

**The important thing in
science is not so much
to obtain new facts as
to discover new ways of
thinking about them.**

Sir William Bragg (1862–1942)

1

Science is ...

The word **science** comes from the Latin word *scientia*, meaning knowledge. For some people it's an occupation; for others it's used to design and build things. But everybody uses scientific knowledge, or devices made using scientific knowledge — every day.



OVERARCHING IDEAS

- Patterns, order and organisation
- Scale and measurement

GENERAL CAPABILITIES

- Literacy
Numeracy
ICT competence
Critical and creative thinking
Personal and social competence

SCIENCE AS A HUMAN ENDEAVOUR

- Nature and development of science
Use and influence of science

SCIENCE INQUIRY SKILLS

- Questioning and predicting
Planning and conducting
Processing and analysing data and information
Evaluating
Communicating

THINK ABOUT SCIENCE

- What do scientists do?
- Do people other than scientists use science in their work or leisure activities?
- How is a science laboratory different from other rooms?
- Is the science laboratory a dangerous place?
- Am I a good observer?
- How are substances heated safely in the science laboratory?
- Is it easy to shoot goals in basketball or netball with only one eye open?



Where's the science?

Work in a small team for this activity. For each of the photographs on this page, work together to write a paragraph about how scientists might be involved in the activity. Select a spokesperson to read the paragraph to the class.



THINK

- 1 Draw a picture of your own 'image' of a scientist on A4 paper.
- 2 Make a list of the differences between real scientists and the scientist you have drawn. Think about the way they look as well as what they do.
- 3 Get together in a group and compare your lists and drawings. Together, compile a group list and draw a group image or description of a scientist.
- 4 As a group, suggest one single word that describes what all scientists do.



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Weblink

Use the Australian Academy of Science weblink in your eBookPLUS to find out more about the work of the Academy.

Science is ... everywhere!

Scientific knowledge is all around you. Whenever you turn on a light, eat food, watch television or flush the toilet you are using the products of scientific knowledge. Nurses, police, dietitians, teachers, doctors, vets, mechanics, gardeners, stage designers and artists use scientific knowledge. In fact you could easily add to this list yourself. For example, engineers use scientific knowledge to design bridges, computers, factories, artificial limbs, sewerage systems and buildings.



Science is ... biology

... the study of living things. There are many branches of biology. **Zoology** is concerned with animals and **botany** with plants. **Entomology** is the study of insects while **microbiology** is the study of living things that are too small to see without the help of a microscope.



Science is ... physics

... the study of the behaviour of natural and manufactured things and reasons for their behaviour. Physics is concerned with movement and different forms of energy such as light, heat, electricity and nuclear energy. Branches of physics include **acoustics**, the study of sound, and **biomechanics**, the study of the forces involved in human and other animal movement.



**Career spotlight: scientist**

Meet marine biologist Jodie Haig and learn about this exciting career in marine science.

eles-0053

Science is ... chemistry

... the study of substances, what they are made of, how they are formed, how they change and what happens when they are combined. Branches of chemistry include **radiochemistry**, the study of radioactive substances, and **pharmacology**, the study of the effect of drugs on living things.



Science is ... geology

... the study of the Earth and how it changes. A geologist might, for example, be concerned with how mountains are formed or with using rocks to trace the Earth's history. **Vulcanology**, the study of volcanoes, **seismology**, the study of earthquakes, and **palaeontology**, the study of fossils, are some of the branches of geology.



Science is ... astronomy

... the study of the stars, the sun, the planets, their moons and other heavenly bodies such as comets and asteroids.



Science is ... psychology

... the study of the mind and behaviour. Most psychologists are concerned with human thought and emotion, but some work with other animals. Branches of psychology include **sports psychology**, which deals with the motivation of athletes, and **forensic psychology**, which deals with psychology and the law.



WHAT DOES IT MEAN?

 Psych comes from the Greek word **psyche**, meaning 'soul' or 'mind'.

The people of science

Scientists can be found just about anywhere. They could be on a river bank taking water samples, on a boat fitting dolphins with radio transmitters to track their movements, searching for fossils in outback cliffs, in a laboratory searching for the cause of a disease, beside a freeway measuring the effects of sound barriers — even in space investigating the effects of weightlessness.

Some scientists work in more than one branch. For example, a **biochemist** works in biology and chemistry, studying the substances in living things. A **biophysicist** might study the small electrical

signals that travel from your ear to your brain, which enable you to hear.

Science and technology

Since prehistoric times, people have been making scientific discoveries that have improved the quality of life. The use of scientific ideas to make devices that make life easier is called **technology**. The invention of the wheel is a good example of early technology. The scientific idea behind the wheel is that objects roll over surfaces more easily than they slide across them. The interaction of science and technology has been the driving force behind our modern technological world.

UNDERSTANDING AND INQUIRING

THINK

- 1 Explain how people in each of the following occupations might use science in their daily work.
(a) Nurse (b) Mechanic (c) Gardener
(d) Chef (e) Architect (f) Police officer
- 2 What would each of the following types of scientist be mainly concerned with?
(a) Biochemist
(b) Geophysicist
(c) Marine ecologist
- 3 List five devices that you have used today that would not have been invented without scientific knowledge.

IMAGINE

- 4 Look at the photo of Australian tennis player Lleyton Hewitt. Propose how each of the following scientists could improve his performance.
(a) Nutritionist
(b) Sports psychologist
(c) Physicist
- 5 Imagine that you are given the chance to interview any scientist from the past or present. Who would you choose? Give reasons for your choice and prepare a list of questions that you would ask.

INVESTIGATE

- 6 What do the initials CSIRO stand for? What does this organisation do?
- 7 Find out what you need to study at school and afterwards to become a scientist or engineer.

eBook plus

- 8 Use the **Da Vinci's machines** weblink in your eBookPLUS to learn about some of the important machines that Leonardo da Vinci invented.

HOW ABOUT THAT!

Not all scientists were high achievers at school. Some very famous scientists were average or below average school students. Albert Einstein is probably the most famous example. He did not talk until he was three years old. He left school at the age of 15 and went back later. He passed his university exams by studying the notes of his classmates.



The science laboratory

Getting to know the science lab

- Sit quietly for a minute or two and look around the science laboratory.
- List as many differences as you can between the science laboratory and other general classrooms at your school.
- Draw a map of the science laboratory on a sheet of A4 paper, labelling each of the following items clearly.
 - student tables and work benches
 - teacher's desk or demonstration bench

- gas taps
- sinks
- eye wash
- fire blanket
- doors
- power points
- fume cupboard
- fire extinguishers
- sand bucket
- rubbish bin
- broken glass bin

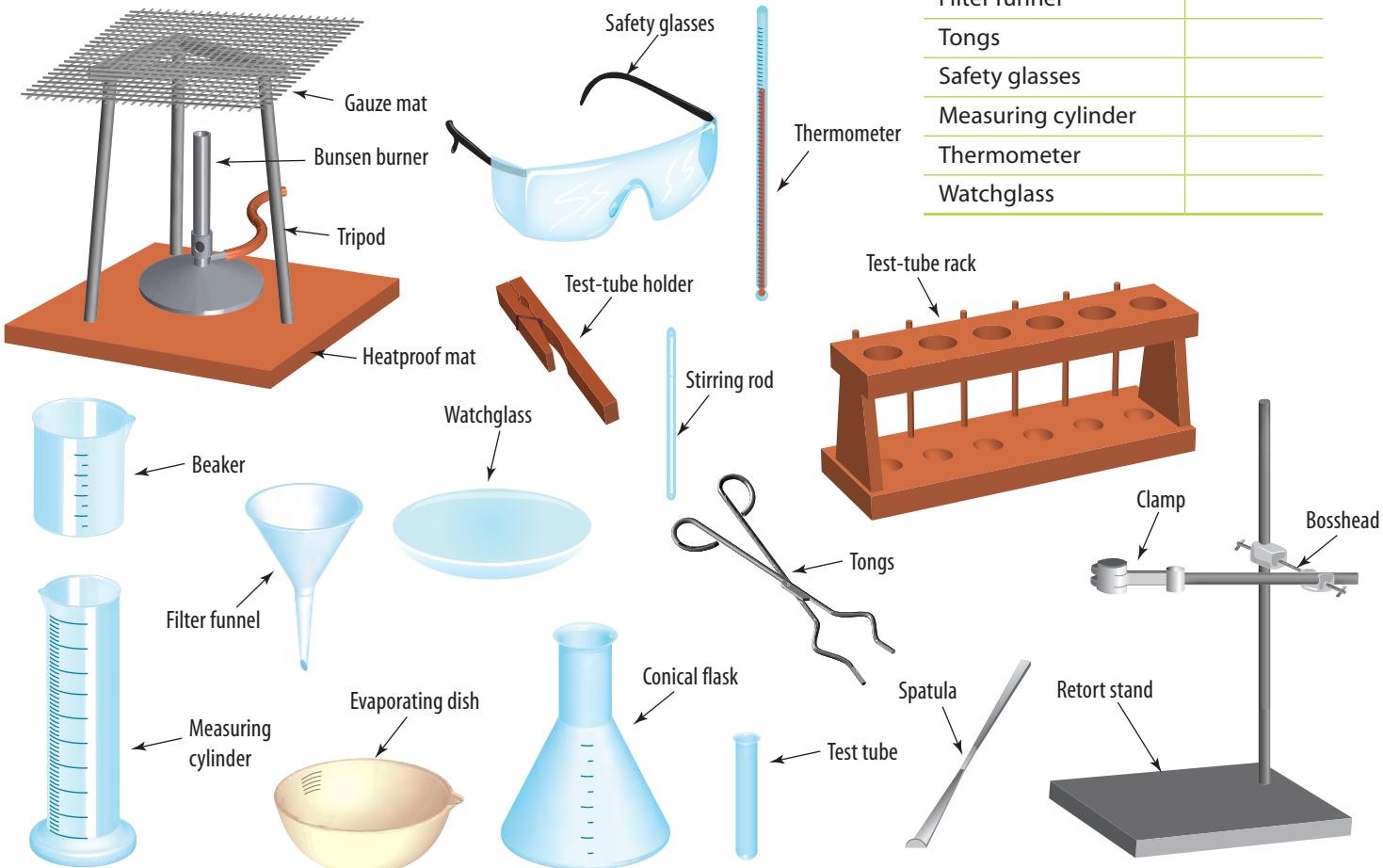
Equipment checklist

Bunsen burner	
Heatproof mat	
Tripod	
Gauze mat	
Beaker	
Stirring rod	
Evaporating dish	
Conical flask	
Test tube	
Test-tube holder	
Test-tube rack	
Spatula	
Retort stand	
Bosshead	
Clamp	
Filter funnel	
Tongs	
Safety glasses	
Measuring cylinder	
Thermometer	
Watchglass	

Laboratory equipment

Some of the equipment that you are likely to use in the science laboratory is illustrated below.

- Use the illustrations to find each item of equipment in the checklist at right. On a copy of the checklist, place a tick beside each item when you have found it.



Playing it safe

Doing experiments in science can be exciting, but accidents can happen if investigations are not carried out carefully. There are certain rules that must be followed for your own safety and the safety of others.

ALWAYS ...

- follow the teacher's instructions
- wear safety glasses and a laboratory coat or apron, and tie back long hair when mixing or heating substances
- point test tubes away from your eyes and away from your fellow students
- push chairs in and keep walkways clear
- inform your teacher if you break equipment, spill chemicals or cut or burn yourself
- wait until hot equipment has cooled before putting it away
- clean your workspace — don't leave any equipment on the bench
- dispose of waste as instructed by your teacher
- wash your hands thoroughly after handling any substances in the laboratory.



NEVER ...

- enter the laboratory without your teacher's permission
- run or push in the laboratory
- eat or drink in the laboratory
- smell or taste chemicals unless your teacher says it's ok. When you do need to smell substances, fan the odour to your nose with your hand
- leave an experiment unattended
- conduct your own experiments without the teacher's approval
- put solid materials down the sink
- pour hazardous chemicals down the sink (check with your teacher)
- put hot objects or broken glass in the bin.

HANDY HINTS

- Use a **filter funnel** when pouring from a bottle or container without a lip.
- Never put wooden test-tube holders near a flame.
- Always turn the tap on before putting a **beaker**, **test tube** or **measuring cylinder** under the stream of water.
- Remember that most objects get very hot when exposed to heat or a naked flame.
- Do not use tongs to lift or move beakers.

Working with dangerous chemicals

Your teacher will tell you how to handle the chemicals in each experiment. At times, you may come across warning labels on the substances you are using.

Always wear gloves and **safety glasses** when using chemicals with this symbol. Corrosive substances can cause severe damage to skin and eyes. Acid is an example of a **corrosive** substance.



These substances are easily set on fire so keep them away from flames. Methylated spirits is **flammable**.

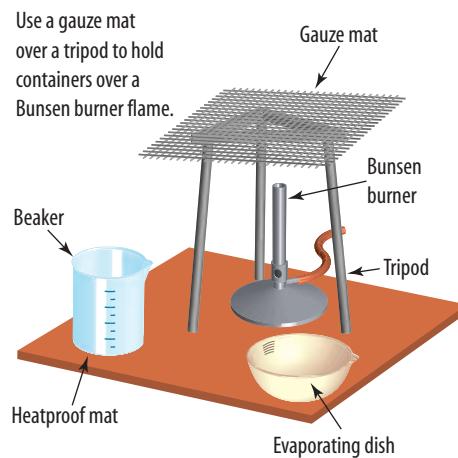


Chemicals with this label can cause death or serious injury if swallowed or breathed in. They are also dangerous when touched without gloves because they can be absorbed by the skin. Mercury is a **toxic** substance.



HEATING CONTAINERS

Beakers and evaporating dishes can be placed straight onto a gauze mat for heating. Never look directly into a container while it is being heated. Wait until the equipment has cooled properly before handling it.



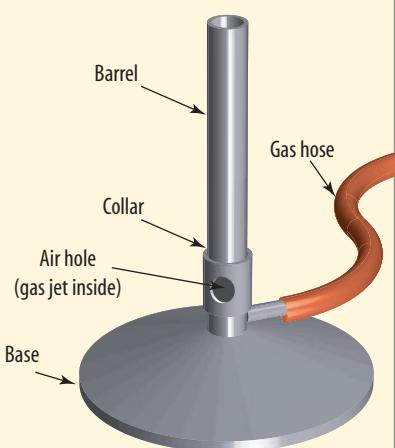
Heating substances

Many experiments that you will conduct in the laboratory require heating. In school laboratories, heating is usually done with a Bunsen burner. A Bunsen burner provides heat when a mixture of air and gas is lit.

Bunsen burners heat objects or liquids with a naked flame. Always tie hair back, and wear safety glasses and a laboratory coat or apron when using a Bunsen burner.

A GUIDE TO USING THE BUNSEN BURNER

- ① Place the Bunsen burner on a heatproof mat.
- ② Check that the gas tap is in the 'off' position.
- ③ Connect the rubber hose to the gas tap.
- ④ Close the air hole of the Bunsen burner collar.
- ⑤ Light a match and hold it a few centimetres above the barrel.
- ⑥ Turn on the gas tap and a yellow flame will appear.
- ⑦ Adjust the flame by moving the collar until the air hole is open and a blue flame appears.
- ⑧ Remember to close the collar to return the flame to yellow when the Bunsen burner is not in use.



INQUIRY: INVESTIGATION 1.1

Which flame is hotter?

KEY INQUIRY SKILL:

- processing and analysing data and information

Equipment:

Bunsen burner	heatproof mat
matches	tongs
pieces of porcelain	safety glasses
clock or watch	

- Light the Bunsen burner according to the guide above.
- Open the air hole.
- Hold a piece of porcelain over the flame with the air hole open.
- Record roughly how long it takes for the porcelain to turn red-hot.
- Let the porcelain cool on the heatproof mat.
- Close the air hole.
- Hold the porcelain in the yellow flame for a few minutes.

DISCUSS AND EXPLAIN

- 1 Describe the flame when the air hole is open. What colour is it? Does it make a noise?
- 2 Describe the flame when the air hole is closed. Is it easy to see?
- 3 Does the porcelain turn red-hot in the yellow flame when the air hole is closed?
- 4 Do you notice anything else about the porcelain after heating in the yellow flame?
- 5 Which is the hotter flame? What observations did you make that support your answer?

INQUIRY: INVESTIGATION 1.2

Where is the hottest part of the flame?

KEY INQUIRY SKILL:

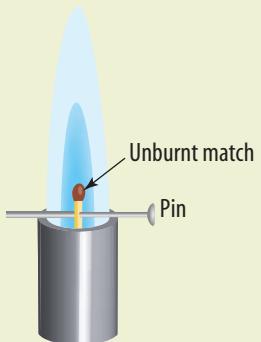
- processing and analysing data and information

Equipment:

Bunsen burner	nichrome wire
heatproof mat	tongs
matches	pin
safety glasses	

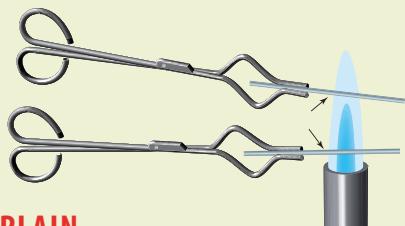
PART A

- Use a pin to hang an unburnt match over the barrel of a Bunsen burner.
- Light the Bunsen burner according to the guide on the opposite page.
- Turn the collar to produce a blue flame.
- Turn the Bunsen burner off and remove the match and pin with tongs.



PART B

- Re-light the Bunsen burner and turn the collar to produce a blue flame again.
- Use the tongs to hold the wire across the flame, close to the barrel of the Bunsen burner and observe the wire.
- Move the wire up a little and continue observing.



DISCUSS AND EXPLAIN

- What happens to the match hanging over the barrel? Explain why.
- What colour does the wire become when held across the flame?
- Is the colour of the wire different when it is held at the top of the flame?
- Draw a diagram of the Bunsen burner flame, labelling the parts that are hottest.
- Students often heat substances in a test tube with a Bunsen burner. Why would it be unwise to:
 - use a yellow flame rather than a blue flame
 - position the test tube at the base of a blue flame?
- Why is the yellow flame often called the safety flame?

INQUIRY: INVESTIGATION 1.3

Heating a substance in a test tube

KEY INQUIRY SKILL:

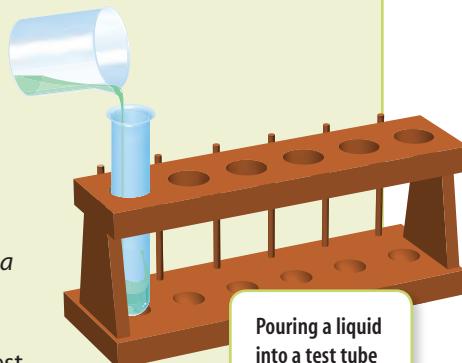
- processing and analysing data and information

Equipment:

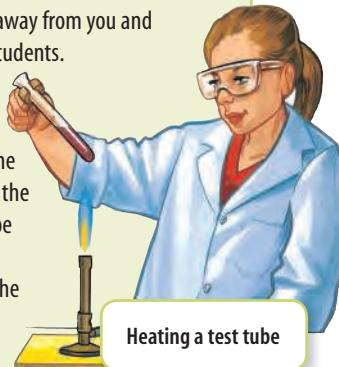
100 mL beaker	Bunsen burner and heatproof mat
matches	safety glasses
test tube	test-tube rack
test-tube holder	food colouring

CAUTION: Before you start heating, check the following:

- If you have long hair, is it tied back?
- Are you wearing safety glasses?
- Is the Bunsen burner on a heatproof mat?
- Carefully pour water from a beaker into a test tube to a depth of about 2 cm as shown in the diagram above. Add a drop of food colouring to make it easier to see.
- Light the Bunsen burner correctly and heat the test tube gently in the blue flame as shown at right. Remember that the open end of the test tube should be pointing away from you and your fellow students. The base of the test tube should be moved gently in and out of the flame. This prevents the liquid from splashing out of the test tube.
- Once the water has started boiling, stop heating and turn off the gas to the Bunsen burner. Place the test tube in the test-tube rack. Leave it there until it has cooled before emptying it and cleaning up.



Make sure that the test tube points away from you and other students.



Move the base of the test tube in and out of the flame.

Keep the test-tube holder away from above the flame.

DISCUSS AND EXPLAIN

- Why is the test tube placed in a test-tube rack rather than in your hand?
- Make a list of any changes you observed inside the test tube as you heated the water.

UNDERSTANDING AND INQUIRING

REMEMBER

- 1 Outline the purpose of each of the following pieces of equipment.
 - (a) Heatproof mat
 - (b) Evaporating dish
 - (c) Test-tube rack
 - (d) Retort stand
- 2 Give three examples of equipment used when heating objects.
- 3 Explain why you should always wear gloves when working with corrosive substances.
- 4 If the teacher says it is safe to smell a chemical, what technique should you use?
- 5 Which colour flame of a Bunsen burner is hottest — the blue or the yellow?
- 6 What should you do if you cut or burn yourself in the laboratory?

THINK

- 7 Identify which item of equipment you would use to:
 - (a) hold a test tube that is to be heated
 - (b) measure a volume of water exactly
 - (c) transfer a small sample of a powder to a beaker
 - (d) mix a sample of powder with water so it dissolves.



- 8 Look carefully at the picture of students in a laboratory on this page.
 - (a) Identify at least five dangerous situations you can see.
 - (b) Explain why each situation is dangerous.
- 9 The following statements are all incorrect. Rewrite them so that they are correct.
 - (a) Matches can be safely washed down the sink.
 - (b) Always point a test tube towards you when heating so you can see what is happening inside it.
 - (c) Safety glasses need to be worn only when heating over a blue Bunsen burner flame.
 - (d) Water spills do not need to be cleaned up because they are not dangerous.

CREATE

- 10 Select one of the safety rules and choose a strategy for publicising your message to the class. You might create a safety poster, video clip or play.

eBook plus

- 11 Identify the equipment you will need to perform a number of laboratory processes by completing the **Using equipment** interactivity in your eBookPLUS. int-0200

- 12 Use the **Robert Bunsen** weblink in your eBookPLUS to learn about the man after whom the Bunsen burner was named.

work
sheets

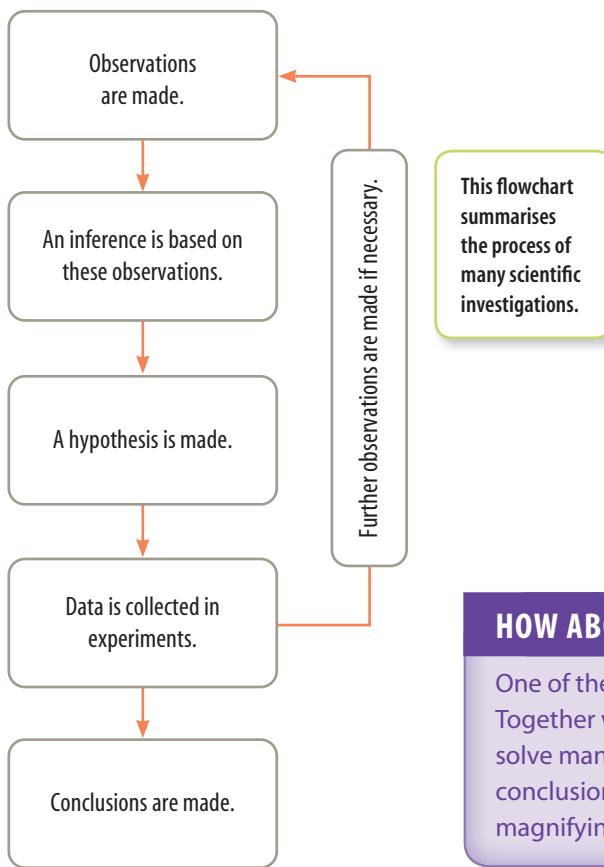
- 1.1 The science laboratory
- 1.2 Playing it safe

Danger in the laboratory

Detective skills

Crime scene investigators make **observations** at the scene of the crime. A footprint, the smell of perfume, an unusual sound or a warm log in a fireplace could provide clues to a crime.

The investigators also collect evidence so that they can make more observations in the laboratory. They use their observations to make an inference about what happened. An **inference** is a suggested explanation of what took place. But inferences are not always right. Further investigation is usually needed. The investigators often form a **hypothesis** about what happened. A hypothesis is an educated guess that can be tested by an experiment, further observations or measurement. After testing a hypothesis you might be able to form a **conclusion** about what happened. A conclusion is a final explanation of what took place. Sometimes the investigator has to return to the scene of the crime to gather more evidence to make further observations and start the process all over again before a conclusion can be formed.

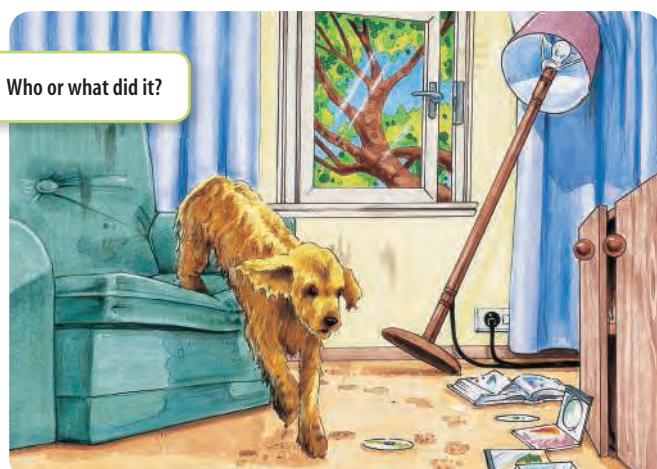


The process used by crime scene investigators is used in almost all scientific investigations. Sometimes scientists form a hypothesis without making an inference first and sometimes no hypothesis is formed before an experiment.

Who or what did this?

To solve the mystery shown in the scene below, careful observations have to be made. Normally you are able to use all five senses to make observations. However, in this case you can use only your sense of sight.

- 1 Look carefully at the drawing and write down as many observations as you can that might help solve the mystery.
- 2 Make an inference about what happened.
- 3 Form a hypothesis about the mystery that can be tested by closer observation, measurement or an experiment. Explain how your hypothesis could be tested by a real crime scene investigator.
- 4 Why is it not possible to form a conclusion about who or what caused the mess using the drawing alone?



HOW ABOUT THAT!

One of the most famous detectives of all time was Sherlock Holmes. Together with Dr Watson he used observations and clever hypotheses to solve many crimes. Every hypothesis had to be tested until he could reach a conclusion about the crime. One of Sherlock's scientific tools was a simple magnifying glass. Of course, Sherlock Holmes didn't really exist — or did he?

INQUIRY: INVESTIGATION 1.4

Are you a good observer?

KEY INQUIRY SKILL:

- processing and analysing data and information

Equipment:

candle and matches jar lid

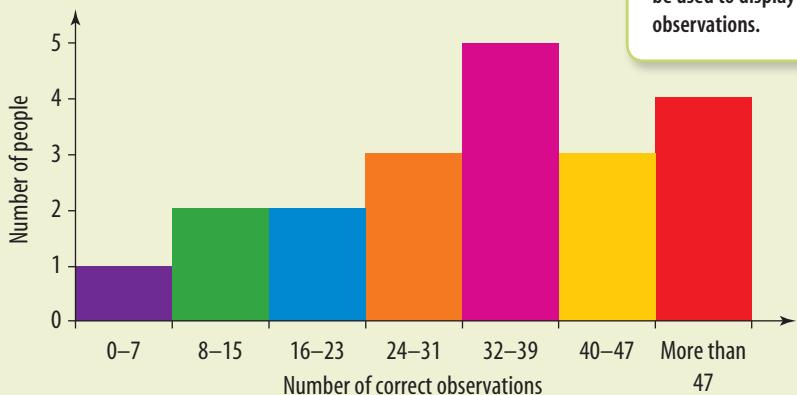
- Light a candle and place it on the lid of a jar. Write down as many observations as you can of the burning candle. Use all of your senses except the sense of taste. No chemicals should ever be tasted in the science laboratory!

CAUTION: Do not touch the flame of the candle.

- Michael Faraday (1791–1867), a scientist famous for his discoveries in electricity and chemistry, made 53 observations of a burning candle. Take note of the number of observations you made.
- Use a table like the one below to record the number of observations made by the people in your class.

'Score' (number of observations made)	Number of people
0–7	
8–15	
16–23	
24–31	
32–39	
40–47	
More than 47	

- Construct a histogram like the one shown below to display your observations.



DISCUSS AND EXPLAIN

- How many observations did you record?
- Form a hypothesis about whether you are a better observer than most people in your class.
- Was your hypothesis supported by the data?
- Write a conclusion to answer the question 'Am I a better observer than most people in my class?'

UNDERSTANDING AND INQUIRING

REMEMBER

- How is a scientist like a detective?
- What is the difference between a hypothesis and a conclusion?
- Which of your five senses can be used to make observations?

THINK

- Explain the difference between an inference and a hypothesis.
- Read the following 'story' and state whether each sentence is an observation, inference or conclusion.
 - The dog in the house next door is barking.
 - There are no lights on in the house.
 - The owners must be asleep.
 - There could be a prowler in the back yard.
 - I heard the sound of breaking glass.
 - The dog is still distressed.

IMAGINE

- Imagine that you have lost your senses of sight and hearing. Write a description, giving as much detail as you can, about walking through a remote forest. Don't forget that your observations can be made only with your senses of touch, taste and smell.

INVESTIGATE

- Sit quietly in a nearby outdoor location and write down all of the things that you notice in two minutes. Use as many senses as you can, apart from the sense of taste.
 - Which sense did you use the most?
 - Compare your observations with those of your friends. Which sense did they use the most?
 - Which other senses did you use?

work sheet

→ 1.3 Observing and recording

Keeping things under control

In order to answer a question scientifically, a controlled investigation needs to be performed. The investigation must also be reliable. The simple investigation of bouncing balls described below illustrates how experiments can be both controlled and reliable.

Variables

There are many factors that affect how high a ball bounces after being dropped. They include:

- the height from which the ball is dropped
- the type of ball
- the type of surface the ball is dropped onto
- how much the ball has been used
- the method of dropping
- the technique used to measure the bounce height.

These factors are called **variables**. The variable that you are investigating is called the **independent variable**. In this investigation the independent variable is the type of ball. You are comparing balls of similar sizes made from different materials. The variable that you are measuring (the height of the bounce) is called the **dependent variable**.

Fair testing

Scientific investigations must be **fair tests**. In a fair test only one variable is changed at a time — the independent variable. In this investigation about the tennis ball bounce, that is the type of ball. All variables other than the dependent variable must be **controlled**; that is, they must be kept the same. If they were not, you couldn't tell which variable was affecting the height of the bounce. You might find it helpful when designing your own investigations to use a table like the one above right to identify all the variables.



Interactivity

Reading scales

Test your skill in identifying temperatures on a number of different thermometers by completing this interactivity in your eBookPLUS.

int-0201

Investigation: Which type of ball bounces the highest after being dropped on the ground?

Independent variable	<ul style="list-style-type: none"> • The type of ball
Dependent variable	<ul style="list-style-type: none"> • The height of the bounce
Controlled variables	<ul style="list-style-type: none"> • The type of surface the ball is dropped onto • How much the ball has been used (use brand-new balls) • The method of dropping • The technique used to measure the bounce height

INQUIRY: INVESTIGATION 1.5

Bouncing balls

KEY INQUIRY SKILLS:

- planning and conducting

Equipment:

<i>tennis ball</i>	<i>baseball</i>
<i>rubber ball (about the size of a tennis ball)</i>	<i>any other ball about the same size as a tennis ball</i>
<i>cricket ball</i>	<i>one-metre ruler</i>

- The question you are trying to answer is 'Which ball bounces the highest?'. Prepare a table in which to record your results.
- Write down a hypothesis.
- Take care not to introduce unwanted variables. Make sure that the balls are dropped each time — don't accidentally give them an extra push down. Also, think about which part of the ball you will measure the bounce height from.
- You will be working in a small group, so decide who will drop the ball, who will make the measurements and who will record them.
- Drop each ball from the same height and measure how high each one bounces. Now go ahead and answer the question — scientifically!
- Write a report about your investigation using the headings on page 20.

Out of control

Sometimes it is not possible to control all of the variables that need to be controlled. These variables are called uncontrolled variables. These ‘out of control’ variables can make your **data** unreliable. In the bouncing ball investigation the size of the ball is uncontrolled. However the effect of size is minimised by testing balls of approximately the same diameter.

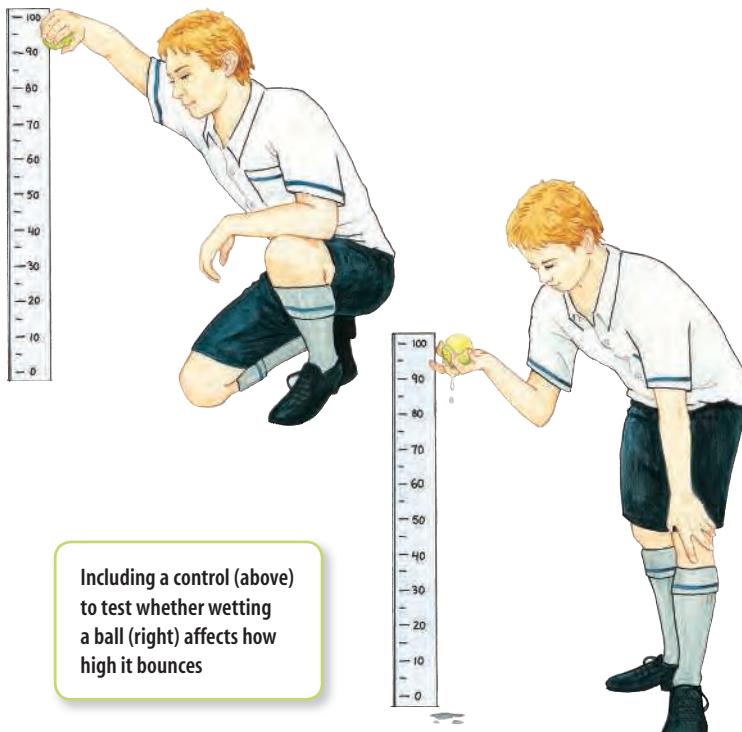


WHAT DOES IT MEAN?

The word *data* comes from the Latin word **datum** meaning ‘something given’. The English word *datum* means a single piece of information. *Data* means more than one piece of information.

Repetition and reliability

If you measured the bounce height of each ball only once, your result may not be reliable. Errors often occur in measurements due to carelessness, a minor change in method (for example in the way the ball was dropped) or inaccuracies in reading a scale. To reduce the effect of these errors, measurements should be repeated a number of times and an average calculated. The table above right shows an example in which the bounce height of a wet tennis ball is compared with the bounce height of a dry tennis ball.



Including a control (above) to test whether wetting a ball (right) affects how high it bounces

Comparing the bounce height of wet and dry tennis balls

Trial	Height of bounce (cm)	
	Wet tennis ball	Dry tennis ball
1	47	47
2	45	48
3	42	50
4	42	48
5	44	52
Average	44	49

The average of these measurements suggests that a dry tennis ball will bounce higher than a wet one. If you recorded only trial 1, you would form a different — and incorrect — conclusion.

Including a control

Some investigations require a **control** or a **control group**. For example, you might be investigating the effects of watering plants with salty water. You could use three different containers of water, each with a different amount of salt in the water. The independent variable is the amount of salt dissolved in the water. The dependent variable might be the height of the plant after ten days of watering. For reliability you observe at least three plants for each amount of salt. To fully investigate the effect of the salt in the water you need a control group of plants, to which you give water without any added salt. In a control group the independent variable (the salt) is not applied.



Some investigations require a control group.

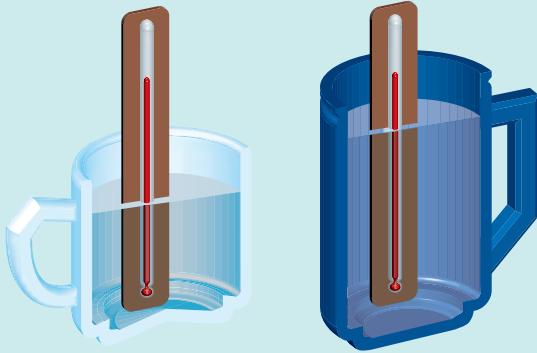
UNDERSTANDING AND INQUIRING

REMEMBER

- 1 What is a variable?
- 2 Explain the difference between an independent variable and a dependent variable.
- 3 Why should only one variable at a time be changed in scientific investigations?

THINK

- 4 Identify some variables that might affect:
 - (a) how quickly a pot plant grows
 - (b) the cost of an overseas airfare
 - (c) the time it takes you to travel to school in the morning.
- 5 Advertisements for washing powders and liquids often claim that they are more effective than others. Imagine that you are conducting an experiment to test a range of washing powders and liquids.
 - (a) Outline a method for your experiment.
 - (b) List the variables you will need to control.
 - (c) What variable will you change?
 - (d) How will you compare the results of your tests?
- 6 Amy and Nguyen are trying to find out whether stoneware or glass cups are better for keeping water hot. The illustration below shows their experiment in progress.



Amy and Nguyen's experiment in progress

- (a) List at least two weaknesses in their experiment design.
- (b) Make a list of all the variables that could affect the results of Amy and Nguyen's experiment.
- (c) List any variables that Amy and Nguyen do not need to control.
- (d) Write a step-by-step outline of the procedure that they could use to find out which cups keep water hot.

ANALYSE AND EVALUATE

Simon and Jessie performed an experiment to find out how effectively two plastic cups maintain the temperature of near boiling water. Their data are shown above right.

Comparing plastic cups

Time (min)	Temperature (°C)	
	Simon's cup	Jessie's cup
0	90	90
10	47	58
20	29	39
30	22	31
40	20	26
50	20	23

- 7 Draw a graph to display the data in the table.
- 8 Which cup maintained the temperature of the water more effectively?
- 9 Estimate the temperature of the water in Simon's cup 15 minutes after timing commenced.
- 10 Use your graph to estimate how long it would have taken the water in Jessie's cup to drop to a temperature of 20°C.

BRAINSTORM

- 11 In a small group, brainstorm and produce a list of problems that you could investigate scientifically at home or in the school laboratory without using expensive scientific equipment. You could start by thinking about investigations involving plants.

INVESTIGATE

- 12 Design an investigation to find out whether distances are easier to judge with two eyes than just one. You can do this by shooting for goal with a basketball or netball from a particular spot under three conditions:
 - left eye closed
 - right eye closed
 - both eyes open.To produce reliable results, more than one person should take the shooting test and each goal shooter should have several attempts.

Plan and carry out your experiment. Write a formal report for the experiment including a table of results and a conclusion. In your discussion section:

- identify the independent and dependent variables
- describe the strategies you used to ensure that this was a fair test.

- 13 How is the bounce height of a tennis ball affected:
 - (a) when it is damp
 - (b) when it is hot
 - (c) as it gets old and worn
 - (d) by different tennis court surfaces?Design and perform an investigation to answer one or more of these questions.



1.4 Developing a fair test

Analysing data

Values or measurements obtained from an investigation are called data. Having collected the data, it is important to present it clearly so that another person reading or studying it can understand it.

Organising data as a graph is a widely recognised way of making a clear presentation. It makes the information easier to read and interpret, and makes it easier to show trends and draw conclusions.

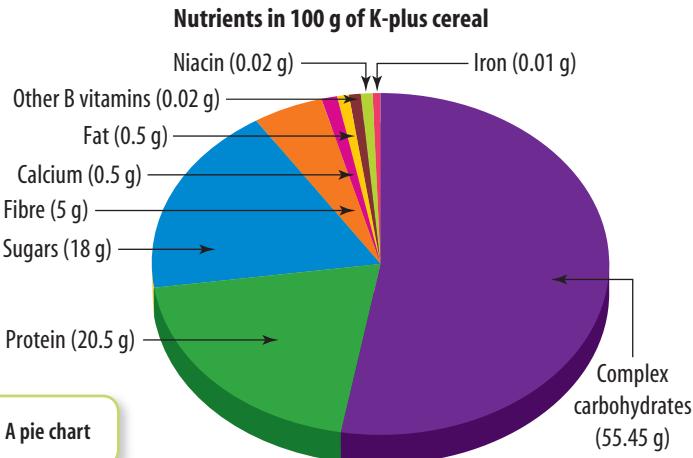
A graph, especially a line graph, can also be used to find values other than those used in the investigation. Line graphs can be used to make predictions. For example, using the line graph on page 18 you can predict how much salt can be dissolved at temperatures other than those actually measured.

What is a graph?

A graph is a diagram that shows the connection between two or more things using dots, lines or bars. There are four different types of graph: a pie chart or sector graph, a bar chart or column graph, a histogram and a line graph.

Pie chart (or sector graph)

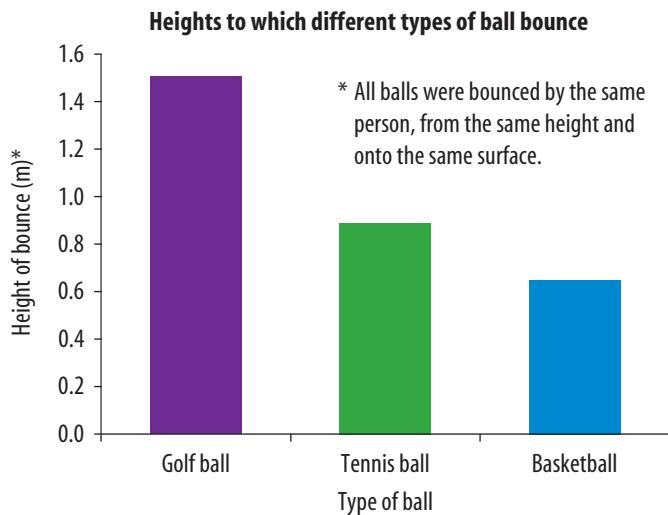
A **pie chart** (also known as a **sector graph**) is a circle divided into sections that represent parts of the whole. This type of graph can be used when the data can be added as parts of a whole. The example below shows the food types, vitamins and minerals that make up the nutrients in a breakfast cereal.



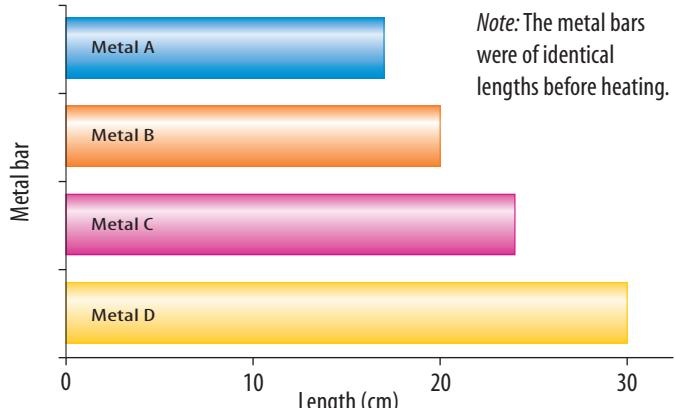
Column graph (or bar chart)

A **column graph** (also known as a **bar chart**) has two axes and uses rectangles (bars or columns) to represent each piece of data. The height or length of the bars represent the values in the data. The width of the bars is kept constant. This type of graph can be used when the data cannot be connected and are therefore not continuous.

The example below shows data on the average height to which different balls bounced during an experiment. Each bar represents a different type of ball. The example at the bottom of this page shows the lengths of different metal bars when heated. Each bar represents a different metal bar.



Lengths of different metal bars when heated in the same way



Two column graphs (also known as bar charts)

Histogram

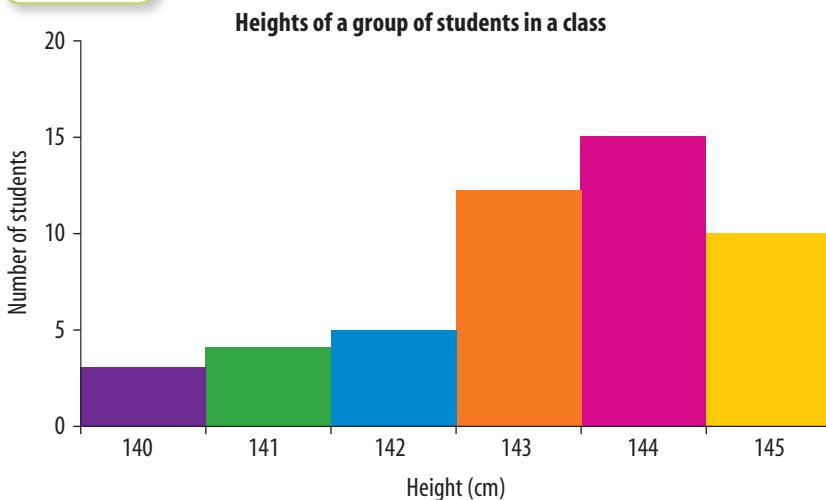
Histograms are similar to column graphs except that the columns touch each other because the data is continuous. They are often used to present the results of surveys. In the histogram on the right, each column represents the number of students that reach a particular height.

Line graph

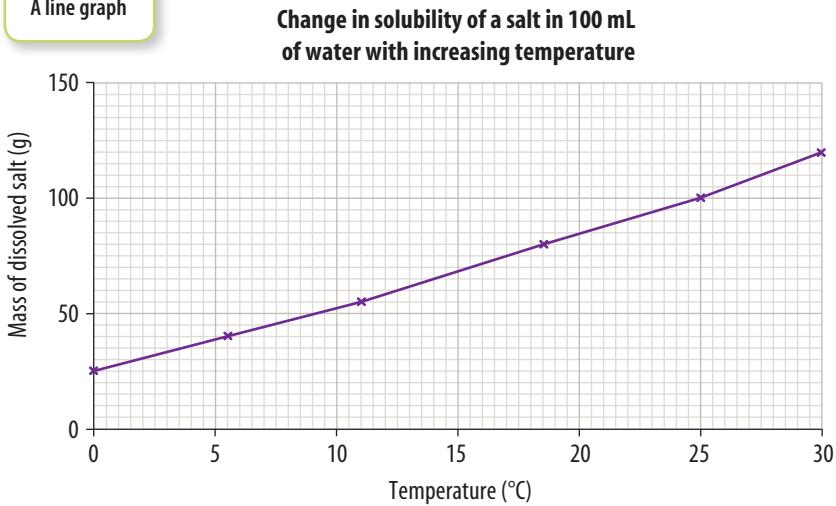
A **line graph** has two axes — a horizontal axis and a vertical axis. The horizontal axis is known as the **x-axis**, and the vertical axis is known as the **y-axis**. The line graph is formed by joining a series of points or drawing a line of ‘best fit’ through the points. Each point represents a set of data for two variables, such as height and time. Two or more lines may be drawn on the same graph.

Line graphs are used to show continuous data — that is, data in which the values follow on from each other. For example, the line graph on the right shows the change in the solubility of a salt in water as the temperature of the water increases. (Solubility is a measure of the mass of a substance that can be dissolved in a liquid.)

A histogram



A line graph



UNDERSTANDING AND INQUIRING

ANALYSE THIS

- 1 Prepare a column graph using the following information on the nutrients present in a serving of ice-cream.

Nutrients in a 30 g serving of ice-cream

Nutrient	Amount (g)
Protein	2.00
Fat	6.00
Carbohydrate — polysaccharide	11.00
Carbohydrate — sugars	10.00
Cholesterol	0.02
Calcium	0.10
Potassium	0.80
Sodium	0.05

- 2 The table below gives the energy contained in various types of food.

- (a) Why is this data not suitable for graphing?
(b) What would you need to do to make it suitable?

Energy content of foods

Food	Energy (calories)
Apple (medium)	75 000
Bread (1 slice)	70 000
Butter (1 tbsp)	100 000
Chocolate cake (medium slice)	250 000
Cornflakes (1 serving)	75 000
Milk (large glass)	150 000
Orange (medium)	50 000
Sugar (1 tbsp)	50 000

- 3 The following table shows the percentage composition of salts present in sea water.
- (a) Prepare a sector graph from this table.

Salt composition of sea water

Salt	Percentage (%)
Calcium carbonate	0.34
Calcium sulfate	3.60
Magnesium bromide	0.22
Magnesium chloride	10.90
Magnesium sulfate	4.70
Potassium sulfate	2.50
Sodium chloride	77.24
All others	0.50

- (b) Apart from sodium, the salts of which metal are the most abundant in sea water?
- 4 The following table shows the uses of plastics in Australia.
- (a) Select a suitable graph type and prepare a graph from this table.

Uses of plastics in Australia

Use	Percentage (%)
Agriculture	4.0
Building	24.0
Electrical/electronic	8.0
Furniture and bedding	8.0
Housewares	4.0
Marine, toys and leisure	2.0
Packaging and materials handling	31.0
Transport	5.0
Others	14.0

- (b) Choose two uses of plastic from your graph. For each use, state a particular item that is made of plastic.
- (c) There has been recent controversy about the waste products that humans create.
- (i) Can you suggest any uses of plastics that would contribute to waste products? List them and explain your choices.
- (ii) Can you suggest alternatives to reduce the amount of plastic waste products?
- 5 Prepare a column graph using the information in the table at right on the amount of energy required in males and females for various activities.
- (a) Why do you think males use more energy per hour than females for the same activity?

- (b) The following list shows the activities for an average female for one day. How many kilojoules would this female need to consume to provide the energy for the day's activities?

Activity	Number of hours
Sleeping	8
Light activity	4
Sitting, reading and desk work	10
Gardening	1
Basketball	1

- (c) If an average male spent a similar day, how much energy would he need?

Amount of energy required for various activities

Activity	Energy used per hour by average female — 58 kg (kJ)	Energy used per hour by average male — 70 kg (kJ)
Sleeping	240	300
Sitting, reading, desk work and studying	360	450
Light activity, such as driving, playing piano and standing with only arms moving	480	600
Walking slowly and gardening; working as a shop assistant or machinist	720	900
Physical work, such as factory or farm labouring; sports, such as cycling, tennis and cricket	960	1200
Heavy physical work, such as loading, stacking and carrying; vigorous sports, such as jogging, basketball, hockey and football (activity that leads to sweating)	1440	1800
Very heavy physical work and vigorous sports, such as football, hockey, running and swimming (activity that causes free sweating, requiring short bursts of extreme energy)	2400–4800	3000–7200

work sheet

→ 1.5 Drawing a line graph

Reporting on investigations

When scientists conduct investigations, they need to write reports to tell other people about their work. When you conduct experiments, you need to write reports that allow others to understand what you did and to read about what you found out.

Your reports should include the following sections.

Aim

A statement about why you did the experiment.

Materials

A list of the equipment and chemicals that were used.

Method

An account of what was done. This will usually include a diagram showing how your equipment was set up. There should be enough details included to allow the reader to repeat your experiment.

Results

A presentation of your data. This might include a list of observations, or tables and graphs.

Discussion

An explanation of your results and a description of any difficulties you had with the experiment. This section might also include suggestions for improvements to the experiment.

Conclusion

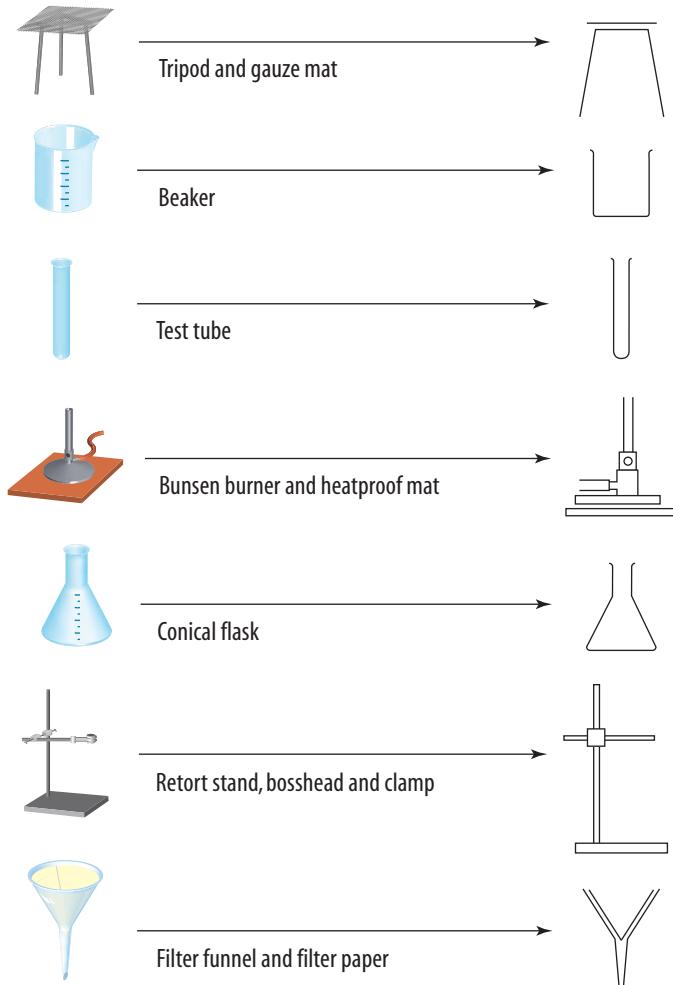
A brief account of what you found out and how your findings relate to your aim. It is a good idea to read your aim again before you write your conclusion.

Drawing science equipment

When reporting your experiments, a good, simple diagram can make it much easier for the reader to understand what was done. There are some rules to remember:

- 1 Diagrams in scientific reports should be drawn in pencil.
- 2 Straight lines should be drawn with a ruler.
- 3 Each item of equipment should be labelled.

The following diagram shows how some commonly used items of equipment should be drawn.



Diagrams in scientific reports should be simple. In each case above, the apparatus is shown on the left and the diagram of this apparatus on the right.

Organising observations and data

When making a lot of observations, it is often helpful to organise them in a table. Observations and measurements that are organised in tables are easier to read. Tables also make it easier for you to draw graphs.

INQUIRY: INVESTIGATION 1.6

Recording observations in a table

KEY INQUIRY SKILL:

- processing and analysing data and information

Equipment:

test tubes	test-tube rack
50 mL beaker	spatula
eye-dropper	drinking straw
vinegar	sodium bicarbonate
sodium carbonate	copper sulfate
methylated spirits	limewater
starch suspension	iodine solution
safety glasses	

CAUTION: Safety glasses should be worn while conducting these experiments.

- Draw a table like the one below to record your observations in each of the following activities.

Activity	Summary of what was done	Observations
1		
2		
3		
4		
5		

Activity 1

- Pour vinegar into a clean test tube to a depth of about 1 cm. Add a spatula full of sodium bicarbonate.



Activity 2

- Quarter-fill two clean test tubes with water. Add a dry spatula full of sodium carbonate to one test tube. Shake the tube until the sodium carbonate dissolves. Add a dry spatula full of copper sulfate to the other test tube and shake it until the crystals dissolve. Pour the contents of the second test tube into the first.



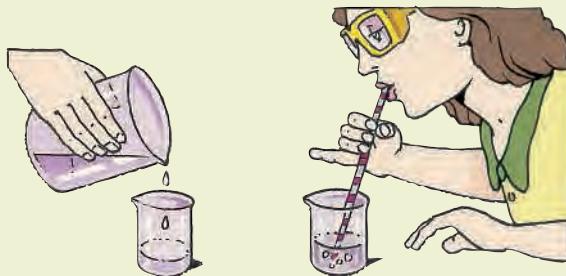
Activity 3

- Use an eye-dropper to put one drop of methylated spirits onto the back of your hand. Blow air gently across the back of your hand.



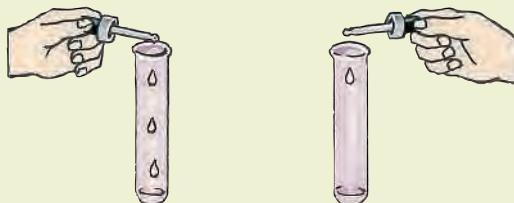
Activity 4

- Quarter-fill a very small beaker with limewater. Gently blow out through a drinking straw into the limewater. Be careful not to share straws.



Activity 5

- Put a few drops of starch suspension in a clean test tube. Add a drop of iodine solution.



CAUTION: Take care not to get iodine solution on your skin or clothes.

DISCUSS AND EXPLAIN

- What senses did you use in making your observations?
- Describe two safety precautions involved in this investigation.
- Explain why it is important to use small quantities of chemicals when doing experiments like these.
- Explain why it is useful to present the observations in a table.
- In activity 4, you had to pour limewater into the beaker. If you took more limewater than required, why is it not a good idea to return any unused limewater to the original bottle?

INQUIRY: INVESTIGATION 1.7

Graphing temperature

KEY INQUIRY SKILL:

- processing and analysing data and information

A line graph is a useful way to present the results of an experiment and gives an overall picture of the results. A line graph can also be used to predict values that occur between, or outside, those measured during an experiment.

The aim of this experiment is to observe how the temperature of water changes while it is heated over a Bunsen burner.

Equipment:

100 mL measuring cylinder

250 mL beaker

Bunsen burner

heatproof mat

matches

tripod

gauze mat

stopwatch

safety glasses

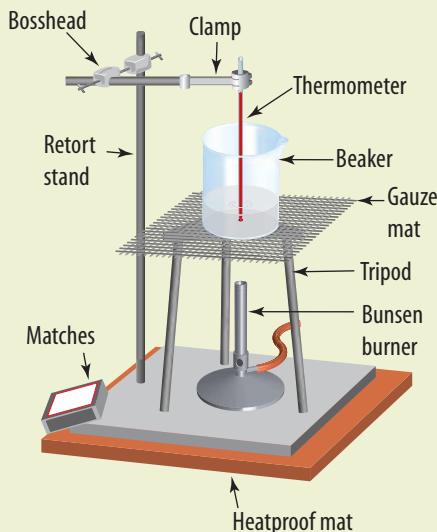
retort stand, bosshead and clamp

thermometer or data logger
and temperature sensor

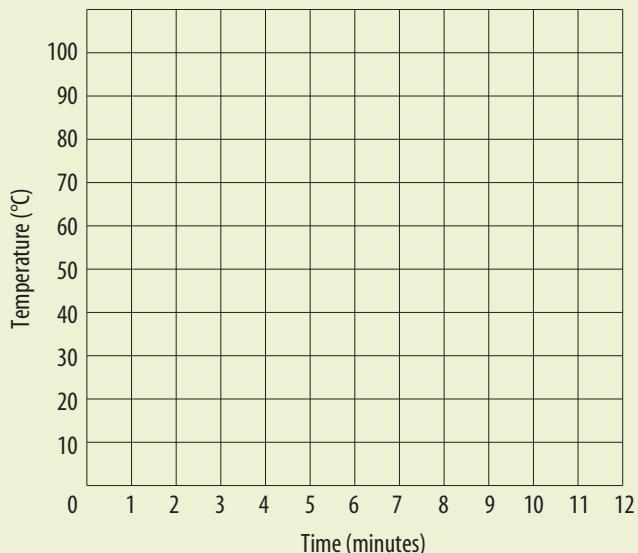
- Use a measuring cylinder to measure 100 mL of water.
- Pour the water into the beaker.
- Set up the equipment as shown in the diagram. Make sure that the bulb of the thermometer is not on the bottom of the beaker or out of the water.
- Wait for a minute to allow the thermometer to adjust to the water temperature.
- Measure the initial temperature of the water and record it in a table. The initial temperature is recorded when time is 0 minutes.

Time (min)	Temp (°C)	Time (min)	Temp (°C)
0		6	
1		7	
2		8	
3		9	
4		10	
5			

- Put your safety glasses on.
- Light the Bunsen burner according to the guide on page 9.
- Open the air hole and heat the beaker over a blue flame.
- Measure and record the temperature of the water every minute for 10 minutes.



- Plot a line graph of the data you have collected on a sheet of graph paper using labels like those below.



- Draw a smooth line near as many points as possible to show the overall trend in the water temperature over time.

DISCUSSION

- Why didn't you record the starting temperature of the water as soon as you poured the water into the beaker?
- Describe in words how the temperature increases.
- How does your graph compare with those of other groups?
- Predict what would happen to the temperature of the water if you continued heating for another two minutes.

Date: 29 February

Dissolving sugar

Aim:

To find out how much sugar will dissolve in hot water compared with cold water.

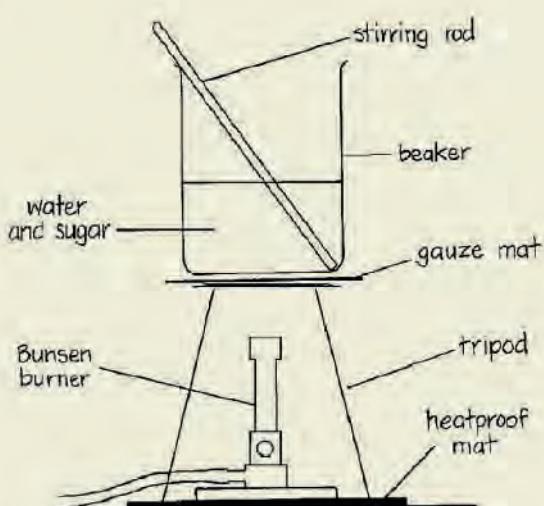
Materials:

Beaker, heatproof mat, Bunsen burner, tripod, gauze mat, matches, spatula, stirring rod, sugar, water.

Method:

A spatula was used to add sugar to 100 mL of cold water in a beaker. The sugar was stirred and more added until no more would dissolve. The amount of sugar dissolved was recorded.

The mixture of sugar and water was heated with a Bunsen burner for 4 minutes and the extra amount of sugar that could be dissolved was recorded.



Results:

Amount of sugar dissolved in cold water = 2 spatulas
Extra amount of sugar dissolved in hot water = 4 spatulas
Total amount of sugar dissolved in hot water = 6 spatulas

Discussion:

I was able to dissolve more sugar in the hot water than in the cold water. A thermometer could have been used to measure the temperature of the water. The amount of sugar could have been measured more accurately by adding smaller amounts at a time.

Conclusion:

Three times as much sugar dissolves in hot water as in cold water.

A good quality report of an experiment

Using technology: spreadsheets

A spreadsheet is a document that stores data in columns and rows. Spreadsheets used to be written on paper by hand. Shopkeepers and bank tellers needed to keep neat handwritten ledgers to record all transactions. Today, computers and software such as Microsoft Excel are used to create and edit spreadsheets. Spreadsheets can also be used to create graphs and charts at the click of a button.

SOME SPREADSHEET TERMINOLOGY

In a spreadsheet, the data is organised in rows and columns. The columns are named using letters (such as column A) and the rows are named using numbers (such as row 3). Cells are the boxes in the spreadsheet. The cell reference tells us which column and row the cell is in. For example, cell B3 is in column B and row 3. The active cell is the cell you will type the data in. In Excel, it has a dark border around it. This is shown in the diagram below.

	A	B	C
1			
2			
3			
4			
5			
6			
7			
8			

Cell B3 is the active cell.

WORKING WITH EXCEL SPREADSHEETS

When you create a spreadsheet, you need to decide how many columns and rows you will need and enter a suitable heading for each column. This is similar to

designing a table. Make sure that you include units where relevant. When using Excel, you can format cells in a variety of ways by using the Format tool.

ENTERING FORMULAE IN EXCEL

If you want to do calculations on the data in a spreadsheet, you need to enter a formula. In Excel, a formula always starts with an equals sign (=). If you want the total of cell A2 and cell B2 to appear in cell C2, you would type the formula '=A2+B2' in cell C2, and then press the [Enter] key. You can also use one of the many functions available in Excel. For example, it is much quicker to use the Average

function to calculate the average of 50 numbers than to type in a formula to add the 50 cells and divide the total by 50. The Insert function button, *fx*, can be used to view the format required for particular functions.

DRAWING GRAPHS AND CHARTS

Drawing a graph using Excel is easy. Just highlight the data you want to graph, click on the Insert tab, select the type of graph you want to draw and then follow the prompts. Remember that a scatter graph (XY chart) is used to plot one set of values against another in Excel.

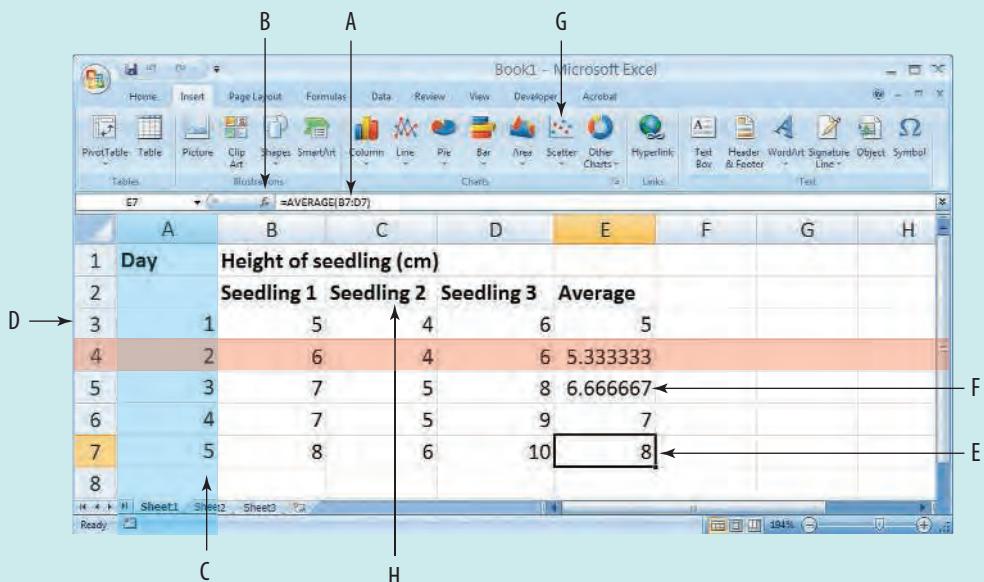
UNDERSTANDING AND INQUIRING

REMEMBER

- 1 Explain why scientists write reports about their experiments.
- 2 Under which heading of your report of an experiment should the following information be included?
 - (a) Suggestions for improvements to your experiment
 - (b) A reason for doing the experiment
 - (c) Graphs and tables
 - (d) A description of what you did
 - (e) A statement saying what you found out by doing the experiment
- 3 Draw a neat, labelled scientific diagram of the following equipment. Water in a conical flask is being heated with a Bunsen burner. The conical flask is supported by a gauze mat on a tripod. The Bunsen burner is standing on a heatproof mat.

UNDERSTAND

- 4 In the screenshot below, identify the letter pointing to:
 - (a) cell C2
 - (b) cell E5
 - (c) the active cell
 - (d) a formula
 - (e) the Insert scatter graph button
 - (f) the Insert function button
 - (g) a column
 - (h) a row.
- 5 List two advantages and two disadvantages of using a computer spreadsheet program to store data rather than keeping handwritten records in a book.



THINK

- 6 Write a full scientific report on Investigation 1.7.
- 7 Draw a neat, labelled scientific diagram of the two sets of equipment that would be needed to safely perform the following activity.

Part 1:

Muddy salt water is being poured from a beaker into a filter funnel (with filter paper). The filter funnel is resting in the opening of a conical flask.

Part 2:

The filtered salt water, now in an evaporating dish, is being heated by a Bunsen burner. The evaporating dish is supported by a gauze mat on a tripod.

- 8 A hypothesis is often included in a scientific report — usually under the ‘aim’ heading, immediately after the reason for carrying out the experiment. What is a ‘hypothesis’?

INVESTIGATE

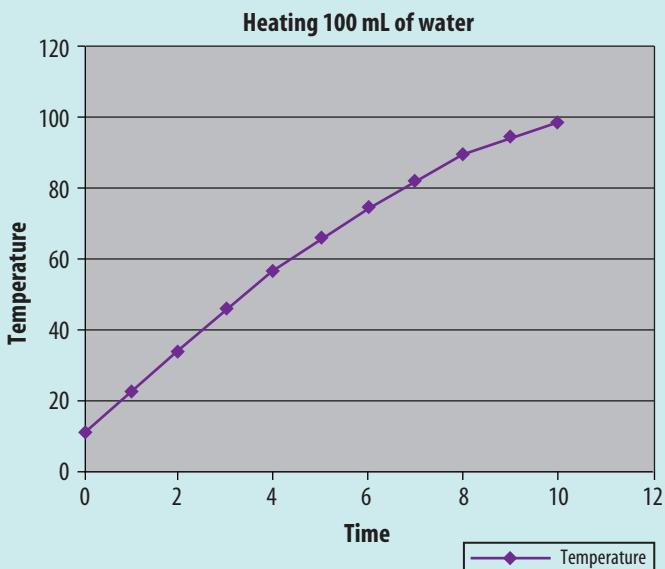
- 9 Design an experiment to investigate whether adding salt to water changes how the temperature rises when the water is heated. Write a scientific report outlining the design of your experiment.

ANALYSING DATA

- 10 (a) Create a spreadsheet with the column headings ‘Time (min)’ and ‘Temperature (°C)’. Enter your data from Investigation 1.7. You should end up with a table similar to the one below.

	A	B
1	Time (min)	Temperature (°C)
2	0	12
3	1	23
4	2	33
5	3	44
6	4	53
7	5	63
8	6	72
9	7	82
10	8	90
11	9	95
12	10	98
13		

- (b) Use your data to create a scatter graph with the points joined by straight lines.
- (c) Create a title for your graph. Label the x-axis ‘Time (min)’ and the y-axis ‘Temperature (°C)’. You should obtain a graph similar to the one above right.



- 11 Use the graph from question 10 to answer the following questions.

- (a) For how long did the experiment run?
- (b) What was the temperature of the water when the experiment began?
- (c) How long did it take for the water to boil?
- (d) How many readings were taken?
- (e) What would you expect the graph to look like after 10 minutes?
- (f) How would you expect the graph to change if only 50 mL of water was heated?
- (g) Sketch a graph of what the predicted results would be for a 200 mL beaker of water. Perform the experiment to check your predictions.

CREATE

- 12 (a) Collect the following data for each student in your class.
 - (i) First name
 - (ii) Gender
 - (iii) Foot length (cm)
 - (iv) Height (cm)
 - (v) Favourite subject
 - (vi) Country where mother was born
- (b) Enter the data you collected into a spreadsheet.
- (c) Click on the Insert tab, then use the Chart function button to construct a scatter graph (without joining points) showing foot length on the x-axis and height on the y-axis.
- (d) Use your graph to decide whether there is a relationship between foot length and height.

SCIENCE AS A HUMAN ENDEAVOUR

- describe how science is used in a range of occupations
- outline some of the branches of science and how they affect everyday life
- distinguish between science and technology

INTRODUCING THE LABORATORY

- identify and use a range of equipment used to perform scientific investigations and collect data
- describe ways to reduce the risk to yourself and others in the laboratory

PLANNING AND CONDUCTING INVESTIGATIONS

- make inferences and testable hypotheses in the light of observations and measurements
- describe a logical procedure for undertaking a controlled experiment
- use repetition of measurement to increase the reliability of data
- form conclusions based on experimental results
- reflect on your methods and make suggestions for improvements to your investigations
- use a scientific report with clear diagrams where necessary to describe your investigations and their findings

PROCESSING AND ANALYSING DATA AND INFORMATION

- make and accurately record observations and measurements using the appropriate equipment
- organise data clearly using tables
- construct an appropriate type of graph (e.g. column graph, pie chart, line graph) to present your data
- use tables and graphs to identify trends and patterns, and assist in the formation of conclusions
- identify data that supports or discounts a hypothesis

INDIVIDUAL PATHWAYS

eBook plus

Activity 1.1
Investigating
[doc-6075](#)

Activity 1.2
Analysing
investigations
[doc-6076](#)

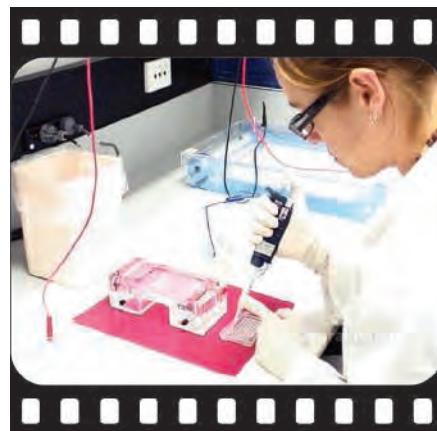
Activity 1.3
Designing
investigations
[doc-6077](#)

Summary

eLESSONS

Career spotlight: scientist

In this video lesson, you will meet marine biologist Jodie Haig and learn what it takes to be a scientist working in the marine environment. With insight into her work in the lab and in the field, you will get some useful advice to help you decide if this could be an attractive career for you.

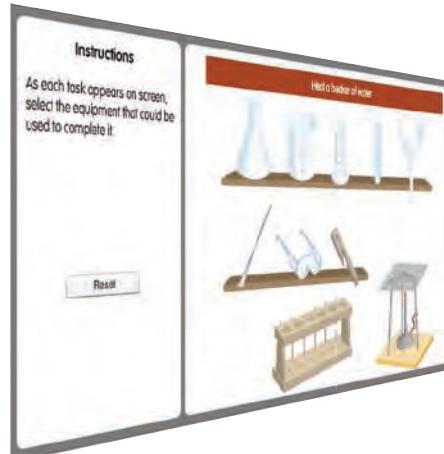


Searchlight ID: eles-0053

INTERACTIVITIES

Using equipment

In this interactivity, you are given a number of scientific processes and you must indicate which equipment from a selection of items commonly found within a laboratory you would use to complete the processes. Instant feedback is provided.



Searchlight ID: int-0200

Reading scales

This interactivity challenges your knowledge of scales by testing your skill in identifying temperatures on a number of different thermometers. Instant feedback is provided.

Searchlight ID: int-0201

LOOKING BACK

1 Match the following scientists with their work.

Scientist	Work
(a) Physicist	(A) Investigates how rocks and mountains form
(b) Chemist	(B) Studies living things
(c) Biologist	(C) Explains things like movement, heat and light
(d) Astronomer	(D) Studies how substances react with others
(e) Earth scientist	(E) Studies the sky

2 What does each of the following scientists study?

- (a) Seismologist
- (b) Biochemist
- (c) Entomologist
- (d) Botanist
- (e) Zoologist
- (f) Vulcanologist

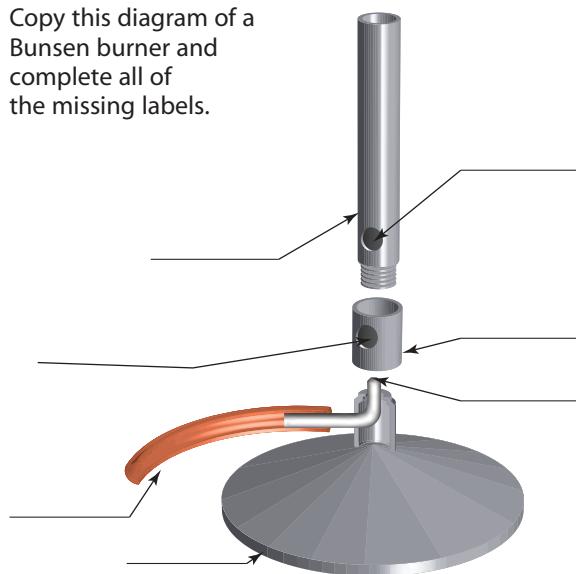
3 Which of the scientists listed in question 2 could be correctly described as geologists?

4 Indicate whether each of the following actions is a 'do' or a 'don't' in the science laboratory.

- Wear safety glasses while mixing chemicals.
- Pour all substances down the sink when finished with them.
- Run in the science laboratory.
- Drink water from the taps in the science laboratory.
- Tie long hair back before using a Bunsen burner.
- Wait until the end of the lesson to tell your teacher that you have burnt yourself.

5 Write a list of all of the equipment that you would need to boil water in a beaker in your science laboratory. Draw a labelled scientific diagram to show the equipment in use.

6 Copy this diagram of a Bunsen burner and complete all of the missing labels.



7 Rewrite the following sentences correctly by selecting the appropriate words in *italics*.

- (a) When lighting a Bunsen burner, light the match *before/immediately after* turning on the gas.

- (b) When using a thermometer to measure the temperature of a liquid as it is heated, place the bulb of the thermometer on the *bottom/near the centre* of the beaker.
- (c) When heating a test tube, hold the test tube using *tongs/a test-tube holder* at the *top/middle* of the test tube and *keep it steady/move it back and forth* over the flame.

8 The steps used to light a Bunsen burner can be displayed as a flowchart, as shown below. Use the information in the flowchart to construct a storyboard with six scenes to show how a Bunsen burner is lit correctly and safely.

Lighting a Bunsen burner

Place the Bunsen burner on a heatproof mat.

Check that the rubber tubing is connected properly to the gas tap.

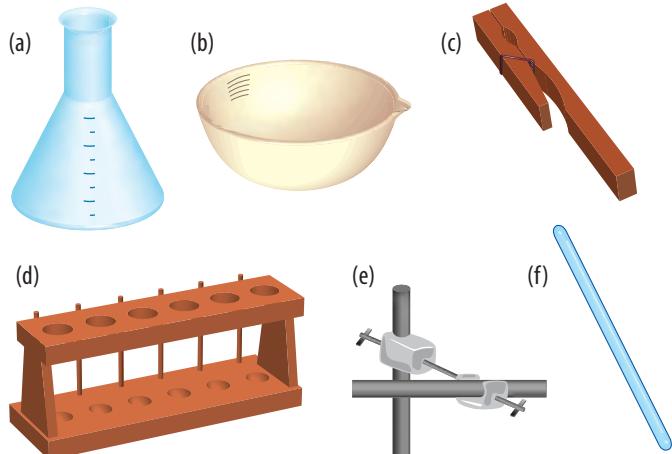
Ensure that the air hole is closed.

Light the match.

Open the gas tap.

Hold the burning match just above the top of the barrel.

9 Name each of the items of equipment below.



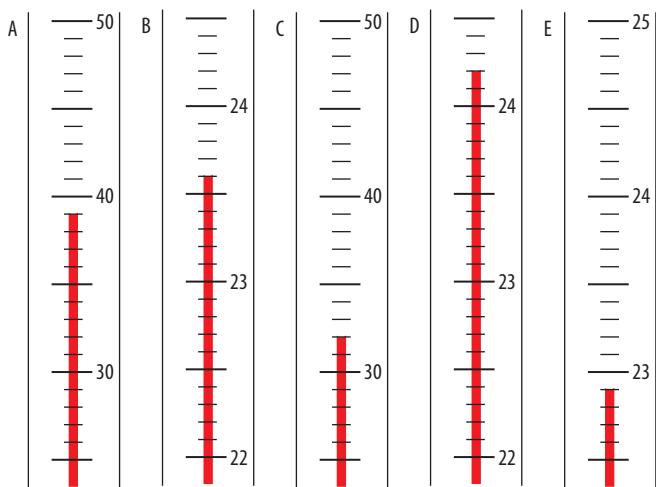
10 Kimberley and Glenn were walking past their neighbour's house when they noticed that a front window was broken. Glenn told Kimberley that somebody had probably thrown a ball through the window. They had a closer look and noticed clothes scattered all over the floor and drawers open. Kimberley noticed some blood on the broken glass. She told Glenn that the house had been burgled. Glenn agreed and they called the police.

- List the observations that were made.
- Who made an inference?
- What was the inference and why was it suggested?
- What conclusion was reached by Kimberley and Glenn?
- Suggest a different conclusion based on the observations that were made.

11 What item of equipment would you use to measure:

- the temperature of hot water
- the mass of a small beaker of water
- the volume of a small quantity of water?

12 What is the temperature measured by each of the thermometers shown below?



13 What is the mass measured by the four-arm beam balance shown below?

0					100			200
10	20	(30)	40	50	60	70	80	90
1	2	3	4	(5)	6	7	8	9
0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8



14 Identify which of the following is an important safety rule in science.

- When smelling chemicals, place your nose carefully over the container.
- Dispose of all materials in the rubbish bin.
- When reading the volume of a liquid, always read the bottom of the meniscus.
- Point test tubes away from your eyes and away from your fellow students.

15 Equipment used for measuring the volume of liquids includes:

- conical flask, beaker, measuring cylinder.
- measuring cylinder, crucible, beaker.
- watchglass, filter funnel, conical flask.
- evaporating basin, test tube, beaker.

16 Luke was sick and tired of being bitten by mosquitoes. He counted several bites each evening when he sat outside to have dinner. He had heard that a burning citronella candle was a good way to keep mosquitoes away. Design an experiment to test Luke's idea. Identify the independent and dependent variables and the controlled variables needed to make this a fair test. Suggest a control for your experiment.

17 Huang and Tina conducted an investigation to find out whether radish plants grow better in the shade. They placed three seedlings under a verandah at the back of the house and another three in a sunny place in the front yard. All plants were planted in the same soil and were watered equally each day. Huang and Tina measured the height of each plant and the number of healthy leaves at the same time every second day.

- What was the independent variable in the investigation?
- What were the dependent variables?
- List the variables that should have been controlled.
- How could Huang and Tina improve the design of their experiment? List as many improvements as possible.
- In your opinion, did Huang and Tina conduct a fair test? Give reasons for your opinion.

18 Now that you've spent some time working on this chapter, think about the best way to describe a scientist.

- Draw a picture of your own image of a 'typical' scientist.
- Write your own description of a 'typical' scientist.
- Write a comment about how your image of a scientist has changed since you started working on this chapter.

Bigger, better beans

SEARCHLIGHT ID: PRO-0091

Scenario

The local agricultural show will be running its annual competition to find the biggest bean plant and you are determined that this year you are going to win. In previous years, you have just planted your seeds in their pots, added some fertiliser, put them in the sun and watered them every day but, while the plants did grow, they didn't grow big enough to have a chance at the prize. As a good science student, you know that the growth of plants depends upon the process of photosynthesis, whereby light energy from the sun causes water and nutrients and carbon dioxide to be combined by the plant to produce oxygen and starch (which is a form of chemical potential energy). The plant then uses this starch to grow. So, if the growth of the plants depends upon how much starch is produced, maybe there's something you could do to the plants that would make them produce more starch and grow faster and bigger?



Your task

You will design and carry out an investigation that will test a number of different growth conditions (for example, different amounts of sunlight or different substances added to the soil) to determine which will give the greatest rate of growth over a three-week period of time. Your findings will be presented in the form of a scientific report.

Process

- Open the ProjectsPLUS application for this chapter located in your eBookPLUS. Watch the introductory video lesson and then click the 'Start Project' button to set up your project group. You can complete this project individually or invite other members of your class to form a group. Save your settings and the project will be launched.
- Navigate to your Research Forum. Here you will find some topic headings that you can use to start your research. As you find more information and different research topics suggest themselves, you may add new topic headings.
- Start researching. Make notes of information that you gather that will provide background for your investigation and direct its design. Enter your findings as articles under your topic headings in

the Research Forum. You should each find at least three sources (other than the textbook, and at least one offline such as a book or encyclopaedia) to help you discover extra information about factors that may influence the growth of your bean plants. You can view and comment on other group members' articles and rate the information that they have entered. When your research is complete, print out your Research Report to hand in to your teacher.

- Design your investigation by determining what will be the dependent, independent and controlled variables, the use of controls and repeated measurements, what substances you will test and how you will measure the plants' growth rates.



SUGGESTED SOFTWARE

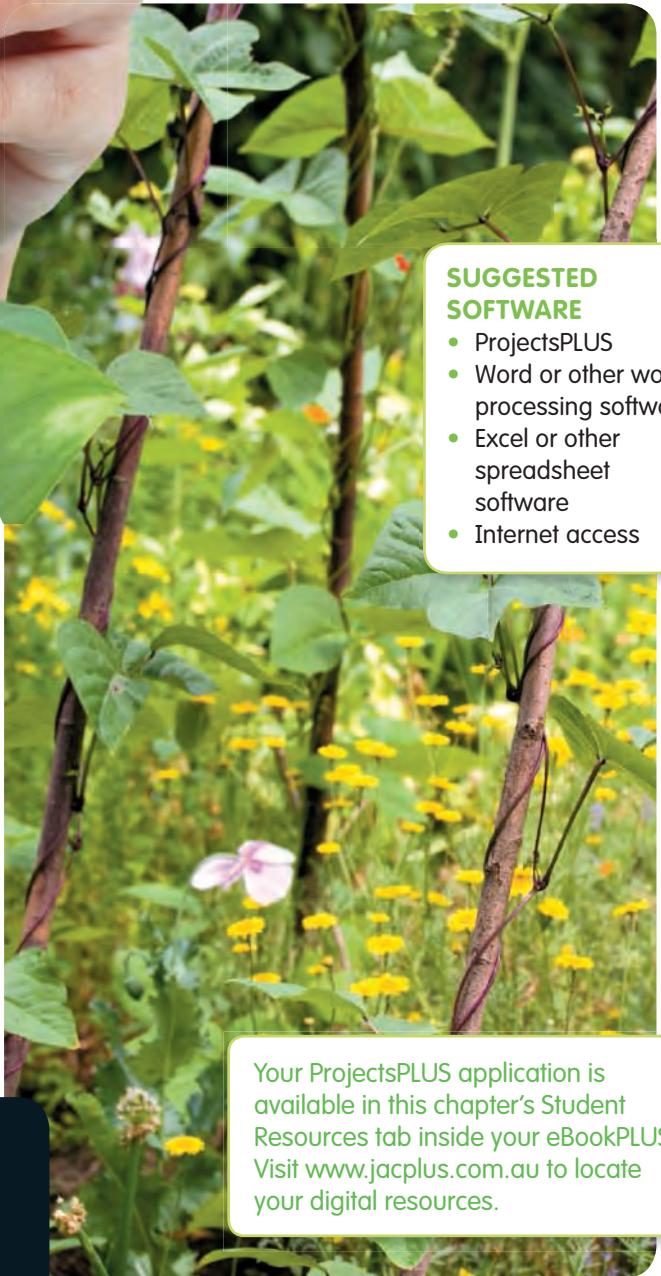
- ProjectsPLUS
- Word or other word processing software
- Excel or other spreadsheet software
- Internet access

- Perform your investigation. Take photographs during your investigation for inclusion in your report.
- Visit your Media Centre and download the report template to help you build your experimental report. In each section of the template, you will find directions as to what information should be included in each report section. Delete these directions as you complete each section. You will also find an Excel spreadsheet that you may use to enter your data from your investigation as you go and that will allow you to produce a line graph of your results. The table and the graph can then be copied and pasted into your report. Your Media Centre also includes images that you may like to use in your report.

MEDIA CENTRE

Your Media Centre contains:

- a report template
- an Excel spreadsheet
- a selection of images
- an assessment rubric.



Your ProjectsPLUS application is available in this chapter's Student Resources tab inside your eBookPLUS. Visit www.jacplus.com.au to locate your digital resources.

eLesson

GROWING PLANTS IN AUSTRALIA

This video lesson is presented by a top Australian horticulturalist and provides you with tips for successfully growing plants in Australia. Watch this video as an introduction to your experiments with plants.

Searchlight ID: eles-0055

