Science toolkit

1.1 Science laboratories contain hazards

Teacher notes (pages 2–3)

Introducing the chapter

This chapter discusses the practical nature of science, including key safety skills, dissection, student-designed experiments, logbooks and formal reports and how to best record results in tables and graphs.

Teaching tips: Safety station

It is good to revisit the classroom’s safety station at the start of each year. Safety stations commonly consist of an easy-pull shower, an eye-wash hose, a sink and soap, though some may be more comprehensive or more basic. Students need to know that they can access the safety station at any time in case of chemical spill, fire (Bunsen burner) or if chemicals or foreign matter get into their eyes. A demonstration of a fume cupboard and its use is also suggested at this time.

Teaching tips: Differentiation

Different learning styles can be acknowledged by asking students to choose a preferred way to demonstrate why their laboratory safety rules need to be followed. They could be offered the following choices: a dramatic skit, a short film, a poster display or a piece of narrative describing a situation where the rules have not been followed.

Additional activity: Common safety rules

Students need to be able to not only work safely themselves, but also identify safety risks in class during an experiment. An introductory activity could include brainstorming unsafe practices in science (for example, running in class, drinking or eating during an experiment, long hair near Bunsen burners). Once a list has been collated on the board, students work in pairs to draw a cartoon scene of an experiment in which three unsafe practices can be observed. Students then swap illustrations and seek to identify safety hazards and unsafe practices. You can also carry out a reflection at the end of experiments where students discuss any unsafe practices they witnessed in class.

Additional activity: Sources of hazards

Another introductory activity involves students considering the sources of hazards. Where do hazards often stem from? Students brainstorm individually and then pair up to share their ideas. Answers could include careless behaviour (i.e. breakages), not following the experiment method closely, not understanding instructions, not awaiting instructions and so on. As a class, students then prepare a table that lists sources of hazards in one column with corresponding safety solutions in the next column. Safety solutions are ways to ensure the hazards do not occur. For example, students should ask the teacher if they do not understand something, tying long hair back.

Additional activity: Teacher demonstration

There are a number of demonstrations that you can use to show students some of the dangers associated with working in a laboratory.

• Staining some cotton fabric with iodine solution.

• Using nichrome wire and a power pack to show that the wire gets very hot (paper can be burnt using the wire).

• Showing how hair could be burnt by a Bunsen burner.

• Demonstrating that concentrated acid can burn a hole in stocking fabric; and that if the acid is in an unlabelled container, it looks just like water.

• Adding water to anhydrous copper sulphate in a test tube to show that the contents of a test tube can get very hot.

On the basis of these demonstrations, students can be encouraged to come up with a class list of laboratory safety rules.

Assessment

Students can be encouraged to produce a short video regarding lab safety. In it, they could highlight some of the potential dangers and model safe behaviour.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

**The 10 rules of science lab safety**  
This video features the ten top rules of science lab safety.

1.2 Dissection is an important science skill

Teacher notes (pages 4–7)

Introducing the topic

‘Dissection’ means ‘to cut to pieces’ in Latin and is the process of cutting apart and observing something to study it. Dissection requires the use of specialised equipment and techniques. This section describes why dissections are important in science as well as the materials and skills required.

Teaching tips: Dissection

Gloves may not be essential for all dissections as some specimens may be by-products of the meat industry and, therefore, items humans eat, such as liver, kidneys or brain. Gloves are generally not worn at home in the kitchen to prepare meat for cooking. Hand washing afterwards is generally enough.

Essential tools for dissection include pins, probes, forceps, scalpels and scissors.

Teaching tips: Initial discussion

Without dissection, our knowledge of human anatomy would be less advanced, as dissection has enabled scientists to see inside organisms and understand how they function.

Prior to reading about dissections, ask students what they understand dissection to mean. For example, if you were to ask them to dissect an organ, what would that involve?

After covering the material in the book, students could reflect on their initial understandings and how similar or different the reality is.

Additional activity: Safety rules for dissections

Ask students to work in pairs to brainstorm some simple safety rules that are specific to dissections. Some examples of common safety rules for a dissection may include the following

• Wear appropriate safety gear.

• Specimen should be wrapped in newspaper and disposed of properly.

• Instruments should be cleaned afterwards.

• Hands should be washed afterwards.

Coats and gloves are needed to protect clothing and skin during clean-up. It is important to leave lab coats and gloves on until after the clean-up is finished to ensure everyone is kept safe and germ-free.

Additional activity: Ethics

Dissections and research involving animals have contributed significantly to our understanding of the human body. In fact, it would probably be fair to say that we couldn’t have come this far without them. Ask students to critically evaluate the positives and negatives involved in using animals for medical research. They should discuss their ideas with a partner and then share them with the class. Ask students whether they think that animals should continue to be used for medical research?

Additional activity: Practicing dissection

Students could dissect something like a heart, eye, liver, kidney or squid to master their dissection skills. There are many videos of dissections available online and can assist as visual aids.

An alternative dissection tray, different from the traditional wooden dissecting board, can be used for most dissections. It contains a plastic tray (tote box lid, which can be bought on its own), newspaper, optional plain newsprint or butcher’s paper on top of newspaper, a white tile and dissecting tools, such as scissors, forceps, probe and scalpel. The benefits of this set-up are that the tote lids are sturdy plastic, therefore they are light to carry and easily washed; the set-up can be done for each board prior to class and stacked on top of each other until needed.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

**Froguts: Virtual dissections**  
This is a demonstration but the available tutorial provides a good overview of dissection skills and frog anatomy.

Skills Lab 1.2

Lab tech notes

Chicken wings are available at all butchers and supermarkets.

Class clean up

Dirty scalpels should be collected and kept separate from other dissection equipment to avoid cuts. Ask the lab tech to clean them.

All other equipment should be washed in hot, soapy water. Ensure sinks are free from specimen parts, as they will smell.

Wrap all specimens and dirty gloves in newspaper, place in a sealed bag, and dispose of in a bin.

Safety

The use of vinyl gloves is recommended, as latex has been known to cause allergic and anaphylactic reactions.

1.3 Scientists design their own experiments

Teacher notes (pages 8–9)

Introducing the topic

In this section, students consider how real scientists design their own experiments. These experiments must be able to be repeated by other scientists. This requires them to control all the variables in the experiment, which is called fair testing.

Teaching tips: Fair testing

In this unit students learn about variables and what factors can affect scientific data – the Australian Curriculum uses the terminology ‘fair testing’ in relation to this. Students consider what a ‘fair test’ is, how they can ensure data is reliable and what some of the factors are that can affect experiments (i.e. air-conditioning during heating experiments). Students also learn how to formulate a logical and testable hypothesis and how to explain their hypothesis using scientific reasoning. At the end of this unit, students should be able to make simple suggestions about improving the method of an experiment in order to ensure ‘fair testing’.

Teaching tips: Evaluating student-designed experiments

Evaluating experimental design is a difficult skill for students to master. It would be a good idea to brainstorm comments about the reliability, accuracy, validity and precision of the experiment. Most students will be able to make comments about these aspects of experiments, but need help to apply these ideas to the terms ‘reliability’, ‘accuracy’, ‘validity’ and ‘precision’.

Teaching tips: Writing in the third person

Some students will struggle with this restrictive form of writing. Give students the opportunity to draft and revise their reports to take in your comments and corrections. To scaffold full-scale scientific reports, template reports can be used, whereby students only need to fill in some aspects of the report to build their skills in that section.

Differentiation

Less able students will benefit from using an example paragraph written in the first person to identify the changes that must be made in order to change it to a third person account. Any paragraph can be used, students could even create their own, and students must highlight the key words that need to be altered. As an extension they can annotate the highlighted words with the replacement ‘third person’ word.

For more able students:

Students could write their own paragraph in the first person, and swap with a friend to rewrite each other’s paragraph in the third person.

Additional activity: ‘Real’ scientific reports

You could show students an example of a ‘real’ scientific report so that students have a better understanding prior to starting work on their own reports. Reports could be downloaded from websites such as *Nature*, *New Scientist* or *The Lancet*.

Additionally, students may benefit from having an annotated scientific report, which they could refer to in the future.

Additional activity: Variables

Understanding the different types of variables can be challenging for some students. Propose scenarios that provide good examples of each type of variable, and link these to fair tests. For example, in a 100-metre sprint race, variables may include the conditions of the track (same for all competitors, so fair), and the age or fitness of the competitors (could be significantly different, so may not be fair or may be the experimental variable). Get students to suggest their own scenarios, and have their peers identify the different variables and whether the test is fair.

Additional activity: Controls

You can discuss the need for controls in experiments with your class. This could be done by demonstrating an experiment to the class that investigates how adding salt to water changes its boiling point. If this is done with the absence of a control, it is very difficult to know whether the salt is having any effect.

Additional activity: Colour coding

Colour-coding variables are a good way of achieving consistency between students. Students can read through the materials and method sections of their experiment instructions and highlight the experimental variable in red and all the controlled variables in blue. As a class, choose appropriate colours and encourage all students to consistently highlight the variables using these colours whenever they appear.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

**New Scientist**This website is where teachers and students can download scientific articles and see examples of scientific writing in the third person.

1.4 Scientists keep a logbook and write formal reports

Teacher notes (pages 10–11)

Introducing the topic

A science logbook is used to record the details of the work done in a science laboratory. It contains information that the scientist may otherwise forget and provides evidence of the planning, changes and results of an experiment.

Teaching tips: Writing experiment reports

Over the course of their studies, students will be expected to prepare many experiment reports. It is important that they have a solid basis to start from. A common layout of an experiment report starts with a title, date and name followed by:

• an aim (the purpose of the experiment)

• a hypothesis (the expected result of the experiment), which also demonstrates student’s understanding of the topic

• materials (a clear and comprehensive list of equipment and materials required)

• method (a clear, logical and comprehensive list of step-by-step instructions); unless it is a student-designed experiment, students must use the method given

• results (a detailed description of what was observed; this often includes data tables, graphs and diagrams)

• discussion (students explain what they observed in their results section using scientific reasoning; this can sometimes include further research ideas or explanations from you).

• conclusion (a statement to sum up the experiment; it can also include an evaluation of the method and mention of any variables).

Differentiation

For less able students:

You could show students an example of a scientific report so they have a better understanding prior to starting work on their own.

For more able students:

Students may benefit from creating their own annotated scientific report that they could refer to in the future.

Additional activity: Class discussion

The standard words students struggle not to use are I, we me, us, they, them. Ask students to create a mnemonic to help them to remember which words not to use.

Additional activity: Jigsaw report

Provide students will all sections of the report, but not in order. Ask students to cut out the sections and paste them in the correct order.

To extend this activity, the name of the section and the description could be separate and students would also have to match these as well.

Additional activity: Scientific method

Students could be introduced to the scientific method as a means of answering questions. This method is different to the approach of philosophers, and relies on observation and experimentation to support or refute hypotheses.

A discussion of the different approaches to taxonomy taken by Aristotle (a natural philosopher) and Carl Linnaeus (a scientist) would also demonstrate this.

Additional activity: Hypothetical hypotheses

When introducing the idea of converting predictions into hypotheses, start with a simple process that all students should be familiar with, such as melting ice. Get each student to propose a ‘What if?’ question. Write a few questions up on the board and ask students to suggest predictions related to each question. Follow the procedure of hypothesis construction on the board with each student suggestion. With each new hypothesis construction, provide less support and ask students for more direction, until a few confident students can come up to the board and write a hypothesis from a ‘What if?’ question and a prediction.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

**Explain that stuff: How to be a scientist**  
This website directs students to think about science as a hobby or career.

1.5 Tables and graphs are used to present scientific data

Teacher notes (pages 12–13)

Introducing the topic

This section explores the use of tables and graphs in science. Graphs make the data that students gather in an experiment easier to analyse. Graphs show what happened so that patterns in the data can be identified.

Teaching tips: Observation skills

Encourage students to make detailed observations about every investigation they undertake in science. It is often an unusual observation that can lead to new questions and new investigations. Highlight the fact that inferences are the decisions that are made about what the observations may mean. Inferences are not always fact; they may need to be tested, but they should be based on existing knowledge.

Students can often confuse observation with inference. A good way for students to distinguish between them is as follows:

Observation – the ‘O’ is like an open eye, so observations are what your senses tell you.

Inference – the ‘In’ is like ‘inside’; your explanation for the observation comes from inside your mind.

Teaching tips: Inference

Students should be aware that their inference may not necessarily be the correct answer, but it is their best guess to explain a phenomenon. A good example is the situation of observing a man being restrained by the police; there are many inferences that can be drawn from this limited observation, ranging from restraint through to police brutality. This demonstrates that we need to collect as many observations as possible to explain what is happening.

Additional activity: Accuracy and error

You could demonstrate the use of the various measuring devices, but, in doing so, make deliberate errors in using them. This could stimulate a discussion about the terms ‘accuracy’ and ‘error’ in the context of the students’ experiments. It is important for students to understand that in science we try to make experiments as accurate as possible and, although error is inevitable, we should always try to reduce it.

Additional activity: Reliable results

Students can sometimes struggle to see that reliable results don’t need to be exactly the same every time, and that repetition can be the same as collating class data. Again, discuss some scenarios to demonstrate how these concepts work in the real world.

Additional activity: Measuring and recording

Ask students to write down 10–20 things that they have used in the last 24 hours that used measurement.

Additional activity: Old ways of measuring

Ask students to check whether the distance around the waist is twice the distance around the neck. What other measurements of the body can be used to measure other body parts? For example, the length between the wrist and elbow is equal to the foot. Ask students to find out if there are any others.

Additional activity: Measurement and units

Ask students what other units of measurements are used and where they have used them or heard them used. They may know that the USA uses different units, but may not know it’s called the imperial system. They are most likely to have used or heard of feet and inches, pounds and Fahrenheit. Units include:

• temperature: Fahrenheit

• length: feet, yards, miles, inches

• weight/mass: pounds

• volume: gallons, litres.

Ask students whether scientists in the USA use metric or imperial measurements and why. They should answer with metric, because it’s the worldwide standard for measurement and if some scientists used a different measurement, there would be confusion.

Additional activity: Recording measurements

Ask students what ‘ms’ would mean if it were written after a number and why it’s not used to indicate metres. They should answer with milliseconds and because it’s a different unit of measurement and means something completely different.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

**Human Senses**  
The ‘BBC Senses Challenge’ gives the students a different means of accessing the relevant information about our different senses.