior knowledge is vital and can help you enormously in setting the level of work in the first few lessons. For every unit it is worth creating a Word wall so students see the words often and can become familiar with them.

Repeat any new words regularly and use them in context. Students should listen, say, read and then write the words. They can also make a list of new non-science specific words they use in lessons.

You could create a science library in your room. Collect resources such as science books and magazines, science encyclopaedias and dictionaries. Students will enjoy helping with the production of these small information booklets and they can include some of their own work. You will find these specific booklets very valuable support for lessons and especially Stretch zone activities.

Unit at a glance

The key teaching points for students in this unit are:

- to introduce the unit objectives
- to introduce the learning outcomes
- to engage students with the content of the unit
- to review and build on prior learning and understanding of the topics.

Read through the key words and then allow students time to enjoy looking over the page before you start the sequence of discussion tasks. A suggested sequence follows below.

Arrange students into pairs or small groups of three or four for discussion work. A useful strategy is to start with students in pairs and then move pairs together to make small groups so students can share their ideas and discussions with others.

There are eight planets in solar system. Which planet is nearest to the Sun?

Students should recall their prior knowledge of different planets in the solar system learned in Grade four, then try to remember the order of all eight planets as they arrange themselves in order.

Answer: *Mercury is the closest/. nearest planet to the Sun.*

This is an artificial satellite. Can you identify its name and its function?

Ask students to look carefully at the satellite on page 165. Remind them to research on artificial satellites. Ask the students if they have this satellite at their home or have seen anywhere.

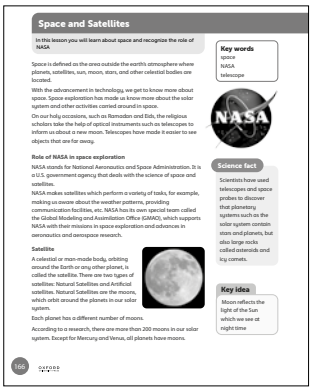
Possible response: *Students may answer that they have seen this mostly on rooftops and are used for catching signals for television.*

Answer: *The picture shows "Direct broadcast" satellites that is used for transmission of television signals.*

Science fact: Any human-made object orbiting Earth that no longer serves a useful purpose is referred to as space junk. Scientists believe that there are around 500,000 pieces of space junk in orbit now, including rocket and satellite parts.

Read out the Science fact or ask a volunteer to read it out. Ask students what does junk mean. Remind them that for many years, satellites have been launched into space by humans. Through these, we can learn more about the Sun, Earth, and other planets as well as peer far into space to observe galaxies, black holes, and far-off stars. But what happens to it once it fulfills its function. It is still in its orbit, circling the planet! Space debris, sometimes known as "junk," is the term used to describe man-made items that are orbiting the Earth but are no longer useful. Ask students how collisions lead to more debris in space.

Space and Satellites


Space and Satellites

In this lesson you will learn about space and recognize the role of NASA

Key words
space
NASA
telescope

Space is defined as the area outside the earth's atmosphere where planets, satellites, sun, moon, stars, and other celestial bodies are located.

With the advancement in technology, we get to know more about space. Space exploration has made us know more about the solar system and other activities carried around in space.

On our holy occasions, such as Ramadan and Eids, the religious scholars take the help of optical instruments such as telescopes to inform us about a new moon. Telescopes have made it easier to see objects that are far away.

Role of NASA in space exploration

NASA stands for National Aeronautics and Space Administration. It is a U.S. government agency that deals with the science of space and satellites.

NASA makes satellites which perform a variety of tasks, for example, making us aware about the weather patterns, providing communication facilities, etc. NASA has its own special team called the Global Modeling and Assimilation Office (GMAO), which supports NASA with their missions in space exploration and advances in aeronautics and aerospace research.

Satellite

A celestial or man-made body, orbiting around the Earth or any other planet, is called the satellite. There are two types of satellites: Natural Satellites and Artificial satellites. Natural Satellites are the moons, which orbit around the planets in our solar system.

Each planet has a different number of moons.

According to a research, there are more than 200 moons in our solar system. Except for Mercury and Venus, all planets have moons.

Science fact

Scientists have used telescopes and space probes to discover that planetary systems such as the solar system contain stars and planets, but also large rocks called asteroids and icy comets.

Key idea

Moon reflects the light of the Sun which we see at night time

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Getting started

In this lesson students will explore the role of NASA in space exploration. They will get to know some technology used by NASA for space exploration.

Language support

Encourage students to sound out the word "exploration" using phonic skills. Ask them if they have explored anything recently at school or at home.

Ask students if they know about NASA and its full form. Explain every word NASA stands for and elaborate them that NASA has played a huge role in space exploration. You could also add to a class Word wall so that students see key words often and become familiar with them.

Resources

Student Book:

Key words

space NASA telescope

Scientific enquiry key words

observe record data communicate findings

Lesson at a glance

The key teaching points in this lesson are:

- through the advancement in technology, we get to know more about space.
- NASA plays a vital role in space exploration.

Ask students to think about what they already know about space exploration. Ask for volunteers to share what they know and write their contributions on the board.

Science fact: Scientists have used telescopes and space probes to discover that planetary systems such as the solar system contain stars and planets, but also large rocks called asteroids and icy comets.

Read out the science fact or ask any volunteer to read the text. Ask students if they know about microscope and its uses. Tell them that microscope are used to see small objects that are not visible to the naked eyes. Give them some examples. Then tell students the function of telescope. Telescopes are used to see distant objects. For. example planets, star etc. The telescopes and probes are used to explore the solar system.

Key idea

Moon reflects the light of the Sun which we see at night time.

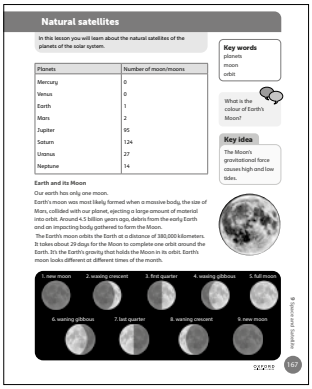
Ask students to recall what are luminous and non luminous objects. Tell them how moon as a natural satellite reflects the light of Sun that we see at night. Make them differentiate between natural and artificial satellite.

Review and reflect

Encourage students to discuss the content that they have learned in this lesson. Ask them how do they find the NASA contribution useful in their life. Explain them by giving the examples of moon sighting using the telescope.

Elaborate how the astronomers have described the space around us, by introducing different space objects including comets, asteroids, planets, natural satellite,etc.

Natural satellites


Natural satellites

In this lesson you will learn about the natural satellites of the planets of the solar system.

Planets	Number of moon/moons
Mercury	0
Venus	0
Earth	1
Mars	2
Jupiter	95
Saturn	124
Uranus	27
Neptune	14

Key words
planets
moon
orbit

What is the colour of Earth's Moon?

Key idea
The Moon's gravitational force causes high and low tides.

Earth and its Moon

Our earth has only one moon.

Earth's moon was most likely formed when a massive body, the size of Mars, collided with our planet, ejecting a large amount of material into orbit. Around 4.5 billion years ago, debris from the early Earth and an impacting body gathered to form the Moon.

The Earth's moon orbits the Earth at a distance of 380,000 kilometers. It takes about 29 days for the Moon to complete one orbit around the Earth. It's the Earth's gravity that holds the Moon in its orbit. Earth's moon looks different at different times of the month.

1. new moon 2. waxing crescent 3. first quarter 4. waxing gibbous 5. full moon
6. waning gibbous 7. last quarter 8. waning crescent 9. new moon

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science 167

Getting started

In this lesson students learn about moon as a natural satellite and how the number of moons varies with different planets. Students will explore about the features of earth's moon.

Language support

Read out the key words and ask students to share what they know about these terms. Ask students what orbit means. Explain that both the planets and moon orbit around.Planets orbit around the Sun and Moon orbits the Earth/ Planet.

Resources

Student Book:

Key words

planets moon orbit

Lesson at a glance

The key teaching points in this lesson are:

- number of natural satellite (moon) varies with every planet.
  There are different phases of moon.

Discussion

What is the colour of Earth's Moon?

Possible response: *Students might say that the colour of the moon is white / gray*

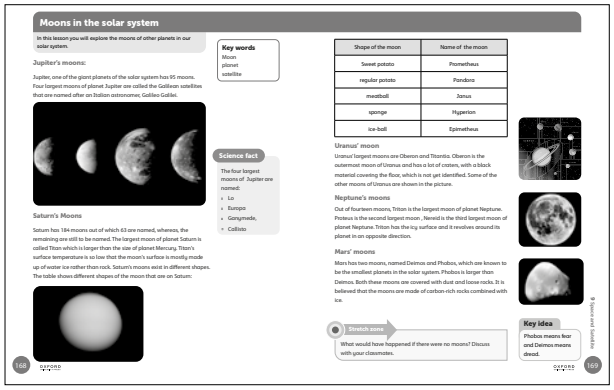
Key idea

The Moon's gravitational force causes high and low tides..

Summarise the lesson by asking students to recall the features of Earth's Moon. Ask students he different shapes of the earth's moon. Ask why does earth's moon look different throughout the month.

After reading the entire text on page 167, conclude the lesson by reading the Key idea on page 167 and tell students that the Moon's gravitational pull causes the oceans to bulge out on both the side closest to the Moon and the side farthest from the Moon. These bulges create high tides. The low points are where low tides occur.

Moons in the solar system


Moons in the solar system

In this lesson you will explore the moons of other planets in our solar system.

Key words
Moon
planet
satellite

Jupiter's moons:

Jupiter, one of the giant planets of the solar system has 95 moons. Four largest moons of planet Jupiter are called the Galilean satellites that are named after an Italian astronomer, Galileo Galilei.

Science fact

The four largest moons of Jupiter are named:
- Io
- Europa
- Ganymede,
- Callisto

Saturn's Moons

Saturn has 184 moons out of which 63 are named, whereas, the remaining are still to be named. The largest moon of planet Saturn is called Titan which is larger than the size of planet Mercury. Titan's surface temperature is so low that the moon's surface is mostly made up of water ice rather than rock. Saturn's moons exist in different shapes. The table shows different shapes of the moon that are on Saturn:

Shape of the moon	Name of the moon
Sweet potato	Prometheus
regular potato	Pandora
meatball	Janus
sponge	Hyperion
ice-ball	Epimetheus

Uranus' moon

Uranus' largest moons are Oberon and Titania. Oberon is the outermost moon of Uranus and has a lot of craters, with a black material covering the floor, which is not yet identified. Some of the other moons of Uranus are shown in the picture.

Neptune's moons

Out of fourteen moons, Triton is the largest moon of planet Neptune. Proteus is the second largest moon , Nereid is the third largest moon of planet Neptune. Triton has the icy surface and it revolves around its planet in an opposite direction.

Mars' moons

Mars has two moons, named Deimos and Phobos, which are known to be the smallest planets in the solar system. Phobos is larger than Deimos. Both these moons are covered with dust and loose rocks. It is believed that the moons are made of carbon-rich rocks combined with ice.

Stretch zone

What would have happened if there were no moons? Discuss with your classmates.

Key idea

Phobos means fear and Deimos means dread.

9 Space and Satellite

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Getting started

In this lesson students will explore moons of different planets in the solar system.

Language support

It is important to ensure that students understand the names of the different soils. planets and their moons. The names of moons will sound difficult so teachers can use audio/vocal dictionary to help the students learn the pronunciation.

Look forward to tell them the meaning / Theory behind the name of different moons. For example: Titan(Saturn's moon) means "a person or thing of very great strength".

Pandora (Saturn's moon) means: The name Pandora (pan-DOR-uh) is from pān, which means "all," and dōron, meaning "gift."

Like this, ask students to research (as many as they can) on the theory behind naming moons. This will make easy to learn the names of moons.

Resources

Student Book:

Key words

Moon planet satellite

Lesson at a glance

The key teaching points in this lesson are:

- there are different types of moon on the planets.

Read out the introductory text and ask students to look at the photographs of wet and dry soil.

Stretch zone: What would have happened if there were no moons? Discuss with your classmates.

Ask students to think about what will happen if there were no moons. Explain them that our planet is held in place by the gravitational attraction of the Moon. If the Moon didn't stabilize our tilt, the tilt of the Earth might fluctuate greatly. From no tilt, which results in no seasons, to a large tilt, which results in extreme weather and even ice ages, it would shift.

Key idea

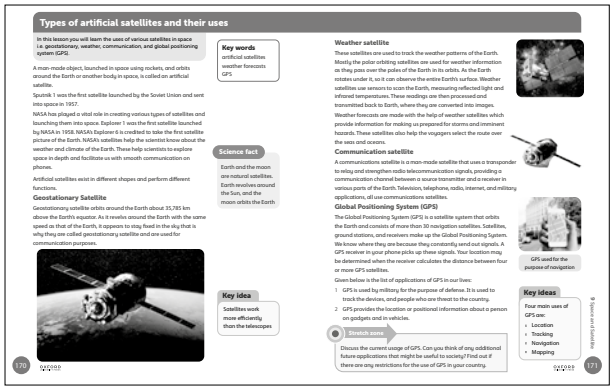
Phobos means fear and Deimos means dread.

Summarise the lesson by asking students what they have learned. Let them share their ideas, read out and discuss the key idea. Ask students to try memorizing some of the Moons' names.

Review and reflect

Encourage students to reflect on their learning throughout the lesson.

Types of artificial satellites and their uses


Types of artificial satellites and their uses

In this lesson you will learn the uses of various satellites in space i.e. geostationary, weather, communication, and global positioning system (GPS).

Key words
artificial satellites
weather forecasts
GPS

A man-made object, launched in space using rockets, and orbits around the Earth or another body in space, is called an artificial satellite.

Sputnik 1 was the first satellite launched by the Soviet Union and sent into space in 1957.

NASA has played a vital role in creating various types of satellites and launching them into space. Explorer 1 was the first satellite launched by NASA in 1958. NASA's Explorer 6 is credited to take the first satellite picture of the Earth. NASA's satellites help the scientist know about the weather and climate of the Earth. These help scientists to explore space in depth and facilitate us with smooth communication on phones.

Artificial satellites exist in different shapes and perform different functions.

Geostationary Satellite

Geostationary satellite orbits around the Earth about 35,785 km above the Earth's equator. As it revolves around the Earth with the same speed as that of the Earth, it appears to stay fixed in the sky that is why they are called geostationary satellite and are used for communication purposes.

Science fact
Earth and the moon are natural satellites. Earth revolves around the Sun, and the moon orbits the Earth

Key idea
Satellites work more efficiently than the telescopes

Weather satellite

These satellites are used to track the weather patterns of the Earth. Mostly the polar orbiting satellites are used for weather information as they pass over the poles of the Earth in its orbits. As the Earth rotates under it, so it can observe the entire Earth's surface. Weather satellites use sensors to scan the Earth, measuring reflected light and infrared temperatures. These readings are then processed and transmitted back to Earth, where they are converted into images.

Weather forecasts are made with the help of weather satellites which provide information for making us prepared for storms and imminent hazards. These satellites also help the voyagers select the route over the seas and oceans.

Communication satellite

A communications satellite is a man-made satellite that uses a transponder to relay and strengthen radio telecommunication signals, providing a communication channel between a source transmitter and a receiver in various parts of the Earth. Television, telephone, radio, internet, and military applications, all use communications satellites.

Global Positioning System (GPS)

The Global Positioning System (GPS) is a satellite system that orbits the Earth and consists of more than 30 navigation satellites. Satellites, ground stations, and receivers make up the Global Positioning System. We know where they are because they constantly send out signals. A GPS receiver in your phone picks up these signals. Your location may be determined when the receiver calculates the distance between four or more GPS satellites.

Given below is the list of applications of GPS in our lives:

1. GPS is used by military, for the purpose of defense. It is used to track the devices, and people who are threat to the country.
2. GPS provides the location or positional information about a person on gadgets and in vehicles.

Thinking zone
Discuss the current usage of GPS. Can you think of any additional future applications that might be useful to society? Find out if there are any restrictions for the use of GPS in your country.

GPS used for the purpose of navigation

Key ideas
Four main uses of GPS are:
- Location
- Tracking
- Navigation
- Mapping

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Getting started

In this lesson students will explore the existence of different artificial satellite and their uses.

Language support

It is important to ensure that students understand different types of artificial satellites.

Resources

Student Book:

Key words

artificial satellites

weather forecasts GPS

Scientific enquiry key words

use equipment observe measure record data

carry out tests group/classify

Lesson at a glance

The key teaching points in this lesson are:

- there are different types of artificial satellites.
- each satellite has different uses.

Read out the text on pages 170-171. There are different types of satellites and have different uses.

Ask the students if they know about any of these satellites. Ask them to tell how they think weather forecasts are made. How are they able to reach to a pinned location? How does the courier send them the parcel to the provided location?

Ask the students to watch a documentary show on artificial satellite and note down its uses. Take the pictures and share with the classmates and ask students to look at the photographs of wet and dry soil.

Science Fact Earth and the moon are natural satellites. Earth revolves around the Sun, and the moon orbits the Earth.

Read out the science fact or ask the volunteer to read the text. Ask the students to recall their last lessons and tell what satellites are. Ask them if they can give examples of artificial satellites.

Key idea

Satellites work more efficiently than the telescopes.

Read the Key Idea and ask the students differentiate between telescope and satellite.

Satellites are sent into space to gather information. On the other hand, telescope is an instrument used to see objects that are far away. Telescopes are often used to view the planets and stars.

This distinction shows that satellites are better than telescope.

Read the text on page 171 and make your notes for each satellite in the text book. Note down the differences among each satellite and how they function differently.

Stretch zone: Discuss the current usage of GPS. Can you think of any additional future applications that might be useful to society? Find out if there are any restrictions for the use of GPS in your country.

Ask students to think about how well GPS works. Note down the uses of GPS and collect the pictures and place on a chart paper. Discuss with your class mates.

Key idea

Four main uses of GPS are:

- *Location*
- *Tracking*
- *Navigation*
- *Mapping.*

Summarise the lesson by asking students what they have learned. Let them share their ideas, read out and discuss the key idea. Ask students why GPS important. Ask students if they use GPS. Discuss in the class.

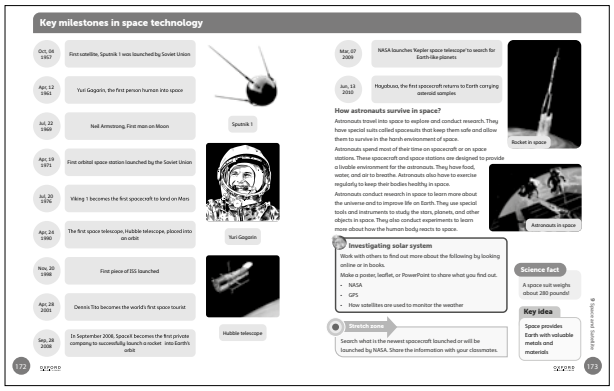
Review and reflect

Encourage students to reflect on their learning throughout the lesson. Use the discussion tasks, the key ideas, stretch zone etc. To encourage students to think about what they understand and what they are finding less straightforward. Discuss the outcomes of each task with students.

Extra activities

1 A useful way to extend work on the different types of satellite is to allow students to watch shows, movies, talk shows, or documentary program to research on artificial satellites.

Key milestones in space technology



Getting started

In this lesson students will explore the key milestones in space. The interesting facts and features of space and the technology in the space. Students will get to know how astronauts survive the space.

Resources

Student Book:

Lesson at a glance

The key teaching points in this lesson are:

- the key milestones in space exploration
- the role of astronauts in space exploration.

Investigation: Investigating solar system

Work with others to find out more about the following by lookingonline or in books.

Make a poster, leaflet, or PowerPoint to share what you find out.

- NASA
- GPS
- How satellites are used to monitor the weather

The aim of this investigation is to encourage students to find out more about satellites and the role of NASA in space exploration.

Stretch zone: SSearch what is the newest spacecraft launched or will be launched by NASA. Share the information with your classmates. Read the text of stretch zone and ask students to make the groups and start their research.

Discussion

Which soil will get muddy after heavy rain? Which soil will be too dry to grow crops?

Elicit that soils that do not allow water to pass through them are most likely to become muddy. The water cannot escape anywhere. Soils that allow water to pass through quickly are most likely to be too dry to grow crops.

> ***Possible response:*** *Students might suggest that clay would become muddy after heavy rain as it does not drain very well. Sandy soil drains quickly and feels dry so this would be too dry to grow crops.*

Science Fact:

A space suit weighs about 280 pounds!

Read out the science fact or ask the volunteer to read the text. Tell them that the suit is made to resist the extremely high temperatures found in space and has a life support system.

Key idea

Space provides Earth with valuable metals and materials

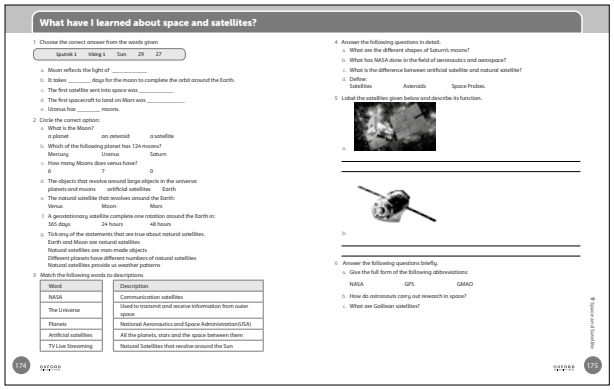
Summarise the lesson by asking students what they have learned. Let them share their ideas, read out and discuss the key idea.

Review and reflect

Encourage students to reflect on their learning throughout the lesson. Use the discussion tasks, the research investigation activity to encourage students to think about what they understand and what they are finding less straightforward. Discuss the outcomes of each task with students.

Encourage students to identify aspects they have not completed correctly and help them to identify improvements. This will help them to develop a positive approach to learning by understanding that learning is a process that will improve with practice and reflection.

What have I learned about space and satellites?



What have I learned about space and satellites?

1 Choose the correct answer from the words given

Sputnik 1 Viking 1 Sun 29 27

a. Moon reflects the light of _____.
b. It takes _____ days for the moon to complete the orbit around the Earth.
c. The first satellite sent into space was _____.
d. The first spacecraft to land on Mars was _____.
e. Uranus has _____ moons.

2 Circle the correct option.
a. What is the Moon?
a planet an asteroid a satellite
b. Which of the following planet has 124 moons?
Mercury Uranus Saturn
c. How many Moons does venus have?
6 7 0
d. The objects that revolve around large objects in the universe:
planets and moons artificial satellites Earth
e. The natural satellite that revolves around the Earth:
Venus Moon Mars
f. A geostationary satellite complete one rotation around the Earth in:
365 days 24 hours 48 hours
g. Tick any of the statements that are true about natural satellites.
Earth and Moon are natural satellites
Natural satellites are man-made objects
Different planets have different numbers of natural satellites
Natural satellites provide us weather patterns

3 Match the following words to descriptions.

Word	Description
NASA	Communication satellites
The Universe	Used to transmit and receive information from outer space
Planets	National Aeronautics and Space Administration(USA)
Artificial satellites	All the planets, stars and the space between them
TV Live Streaming	Natural Satellites that revolve around the Sun

4 Answer the following questions in detail.
a. What are the different shapes of Saturn's moons?
b. What has NASA done in the field of aeronautics and aerospace?
c. What is the difference between artificial satellite and natural satellite?
d. Define:
Satellites Asteroids Space Probes.

5 Label the satellites given below and describe its function.

a.

b.

6 Answer the following questions briefly.
a. Give the full form of the following abbreviations:
NASA GPS GMAO
b. How do astronauts carry out research in space?
c. What are Galilean satellites?

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Getting started

The aim of this section is to encourage students to review their learning after each lesson in the unit and also to undertake some end-of-unit review and reflection. On pages 174–175 of the Student Book there are questions linked to concepts and topics covered in the unit. These will assess students' knowledge and understanding of the topic. You may have been using questions after each lesson where provided; there are links to relevant questions in the lesson sections in this Teacher's Guide. However, it is also worth allowing students to answer all of the questions at the end of the unit. This will test longer-term understanding and recall. You can do this as an informal individual or pair activity and allow students to look information up as they work through the questions or you can set it as an individual 'closed-book' activity.

It is important that students report areas that they are not confident with. This information is useful for them in that they can think about what they need to review or ask advice about. It is also vital for you as it provides information about any topics you may wish to revisit.

'What have I learned about the lives of animals and humans?' answers

1 Circle the letter that shows the correct life cycle for a butterfly.

Make sure students understand that they have three options but they should only circle one choice – A, B or C.

Answer: *a Sun , b 29 , c Sputnik, d Viking 1 , e 27*

2 Circle the correct option.

a. What is the Moon? a planet an asteroid a satellite

b. Which of the following planet has 124 moons? Mercury Uranus Saturn

c. How many Moons does venus have? 6 7 0

d. The objects that revolve around large objects in the universe: planets and moons artificial satellites Earth

e. The natural satellite that revolves around the Earth: Venus Moon Mars

f. A geostationary satellite complete one rotation around the Earth in: 365 days 24 hours 48 hours

g. Tick any of the statements that are true about natural satellites. Earth and Moon are natural satellites. Natural satellites are man-made objects. Different planets have different numbers of natural satellites. Natural satellites provide us weather patterns.

Answer: *a: a satellite b: Saturn c: 0 d: planets and moon, artificial satellites e: Moon f: 24 hours g: Different planets have different numbers of satellites*

3 Match the following words to descriptions.

Word	Description
NASA	Communication satellites
The Universe	Used to transmit and receive information from outer space
Planets	National Aeronautics and Space Administration(USA)
Artificial satellites	All the planets, stars and the space between them
TV Live Streaming	Natural Satellites that revolve around the Sun

Point out that there are two questions within question 3. They should think about each one separately. Suggest they start by completing the frog life cycle first. Remind them to write the correct letter in each box from the options presented in the box in the middle of each cycle.

Answer: *NASA - National Aeronautics and Space Administration(USA)*
The universe - All the planets, stars and the space between them Planets - Natural Satellites that revolve around the Sun Artificial satellites-Used to transmit and receive information from outer space
TV live Streaming- Communication satellites Planaets

4 Answer the following questions in detail.

a. What are the different shapes of Saturn's moons?

b. What has NASA done in the field of aeronautics and aerospace?

c. What is the difference between artificial satellite and natural satellite?

d. Define: Satellites Asteroids Space Probes.

Answer: *a. The planet Saturn has got 124 moons. Each moon has a different shape and size. Some of them are:*

- *Prometheus shaped as a sweet potato.*
- *Pandora shaped as a regular potato.*
- *Janus shaped as a meatball.*
- *Hyperion shaped as a sponge.*
- *Epimetheus shaped as an ice-ball.*

b. What has NASA done in the field of aeronautics and aerospace?

The National Aeronautics and Space Administration is known as NASA. It is a government organization in the United States that studies satellites and space research.

NASA produces satellites that carry out a range of functions, including as informing us about weather patterns and offering communication capabilities. The Global Modeling and Assimilation Office (GMAO), a dedicated staff inside NASA, assists the agency in carrying out its space exploration missions and advancing aerospace research and engineering.

c. What is the difference between natural and artificial satellite? Natural satellite: The natural Satellites are celestial bodies that formed by nature.

The most well-known Natural Satellite is the Moon. The natural satellite is made up of natural material, rock, minerals, water, dust etc.

Artificial satellite.

The artificial satellite is a device placed in orbit around the earth, moon, or another planet. The artificial satellites are man made. The artificial satellite is made out of metal and electronics material.

d. Satellite:

A celestial or man-made body, orbiting around the Earth or any other planet, is called the satellite. ***Asteroids*** *a little rocky object orbiting the sun. Though some have more erratic orbits, a large number of them, varying greatly in size, are found between the orbits of Mars and Jupiter.*

Space Probe

A space probe is a device dispatched to investigate space and collect data for science. With a variety of scientific instruments and tools, a space probe is launched from Earth to investigate the composition and atmosphere of space, as well as other planets, moons, and celestial bodies.

5 Label the satellites given below and describe its function

a.

b.

Answer: *a. Weather satellite*
These satellites are used to track the weather patterns of the Earth.

b. Communication satellite
A communications satellite is a man-made satellite that uses a transponder to relay and strengthen radio telecommunication signals, providing a communication channel between a source transmitter and a receiver

6 Answer the following questions briefly.

a. Give the full form of the following abbreviations:
NASA GPS GMAO

b. How do astronauts carry out research in space?

c. What are Galilean satellites?

Answer: *a.* ***NASA:*** *National Aeronautics and Space Administration* ***GPS:*** *Global Positioning System* ***GMAO:*** *Global Modeling and Assimilation Office*

b. To improve life on Earth and to understand more about the cosmos, astronauts carry out research in space. To examine the stars, planets, and other celestial bodies in space, they employ specialized equipment and devices. In order to find out more about how the human body responds to space, they also carry out tests.

c. The Galilean satellites, named after the Italian astronomer Galileo Galilei, are the four biggest moons of the planet Jupiter. They are: Lo, Europa, Ganymede, Callisto

Summative assessment

You can read out the answers to the 'What have I learned about the space and satellite?' section in the Student

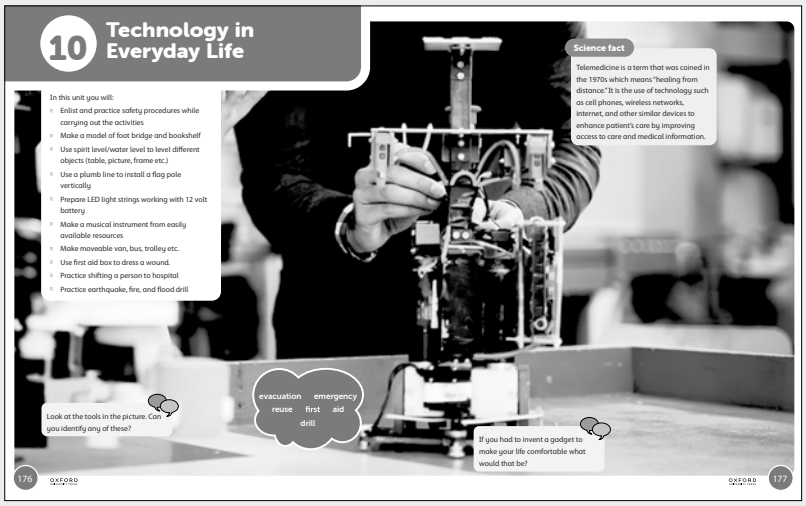
Book for students to self-assess or you can take in the pages and mark them to award an overall score. You could allocate marks as follows: question 1 = 5 question 2 = 7 question 3a = 5 question 4 = 10 question 5 = 4 question 6 = 7 This makes a total of 38 marks.

If necessary, ask students to revisit topics and questions, and recall their background knowledge and notes given during the lecture, to help them to learn more about any they did not score well on. In this way the questions are both summative and formative. All assessments should be linked to enhancing learning and in this way the 'What have I learned about?' pages will support this as well as providing data to report back to students, parents and/or other significant adults.

10 Technology in everyday life

In this unit students will:

- Enlist and practice safety procedures while carrying out the activities
- Make a model of foot bridge and bookshelf
- Use spirit level/water level to level different objects (table, picture, frame etc.)
- Use a plumb line to install a flag pole vertically
- Prepare LED light strings working with 12 volt battery
- Make a musical instrument from easily available resources
- Make moveable van, bus, trolley etc.
- Use first aid box to dress a wound.
- Practice shifting a person to hospital
- Practice earthquake, fire, and flood drill



Getting started

In this unit students review prior learning of various topics related to health, safety, electricity, gravity, etc.

The introductory lesson is designed to engage and inspire students. It prepares them for the upcoming unit and this specific intro lesson also introduces the ideas, applications, and concepts of electricity. In subsequent lessons, students will actively use their knowledge of electrical conductors and insulators and electrical circuits and building a test circuit. Students will also learn about natural disasters and other situations requiring first aid and practice accordingly.

Science in context

Use the lessons in this unit to encourage students to learn more about the importance of technology, its various aspects and their applications in everyday life. Encourage students to find out about how technology is used to enhance life. Discuss the dangers of over reliance on technology and use examples from their daily life. Encourage students to keep a diary of of their observations and ideas and to imagine what life would be like without technology.

Scientific enquiry skills

Students plan and carry out a range of investigations to help them test their ideas. They make predictions and write conclusions. They are expected to evaluate their enquiry work and ensure that they set up and carry out fair tests.

Prompt questions and discussions are included to support students as they plan and evaluate their investigations. Students also have opportunities to record findings in different ways and to interpret results.

You can use the Investigation master sheet on pages 4–5 to support investigative work. This provides prompts and structure to support students in planning and carrying out fair tests and in recording and drawing conclusions about their findings.

Resources

Student Book: small box/ boxes, colourful papers, cardboard, 2 to 4 big boxes of the same size, packing tape, scissors, wrapping paper /colourful paper, glue, paint/coloured pencils/ markers; 20 coloured straws; Clean matchsticks, ice cream sticks, tape, and paint; spirit level; plumb line; 3 connecting wires with clips on the end; 12 volt battery cell; 3 to 10 LED lights; A switch to turn the circuit on and off; torch; fire extinguisher; gauze; stretcher or carry pad.

Key words for unit

are in the Word cloud.

ammeter appliance **battery** **bulb**
buzzer cable cell circuit circuit breaker
circuit diagram circuit symbol **component**

conductor current fuse gauge **insulator** mains electricity metal **parallel circuit** plastic plug **series circuit** **switch** symbol **voltage** **voltmeter** wire

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Language support

The introductory lesson contains a Word cloud of the key words to be covered in the unit. These words could be placed on a Word wall in the classroom and students should add definitions of these words to their glossary when they have used the words and are familiar with how to use them.

You could collect science books and encyclopaedias to form a small class library as a resource for students to research definitions and also act as support for 'finding out' tasks. Consider downloading information sheets about the concepts to be covered in the unit, as well as allowing students access to the internet to help develop their computer skills.

Unit at a glance

The key teaching points for students in this unit are:

- to introduce the safety procedures
- to practice safety procedures while carrying out the activities
- to engage students with the content of the unit
- to review and build on prior learning and understanding of the topics.

The introductory pages are designed to encourage students to think about examples of application of technology they have seen. They are asked to think about what technology means in context of development and ease of availability, i.e. what seems common place to them may seem very technologically advanced in less privileged areas. Thelessons in the unit all place an emphasis on safety.

Read out the key words in the Word cloud and remind students to add definitions of these words to their glossary throughout the unit. Encourage students to study the main photograph as this is meant to generate interest. The discussion tasks can be covered in any sequence, but a suggested order is shown below.

Look at the tools in the picture. Can you identify any of these?

Ask students to work with a partner. Allow them to study the picture showing how the person is connecting an internal circuit. Ask them to share examples of where they have observation usage of this technique and then pairs can share their ideas with the class.

Possible response: *Students might suggest that internal circuits are found in almost all current electrical devices, including their cars.*

If you had to invent a gadget to make your life comfortable, what would that be?

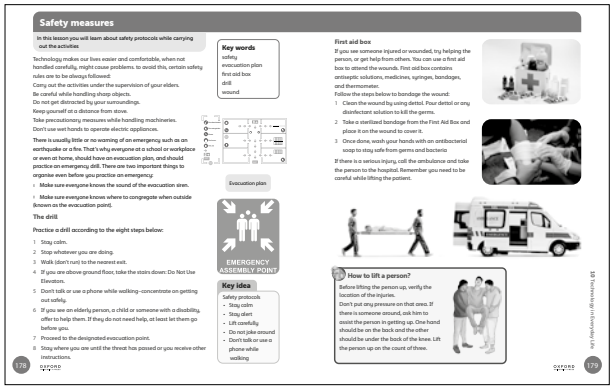
Allow students to work in pairs or small groups. Elicit that many of the machines that help us at home, such as vacuum cleaners and refrigerators, use electricity that flows through wires. Ask if they can name any other use of electricity, or a device which does not use electricity. Ask if they can imagine a world where electricity is not used, not is oil or gas: what type of technology would that world have?

Possible response: *Students might suggest any idea(s) that come to mind: some may suggest use of alternate fuels, whereas some may focus on other renewable energy sources.*

Science fact: Telemedicine is a term that was coined in the 1970s which means "healing from distance." It is the use of technology such as cell phones, wireless networks, internet, and other similar devices to enhance patient's care by improving access to care and medical information.

Read out the Science fact or ask a volunteer to read it out. Ask students to consider the the role of technology in making the information accessible and its impact on general health.

Safety measures


Safety measures

In this lesson you will learn about safety protocols while carrying out the activities

Technology makes our lives easier and comfortable, when not handled carefully, might cause problems. to avoid this, certain safety rules are to be always followed:
Carry out the activities under the supervision of your elders.
Be careful while handling sharp objects.
Do not get distracted by your surroundings.
Keep yourself at a distance from stove.
Take precautionary measures while handling machineries.
Don't use wet hands to operate electric appliances.

There is usually little or no warning of an emergency such as an earthquake or a fire. That's why everyone at a school or workplace or even at home, should have an evacuation plan, and should practice an emergency drill. There are two important things to organise even before you practice an emergency:

1 Make sure everyone knows the sound of the evacuation siren.
2 Make sure everyone knows where to congregate when outside (known as the evacuation point).

The drill

Practice a drill according to the eight steps below:

1 Stay calm.
2 Stop whatever you are doing.
3 Walk (don't run) to the nearest exit.
4 If you are above ground floor, take the stairs down: Do Not Use Elevators.
5 Don't talk or use a phone while walking–concentrate on getting out safely.
6 If you see an elderly person, a child or someone with a disability, offer to help them. If they do not need help, at least let them go before you.
7 Proceed to the designated evacuation point.
8 Stay where you are until the threat has passed or you receive other instructions.

Key words
safety
evacuation plan
first aid box
drill
wound

Evacuation plan

EMERGENCY ASSEMBLY POINT

Key idea

Safety protocols
- Stay calm
- Stay alert
- Lift carefully
- Do not joke around
- Don't talk or use a phone while walking

First aid box

If you see someone injured or wounded, try helping the person, or get help from others. You can use a first aid box to attend the wounds. First aid box contains antiseptic solutions, medicines, syringes, bandages, and thermometer.

Follow the steps below to bandage the wound:

1 Clean the wound by using dettol. Pour dettol or any disinfectant solution to kill the germs.
2 Take a sterilized bandage from the First Aid Box and place it on the wound to cover it.
3 Once done, wash your hands with an antibacterial soap to stay safe from germs and bacteria

If there is a serious injury, call the ambulance and take the person to the hospital. Remember you need to be careful while lifting the patient.

How to lift a person?

Before lifting the person up, verify the location of the injuries.
Don't put any pressure on that area. If there is someone around, ask him to assist the person in getting up. One hand should be on the back and the other should be under the back of the knee. Lift the person up on the count of three.

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Getting started

In this lesson students review different safety measures, in and out of lab, during emergencies and when helping yourself or others. they will revisit the first aid box which they explored the previous year and recall its items and their functions.

Language support

To explain the word 'drill' ask students to lshare where may have heard the word before, such as in a fire drill. Explain that drill means rigorous practice of a procedure. Similarly explain what is meant by am evacuation plan.

Resources

Student Book: Explain that drill means rigorous practice of a procedure. Similarly explain what is meant by am evacuation plan..

Key words

safety evacuation plan first aid box drill wound

Scientific enquiry key words

Recognise and control variables

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- safety protocols should be used when working in lab and during emergencies
- it is a good idea to practice for emergencies.

In the next lesson, students will learn more about how to react to and behave during an earthquake.

Begin by reading with student the introductory passage of the unit. Review and discuss the safety rules listed.

Remind students that emergency situation does not come with a clear warning and can arise at any time. Which is the reason why drills and clear evacuation plan and protocols are essential.

At this stage, if the school does not have an evacuation plan, work with the students to develop one. If the school does have an evacuation plan, ensure all exits are clearly marked and the siren is working. Indicate clearly the evacuation points to the students so that they are clear of where they need to congregate.

Review with the students, the eight drill steps listed in the book. Once you have discussed, arrange for evacuation drills for individual classes, and ultimately the entire school.

Make sure the students are clear on the drill steps to be followed during evacuation; conduct a class activity to prepare large posters and signposts to be placed throughout school for the evacuation protocol.

Ask students what they remember from their interaction with the first aid kit in the previous year, or due to any emergency since. You may get volunteers who will recall and share with class the contents of the first aid box.

Next, ask student volunteers to demonstrate bandaging. Remind the students that the volunteers will teach further students the proper procedure to treating and bandaging a wound. Guide the volunteers and students through the bandaging process and remind them again that in case of a serious injury, it is better to transfer the injured person to the hospital soon after providing first aid.

How to lift a person?

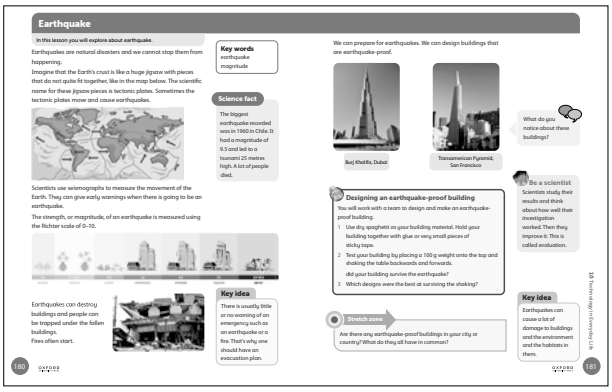
Allow students to work in groups of three or four. Explain that they are going to learn how to transport an injured person from one place to another. You can guide them on use of a stretcher if available. Otherwise, follow the instructions and practice in groups of students.

Key idea

- ***Safety protocols***
  - *Stay calm*
  - *Stay alert*
  - *Lift carefully*
  - *Do not joke around*
  - *Don't talk or use a phone while walking*

Read out the key ideas or ask a volunteer to read them out. These will remind students about the safety rules to be followed. You can invite a certified first aider or a fire fighter to class to demonstrate and review all the learning done so far.

Earthquake


Earthquake

In this lesson you will explore about earthquake.

Earthquakes are natural disasters and we cannot stop them from happening.
Imagine that the Earth's crust is like a huge jigsaw with pieces that do not quite fit together, like in the map below. The scientific name for these jigsaw pieces is tectonic plates. Sometimes the tectonic plates move and cause earthquakes.

Scientists use seismographs to measure the movement of the Earth. They can give early warnings when there is going to be an earthquake.
The strength, or magnitude, of an earthquake is measured using the Richter scale of 0–10.

Earthquakes can destroy buildings and people can be trapped under the fallen buildings.
Fires often start.

Key words
earthquake
magnitude

Science fact
The biggest earthquake recorded was in 1960 in Chile. It had a magnitude of 9.5 and led to a tsunami 25 metres high. A lot of people died.

Key idea
There is usually little or no warning of an emergency such as an earthquake or a fire. That's why one should have an evacuation plan.

We can prepare for earthquakes. We can design buildings that are earthquake-proof.

Burj Khalifa, Dubai

Transamerican Pyramid, San Francisco

What do you notice about these buildings?

Designing an earthquake-proof building
You will work with a team to design and make an earthquake-proof building.
1. Use dry spaghetti as your building material. Hold your building together with glue or very small pieces of sticky tape.
2. Test your building by placing a 100 g weight onto the top and shaking the table backwards and forwards.
did your building survive the earthquake?
3. Which designs were the best at surviving the shaking?

Stretch zone
Are there any earthquake-proof buildings in your city or country? What do they all have in common?

Be a scientist
Scientists study their results and think about how well their investigation worked. Then they improve it. This is called evaluation.

Key idea
Earthquakes can cause a lot of damage to buildings and the environment and the habitats in them.

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OXFORD 181

Getting started

In this lesson students investigate the causes and effects of an earthquake. They will also learn how to behave during and after an earthquake. This lesson builds upon the skills the students have learned from the previous unit.

Language support

The Word cloud at the beginning of the unit could be used throughout to check students' understanding of concepts earthquake magnitude. Most students should be familiar with the key words in this topic, although 'magnitude' may be unfamiliar. Remind students that the word is used to explain the size and impact of a phenomenon.

Resources

Student Book: dry spaghetti; glue; tape; weights of different types up to 100 grams; table; materials to do calculations and notes.

Key words

earthquake magnitude

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make observations

Take measurements, using equipment accurately

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- earthquakes are natural disasters
- seismographs can give early warnings when there is going to be an earthquake.
- we can prepare for earthquakes to minimize their destructions.

Ask students if they have ever experienced an earthquake. Be sensitive as the students may have suffered due to earthquake.

Read the text on top half of page 180 and encourage a class discussion. Discuss the term magnitude and point out the chart indicating magnitude and corresponding Richter scale.

Science fact: The biggest earthquake recorded was in 1960 in Chile. It had a magnitude of 9.5 and led to a tsunami 25 metres high. A lot of people died.

Read the science fact and encourage students to discuss why the Chile earthquake was so devastating.

Ask students to read the text and look at the photograph at the bottom of page 180. Encourage them to look at the photos on pages 181 next and try to answer the discussion question.

Answer: *Students may point out that though the buildings are very tall, they have broad bases for stability*

Designing an earthquake-proof building

Explain that in this investigation students are going to work in groups of three or four so they can share roles and discuss ideas.The aim is to design and make an earthquake proof building.

Leave students to set up their design prototypes and then test the different designs one by one. Encourage them to make note of which designs worked best, and which didn't work at all. Ask them to consider refining their designs by merging and testings different elements of each others designs. Ask them to record their observations. After testing all of the designs, students should draw their conclusions.

Allow students to reflect on their investigation and then write down some ways they could improve it to make it a fair test. Did they make any mistakes? The observations will always result in some errors.

Possible response: *Some metals are better conductors of electricity. Silver is the best. Students should use the same bulb and battery, and the same amount of material that they are testing, to make it a fair test. Conductivity will depend on the metals used but copper and iron-based products such as cutlery will conduct well. Metals that have been painted or covered in other materials will conduct less well.*

Be a scientist: Scientists study their results and think about how well their investigation worked. Then they improve it. This is called evaluation.

Ask students to read the Science fact as they are carrying out their investigation so it can encourage them to evaluate their work and suggest improvements.

Explain the evaluation is an essential step in the scientific process. Encourage students to share examples of when they used the process of evaluation in their daily lives.

Stretch zone: Are there any earthquake-proof buildings in your city or country? What do they all have in common?

Ask students to talk about the Stretch zone question with a partner. Ask them to decide on a reason and then you can ask volunteers to share their ideas with the class.

Key ideas

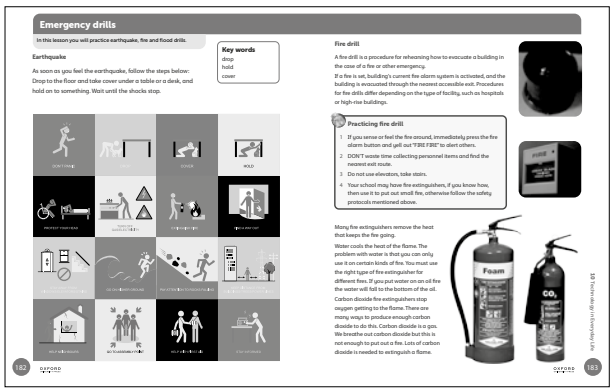
- *There is usually little or no warning of an emergency such as an earthquake or a fire. That's why one should have an evacuation plan.*
- *Earthquakes can cause a lot of damage to buildings and the environment and the habitats in them.*

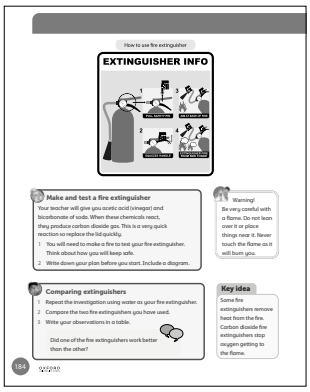
Summarise the lesson by asking a volunteer to read out the key ideas. Then ask students to share their thoughts on the key ideas, after the reflection exercise next.

Review and reflect

Encourage students to reflect on their own learning by pausing for a few moments and thinking about which parts of the work they found tricky. Talk about how they managed this and suggest that next time they stop for a short while and take a few deep breaths. Also remind them that when they are doing challenging work, they are training their brain and this will help their future learning. Allow them to walk around the displays of posters and information leaflets about Ampère to compare their work with others and pick up ideas for improvements.

Emergency drills





Getting started

This lesson is a continuation of the previous two lessons on safety and disaster management. Students are to get a more proactive, and a hands-on approach to behaving during an earthquake and a fire. They will gain an appreciation of getting to safety and then helping others.

Language support

Most of the key words in this lesson will already be familiar to students.

Key words

drop hold cover

Scientific enquiry key words

Make observations

drop hold cover

Lesson at a glance

The key teaching points for students in this lesson are:

- earthquake protocol drill
- fire safety drill.

In the next lesson, students will learn proper behaviour during a flood.

Begin by reviewing with the students their learning from the previous two lessons. At this stage, it will be useful to invite a first aider or a Civil Defense Trainer or a Rescuer to come to class, discuss with students and give demonstrations.

Ask students to read the text on page 182 before starting a demonstration. They should also be guided to review and remember the earthquake protocol given in the images.

Next, ask the students to read page 183, which covers the fire drill. Encourage them to recall the fire evacuation plan, before asking the fire rescue person to discuss putting out of fire.

Round up the students to do a fire drill, then the fire wardens can demonstrate the different types and uses of fire extinguishers.

It is recommended that students are strongly encouraged to study the how to use a fire extinguisher image on page 184. It is also advisable to place a how-to image next to accessible fire extinguishers around the school.

Investigation: Make and test a fire extinguisher

Explain that the purpose of this investigation is to demonstrate the principle behined the working of a fire extinguisher. Make a strong note of the warning regarding use of chemicals near fire and remind students that even a small flame such as on a burner can be lethal.

Encourage students to work in pairs and then share their designs with the class. It might be useful to have a senior fire warden discuss the design requirements of a fire extinguisher with the students at this stage.

Investigation: Comparing extinguishers

The purpose of this investigation is to encourage students to consider how different fire extinguishers work. Does it put out the fire? Does it prevent the material from burning? Does it prevent oxygen from reaching the fire?

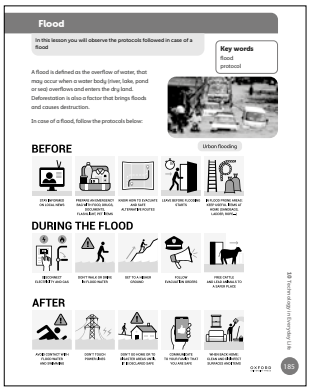
This investigation can be easily demonstrated in a lab. It is advisable to form small groups of students and to assign each a lab attendant or supervisor, as they take part in the investigation.

Key idea

- *Some fire extinguishers remove heat from the fire. Carbon dioxide fire extinguishers stop oxygen getting to the flame.*

Read out loud the key idea and then you can encourage a discussion about how it is possible for a fire to spread. Remind students not to repeat the class experiments at home, but to remember the fire drill and safety procedures.

Flood



Getting started

This lesson describes the procedures and protocols to be followed before, during and after a flood.

Language support

Read through the key words with the class. 'Protocol' is a difficult word – it may have been covered in previous lessons but make sure you give examples of the use of the word.

Resources

Key words

flood protocol

Scientific enquiry key words

Make predictions

Make observations

Record data and results

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- floods can occur in rural as well as urban areas
- the protocols are designed to help us remain safe during and after flooding.

This lesson lends itself to a detailed class discussion, especially if you live in an area with less chances of annual or seasonal flooding. However, it is strongly recommended that you show students videos and new reports related to flooding in the country in the recent years.

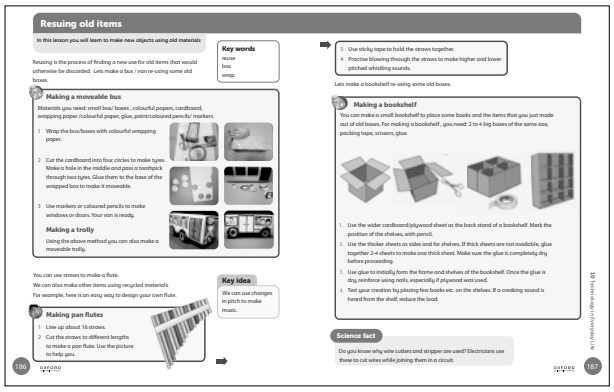
Encourage them to discuss the reasons behined the causes of flooding and whether anything can be done to reduce the chances of flooding.

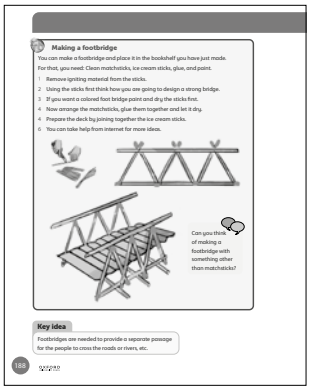
Finally discuss in detail the protocol shown in the images.

Review and reflect

Use the discussion tasks to encourage students to think about what they understand and what they are finding less straightforward. Discuss the outcomes of each protocol instruction with students. Encourage them to identify aspects they have not understood and help them to identify improvements. This will help students to develop a positive approach to learning by understanding that learning is a process that will improve with practice and reflection.

Resuing old items





Getting started

In this lesson students will explore how materials can be reused to create toys, useful items, and even models. This helps them appreciate that scientific working can be an environmentally sound process.

Language support

The key words in the lesson will be well known to most students. A strategy you can use is to write the words on the board but leave some gaps so letters are missing. Students can copy the words and then discuss which letters are missing. They can self-check by referring to the key words box.

Resources

Student Book: straws; empty boxes; cardboard boxes of different sizes; coloured papers, matchsticks or ice-cream sticks; strong glue; paints.

Key words

reuse box wrap

Scientific enquiry key words

Plan and/or carry out activities

Make observations

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Lesson at a glance

The key teaching points for students in this lesson are:

- eusing is the process of finding a new use for old items
- reusing items is good for the environment.

In the next lesson, students will draw circuit diagrams using circuit symbols.

Think back: Can you describe what a switch is used for?

This is a very activity oriented unit, so after an initial discussion, the students can pick and choose, which of the activities they wish to do. It is preferred that students do the initial 2 activities in small teams. The third activity can be a class project resulting in usable bookshelves. The last activity can be designated a STEAM competition between different grades or sections.

Investigation: Making a moveable bus

Ask students to work in pairs. Encourage them to be careful using scissors and be ready to help them when cutting out shapes.

Investigation: Making pan flutes

Remind students to carefully line up, measure, tape and trim the straws. Students can even do this activity by themselves, though they need to exercise caution when cutting or trimming the straws.

Investigation: Making a bookshelf

Arrange students into groups of three or four. Start by reading out the step by step method and asking students to discuss if they have any questions.

Encourage them to build the small bookshelves, and once they are assembled, you can then further attempt to join the bookshelves together to make a bigger storage area. Work together to line up the bookshelves along a corner and test out the optimal weight that they can carry. Decorate and populate the bookshelves.

Science fact: Do you know why wire cutters and stripper are used? Electricians use these to cut wires while joining them in a circuit.

Read out the Science fact or ask a volunteer to read it out. Ask students to discuss how this could keep us safe. They can suggest ideas about what might happen if ordinary scissors were used to cut wires.

Investigation: Making a footbridge

Ask the students to follow the steps given carefully. Encourage them to think if the model can be scaled up to create a functioning bridge? What steps and calculations will be required to do so?.

Key ideas

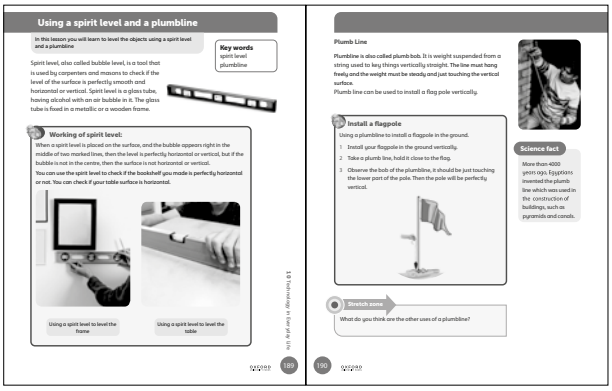
- We can use changes in pitch to make music.
- Footbridges are needed to provide a separate passage for the people to cross the roads or rivers, etc.

Read the key ideas yourself, or ask a volunteer to read them out aloud. Ask the students to share their reflections on the key ideas and the activities they have performed.

Review and reflect

Encourage students to find a quiet place to think about their learning in this lesson. Ask them if they found any part of the lesson challenging. Remind them that when they overcome a challenge, they are making their brain work harder. This is like going for a run to make your lungs work harder. Ask students how they felt when the learning was challenging and how they overcame the challenge. Ask them to record the strategies they used as this will help them in future situations. If all students found some part more difficult than others, you might want to review this as a class before moving onto the next lesson.

Using a spirit level and a plumbline


Using a spirit level and a plumbline

In this lesson you will learn to level the objects using a spirit level and a plumbline

Key words
spirit level
plumbline

Spirit level, also called bubble level, is a tool that is used by carpenters and masons to check if the level of the surface is perfectly smooth and horizontal or vertical. Spirit level is a glass tube, having alcohol with an air bubble in it. The glass tube is fixed in a metallic or a wooden frame.

Working of spirit level:

When a spirit level is placed on the surface, and the bubble appears right in the middle of two marked lines, then the level is perfectly horizontal or vertical, but if the bubble is not in the centre, then the surface is not horizontal or vertical.

You can use the spirit level to check if the bookshelf you made is perfectly horizontal or not. You can check if your table surface is horizontal.

Using a spirit level to level the frame

Using a spirit level to level the table

Plumb Line

Plumbline is also called plumb bob. It is weight suspended from a string used to key things vertically straight. The line must hang freely and the weight must be steady and just touching the vertical surface.

Plumb line can be used to install a flag pole vertically.

Install a flagpole

Using a plumbline to install a flagpole in the ground.

1 Install your flagpole in the ground vertically.
2 Take a plumb line, hold it close to the flag.
3 Observe the bob of the plumbline, it should be just touching the lower part of the pole. Then the pole will be perfectly vertical.

Science fact

More than 4000 years ago, Egyptians invented the plumb line which was used in the construction of buildings, such as pyramids and canals.

Stretch zone

What do you think are the other uses of a plumbline?

Getting started

In this lesson students are introduced to stwo commonly used tools in carpentry and construction.

Language support

Study the key words at the beginning of the lesson and have a class discussion about either of the unfamiliar one.

Key words

spirit level plumbline

Scientific enquiry key words

spirit level plumbline

Make observations

Analyse data, notice patterns and group or classify things

Draw conclusions and give explanations

Lesson at a glance

The key teaching points for students in this lesson are:

- the use of spirit level
- the use of plumb line.

Ask students to make a list of all the things they have observed a carpenter or a mason using in their daily life. You should arrange a visit to a carpenters workshop and/or a construction site, taking appropriate safety measures.

Read and discuss the introductory paragraph on bubble or spirit level. If possible, bring such levels to class and allow students to use them to measure their tables, window ledges, hanging posters, and even the bookshelves they made earlier.

Investigation: Working of spirit level

Ask students to discuss in small groups how the use of a spirit level can be helpful during carpentry and construction work. Ask them if they can improve their earlier designs (from the previous unit) by using the level.

> ***Possible response:*** *Apart from the usual use for checking the level of walls, door and window casings, foundations, and walls, plumb lines can also be used to measure angles and to determine the center of gravity of an irregular shape.*

Lead a class discussion about the value of a plumb line. You can begin by sharing the science fact and then drawing their attention to the unique shape a plumb line, which makes its function possible.

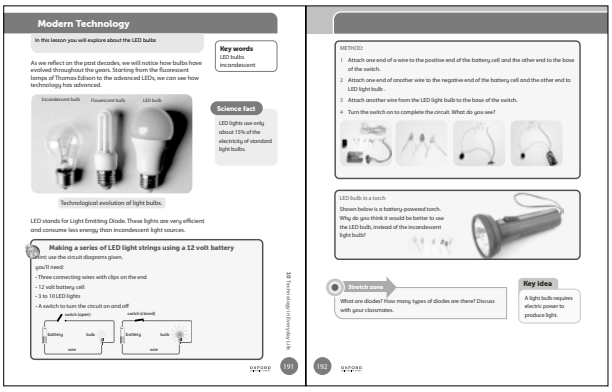
Investigation: Using a plumbline to install a flagpole

The purpose of this investigation is to allow students to apply their knowledge of a tool and then to apply it in a constructive manner. Ensure that you have plenty of adult supervision while the students are attempting this activity.

Stretch zone: What do you think are the other uses of a plumbline?

Allow students to work with a partner. Encourage them to research the answer online or using books.

Modern Technology



Getting started

In this lesson students will reflect on technological advances, using the example of a light bulb. They will also recall earlier learning about electricity and conductors.

Language support

To help develop language skills you could use flashcards with the names of the different circuit symbols. Students have to name the symbol and describe how it is used.

Resources

Student Book: batteries; wires; connectors; bulbs; switches; materials to make information sheets.

Key words

LED bulbs incandescent

Scientific enquiry key words

Plan and/or carry out enquiries to answer questions

Make predictions

Make observations

Record data and results

Analyse data, notice patterns and group or classify things

Report and present findings

Draw conclusions and give explanations

Identify causal relationships

Lesson at a glance

The key teaching points for students in this lesson are:

- series circuits have the components in a line one after the other
- LED lights are very efficient and consume less energy than incandescent light sources.

Read with the students the introductory passage about the LEDs. Point out the different types of bulbs: if possible, bring these bulbs into the class and let the students carefully handle them and observe the types of light they emit.

Science fact: LED lights use only about 15% of the electricity of standard light bulbs.

After a read through of the information, gather the students to conduct the investigative activity.

Investigation: Making a series of LED light strings using a 12 volt battery

Ask students to look at the two circuit diagrams. Ask them to discuss why we use circuit diagrams. Remind them that electricity is very dangerous, and elicit that circuits must be set up correctly so that there are no accidents. Highlight the importance of internationally

used symbols. Working from a photograph can be very confusing and could cause accidents. Explain that a circuit diagram is like an underground railway map – it is easy to follow. Railway lines may be at dierent levels and bend in many dierent directions but a map shows these in a simpler way. Show students a map if possible to demonstrate the similarity.

Students can work in groups of three or four to plan and carry out the investigation. Once they have set up the circuits, they can predict whether circuit will have the lit bulbs and then close the switches and compare the brightness of the bulbs. Remind them to record their observations and check their prediction. Next, they should attempt to answer the question related to the use of bulbs in a torch. Encourage a class discussion and then lead them to consider energy efficiency and heat waste of the type of bulb used.

Stretch zone: What are diodes? How many types of diodes are there? Discuss with your classmates.

Ask students to work with a partner or in a small group. Allow them to research their own answers. This will give them some ownership of their learning.

Key idea

A light bulb requires electric power to produce light.

Encourage students to read the key idea and discuss it with a partner. This activity can lead into the review and reflect part of the lesson.

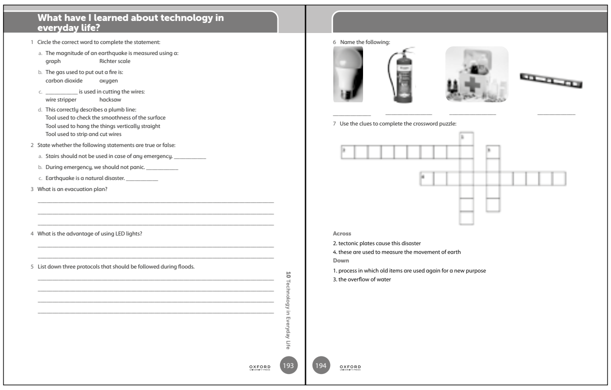
Review and reflect

Encourage students to display their circuits and circuit diagrams and allow them to walk around to see what other students have produced. They can then have some quiet time to reflect on how they could modify their circuits to improve them. Point out that reflecting on their work and learning from others is a very important part of learning.

Extra activities

1 Students research the symbols for a fuse and a diode. They describe what these components are used for.

What have I learned about technology in everyday life?


What have I learned about technology in everyday life?

1 Circle the correct word to complete the statement:

a. The magnitude of an earthquake is measured using a:
graph Richter scale

b. The gas used to put out a fire is:
carbon dioxide oxygen

c. __________ is used in cutting the wires:
wire stripper hacksaw

d. This correctly describes a plumb line:
Tool used to check the smoothness of the surface
Tool used to hang the things vertically straight
Tool used to strip and cut wires

2 State whether the following statements are true or false:

a. Stairs should not be used in case of any emergency. __________

b. During emergency, we should not panic. __________

c. Earthquake is a natural disaster. __________

3 What is an evacuation plan?

4 What is the advantage of using LED lights?

5 List down three protocols that should be followed during floods.

10 Technology in Everyday Life

OXFORD

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6 Name the following:

7 Use the clues to complete the crossword puzzle:

Across

2. tectonic plates cause this disaster
4. these are used to measure the movement of earth

Down

1. process in which old items are used again for a new purpose
3. the overflow of water

OXFORD

Getting started

As you will know from previous units, the aim of this section is to encourage students to review their learning after all of the lessons in the unit. Remember that all lessons have questions and discussion tasks for students to answer and these can be used formatively during lessons. Use student responses to these to help you to assess student knowledge and understanding of the topic.

On pages 193-194 of the Student Book there are seven questions related to the content of the unit. As with other units, students can tackle these one at a time after each relevant lesson. The questions within this section can also be answered as a single summative activity. This could be done by reading out the questions to the class and asking for volunteers to answer them, carrying out the activity as a group work task with students talking about each question or, if students can confidently read the questions, as an individual task. Whichever approach is adopted the questions are designed to give you and students feedback about progress and to help in identifying targets for development. The questions are arranged in increasing order of conceptual demand and not topic order.

It is important students feel confident that their reflections will be listened to and dealt with sensitively so that they do not hesitate to report areas they are not confident with. This information is vital for the teacher to provide support strategies in the end-of-unit summative assessment.

What have I learned about technology in everyday life? answers

1 Circle the correct word to complete the statement:

a. The magnitude of an earthquake is measured using a:

b. The gas used to put out a fire is:

c. __________ is used in cutting the wires:

d. This correctly describes a plumb line: .

Answer: *a. Richter scale; b. carbon dioxide; c. wire stripper; d. Tool used to hang the things vertically straight.*

2 State whether the following statements are true or false:

a. Stairs should not be used in case of any emergency.

b. During emergency, we should not panic.

c. Earthquake is a natural disaster.

Answer: *a. false; b. true; c. true.*

3 What is an evacuation plan?

Answer: *Students should give the answer in their own words. A possible answer may be that an evacuation plan is a map or a diagram showing an immediate and unblocked exit from an area of emergency.*

4 What is the advantage of using LED lights?

Answer: *LED or the Light Emitting Diode, lights are very efficient and consume only about 15% of the electricity of standard light bulbs. In other words, they use 85% less energy than incandescent light bulbs.*

5 List down three protocols that should be followed during floods.

Answer: *Students can list any three of the listed protocols in the spread.*

6 Name the following.

Answer: *a LED bulb; fire extinguisher; first aid box and kit; spirit (or bubble) level.*

7 Use the clues to complete the crossword puzzle.

Answer: *2. earthquake; 4. seismographs; 1. recycle; 3. flood.*

Summative assessment

The questions in the What have I learned about technology in everyday life? pages of the Student Book

can be used to consider the progress of each student individually. You can also use the information to create summative reports – such as end-of-term reports – for each student. If you wish to allocate a score or mark for the questions, then the total number of marks you could allocate is 20 (question 1 = 4; question 2 = 3; question 3 = 1; question 4 = 1; question 5 = 3; question 6 = 4; question 7 = 4). question 8 = 1; question 9a = 1; question 9b = 1).

It may also be useful to keep a record of whole-class overall confidence levels to identify areas that may need revision later on.

This feedback can then be used to form support strategies to help students improve. Keep the recording and analysis of student self-evaluations simple. A general impression of the class's self-evaluation, not individual student records, is all that is required, e.g. 'Fifty per cent of the class were not confident about …'.

Investigate like a scientist

The below tasks are is designed to encourage students to apply their investigative and creative skills and review key aspects of the content of the unit.

Can a pencil be used to complete a circuit?

Resources: batteries; wires; connectors; bulbs; pencils.

Provide students with the equipment for this investigation in which students work together as a team to investigate if a pencil could complete a circuit in the place of a wire. Students have made circuits and tested materials to find out if they are insulators or conductors of electricity throughout this unit. Ask the teams to predict whether or not the pencil will work. The teams can then discuss the problem and agree on a design to investigate and test this. Allow them to set up a circuit to test the pencil and ask them to research the properties of the pencil. Students can observe and record their results and then report on their findings. Ask them to decide if their results support the research findings. To share their ideas, students can present their investigation and findings as a news report.

Making symbols

Resources: internet and science books, materials to make booklets.

Ask students to work with a partner or individually for this task. Explain that they should find 20 symbols for components that they recognise or have heard of before. You could suggest some of the following to add to the ones they have used in lessons: antenna; transformer; resistor; fuse; diode; LED; amplifier; push button switch and loudspeakers. Point out that students are then going to be allowed to invent new symbols for these components. Stress to students that the symbols they invent should be easy to draw and also make sense to other scientists. If they are too elaborate, they will take too much time to draw and people will not use them.

Suggest they might decide to make their symbols easier or more meaningful for a younger audience. Ask students to share their ideas by making a booklet to show their new symbols alongside the old symbol. Remind them to also describe the symbol with a brief description of what the component does.