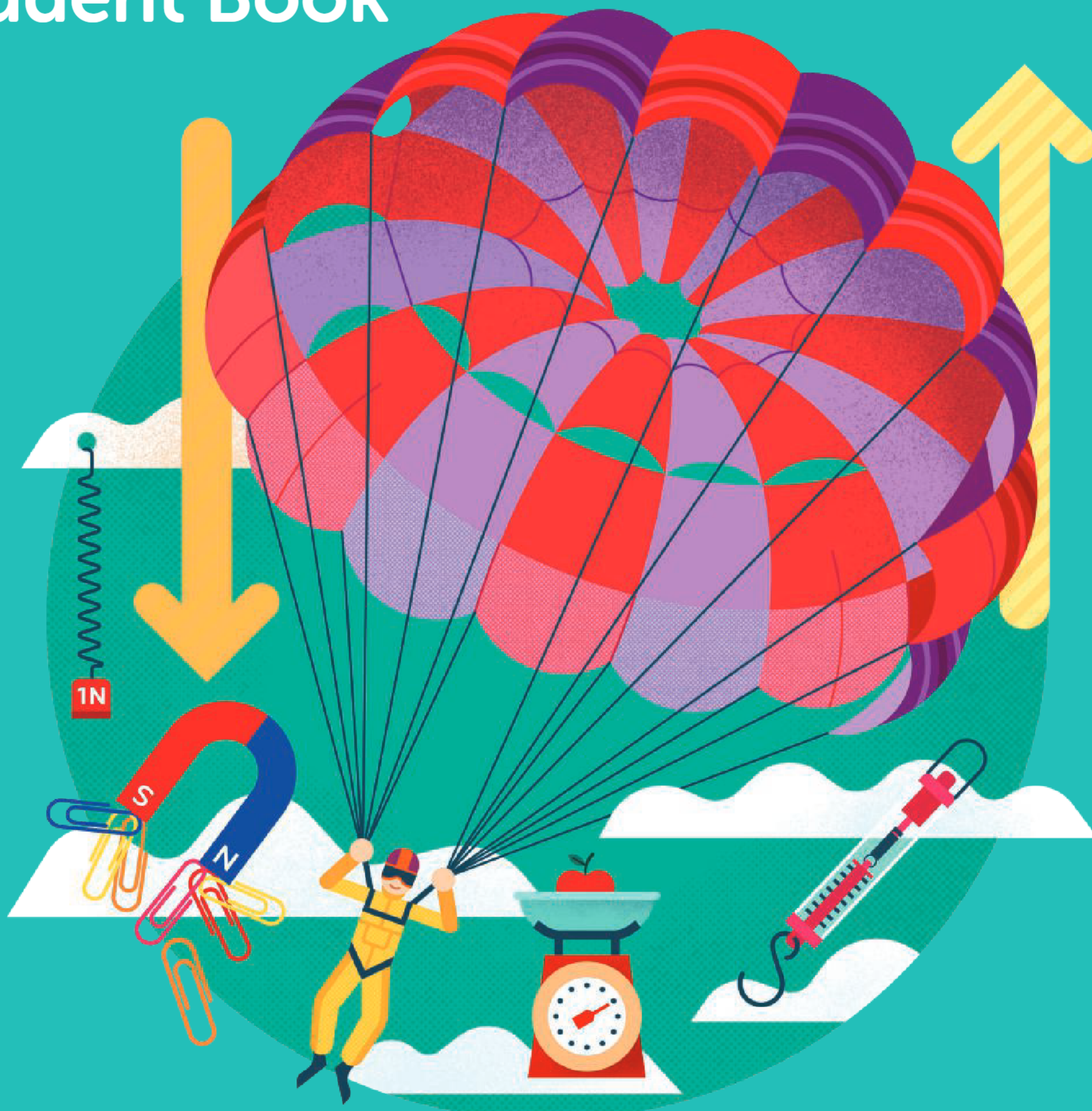
Oxford International Resources

Revised Edition

7

Science

Student Book



Lower Secondary

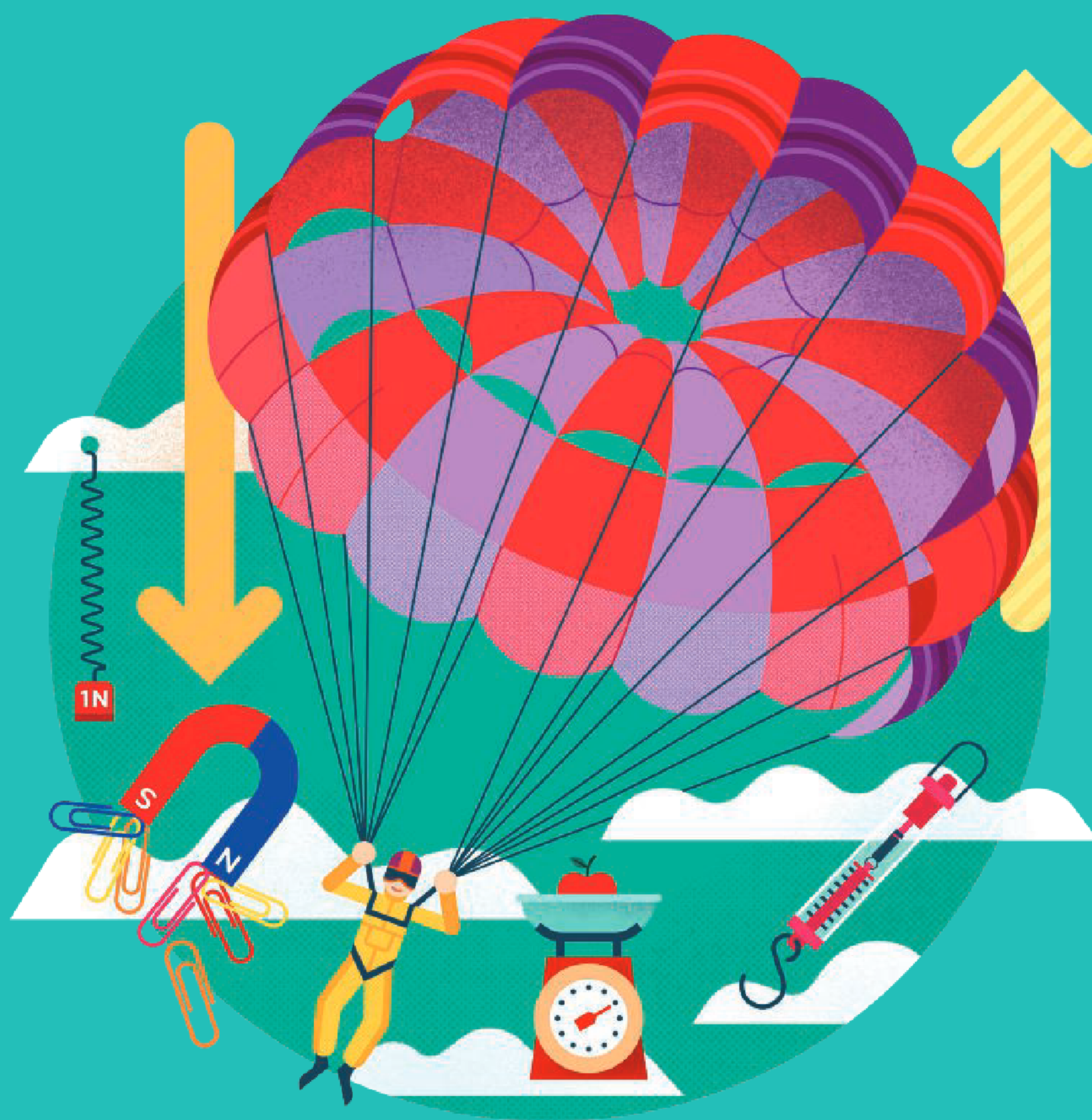
OXFORD

Oxford International Resources

7

Science

Student Book



Dr Andrew Chandler-Grevatt
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Helen Reynolds

OXFORD

Contents

Chemistry 86

Physics 148

How to use this book

Each topic begins with a set of learning objectives. These tell you what you will be able to do by the end of the lesson.

Think back

Here you will find some short questions that will remind you what you already know about a topic.

Key idea

The key idea summarizes the main points of each topic in a few sentences.

Key words

The key words for each topic are highlighted in **bold** in the text. They are also included in order of appearance in this box. You can also find them in the Glossary at the back of your Student Book.

Summary questions

1 The first question asks you to recall information.

2 The second question builds on what you have learned.

Stretch zone

3 The third question moves you into the 'stretch zone'. This means you will need to think more deeply about scientific concepts. It is OK if you find this question difficult – doing challenging work is the exercise that your brain needs.

Welcome to your Student Book

This introduction shows you all the different features *Oxford International Science* has to support you on your journey through Lower Secondary Science.

Being a scientist is great fun. As you work through this Student Book, you will learn how to work as a scientist and get answers to questions that science can answer.

This book is full of activities to help build your confidence and skills in science.

These boxes contain a short question after each section of text so you can check your understanding of the topic so far.

Working scientifically

Scientists work in a particular way to carry out fair and scientific investigations. These boxes contain activities and tips to help you build these skills and understand the process so that you can work scientifically.

Maths skills

Scientists use maths to help them solve problems and carry out their investigations. These boxes contain activities and tips to help you practise the maths you need for scientific purposes.

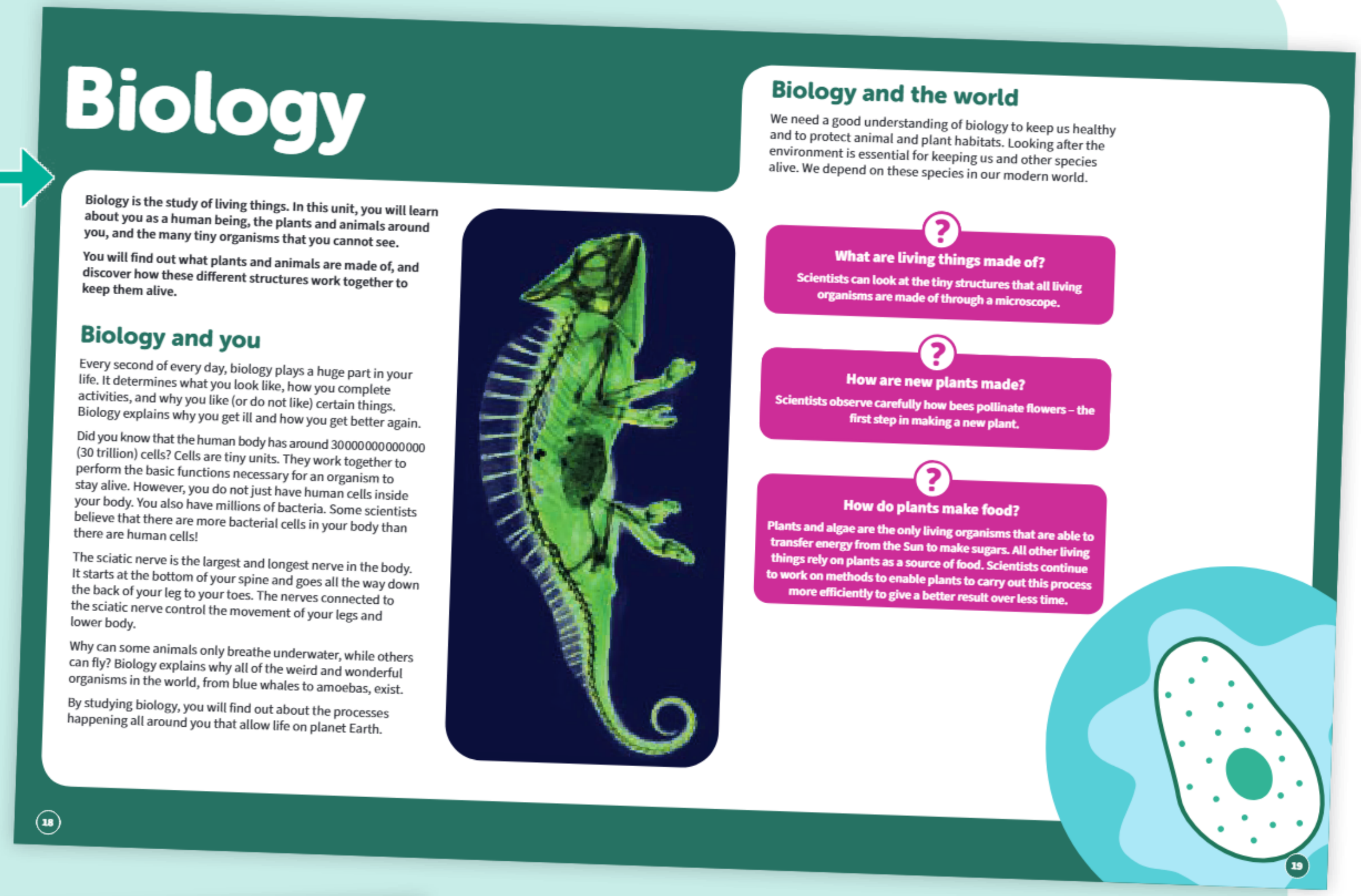
Literacy skills

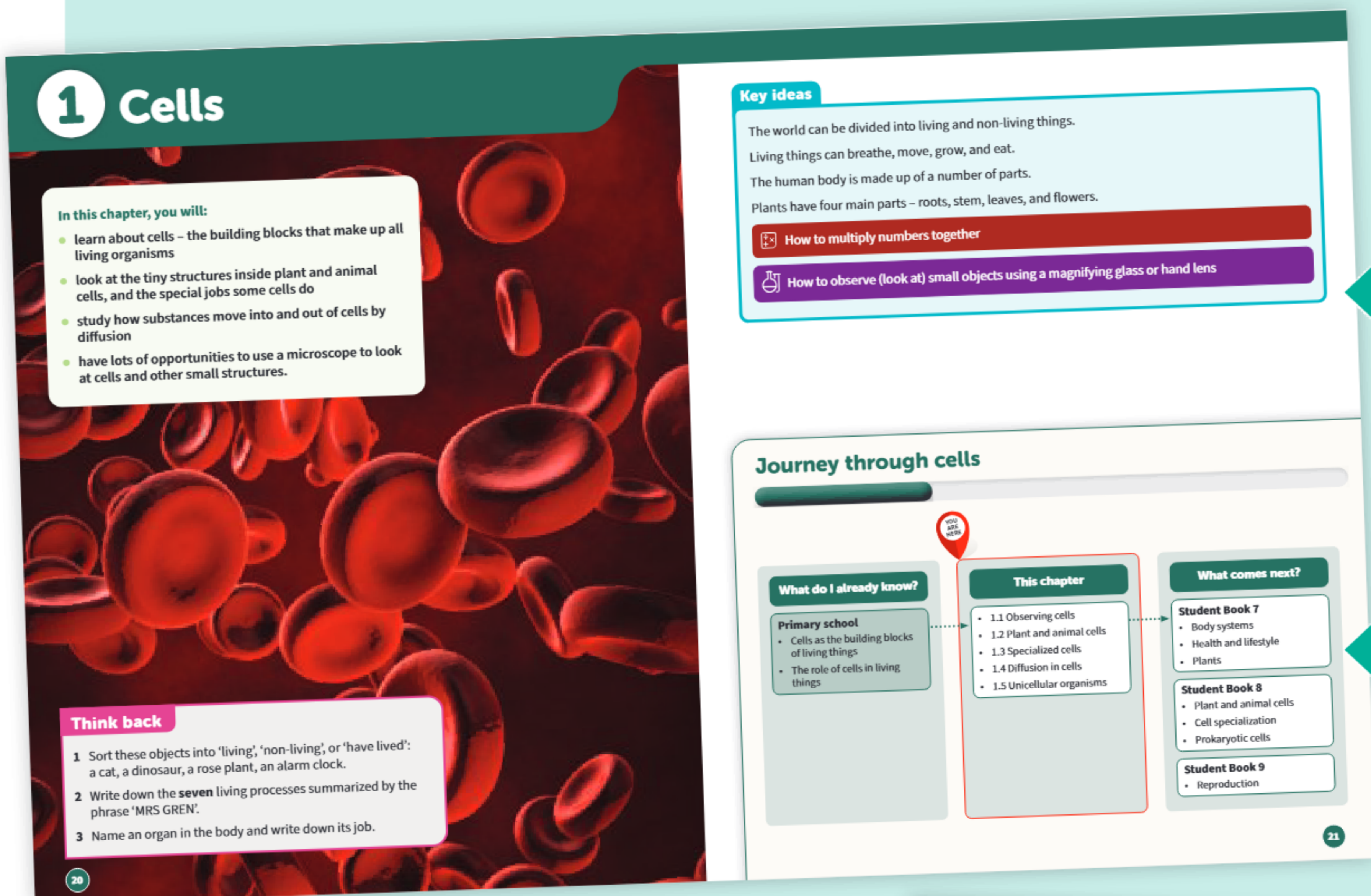
Scientists need to be able to communicate and share their ideas. These boxes contain activities and tips to help develop your reading, writing, listening, and speaking skills.

Unit opener

Each unit begins with an introduction. This introduces you to the awe and wonder of science and helps you understand your place in the scientific world.

It asks some important questions that you will find the answers to in the unit.





Chapter opener

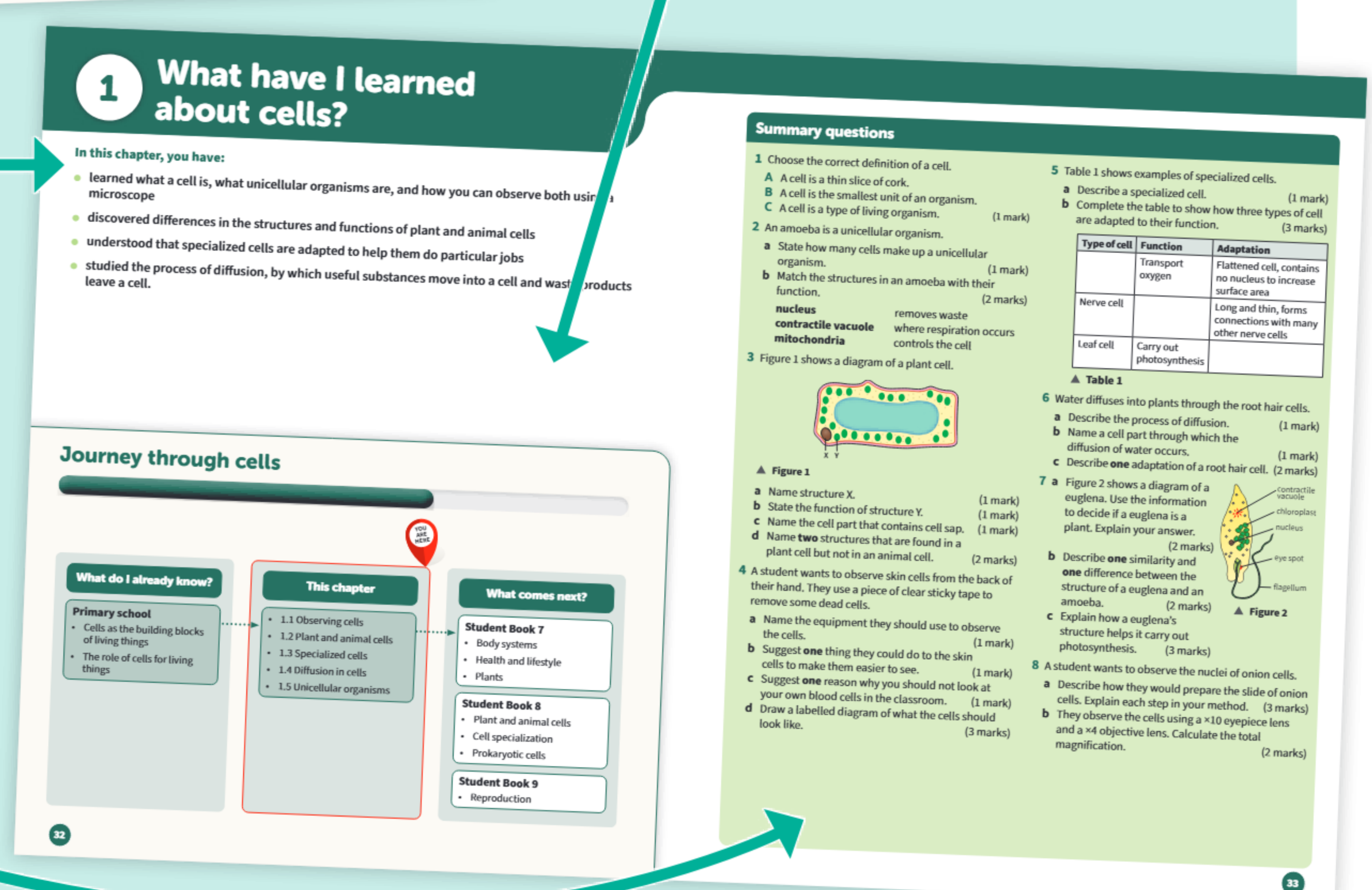
Each chapter begins with an introduction. This reminds you what you already know and shows you what is coming up in the chapter. It also shows you the Working scientifically and Maths skills that you will learn. The chapter map shows how far through the unit you have progressed.

Learning journey

This shows clearly what science you already know, the new topics you will study in this chapter, and the next steps in your science learning.

Chapter summary

This summarizes what you have learned so far and shows your progress through the unit.



Summary questions

You can use these exam-style questions to test how well you know the topics in the chapter.

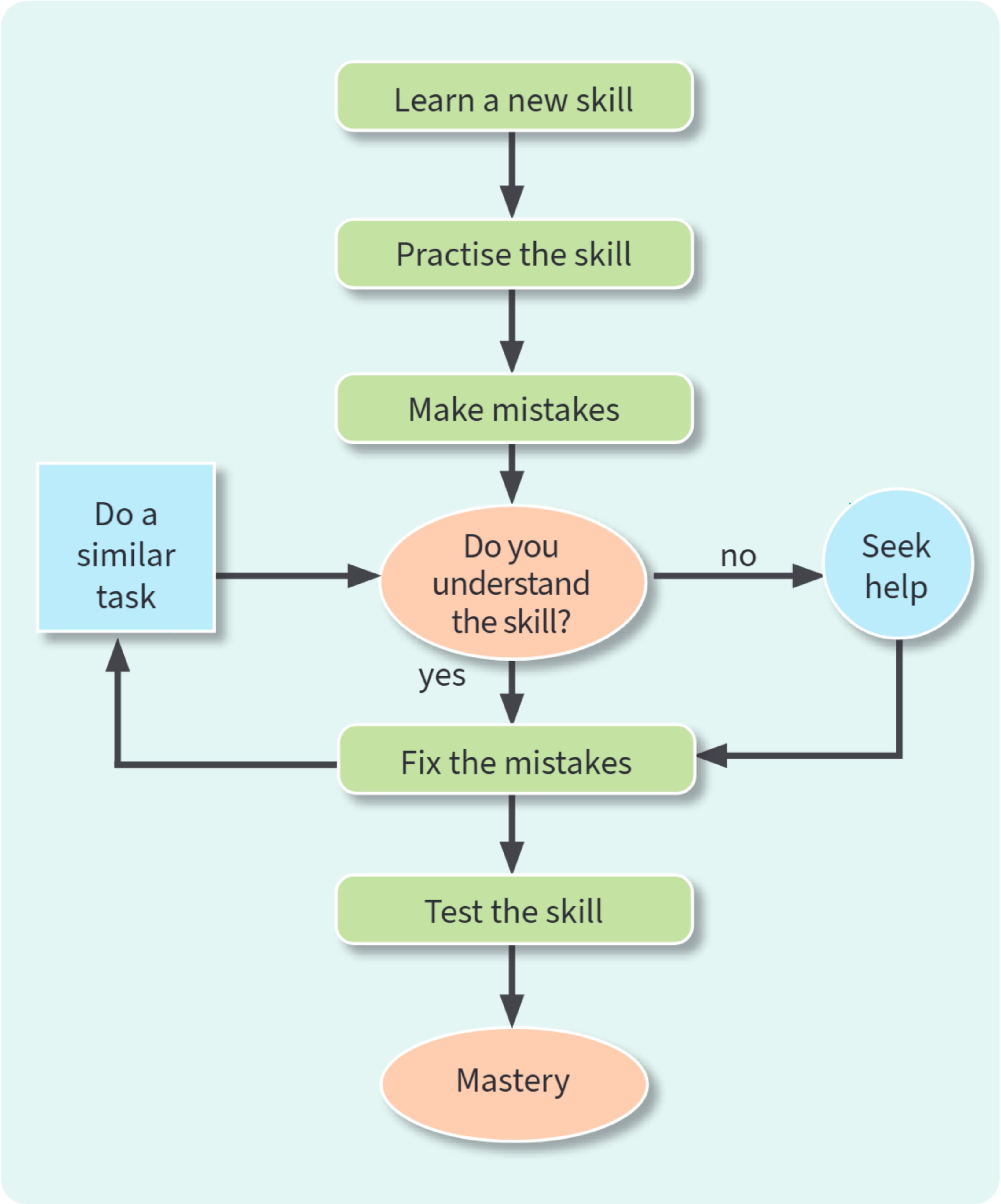
Being a scientist

Often science lessons at secondary school are very different from what you may be used to in primary school. Secondary students need to work more independently – this could be doing an experiment in small groups, or working on your own to understand a new topic. It is important that you have a range of strategies to use when learning new scientific content.

Mastering secondary science

At secondary school, you often need to approach learning in a much more independent way. It is important that you know what resources are available to help you. This includes reviewing the notes in your book, using online resources like Kerboodle, and knowing when to ask a partner or your teacher for help. Knowing who or what can help you will mean you can work on any task with confidence.

Sometimes when you start to learn a new topic it can feel like you will never remember it all. However, by practising your skills, learning from your mistakes, and seeking help when you need it, you will soon master any new topic. You can use the flowchart in Figure 1 to help you master secondary science.



▲ **Figure 1** A flowchart to help you master secondary science.

Reading scientific texts

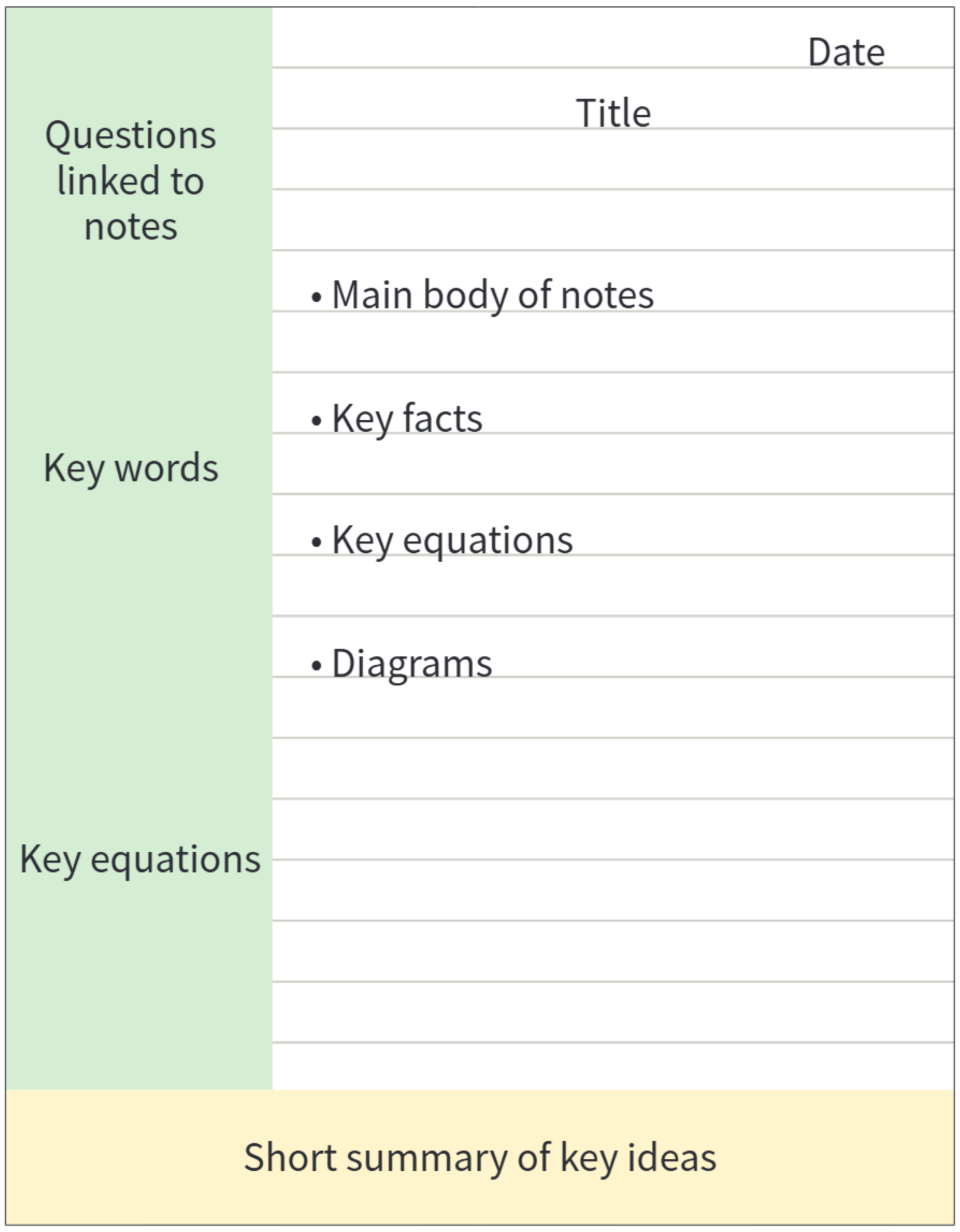
Reading and understanding scientific texts is a big part of secondary science. It is different from reading a book. Usually there is a lot of information in short paragraphs and there are lots of examples, diagrams, and data for you to understand.

The SURE method is an approach you can use to help you read and understand scientific texts. Each letter in SURE represents a different step in the process. You should follow this process every time.

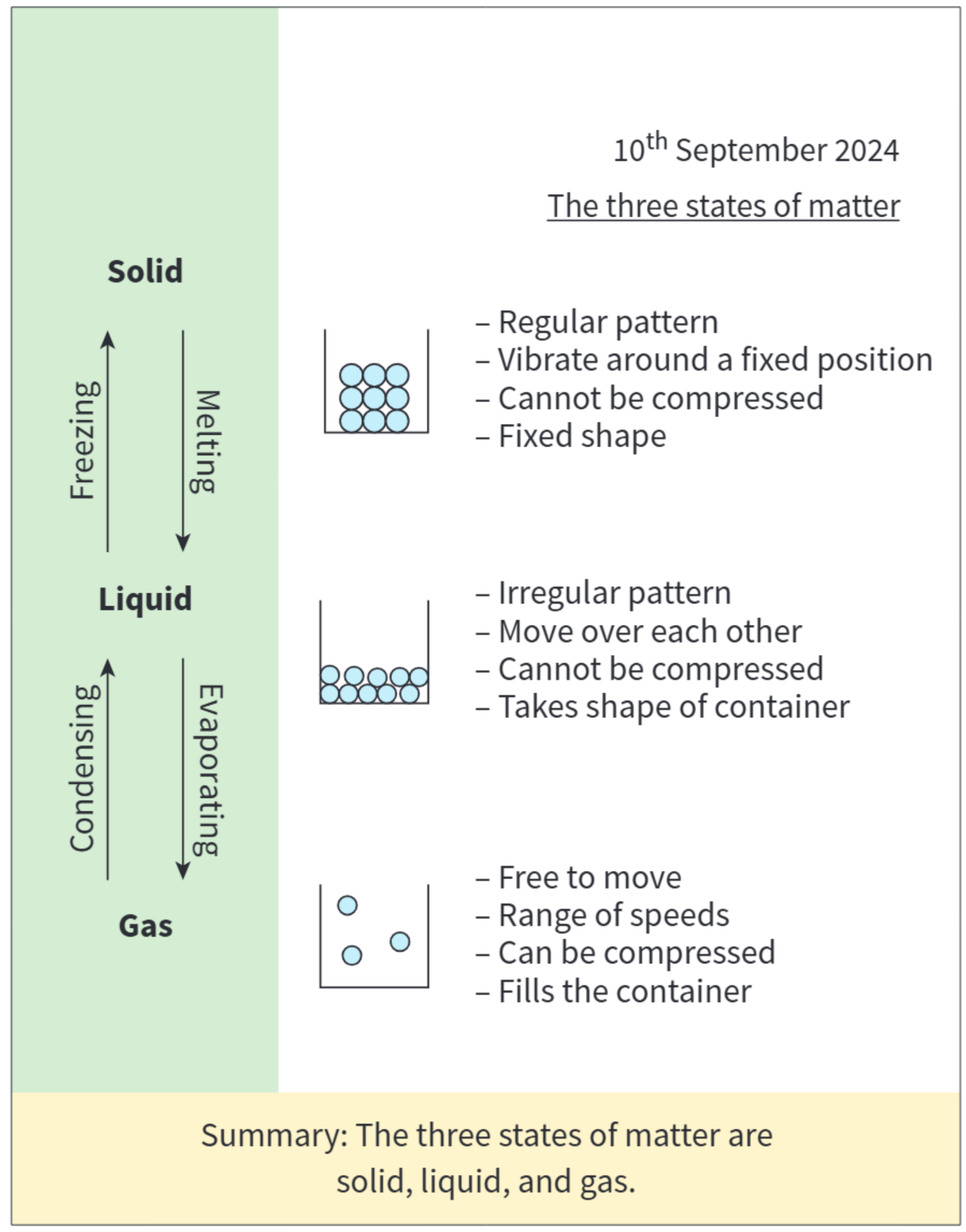
Skim the text
Underline and understand
Reread
Extract information

Finish with a one-sentence summary.

When extracting information from a text, it is important to keep to key facts. You might just write a list of bullet points that cover the key ideas, including any equations or diagrams. Or you may choose to write notes with more detail. You can also use the Cornell notes method in Figure 2 when taking notes. To help you understand what using this method would look like in a lesson, see Figure 3.



▲ **Figure 2** The Cornell notes method. This is a strategy to help you when taking notes.



▲ **Figure 3** An example of using the Cornell notes method in a lesson on the three states of matter.

Talk about ...

Discuss with a partner what resources you can use if:

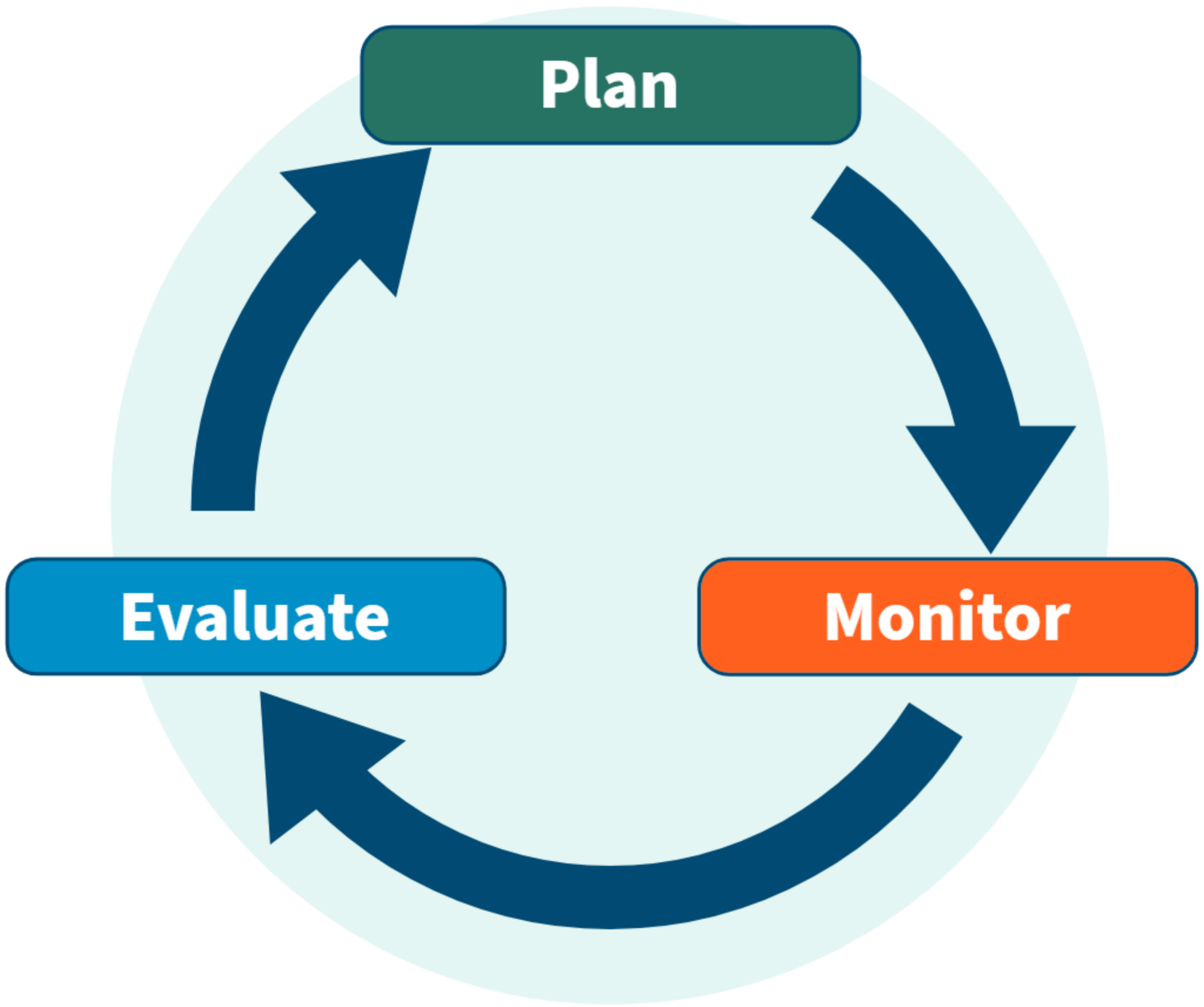
- you are stuck with a question in a lesson
- you are stuck with a question when doing homework
- you are unsure about what to do during a practical investigation
- you are unsure if your answer is correct.

Plan, monitor, evaluate

Expert learners approach new and unfamiliar tasks in a structured way. Often they will start by studying the question or task, thinking carefully about what subject knowledge they are going to need or whether they have seen something similar before.

During a task, an expert learner will keep checking to make sure they are focusing on the right thing by regularly looking back at the question. Sometimes they may even decide to start the task again and choose a different approach. After they have finished, an expert learner will reflect on their work by thinking about any areas of improvement and what they would do differently next time.

The Plan, Monitor, Evaluate cycle is a structure you can follow to help you approach a new task like an expert learner. The cycle should be used every time you complete a task.



Talk about ...

Discuss with a partner your answers to these questions:

- When does the planning phase take place?
- How can you monitor your progress during the monitoring phase?
- Why is the evaluation phase important?

Plan

The planning phase takes place **before** you start the task. Before you start a new task, whether it is revision at home or a science question in class, you need to plan your approach. This includes thinking about what you already know and what pieces of information relate to the task.

Here are some example questions you could ask yourself before starting a new task:

- How many marks does this question have?
- What scientific knowledge do I need to recall to answer the question?
- Have I answered a similar question before? What did success look like then?
- What have I learned from the examples my teacher has shown me?

Monitor

The monitoring phase takes place **during** a task. Monitoring your progress is when you pause and check again that you are including everything that is needed. Sometimes you may need to stop and change your approach. You may even decide that you need to go back and re-read some scientific content to help you complete the task.

Here are some example questions you could ask yourself during a task:

- How do I feel now that I am answering the question? Confident or unsure?
- Am I meeting the requirements of the task or question?
- Do I need to stop and change anything I have done?
- Have I followed the examples that my teacher showed me?

Evaluate

The evaluation phase takes place **after** a task. During this phase, look at what you have done, and decide what was successful and what you could improve next time. Then make a brief plan of what you would change if you were to carry out the task again.

Here are some example questions you could ask yourself after a task:

- What went well?
- Did I miss any marks? If so, for what?
- Is there any other strategy that I could have used to complete this task?
- What areas do I need to improve for next time?

Working scientifically

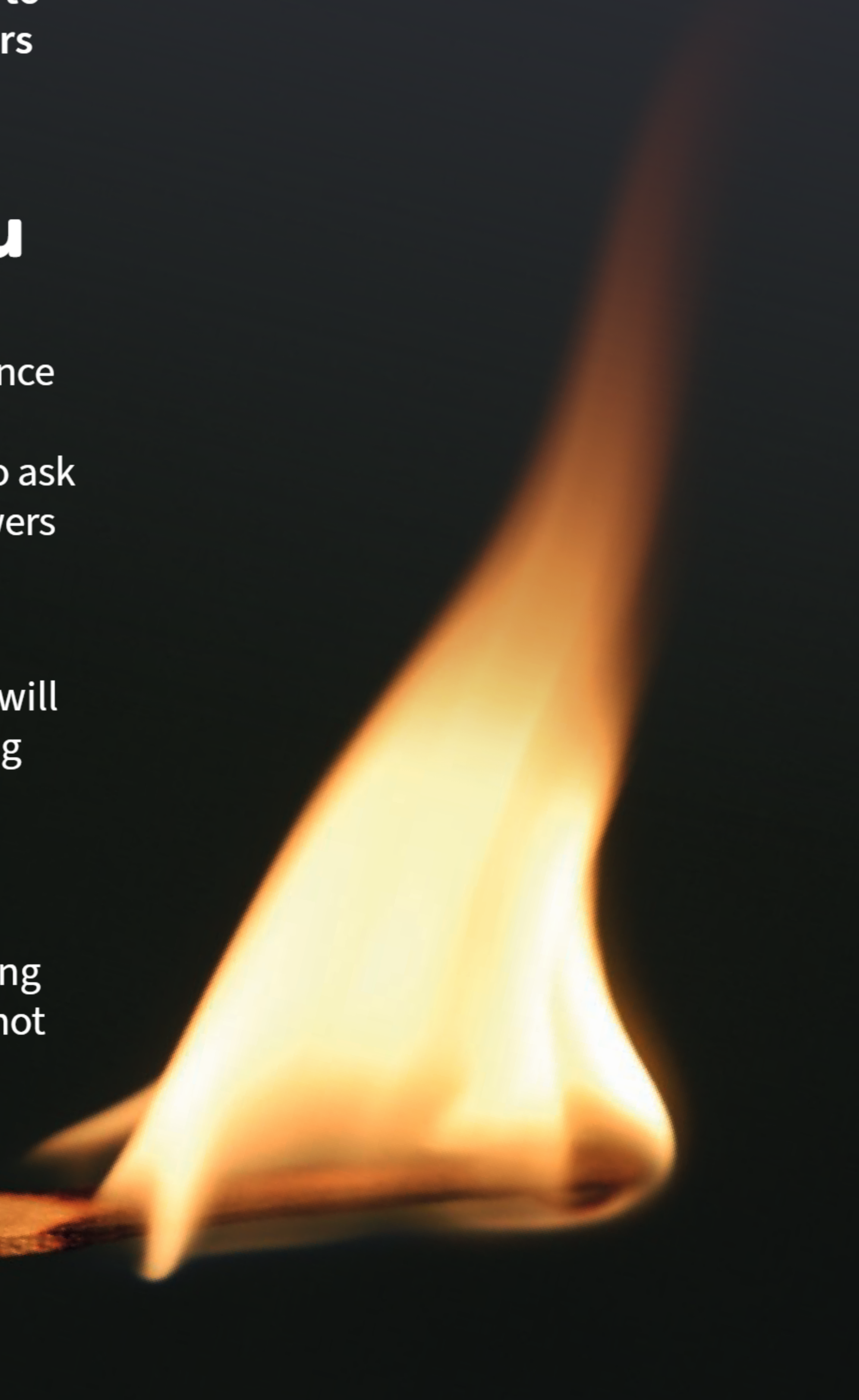
When you carry out scientific experiments or try to solve problems, it is important to think and work in a scientific way. In this unit, you will develop your working scientifically skills. You will learn how to take ideas and turn them into scientific questions that can be tested. You will use scientific equipment to collect and record measurements (the size, length, or amount of something) and observations (what you see). You will then examine your data to see if it can answer your scientific questions. You will also learn how to work safely, and begin to evaluate your work to find errors and suggest improvements.

Working scientifically and you

You were born a scientist. Humans are naturally curious and wonder ‘How, why, what?’ about the world we live in. Ever since you were little, you asked questions to try to understand the world around you. As your knowledge grew, you were able to ask more difficult questions, and started to understand the answers you got. This is how our understanding of science develops.

By learning to work scientifically, you will be able to ask scientific questions based on observations you make. You will also start to make sense of the answers you find by carrying out practical investigations and doing experiments.

Scientific research is happening all the time, all over the world. In 2020, scientists from many different countries worked together to develop vaccines, medicines, and testing equipment in the fight against COVID-19. But research does not just happen in a laboratory, or in hospitals. Science and research take place at the tops of mountains, at the bottom of oceans, and even on planet Mars!



Working scientifically and the world

It is important to understand how science works so that we can make decisions about things that affect us. We hear and read new information every day. Scientific knowledge can help us understand this information. It can help us work out whether it is reliable and whether we can believe it. Scientists keep us well-informed using accurate information.

How do scientists find out how things happen?

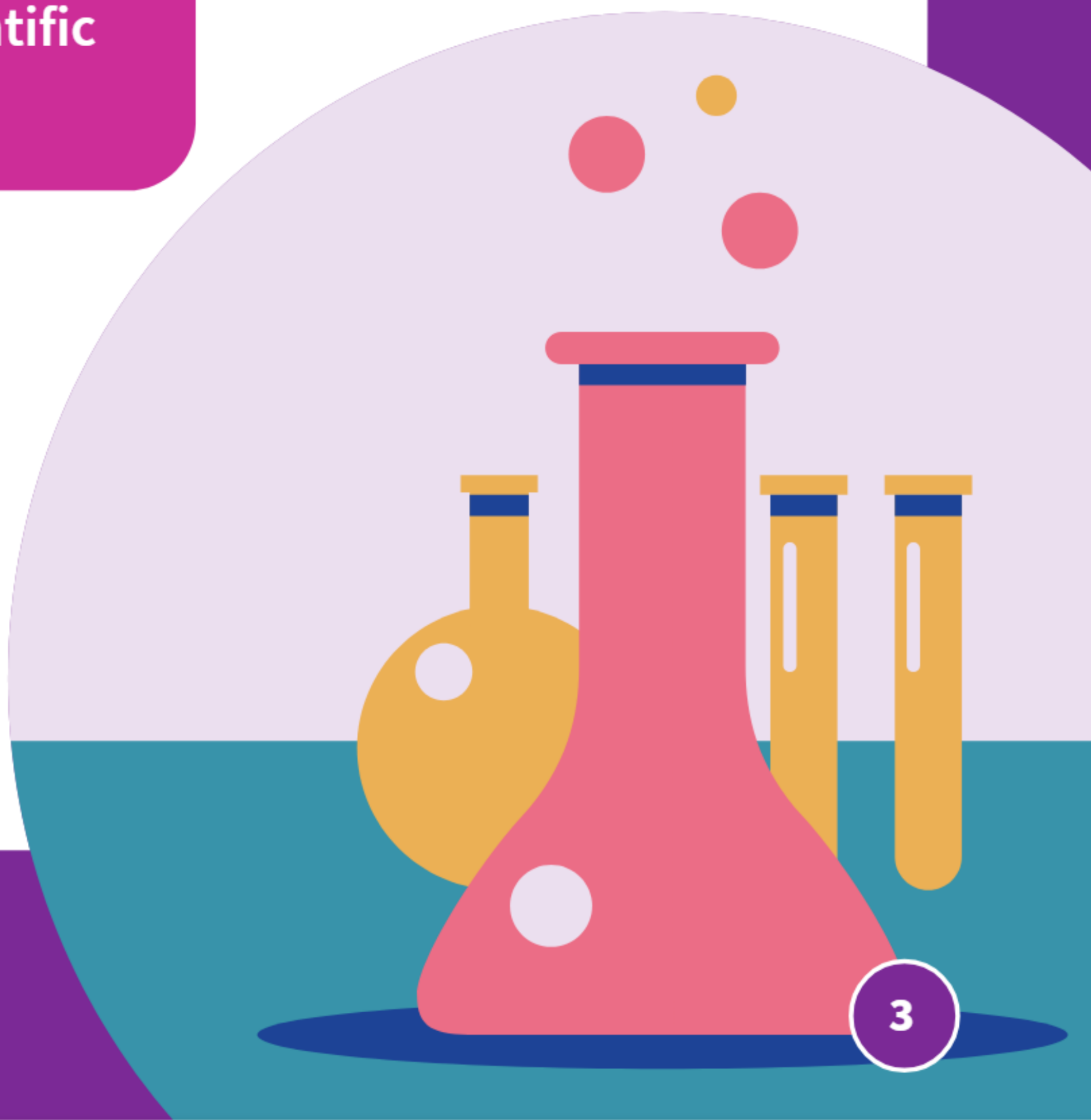
Scientists make observations of the world and ask questions about how or why something happens. They then work scientifically to find the answer.

How do scientists carry out an investigation?

To answer a scientific question, scientists need to choose equipment and carefully follow a method to collect results.

How do scientists use data to answer their questions?

Scientists carefully examine the results of an investigation to see if there are any patterns or trends. These help us answer scientific questions.



1.1 Asking scientific questions

After this topic, you will be able to:

- develop an idea into a question that can be investigated
- identify independent, dependent, and control variables
- make a scientific prediction.

Think back

1. What name is given to observations and measurements made during an investigation?
2. What is a fair test?
3. Name some sources of data.

Key idea

Scientists ask questions based on their observations (what they see). They make a prediction before carrying out a scientific investigation. In all investigations, there are an independent and a dependent variable, and control variables.

Key words

observation, investigation, data, variable, independent variable, dependent variable, control variable, prediction

▲ **Figure 1** What is causing the polar ice caps to melt?

Is the temperature of the world rising? Why are the polar ice caps melting (see Figure 1)? We can ask lots of different questions about the world around us. Some are questions that science can answer.

What is a scientific question?

Scientists make **observations** of the world around them. They ask questions such as 'Why is the sky blue?' or 'Why do some animals become extinct?'. These are examples of scientific questions because they can be answered through scientific **investigations**.

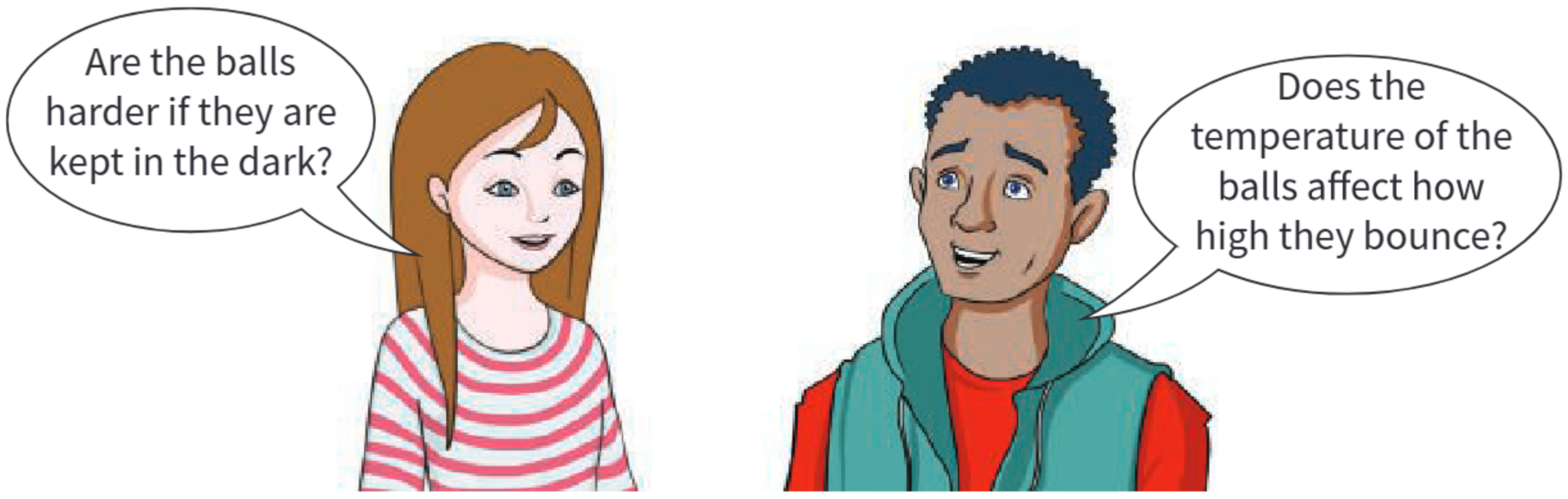
Scientific investigations are experiments where you collect **data** (observations or measurements) to answer your question.

Suggesting ideas

Katie and Rahim are watching a tennis match. Rahim observes (notices) that new tennis balls are taken from a refrigerator during the match. Observations like this can give you ideas that you can scientifically investigate.

Developing ideas into questions

In Figure 2, Katie and Rahim discuss why the new balls are kept in a fridge.



▲ **Figure 2** Why are the new balls kept in a fridge?

What is a variable?

In science, anything that can change during an investigation is called a **variable**. There are three types of variable:

- **Independent variable:** a variable you change in an investigation.
- **Dependent variable:** a variable that changes when you change the independent variable.
- **Control variables:** variables you need to keep the same in an investigation.

Katie and Rahim decide they want to investigate if the temperature affects how high a ball bounces. In their experiment, temperature is the independent variable. How high the ball bounces is the dependent variable.

A A scientist investigates how the brightness of a torch affects how far you can see at night. Identify the independent variable.

Control variables

The temperature of the ball is not the only thing that might affect how high the ball bounces. Katie and Rahim think about other variables that might affect how high tennis balls bounce:

- the height you drop the ball from
- the surface that you drop it onto
- the size of the ball.

Katie and Rahim need to keep these variables the same during their investigation. This is to make sure that they do not affect how high the ball bounces. These are their control variables.

B Suggest **one** other control variable in Katie and Rahim's investigation.

Making a prediction

Scientists often have an idea about what they might expect to happen in an investigation. This is called their **prediction**. Predictions are not always true, though!

Katie predicts that *the higher the temperature of the ball, the higher it will bounce*. She can then test these ideas out when she completes her experiment.

Working scientifically

Imagine that Katie and Rahim decide to investigate whether the **size** of a ball affects how high it bounces.

a State the dependent and independent variables.

b List all the variables that Katie and Rahim would need to control.

Summary questions

1 Copy and complete the sentences.

The ____________ variable is the variable you change.
A ____________ variable should be kept the same during an investigation.
The ____________ variable is the variable which changes when the independent variable changes.

2 A student is looking at an ice cube melting.

a Suggest a scientific question that could be investigated.

b Explain why this is a question that science can answer.

Stretch zone

3 A student investigates how the length of a leaf affects how long it takes to fall from a tree to the ground.

a Identify the independent variable.

b Identify the dependent variable.

c Name **three** control variables for this investigation.

1.2 Working safely

After this topic, you will be able to:
- recognize commonly used hazard symbols and their meanings
- identify possible hazards in practical work
- understand the purpose of a risk assessment.

Think back

1 List **two** ways of staying safe when heating water in a pan.
2 Why do most countries have signs to show when there is a sharp bend in the road?
3 What is a scientific investigation?

Key idea

Scientists need to identify hazards (anything that can harm us) in their investigation and understand how to manage the risks. Common hazard symbols help keep themselves and others safe.

Key words

hazard, hazard symbol, risk, control measure, risk assessment

▲ **Figure 1** Hazard signs show people how to stay safe.

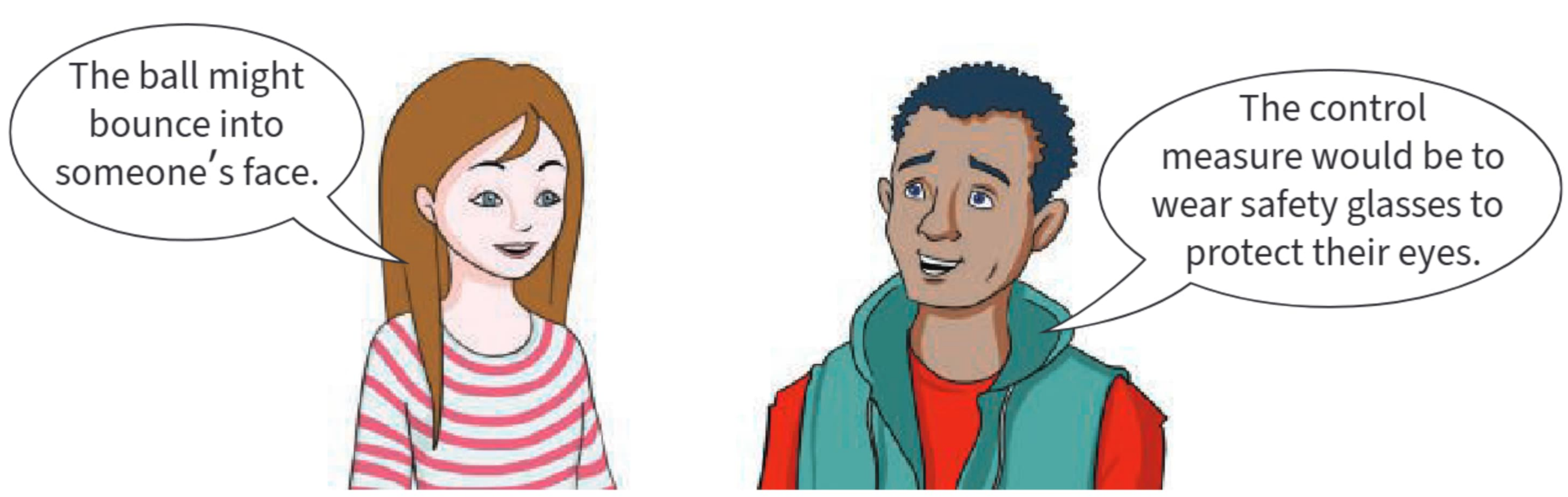
Have you ever seen the symbols in Figure 1? Sometimes they are at the back of lorries, on labels of cleaning products, or on posters in public spaces. They warn us of dangers and tell us how to work safely.

What is a hazard?

A **hazard** is anything that can harm us or people around us. This could involve chemicals, working on a ladder, using electrical equipment, or working with animals.

Safety is one of the first things scientists must think about before carrying out an experiment. They must think about their own safety and the safety of others.

Katie and Rahim's experiment involves bouncing tennis balls. In Figure 2, Katie and Rahim discuss the hazards they must think about during their investigation.



▲ **Figure 2** What are the hazards of bouncing tennis balls?

A State **one** way Katie and Rahim can carry out the experiment safely.

Hazard symbols

Hazard symbols are placed on product labels, walls, signs, and vehicles. They let us know the danger so we can be safe. Figure 3 shows some common hazard symbols.

Before 2017, different countries used different hazard symbols. In 2017, all countries agreed to use the same symbols to label dangerous substances and situations. These symbols are called the Globally Harmonized System (GHS).

B Suggest why hazard symbols need to be the same all over the world.

What is a risk?

A **risk** is the chance that a hazard will cause an injury. Scientists need to think how likely it is that someone will come across the hazard, or how serious the effects of the hazard could be.

You can put a **control measure** in place to reduce the risk of a hazard causing an injury. A control measure could involve choosing a different method, using safety equipment, or using a less hazardous substance.

Is it safe?

A plan for an experiment should include the steps you will take to stay safe. You will need to wear safety glasses in many scientific investigations. Safety glasses will help to protect your eyes. You should also tie back long hair as it could dip into chemicals, catch fire if using a Bunsen burner, get caught in springs when measuring extension, or distract you by falling into your face.

If you are following someone else's plan, it will often include a **risk assessment**. This explains what you *must* do – or *not* do – to avoid harming yourself or other people.

C Explain why you should tie back long hair when using a Bunsen burner.

▲ **Figure 3** These are the international hazard symbols and their meanings.

Summary questions

1 Match the symbols to the hazards.

Flammable

Corrosive

Environmental hazard

Irritant

2 An experiment involves using a flammable chemical. This means it can catch fire easily. The students are wearing safety glasses. State **one** other control measure that should be in place to protect the students.

Stretch zone

3 A student measured 20 cm^3 of dilute acid using a glass measuring cylinder.

a Identify the possible hazards for this part of their method.

b Suggest control measures for each of these hazards.

1.3 Planning investigations

After this topic, you will be able to:
- write a plan for a scientific investigation
- identify the scientific equipment used to measure different quantities
- take accurate measurements.

Think back

1 Name some equipment used to take measurements.
2 What is an independent variable?
3 What is a control variable?

Key idea

Scientists first write a plan for their investigation. The plan includes the scientific question, the variables, their prediction, the equipment they need to collect accurate data, a method, and any possible hazards.

Key words

plan, method, accurate data, true value, range, interval

▲ **Figure 1** You have to follow a clear plan when carrying out scientific investigations.

Have you ever cooked from a recipe? Did it turn out the way you wanted? The plan for a science investigation or experiment is like a recipe. It lists what equipment and materials you are going to use. It says what you are going to do with them.

Look at the students doing a chemistry experiment in Figure 1.

Planning a scientific investigation

▲ **Figure 2** Katie is talking about changing the independent variable in their investigation. Rahim is suggesting how to measure the dependent variable.

In Figure 2, Katie and Rahim want to know whether the temperature of a ball affects how high it bounces. They now need to write a **plan** for their scientific investigation to find the answer to their question.

A scientific plan includes the following information:

- the scientific question that you want to answer
- the independent and dependent variables
- a list of variables you will control, and how you will do this
- a prediction
- a list of the equipment you will need – this can include a diagram
- a step-by-step **method** of how you will collect data or make observations
- possible hazards and how to stay safe.

Choosing the right equipment

Your equipment should be able to produce measurements or observations to help you answer your scientific question. For example, you could use a microscope to see very small objects, or a ruler to measure length. You need to choose equipment to measure both the independent and the dependent variables.

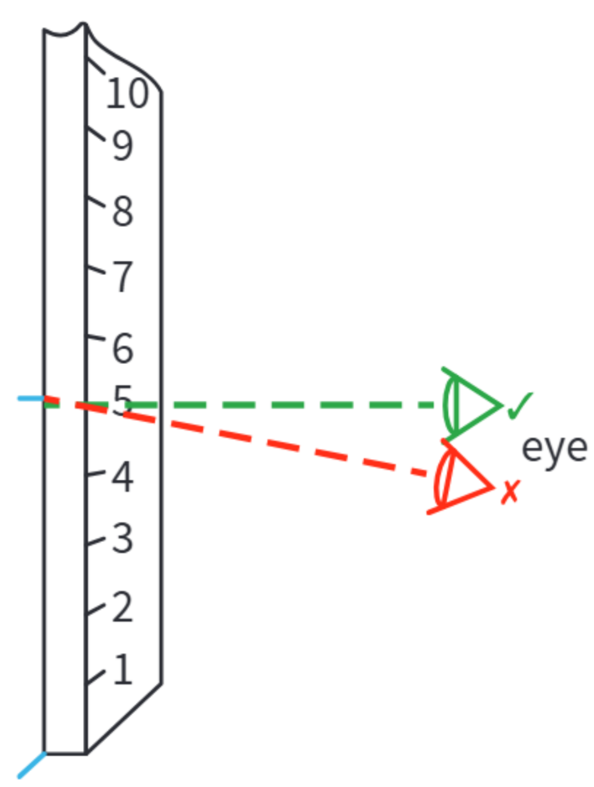
Equipment	Quantity measured
ruler or tape measure	length
thermometer	temperature
stopwatch	time
balance	mass
measuring cylinder	volume

▲ **Table 1** Common scientific equipment.

A What equipment should Katie and Rahim use to measure the temperature of the tennis balls?

B What equipment should Katie and Rahim use to measure how high the ball bounces?

You must be able to use equipment correctly to stay safe and collect **accurate data**. Accurate data is close to the **true value** of what you are trying to measure. For example, in Figure 3, Rahim needs to look directly at the ruler to get an accurate measurement of the bounce height.



▲ **Figure 3** Look straight at a scale to take an accurate measurement.

Taking measurements

To answer a scientific question, you often need a number of observations to see a pattern or trend. This means you will need to take several measurements of both the independent and the dependent variables. If possible, you should take each measurement three times.

Katie and Rahim need to choose which temperatures to test for their plan. They need to decide:

- the biggest and smallest temperatures – this is called the **range**
- how many different temperatures, usually five or more
- the **interval** (gap) between their temperature measurements.

Summary questions

1 Copy and complete the sentences.

The plan for an investigation includes a list of the ______ that you will use. You should name the independent and ______ variables, and also any variables you need to ______. You then include a step-by-step ______ to explain how you will carry out your investigation.

2 A student decides to investigate how the volume of water in a beaker affects the mass of sugar which can dissolve in it.

a State which equipment they could use to measure the volume of water.

b State which equipment they could use to measure the mass of sugar. Describe how to use it.

Stretch zone

3 A student investigates whether the type of surface affects how high a ball bounces. They use four different surfaces. They test each surface two times.

a Explain why they should read the scale on the ruler by looking straight at it when measuring the bounce height.

b Suggest why it is a good idea to repeat their results.

c State and explain whether they need to think about safety for this experiment.

1.4 Recording data

After this topic, you will be able to:
- design a results table
- present data in a results table
- calculate a mean from repeat measurements.

Think back

1. What is a dependent variable?
2. What safety equipment protects your eyes?
3. Name the equipment used to measure mass.

Key idea

Scientists record and present their data in a results table. This helps them identify an anomaly (a result that is very different from others). When they have all their results, they calculate the mean average of repeat measurements.

Key words

mean, anomaly

Have you ever looked for numerical information (based on numbers), such as the results of school sports day, or how fast a certain type of car can speed up?

Table 1 shows data from a school football league. When organizing data, scientists use results tables to make the data easier to understand.

Results table

Results tables always look the same way in science. Table 2 shows the features of a results table.

▲ **Table 2** How to draw a simple results table.

School team	Played	Won	Drawn
Albester	12	6	5
Barnshot	11	7	2
Clovehill	10	7	1
Donston	10	7	1
Erdham	11	6	2

▲ **Table 1** A football league table.

A results table helps you organize your data. Not all data are numbers. Sometimes you need to use words and record observations in a table using scientific language. For example, you could record a colour change in a chemical reaction.

A Where should you record the units of a quantity in a results table?

Recording repeat measurements

Katie and Rahim decide to collect data on how high a ball bounces, at five different ball temperatures. They also decide to repeat each result three times to check their results were correct. Look at their results table design in Table 3.

Temperature of ball in °C	Height of bounce in cm			
	1st measurement	2nd measurement	3rd measurement	Mean
0				
10				
20				
30				
40				

Values of the independent variable go from smallest to largest.

Repeat measurements go here.

The mean bounce height goes here.

▲ **Table 3** Katie and Rahim's results table.

Calculating a mean

The **mean** is a type of average. To calculate the mean, you add up all the results and divide by the number of results.

$$\text{Mean average} = \frac{\text{result 1} + \text{result 2} + \text{result 3} + \ldots}{\text{number of results}}$$

For example, Katie and Rahim collected the following results at 0 °C:

Result 1: 25 cm   Result 2: 35 cm   Result 3: 30 cm

$$\text{Mean} = \frac{25\text{ cm} + 35\text{ cm} + 30\text{ cm}}{3} = \frac{90\text{ cm}}{3} = 30\text{ cm}$$

Checking for an anomaly

As they collect their data, Katie and Rahim fill in their results table in Table 4.

Temperature of ball in °C	Height of bounce in cm			
	1st measurement	2nd measurement	3rd measurement	Mean
0	25	35	30	30
10	45	35	40	40
20	50	55	15	
30	60	60	60	60
40	65	75	70	70

This is an anomaly, as it is much lower than the other results at 20 °C.

▲ **Table 4** Results table showing how high a tennis ball bounces at different temperatures.

You should check your data for an **anomaly**. An anomaly is a result that is very different from the others. You should repeat the measurement to replace an anomaly. In Table 4, the third measurement for the 20 °C ball temperature, 15 cm, is an anomaly. Katie and Rahim repeat this result before calculating their mean – the ball bounces to 60 cm.

B Calculate the new mean bounce height for the ball at 20 °C.

Summary questions

1 Copy and complete the sentences.

Scientists present the data they collect in a ________ table. The first column has the ________ variable. The second column has the ________ variable. You write the ________ next to the variable name.

2 A student investigates how long it takes sugar to dissolve at different temperatures. They collect three repeat measurements. Table 5 shows their results.

Temperature in °C	Dissolving time in s		
	1st	2nd	3rd
50	40	16	48
80	17	14	14

▲ Table 5

a Identify the anomaly in the student's results.

b Calculate the mean dissolving time at 80 °C.

Stretch zone

3 A group of students investigate how the volume of an ice cube affects how long it takes to melt. They collect data on five different volumes. They take each measurement three times.

a Design a results table for the students' data.

b Explain **one** way to deal with an anomaly in a set of repeated measurements.

1.5 Presenting data

After this topic, you will be able to:
- classify data as continuous, discrete, or categorical
- present data in a chart or graph.

Think back

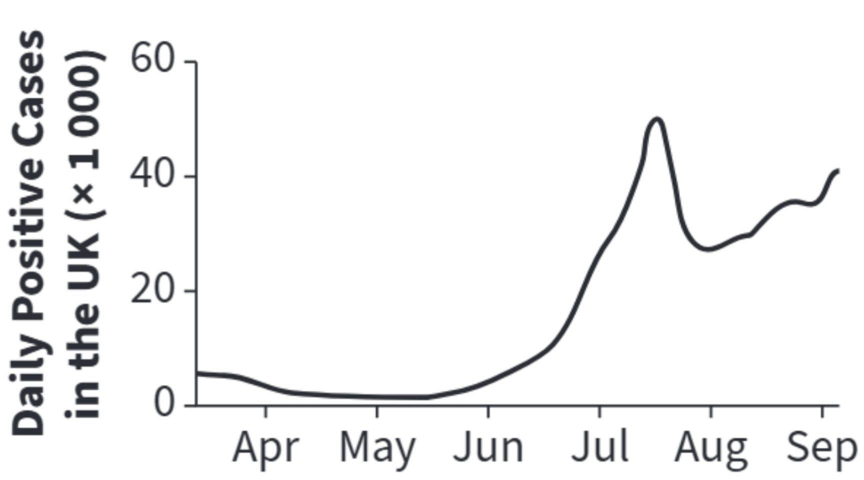
1. Name some different types of graph.
2. What is an anomaly?
3. How do you calculate a mean?

Key idea

There are three types of scientific data: continuous, discrete, and categorical. Based on the type of data collected, scientists present their results in a bar chart, a line graph, or a pie chart.

Key words

continuous, discrete, categorical, bar chart, line graph, pie chart



▲ **Figure 1** During the COVID-19 pandemic, the UK government used line graphs to show how the number of positive cases varied over time.

How do you share large numbers of measurements or observations with others? Scientists use graphs to make it easier to see patterns or trends within data. Figure 1 shows an example.

Types of scientific data

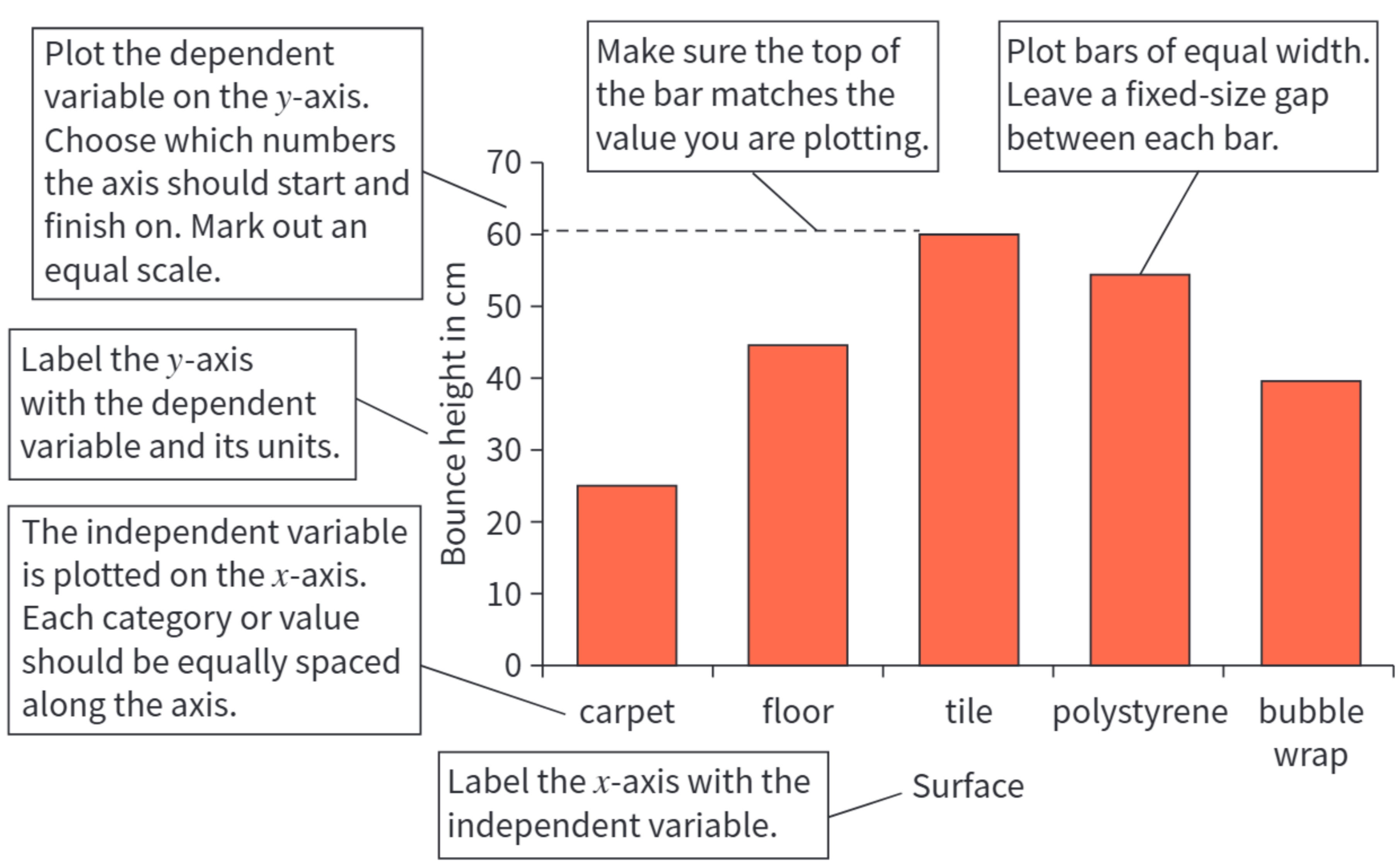
When you carry out an investigation, the data you collect might be in the form of words or numbers. Data can be:

- **continuous** – the data can have any value within a range, such as length or temperature
- **discrete** – the data can have only whole-number values, such as shoe size or the number of insects collected
- **categorical** – the value is a word, such as ‘blue’ or ‘fizzing’.

Presenting scientific data

You will use three main types of chart or graph in science. These are:

- **bar chart** – used to plot discrete and categorical data
- **line graph** – used when both the independent and dependent variables are continuous
- **pie chart** – used to plot discrete and categorical data.



▲ **Figure 2** A bar chart showing how high a tennis ball bounces on different surfaces.

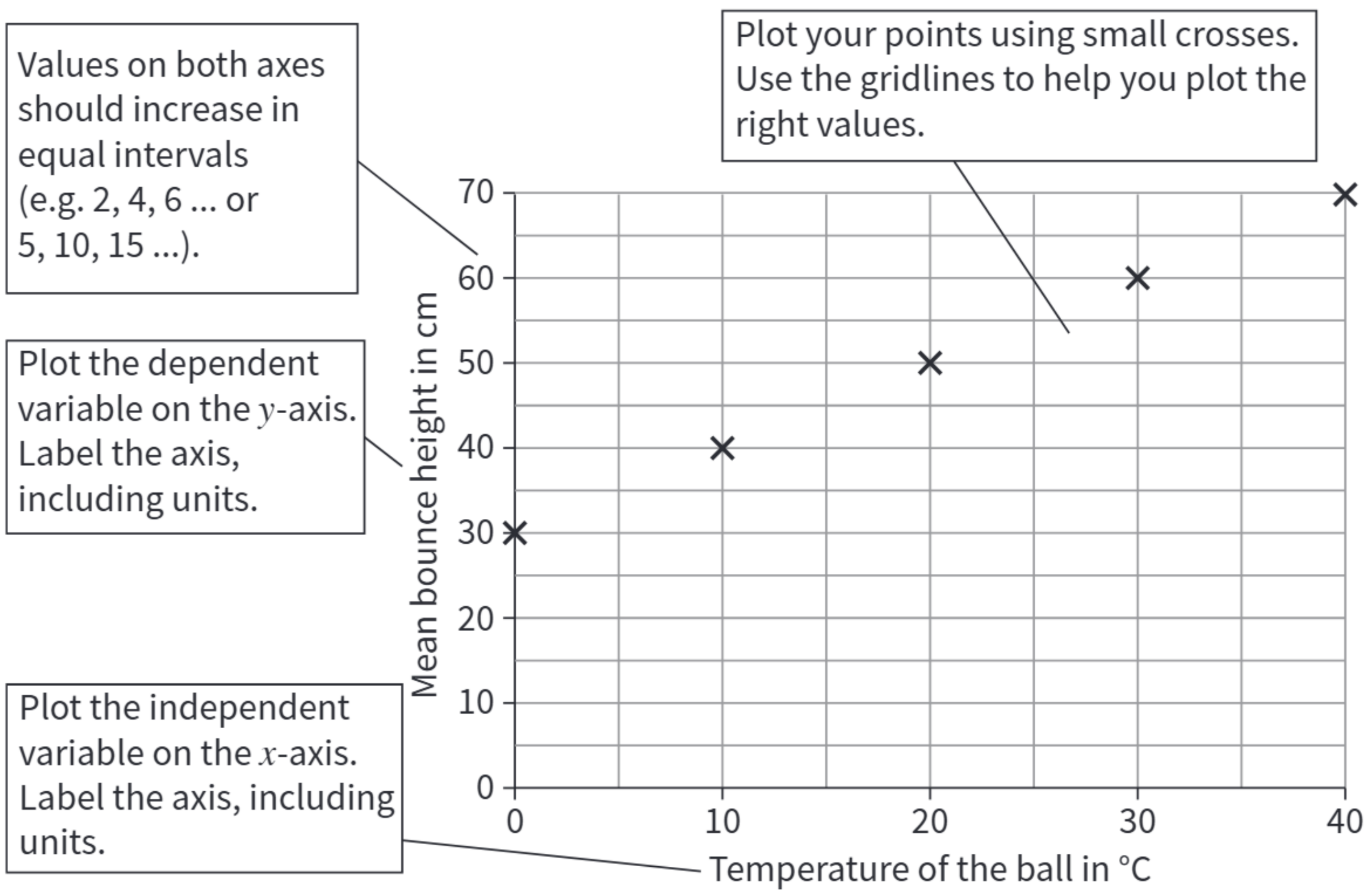
Drawing a bar chart

A group of students bounced a tennis ball on different surfaces. Their results are shown in the bar chart in Figure 2.

A Use Figure 2 to find how high the tennis ball bounces on a tiled surface.

Drawing a line graph

Figure 3 shows how Katie and Rahim plotted a graph from their data. They chose a line graph as their experiment produced continuous data.

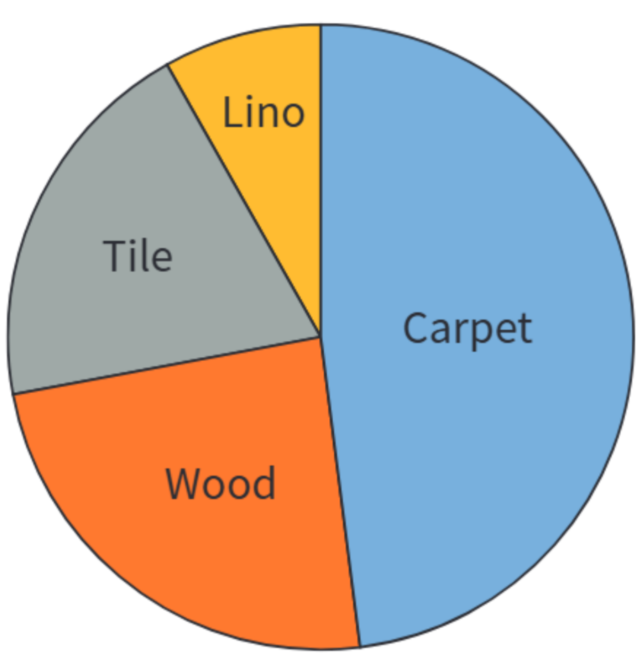


▲ **Figure 3** A line graph of Katie and Rahim's results. It shows the effect of temperature on the mean bounce height of a tennis ball.

Drawing a pie chart

Pie charts, like the one in Figure 4, use segments of a circle to represent the data. To plot a pie chart, you will need to use a protractor to measure the angle of each segment.

- Draw a line from the centre of the circle to the edge.
- Use a protractor to measure the angle of each segment as you draw them.
- Remember to label each segment.
- Shade each segment a different colour.

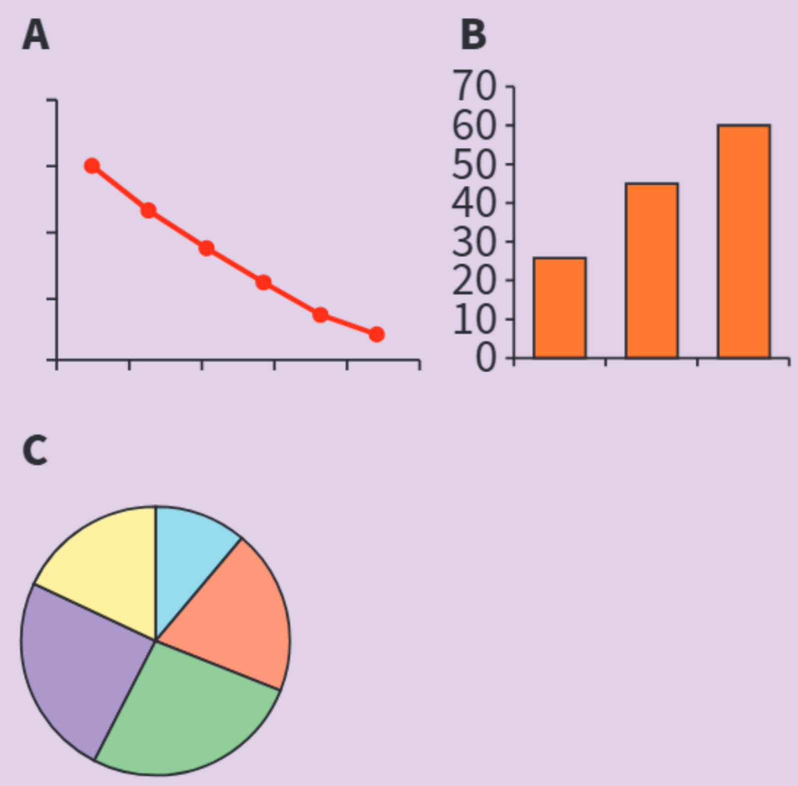


▲ **Figure 4** A pie chart of Katie and Rahim's survey results. The pie chart shows the types of floor covering used in hallways.

B Use Figure 4 to identify which is the most common floor covering.

Summary questions

1 Name the graphs and charts.



2 Plot a bar chart of the data in Table 1.

School transport type	Number of students
Walk	20
Cycle	12
Bus	6
Car	8

▲ Table 1

Stretch zone

3 A group of students investigates how the mass of a seed affects how long it takes to fall a distance of 1 m.

a State which type of graph the students should choose to present their data.

b Explain your answer.