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How to use this book

PEARSON science 8 Activity Book

PEARSON science 8 Activity Book is an integral part of the Australian Curriculum series PEARSON science. It caters for a variety of learning styles and will reinforce, extend and enrich learning initiated through the student book. Clear references within the student book indicate when a worksheet is best completed.

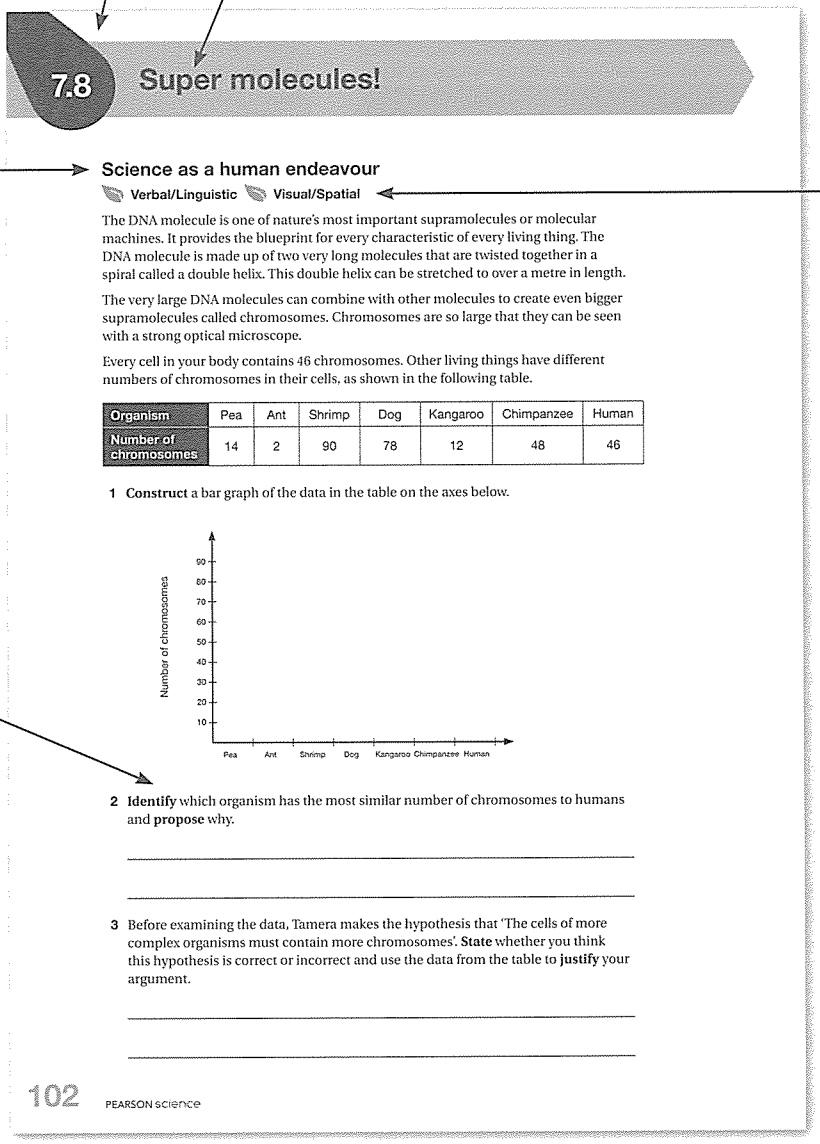
PEARSON science 8 Activity Book is designed for independent use by students and is suitable for in-class use or as a complete homework program.

Worksheet number and title

Indicates the curriculum strand or strands targeted by the worksheet

Indicates which learning style or styles the worksheet is focusing on

Verbs in bold assist students to interpret the intent of a question and the scope of the answer required.



7.8 Super molecules!

Science as a human endeavour

Verbal/Linguistic Visual/Spatial

The DNA molecule is one of nature's most important supramolecules or molecular machines. It provides the blueprint for every characteristic of every living thing. The DNA molecule is made up of two very long molecules that are twisted together in a spiral called a double helix. This double helix can be stretched to over a metre in length.

The very large DNA molecules can combine with other molecules to create even bigger supramolecules called chromosomes. Chromosomes are so large that they can be seen with a strong optical microscope.

Every cell in your body contains 46 chromosomes. Other living things have different numbers of chromosomes in their cells, as shown in the following table.

Organism	Pea	Ant	Shrimp	Dog	Kangaroo	Chimpanzee	Human
Number of chromosomes	14	2	90	78	12	48	46

1 **Construct** a bar graph of the data in the table on the axes below.

2 **Identify** which organism has the most similar number of chromosomes to humans and **propose** why.

3 Before examining the data, Tamera makes the hypothesis that 'The cells of more complex organisms must contain more chromosomes'. **State** whether you think this hypothesis is correct or incorrect and use the data from the table to **justify** your argument.

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Verbs

The verbs below, based on Bloom's Taxonomy, appear in **bold** text throughout this book. The verbs help students know the level of response required for a question and provide a common language and consistent meaning in the Australian Curriculum documents.

Remembering	
enter	Place data into a computer program by key strokes or copying from a digital source, e.g. CD, DVD, USB storage device
label	Add annotations to a diagram or drawing
list	Write down phrases or items only without further explanation
name	Present remembered ideas, facts or experiences
present	Provide information for consideration
recall	Present remembered ideas, facts or experiences
record	Store information and observations for later
specify	State in detail
state	Provide information without further explanation
Understanding	
account	Account for—state reasons for, report on. Give an account of—narrate a series of events or transactions
calculate	Ascertain/determine from given facts, figures or information (simply repeating calculations that are set out in the text)
clarify	Make clear or plain
define	State meaning and identify essential qualities
describe	Provide characteristics and features
determine	Find out the size or extent, either by using an equation, counting, estimating, or similar method
discuss	Identify issues and provide points for and/or against
draw	Use a pencil to produce a likeness onto a page, or sketch to provide a representation or view
explain	Provide a sequence to make the relationships between things evident; provide why and/or how
extract	Choose relevant and/or appropriate details
gather	Collect items from different sources
modify	Change in form or amount in some way
outline	Sketch in general terms; indicate the main features
predict	Suggest what may happen based on available information
produce	Provide
propose	Put forward for consideration or action
rank	Place in order of size, age, or as instructed
recount	Retell a series of events
summarise	Express, concisely, the relevant details
write	Compose or construct a sentence that explains a feature

Applying	
apply	Use, utilise, employ in a particular situation
calculate	Ascertain/determine from given facts, figures or information
demonstrate	Show by example
examine	Inquire into
identify	Recognise and name
use	Employ for some purpose
Analysing	
analyse	Identify components and the relationship between them; draw out and relate implications
calculate	Ascertain/determine from given facts, figures or information (requiring more manipulation than simply applying the maths)
classify	Arrange or include in classes/categories
compare	Show how things are similar or different
contrast	Show how things are different or opposite
critically (analyse/ evaluate)	Add a degree or level of accuracy, depth, knowledge and understanding, logic, questioning, reflection and quality to (analyse/ evaluate)
discuss	Identify issues and provide points for and/or against
distinguish	Recognise or note/indicate as being distinct or different from; to note differences between
infer	Recognise and explain patterns and meaning and relationships
interpret	Draw meaning from
research	Investigate through literature or practical investigation
Evaluating	
appreciate	Make a judgement about the value of
assess	Make a judgement of value, quality, outcomes, results or size
conclude	Come to a judgement or result based on the reasoning or arguments that you present
critically (analyse/ evaluate)	Add a degree or level of accuracy, depth, knowledge and understanding, logic, questioning, reflection and quality to (analyse/ evaluate)
deduce	Draw conclusions
evaluate	Make a judgement based on criteria; determine the value of
extrapolate	Infer from what is known
justify	Support using an argument or conclusion
propose	Put forward (for example a point of view, idea, argument, suggestion) for consideration or action
recommend	Provide reasons in favour
select	Choose one or more items, features, objects
Creating	
construct	Make; build; put together items or arguments
design	Provide steps for an experiment or procedure
investigate	Plan, inquire into and draw conclusions about
synthesise	Put together various elements to make a whole

1.1 Spot the difference

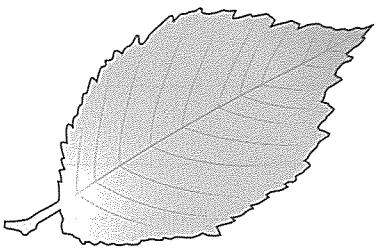
Science inquiry

Visual/Spatial Logical/Mathematical

Scientists need to be able to pick out the similarities and differences in what they see around them. These similarities and differences allow them to classify all sorts of things such as rocks, stars, chemicals and living organisms.

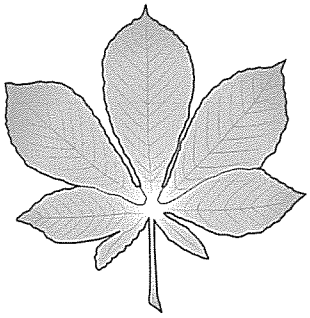
Compare the following pairs of organisms by **listing** their similarities and differences.

a



Similarities

b



Differences

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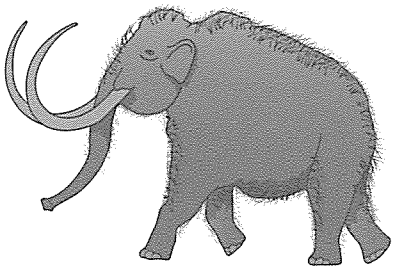
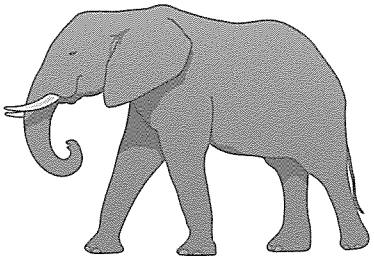
c



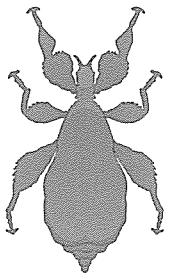
Similarities

d



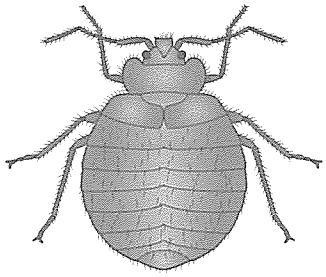
Differences

e



Similarities

f



Differences

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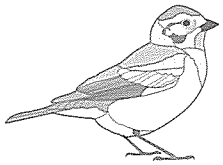
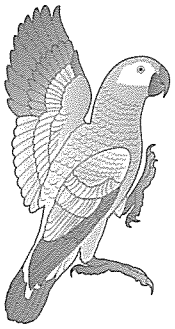
g



Similarities

h



Differences

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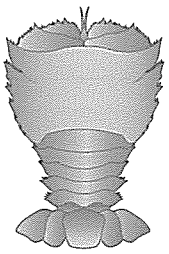
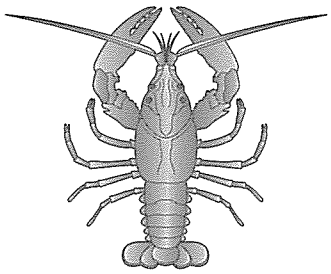
i



Similarities

j



Differences

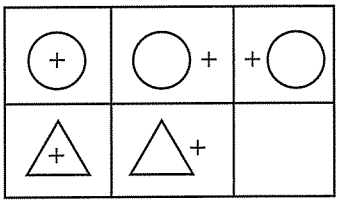
1.2 Patterns in observations

Science inquiry

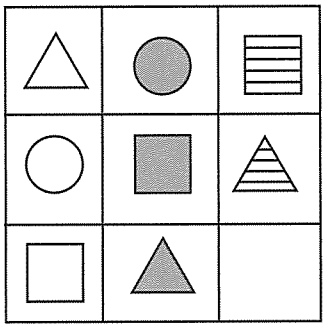
Visual/Spatial **Logical/Mathematical**

Scientists not only need to carefully observe the world around them but must also be able to recognise patterns in what they see. In each of the following, use the patterns to **predict** the final missing design.

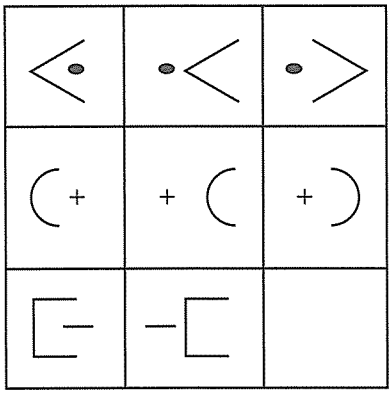
a



b



c



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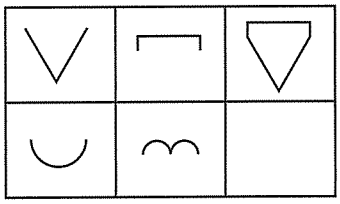
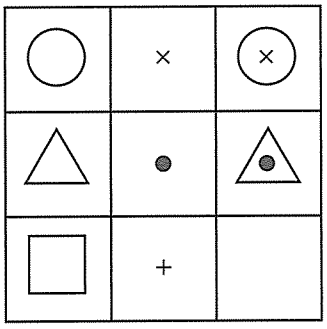


e



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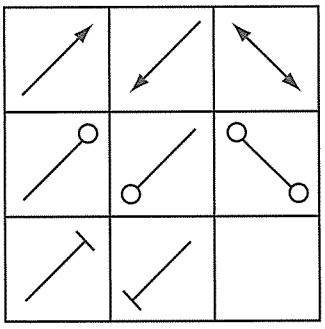
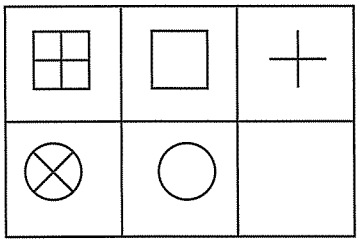
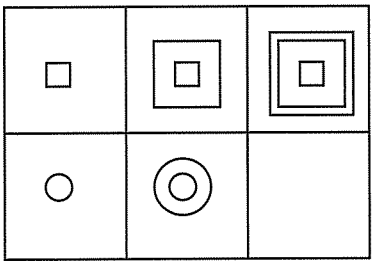


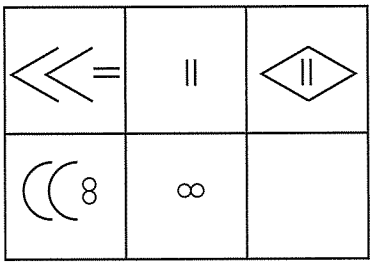
g



h



i



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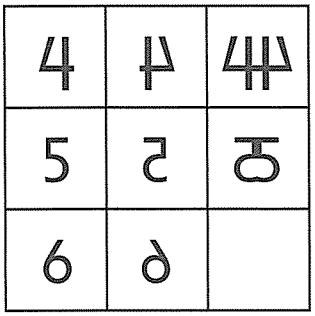
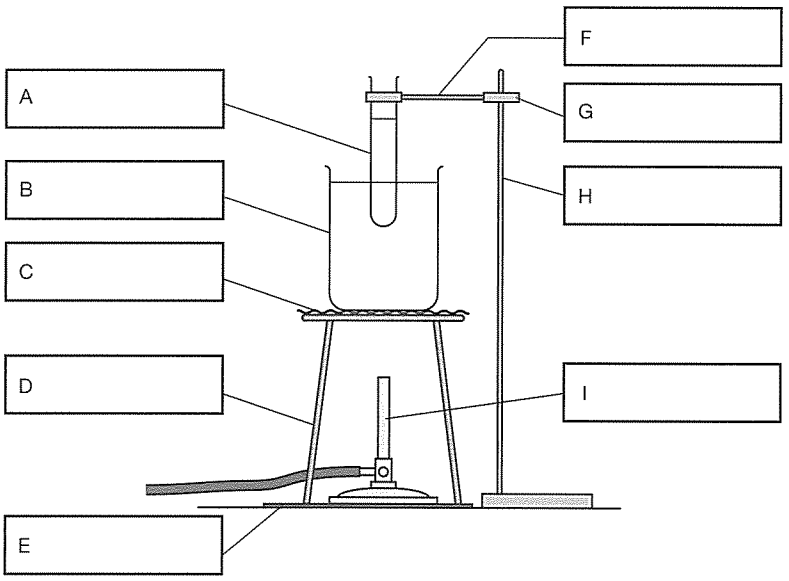


1.3 Equipment

Science understanding

Verbal/Linguistic **Visual/Spatial**

Scientists rarely draw realistic three-dimensional (3D) diagrams of the equipment they use. Instead, they draw simple two-dimensional (2D) diagrams showing each piece of equipment as a cross-section. One such diagram is shown below.



tripod
Bunsen burner
beaker
conical flask
test-tube
filter paper
retort stand
bosshead
funnel
clamp
bench mat
gauze mat

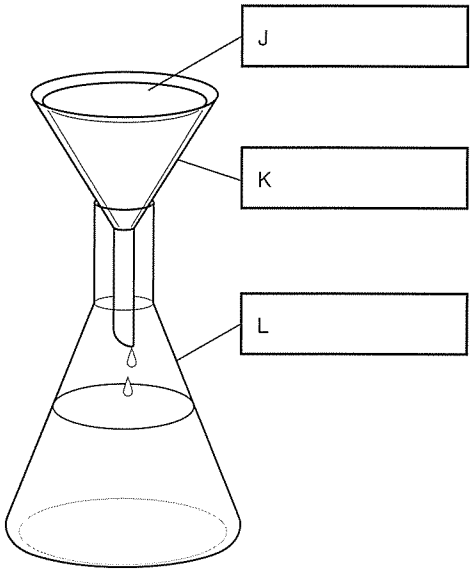
1 **Use** words from the box to label all the pieces of equipment shown above.

2 **Propose** what this arrangement of equipment might be used for.

_____

_____

3 Below is another experiment, this time drawn in a realistic 3D manner. **Use** words from the box to label all the pieces of equipment, and then a 2D diagram of this set-up in the space provided.



1.4 Can you follow instructions?

Science inquiry

Verbal/Linguistic

To complete this activity you need to follow the instructions given below as quickly as you can.

Instructions

1 Don't do anything until you have carefully read every instruction.

2 Write your full name in capitals. _____

3 Circle your surname.

4 **Name** the capital city of Australia. _____

5 Fold over one of the top corners of this page.

6 **State** how many kangaroos are on the $1 coin. _____

7 Complete the following diagram to **construct** a hexagon (six sides).

8 **Specify** which Australian coin has a platypus on it. _____

9 **Construct** a diagram of a smiley face in the bottom right corner of this page.

10 **Name** Australia's current Prime Minister. _____

11 **Calculate** the answer to 345 + 289 + 365. _____

12 **State** today's date. _____

13 **Specify** the value of the Australian banknote that is red in colour. _____

14 **Construct** a diagram of the letter E but back-to-front, so that it appears as if it is reflected in a mirror.

_____

15 Arrange the following numbers in order from smallest to biggest: 21, 8, 64, 19, 3.

_____

16 **Construct** a diagram of a square in the bottom left corner of this page.

17 Write the number 8 in the square.

18 **Calculate** the answer to 1 × 2 × 3 × 4 × 5. _____

19 **Name** the Australian state that is also an island. _____

20 Ignore all the above instructions except Instructions 1, 2 and this one.

1.5 Mega quantities

Science inquiry

Bodily/Kinaesthetic **Visual/Spatial** **Logical/Mathematical**

Scientists use metric units to measure quantities. The basic units scientists use are metre (m), gram (g) and litre (L). However, sometimes these units are too small to measure extremely large quantities. Likewise, at other times these units are too large to measure really small quantities. This is when unit prefixes such as kilo (k), mega (M), giga (G), centi (c), milli (m), micro (μ) and nano (n) are used.

Mega (symbol M) is the prefix for a million. For example, 1 megalitre (ML) of water is the same as 1 million litres and 1 megatonne (Mt) represents 1 million tonnes. The prefix mega can be attached to anything. For example, 1 megapeople would represent 1 million people and so Australia has a population of around 20 megapeople. Likewise, you would be rich if you won 1 megadollar ($1 M).

The following three tasks will give you some idea of how big a million or a mega is.

Task 1: A million letters

1 For this task, you need a novel. Estimate how many pages will contain 1 000 000 letters.

Estimate = _____ pages.

2 Once you've made your estimate, turn to a page in the novel that is all text with no pictures. Don't pick the first or last page of a chapter because they usually aren't a full page. Count the number of letters in the first, second and third lines on the page. Record your results in the table on the next page.

3 Find the average number of letters in one line by adding your three numbers and dividing by 3.

$$\text{Average letters per line} = \frac{\text{line 1} + \text{line 2} + \text{line 3}}{3}$$

4 Count how many lines there are on one page and then find the average number of letters on 1 page.

Average letters per page = average letters per line × number of lines on 1 page

5 Calculate how many pages would be equivalent to 1 000 000 letters by dividing 1 000 000 by the average number of letters on one page.

$$\text{Number of pages} = \frac{1\,000\,000}{\text{average per page}}$$

6 Place all your results in the following table.

Letters on line 1	
Letters on line 2	
Letters on line 3	
Average letters in 1 line	
Lines on 1 page	
Average number of letters on 1 page	
Number of pages that make up 1 000 000 letters	

7 **Compare** your estimate with the number of pages calculated above.

_____

Task 2: A million heartbeats

8 Estimate how long it would take for your heart to beat 1 000 000 times.

Estimate = _____ minutes, hours or days

9 **Construct** a method showing how you could calculate how many days it would take for your heart to beat 1 000 000 times (the table below might give you some ideas how this could be done). Write your method below.

_____

_____

_____

_____

_____

10 Carry out your method, recording all the results in the following table.

Average beats per minute	
Beats per hour	
Beats per day	
Days taken for 1 000 000 beats	

11 **Compare** your estimate with the number of days calculated in the table above.

_____

_____

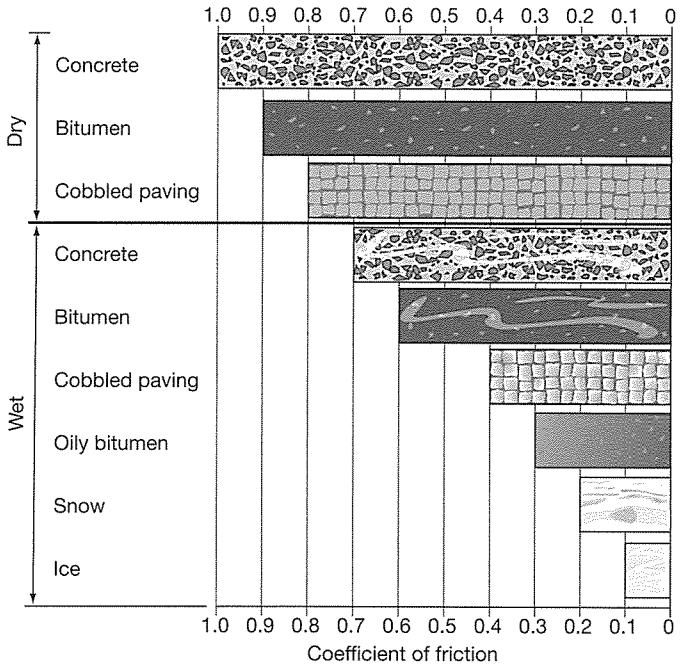
1.6 Analysing graphs

Science inquiry

Visual/Spatial Logical/Mathematical

Friction

Friction is the force that causes your bike to slow down and is the force that stops a car at the traffic lights. For a bike or a car, friction depends on the type of tyres and the type of surface you are travelling on. Some surfaces are extremely smooth and have low friction while others are very rough and have a lot of friction. The coefficient of friction measures how rough a surface is. This bar graph shows the coefficients of friction for different types of road surfaces.



1 **Use** the bar graph to rank the different surfaces in order from the surface that provides the most friction to the surface that provides the least.

_____

2 **Identify** the surface on which it would be:

(a) easiest to stop _____

(b) most difficult to stop _____

3 **Identify** which surface would produce the biggest skids. **Justify** your choice.

_____

4 Friction also allows you to get moving. Without it, your bike wheel would just spin on the spot. **Identify** the surface on which it would be:

(a) easiest to get moving _____

(b) most difficult to get moving _____

5 **Compare** the coefficients of friction of the following road surfaces.

(a) Dry bitumen, wet bitumen and oily bitumen _____

(b) Snow and ice _____

(c) Dry concrete and ice _____

(d) Dry concrete and wet concrete _____

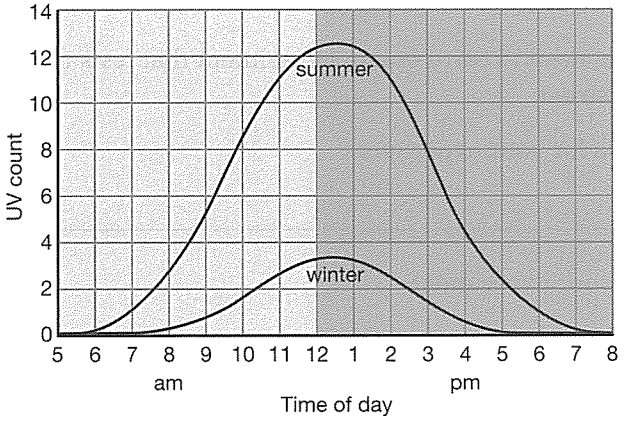
(e) Dry cobbled paving and wet cobbled paving _____

6 **Propose** what material roads should be made from.

_____

UV counts

Ultraviolet (UV) radiation from the Sun is known to cause skin cancers. The amount



of UV radiation falling on Australia depends on the time of year and the time of day. This variation is shown as the UV count in the following line graph.

7 **Use** the line graph to state the UV count for:

(a) maximum UV radiation in summer _____

(b) maximum UV radiation in winter _____

8 Any exposure to UV radiation can be dangerous but exposure to UV counts of 6 or above puts you at a much higher risk. **State** the times of the day at which the UV count is 6 or above in:

(a) January _____ **(b)** July _____

9 **Propose** why the UV counts in January are higher than those in July.

_____

10 **State** the times at which the UV count is zero in:

(a) summer _____ **(b)** winter _____

11 **Propose** why the UV count drops to zero much later in summer than in winter.

_____

1.7 Planning your own experiment

Science inquiry

Verbal/Linguistic **Logical/Mathematical**

Imagine that you have been given the task of finding what influences the time it takes for a parachute to drop.

1 **List** as many variables as you can think of that *might* influence the drop time of a parachute.

2 the variable that you think will have the biggest influence on a parachute's drop time.

3 Imagine that you now need to carry out an experiment that tests this variable. Before you start, **construct**:

(a) an aim or purpose for your experiment

(b) a hypothesis for your experiment

(c) a list of materials and equipment you will need

(d) a step-by-step method or procedure of how you will carry out your experiment. (Remember that you should only change the variable you are testing.) Your method should give enough detail so that another Year 8 student would be able to carry out your experiment without needing to guess anything.

1.8 Investigating the pendulum

Science inquiry, Science as a human endeavour

Visual/Spatial Logical/Mathematical

Refer to the Science as a Human Endeavour on pages 30 and 31 of your student book to answer the following questions. A pendulum is a mass on the end of a string, cable, chain or bar that repeatedly swings back and forth.

1 **Recall** definitions by matching each of the following terms with their correct description by joining them with a line.

(a) Bob	The number of swings a mass completes every second
(b) Period	The unit used to measure frequency
(c) Frequency	The time it takes for a mass to swing back and forth once
(d) Hertz	The swinging mass of a pendulum

Nathan was investigating the variables that affected how a pendulum swung. The results he obtained in one experiment are shown below.

Mass (g)	String length (cm)	Angle swung from	Time for 10 swings (s)				Period = average time for one swing (s)
			Time 1	Time 2	Time 3	Average	
150	20	30°	9.12	8.95	9.08		
150	40	30°	12.53	13.12	12.74		
150	60	30°	16.30	16.03	15.25		
150	80	30°	18.41	18.84	18.38		
150	100	30°	19.89	20.11	20.87		

2 From these results, **identify** his:

(a) independent variable (the variable that Nathan decided to alter in his experiment)

_____

(b) controlled variables (the variables that Nathan kept the same throughout the experiment)

_____

(c) dependent variable (the variable that changed naturally as Nathan changed other variables in his experiment)

_____

3 **Calculate** Nathan's missing values to complete his results table.

4 **Propose** a reason why Nathan measured 10 swings each time and not just one swing.

_____

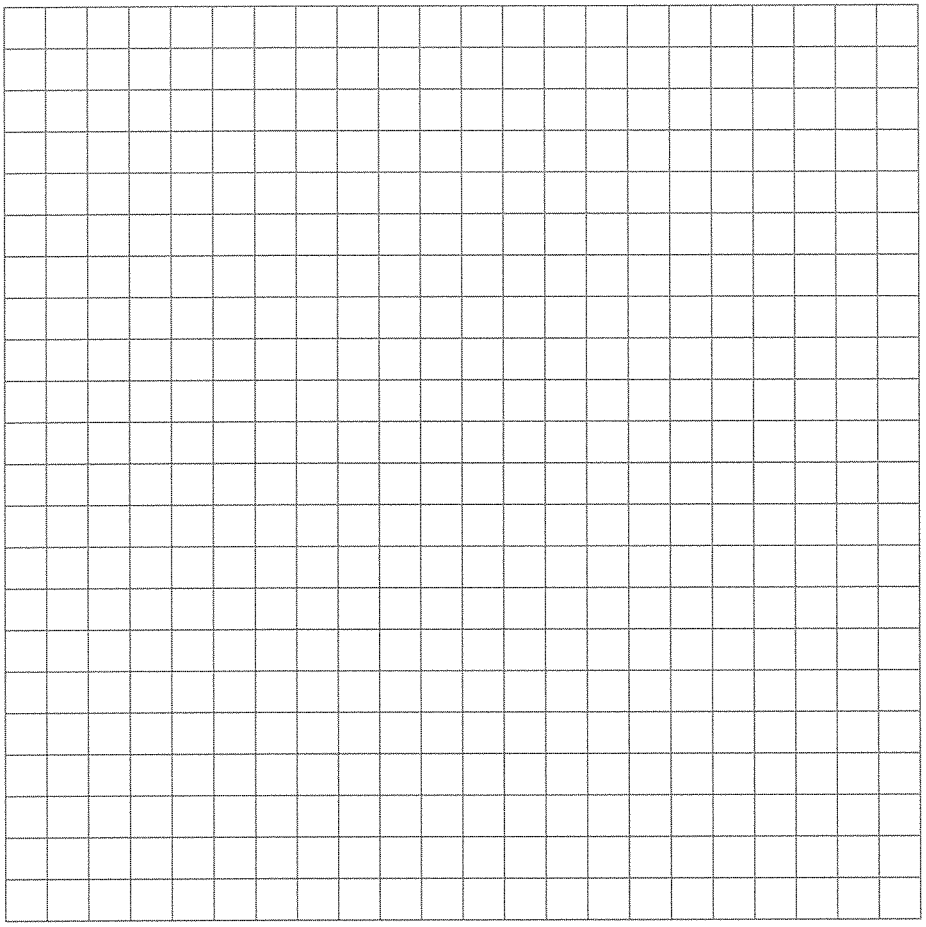
_____

5 Nathan measured each set of swings three times and then took an average. **Explain** the advantage of this.

_____

_____

6 On the graph axes below, **construct** a line graph showing period versus length for Nathan's experiment.



7 From the following sentences, **identify** the best conclusion to Nathan's experiment.

A The length of a pendulum does not affect the period of a pendulum.

B If the length of a pendulum doubles, then its period also doubles.

C As the length of the pendulum increases, its period increases at an increasing rate (i.e. it keeps on increasing and increasing).

D As the length of the pendulum increases, its period increases but at a lesser rate than before (i.e. it flattens out).

_____

1.9 Literacy review

Science understanding

Verbal/Linguistic

Use the clues below to **identify** the missing words.

1 The mean. Add up all the good values and divide by how many there are.

A _ _ _ _ _ _

2 The method for an experiment P _ _ _ _ _ _ _ _ _

3 A type of error caused by looking at a measurement from a slight angle

P _ _ _ _ _ _ _

4 An observation made using numbers Q _ _ _ _ _ _ _ _ _ _ _ _

5 An observation that has no numbers but uses a description or diagram

Q _ _ _ _ _ _ _ _ _ _

6 A resource list is sometimes called this B _ _ _ _ _ _ _ _ _ _ _

7 The purpose of an experiment A _ _

8 Logical extension of a graph E _ _ _ _ _ _ _ _ _ _ _ _

9 An educated guess about what might happen H _ _ _ _ _ _ _ _ _

10 A boy's name but also the swinging mass at the end of a pendulum B _ _

11 The number of swings a pendulum makes in a second

F _ _ _ _ _ _ _ _

12 A factor that might influence what happens in an experiment

V _ _ _ _ _ _ _

13 A short summary of what was found out in an experiment

C _ _ _ _ _ _ _ _ _

14 The last part of the address of a webpage D _ _ _ _ _

15 Data that you collect yourself in an experiment F _ _ _ _ _ _ _ _

16 Altering an electronic scale so that it reads zero T _ _ _

17 Often confused with errors. Can be avoided with care M _ _ _ _ _ _ _

18 Slight changes in measurements that occur naturally, regardless of how careful you are

E _ _ _ _ _

19 Measurements and observations about something D _ _ _

20 Something that swings back and forth, used to control timing of grandfather clocks and metronomes

P _ _ _ _ _ _ _

1.9

Once you have identified the missing words, find and highlight them in the wordfind below.

T	P	A	Y	K	E	X	P	L	B	S	G	E	B	E
H	S	R	T	H	K	L	Q	O	I	I	X	M	F	V
O	E	Q	O	A	P	Z	B	S	I	T	H	I	D	I
F	K	A	C	C	D	A	E	A	R	Q	R	A	O	T
R	A	I	V	W	E	H	R	A	I	S	J	E	M	A
E	T	J	Y	E	T	D	P	G	T	R	R	V	A	T
Q	S	C	I	O	R	O	U	H	O	R	A	W	I	I
U	I	D	P	G	L	A	A	R	O	I	C	V	N	L
E	M	Y	F	A	E	N	G	R	E	A	L	H	L	A
N	H	M	T	M	D	Y	S	E	J	I	H	B	O	U
C	N	I	C	O	N	C	L	U	S	I	O	N	I	Q
Y	O	E	V	I	T	A	T	I	T	N	A	U	Q	B
N	Y	N	G	U	N	X	X	A	L	L	A	R	A	P
P	E	N	D	U	L	U	M	E	R	A	T	Z	D	Z
I	L	S	P	O	S	G	B	C	O	P	S	M	T	L

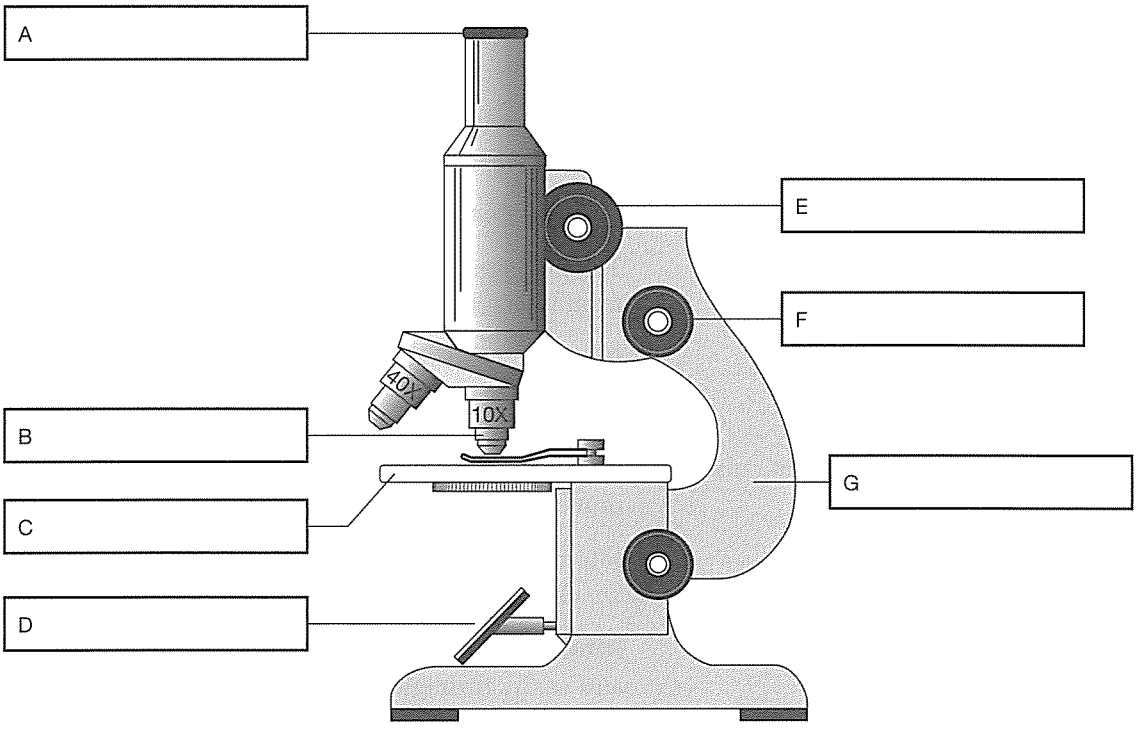
2.1 Getting to know your microscope

Science understanding

Verbal/Linguistic Visual/Spatial

1 **Name** the parts labelled A to G on the diagram from the list below.

stage	fine focus knob	coarse focus knob	mirror	objective lens	eyepiece	handle



2 **Identify** the correct description of each of the following parts of the microscope by joining them with a line.

(a) Eyepiece	Part of the microscope on which the specimen is placed
(b) Coarse focus knob	Sharpens the focus on high power
(c) Stage	Unit used to measure microscopic objects
(d) Objective lens	Equipment used to make a wet mount
(e) Micrometre	The object being studied using the microscope
(f) Specimen	The lens of the microscope closest to the specimen
(g) Mirror	The part of the microscope you look through
(h) Fine focus knob	Used to reflect light through the specimen
(i) Slide and coverslip	Used to focus the microscope on low power

2.2 Plant and animal cells

Science understanding

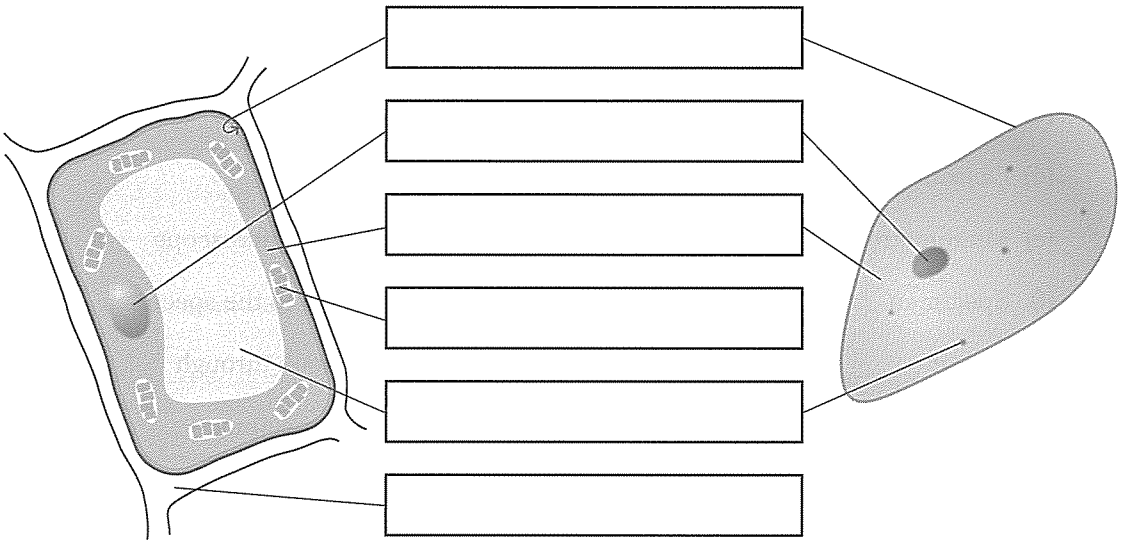
Verbal/Linguistic Visual/Spatial

1 Plant and animal cells have a number of different parts. **Recall** the job of each by matching the cell part (on the left-hand side) with the job it does (on the right-hand side) by joining them with a line. Two have been done for you.

(a) Cell wall	The 'skin' that holds the cell together
(b) Cell membrane	A watery, jelly-like mixture that contains many smaller parts where the work of the cell takes place
(c) Nucleus	The powerhouse of the cell where the energy we need is released from the food we eat
(d) Cytoplasm	The skeleton of a plant
(e) Vacuole	The garbage disposal units that get rid of wastes from the cell
(f) Mitochondria	Part of the cell where photosynthesis takes place
(g) Ribosome	Control centre of the cell
(h) Endoplasmic reticulum	Contains wastes or chemicals that are being moved around the cell
(i) Lysosome	Microscopic factories that produce the proteins we use to grow and repair our bodies
(j) Chloroplast	Pathways that allow materials to move quickly and easily through the cell

2 Some features are found only in plant cells, some are found only in animal cells, and others are common to both plant and animal cells. **Identify** the parts of the plant and animal cells by selecting the correct word from the list below.

nucleus	chloroplast	vacuole	cell wall	cell membrane	cytoplasm



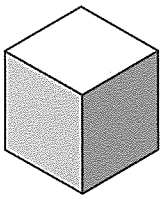
2.3 Thinking about cells

Science inquiry

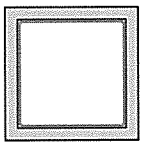
Verbal/Linguistic Visual/Spatial

A major difference between plant and animal cells is that plant cells have a cell wall and animal cells do not. Let's investigate the significance of this difference.

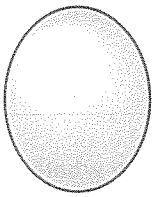
For this activity you will need to think and imagine. Think of an animal cell as being like a water-filled balloon. A plant cell will be like a box made of stiff cardboard with a water-filled balloon inside.



Plant cell: outside view



Plant cell: inside view



Animal cell

1 (a) **Construct** diagrams of what the following could look like.

A pile of 10 plant cells	A pile of 10 animal cells

(b) **Describe** what would happen if you piled the animal cells one on top of another.

_____

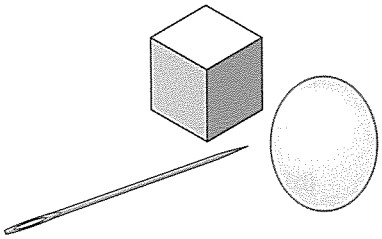
(c) **Describe** what would happen if you piled the plant cells one on top of another.

_____

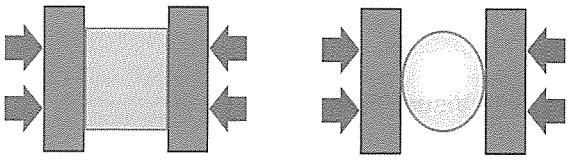
2 **Compare** how easy it would be to burst open the plant and animal cells to let the watery contents spill out.

_____

_____



3 Imagine the cells are being pushed from two sides.



(a) **Construct** diagrams to show what would happen to both types of cell.

Plant cell	Animal cell

(b) **State** whether the plant or animal cell is able to change its shape most easily.

_____

4 **Propose** what would happen to a tree if suddenly all of its cells turned into animal cells.

_____

5 **Propose** what would happen if all the cells in the body of this runner suddenly changed to plant cells.

_____

_____

6 (a) **List** the advantages and disadvantages of having cells like animal cells.

Advantages	Disadvantages

(b) **Explain** how animals have overcome these disadvantages.

_____

7 (a) **List** the advantages and disadvantages of having cells like plant cells.

Advantages	Disadvantages

(b) **Explain** how plants have overcome these disadvantages.

_____

2.4 Size of cells

Science understanding, Science inquiry

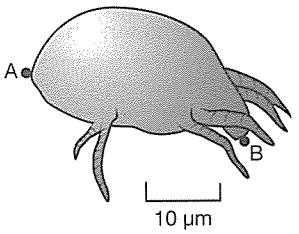
Logical/Mathematical Verbal/Linguistic

It is not practical to measure microorganisms and cells of plants and animals with a normal ruler. Cells measure only fractions of a millimetre. The unit used to measure cells is a micrometre. A micrometre is a thousandth of a millimetre and has the symbol µm.

1 **Use** your knowledge of conversions to complete the table below. To convert from centimetres to millimetres, multiply by 10. To convert millimetres to micrometres, multiply by 1000. To reverse each of these, divide by these factors of 10 and 1000. The first one has been done for you.

cm	× 10 → / ← ÷ 10	mm	× 1000 → / ← ÷ 1000	µm
0.03		0.3		300
0.7				
		2		
				45
0.03				
				130
		0.04		
				78

Using scales



2 When scientists draw diagrams of very small objects, they enlarge them. A scale is then added to the diagram to give an idea of the real size. This is a drawing of a dust mite. Dust mites are found everywhere but they are too small for us to see easily. How big are they?

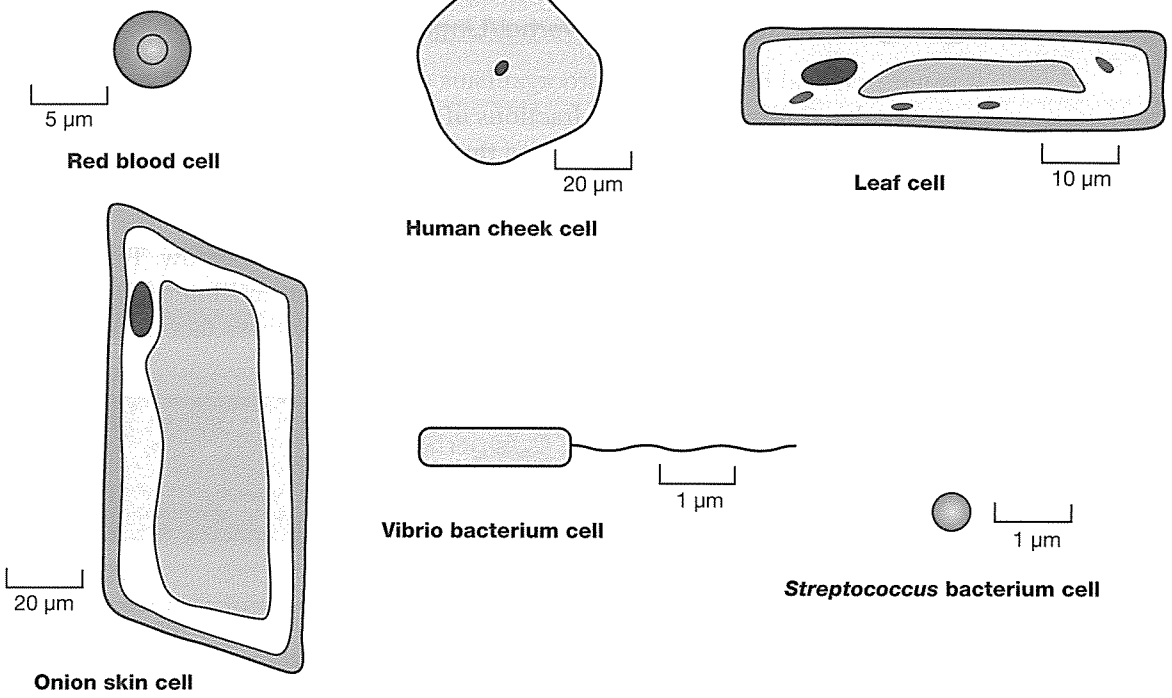
(a) Use a ruler to measure the length of the body from point A to point B. **State** this measurement in centimetres. _____

Use a ruler to measure the length of the line on the scale. It should be 1 cm long. This tells you that every centimetre of the drawing represents 10 µm of the real animal.

Multiply the length of the dust mite (measured in centimetres) by 10. This will give you the actual length of the dust mite in micrometres (µm).

(b) **State** the length of the dust mite. _____

3 **(a)** **Use** these drawings to **calculate** how big cells really are then complete the table below.



Question	Measurement (cm)	Scale	Calculation	Actual size (µm)
What is the diameter of the red blood cell?				
What is the diameter of the human cheek cell?				
What is the length of the cell from the leaf?				
What is the width of the cell from the leaf?				
What is the length of the onion skin cell?				
What is the width of the onion skin cell?				
What is the length of the body of the *Vibrio* bacterium?				
What is the diameter of the body of the *Vibrio* bacterium?				
What is the length of the tail of the *Vibrio* bacterium?				
What is the diameter of the *Streptococcus* bacterium?				

(b) **Calculate** the number of *Streptococcus* bacterial cells placed side by side that would fit across the diameter of a human cheek cell. _____

(c) **Calculate** the number of red blood cells placed side by side that would fit along the length of a leaf cell. _____

2.5 The first time it was seen

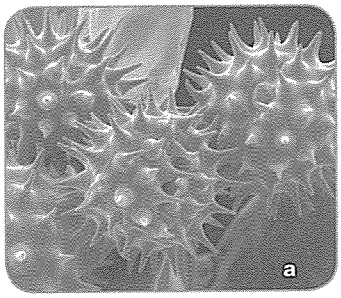
Science as a human endeavour

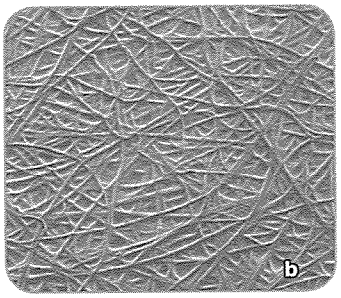
Visual/Spatial

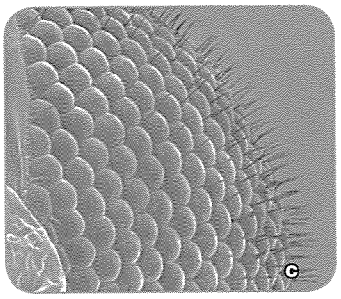
When scientists first used microscopes and then electron microscopes they saw familiar things magnified and saw other things that had never been seen before. They had to try to make sense of the images. How easy do you think that was?

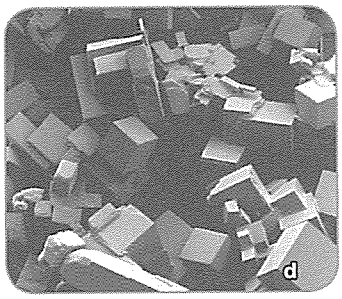
The following pictures are electron micrographs of familiar objects.

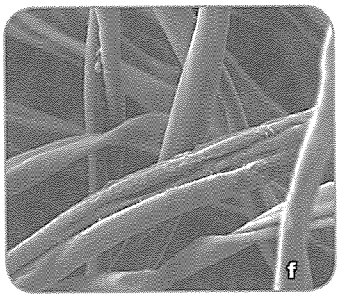
1 **Propose** what the following photographs represent. **Record** your ideas in the boxes under the pictures.

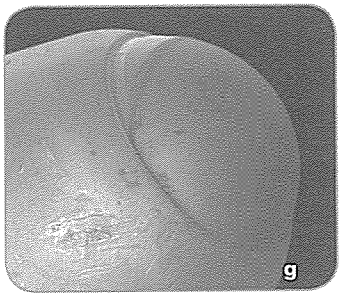


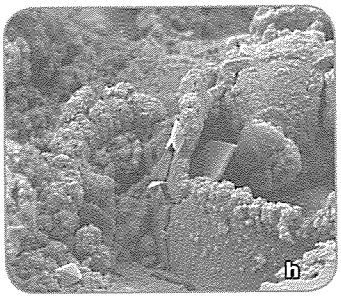












2 **Discuss** your experience of trying to work out what these photographs represent.

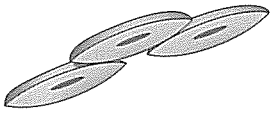
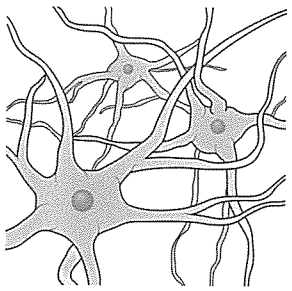
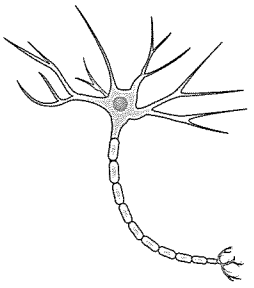
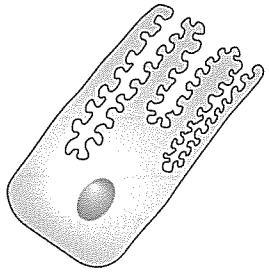
2.6 Shape and structure

Science understanding, Science inquiry

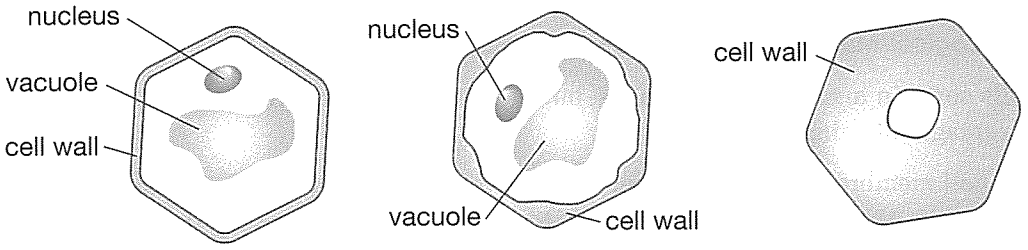
Verbal/Linguistic Visual/Spatial

The cells found in plants and animals are of different shapes and sizes depending on what they do.

1 Think about where these cells are found and the jobs they have to do. **Explain** why their shapes mean that the cells are well suited to the jobs.

	Cell type	Diagram of cell	Cell function	Why the shape makes the cell suited to its job
(a)	Human skin cell		Provides a complete covering for the body	
(b)	Nerve cell in brain		Sends information to and receives information from different parts of the brain	
(c)	Nerve cell in body		Sends information from all parts of the body to the brain	
(d)	Cell from small intestine		Passes digested food from space inside the intestine into the body	

2 Some plant cells change as they get older. These three diagrams represent a cell from the stem of a tree.



Cell in the stem of a seedling | **Same cell at 3–4 months old** | **Same cell in mature tree**

(a) **Describe** the changes that have occurred.

(b) **Propose** how these changes would help the plant survive.

3 The following table contains a list of features of particular cells. **Propose** how each feature would help the cell carry out its job.

	Feature of cell	How the feature helps the cell do its job
(a)	Cells in the upper layers of leaves have large numbers of chloroplasts.	
(b)	Muscle cells in the human leg have large numbers of mitochondria.	
(c)	Cells in plant stems that carry water from the roots have no cross walls so they form a continuous tube like a drinking straw.	
(d)	Cells in bone can produce a hard substance that completely surrounds them.	

2.7 Surface area

Science inquiry

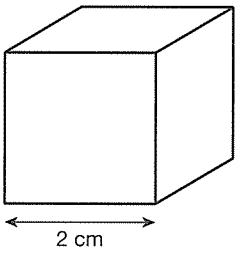
Logical/Mathematical **Visual/Spatial**

Cells come in many different shapes, but they are all small. This activity explores the advantages of being small.

The cell membrane acts as a barrier between the outside of the cell and the inside of the cell. Anything that the cell needs to get rid of has to move out through the membrane. Anything the cell needs has to move in through the membrane. The cell will function best if there is an efficient exchange of materials across the membrane, which is the surface of the cell.

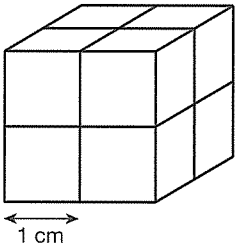
1 For this part of the activity, imagine a cell as being like a cube.

The surface of this cube is made up of the faces of the cube that are in contact with the air. The surface area of the cube is the area of all six sides of the cube added together.



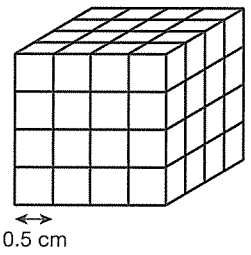
(a) This cube has sides that are 2 cm long. **Calculate** the surface area of the cube.

Imagine the cube now being cut into eight smaller cubes.



(b) **Calculate** the surface area of each of the smaller cubes and then the total surface area of the cubes.

(c) Now cut each small cube into eight smaller cubes again. **Calculate** the surface area of each of the smaller cubes and then the total surface area.



(d) **Record** your results in the first three rows of this table.

	Length of side (cm)	Surface area of cube (cm^2)	Number of cubes	Total surface area (cm^2)
(a)	2		1	
(b)	1		8	
(c)	0.5			
	0.25			
	0.125			

(e) **Describe** the pattern of change in the surface area.

_____

_____

(f) Use this pattern to **predict** the values that will complete the last two rows of the table. At each stage, each cube is cut into eight.

(g) **Calculate** how much faster water would move into 64 cube-shaped cells with sides of 0.5 cm than into one cell with sides of 2 cm.

_____

2 The cells covering the surface of a plant root are mostly like those shown in Figure 2.7.1a. However, in the area where most water enters the root, the cells are shaped like those of Figure 2.7.1b. **Explain** why these cells would be an advantage to the plant.

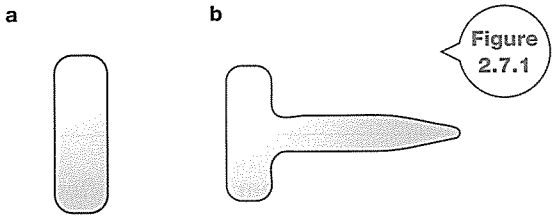


Figure 2.7.1

_____

_____

3 Figure 2.7.2a shows the typical shape of the cells lining your gut. In a part of the gut called the small intestine the cells are more like those of Figure 2.7.2b. **Propose** what might happen in the small intestine.

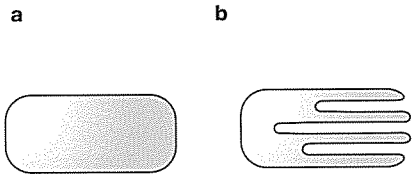


Figure 2.7.2

_____

_____

4 In the cells of leaves, the gas the plants need from the air (oxygen) is taken in and the waste gas (carbon dioxide) passes out into the air. This gas exchange happens at night. **Evaluate** the two arrangements of cells shown in Figure 2.7.3 and decide which one would carry out the job of gas exchange more efficiently. **Justify** your answer.

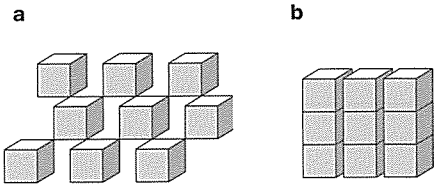


Figure 2.7.3

_____

_____

2.8 Growing cells

Science as a human endeavour

Verbal/Linguistic

Refer to the Science as a Human Endeavour on pages 69 and 70 of your student book to answer the following questions.

1 **Define** cell culture.

_____

2 **List** some of the uses of cultured cells.

_____

_____

3 **Explain** how stem cells are different from other cells such as muscle cells.

_____

_____

4 **Create** a flow diagram of the process of growing a new bladder.

5 **Explain** why a shell is necessary when growing a new bladder but is not used when growing skin.

_____

_____

6 **List** the two types of cells that were cultured to grow the new bladder.

_____

7 **Explain** why two different types of cells were needed.

_____

_____

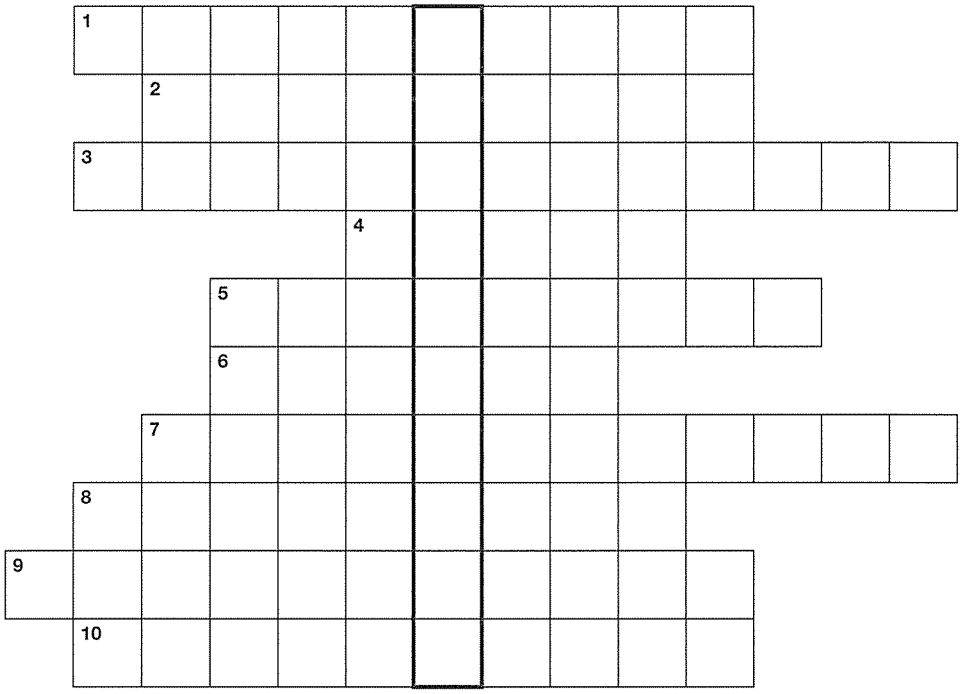
2.9 Literacy review

Science understanding

Verbal/Linguistic

Cells crossword

Use the clues to complete the crossword.



1 Unit used to measure microscopic things.

2 When small things are made to look bigger they are _____.

3 Describes an organism made up of many cells.

4 Group of different tissues that work together.

5 Watery, jelly-like substance found inside cells.

6 Groups of cells of the same type.

7 Powerhouses of the cell.

8 Organelles that produce proteins.

9 The organelle that makes plants green and where they make their food.

10 Small parts found within cells.

Read the letters in the bolded column. **State** the word they spell. _____

Define this word.

_____

2.9

Cells wordfind

S	P	E	C	I	M	E	N	A	C	G	L
B	E	R	R	E	T	I	C	U	L	U	M
L	P	N	E	N	T	I	S	S	U	E	S
F	I	E	L	D	O	F	V	I	E	W	N
B	T	W	R	O	O	F	A	M	A	R	E
T	H	A	H	P	R	O	C	U	L	A	R
C	E	L	L	L	G	G	U	N	E	F	V
L	L	L	C	A	A	H	O	S	N	F	E
U	I	A	R	S	N	E	L	O	S	E	C
V	U	F	I	M	A	G	E	L	A	G	E
D	M	U	S	I	S	I	M	F	U	C	L
O	T	N	U	C	L	E	U	S	R	L	L

The key terms in the following list are somewhere in the wordfind. Where there is more than one word in the key term, the words will either be on the same line or will intersect, like the words in a crossword.

Find each term in the grid, then **define** the key term to complete the table.

Key term	Definition
Cell wall	
Endoplasmic reticulum	
Epithelium	
Field of view	
Image	
Nerve cell	
Nucleus	
Ocular lens	
Organ	
Specimen	
Tissue	
Vacuole	

3.1 Parts of the digestive system

Science understanding

Visual/Spatial

Your digestive system changes the food you eat into a form your body can use.

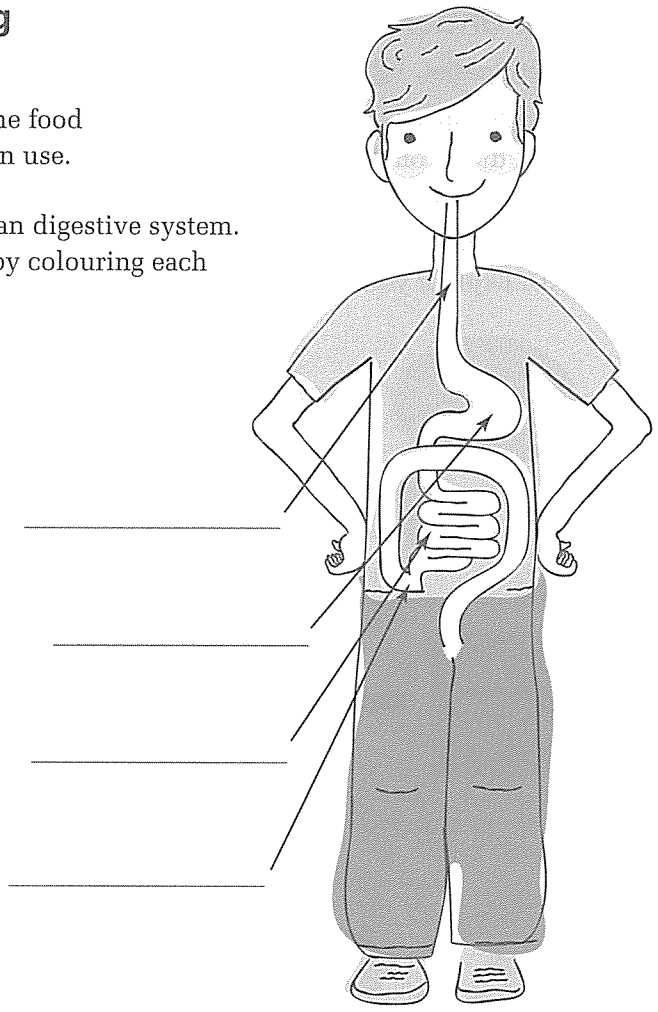
1 The diagram shows the human digestive system. **Identify** the following parts by colouring each as follows and adding labels.

small intestine: red

oesophagus: blue

large intestine: green

stomach: yellow



2 Draw a line to **identify** the part of the digestive system with its description.

Part of the digestive system	Description
Mouth	This is where water is taken back into the body and any wastes and unwanted food are passed out of the body through the anus. This structure is short but quite wide.
Oesophagus	Most of the digestion is finished here. Food is now very tiny particles that can be absorbed by the body. This structure is quite long, but is quite narrow. Useful nutrients pass through the wall into the body where they are taken by the blood to the cells.
Stomach	Mechanical digestion starts here when you chew your food. Chemical digestion of carbohydrates starts here using chemicals found in saliva.
Small intestine	This is the tube that carries the chewed food from the mouth to the stomach. A muscle wave known as peristalsis moves the food to the stomach.
Large intestine	This is where very strong acid helps to digest proteins and helps to kill any bacteria in the food.

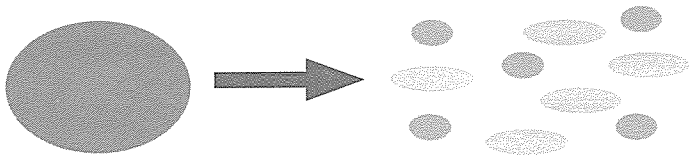
3.2 Mechanical and chemical digestion

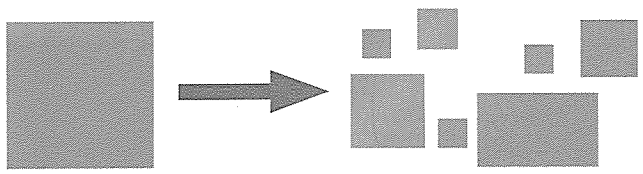
Science understanding, Science inquiry

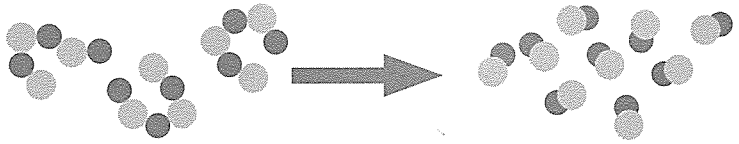
Visual/Spatial Verbal/Linguistic

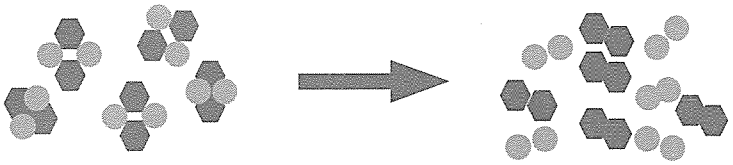
When you bite off a piece of apple and chew it into smaller pieces of apple, this is mechanical digestion. Chemical digestion occurs when the complex sugars in the apple are changed into simple sugars by chemicals in your mouth and small intestines.

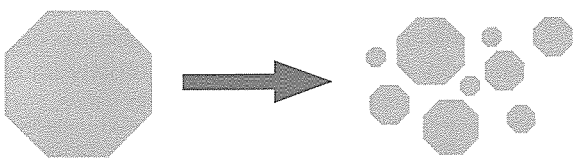
The following five diagrams represent digestion. **Propose** which type of digestion each represents. **Explain** your decision in each case.

1 

2 

3 

4 

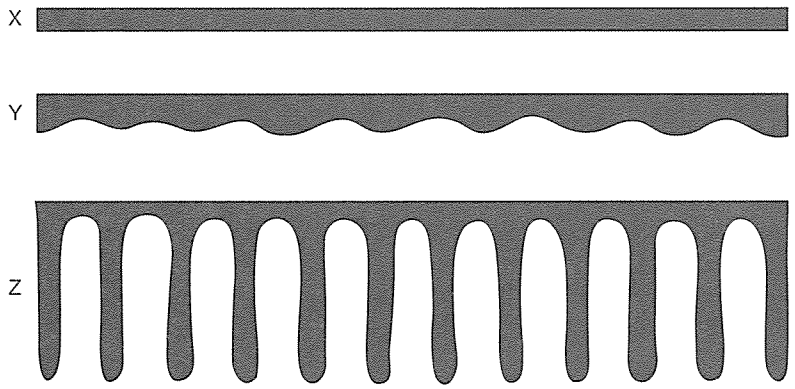
5 

3.3 Investigating villi

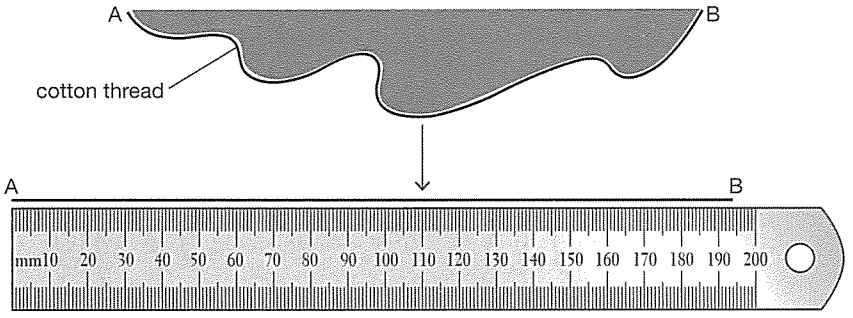
Science inquiry

Bodily/Kinaesthetic Verbal/Linguistic

The following diagram represents three different surfaces.



1 **Use** cotton thread or fine string and a ruler to measure the length of the lower side of each surface, as shown below.



Length of surface **X** _____ **Y** _____ **Z** _____

2 Assume that each centimetre of surface absorbs 5 mL of digested material every 10 minutes. **Calculate** the amount of digested material absorbed in one hour by each surface.

Y _____

Z _____

X _____

3 **Compare** the efficiency of surfaces X, Y and Z.

_____

_____

4 **Explain** why it is an advantage to have villi lining the small intestine.

_____

_____

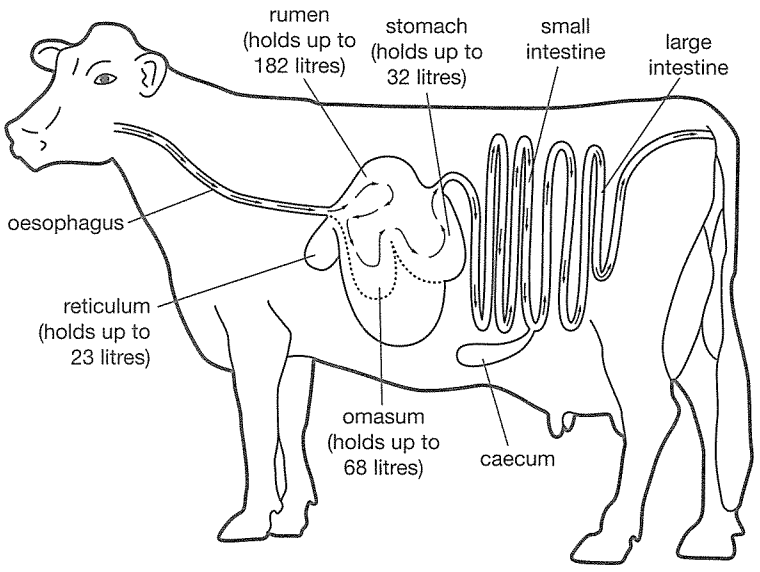
3.4 Comparing digestive systems

Science inquiry

Verbal/Linguistic

Digestive system of a cow

The stomach, small intestine and large intestine of cows are similar to those found in dogs and humans. Cows are herbivores, which means that they only eat plant material. Plant cell walls are very difficult to digest. To help the digestive process, cows have three extra parts to their digestive systems between the oesophagus and the stomach. These are the rumen, reticulum and omasum. The parts of the digestive system of a cow are shown in the diagram below.



Rumen

Cows graze, taking the food into their rumen. They can store large amounts of food in the rumen. The rumen also contains micro-organisms that digest the fibre in the plant material.

After eating, the cow rests and ruminates. Rumination involves bringing back the chewed plant material from the rumen into the mouth. In the mouth, it is chewed again and mixed with saliva. We call this 'chewing the cud'. Cows can produce up to 100 litres of saliva every day.

Because they go through the process of rumination, cows and other animals that chew the cud are known as ruminants.

Gases such as carbon dioxide and methane are produced as the bacteria digest the food in the rumen. Cows belch frequently to get rid of the gas.

Reticulum and omasum

When the plant material is partly digested, it is pushed along into the reticulum. Like the rumen, the reticulum is a large muscular sack containing micro-organisms. The muscular walls continually contract and relax, churning the partly digested food.

The food is then pushed along further to the omasum and the stomach.

Stomach and beyond

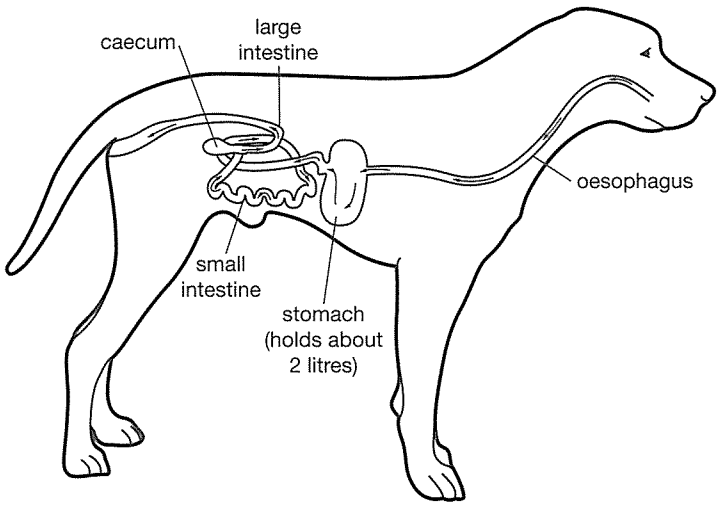
In the stomach, the micro-organisms from the rumen are digested before the stomach contents pass into the small intestine. In the small intestine, the nutrients are absorbed into the bloodstream just as in the human digestive system.

The remaining contents of the small intestine then pass into the caecum. In the caecum are bacteria that further digest any remaining plant material.

The large intestine is the last part of the digestive system. There, water is reabsorbed just as it is in the human digestive system.

Digestive system of a dog

Dogs are carnivores. They have a simple digestive system that is adapted to meals of meat. The digestive system of a carnivore is the shortest of all types of animals. It is basically a long tube with a single bulge (the stomach) near the beginning. The parts of the digestive system of a dog are shown in the diagram below.



In the mouth, the teeth tear and crush the food. Although saliva is produced, it is not involved in digestion. It just helps lubricate the food so that it can be swallowed easily.

The dog's stomach is very small. It can only hold about 2 litres of food, which is all the food that a dog can eat at one time. Carnivores do not need a lot of food because meat and fat have high concentrations of nutrients.

In the dog's stomach, concentrated hydrochloric acid dissolves the food. Any food that cannot be dissolved, such as raw plant material and bone, either passes through or is vomited out.

Up to this point, the food has been digested mechanically. Chemical digestion does not start until the food passes into the small intestine. In the small intestine, the food is digested and enters the bloodstream.

Carnivores cannot digest plant cell walls. Plant material joins other undigested material and passes from the small intestine into the large intestine past the caecum. The caecum in carnivores does not have a function. In the large intestine, water is reabsorbed from the wastes and solid faeces is produced.

3.4

1 **Name** in order the parts of the cow digestive system through which food passes.

2 **Explain** what happens to the cow's food in the rumen.

3 **Explain** why dogs and other carnivores are able to survive without a rumen.

4 **(a) Describe** what is happening when cows 'chew the cud'.

(b) Explain how chewing the cud is of benefit to the cow.

5 **Explain** why a dog only has a small stomach.

6 **Compare** the function of the stomach in a cow and a dog.

7 Miniature cows are a special breed of cows that may not be much larger than some large dogs. Yet their digestive system is longer and can hold a much larger volume of food.
Propose why a dog and a miniature cow of the same size do not have digestive systems the same size.

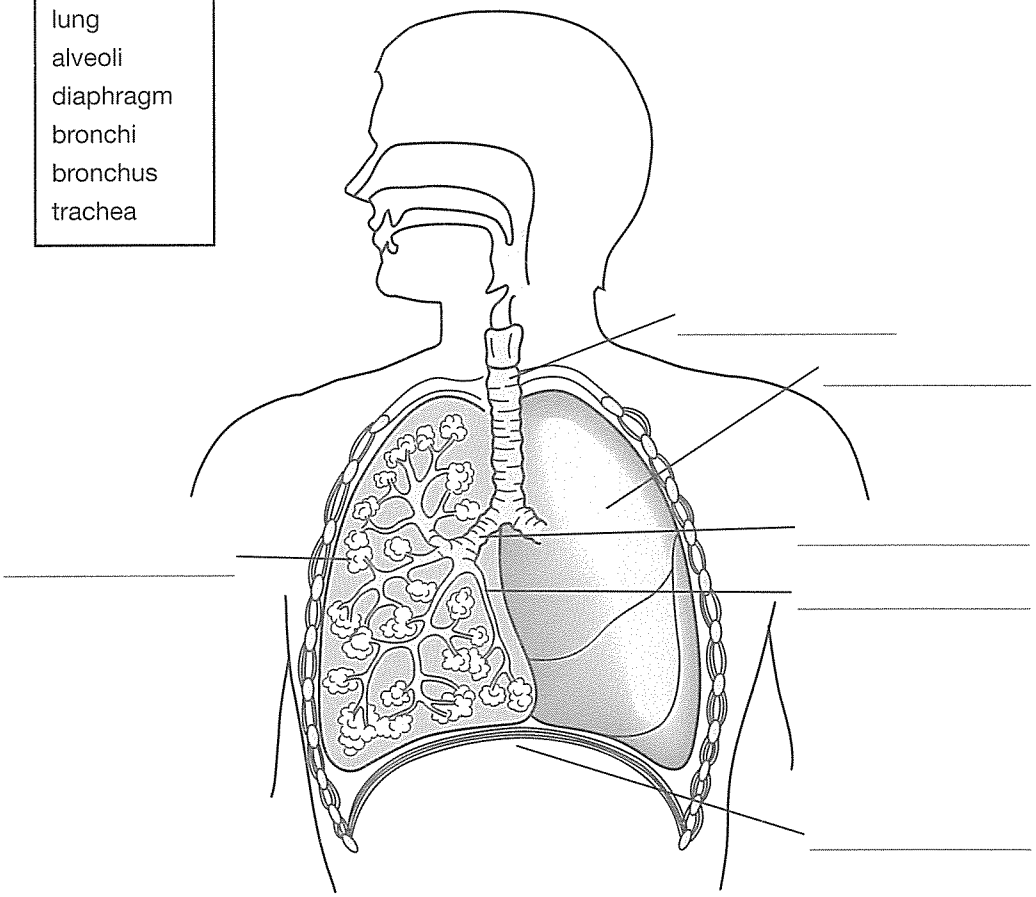
3.5 The respiratory system

Science understanding

Verbal/Linguistic Visual/Spatial

1 Select terms from the list below to **name** the parts of the respiratory system indicated.

lung
alveoli
diaphragm
bronchi
bronchus
trachea



2 Recall your knowledge of the respiratory system by drawing lines to match the parts of the respiratory system with their description.

Part of the respiratory system	Description
Trachea	A sheet of muscle that separates the chest from the abdomen. It contacts and flattens as you breathe in and arches up as you breathe out.
Bronchi	A cluster of sacs in which oxygen and carbon dioxide are exchanged.
Alveoli	Thin-walled tube reinforced with rings of cartilage. You can feel these rings as ridges on the front of your throat.
Diaphragm	One of these carries air into each lung.

3.6 Comparing respiratory systems

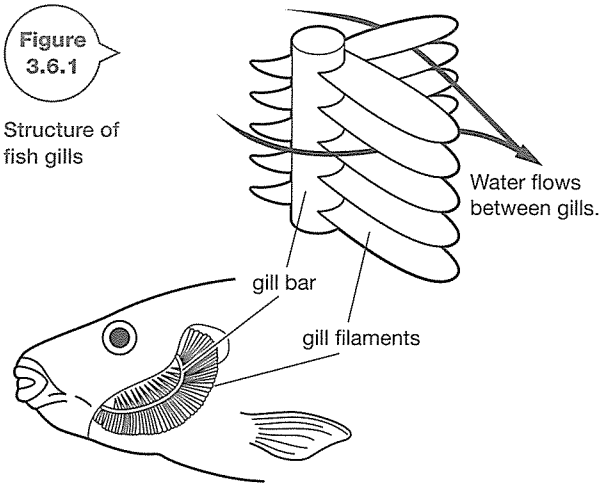
Science understanding, Science inquiry

Verbal/Linguistic **Visual/Spatial**

In humans, millions of tiny alveoli provide a large surface area through which the gases oxygen and carbon dioxide can be exchanged. Other animals have slightly different respiratory systems. Fish have gills, insects have structures called trachea and earthworms exchange gases through their skin. You are going to compare these respiratory surfaces.

Figure 3.6.1

Structure of fish gills



Side of head cut away to show gills

The gills of fish have a large surface area. Gills are made up of many fine filaments (thread-like structures), each of which has a very good blood supply.

Gills are always moist because they are surrounded by water.

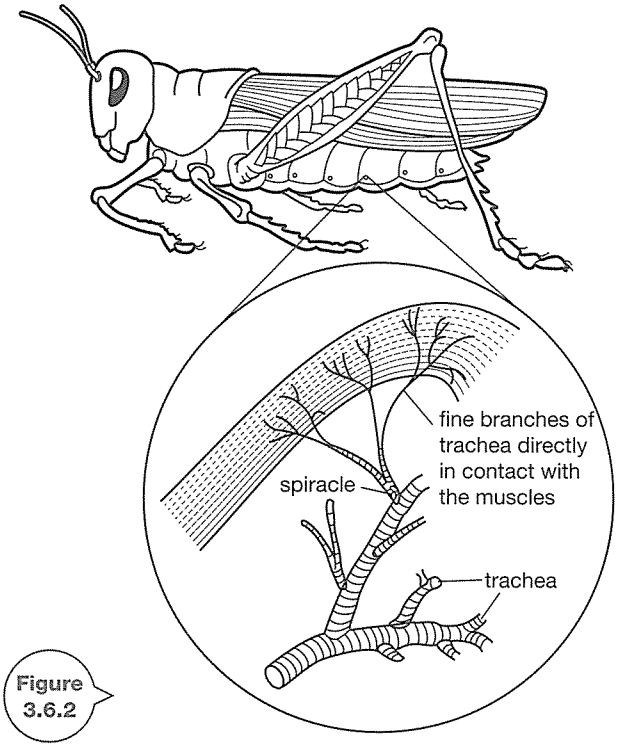


Figure 3.6.2

Structure of insect trachea

Insects have small tubes called trachea that carry air to every cell of the body. The ends of the small branches of the trachea are moist. Oxygen dissolves at the moist surface and then moves into the cells.

Small openings called spiracles on the outside of the insect's body close the trachea when the insect is not active. This prevents water being lost and makes sure that the ends of the trachea do not dry out.

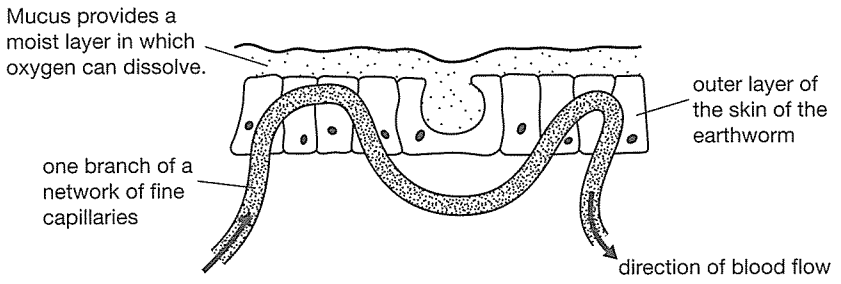


Figure 3.6.3

An earthworm's skin acts as a gas exchange surface.

Earthworms produce a layer of mucus over their skin. Mucus is a thin jelly that keeps the skin moist. Oxygen from the air dissolves at the moist surface. The earthworm has many blood capillaries close to the surface and its blood contains haemoglobin and is red, just like human blood. The haemoglobin collects the dissolved oxygen and the blood carries it to the cells.

1 **List** the characteristics that make an efficient gas exchange surface.

2 **Compare** the human, fish, insect and worm gas exchange surfaces in terms of the characteristics you have listed.

3 The maximum amounts of oxygen that can be supplied to each gram of muscle tissue in 1 hour are: earthworm 60 mm^3, mouse running 20 000 mm^3 and butterfly flying 100 000 mm^3.

(a) **Explain** how a butterfly is able to supply oxygen to its muscles more quickly than a mouse can.

(b) **Explain** why the earthworm has such a limited supply of oxygen.

(c) Where do you think a human would fit in the list? **Justify** your response.

3.7 The heart

Science understanding

Visual/Spatial Verbal/Linguistic

1 A basic diagram of the heart is provided below.

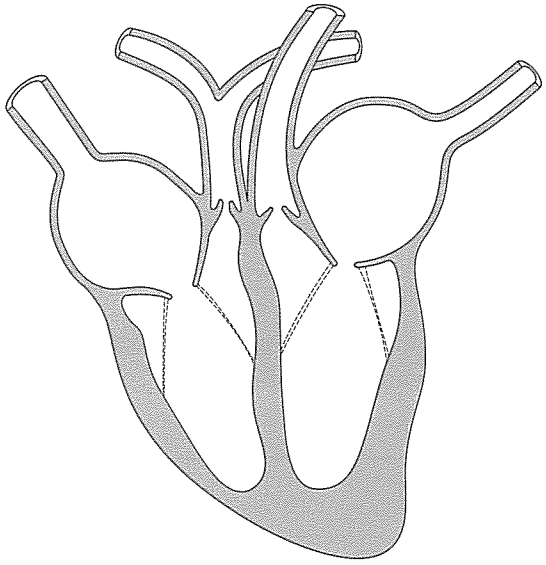
(a) Add labels from the box to **identify** the parts of the diagram.

(b) Colour the heart and blood vessels to **identify** where there is oxygenated blood (red) and deoxygenated blood (blue).

(c) Add arrows to **identify** the direction of blood flow through the heart.

(d) At the end of the blood vessels, **name** the part of the body the blood is flowing to or from.

right atrium
left atrium
right ventricle
left ventricle
aorta
vena cava
pulmonary artery
pulmonary vein
valves



2 **(a)** **Identify** whether the right or left ventricle is larger and has thicker walls.

_____

(b) **Propose** a reason for having the thicker walls.

_____

_____

3 **Construct** a flow diagram for the passage of the blood through the body and heart. Start and end with the right ventricle.

3.8 Effect of exercise

Science inquiry

Logical/Mathematical

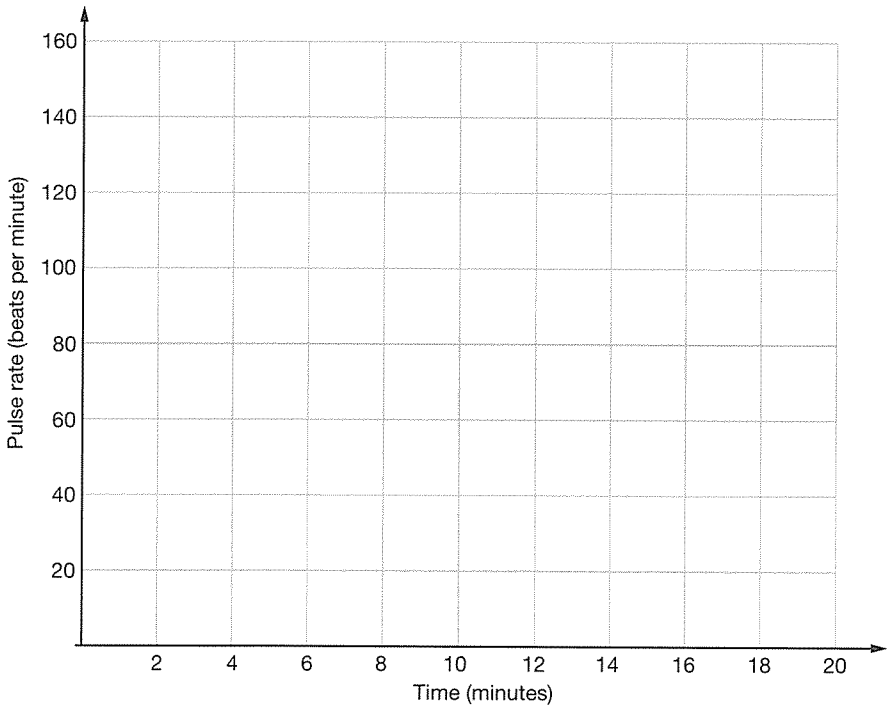
Two people had the change in their heart rate recorded during exercise. Mary trained on a regular basis and was reasonably fit. Ella did not train at all. The results are shown below.

Table 3.8.1 Pulse rate during exercise

	Time (minutes)	Pulse rate (beats per minute)	
		Mary (fit)	Ella (unfit)
Before exercise	1	55	62
	2	56	61
	3	55	62
	4	55	62
	5	56	61
During exercise	6	60	70
	7	70	80
	8	75	90
	9	97	120
	10	106	130
	11	120	140
	12	130	142
	13	132	148
	14	131	150
	15	131	150
After exercise	16	115	140
	17	98	118
	18	75	100
	19	60	90
	20	55	80

3.8

1 **Construct** line graphs of these data using the set of axes provided.



2 **Describe** how the pulse rates for Mary and Ella changed during exercise.

3 **Propose** why these changes occurred.

4 **Compare** the changes in pulse rate and account for the differences:

(a) before exercise

(b) in the first 5 minutes of exercise

(c) in the second 5 minutes of exercise

(d) after exercise was completed.

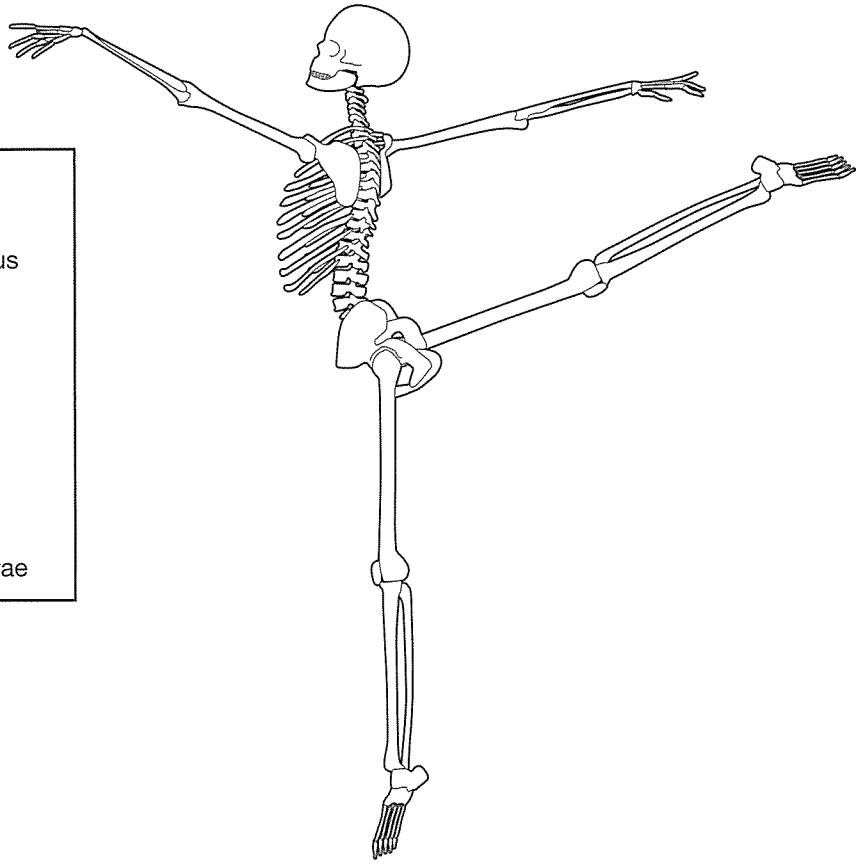
3.9 The skeleton

Science understanding

Verbal/Linguistic Visual/Spatial

1 **Use** the list of words in the box to label the different parts of the human skeleton.

2 Colour in the axial skeleton red.



femur
fibula
humerus
patella
pelvis
radius
ribs
skull
tibia
ulna
vertebrae

3 Circle in green and label a:

(a) hinge joint

(b) pivot joint.

4 **Explain** how the joints of the skeleton allow the dancer to hold her right leg in the position shown in the diagram.

3.10 Sore backs

Science as a human endeavour

Verbal/Linguistic

The spine is made of 33 small bones called vertebrae, each separated by a gel-filled cushion called a disc. Having a large number of small bones gives your spine flexibility. The spine gets compacted, stretched and twisted as you move and the discs act as shock absorbers between the bones.

Sometimes a disc may split, allowing the gel inside to escape into the surrounding tissue. The leaking gel can put pressure on the spinal cord and cause pain. The common name for this injury is a 'slipped disc'. However, the disc has not slipped or moved position; it has actually split.

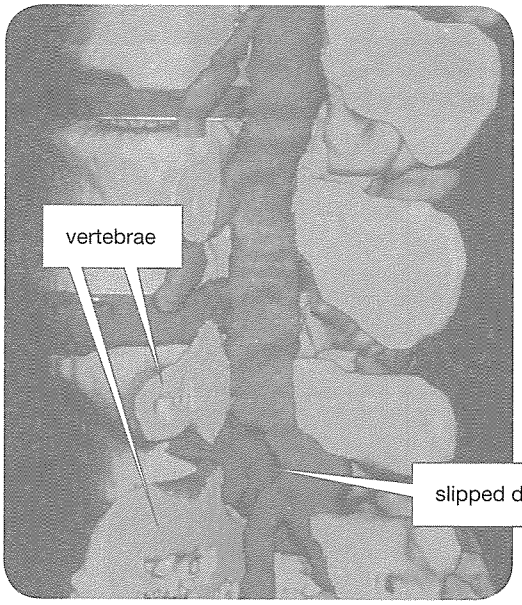


Figure 3.10.1

The disc between the two vertebrae has ruptured and is causing pressure on the spinal cord.

Badly split discs require injections and sometimes an operation. To protect your back and prevent ruptured discs, it is important to learn to lift heavy objects correctly.

There are two rules to remember.

- Do not try to lift things that are too heavy for you.
- Do not bend over at the waist to lift. Keep your back straight.

Lifting correctly

- If the item is on the floor, bend at the knees and come to a squat position. You will then be using your leg muscles rather than the muscles of your back and shoulders to lift the item.
- Hug the item close to your body.
- Use the strength of your legs to push straight up. Don't bend or twist your back.
- Plan where you are going to put the item and then reverse the moves. First bend the knees and gently lower the object.

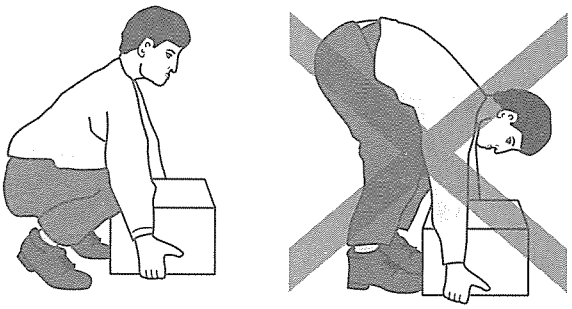


Figure 3.10.2

Lifting heavy objects the correct way protects your back.

1 **Name** the bones that make up your spine.

2 **Name** the parts of the spine that protect the bones.

3 **Propose** ways in which your life would be different if your spine was made of one strong bone like the femur instead of many small vertebrae.

4 **Describe** what happens when a person has a slipped disc.

5 **Explain** why the term *slipped disc* is not an accurate name for the problem.

6 **Explain** why it is important to learn how to lfft heavy objects correctly.

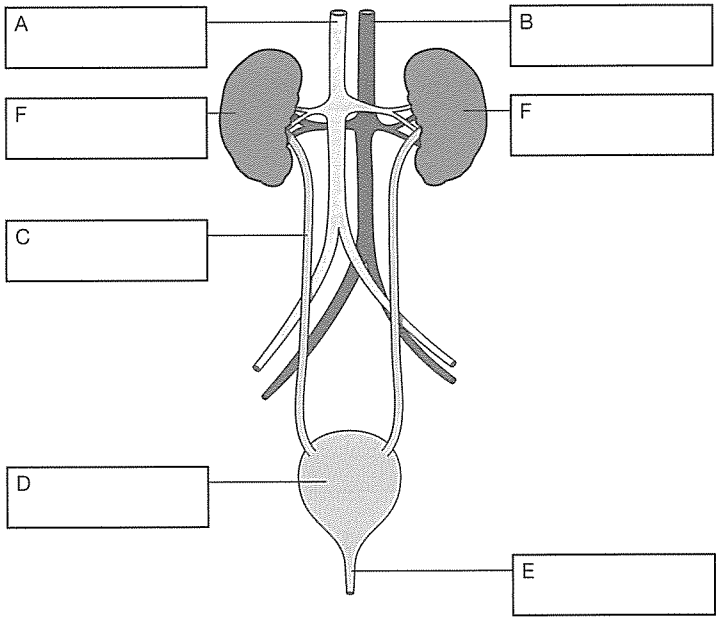
3.11 It's waste!

Science understanding

Verbal/Linguistic

1 Select terms from the list below to **name** each part of the excretory system indicated.

bladder
ureter
urethra
kidney
kidney artery
kidney vein



The respiratory system

Air is breathed in by the respiratory system. Within the lungs exchange of gases takes place and the air that is breathed out has a different composition.

Table 3.11.1 Comparison of inhaled and exhaled air

Gas	Percentage (%)	
	Inhaled air	Exhaled air
Nitrogen	78	78
Oxygen	21	17
Inert gases such as argon	1	1
Carbon dioxide	0.04	4
Water vapour	little	saturated

2 (a) **List** the gases that are present in the same quantities in inhaled and exhaled air.

_____

(b) **Explain** why the quantities of these gases do not change.

_____

3 The respiratory system functions as part of the excretory system. **Identify** what is being excreted by the lungs.

_____

4 **Explain** where these excretory products have come from and how they were produced.

_____

3.12 Ultrasound imaging

Science understanding, Science as a human endeavour

Verbal/Linguistic

Refer to the Science as a Human Endeavour on page 122 of your student book.

1 **Name** the form of energy used to create ultrasound images.

2 **Identify** differences between parts of the object being examined that enable the ultrasound image to be created.

3 **Explain** why grey-scaling was a significant breakthrough in ultrasound imaging.

4 **Describe** a situation where ultrasound images are useful.

5 **Propose** a potential use of ultrasound technology in dentistry.

6 **Describe** the benefits this innovation could provide for dental patients.

3.13 Literacy review

Science understanding

Verbal/Linguistic

Recall your knowledge of human body systems by matching the key words on the left with their definitions on the right. Using a ruler, draw a line between the dots next to the matching terms or definitions. The line you draw should pass through one of the letters in the middle column. Reading down, the letters should spell out a key term relevant to this chapter.

Antagonistic	E A	Reactions that change food chemically
Urine	S X	Describes a pair of muscles that work in opposition to each other
Excretion	C R	The tube that carries air from the nose and mouth into the chest cavity
Chemical digestion	R	Bony structure that holds body upright and protects organs
Trachea	E T O	The material that has been filtered out of the blood by the kidneys
Villi	O T N	Cluster of sacs where gas exchange takes place
Skeleton	S O	Getting rid of the wastes the body has produced
Aorta	R M	The artery that carries blood from the heart to the lungs
Atrium	T Y Y	Microscopic 'fingers' that greatly increase the surface area of the wall of the small intestine
Alveoli	T S M	The main artery leaving the left ventricle of the heart
Circulatory system	Y C	The system of the body that carries materials around the body. It comprises the heart, blood vessels and blood
Diaphragm	X S O	One of the chambers at the top of the heart that receives blood into the heart
Tendons	T	The lower chambers of the heart that contract, pushing blood out of the heart
Pulmonary artery	M E X	A sheet of muscle that separates the chest from the abdomen
Ventricles	N Y M	Elastic tissue that attaches muscle to bone

Key term: _____

4.1 Life as a fluke

Science understanding

Verbal/Linguistic

Parasites are organisms that live in or on another organism and are dependent upon it for food or nutrients. The organism they live in or on is known as the host. Many parasites have very complicated life cycles. Some species may have several different hosts and go through different distinct stages in their life cycle (much like butterflies do).

The liver fluke shown in Figure 4.1.1 is a type of flatworm that is a parasite of humans. The adult fluke is about 3 cm long and lives in tubes in the liver known as bile ducts. Humans become infected with liver flukes by eating raw water plants such as watercress. The main symptom of liver fluke infection is general tiredness, and it rarely causes death. Infection may weaken people enough to lead to death from other illnesses. The liver fluke is only found in a few places in Australia and is not very common. However, it is widespread in Asian countries.

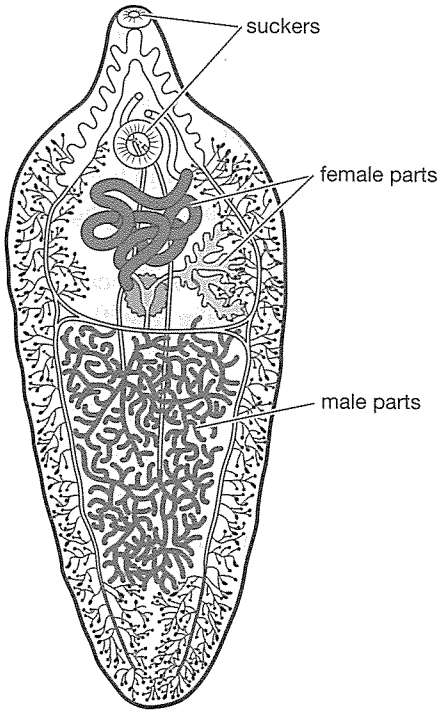
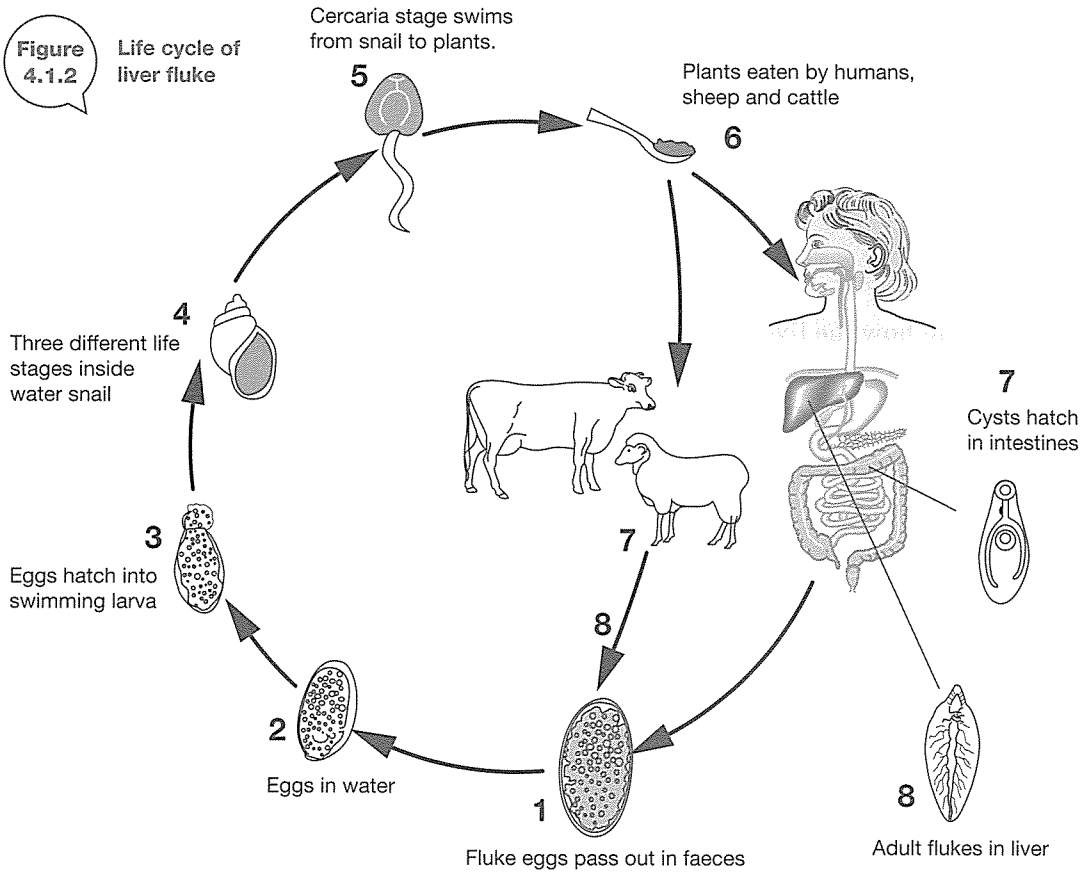


Figure 4.1.1 The adult liver fluke has both male and female reproductive systems on one animal, so it can fertilise its own eggs. It also has two suckers it can use to hold on to the wall of the bile ducts.

Figure 4.1.2 Life cycle of liver fluke



4.1

The liver fluke has a life cycle in which it lives in several different hosts. The adult fluke lives in humans, sheep and cattle. Its eggs pass out with faeces. If the eggs enter bodies of water, they hatch into microscopic free-swimming larvae. A swimming larva burrows into a water snail and there it develops through several different life stages. The last stage in the snail is called a cercaria. The cercaria escapes from the snail's body and swims to plants, where it turns into a fluid-filled ball called a cyst. This has a protective wall around it. If a cyst is eaten by humans, it hatches in the intestines and burrows through to the bile ducts, where it develops into an adult fluke. Now the life cycle is completed. The stages are shown in Figure 4.1.2 on page 47.

1 The adult liver fluke can live in many different hosts such as humans, cattle and sheep. **Describe** how the life cycle is connected between a human and the snail.

2 **Explain** the kind of environment in which infection by a liver fluke would be common.

3 **Propose** how a farmer could minimise infection of livestock by liver flukes.

4 Many species of parasitic worms are hermaphrodites, meaning they can fertilise their own eggs. **Propose** how being a hermaphrodite would be an advantage in a life cycle like that of a liver fluke.

5 **Explain** how the liver fluke is dependent on snails for survival of its species.

6 **Propose** why the survival of the liver fluke as a species depends on its ability to produce enormous numbers of eggs.

4.2 Malaria and mosquitoes

Science as a human endeavour

Logical/Mathematical **Verbal/Linguistic**

Malaria is an infectious disease caused by a single-celled parasite called *Plasmodium*. Between 1.5 million and 3 million people die of malaria every year. This is about 4–5% of all deaths in the world; 85% of these deaths from malaria are in Africa.

The *Plasmodium* parasite is transmitted from human to human by female mosquitoes (a particular type of mosquito called *Anopheles*). The female mosquito must drink blood to be able to reproduce. The life cycle of the parasite involves living in both mosquitoes and humans. You can see this in Figure 4.2.1, starting at stage 1. The first life stage of the parasite is a type of infective cell known as a spore. The spores develop in the female mosquito and are injected into a human who has been bitten by the mosquito. In stage 2 inside the person, each spore changes into life stages that develop in the liver and red blood cells. In stage 3 the parasite then forms special reproductive cells (sex cells) that remain in human blood. In stage 4 these sex cells can infect any mosquito that bites the person from then on. Once they are in the next mosquito, the sex cells join together. In stage 5 the parasite goes through several life stages one after another before again forming new infective spores. This completes the life cycle of the malaria parasite.

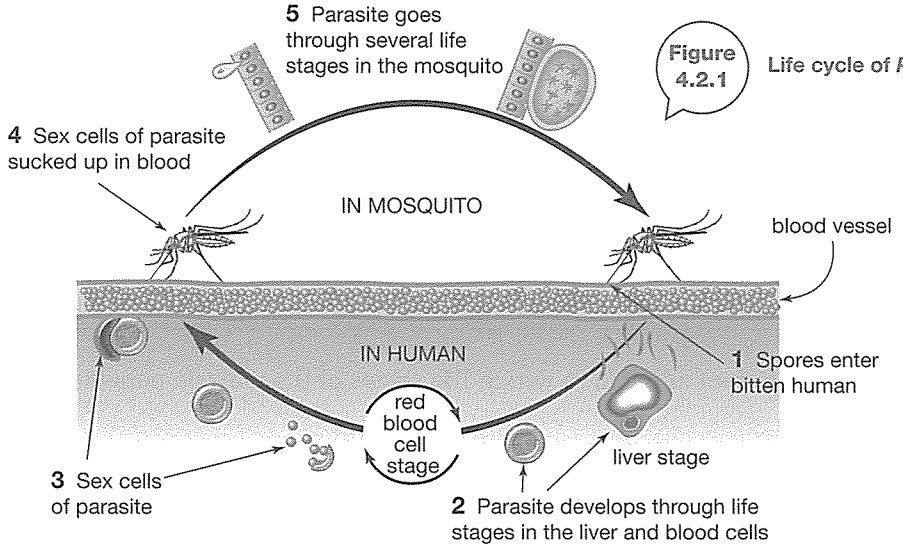


Figure 4.2.1 Life cycle of *Plasmodium*

One strategy to control malaria is to use certain drugs to kill the parasite while it is in the human body. If the parasite is eradicated from humans, it cannot be transmitted from human to mosquito and the life cycle will stop. However, it is impossible to eradicate the parasite from every human at the same time. This approach can only slow down the spread.

Another effective strategy in malaria control is to prevent the mosquito breeding. Mosquitoes have a life cycle in which it lives in water in three of the stages: the eggs, larva and pupa. These stages are shown in Figure 4.2.2 on page 50.

There are two main approaches to preventing mosquitoes breeding:

- Removing breeding sites: The easiest, cheapest and most direct method to control malaria is to prevent the mosquito from laying eggs. This is done by eliminating places where water can collect, such as old tyres, buckets and bottles. All water tanks should be kept tightly closed. Waterlogged areas can also be drained.

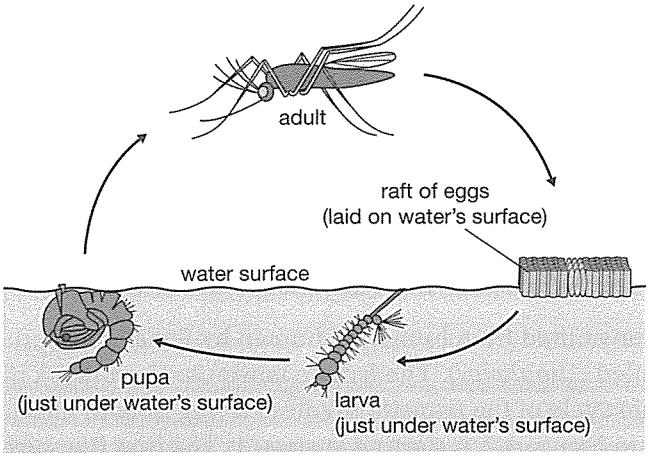


Figure 4.2.2 Life cycle of mosquito

- Killing them in the water: The larvae developing in the breeding sites can be destroyed by using chemicals or biological control. Different chemicals can be used on drinking water and non-drinking water. Oils may be spread on the water surface, suffocating the mosquito larvae and pupae. Biological control agents are organisms such as *Gambusia* fish, nematode worms and water beetles that eat the larvae. Several types of bacteria can also be spread to kill mosquitoes.

1 **State** why malaria is a problem for world health.

_____

2 **Name** the organism that causes malaria.

_____

3 **Name** the organism that transmits malaria from human to human.

_____

4 **Name** two different animals in which life stages of the malaria parasite can be found.

_____

5 **Explain** how knowledge of the life cycle of the malaria parasite can be used to develop a plan to control malaria.

_____

_____

6 **Explain** how knowledge of the life cycle of mosquitoes is used to help control malaria.

_____

_____

4.3 Flowers and pollination

Science understanding, Science inquiry

Logical/Mathematical Verbal/Linguistic

Flowers can have many different shapes, sizes and colours. Careful study of different flowers has led biologists to conclude that these differences are related to how the plants reproduce. This table is a summary of how the main features of cross-pollinating flowers depend on the way in which they are pollinated.

Method of pollination	Flower structure/ colour/size	Anther/stamens	Stigma/style
Wind	Often small but with many flowers in one head, often no petals, not brightly coloured, no nectar, no scent	Long stamens with large anthers exposed	Long style with exposed stigma; stigma has large surface area—often look like brushes
Insect	Usually small, some with many flowers in one head, brightly coloured petals especially blues and yellows, small amounts of nectar, strong scent, often strongly marked with 'landing guides'	Often short stamens and small anthers, close to nectar source in most flowers, sticky pollen	Short style, small stigma close to nectar source
Bird	Large strong flowers, some have petals but many don't, lots of nectar, often red	Often long, strong stamens and large anthers, sited a long way from the nectar source	Long style, smallish stigma, sited a long way from the nectar source
Mammal	Large strong flower heads, often not brightly coloured in many and often hidden in plant, much nectar produced at night	Strong and rigid	Strong and rigid

Some characteristics of Australian animals that pollinate flowers have also been studied, and are shown in the following table.

Animal	Characteristics
Insects	Poor eyesight, low intelligence, good sense of smell, small bodies
Birds	Good eyesight, intelligent, most active in daylight (diurnal), poor sense of smell, large bodies
Mammals	Good eyesight, intelligent, most are nocturnal, good sense of smell, large bodies

4.3

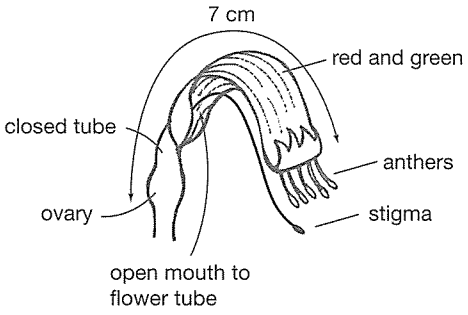
1 The flower features are related to the way the pollen is carried. **Propose** why bird-pollinated flowers would be larger and stronger and have more nectar than insect-pollinated flowers.

2 **Propose** why wind-pollinated flowers would have large brush-like stigmas and large anthers with a lot of pollen.

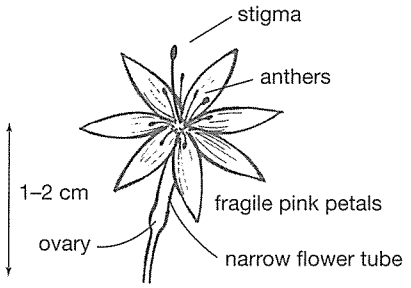
3 **Propose** why mammal-pollinated flowers in Australia lack colour, have a strong scent, and are hidden away.

4 For each flower below, **propose** which method of pollination occurs and **justify** your choice.

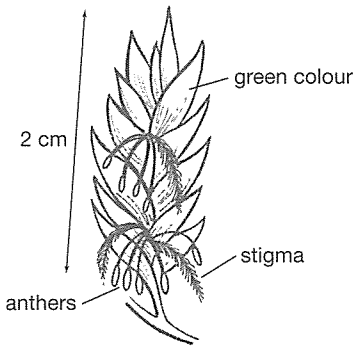
(a) Kangaroo paw



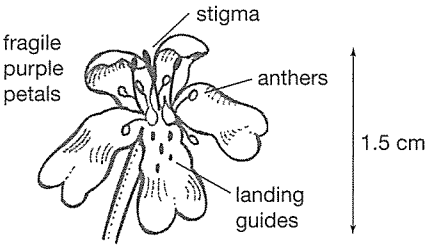
(b) Starflower



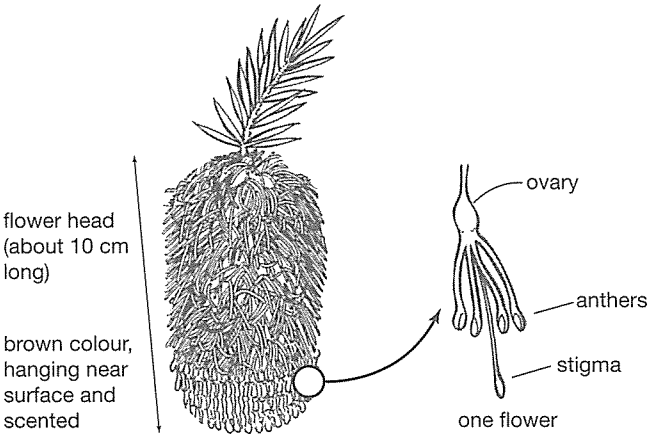
(c) Veldt grass



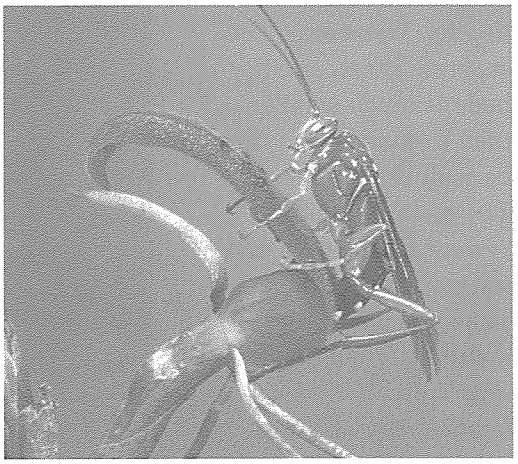
(d) Westringia



(e) Nodding banksia



5 Some amazing orchids have a flower that resembles a female wasp. The male wasp is tricked into trying to mate with the flower, as shown. When the male attempts to mate, a packet of pollen sticks to the wasp's abdomen. Then the wasp flies to another flower and attempts to mate with that one too. This pushes the pollen into the flower and pollinates it. Wasps have fairly poor vision and cannot see more than a few metres. **Propose** how the wasp finds the flower.



4.4 Sex stories

Science understanding, Science inquiry

Logical/Mathematical Verbal/Linguistic

An organism's method of reproduction can be related to its environment. Asexual reproduction may be suitable for some environments, but not others. Separate sexes and cross-fertilisation may be a disadvantage in some places. Some examples of how the method of reproduction relates to environment can be seen in the life cycles of the following organisms.

Tripod fish

The tripod fish is a strange animal. It spends most of its time resting on the bottom of the ocean in complete darkness, supported by the three large stiffened fins that give it its name. These can be seen in Figure 4.4.1. There is not much food on the bottom of the ocean and it is extremely cold. The chance of a tripod fish seeing another of its species in such an environment is low because only small numbers of fish can live in a place where food is in short supply. The tripod fish is a hermaphrodite, having male and female sex organs on the one individual. It can fertilise its own eggs.

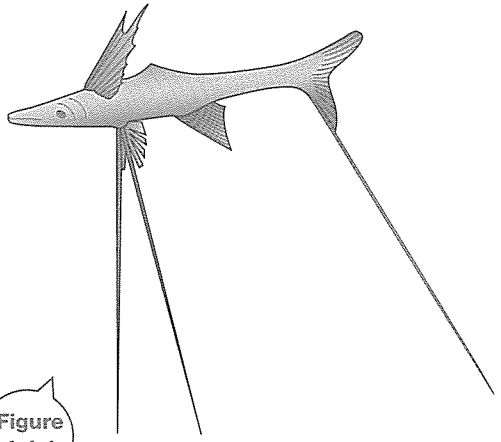


Figure 4.4.1

Tripod fish

Angler fish

Angler fish also live in darkness in the ocean depths. There are separate sexes, and the male is much smaller than a female. This can be seen in Figure 4.4.2. The male's digestive system shuts down and starts to break down as he reaches sexual maturity. Then the male must quickly find a female before he dies. When he finds a female, he bites into her skin, and the blood vessels of his mouth and her body join together. The male body then slowly shrivels up and he loses his brain, heart and eyes. The photograph shows this happening. The male then becomes nothing more than a pair of sex organs or gonads that release sperm into the female's bloodstream when hormones signal that an egg has been released.

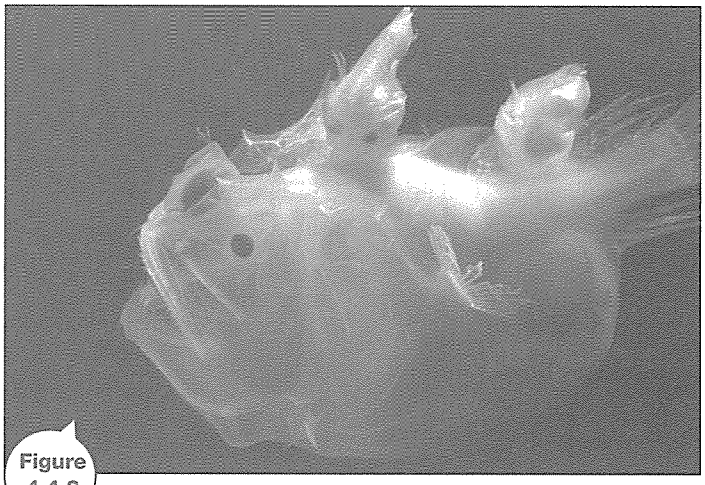


Figure 4.4.2 A female anglerfish with the tiny male attached

Seahorses

Seahorses are bony fish. In seahorses, the males become pregnant. Their mating involves the female inserting her oviduct into the male's brooding pouch and passing her eggs into it. The male passes his sperm into the brooding pouch where the eggs are fertilised. The eggs hatch in the male's pouch and are expelled by contractions of his body (Figure 4.4.3).

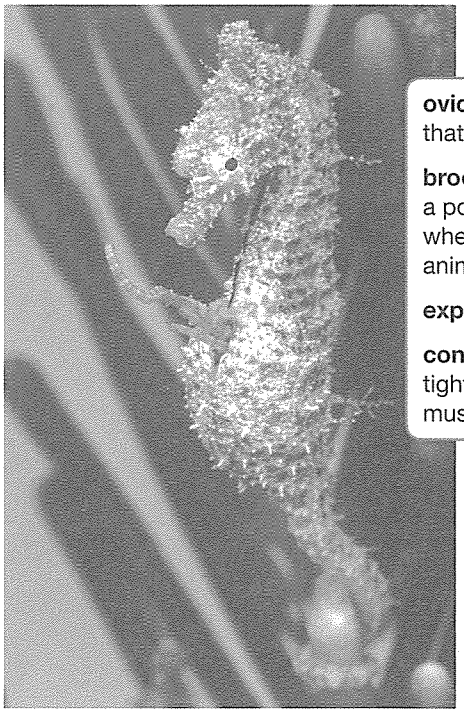


Figure 4.4.3
Male seahorse giving birth

oviduct (n) a tube that carries the eggs

brooding pouch (n) a pocket or place where a young animal develops

expel (v) to force out

contractions (n) tightening of muscles

HINT
Imagine where the tripod fish lives. Could it find a mate?

1 Think about the place where the tripod fish lives. **Propose** why the survival of the species depends on individuals being able to fertilise their own eggs.

2 Think about the place where the angler fish lives. **Propose** an advantage of a male angler fish becoming attached to the female's body.

3 **Propose** an advantage of the male seahorse keeping the developing babies in its pouch rather than allowing fertilised eggs to develop in the water like those of other fish.

HINT
In questions that include 'whether', you need to choose one of two things.

4 **Propose** whether angler fish or tripod fish would have more variation in their offspring. **Explain** your answer.

The has more variation in its offspring than the because

offspring (n) children of a parent animal

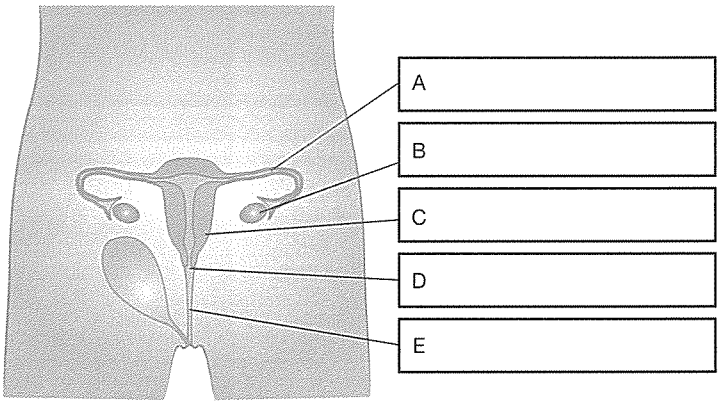
4.5 Human reproductive system

Science understanding

Verbal/Linguistic

1 Select words from the box below to **name** the parts of the female reproductive system indicated.

oviduct
vagina
ovary
cervix
uterus



2 **Write** the function of each of the following parts of the female reproductive system.

(a) ovary _____

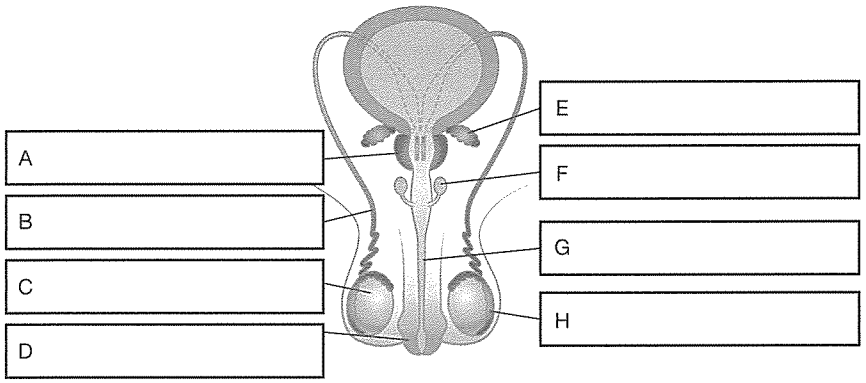
(b) uterus _____

(c) oviduct _____

(d) vagina _____

3 Select words from the box below to **name** the parts of the male reproductive system indicated.

epididymis
urethra
testicle (testis)
sperm duct (vas deferens)
prostate gland
seminal vesicle
Cowper's glands
penis



4 **Write** the function of each of the following parts of the male reproductive system.

(a) testes _____

(b) epididymis _____

(c) sperm duct _____

(d) penis _____

4.6 Puberty and growth

Science inquiry

Logical/Mathematical

The table shows the average heights of boys and girls at different ages.

Age (years)	Male height (cm)	Female height (cm)
Birth	50.5	50.2
2	87.5	86.6
4	103.4	103.2
6	117.5	115.9
8	130.0	128.0
10	140.3	138.6
12	149.6	151.9
13	155.0	157.1
14	162.7	159.6
16	171.6	162.2
18	174.5	162.5

1 Use the axes provided on the next page to **construct** line graphs showing males and females on the same axes. Put age on the horizontal axis and height on the vertical axis.

2 **Compare** the growth patterns of boys and girls up to age 10.

3 **Compare** the growth patterns of boys and girls between ages 10 and 16.

4 **Identify** the ages when girls grow faster than boys.

5 Many people say 'Girls mature faster than boys.' Use your graph as evidence to **justify** this claim.

6 **Propose** why growth spurts occur.

4.7 Drugs and pregnancy

Science understanding, Science as a human endeavour

Verbal/Linguistic

Refer to the Science as a Human Endeavour on page 162 of your student book to answer the following questions.

1 **Explain** why thalidomide taken by a pregnant woman could damage her developing fetus.

2 **Explain** why the fetus could be affected each time a pregnant woman drinks alcohol.

3 **Identify** four signs of fetal alcohol syndrome in newborn babies.

4 **List** four permanent long-term effects of fetal alcohol syndrome on the lives of affected children.

5 **State** three ways smoking can affect the chances of a normal birth.

6 **Identify** two long-term effects that smoking during pregnancy could have on the health of children.

7 **Summarise** the advice that should be given to a pregnant woman regarding smoking, alcohol and other drugs during pregnancy.

4.8 Literacy review

Science understanding

Verbal/Linguistic

1 **Use** the clues to **identify** the jumbled words.

Jumbled word	Clue	Answer
mendlovepete	Changes in body form and shape in an organism's life	
unopredictor	The process of parents producing new individuals, or offspring	
hogwrt	An increase in body size	
harten	Part of the flower that produces the pollen	
ymebro	A developing offspring at a very early stage of development	
thedimraphero	Individual with both male and female sex organs	
lootinplain	Transfer of pollen from the anther to the stigma	
ronshome	Chemicals made in the body to control reproduction and physical characteristics	
testagoni	The time period from fertilisation to birth	
boralu	Process leading to birth, from first uterine contractions to afterbirth expulsion	

2 **Use** the clues to **identify** the words.

Clue	Word
Stage in an insect life cycle during which the larva changes into an imago	p _ p _
Changes that happen to an individual from its formation to when it has produced offspring	l _ _ e c _ _ l _
The structure that the ovary of a flowering plant turns into as the seeds ripen	f _ u _ _
Part of the uterus that keeps it closed while the baby is developing	c e _ _ i _
Regular monthly changes in the hormones and reproductive organs of females	m _ _ s _ r u _ _ c _ c l _
Organ in which the fetus grows and develops	u _ e _ _ s
The process of two individuals joining to allow gametes to become fertilised	c _ p _ _ a t _ _ n
The process of the blastocyst burrowing into the lining of the uterus	i _ p _ _ n _ _ t _ _ n
The time in life when physical changes bring sexual maturity	p _ _ _ r t _
The first cell of the new individual after fertilisation	_ _ g o t _

3 **Recall** key terms and their meanings by drawing a line to match each statement in column 1 with the correct term in column 2.

Column 1	Draw your lines across here	Column 2
When an organism looks quite different at different stages in its life		fetus
The joining of gametes		ovulation
Tubes down which the egg passes and where fertilisation occurs		placenta
Stage of development when most of the major organs and systems are present		germination
Preventing pest and disease organisms from entering our country		metamorphosis
When the young growing plant sprouts out of the seed		amniotic fluid
The egg bursting out of the follicle		stigma
Membranes of the fetus and mother allowing exchange of nutrients and oxygen for wastes		oviducts (fallopian tubes)
New individual grows from one parent's body and does not involve joining of gametes		fertilisation
Flower part that receives the pollen		asexual reproduction
Fluid around the embryo acting as a shock absorber and keeping the embryo at a constant temperature		biosecurity

5.1 Energy around you

Science understanding

Verbal/Linguistic

1 There are many different forms of energy. Using the list below, **classify** which types of energy are present in each of the following situations.

kinetic energy sound energy light energy heat energy electrical energy chemical energy gravitational potential energy elastic potential energy nuclear energy

Situation	Types of energy present
(a) A racing car starts a race.	kinetic, heat, sound
(b) A rubber ball warms up in the sun.	
(c) A hot air balloon sails above some clouds.	
(d) The springs on a trampoline are stretched before it bounces upwards.	
(e) Petrol is put into a car.	
(f) A desk lamp shines brightly.	
(g) A candle burns.	
(h) A ball rolls down a hill.	
(i) A boy brushes his teeth.	
(j) A cat climbs up a tree.	

2 Kinetic energy is the energy of a moving object. Potential energy is the energy stored in an object. **Classify** each example below as having either kinetic or potential energy.

(a) A slingshot about to fire _____

(b) A ball at the highest point of a bounce _____

(c) A swimmer about to dive from a high platform _____

(d) A swimmer hitting the water from a dive _____

(e) A teenager skating along a footpath _____

(f) A hamburger with the lot sitting on a plate _____

(g) A stone rolling along a road _____

(h) A new packet of AA batteries _____

(i) A bowl of cereal with milk _____

(j) A leaf on a tree _____

5.2 Energy changes

Science understanding

Visual/Spatial Verbal/Linguistic

Energy makes things happen. When something happens, energy may be passed, or *transferred*, from one object to another. This happens when you hit a tennis ball. Some of the kinetic energy of the racquet is transferred to the ball. Energy can also be *transformed* into another type of energy. In order to hit the tennis ball, chemical energy from food that you ate was transformed into kinetic energy in your arm.

1 For each example below, the source of the energy is given. **State** the receiver of this energy and **identify** whether energy was transferred or transformed in the process.

Example	Source of energy	Receiver of energy	Is energy transferred or transformed?
(a) Tom runs in a race.	chemical energy (food)		
(b) A shirt hanging on a washing line dries in the sun.	heat energy (the Sun)		
(c) An aeroplane takes off.	chemical energy (fuel)		
(d) A golf club hits a golf ball.	kinetic energy (the club)		
(e) A cat warms up by an open fire.	heat energy (the fire)		
(f) A ceiling fan is switched on.	electrical energy		

2 An energy flow diagram is a way of showing the energy changes that happen. **Construct** an energy flow diagram for the following energy changes.

(a) A petrol lawn mower cuts some grass.

(b) A solar cell is used to operate an outside light.

(c) An electric knife is used to carve a roast.

(d) A wind-up beetle is released and scuttles across the floor.

5.3 Specific heat capacity

Science understanding, Science inquiry

Logical/Mathematical **Verbal/Linguistic**

You may have walked along the beach on a hot day and felt the sand burning your feet, but jumped in the water and cooled down straight away. This happens because it only takes 880 J of energy to raise the temperature of sand by 1°C, but 4200 J to raise the temperature of the same amount of water by 1°C. As a result, sand heats up much faster (and cools down much faster) than water. The amount of energy required to raise the temperature of 1 kilogram of a substance by 1°C is called its specific heat capacity (symbol c).

The table below lists the specific heat capacity of a number of common substances.

Substance	Specific heat capacity, c (J/kg/K)
Water	4200
Human body	3500
Alcohol	2450
Ice	2100
Steam	2000
Rubber	1700
Air	1000
Aluminium	900
Sand	880
Glass	670
Iron	440
Copper	390
Lead	130

The amount of heat energy needed to change the temperature of a substance by a certain number of degrees can be calculated using the formula:

Amount of heat energy required (J) = $m \times c \times \triangle T$

where m = mass of substance (kg)

c = specific heat capacity (J/kg/K)

$\triangle T$ = temperature change (°C)

Worked example

1 **Calculate** the amount of heat energy required to raise the temperature of:

(a) 2 kg of water by 5°C

(b) 2 kg of copper pipe by 5°C.

2 **Compare** these results.

Solution

1 (a) For water, $m = 2\,\text{kg}$, $c = 4200\,\text{J/kg/K}$ and $\triangle T = 5°\text{C}$.
Using the formula:
Amount of heat energy required (J) = $m \times c \times \triangle T$
$= 2 \times 4200 \times 5$
$= 42\,000\,\text{J}$

(b) For copper $m = 2\,\text{kg}$, $c = 390\,\text{J/kg/K}$, $\triangle T = 5°\text{C}$.
Amount of heat energy required (J) = $m \times c \times \triangle T$
$= 2 \times 390 \times 5$
$= 3900\,\text{J}$

2 This explains why a copper pipe will heat up much faster than the same mass of water when equal amounts of heat energy are absorbed.

1 As humans, we can absorb a lot of heat before our temperature rises. **Explain** why this is beneficial to us.

_____

2 Water is used in the radiator of a car to absorb heat from the engine. **Explain** why water is suitable for this task.

_____

3 Refer to the formula stated opposite and the specific heat capacities listed in the table to **calculate** the amount of heat needed or released in raising or lowering the temperature of the following materials:

(a) A 1 kg iron bar heats up from 10°C to 30°C lying in the sun.
Amount of heat required = $m \times c \times \triangle T$

_____

(b) 1 kg (1 litre) of water at 12°C is boiled in a kettle.
Amount of heat required = $m \times c \times \triangle T$

_____

(c) 2 kg of water in a hot water bottle cools from 39°C to 10°C overnight.
Amount of heat released = $m \times c \times \triangle T$

_____

(d) A 100 gram (0.1 kg) aluminium spoon heats up from 8°C to 28°C while being used to stir a mug of hot chocolate.
Amount of heat required = $m \times c \times \triangle T$

_____

(e) A 500 gram (0.5 kg) glass bottle that was 60°C cools to 20°C.
Amount of heat released = $m \times c \times \triangle T$

_____

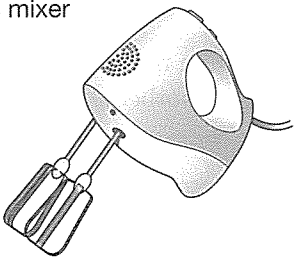
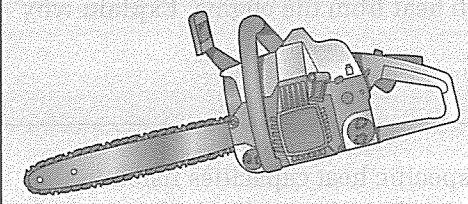
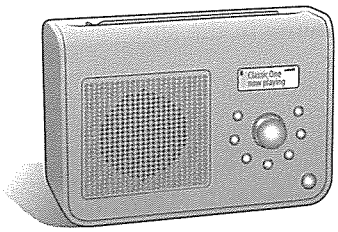
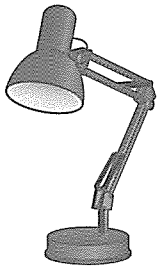
5.4 Energy efficiency

Science understanding

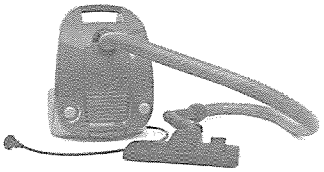
Logical/Mathematical Visual/Spatial

Many household devices convert electrical energy into other forms.

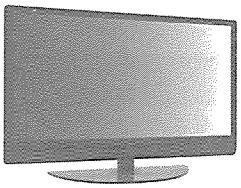
1 **Identify** the types of energy, both useful and wasted, that result from transformations by the following devices. The first example has been done for you.

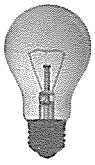
Device	Useful energy produced	Wasted energy produced
(a) Electric mixer 	kinetic	heat, sound
(b) Chain saw 		
(c) Radio 		
(d) Treadmill 		
(e) Desk lamp 		

2 The following devices convert the electrical energy supplied into specific amounts of other forms of energy. Recalling that energy is conserved, **calculate** the missing values to complete the following energy conversions:

(a) 500 J ⟶  ⟶ 150 J heat energy
⟶ 50 J sound energy
⟶ _____ J kinetic energy

(b) 500 J ⟶  ⟶ _____ J heat energy
⟶ 50 J light energy

(c) 500 J ⟶  ⟶ _____ J heat energy
⟶ 100 J light energy
⟶ 50 J sound energy

(d) 100 J ⟶  ⟶ 70 J heat energy
⟶ _____ J light energy

3 The efficiency of the devices in the previous question can be calculated using the following equation:

$$\frac{\text{useful energy output (J)}}{\text{energy input (J)}} \times 100$$

(a) Use the equation above to **calculate** the efficiency of the toaster.

_____

_____

(b) Assuming that light and sound are the useful forms of energy from a television, **calculate** the efficiency of the plasma television.

_____

_____

(c) **State** whether the toaster or the television is more energy efficient.

_____

(d) **Justify** your answer above.

_____

_____

5.5 Space heating energy consumption in Australia

Science understanding, Science inquiry

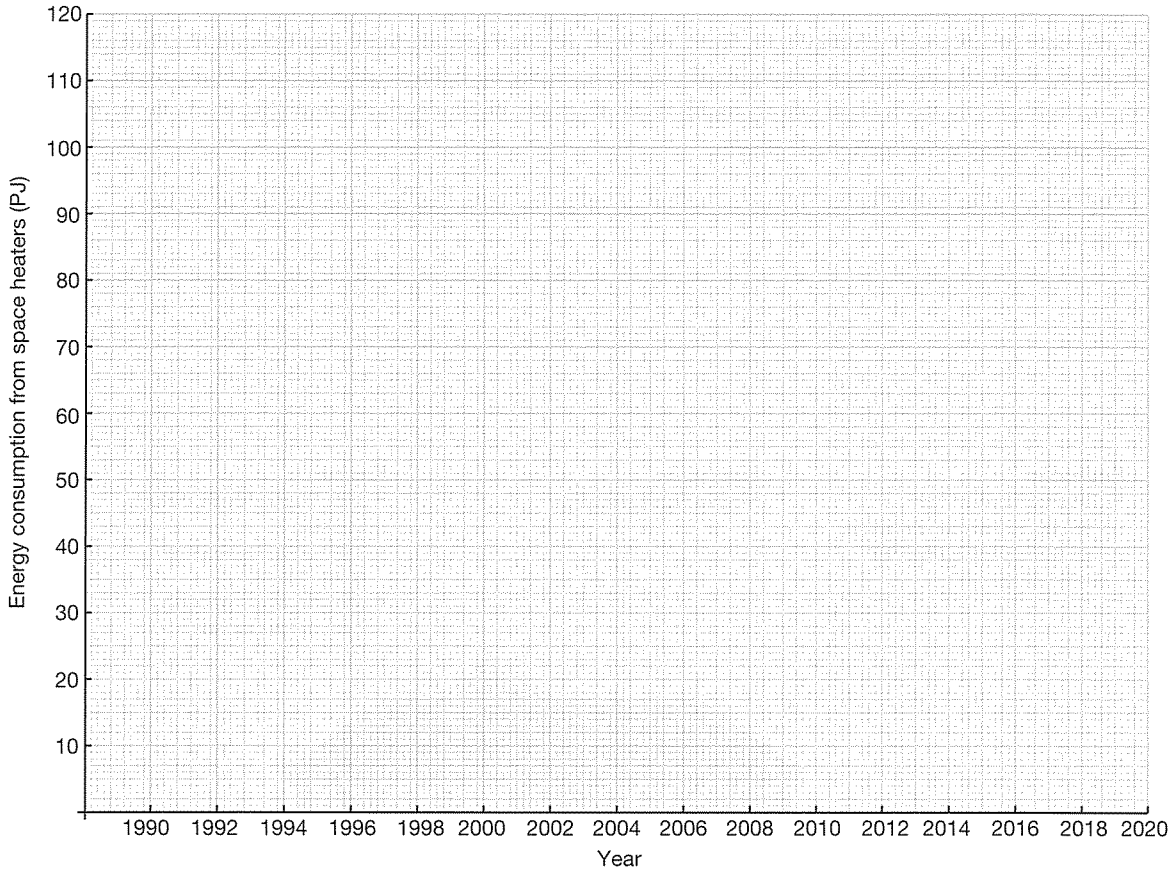
Logical/Mathematical Visual/Spatial Verbal/Linguistic

An Australian government report titled *Energy Use in the Australian Residential Sector 1986–2020* presents data about how Australian households use energy, and predicts how this will change. Despite the increasing floor area of new homes and the trend for larger televisions and more household appliances, consumption is predicted to drop by 6% by 2020. This decrease is expected as a result of the use of energy-efficiency awareness programs. Table 5.5.1 lists data from each state and territory of Australia. It outlines energy use and projected energy use of space heaters. Space heaters use about 38% of total household energy.

Table 5.5.1 Space heating energy consumption (petajoules) by state 1986–2020
(1 petajoule (PJ) = 1 000 000 000 000 000 J)

Year	NSW	Vic	Qld	SA	WA	Tas	NT	ACT
1990	26.6	62.6	3.4	9.4	7.7	14.0	0.0	2.6
1991	24.0	59.3	2.8	8.2	7.1	13.0	0.0	2.4
1992	26.2	64.8	3.1	8.9	7.4	14.7	0.0	2.9
1993	29.1	63.3	2.9	9.8	8.4	15.7	0.0	3.5
1994	25.9	67.2	2.7	8.5	7.3	14.6	0.0	3.2
1995	30.1	78.5	3.5	9.6	9.1	15.7	0.0	3.5
1996	28.8	80.2	3.1	9.2	8.8	15.5	0.0	3.7
1997	29.3	78.0	3.7	9.6	8.7	15.4	0.0	3.8
1998	28.8	82.8	3.1	9.4	8.8	14.5	0.0	3.8
1999	28.6	80.1	2.6	9.6	8.3	14.8	0.0	4.0
2000	25.5	70.2	3.1	8.4	7.3	13.7	0.0	4.1
2001	23.8	71.4	3.2	8.3	6.7	12.5	0.0	4.1
2002	24.8	76.4	3.1	9.3	7.2	12.0	0.0	4.2
2003	22.3	71.9	3.2	8.3	6.3	10.7	0.0	4.2
2004	24.9	84.6	3.1	9.6	7.0	11.1	0.0	4.7
2005	25.4	85.9	3.3	9.2	7.7	11.0	0.0	5.0
2006	25.3	87.1	3.2	9.1	7.6	10.9	0.0	5.2
2007	25.2	88.4	3.2	9.1	7.5	10.8	0.0	5.4
2008	25.1	89.7	3.2	9.0	7.4	10.6	0.0	5.6
2009	25.0	90.0	3.2	9.0	7.3	10.5	0.0	5.8
2010	24.9	92.3	3.2	9.0	7.3	10.4	0.0	5.9
2011	24.9	93.8	3.2	9.0	7.2	10.2	0.0	6.1
2012	24.9	95.5	3.2	8.9	7.2	10.1	0.0	6.3
2013	24.9	97.3	3.2	8.9	7.1	10.0	0.0	6.5
2014	24.9	99.2	3.2	8.9	7.1	10.0	0.0	6.7
2015	25.0	101.1	3.2	8.9	7.1	9.9	0.0	6.9
2016	25.0	103.1	3.2	8.9	7.1	9.8	0.0	7.1
2017	25.1	105.2	3.2	9.0	7.1	9.7	0.0	7.3
2018	25.1	107.4	3.2	9.0	7.0	9.7	0.0	7.6
2019	25.2	109.5	3.2	9.0	7.0	9.6	0.0	7.8
2020	25.3	111.8	3.2	9.1	7.0	9.5	0.0	8.0

1 Use the data in Table 5.5.1 to **construct** a line graph for each state and territory on the axes below to show its energy consumption for space heating. Show each graph as a different colour or use a key to label them. (Round the decimal points off to the nearest whole number to plot these graphs.)



2 (a) **State** which state or territory uses the most energy for space heating.

_____

(b) **Propose** reasons that could explain this result.

_____

3 Tasmania has the coolest climate in Australia yet does not use the most energy for heating. **Propose** a reason to explain why.

_____

4 **Discuss** how increasing the floor area of new homes and extensions of existing homes affect the cost of heating and cooling.

_____

5 New building standards demand that the shell of a home be better insulated. **Explain** how this would affect heating and cooling costs.

_____

_____

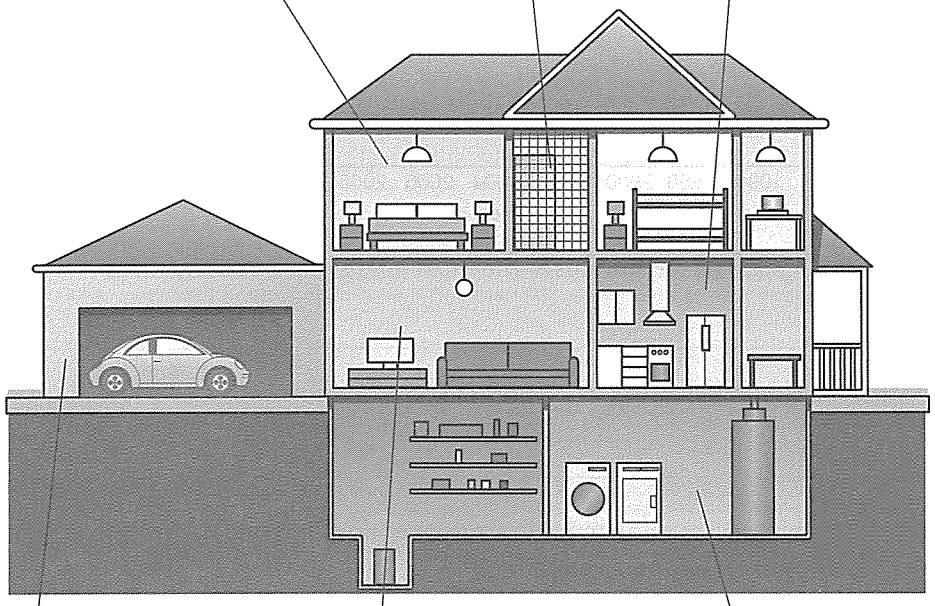
5.6 Conserving energy

Science understanding, Science as a human endeavour

Verbal/Linguistic Visual/Spatial

If we can reduce our energy use, then we will reduce greenhouse gas emissions. Some ways of saving energy are very simple, such as turning off an appliance at the power point when it is no longer being used. The diagram below gives some tips on how you can save energy around your home.

Propose as many additional ways to save energy as you can by adding these to the diagram.



Bedroom
- close curtains in the evening to save on heating
- turn computer screen off if not being used

Bathroom
- have short showers

Kitchen
- thaw frozen foods before cooking
- only run a dishwasher when it is full
- use lids when heating food in saucepans

Garage
- try to walk, ride or catch public transport so that your family uses a car less

Lounge room
- close blinds, curtains and windows on a hot day
- don't use heaters overnight or when no one is home

Laundry
- try to dry clothes on the washing line, or on a rack above a heating duct or near a heater (if safe)
- wash clothes in cold water

5.7 Home insulation

Science as a human endeavour

Verbal/Linguistic

Heat naturally flows from regions of higher temperature to regions of lower temperature. As a result, when you use heating to warm up the living areas of your home in winter, this warm air, if it can flow, will flow through cracks or gaps in walls to the cool air outside. Alternatively, heat can flow up into the roof space, or through walls into a garage. This means that to keep a house warm in winter, householders need to use a lot of energy.

Similarly, in summer, the warm air outside will naturally flow into a cool house. Once again, householders need to use a lot of energy to cool their homes.

Insulation is a material that can be added in ceilings and between the walls of a home to reduce heat flow. If heat flow is restricted, the energy costs required to heat and cool a home are reduced. The following fact sheet produced by the Queensland Government explains what types of insulation are available.

EnergyWise
Queensland

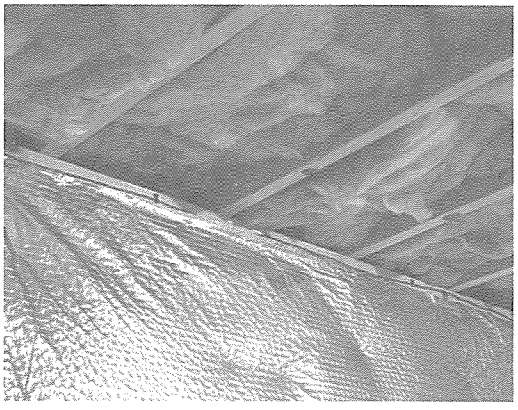
Insulation – saving energy and money

Energy efficient cooling and heating

Insulation can be the most effective item you can add to your home to improve its energy efficiency.

Insulation works by creating a barrier to heat transfer through the ceiling and walls. In summer it helps keep your home cooler by reducing the amount of heat entering your home. In winter it helps keep your home warmer by trapping the warm air inside. For best results, all ceilings, walls and raised walls should be insulated.

Save up to 45 percent on heating and cooling energy with roof and ceiling insulation.



Insulate to help cut air conditioning and heating running costs

Ceiling insulation can make a significant difference to the cost of running your air conditioner.

When your home is insulated, it will be more comfortable regardless of the season, and less reliant on climate-controlled appliances, such as air conditioners and heaters. As you reduce the amount of energy you use to stay comfortable, you will save money on appliance running costs and reduce the amount of greenhouse gases emitted.

When you do turn on your air conditioner or heater, it will use less energy and cost you less to run. There will also be less wear and tear on your heating and cooling appliances as they don't have to work as hard.

5.7

Types of insulation available

There is a variety of insulation products available and it is important to assess the type of insulation that will best suit your energy needs. There are three main types of ceiling insulation—loose fill, bulk fill (commonly referred to as 'batts') and reflective foil. The right type for your home will depend on the type of ceiling cavity, access available to the ceiling and personal choice.

The most important thing to consider when choosing insulation is the **R value**. An R value is a measure of the insulation's resistance to heat flow and therefore, its performance.

The higher the R value, the greater the resistance to heat transfer. The climate where you live and the design of your home will influence the R value and type of insulation suitable for your home, and potential for energy savings.

Enhancing home insulation

You may already have adequate roof insulation, however, **roof ventilators** are recommended when you install bulk fill insulation. Ventilation removes excess heat in summer preventing overheating and removes moisture in winter. **Eave vents**, usually small rectangular grids located under your eaves, are required when a roof ventilator is installed. The roof ventilator extracts air from the roof and the eave vents replenish the ceiling cavity with fresh air from outside.

West-facing **windows should be shaded or tinted** to maximise the benefit of insulation. This can be achieved with awnings, blinds or specialised products such as solar window tinting.

1 **Explain** why, without insulation, it is hard to keep a home cool in summer and warm in winter.

2 **List** places that insulation may be used in a home.

3 **Explain** how adding insulation to a home will improve its energy efficiency.

4 **List** the three main types of ceiling insulation that is available.

5 (a) **Explain** what is meant by the term 'R value'.

(b) **State** whether it is better to use insulation with a low or a high R value.

5.8 The development of aircraft

Science as a human endeavour

Verbal/Linguistic

Refer to the Science as a Human Endeavour on pages 195 and 196 of your student book to answer the following questions.

1 **Recall** the name of the flying machine that Leonardo da Vinci designed in the 1480s.

2 **Describe** how Sir George Cayley discovered many principles of flight.

3 **Identify** three features of George Cayley's fixed-wing flying machine.

4 **Identify** the two types of gliders built by Otto Lilienthal. **Explain** the basic difference between the two types.

5 **Describe** the major change to aircraft bodies that happened in the early 1900s, which enabled aircraft to fly faster.

6 **Recall** what provided thrust for aircraft built after World War 2.

7 Jet engines were developed in 1937. **Explain** how a jet engine works.

8 **Discuss** the advantage of using composite materials such as carbon fibre reinforced plastic in improving the efficiency of modern passenger jets.

9 **Describe** what powered the flight of the *Solar Impulse* in 2010.

10 **Outline** what you think have been the most important developments in aircraft design since the early 1900s.

11 **Design** what you think aircraft of the future may look like in the space below.

5.9 Literacy review

Science understanding

Verbal/Linguistic

1 **Use** the clues to **identify** the missing words.

CLUE	WORD
(a) We measure energy using this unit.	j_ _ _ _
(b) Energy of movement	_i_ _ _ _ _c
(c) Energy that warms you up	_ _ _ _t
(d) Energy that enables us to see	l_ _ _ _t
(e) This energy is caused by vibrations	_ _ _ _nd
(f) Energy that powers a television	e_ _ _ct_ _ _ _ _ _ _
(g) Stored energy	_ot_ _ _ _ _ _ _
(h) Stored energy due to height above the ground is called	g_ _ _ _it_ _ _ _ _ _ _ _ potential energy
(i) The stored energy found in food and fuel	_h_m_ _ _ _
(j) Energy stored in a stretched rubber band	_ _ _ _ _tic
(k) Energy stored inside the particles that make up matter	n_ _ _ _ _ _ _
(l) A measure of the proportion of useful energy that is produced by a device	_f_ _ _ _ _ _ _ _ _
(m) A law that states that energy can never be created or destroyed is called the law of _____ of energy.	_ _ _ _s_ _ _ _ _ _ _ _ _
(n) A label showing a number of stars that is used to compare energy efficiency of appliances is called the energy _____ label.	_ _ _t_ _ _ _

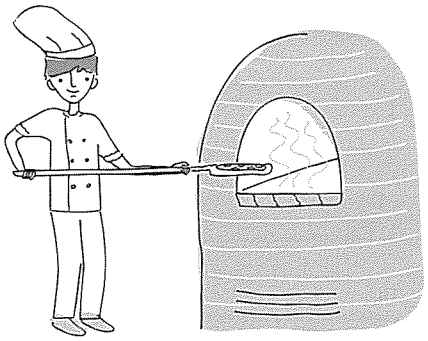
6.1 Which change is that?

Science understanding

Visual/Spatial

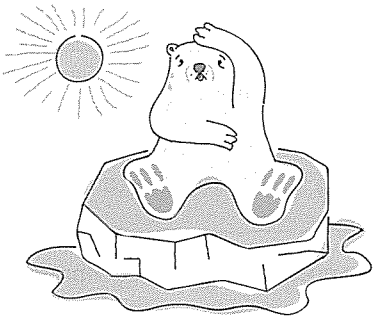
The world around you is constantly changing. Some of these changes are known as physical changes, in which no new substances are produced. Other changes are known as chemical changes, in which new substances are produced. **Classify** each of the following situations as a physical or chemical change.

(a) Cooking a pizza



Physical ☐ **Chemical** ☐

(b) Ice melting

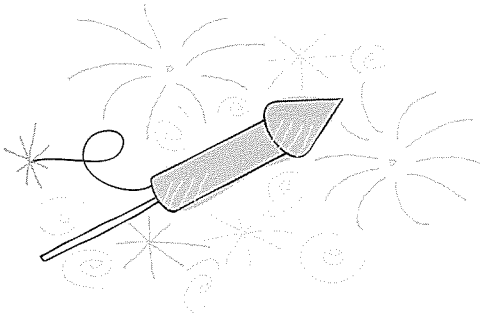


Physical ☐ **Chemical** ☐

(c) Chopping wood

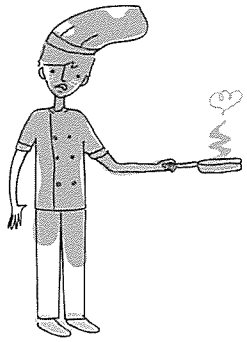
Physical ☐ **Chemical** ☐

(d) Fireworks



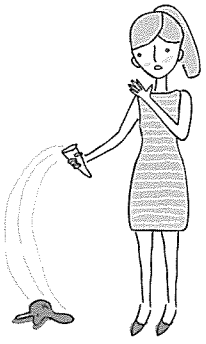
Physical ☐ **Chemical** ☐

(e) Burning breakfast



Physical ☐ **Chemical** ☐

(f) Ice-cream hitting the ground

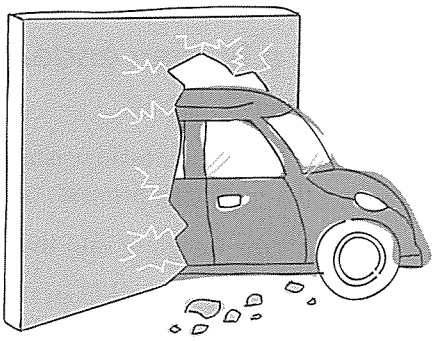


Physical ☐ **Chemical** ☐

(g) Stirring a cake mixture

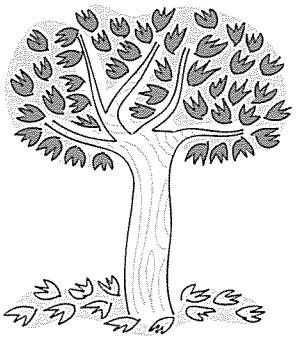
Physical ☐ Chemical ☐

(h) Crashing a car



Physical ☐ Chemical ☐

(i) Autumn leaves changing colour



Physical ☐ Chemical ☐

(j) An explosion

Physical ☐ Chemical ☐

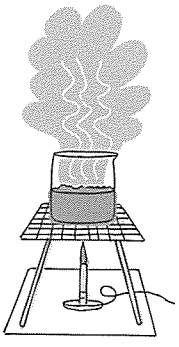
(k) Synthesising a new chemical

Physical ☐ Chemical ☐

(l) Baking bread

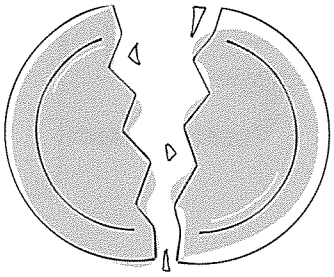
Physical ☐ Chemical ☐

(m) Boiling water



Physical ☐ Chemical ☐

(n) Breaking a plate



Physical ☐ Chemical ☐

6.2 Recycling glass

Science as a human endeavour

Visual/Spatial

Glass makes up 7% of domestic waste. Fortunately glass can be recycled over and over again. During the recycling process, the glass goes through several physical changes.

1 When you throw the glass into the bin, it gets mixed in with the rest of the rubbish.

2 The glass is then separated from the general waste.

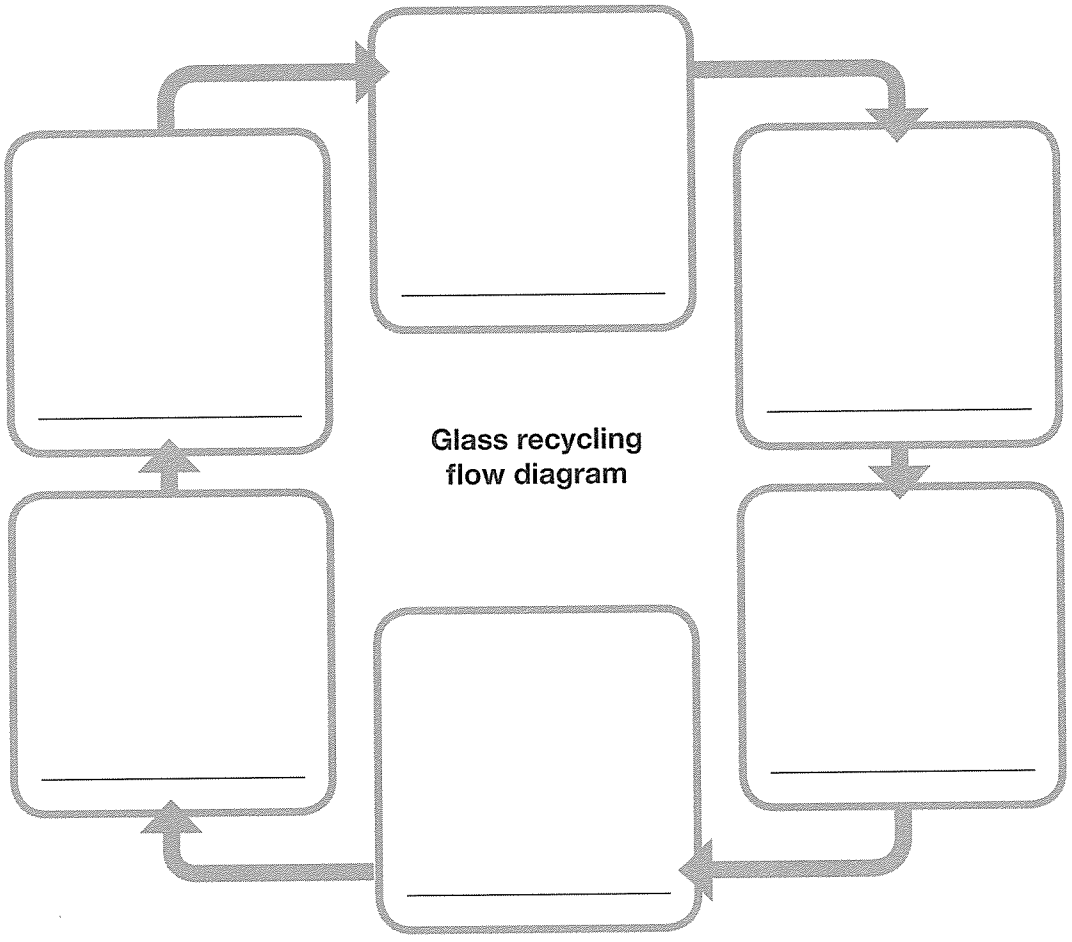
3 The glass is then separated by colour.

4 Each type of glass is then crushed into small pieces.

5 The small pieces of glass are then melted in a furnace to make liquid glass, which is then poured into moulds.

6 The glass is then allowed to solidify into its new form, such as bottles, plates or windows.

Use this information to fill in the flow diagram below. **Label** each physical change and **construct** a diagram to represent each stage in the process.



6.3 The particle model

Science understanding

Verbal/Linguistic Visual/Spatial

Scientists use models to help understand and predict how things work. The models are simplified versions of the real thing that explain the most important features.

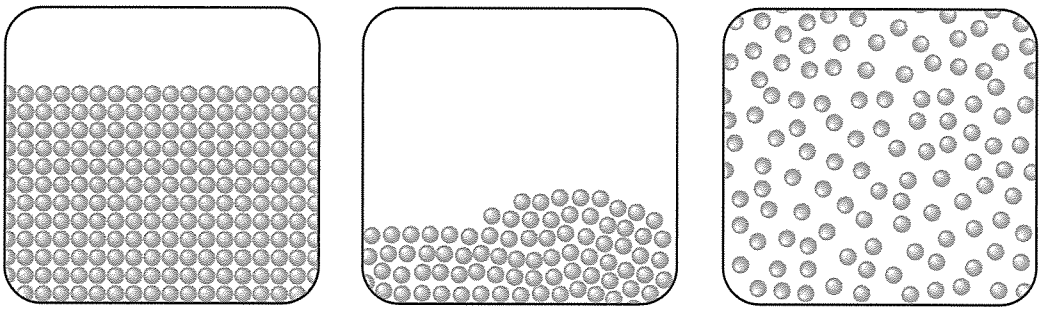
A very important model in science is the particle model. The particle model is used by scientists to understand the physical properties of solids, liquids and gases. The particle model makes three assumptions:

1 Solids, liquids and gases are all made up of hard, ball-like particles that cannot be split (are indivisible) and are invisible to the naked eye.

2 These particles are constantly moving and/or vibrating.

3 There are forces of attraction between the particles.

Below are diagrams of solids, liquids and gases as described by the particle model.



1 Refer to the particle model diagrams above to **compare** the movement of particles in solids liquids and gases.

_____

_____

_____

_____

2 **(a)** The forces of attraction hold the particles of substance together. **Deduce** in which state of matter (solid, liquid or gas) these forces are:

(i) strongest _____

(ii) weakest _____

(b) **Justify** your answers.

_____

_____

_____

_____

3 From your answers to questions 1 and 2, **propose** why solids hold their shape, liquids take on the shape of their container, and gases fill their container.

4 **Use** the particle model diagrams to **describe** the distance between particles in solids, liquids and gases.

5 **Explain** why solids and liquids are incompressible (cannot be squashed) while gases are compressible.

6 **Use** the particle models to **construct** particle model diagrams of the following cases.

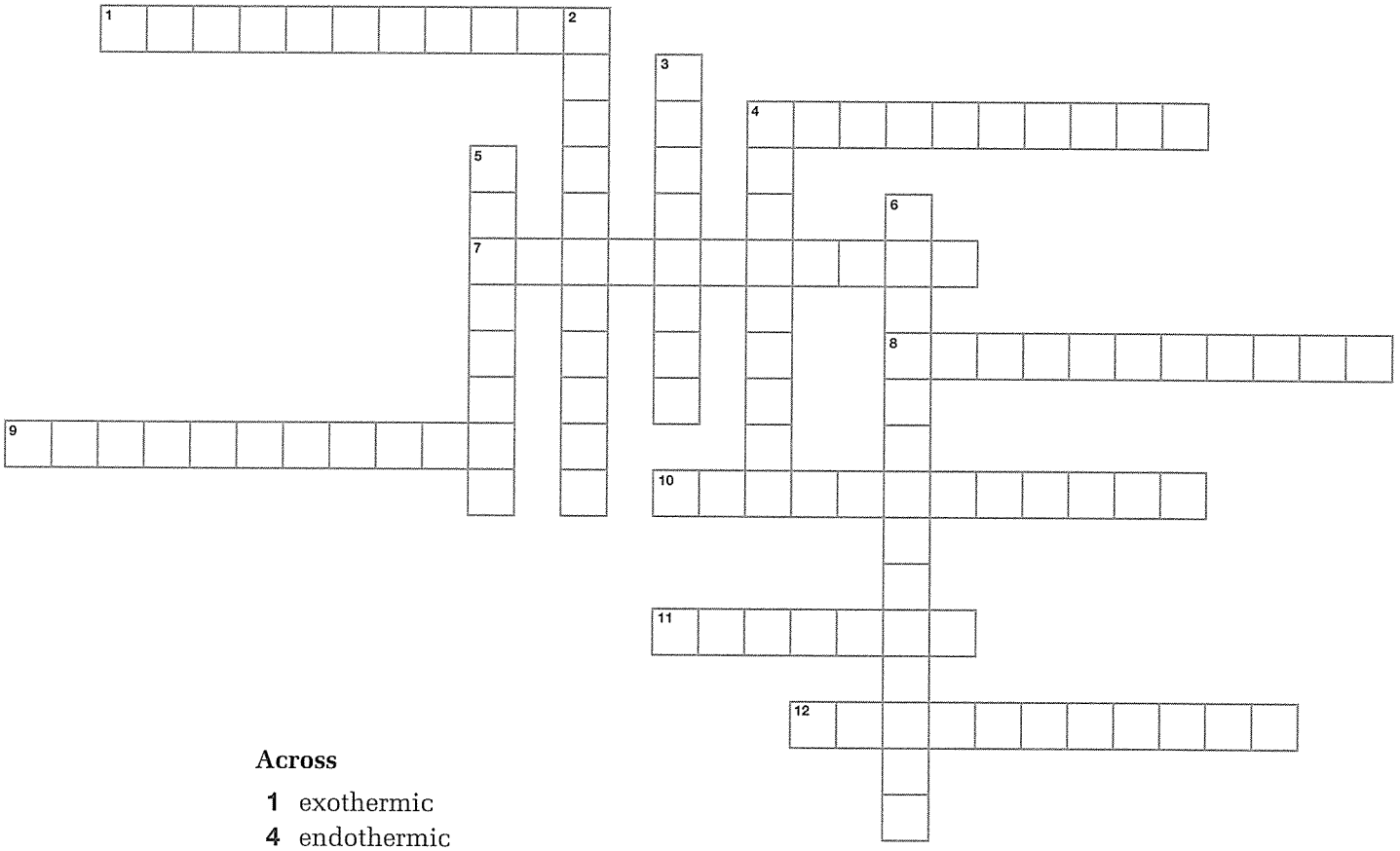
(a) An ice cube floating in water	**(b)** A bubble of air trapped in a block of ice
(c) Boiling water	**(d)** A water droplet suspended in air

6.4 Opposite processes

Science understanding

Verbal/Linguistic

To solve the puzzle, **identify** and record the name of the process that is *opposite* to the clue provided.



Across

1 exothermic
4 endothermic
7 condensation
8 deposition
9 expansion
10 evaporation
11 freezing
12 non-spontaneous

Down

2 dissolve
3 crystallise
4 contraction
5 melting
6 spontaneous

6.5 Breaking bonds

Science inquiry

Verbal/Linguistic Visual/Spatial

The particles in solids are held together by strong bonds that fix the particles in position. When the solid is heated, the particles begin to vibrate more and more. At the melting point, the particles vibrate so rapidly that the particles break their bonds and move around freely. This is when the solid melts and becomes a liquid.

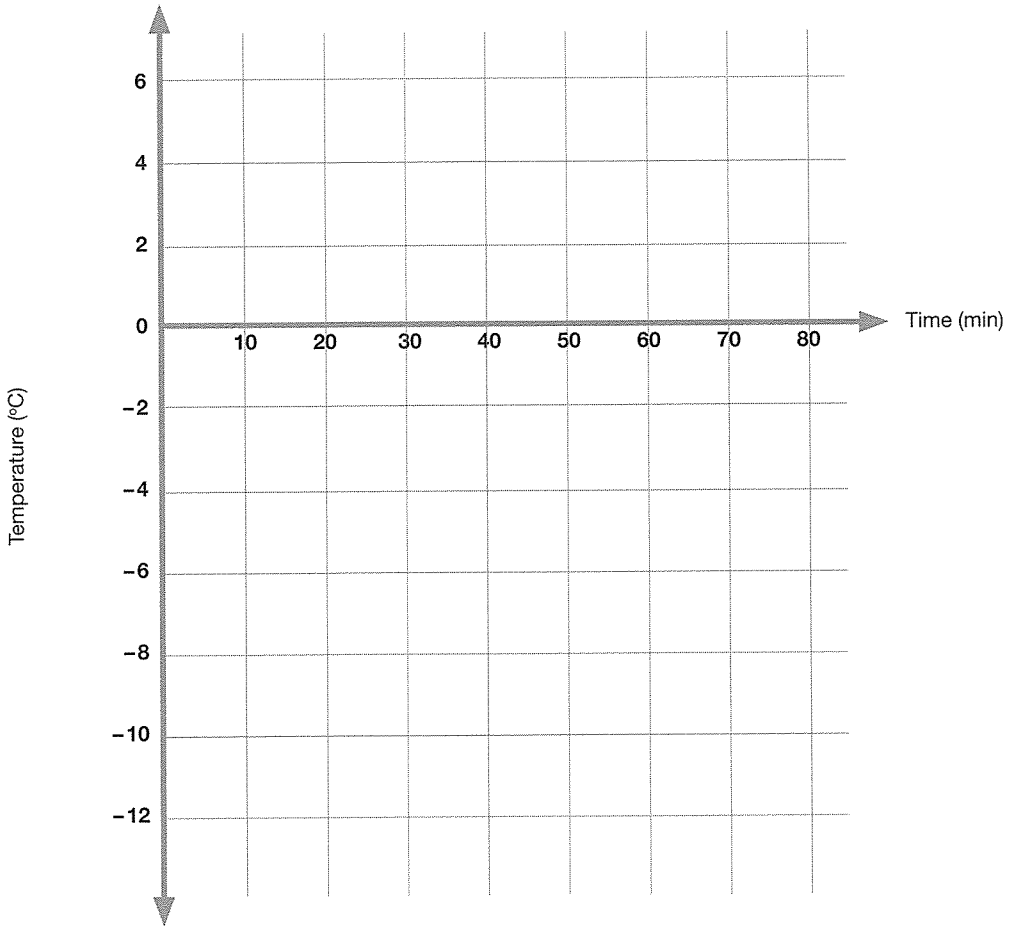
Jessica decided to measure the temperature of ice as it was heated through the melting point. She took a beaker of ice and heated it gently with a constant heat. She then measured the temperature of the ice–water mixture every 5 minutes. Her results are shown in the table below.

Time (min)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
Temperature (°C)	–11	–9	–7	–5	–3	–1	–0.5	0	0	0	0.5	1	2	3	4	5

1 **Construct** a graph of Jessica's results on the axes below.

2 **State** the melting point of ice. _____ °C

3 Using the graph, **identify** whether ice or liquid water heats up fastest. _____



4 **Describe** what happens to the temperature of the ice–water as it passes through the melting point.

5 The particle model makes three assumptions about the particles in solids, liquids and gases.

1 The particles are made up of hard, incompressible and indivisible balls.

2 The particles are constantly moving.

3 The particles are attracted to each other.

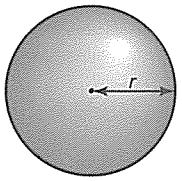
Propose which of these properties explains how the temperature changes near the melting point. **Use** the particle model to **justify** your answer.

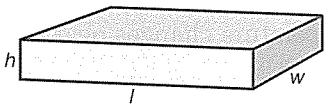
6.6 Density calculations

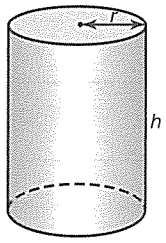
Science understanding, Science inquiry

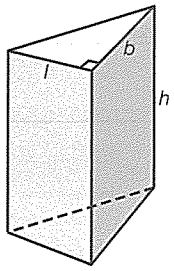
Logical/Mathematical

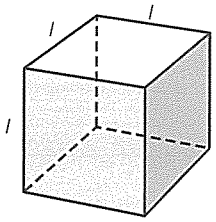
1 The volume of the following regular objects can be calculated by using a mathematical formula. **Identify** the correct name and formula for each of the following regular objects by linking them with lines.











Cube $V = l^3$

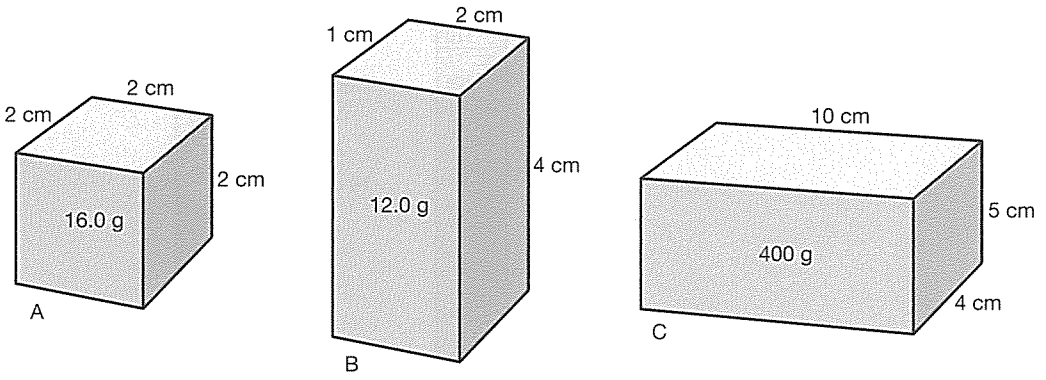
Rectangular prism
$V = lwh$

Triangular prism
$V = \frac{1}{2}lbh$

Cylinder $V = \pi r^2 h$

Sphere $V = \frac{4}{3}\pi r^3$

2 (a) **Use** the formula $V = lwh$ to **calculate** the volume of the rectangular prisms shown.



Prism A: $V =$ _____ cm^3

Prism B: $V =$ _____ cm^3

Prism C: $V =$ _____ cm^3

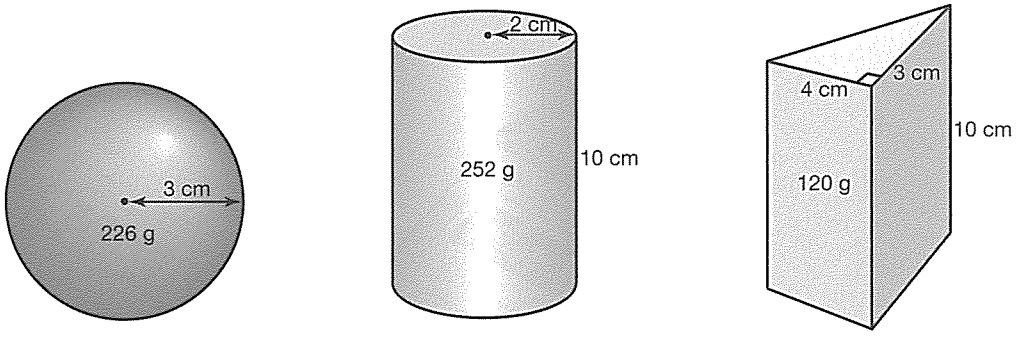
(b) **Use** the masses given for each of the prisms to **calculate** their densities.

Prism A: $d = \frac{m}{V} =$ _____ / _____ = _____ g/cm^3

Prism B: $d = \frac{m}{V} =$ _____ / _____ = _____ g/cm^3

Prism C: $d = \frac{m}{V} =$ _____ / _____ = _____ g/cm^3

3 (a) **Use** the mathematical formulas given on the previous page to **calculate** the volume of the regular objects below.



Sphere A:

$V =$ _____

_____ cm^3

Cylinder B:

$V =$ _____

_____ cm^3

Triangular prism C:

$V =$ _____

_____ cm^3

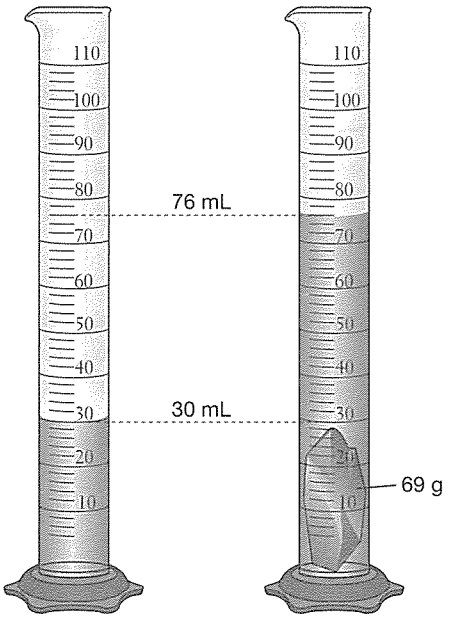
(b) **Use** the masses given for each of the objects to **calculate** their densities.

Sphere A: $d = \frac{m}{V} =$ _____ / _____ = _____ g/cm^3

Cylinder B: $d = \frac{m}{V} =$ _____ / _____ = _____ g/cm^3

Triangular prism C: $d = \frac{m}{V} =$ _____ / _____ = _____ g/cm^3

4 (a) Calculate the volume of the irregular object shown.

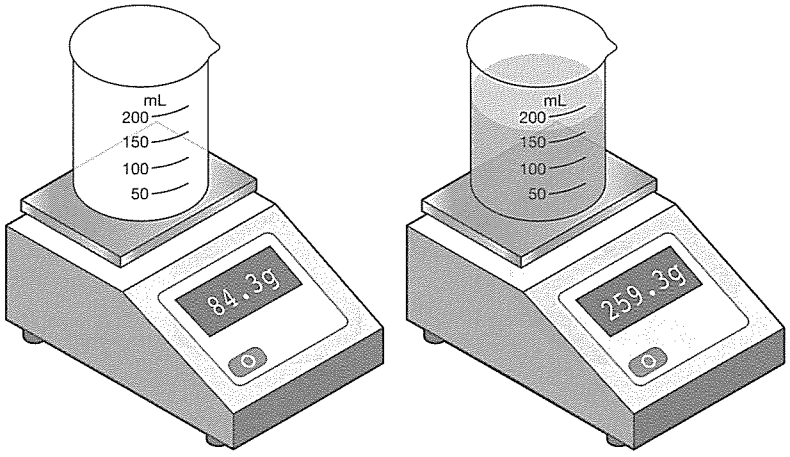


V = _____ mL = _____ cm^3

(b) Use the mass given for the irregular shape to **calculate** its density.

Irregular shape: $d = \frac{m}{V}$ = _____ / _____ = _____ g/cm^3

5 The mass of an unknown liquid was determined by the method shown.



(a) Use this information in the diagram to **calculate** the density of the liquid.

_____

_____

(b) From its density, **propose** what the unknown liquid is most likely to be.

_____

6.7 Math-o-mat reactions

Science understanding

Visual/Spatial

Nitric oxide (NO) is a very important chemical that has both advantages and disadvantages to our society. Small amounts of nitric oxide are needed in our blood to help send chemical messages around the body. However, too much can be toxic. Nitric oxide is also used in many industrial processes to produce nitric acid and ammonia. Unfortunately, when nitric oxide is released into the atmosphere it can mix with the water in the clouds and form acid rain.

Nitric oxide also contributes to the depletion of the ozone layer. The nitric oxide reacts with the ozone (O_3) in the atmosphere to produce nitrogen dioxide (NO_2) and oxygen gas (O_2).

1 **Construct** a word equation for the depletion of ozone by nitric oxide by filling in the blanks.

_____ + _____ → _____ + _____

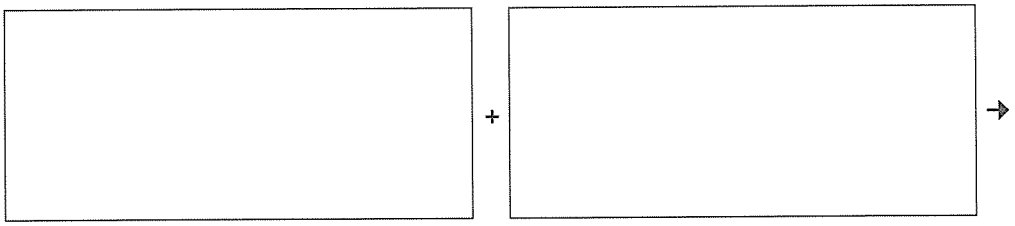
2 **Identify** the reactants and products of this equation by their chemical formulas.

	Chemical name	Chemical formula
Reactants		
Products		

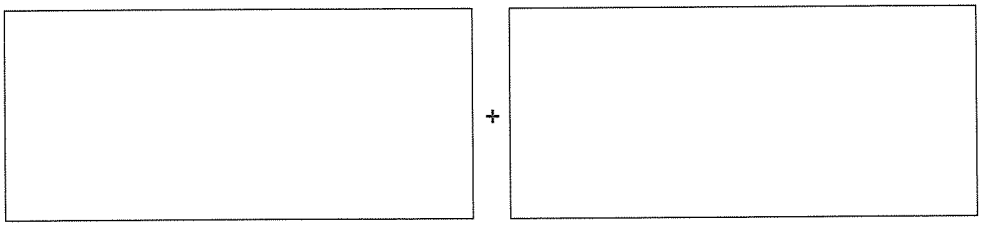
3 **Construct** a formula equation by filling in the blanks.

_____ + _____ → _____ + _____

4 **Use** the chemical formulas and a math-o-mat or compass to **construct** models of the reactants in the equation above. Choose a different colour for the nitrogen and oxygen atoms in the reaction and indicate which colour corresponds to which element.



5 **Use** the chemical formulas and a math-o-mat or compass to **construct** models of the products.



6.8 Making equations

Science understanding

Verbal/Linguistic

Use the combined word and formula equations to fill in the blanks in the following equations.

Equation 1

carbon + _____ → carbon dioxide

C + O_2 → _____

Equation 2

sodium hydroxide + _____ → sodium chloride + _____

NaOH + HCl → _____ + H_2O

Equation 3

sulfuric acid + calcium carbonate → calcium sulfate + carbon dioxide + water

H_2SO_4 + $CaCO_3$ → _____ + _____ + _____

Equation 4

_____ + sulfur → hydrogen sulfide

H_2 + S → _____

Equation 5

_____ → calcium oxide + _____

$CaCO_3$ → CaO + CO_2

Equation 6

potassium hydroxide + nitric acid → potassium nitrate + _____

KOH + HNO_3 → _____ + H_2O

Equation 7

hydrochloric acid + silver nitrate → silver chloride + _____

_____ + $AgNO_3$ → _____ + HNO_3

Equation 8

copper sulfate + _____ → copper chloride + _____

_____ + $BaCl_2$ → _____ + $BaSO_4$

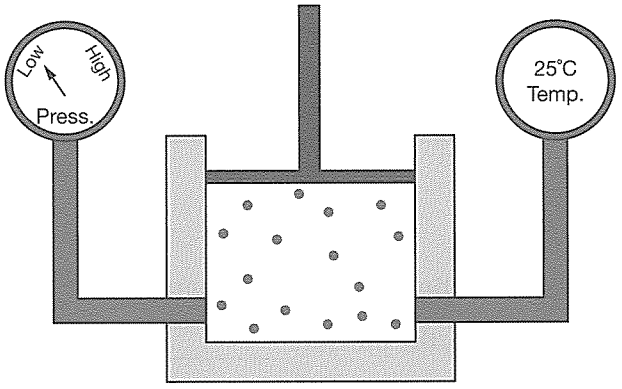
6.9 Boyle's law

Science as a human endeavour

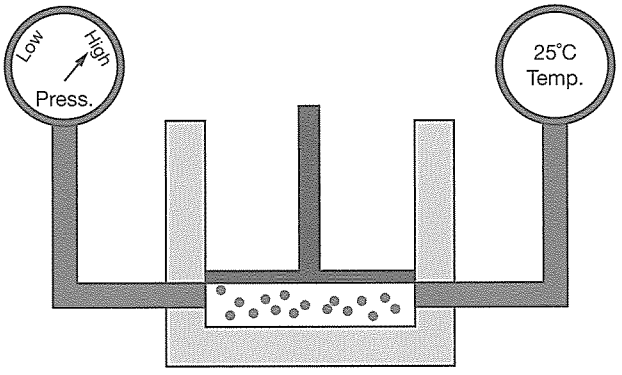
Visual/Spatial **Verbal/Linguistic**

Robert Boyle (shown right) was born in Ireland in 1627 and was considered to be an alchemist. Like all alchemists, he believed that base metals such as lead could be turned into gold. However, unlike other alchemists, he approached his work with strict scientific method and criticised other alchemists for their careless approach. For this reason, he can also be considered one of the world's first chemists.

Boyle was particularly interested in studying the pressure of gases. The pressure of a gas is how much force the gas puts on its container. Boyle discovered that the pressure of a gas changed when the size of its container (volume) changed. In one of his most famous experiments, Boyle measured the pressure of a gas as the volume of the container was decreased. He also made sure the temperature stayed the same.



When the volume is large, the pressure is low.

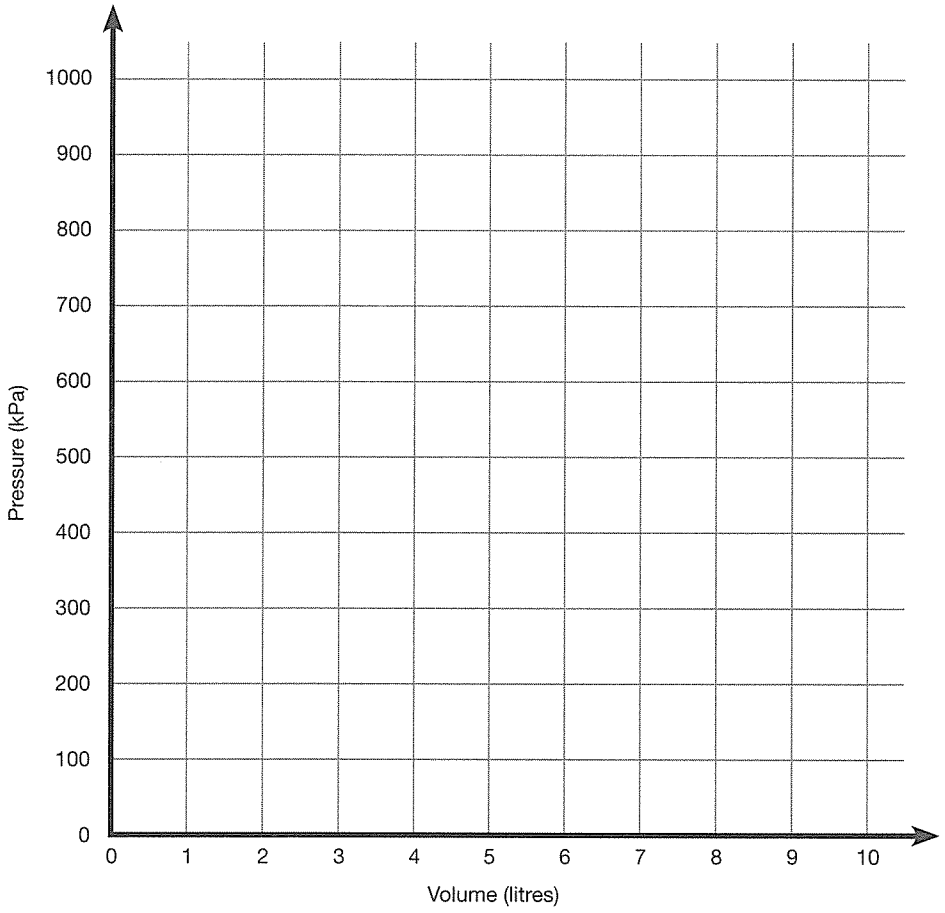


When the volume is small, the pressure is high.

Some results that he may have observed are shown in the table.

Volume (L)	10	9	8	7	6	5	4	3	2	1
Pressure (kPa)	100	111	125	143	167	200	250	333	500	1000

1 Using the data from the table, **construct** a line graph on the axes below to show how the pressure of the gas changed as its volume decreased.



2 **State** Boyle's law by completing the following sentences.

(a) As the volume increases, the pressure _____.

(b) As the pressure increases, the volume _____.

(c) When the volume doubles, the pressure _____.

(d) When the pressure doubles, the volume _____.

6.10 Literacy review

Science understanding

Verbal/Linguistic

Recall your knowledge of physical and chemical change by choosing words from the list to complete the statements below. Cross out the words as you write them.

substances	mass	physical	products	precipitate
heat	particle	reactants	equations	volume
formulas	moving	colour	gas	chemical
attracted	products	high	low	chemical
chemical				

1 The world around you is constantly changing. These changes can be classified as either _____ or _____ changes.

2 During a physical change, no new _____ are produced. During a chemical change, new substances are produced. A chemical change can be identified by a permanent change in _____ , a _____ being given off, a _____ forming from two clear solutions or energy being produced or absorbed in the form of _____ and light.

3 Physical and chemical changes can be understood by the _____ model. This model assumes that all substances are made up of hard, indivisible particles. The model also assumes that these particles are _____ to each other and are constantly _____ .

4 Density is a measure of how much _____ is contained in a certain _____ . A large, lightweight object is said to have _____ density. A small, heavy object is said to have _____ density.

5 When a chemical change occurs, scientists say that a _____ reaction has taken place. A chemical reaction is the process of converting substances into different substances. The initial substances are known as the _____ . The substances that are produced by the chemical reaction are known as the _____ .

6 Scientists use chemical _____ to describe what is happening during a chemical reaction clearly and efficiently. A _____ equation uses the chemical names of the reactants and products to describe the chemical reactions. A formula equation uses the chemical _____ of the reactants and products to describe the chemical reaction.

7.1 Element mnemonics

Science understanding

Verbal/Linguistic

A mnemonic (*ne-mon-ik*) is a phrase or poem that helps you to remember something. Below is a mnemonic to help you remember the first ten elements in the periodic table. See if you can create your own mnemonic to help remember the next ten.

Atomic number	Chemical name	Chemical symbol	Mnemonic
1	Hydrogen	H	Harry
2	Helium	He	Helped
3	Lithium	Li	Little
4	Beryllium	Be	Betty
5	Boron	B	Brown
6	Carbon	C	Carry
7	Nitrogen	N	Nine
8	Oxygen	O	Oranges
9	Fluorine	F	For
10	Neon	Ne	Neil

Atomic number	Chemical name	Chemical symbol	Mnemonic
11	Sodium	Na	
12	Magnesium	Mg	
13	Aluminium	Al	
14	Silicon	Si	
15	Phosphorus	P	
16	Sulfur	S	
17	Chlorine	Cl	
18	Argon	Ar	
19	Potassium	K	
20	Calcium	Ca	

7.2 Periodic table quiz

Science understanding

Verbal/Linguistic

Scientists organise the elements from lightest to heaviest on a grid called the periodic table. The periodic table helps scientists to look up the names and symbols of all the known elements. Use the periodic table to answer the following questions.

H hydrogen 1																	He helium 2
Li lithium 3	Be beryllium 4											B boron 5	C carbon 6	N nitrogen 7	O oxygen 8	F fluorine 9	Ne neon 10
Na sodium 11	Mg magnesium 12											Al aluminium 13	Si silicon 14	P phosphorus 15	S sulfur 16	Cl chlorine 17	Ar argon 18
K potassium 19	Ca calcium 20	Sc scandium 21	Ti titanium 22	V vanadium 23	Cr chromium 24	Mn manganese 25	Fe iron 26	Co cobalt 27	Ni nickel 28	Cu copper 29	Zn zinc 30	Ga gallium 31	Ge germanium 32	As arsenic 33	Se selenium 34	Br bromine 35	Kr krypton 36
Rb rubidium 37	Sr strontium 38	Y yttrium 39	Zr zirconium 40	Nb niobium 41	Mo molybdenum 42	Tc technetium 43	Ru ruthenium 44	Rh rhodium 45	Pd palladium 46	Ag silver 47	Cd cadmium 48	In indium 49	Sn tin 50	Sb antimony 51	Te tellurium 52	I iodine 53	Xe xenon 54
Cs caesium 55	Ba barium 56	La lanthanum 57	Hf hafnium 72	Ta tantalum 73	W tungsten 74	Re rhenium 75	Os osmium 76	Ir iridium 77	Pt platinum 78	Au gold 79	Hg mercury 80	Tl thallium 81	Pb lead 82	Bi bismuth 83	Po polonium 84	At astatine 85	Rn radon 86
Fr francium 87	Ra radium 88	Ac actinium 89	Rf rutherfordium 104	Db dubnium 105	Sg seaborgium 106	Bh bohrium 107	Hs hassium 108	Mt meitnerium 109	Ds darmstadtium 110	Rg roentgenium 111	Cn copernicium 112	Uut ununtrium 113	Uuq ununquadium 114	Uup ununpentium 115	Uuh ununhexium 116	Uus ununseptium 117	Uuo ununoctium 118

Lanthanoids	Ce cerium 58	Pr praseodymium 59	Nd neodymium 60	Pm promethium 61	Sm samarium 62	Eu europium 63	Gd gadolinium 64	Tb terbium 65	Dy dysprosium 66	Ho holmium 67	Er erbium 68	Tm thulium 69	Yb ytterbium 70	Lu lutetium 71
Actinoids	Th thorium 90	Pa protactinium 91	U uranium 92	Np neptunium 93	Pu plutonium 94	Am americium 95	Cm curium 96	Bk berkelium 97	Cf californium 98	Es einsteinium 99	Fm fermium 100	Md mendelevium 101	No nobelium 102	Lr lawrencium 103

H — symbol
hydrogen — name
1 — atomic number

1 **State** the total number of elements listed on the periodic table. _____

2 **Identify** the chemical symbol of the following elements.

Hydrogen _____ Helium _____

Carbon _____ Oxygen _____

Nitrogen _____ Aluminium _____

Calcium _____ Iron _____

3 **Identify** the names of the elements with the following chemical symbols.

Li _____ B _____

Na _____ Si _____

P _____ Cl _____

Cr _____ Cu _____

4 **List** the names and symbols of all the elements whose names start with the letter 'C'.

_____

_____

_____

5 **Identify** three elements named after famous scientists.

_____

6 **Identify** three elements named after a place, country, continent or planet.

_____

7 Some chemical symbols do not appear to correspond to the chemical names. For example, the chemical symbol for silver is Ag. **List** the name and symbol of five other elements whose chemical symbols do not correspond with the name of the elements.

_____

_____

8 In the table below, **list** five elements that you might use in your everyday life and **identify** where they might be used.

Element	Uses

7.3 Elemental crossword

Science understanding

Verbal/Linguistic

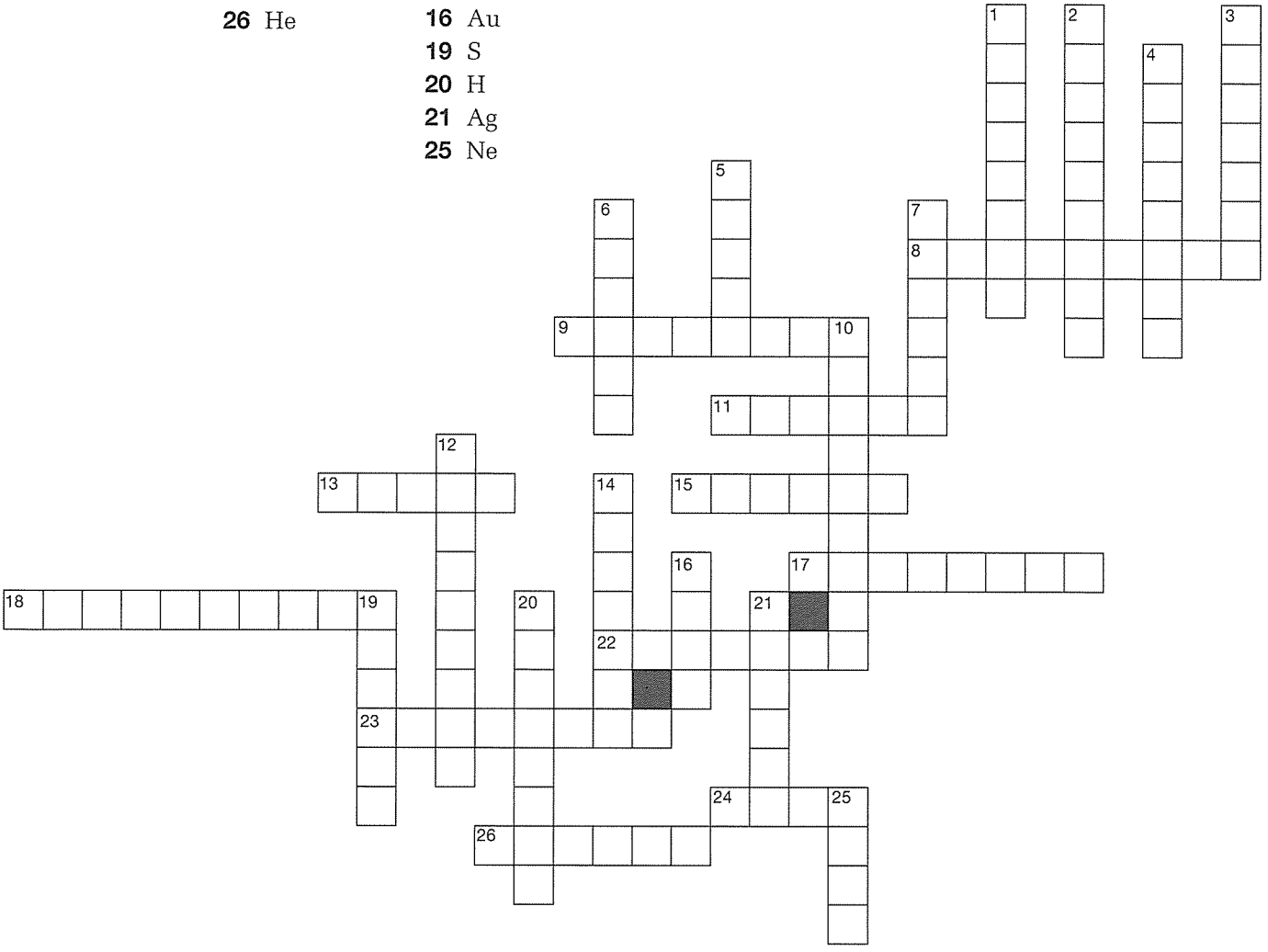
Use the periodic table on page 93 to complete the crossword below by filling in the element name that corresponds to each symbol.

Across

8 Al
9 Ti
11 O
13 B
15 Cu
17 N
18 P
22 Ca
23 F
24 Fe
26 He

Down

1 Pt
2 Be
3 Li
4 Cl
5 Ar
6 Na
7 C
10 Mg
12 K
14 Si
16 Au
19 S
20 H
21 Ag
25 Ne



7.4 Which element am I?

Science understanding

Verbal/Linguistic

Use what you know about the elements that you find in your everyday life to match the elements below to the properties listed in the table.

Carbon C	Helium He	Sulfur S	Gold Au	Aluminium Al
Chlorine Cl	Iron Fe	Copper Cu	Oxygen O	Nitrogen N

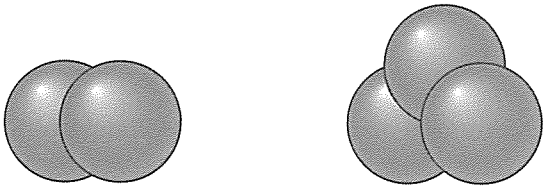
Description of properties		Chemical name	Chemical symbol
1	I am lightweight and shiny and conduct electricity very well. For these reasons, I am used in overhead power lines. I am also used in soft-drink cans because I can be recycled.		
2	At room temperature I am a solid, bright yellow powder. I am a typical non-metal. I don't conduct electricity and I crumble easily. I can be found under oxygen on the periodic table.		
3	I can be found in many different forms. Sometimes I am a black crumbly solid called charcoal. However, I can also form very hard, beautiful and expensive crystal lattices called diamond.		
4	I am a colourless, odourless gas that makes up most of the air you breathe but I am not oxygen. I am one of the first 10 elements listed in the periodic table.		
5	I am a yellow gas with a pungent smell. But don't breathe me in or I will damage your lungs. I am also used in swimming pools to kill bacteria. I am between elements 10 and 20 on the periodic table.		
6	I am yellow and shiny. I conduct electricity very well so am sometimes used for wiring in electrical equipment. However, I am more commonly used in jewellery because I am rare and expensive.		
7	I am strong and hard and can be bent into many different shapes. That's why I am used in construction. However, I am often mixed with metals and carbon. Otherwise I will rust.		
8	I am a very light and non-toxic gas. I do not react with other substances so I am often used to make party balloons that float.		
9	I am an invisible, non-toxic gas. I am one of the most important elements on Earth. I am in water, sand and air. You need me to breathe and stay alive. Plants produce me through photosynthesis.		
10	I am shiny and orange-brown in colour. I can be drawn into wires or hammered into sheets. I conduct electricity very well and am cheap to produce, which makes me perfect for household wiring and electrical equipment.		

7.5 The ozone allotrope of oxygen

Science as a human endeavour

Visual/Spatial **Verbal/Linguistic**

Ozone (O_3) is a very important allotrope of oxygen. The oxygen you breathe (O_2) consists of molecules made up of two oxygen atoms. Ozone is made up of molecules with three oxygen atoms as shown below.



Oxygen O_2 Ozone O_3

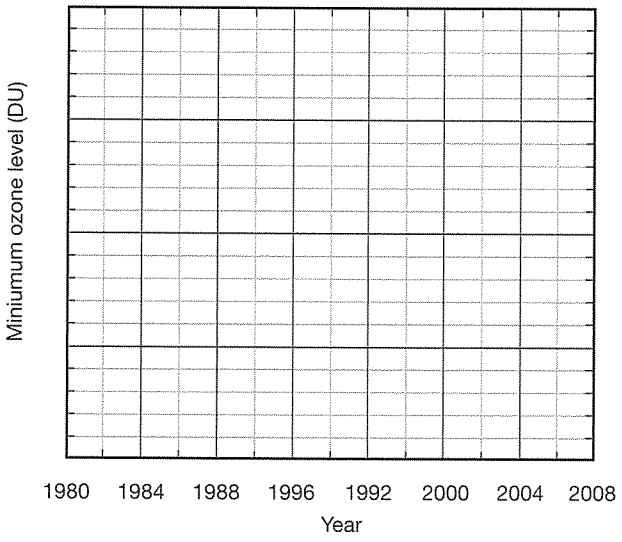
The highest concentrations of ozone are found in the stratosphere, about 10–50 km above the Earth's surface. This layer of ozone that surrounds the Earth is known as the ozone layer. The ozone layer absorbs ultraviolet light from the Sun and therefore plays an important role in protecting you from damaging ultraviolet rays.

However, 25 years ago it was discovered that industrial gases were depleting the ozone layer near the North and South Poles. As a result, the Earth's natural protection was being destroyed and people were more susceptible to sunburn and skin cancers.

The table below records the minimum level of ozone recorded every two years above the South Pole in Dobson units (DU). Dobson units are units of measurement developed specially to measure the concentration of ozone.

Year	1980	1982	1984	1986	1988	1990	1992	1994	1996	1998	2000	2002	2004	2006
Ozone minimum (DU)	194	195	154	124	109	108	84	–	–	99	97	91	91	102

1 **Construct** a line graph using the axes provided to show how the level of ozone has varied from 1980 to 2006.



2 **Deduce** from the graph what you might expect the minimum ozone level to be in 1994 and 1996.

1994 _____ 1996 _____

3 **Describe** what happened to the ozone levels over this 26-year period.

_____

_____

_____

4 **Calculate** how the minimum ozone level in 2006 compares to the minimum ozone level in 1980.

$\frac{\text{ozone level in 2006}}{\text{ozone level in 1980}} =$ _____

5 **Predict** what the minimum level of ozone might be this year.

_____

6 **Propose** what you think will happen to the minimum ozone level over the next 10 years based on the data in the graph. **Justify** your answer.

_____

_____

_____

_____

_____

_____

7.6 Math-o-mat molecules

Science understanding

Visual/Spatial

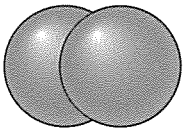
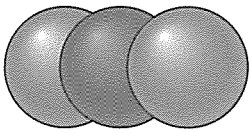
The elements and compounds found in the world around you can exist as single atoms, molecules or large grid-like structures called crystal lattices. The single atoms, molecules and lattices formed by elements contain only one type of atom, while the molecules and lattices formed by compounds contain more than one type of atom.

Molecules

Molecules are clusters of atoms. The molecules that make up pure substances such as elements and compounds are all identical.

The molecular formulas for elements and compounds tell you which type of atoms are in the molecule and how many of each type there are. For example, the molecular formula for the element oxygen is O_2, which means that each molecule contains two oxygen atoms. The molecular formula for the compound carbon dioxide is CO_2, which means that there is one carbon atom and two oxygen atoms in each carbon dioxide molecule.

1 Use a math-o-mat or compass to **construct** diagrams of the following molecules.

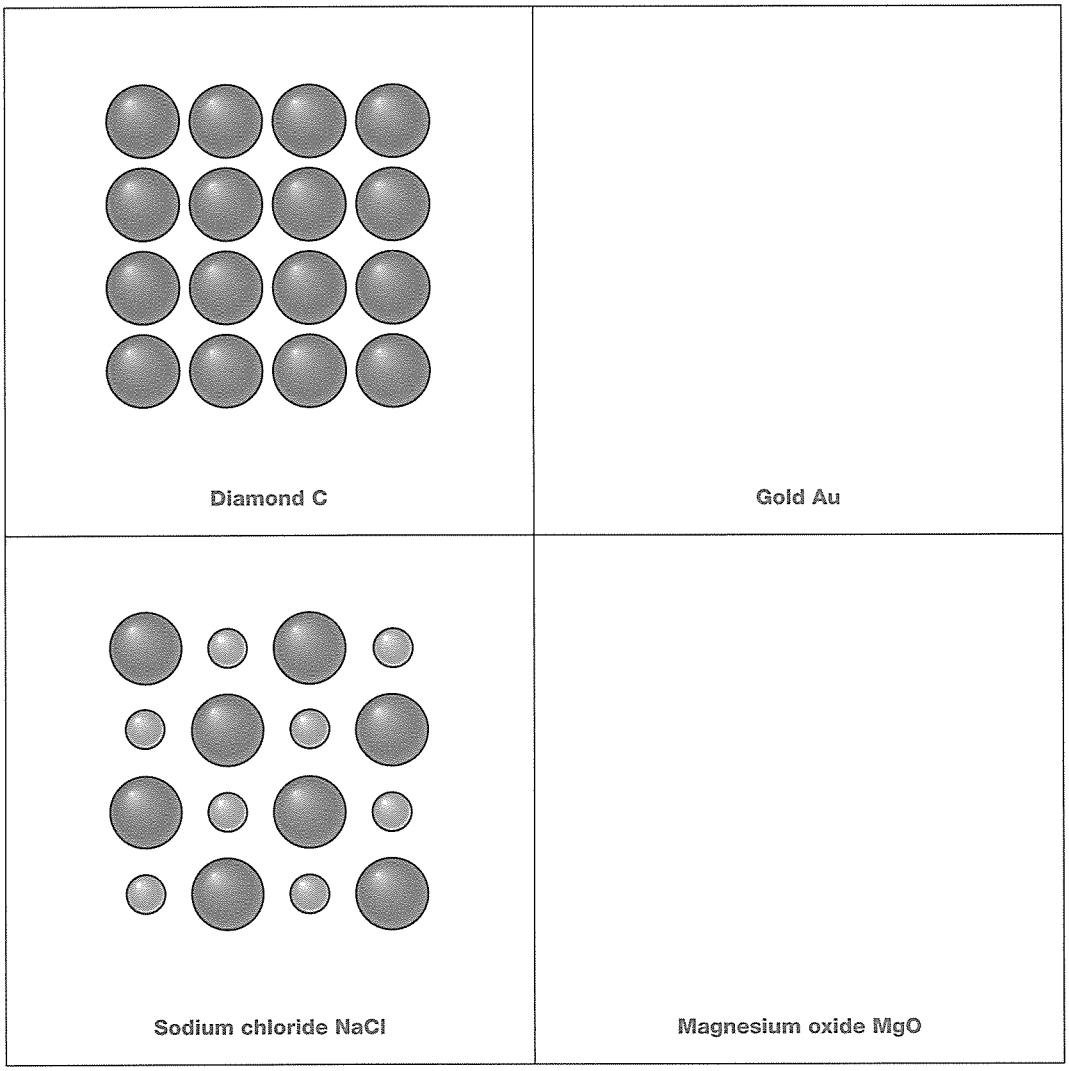
 Oxygen O_2	 Carbon dioxide CO_2	Nitrogen N_2
Water H_2O	Ozone O_3	Carbon monoxide CO
Phosphorus P_4	Methane CH_4	Hydrogen peroxide H_2O_2

Lattices

Crystal lattices such as diamond or sodium chloride are made up of a huge number of atoms stuck together in large grid-like structures. For this reason, crystal lattices do not have molecular formulas. Instead they are referred to by their chemical formulas. The chemical formula of a lattice tells you which type of atoms make up the lattice and the ratio of each type of atom in the lattice. For example, the chemical formula for sodium chloride (table salt) is NaCl. This means that in the crystal lattice there is one sodium atom for every chlorine atom. For silicon dioxide (beach sand), the chemical formula of SiO_2 means that for every silicon atom in the lattice there are two oxygen atoms.

The crystal lattices of elements are made up of only one type of atom so their chemical formulas are exactly the same as the chemical symbols for the elements. For example, diamond is a crystal lattice made up of only carbon atoms, so its chemical formula is just C.

2 **Construct** diagrams of lattices of gold and magnesium oxide.



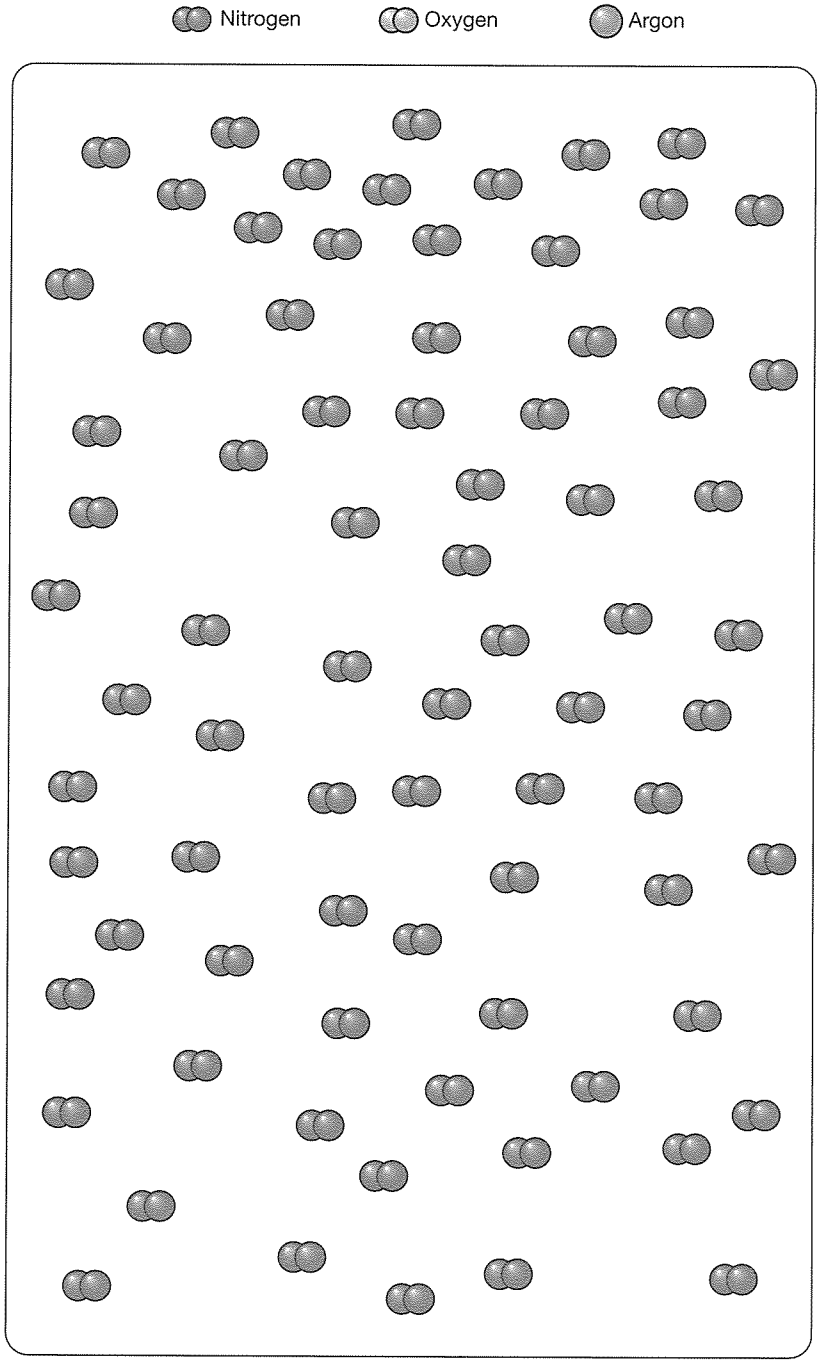
7.7 Air mixture

Science inquiry

Visual/Spatial

The air you breathe is actually a mixture of elements and compounds. It contains approximately 78% nitrogen (N_2), 21% oxygen (O_2) and 1% argon (Ar). It also contains very small amounts of carbon dioxide (CO_2), neon (Ne), helium (He) and methane (CH_4). The box below contains 78 molecules of nitrogen (N).

Identify how many molecules of oxygen and argon are required to make this a box of air and add them to the diagram.



7.8 Super molecules!

Science as a human endeavour

Verbal/Linguistic Visual/Spatial

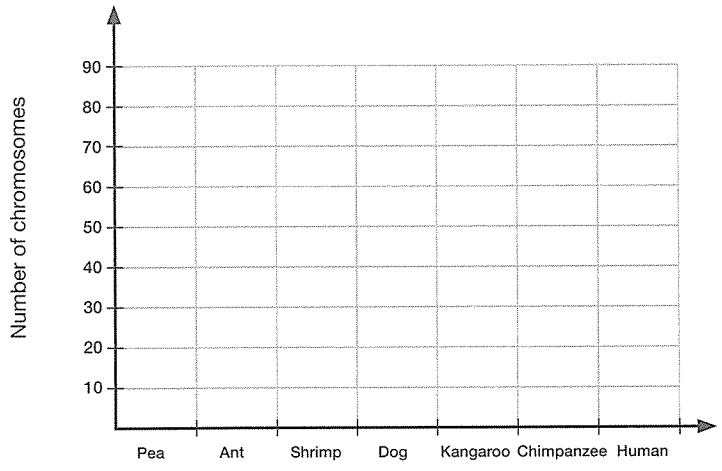
The DNA molecule is one of nature's most important supramolecules or molecular machines. It provides the blueprint for every characteristic of every living thing. The DNA molecule is made up of two very long molecules that are twisted together in a spiral called a double helix. This double helix can be stretched to over a metre in length.

The very large DNA molecules can combine with other molecules to create even bigger supramolecules called chromosomes. Chromosomes are so large that they can be seen with a strong optical microscope.

Every cell in your body contains 46 chromosomes. Other living things have different numbers of chromosomes in their cells, as shown in the following table.

Organism	Pea	Ant	Shrimp	Dog	Kangaroo	Chimpanzee	Human
Number of chromosomes	14	2	90	78	12	48	46

1 **Construct** a bar graph of the data in the table on the axes below.



2 **Identify** which organism has the most similar number of chromosomes to humans and **propose** why.

_____

_____

3 Before examining the data, Tamera makes the hypothesis that 'The cells of more complex organisms must contain more chromosomes'. **State** whether you think this hypothesis is correct or incorrect. Refer to the data from the table to **justify** your argument.

_____

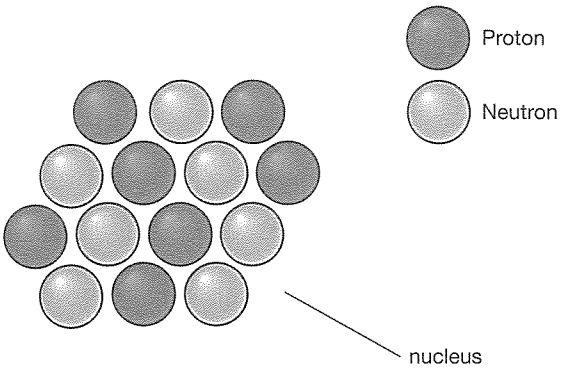
_____

7.9 Nuclear numbers

Science inquiry

Visual/Spatial

Atoms are the building blocks that make up all the elements and compounds in the world around you. Every atom has its own unique properties but all atoms are made up of three subatomic particles known as electrons, protons and neutrons. The protons and neutrons form a cluster at the centre of the atom known as the nucleus. Electrons form a cloud around the nucleus.



The number of protons in the nucleus is called the atomic number. The number of protons and neutrons in the nucleus is called the mass number. For example, a nitrogen atom has seven protons and seven neutrons in its nucleus. Therefore the atomic number of nitrogen is 7 and its mass number is 7 + 7 = 14. This information is often written next to the chemical symbol as shown below. When written like this, the symbol is referred to as the atomic symbol.

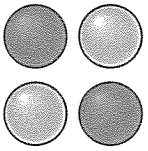
Mass number
Atomic number
$^{14}_{7}N$ } Atomic symbol

Identify the atoms and subatomic particles by completing the following atomic symbols and diagrams.

Hydrogen atom

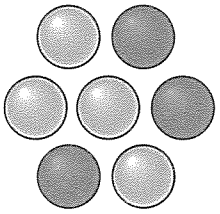
$^{\square}_{1}H$

Helium atom



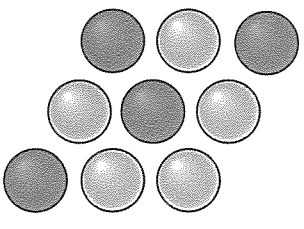
$^{4}_{\square}He$

Lithium atom



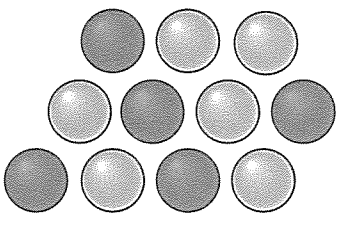
$^{\square}_{3}Li$

Beryllium atom



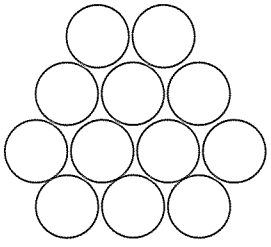
$^{\square}_{\square}Be$

Boron atom



$^{\square}_{\square}B$

Carbon atom



$^{12}_{6}C$

7.10 Literacy review

Science understanding

Verbal/Linguistic

Recall your knowledge of elements and compounds by choosing words from the list to complete the statements below. Some words may be used more than once.

solid	nucleus	break	liquid	cloud
molecules	compounds	mixtures	atomic	atoms
protons	neutrons	negatively	positively	mass
lattices	electrons	elements	conduct	

1 _____ are the smallest building blocks that make up all the substances around you. Substances made up of just one type of atom are known as _____.

2 Metallic elements are shiny, _____ electricity and heat, and can be drawn into wires or hammered into sheets. They are usually _____ at room temperature.

3 Non-metallic elements are usually dull, do not conduct electricity or heat and _____ when a force is applied. Most non-metals are solid or _____ at room temperature.

4 The atoms that make up the elements can be monatomic, in clusters called _____ or in large crystal _____. Most non-metallic elements are made up of _____. The atoms in all metallic elements form _____.

5 Pure substances made up of more than one type of atom are known as _____. These substances can be made up of atoms in crystal lattices. They can also be made up of identical _____.

6 Substances that are made up of a combination of different elements and compounds are known as _____.

7 The atoms that make up elements and compounds are all made up of the same three subatomic particles called _____, _____ and _____. The smallest of the three are the _____, which are _____ charged. The _____ are _____ charged and the _____ are neutral.

8 The protons and neutrons form a cluster at the centre of the atom called the _____. This is surrounded by a _____ of electrons.

9 The number of protons in the nucleus is the _____ number. The number of protons and neutrons is the _____ number.

8.1 Piezo igniters

Science understanding, Science as a human endeavour

Verbal/Linguistic

Piezoelectricity

Piezo is a Greek word meaning pressure. Piezoelectricity refers to making electricity by putting pressure on certain materials. Two French scientists, Pierre and Jacques Curie, discovered the effect in 1880. Their experiments showed that they could produce electric charges on the surface of some crystals simply by hitting or twisting them. The crystals they tried included quartz, cane sugar and topaz. These discoveries, and further experiments by other scientists, led to the development of many devices including:

- electronic alarms in mobile phones, cars and watches
- gas lighters (piezo igniters)
- microphones
- timers in clocks.

Piezoelectricity can easily be seen by striking two pieces of quartz together in a darkened room. 'Blue metal' on road surfaces often has pieces of quartz mixed in with it. In a dark room, one piece of quartz can be struck against the other like striking a match. Sparks or flashes of light can be seen if the room is dark enough.

Piezo igniters

A piezo igniter is a device that creates a spark without an outside source of electricity such as a battery or mains power. Most piezo igniters have a spring-loaded hammer that hits a piece of quartz. You can hear a definite loud 'click' as the hammer fires. A piezo igniter can only fire once each push because it is triggered by a spring. The spring can only reset when you release the button back up.

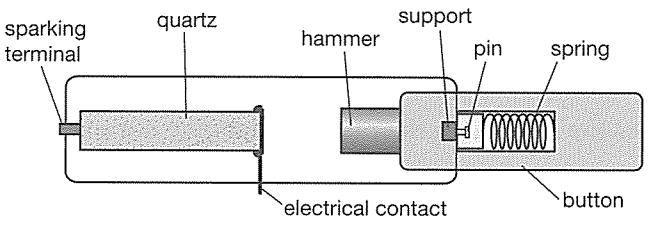


Figure 8.1.1

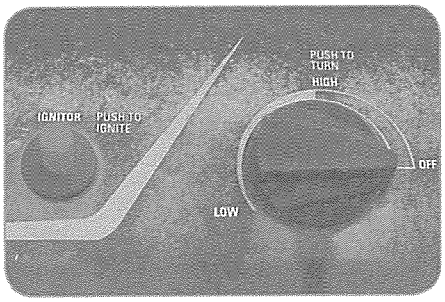
Side view of a piezo igniter button. Piezo igniters can give you a mild shock. Use them with caution because they can ignite gas.

Uses of piezo igniters at home

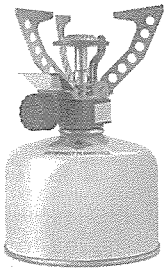
Piezo igniters may be found in homes in:

- gas heaters: On many types of gas heaters, the piezo igniter has a star shape or a 'lightning flash' symbol on the push button, which is often red or black. Other piezo igniters are connected to a knob that must be turned.
- gas barbecues: Most gas barbecues have a knob attached to the piezo igniter. When turned, there is a click and the gas is turned on at the same time. Other barbecues have knobs to turn on the gas, and the igniter is a separate push button.
- gas hot water systems: Some gas hot water systems such as storage systems have piezo igniters. The igniter lights a special flame in the system called a pilot light, which usually stays burning.

- portable gas cookers: Portable gas cookers use piezo lighters. Note that kitchen gas cooktops that are fixed use mains electricity instead to create sparks. You can tell because you cannot hear the click of the hammer firing, just a crackling sound of the sparks. The other indicator is that the sparks continue to appear with the one turn of the knob, unlike the single fire action of a piezo igniter.



Barbecue



Portable cooker

Figure 8.1.2
Some piezo igniter knobs

1 **Name** the scientists who discovered piezo electricity.

2 **Describe** what the scientists did in their experiments.

3 **Describe** how piezo electricity can be observed using two pieces of quartz.

4 **State** an advantage that a piezo igniter has over other methods of lighting gas.

5 **Name** the mineral inside most piezo igniters that creates the spark.

6 **Explain** what action makes the mineral in the piezo igniter give out a spark.

7 Refer to the diagram in Figure 8.1.1 on page 105 of the piezo igniter, and **explain** why only one click is heard when a piezo igniter fires.

8 **List** some devices at home that may contain a piezo igniter.

8.2 All four engines have failed!

Science as a human endeavour

Verbal/Linguistic

Refer to the Science as a Human Endeavour on page 284 of your student book to answer the following questions.

1 **State** where the British Airways 747 was when it lost power to all four engines.

2 **Propose** a reason why the crew did not see the volcanic ash cloud.

3 **Propose** a reason why the crew were confused about the cause of the engine failure.

4 (a) **Describe** the contents of a volcanic ash cloud.

(b) **Explain** how they interfere with the engines.

5 **Describe** the response of the international community to Flight BA009 nearly crashing.

6 **Describe** the information that is now gathered about ash clouds.

7 **Discuss** how the crew of an aircraft knows that an ash cloud is on its route.

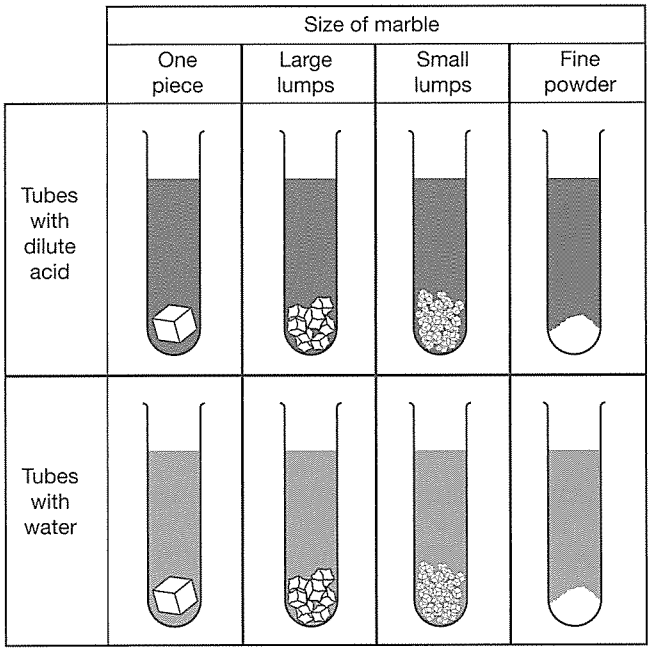
8.3 Weathering experiment

Science inquiry

Logical/Mathematical **Verbal/Linguistic**

Two students, Sita and Glenn, wanted to find out if physical and chemical weathering acted together in the weathering of marble. They knew from previous experiments that acid could attack marble and limestone. They wanted to see if this chemical weathering was affected by physical weathering of the marble.

They designed an experiment where they smashed up some marble pieces into different sizes to represent physical weathering and added dilute hydrochloric acid to them. You can see the set-up for their experiment below.



They made sure they used the same mass of marble, 5 grams, in each test-tube, and the same volume of hydrochloric acid, 25 mL, in each tube. In the first trial, Sita and Glenn used one piece of marble, in the second they used a number of large lumps, in the third trial they used numerous small lumps and in the final trial they used fine powder. To decide how fast the marble weathered, they decided to look at the mass of marble left after 10 minutes. After 10 minutes, they tipped each of the test-tube contents through separate filter papers. They then rinsed the solid captured in each filter paper with water until they were sure there was no acid left. Then they dried and weighed each filter paper to see how much of the marble solid was left.

Their results are shown in the table below. This shows the mass of marble left after 10 minutes in acid or water. Remember that each test-tube originally had 5 grams of marble in it at the start.

Liquid in test-tube	Mass of marble left (g) for different size of marble			
	One piece	Large lumps	Small lumps	Fine powder
Acid	4.5	1.1	0.5	0
Water	5.0	5.0	5.0	5.0

1 **Explain** why Sita and Glenn used the test-tubes with water in them.

2 **Explain** why Sita and Glenn made sure they started with the same mass of marble in each test-tube.

3 **Propose** why they rinsed (washed) the filter paper with water.

4 **Explain** why they dried the filter paper before weighing it.

5 **Describe** what effect changing the size of the marble pieces had on the amount of marble left at the end.

6 **Interpret** the results to produce a conclusion for this experiment.

7 **Propose** how Sita and Glenn could have improved on the design of this experiment.

8.4 Settling sediments

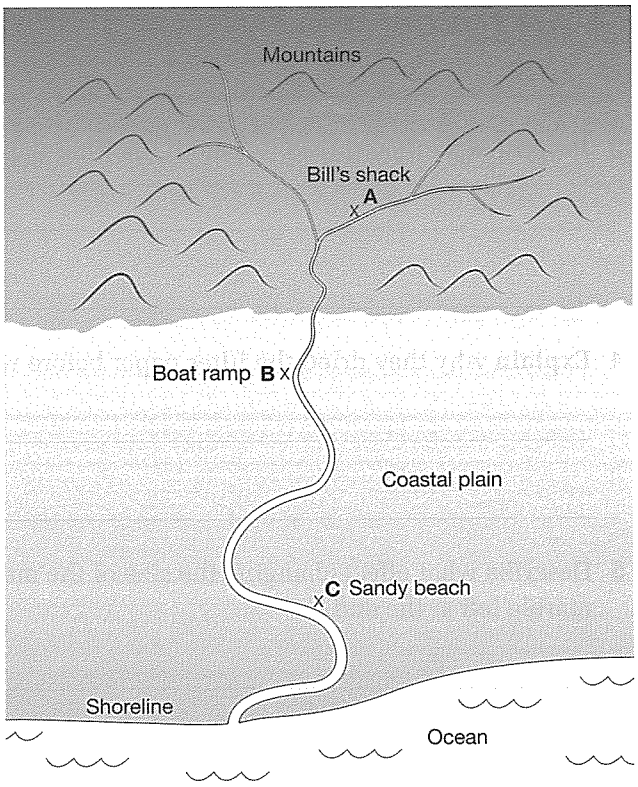
Science understanding, Science inquiry

Logical/Mathematical **Verbal/Linguistic**

Sediments are carried by rivers and eventually deposited. While the river is flowing fast, large sediments can be carried. If the river slows, only smaller sediments can be carried. If the river stops flowing, even the smallest sediments are deposited.

By studying the particles in sediment, you can learn a lot about the history of a place. The first step is to pass the sediments at a site through a stack of sieves. The sieves are of different sizes, from large at the top to small at the bottom. These sieves sort out the grains into size ranges. The next step is to measure the mass of each category of grain size.

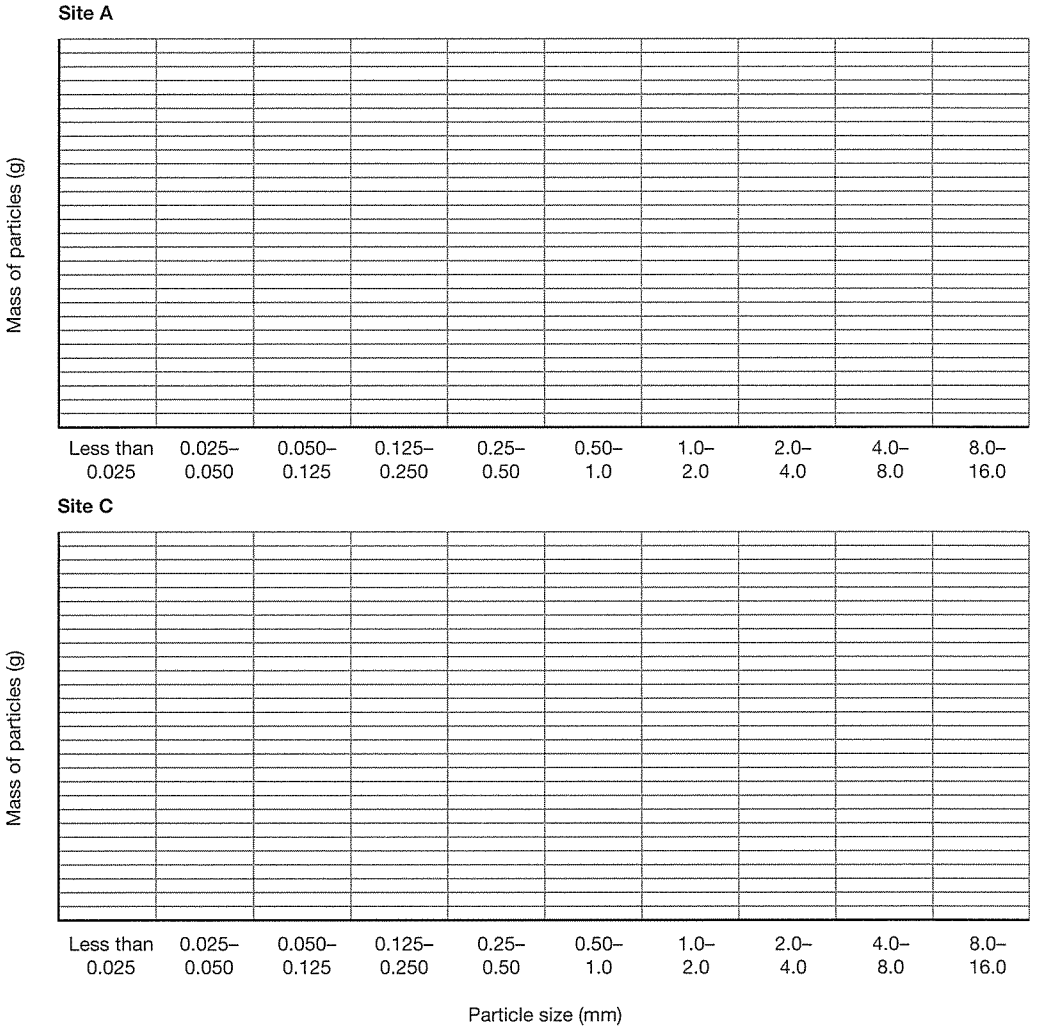
Consider the sites shown in the river valley to the right.



The river valley was studied by sampling the sediments at two of the sites, A (Bill's shack) and C (Sandy Beach). The results for sites A and C are shown in the table.

Particle size (mm)	Mass of particles (g) at site:	
	A: Bill's shack	C: Sandy beach
8.00–16.00	320	0
4.00–8.00	560	0
2.00–4.00	1200	0
1.00–2.00	1410	0
0.50–1.00	2410	0
0.25–0.50	700	600
0.125–0.250	400	1050
0.050–0.125	0	2000
0.025–0.050	0	2600
Less than 0.025	0	750

1 On the axes below **construct** column graphs of these results.



2 **Identify** the site where the sediment is mainly composed of smaller particles.

3 **Discuss** some differences in the range of the particle sizes at the two sites.

4 **Propose** why there was a difference in the average size of the particles found at sites A and C (about 1 mm compared with about 0.05 mm).

5 **Predict** what the particle sizes may be like at site B, the boat ramp. **Justify** your answer.

8.5 The Grand Canyon

Science understanding, Science inquiry

Logical/Mathematical Verbal/Linguistic

The Grand Canyon is one of the deepest cuts in the Earth's crust where rock layers are exposed and visible. It is found in the United States in Colorado state, about 500 km from the sea. It was created by the Colorado River cutting its way down to a depth of 1.6 km into the rock beneath it. Geologists have concluded it took about 70 million years for the canyon to form. The canyon gave geologists an amazing opportunity to study the sequence in which the rocks were laid down. They concluded that the oldest rocks at the bottom of the canyon are 2000 million years (2 billion years) old.

The names and types of rock found in the different strata are shown below.

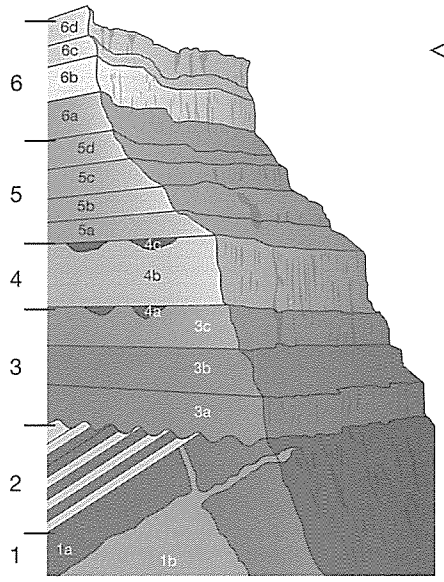


Figure 8.5.1

Key

6	**Hermit, Coconino, Toroweap and Kaibab**
6d	Kaibab limestone
6c	Toroweap formation
6b	Coconino sandstone
6a	Hermit shale
5	**Supai group**
5d	Esplanade formation
5c	Wescogame formation
5b	Manakacha formation
5a	Watahomigi formation
4	**Temple Butte, Redwall and Surprise Canyon**
4c	Surprise Canyon formation
4b	Redwall limestone
4a	Temple Butte limestone
3	**Tonto group**
3c	Muav limestone
3b	Bright Angel shale
3a	Tapeats sandstone
2	**Grand Canyon supergroup**
1	**Vishnu group**
1b	Zoroaster granite
1a	Vishnu schist

Layer 1, the Vishnu group, contains mainly igneous rocks. It is tilted at an angle due to Earth movements. There are no sedimentary rocks in this layer.

Layer 2, the Grand Canyon supergroup, consists of several different sedimentary rock layers and some igneous rock layers. The lowest sedimentary layer in the supergroup is called the Bass formation. This was tilted by Earth movements after it was laid down. The Bass formation contains fossilised structures known as stromatolites. These were formed by living organisms called blue-green bacteria that lived in shallow coastal seas. The existence of similar structures today in Western Australia and elsewhere indicates that the Grand Canyon must have been a shallow coastal sea at the time these rocks were formed. Other sedimentary layers occur on top of the Bass formation. Two of these layers are shale. One shows ripple marks in the shale that only form in shallow coastal seas. Above this layer is some basalt from volcanic activity, and above them again more sedimentary layers formed in shallow seas.

Layer 3, the Tonto group, is a horizontal series of three sedimentary layers. The first is Tapeats sandstone, which probably formed near an ocean shoreline. Fossils of sea creatures called trilobites (extinct relatives of horseshoe crabs) and brachiopods (shelled molluscs) have been found here. Above this there is a shale layer formed from mud that was just offshore, and contains brachiopod, trilobite and worm fossils. The next layer, called Muav limestone, is a chemical sedimentary rock formed at the bottom of a shallow sea that was probably deeper than layer 3b.

Layer 4a, the Temple Butte limestone, had fossils of animals with backbones. In the eastern part of the canyon, this layer contains bony plates from freshwater fish. In the western part this layer contains many marine (salt water) fish fossils. Layer 4b is the Redwall limestone, a very thick layer of limestone that indicates that the area was at the bottom of the sea for a long period of time. Many fossilised crinoids (sea star relatives), brachiopods, bryozoans (coral relatives), corals, nautiloids, sponges and trilobites have been found here.

Layer 5, the Supai group of strata, contains land plant fossils as well as amphibian footprints and reptile fossils. There were also some marine fossils in other parts of the canyon. This seems to show that the sea was retreating and land was forming at the time these layers were formed.

Layer 6a, the Hermit shale, had fossils of winged insects, cone-bearing plants and ferns, as well as tracks of amphibians and reptiles. This shows it was a swampy land environment. Layer 6b, the Coconino sandstone, formed from sand dunes on land. Layer 6c, the Toroweap formation, had some marine limestone in it, indicating that the sea had again submerged the area. Layer 6d, the Kaibab limestone, had many marine fossils such as shells so this must have been under the sea.

1 **Identify** the oldest sedimentary layer in the Grand Canyon.

_____

2 **Identify** the youngest sedimentary layer in the Grand Canyon.

_____

3 **Propose** why geologists would think that the Redwall limestone was laid down over a very long period of time.

_____

_____

4 Clastic sedimentary rocks are composed of weathered rock particles cemented together. **Identify** three layers that are definitely clastic sedimentary rocks.

_____

_____

5 The Grand Canyon is over 500 km from the sea. **Discuss** some evidence from these rock layers supporting the view that in the past this area was sometimes covered by the sea, but not at other times.

_____

_____

6 **Explain** how the Grand Canyon is evidence that the Earth's sedimentary rocks were laid down over a very long period of time.

_____

_____

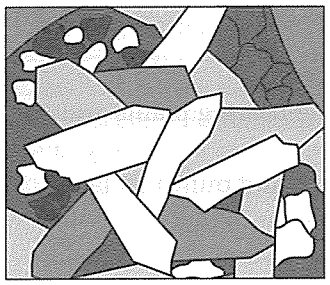
8.6 Identifying rocks

Science understanding, Science inquiry

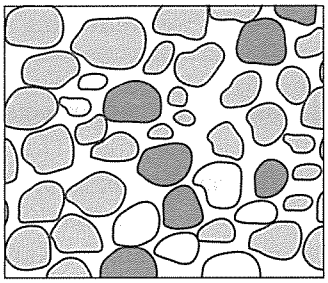
Logical/Mathematical Visual/Spatial

Consider the diagrams of the rocks.

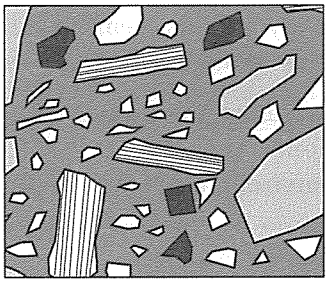
a



b



c



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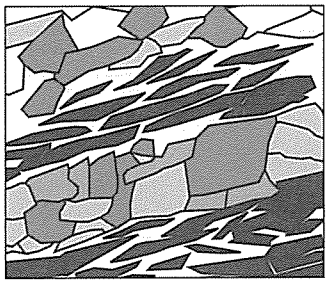

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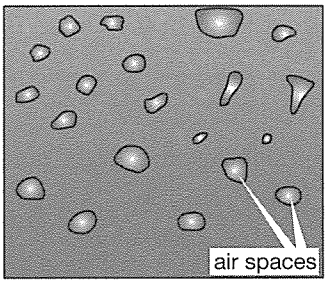

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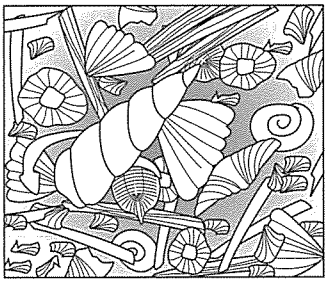


Classify each of the rocks into a type and justify your decision. Select the type of rock from the following list: extrusive igneous, intrusive igneous, clastic sedimentary (sandstone), organic sedimentary, clastic sedimentary (breccia) and banded metamorphic.

Rock	Type of rock	Justification for classification
a		
b		
c		
d		
e		
f		

8.7 You are a diamond!

Science as human endeavour

Verbal/Linguistic

When someone says 'You are a diamond', they mean you are a wonderful person. However, now it could be true—you could really become a diamond! Several companies throughout the world make dead bodies into diamonds. A Swiss company called LifeGem was the first company to do this. LifeGem will also turn dead pets into diamonds. Dozens of diamonds can be made from one individual.

One woman had her dead husband turned into a diamond necklace, so she feels close him to whenever she wears it. The ring shown in Figure 8.7.1 was made from the ashes of a dog. However, you don't have to be dead for some of you to end up in a diamond. Diamonds can be made from anything that is organic, meaning containing the element carbon, and once part of a living thing. Hair can therefore be turned into a diamond. In 2008, hair from the dead composer Ludwig van Beethoven was turned into a diamond and sold on eBay for US$200 000.

The diamonds from humans are made by creating similar conditions to when real diamonds are formed beneath the Earth's crust. These conditions are very high pressures and temperatures. The first step is to cremate the dead body. This means to burn it so that it turns into ash. This would happen at a normal cremation service at a cemetery. The family then gives the ashes to LifeGem.

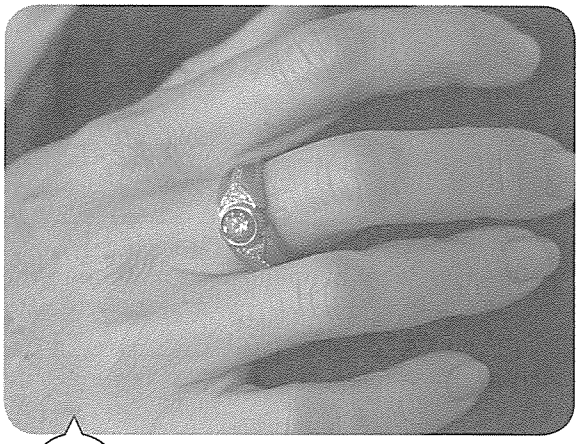


Figure 8.7.1 This ring was made from the ashes of Digby the dog.

The ashes are heated to about 3000°C. This turns the ash into graphite, a form of carbon. The graphite is then added to a press—a metal device with sections called anvils that squeeze the graphite between them at pressures about 100 000 times greater than the pressure of the atmosphere. At the same time, the graphite is also heated to about 1500°C. The atoms in the graphite break apart from each other and rearrange into a different arrangement. The graphite is now diamond.

Human and pet remains contain many elements, such as boron. If some of the boron remains in the graphite, it results in diamonds that are blue. Early attempts produced all blue diamonds, but now other colours can be made by adding particular elements to the graphite before it is compressed.

Other uses of synthetic diamonds

Diamonds have many uses, but natural ones are rare and therefore expensive. Diamonds made in the laboratory are called synthetic diamonds. Synthetic diamonds are generally much cheaper than natural ones. Diamonds are valued mainly for their hardness, but also for their colour and purity. Synthetic diamonds can be harder than natural ones. This makes them especially useful as powder for polishing and sanding and for cutting tools. These are the largest uses of synthetic diamonds at present.

8.7

Synthetic diamonds can be cut into gems. The purity and lower price of artificial diamonds makes them popular for jewellery. Synthetic diamonds can be artificially coloured yellow, brown, blue, green or orange. Natural diamonds also occur in a range of colours. Australia's Argyle diamond mine is famous for its pink diamonds. Special devices called spectroscopes can be used to tell the difference between natural and artificial diamonds. Natural diamonds can also have a number burned into them by a laser to show they are authentic.

1 **Name** the element that must be in the ash before it can be made into a diamond.

2 **State** the conditions below the Earth's crust that result in the formation of natural diamonds.

3 **Explain** what must be done to the ash before it can be placed in the press.

4 **Describe** the conditions necessary in the press to turn the graphite into diamonds.

5 **Describe** what happens to the carbon in the press.

6 **Explain** why diamonds made from human and pet ash may be blue.

7 **Explain** why synthetic diamonds rather than natural diamonds are often used in cutting blades or for polishing and sanding.

8.8 Literacy review

Science understanding

Verbal/Linguistic

1 **Use** the clues to **identify** the jumbled words.

Jumbled word	Clue	Answer
logyoge	The study of rocks, their history and the processes that form and change them	
iclokrenting	Crystals that grow into each other in a rock	
gamma	Molten rock that does not reach the Earth's surface	
newheatrig	The physical and chemical processes that break rocks down into smaller pieces	
meantedysir	Rocks made by sediments being cemented together	
nitfoolia	Process where minerals under pressure become squashed flat and the rock develops layers or bands	
phormaticme	Rocks formed when high temperature and pressure alter existing rocks	
cork cecly	Model that geologists use to explain the endless cycle of change that happens to rocks as they change from one form to the other	
medestination	The process of water or wind depositing eroded rock particles	
ogenius	Rocks formed from cooling magma	

2 **Use** the clues to **identify** the missing words.

Clue	Word
Igneous rock forming below the surface of the Earth	m _ g _ _
Molten rock reaching the Earth's surface	l _ v _
Whether a rock is rough, smooth or has lumps or holes in it	t _ x _ _ r _
Type of weathering caused by water and chemicals in the water and air reacting and breaking down rock	c _ _ m _ c _ l
How well soil particles stick together	c _ _si _ _ e _ _ y
How well the soil particles join up to form lumps	s _ r _ c _ u r _
Rocks that form by the accumulation of plant or animal debris, which is then cemented together	s _ _ _ m _ _ t _ _ y
Type of weathering caused by ice, temperature change, salts, wind and plant roots	p _ _ s _ c _ l
Combined with high temperature, this can cause metamorphism	_ r _ _ s _ r _

9.1 Gold prospecting

Science understanding

Verbal/Linguistic

Prospecting for gold can be fun and if prospectors discover gold then they will make a lot of money. Many gold mines that are still producing gold today were found by individual prospectors who discovered the gold there by chance.

Locating the gold

About 3.5 billion years ago, gold was deposited in the igneous rocks that formed the continents. Since then the original rocks have undergone metamorphosis, have been eroded and the gold has been moved around by hydrothermal fluids. This means the gold has been concentrated in some places in the rocks to form large nuggets, and has also been washed away and carried by surface waters to other locations.

Gold is often deposited close to fault lines because it is moved around by hydrothermal fluids deep underground. These fluids can flow through the cracks in the rocks and deposit the gold in veins. A geological map of a known gold-producing area is a good place to start the search for gold. This is how the prospectors of the 1800s searched for gold and the process is not much different today.

Early prospectors found gold nuggets on the surface of the ground. However, as the surface nuggets ran out, prospectors soon learned to dig to search out the rock the nuggets came from.

Methods and equipment

For modern-day prospectors, the methods, laws and equipment used are similar in all Australian states. However, prospectors have to check the prospecting laws in each state before they start digging.

Crushing the ore

A dolly pot is a simple crushing device used by individual prospectors. Ore is placed in the dolly pot and crushed into small granules and powder.

Panning

Crushed ore can be mixed with water and the gold separated out by panning. Panning uses a shallow, wide bowl and water is swirled around to wash the rock grains away from the gold. The heavier gold sinks to the bottom of the pan. Panning is only possible in places where there is enough water present.

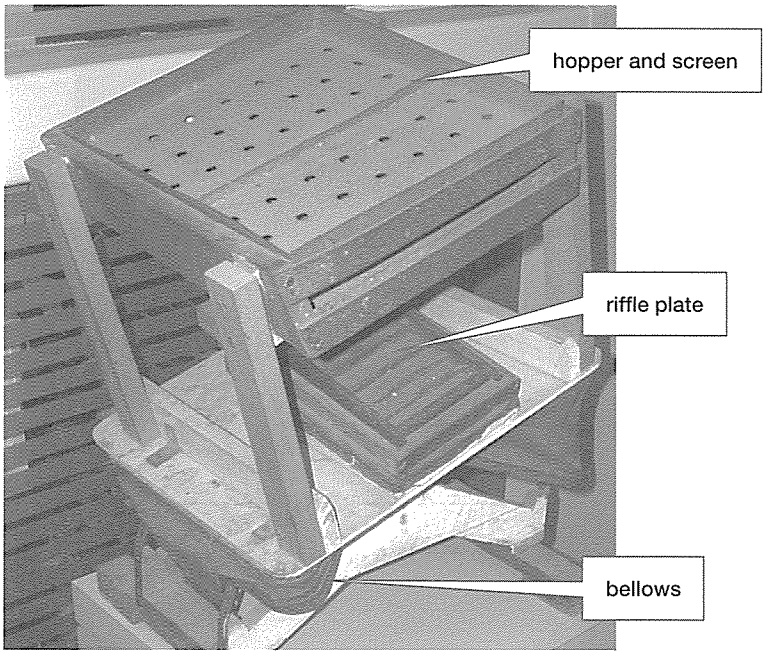
Dry blowers

In much of Australia, there is not enough water available for panning, so 'dry blowers' are used instead. Dry blowers use air to separate the gold from the crushed rock and soil. In the past, prospectors used a bellows. A bellows is a bag-like structure with a valve that allows air in one end and blows air out the other end when the bellows is pumped. Modern dry blowers have engines that blow air through crushed rock and soil. The crushed rock drops into a narrow box that has a series of horizontal bars called riffles across the bottom. You can see these in Figures 9.1.1 and 9.1.2. The air is blown through the riffle box and blows much of the crushed rock away. The gold collects behind the riffles because it is heavier than the rock powder.

If water is available, it can be used with a riffle box of a different design, called a sluice. A sluice is more efficient and cheaper than dry-blowing using a petrol engine.

Figure 9.1.1

An early 20th century dry blower from the Kalgoorlie goldfields in Western Australia. Rocking from side to side pumped air through the riffle plate.



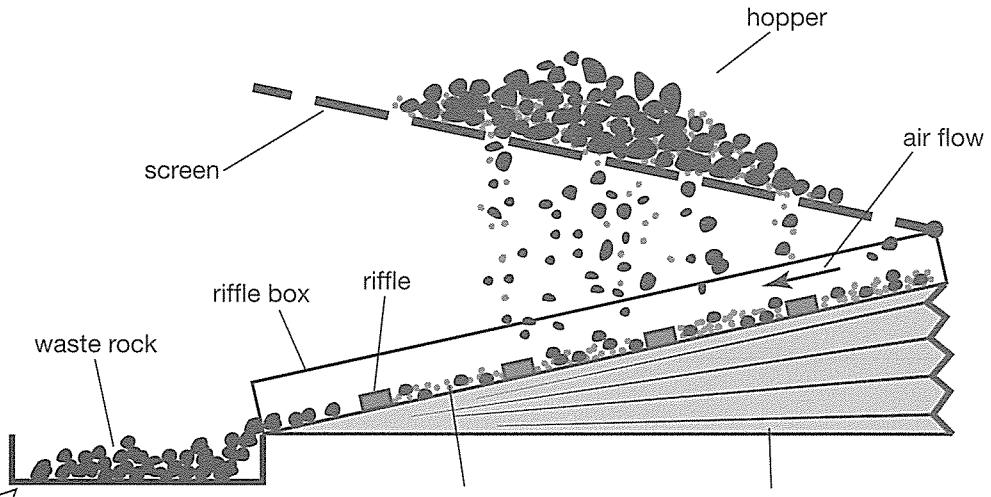


Figure 9.1.2 The general parts of a dry blower

Metal detectors

Many modern prospectors don't crush rock or use a dry blower or sluice. They use metal detectors, which can cover a large area of ground very quickly. A metal detector is shown in Figure 9.1.3 on page 120. Metal detectors are especially good for searching soil for larger gold nuggets. These can be dug up with a pick and shovel, or earthmoving equipment. Modern metal detectors can search much deeper in the ground than earlier models. Many prospectors are now locating nuggets in areas previously thought to be exhausted of gold.

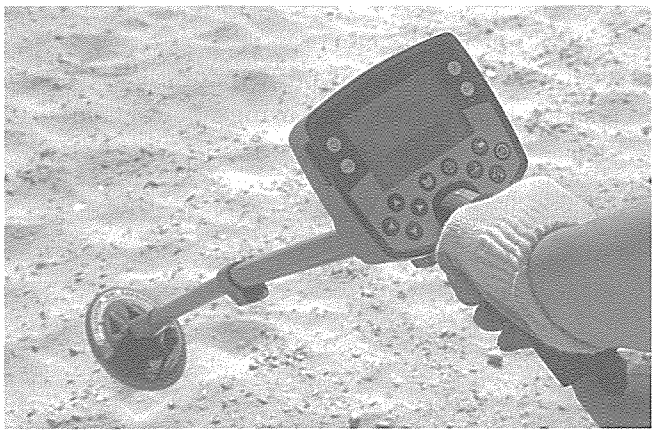


Figure 9.1.3

A metal detector uses magnetism to detect metals buried in the ground.

1 **Discuss** whether all gold nuggets were formed at the sites where prospectors find them.

2 **Justify** the argument that it is a good idea to consult a geological map when prospecting for gold.

3 **Describe** what you have to check first before deciding to prospect in an area.

4 **Explain** the function of the dolly pot.

5 **Describe** how a dry blower works.

6 **Propose** why prospectors would use a metal detector rather than a dry blower.

9.2 Golden bacteria

Science as a human endeavour

Verbal/Linguistic

Refer to the Science as a Human Endeavour on page 322 of your student book to answer the following questions.

1 **State** the observation that made scientist Frank Reith curious about bacteria and gold.

2 **State** a hypothesis that Reith wanted to test by conducting further research on the bacteria.

3 **Propose** why he organised a team of several scientists from around the world to help him with the research.

4 **Describe** what the scientists discovered the bacteria could do when placed in a solution that contained gold.

5 **Explain** how the response of the bacteria to gold was of use to the scientists.

6 **Name** the technique used to image the bacteria and the metal particles they were accumulating.

7 **Discuss** whether the group's research could be of use to the mining industry.

9.3 Finding mine sites

Science inquiry

Logical/Mathematical **Visual/Spatial**

Geochemists searching for new nickel deposits decided to take soil samples from the area shown in the diagram. This diagram shows a map of the magnetic anomalies in the area. There is a stream flowing through the site.

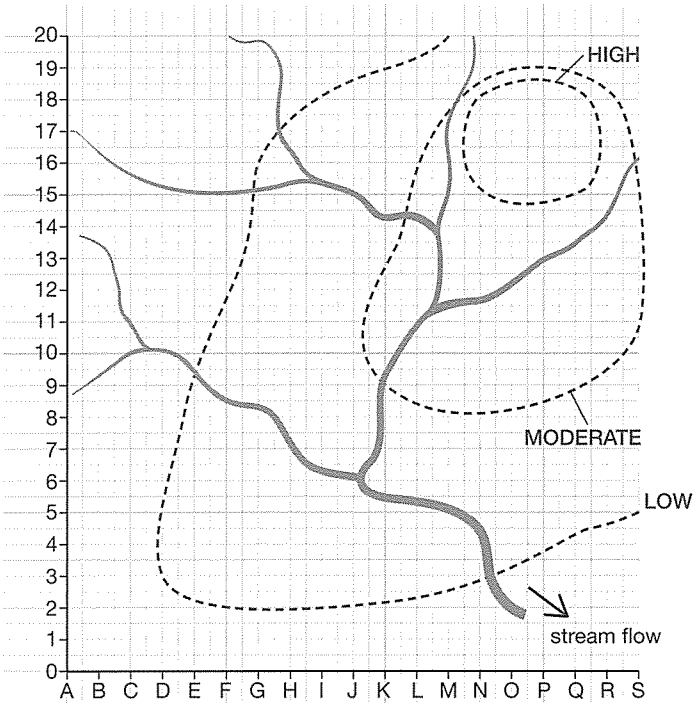


Figure 9.3.1

Locations of sites where soil samples were taken.

1 **Describe** the method probably used by geophysicists that helped them decide that this area was worth sampling.

_____

_____

2 **Explain** why the geochemists would not have sampled the water in the stream to detect minerals in the area.

_____

_____

3 **Predict** where the geochemists would have decided to take soil samples. **Explain** why you chose that area.

_____

_____

After studying the map, the geochemists took their soil samples. The samples returned the results for nickel shown in the table below. The values are parts per million (ppm). Anything under 30 ppm was recorded as zero.

Grid reference	8	9	10	11	12	13	14	15	16	17
M	0	0	30	0	0	0	0	0	0	0
N	0	35	37	59	71	74	78	109	77	35
O	0	35	37	78	87	100	140	150	135	80
P	0	35	61	66	69	85	137	100	76	55
Q	0	0	0	31	33	30	31	30	0	0

4 **Classify** these values for nickel grade as low (L) if they are in the range 30–50 ppm, moderate (M) if they are 51–100 ppm or high (H) if they are over 101 ppm. Write the letters L, M or H in the table below. Leave zeroes blank.

Grid reference	8	9	10	11	12	13	14	15	16	17
M										
N										
O										
P										
Q										

5 On the map in Figure 9.3.1, colour the three grades of nickel (low, moderate and high) with a different colour to **identify** high concentrations of nickel.

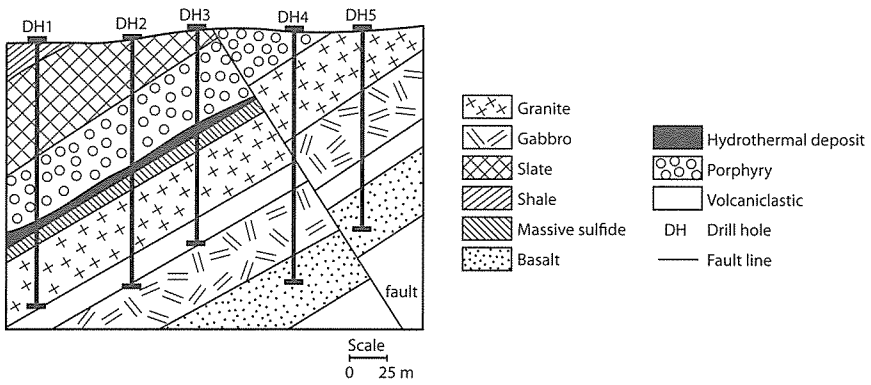
6 **Explain** the next step that geochemists would probably take.

9.4 Geological maps

Science understanding, Science inquiry

Visual/Spatial

This is a geological cross-section of an area that a company is mining.



1 The sulfide deposit shown in the cross-section was the layer of interest to the mining company. **Identify** how many of the drill holes would have cut through the sulfide deposit.

_____

2 **Describe** how the geologists at the mining company probably created this cross-section.

_____

_____

3 The rock layers at the surface all run parallel to each other for several hundred metres. In the space below, **construct** a diagram showing a 50-metre deep strip at the surface that runs across the diagram from left to right. Use a key (legend) to indicate the type of rock in each layer.

9.5 Super pit

Science understanding

Verbal/Linguistic

The mining process

Open-cut mining operates in a sequence of steps. All the mine workers in every job must cooperate fully or the process may fail. The Super Pit is a huge gold mine near Kalgoorlie in Western Australia. It is a good model of how an open-cut mine is designed and operated.

1 Designing the mining layout

Mining proceeds on a series of levels, called benches. The benches gradually go deeper into the ground as each layer of rock is cleared away. The explosive blasting of the benches must be carefully designed in a cooperative effort between planning engineers, geologists, drill and blast engineers and voids officers design the size and shape of the blasts on these benches.

2 Marking old mine shafts

The Super Pit is built over many old underground mines. The location of old shafts in the pit must be marked for safety. This is the job of the voids officer (*void* is another word for a hole). The old workings are marked with different types of flags. Special drills called probe drills search for these old workings.

3 Grade control drilling

Geologists locate the ore blocks on the bench by drilling holes and checking the quality of the ore. A sample is taken every 2 metres down the hole and sent to the laboratory to find out how much gold is in each sample.

4 Production drilling and charging

The rock is very hard, so it must be blasted apart with explosives. Holes are drilled in a pattern about 5 metres apart. The drill holes are filled with ANFO (ammonium nitrate and diesel) explosive at the bottom. The hole is filled with several metres of gravel. This forces the explosion to go into the rock, rather than back out the hole. The explosives in all holes are connected together to go off in a certain sequence. Then the blast is ready for firing by a worker known as a shot firer.

5 Blasting

People in nearby towns are informed of blast times, and can see the process from a viewing platform. Workers and equipment are not allowed into a blast site for at least 12 hours after the blast. This gives the ground time to settle. The shot firer inspects the blast for any explosives that may not have detonated. When safe, the shot firer opens the site for the geologists and production crew to begin work.

6 Digging

Geologists mark where the ore blocks are with wooden pegs and coloured tape, to identify them for the digging teams. Then geologists produce a 'dig plan'. An electronic copy of this is sent to the on-board navigation system of the shovels and other loading vehicles driven by the production crew.

9.5

Hydraulic shovels are huge digging machines that can move 60 tonnes of rock and ore per bucketful. They load the haul trucks, which can each carry 225 tonnes. Bulldozers keep the floor of the bench level and clear up any spillage.

Dust is controlled by water trucks that constantly spray the area. This reduces the overall dust levels that the mine produces and gives operators a clearer view of the operations.

Once a haul truck is full, it takes its load to be crushed. The truck dumps its load and returns to the loading area to collect another one. Generally a load is picked up every 20–40 minutes.

The mining cycle continues 24 hours a day, 365 days a year. At present, about 240 000 tonnes of rock and ore are moved every day. In one year, 800 000 ounces of gold are produced. An ounce is about 28.5 grams.

1 **List** ten different jobs involved in running the Super Pit.

2 **Explain** why a worker in this mine has to be careful and observant.

3 **Clarify** why old underground workings are a problem in the Super Pit.

4 **Explain** why the blasting holes are plugged at the top.

5 **Name** the explosive used for blasting.

6 **Describe** how the driver of a hydraulic shovel knows where to dig.

7 **Calculate** how many tonnes or kilograms of gold the Super Pit produces in a year. **Compare** it with the mass of rock and ore carried by a haul truck on one trip.

9.6 Environmental effects of mining

Science as a human endeavour

Verbal/Linguistic

Refer to the Science as a Human Endeavour on pages 338 and 339 of your student book to answer the following questions.

1 **List** five types of environmental damage that have occurred through mining.

2 **Clarify** what is meant by *tailings*.

3 **Describe** how tailings are stored.

4 **Name** an example of an earth wall at a mine bursting and contaminating rivers and soil.

5 **Describe** how dust is controlled at mine sites.

6 **Compare** the impact on land use of mines operating underground and open-cut mines.

7 **Describe** how open-cut mines are rehabilitated.

9.7 Literacy review

Science understanding

Verbal/Linguistic

1 **Use** the clues to **identify** the jumbled words.

Jumbled word	Clue	Answer
lanemir	A naturally occurring inorganic liquid or solid in the Earth's crust	
mopetrule	Oil and gas occurring naturally in rocks	
terygocismeh	The use of chemistry to show what minerals are present in an area	
tamomgetneer	Device that measures magnetic field strength	
gredding	A process that uses a floating platform that mixes water and rocks or soil to separate minerals	
nope tuc	A large pit dug into the ground surface	
gratenitconnc	Removing unwanted material such as rock and increasing the concentration of the mineral	

2 **Recall** key terms by drawing a line between the correct definition from column 1 with the correct term in column 2.

Column 1	Draw your lines across here	Column 2
Superheated liquids in the crust		seismic survey
A survey that measures the effect of applying a magnetic field to the Earth		electromagnetic survey
Sending a shock wave into the ground surface and recording the reflected sound waves		decline
An underground shaft that is on a slope, allowing vehicles to drive up and down		hydrothermal fluids
Using chemical methods to get the metal from the concentrated ore		extracting

3 **Use** the clues to **identify** the missing words.

Clue	Word
Physical property based on ability to scratch particular minerals	h _ _ dn _ _ _
How shiny a mineral is	l _ _ _ r _
Rocks containing minerals, but not including oil	_ r _
The colour left behind on an unglazed white tile when the mineral is scratched across its surface	s _ _ _ _ k
Very sensitive instrument that measures small differences in the gravitational pull of the Earth in different places	g _ _ _ _ m _ _ _ r
Horizontal tunnel through a mountain	a _ _ _
When a solution is pumped into the ground to dissolve minerals in the rocks	l _ _ _ h
Large deposits of ore	_ r _ b _ _ _ _ _
A drilled sample of rock	_ o r _ s _ _ _ _ _