Chapter 1: DNA and genetics

Unit 1.1

1 phosphate; base; deoxyribose sugar

2 TATCGCAGTTCACAGTGGG A

3 **a** ii

b **i** Not a possible sequence. G is paired with G instead of with C.

ii A possible sequence. All base pairs are complimentary.

iii Not a possible sequence. In the third pair, A is paired with A instead of T; in the eighth base pair, G is paired with G instead of C.

iv Not a possible sequence. In the seventh base pair, T is paired with C instead of A; in the tenth base pair, T is paired with G instead of A.

Unit 1.2

1 **a** 1869

b Johannes Friedrich Miescher

2 Levene identified the components of DNA and the arrangement of sugar, phosphate and base in a nucleotide.

3 Levene thought that the DNA molecule was too simple to carry the genetic code.

4 Oswald Avery demonstrated that DNA was the material that contained genetic information.

5 X-ray crystallography

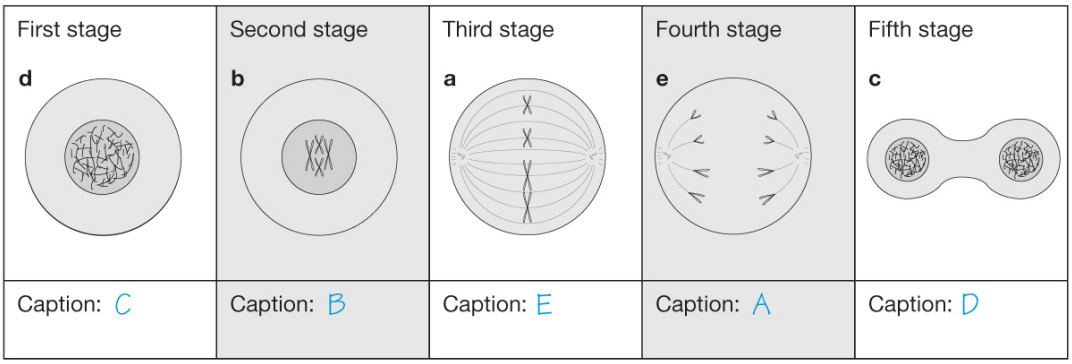
6 The amounts are the same because adenine always pairs with thymine, and guanine always pairs with cytosine in DNA.

7 Answers may vary. Timeline should include the following:

- 1869—DNA isolated by Miescher
- 1900—Levene identifies the chemical components of DNA
- 1913–1914—X-ray crystallography invented by the Braggs
- 1940s—Chargaff's research leads to Chargaff's rule
- 1943—Avery identifies DNA as the molecule carrying the genetic code
- 1951—Franklin and Wilkins create X-ray crystallography of the DNA molecule
- 1953—Watson and Crick determine the structure of DNA
- 1965—Watson, Crick and Wilkins are awarded the Nobel Prize in Chemistry.

Unit 1.3

1 a



b C, B, E, A, D

Unit 1.4

1 e

2 d

3 c

4 a

5 g

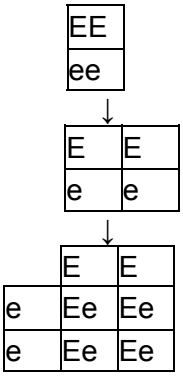
6 b

7 f

8 h

Unit 1.5

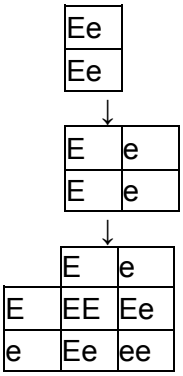
1



a Ee

b long lashes

2



2 **a** 1 EE : 2 Ee : 1 ee

b 3 long lashes : 1 short lashes

3 **a** F_1 genotype: ½ Bb : ½ bb

F_1 phenotype: ½ black : ½ white

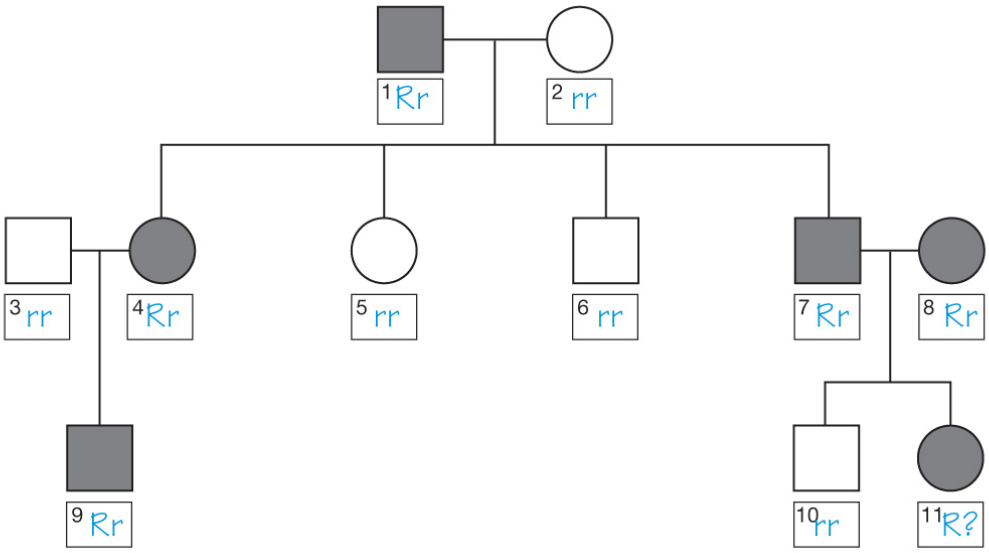
b Heterozygous black: Bb. Gametes: ½ B + ½ b

Homozygous white: bb. Gametes: all b

	B	b
b	Bb	bb
b	Bb	bb

Unit 1.6

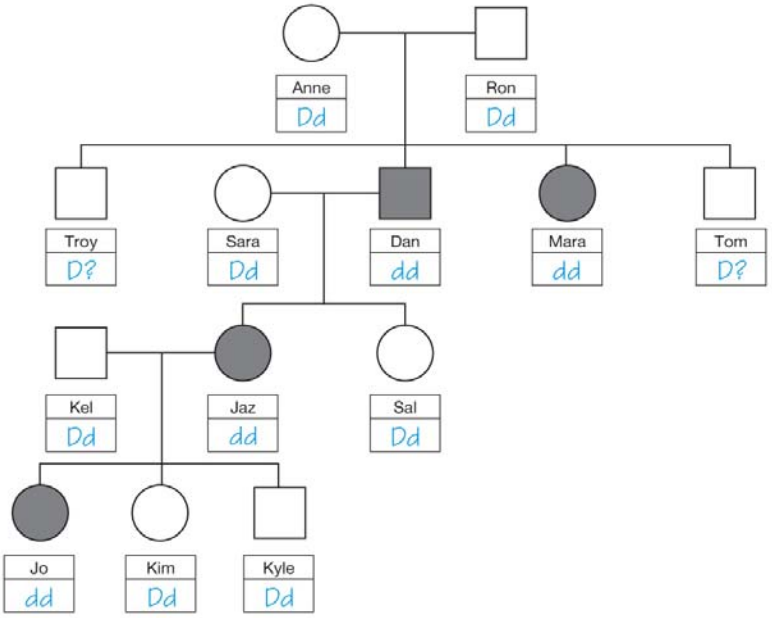
1



2 a recessive

b The phenotypes of individuals 5 and 6 do not show the trait, but the daughter of 5 and 6 (individual 14) does show the trait. Therefore, 5 and 6 must both carry the allele for the trait. If they carry the allele and it is not their phenotype, then it must be a recessive characteristic.

3 a



b Troy, Tom

c Troy and Tom could have inherited dominant alleles from both their parents and been homozygous for the dominant normal allele. Alternatively, one or both of them may have inherited the recessive allele from either of their parents, in which case they would be heterozygous carriers of the CF allele. They do not have any children, so we do not know which alleles they carry.

Unit 1.7

1

X_oX_o
X_BY

↓

X_o	X_o
X_B	Y

↓

	X_o	X_o
X_B	X_oX_B	X_oX_B
Y	X_oY	X_oY

2 **a** The father was black (X_BY). If the father was orange (X_oY) instead of black, there could be no black, female offspring (X_BX_B) with a tortoiseshell mother (X_oX_B).

b

X_BX_o
X_BY

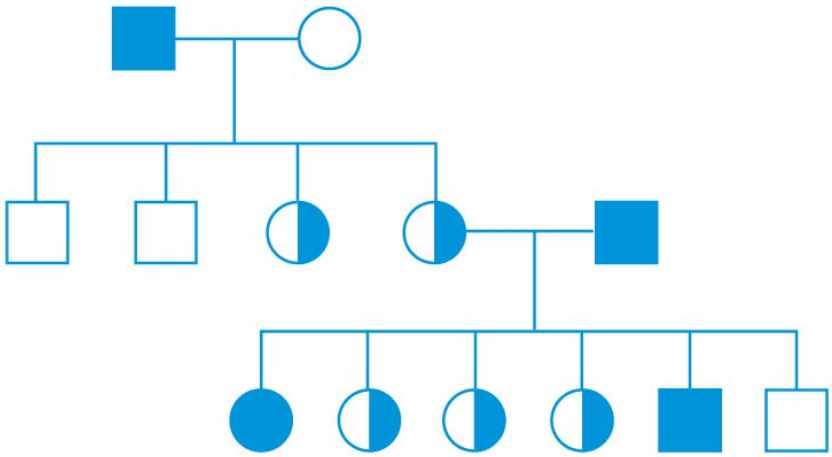
↓

X_B	X_o
X_B	Y

↓

X_B	X_o
X_BX_B	X_oX_B
X_BY	X_oY

3



Unit 1.8

1 Answers will vary. Both attempt to increase food production. The Green Revolution used chemicals to control weeds, pests and diseases. New crop varieties and fertilisers also helped to increase food production. The Gene Revolution uses genetic modification to grow more productive crops using fewer chemicals.

2 Ideas to consider include: selective breeding gradually changes the genetic make-up of organisms; the genes that are selected may occur naturally or may result from exposure to mutagens; genetic modification changes the genetic make-up faster; the genes added may not naturally occur in that organism.

3 Ideas to consider include: the DNA in your cells is manufactured from the DNA consumed in your food; a gene derived from fish DNA inserted into a tomato becomes a tomato gene; many organisms share a substantial number of genes; is an identical gene from a horse and a human a human gene or a horse gene?

4 individual student response

5 individual student response

6 **a** individual student response

b individual student response

Unit 1.9

1 Cells that are *pluripotent* are capable of becoming any one of the 220 different cell types found in the human body.

2 Human adult stem cells were discovered by scientists experimenting with bone marrow for use in the treatment of leukaemia.

3 Adult stem cells are only found within organs that require a large number of new cells. Embryonic stem cells are all the cells of the embryo before differentiation. Adult stem cells are specialised and are only able to make certain types of cells. Embryo stem cells are able to make any type of body cell.

4 Stem cells have potential to treat and possibly cure diseases such as cancer, diabetes, heart disease and spinal-cord injuries where cells have been damaged. Adult stem cells are not suitable for these treatments. Experimentation with embryonic stem cells is not accepted by some sectors of the community. iPSCs could be as useful as embryonic stem cells but without the ethical problems.

5 Answers may vary. Example:

Genes are introduced into virus DNA.

↓

The genes become part of the mouse DNA.

↓

The genes reprogram the skin cell.

↓

The skin cell becomes a pluripotent cell.

6 iPSCs have sometimes functioned incorrectly because the genes inserted into the cell interfered with the ‘on switches’ in some of the mouse DNA, so that necessary proteins were not manufactured. Research is necessary to make sure that iPSCs behave in exactly the same way as embryonic stem cells.

7 They are all diseases where cells have been damaged and are not regenerated normally by the body.

Unit 1.10

1 Deoxyribonucleic acid

complementary

base

pairs

thymine

cytosine

replication

meiosis

mitosis

Mitosis

Meiosis

Homologous

alleles

genotype

phenotype

differentiate

genetically

modified

gene

splicing

recombinant

DNA

Adult

stem

cells

pluripotent

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Chapter 2: Geological time

Unit 2.1

1 **a** ray (fish)

b seastar

c plant

d beetle

e frog

f turtle

g bird/dinosaur (it is *Archaeopteryx*)

h crustacean/lobster etc.

i horse

j dinosaur

2 c

3 a, e, f, g, i and j

4 There don't appear to be any external moulds, indirect fossils or casts.

5 **a** In fossil j, the chemicals in the bones were replaced slowly by another chemical called silica. In fossil d, at least some of the original chemicals in the beetle's body are still present in the fossil.

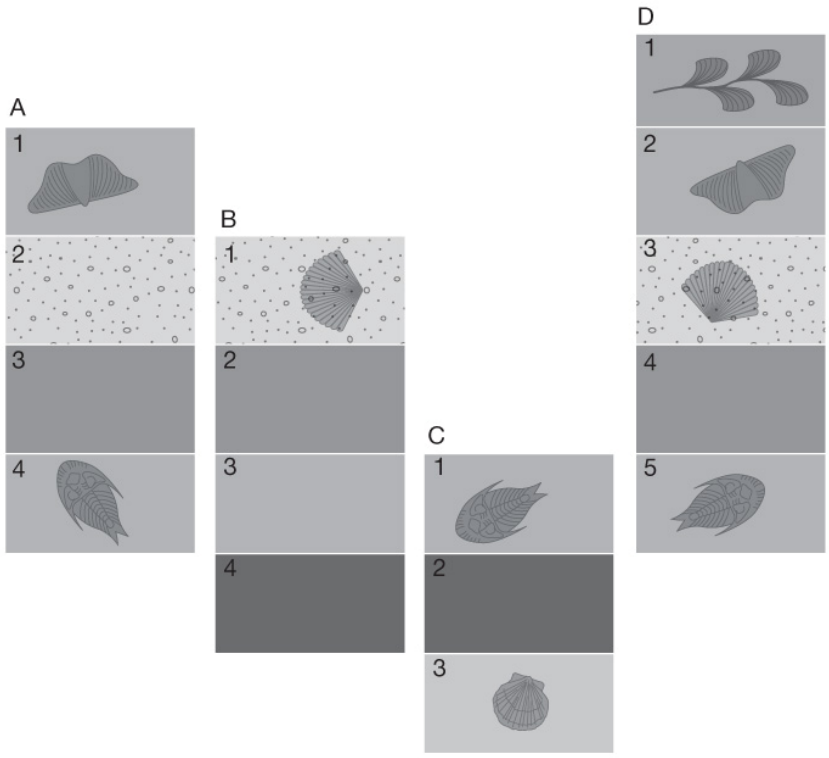
b You could tell what chemicals were in the beetle's body (fossil d) when it was alive, but you could not tell what chemicals were present in fossil j because they have all disappeared.

6 There seem to be imprints of feathers in the rock around the front limbs. *Archaeopteryx* is now thought to be a genus of a theropod dinosaur that is closely related to modern birds.

7 A list of all the species that have appeared as fossils (including the order in which they appeared).

Unit 2.2

1



2 The contours rank the heights of the sites from highest to lowest as D, A, B and C. (The contours are 305 m, 300 m, 295 m and 290 m.) Matching the strata to each other also ranks the sites in the order D, A, B and C.

3 stratigraphy

4 **a** The oldest layer is C3.

b It is the lowest stratum of the four sites.

5 **a** The youngest layer is D1.

b It is the highest stratum of the four sites.

6 B3

7 B1 and D3

Unit 2.3

1 1251 million years old

2 about 625 million years old

3 2 half-lives; 2502 million years

4 3 half-lives of potassium-40 (actually about 3.6 half-lives)

Unit 2.4

1 the Devonian period

2 four-footed land animal (reptiles, mammals, amphibians and birds)

3 The bones of the limbs provide evidence of life moving from the water to the land.

4 humerus

5 humerus, radius and ulna

6 Their limbs would have been much better than fins at moving through the environment of water that contained a lot of vegetation. They could move by gripping it and pushing on it.

Unit 2.5

1 Birds are related to dinosaurs.

2 *archaeopteryx*

3 feathers and a ‘wishbone’ in the chest

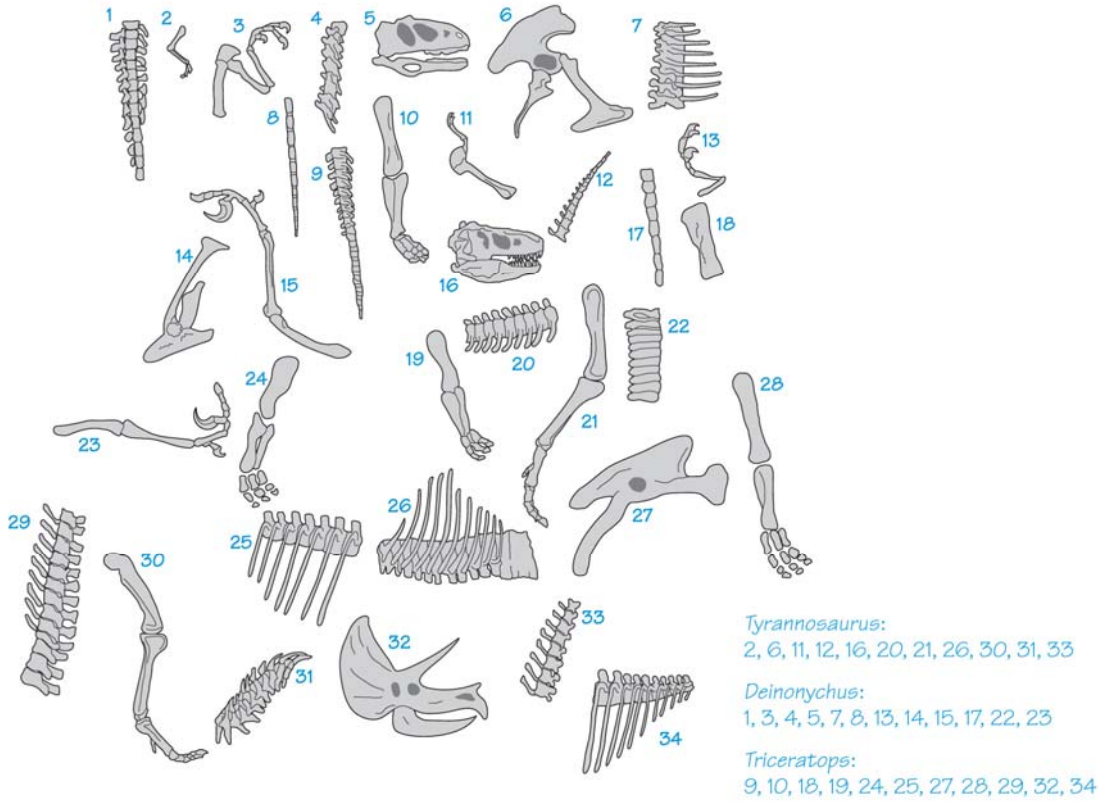
4 They had preserved body tissue. Their chemical structure was like that of modern bird feathers.

5 They were bipedal, had long tails and their ‘arms’ had an ulna that was curved outwards. They also laid eggs and nested, which is similar to birds.

6 *Anchiornis* is the oldest bird-like dinosaur discovered. It was covered in feathers, some of which are similar to those used in flight in modern birds.

7 Feathers were good for temperature control, and probably helped to keep some dinosaurs warm.

Unit 2.6



1 *tyrannosaurus*, *deinonychus*, *triceratops*

2 Depends on answer. Size of bones should be similar, bones should be similar on both sides of skeleton, bones may look like a skeleton they already know etc.

Unit 2.7

1 forensic science

2 They could copy bones from the other side because the body should be symmetrical.

3 Marks on the bones show where and how large the muscles were. Comparing with living relatives helps.

4 Scientists study the colour patterns of the nearest living relatives. The skin covering (such as feathers or scales) is known for some dinosaurs because of fossils.

5 By measuring the distance between footprints and comparing this with body size, scientists can estimate running speed.

6 Dinosaur tracks are a good guide that many dinosaurs lived in groups. There are some very good fossil sites that show a herd of dinosaurs walking.

7 Carnivores had many sharp teeth, whereas herbivores generally had flatter teeth to grind plant material. Fossilised dung showed remains of plants and some fossil sites show dinosaurs preying on others.

Unit 2.8

1 fossil

palaeontologist

index

stratigraphy

lobe finned

tetrapods

dinosaurs

fossil record

relative

2

Term	Definition
carbon film fossil	when a dead body partially decays and leaves a thin black deposit of carbon
cast	when an organism in rock decomposes and the space in the rock fills with soil that turns to rock
mould	an imprint of the outside of the body in rock
palaeontology	the study of prehistoric life
absolute dating	way of determining the actual age of rocks and fossils
half-life	layers of sedimentary rock or soil
strata	the time it takes for half of a radioactive sample to decay
organic matter	chemicals such as protein that were made by a living thing
geological time	a scale showing the history of life and geology

Chapter 3: Natural selection and evolution

Unit 3.1

1 **a** The four limbs that are most like the basic vertebrate limb are human, rabbit, bat and mole.

b They all have five digits that are similar to each other. The whale has five digits, but these have many more bones in them than the digits on the other limbs.

2 **a** horse and whale

b The whale has five digits, but three are tiny and two are very large. The horse seems to have only one digit, and seems to have only one ‘forearm’ bone.

3 The bat has long phalanges, which give it a large wing area.

The horse limb is long, thin, light and strong to allow fast running and to support its body weight.

The mole hand is short (so it does not get in the way in a burrow) and broad to give it a big surface to shovel dirt.

4 **a** The horse or the whale seem to have changed the most.

b The whale digits have more bones in them, although there are five digits. The horse only has one metacarpal and digit.

5 It seems to support it, although rabbits probably look more like the human limb than the bat does.

Unit 3.2

1 The two problems included a bitter taste and the seed pods shattered and scattered their seeds, so farmers found them difficult to harvest.

2 He was looking for mutants that may not have shattering pods. An inherited feature could then be used to breed.

3 That pod shattering was controlled by two independently inherited recessive genes.

4 **a** He cross-bred the two mutant plants.

b He did this to produce offspring with both of the genes for non-shattering, to see if completely non-shattering pods would be the result.

5 The cross-bred lupins still had bitter tasting seeds, which animals did not eat.

6 He crossed the non-shattering pod plants with sweet-seeded plants to combine the two characteristics.

7 Gladstones's story shows that a species can change as a result of selecting which individuals breed.

Unit 3.3

1 % banded in living population is (264/560) × 100 = 47.1%

% banded killed by snails = (486/863) × 100 = 56.3%

2 Banded phenotype is being removed at a greater rate from the population than the unbanded. Thus, banded genes are being removed and there will be fewer in the population.

3 58; 87

early spring

21/36 × 100 = 58%

late spring

64/73 = 87%

4 **a** The percentage killed that were a brown background colour increased from early to late spring.

b Bird predators could see the brown snails more easily in late spring as the green background developed. Thus, brown were selected out.

5 The percentage of brown alive in the population was very similar in early and late spring. In fact, there was a slightly greater proportion of brown snails present in early spring than in late spring. So it does not seem true that there was a chance increase in the number of brown snails in late spring.

Unit 3.4

1 on farms, in hospitals, in human foods, in soil and water

2 widespread antibiotic use, unnecessary antibiotic use in people, incorrect dosing amounts, failure by the patient to complete the course of pills, gene transfer between bacteria

3 The antibiotics are being fed to farm animals to improve their growth.

4 in animal droppings, uneaten food, dead animals, water runoff, windblown food

5 destroy/inactivate antibiotic molecule, altering cell wall to stop antibiotic attaching, reducing cell membrane permeability, pumping antibiotic out of cell

6 mutation, gene transfer (plasmids) between bacteria

7 Common bacteria can gain combinations of genes that enable resistance to multiple antibiotics that they have never been exposed to.

Unit 3.5

1 Light reflects off the tapetum back to the rods, enabling them to detect light that was missed the first time. So, more light is collected.

2 The tarsier eye is ‘tube shaped’. The front of the eye has become enlarged. The pupil and lens are huge in proportion to the size of the eyeball.

3 Tarsiers are nocturnal, and animals of similar size with a tapetum have much smaller eyes. The tarsier’s eyes fill a huge proportion of its skull and the shape is different in a way that maximises light gathering.

4 The eye shape of tarsier ancestors that began hunting at night (e.g. due to food shortage) varied. All lacked a tapetum, but their eyeball shape was different due to differences in genes controlling it. The animals with a shape that gathered more light could catch more insects and their survival rate was higher. Natural selection resulted in an increasing proportion of genes for eye shape and mutations were selected for.

Unit 3.6

1 The student should fall towards the side where the leg was lifted, i.e. away from the wall.

2 Your head moves away from the leg you lift because this ‘balances’ it.

3 It is the same situation as in the second activity.

4 They should have been towards the centre line of the body.

5 In humans, the femur is angled inwards. This is an advantage because the feet are closer to the centre line of the body.

Unit 3.7

1 evolution

generation

homologous

variation

antibiotics

species

speciation

hominidae

primates

2 resistance

transitional

natural selection

distribution

embryology

selective agent

mitochondrial

genetic isolation

Homo

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Chapter 4: The periodic table

Unit 4.1

1 / H / 1

2 / He / 2

3 / Li / 2, 1

4 / Be / 2, 2

5 / B / 2, 3

6 / C / 2, 4

7 / N / 2, 5

8 / O / 2, 6

9 / F / 2, 7

10 / Ne / 2, 8

11 / Na / 2, 8, 1

12 / Mg / 2, 8, 2

13 / Al / 2, 8, 3

14 / Si / 2, 8, 4

15 / P / 2, 8, 5

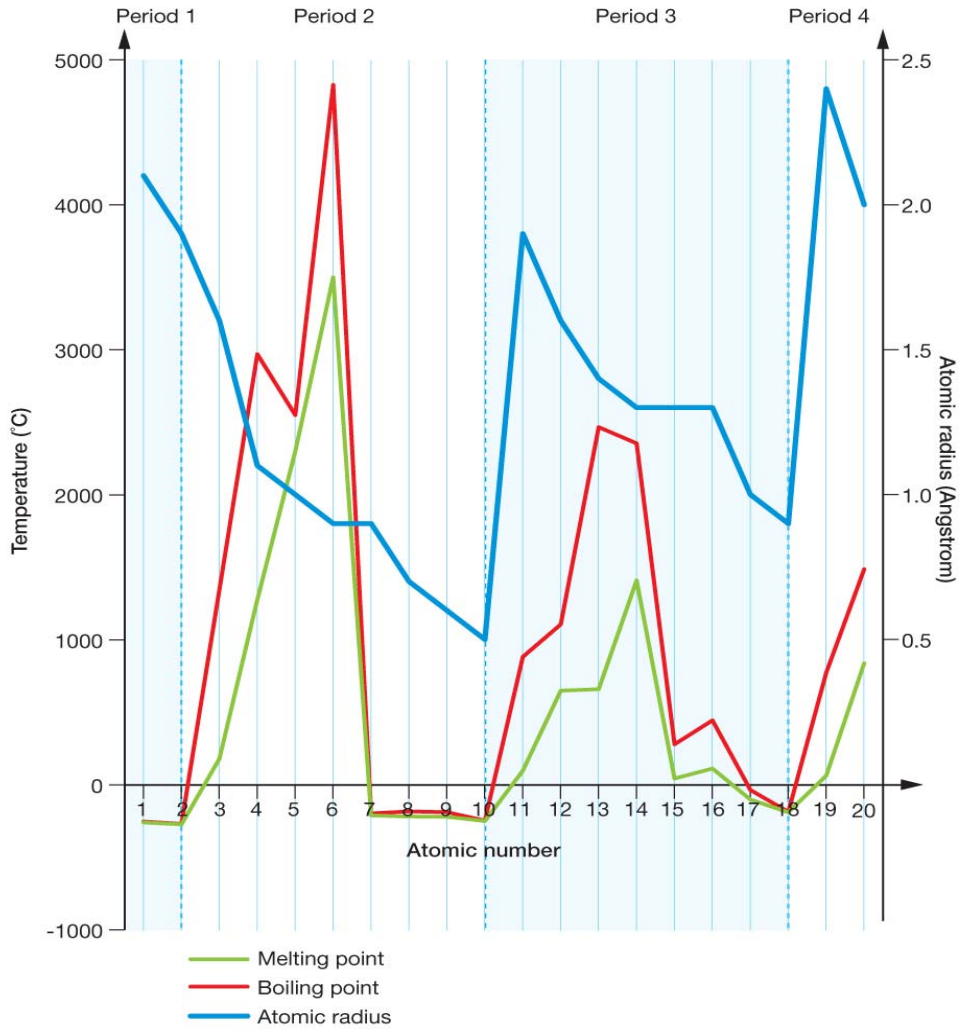
16 / S / 2, 8, 6

17 / Cl / 2, 8, 7

18 / Ar / 2, 8, 8

Unit 4.2

1–3



4 The melting and boiling point graphs have roughly similar shapes. When one peaks, so does the other. Likewise, when one dips, so does the other. Some points are nearly identical on both graphs.

5 As you move across the period of the periodic table, the melting point increases then suddenly drops, the boiling point increases then suddenly drops and the atomic radius decreases regularly. The radii suddenly increase with a new period and then once again decrease.

6 The pattern tends to repeat itself when you move from one period to another.

7 As you move down a group, the atoms increase, apart from period 1 elements. For example, in group 2, the atomic radii are: Be 1.1, Mg 1.6, Ca 2.0. Similar trends are found in the rest of the groups.

8 Another shell is added for every period as you move down a group. This will increase the size of the atom and its atomic radius.

Unit 4.3

a William Ramsay

b Lothar Meyer

c John Newlands

d William Ramsay

e Jons Jacob Berzelius

f Dmitri Ivanovich Mendeleev

g Johann Dobereiner

h Antoine-Laurent de Lavoisier

i Lothar Meyer

j John Dalton

k Henry Moseley

l Henry Moseley

m Antoine-Laurent de Lavoisier

n Dmitri Ivanovich Mendeleev

o John Dalton

p Antoine-Laurent de Lavoisier

q John Dalton

r Jons Jacob Berzelius

s Jons Jacob Berzelius

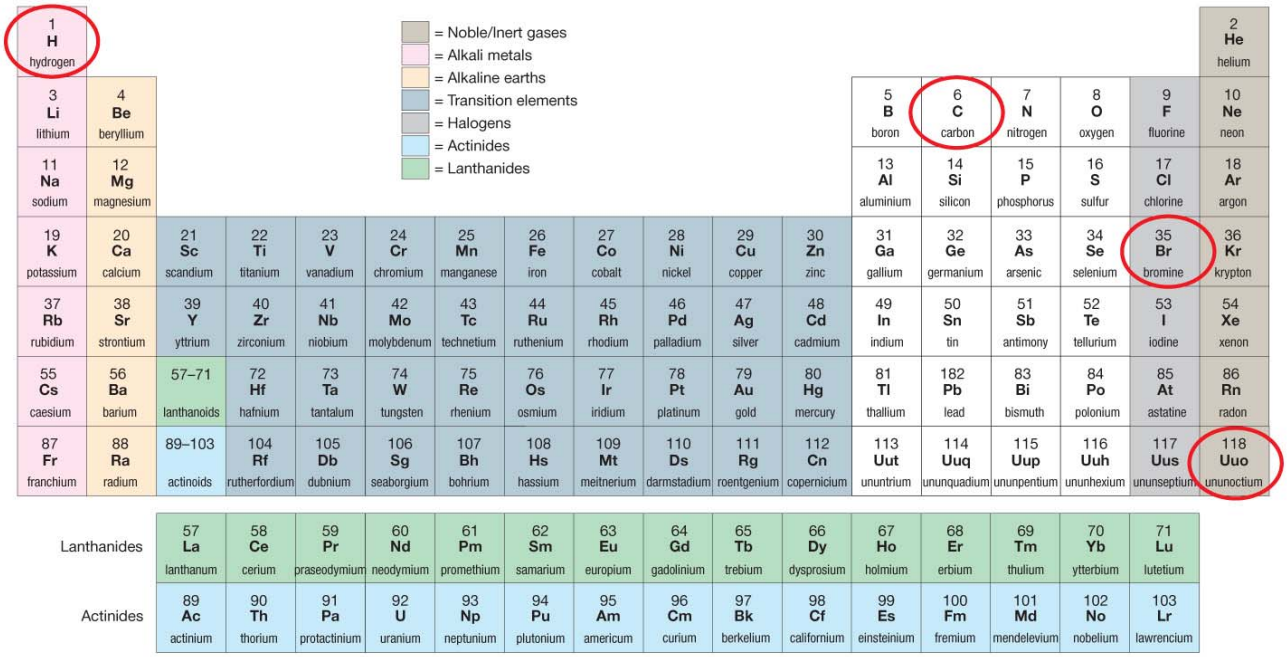
t Dmitri Ivanovich Mendeleev

u Antoine-Laurent de Lavoisier

v Antoine-Laurent de Lavoisier

Unit 4.4

1 a



2 a Br

b C

c H

d Uuo

Unit 4.5

1 Each carbon atom is involved in 4 covalent bonds.

2 Living things are carbon-based. Hence, the term ‘organic’ has become associated with ‘natural’ products. The most ‘natural’ produce is free from pesticides and herbicides and only fertilised with natural materials.

3 a An organic chemist studies organic compounds that have carbon backbones.

b An inorganic chemist studies inorganic compounds that do not have carbon backbones.

4 Similarities: backbone (or ring) or carbon, hydrogen atoms attached to the backbone, covalently bonded.

Differences: single/double bonds, backbone is linear/ring-shaped.

5 **a** carbon dioxide, which is used in photosynthesis

b Animals eat plants (or eat animals that eat plants), absorbing the carbon-containing glucose or starch that the plants contain.

c From original plants, animals and material like algae. The carbon is still there in their remains but is now part of new compounds.

d Oil (a fossil fuel). Since fossil fuels contain carbon, the plastics do too.

6 *Fossil fuels* are the remains of long-dead plants and animals compressed and changed into new forms.

7 The combustion of fossil fuels releases carbon dioxide, a greenhouse gas. Scientists believe that increasing carbon dioxide concentrations in the atmosphere is stopping heat radiating back from Earth into space. Hence, global warming and climate change may result.

Unit 4.6

1 the International Union of Pure and Applied Chemistry (IUPAC)

2 Scientists would not be able to easily share information they find out about the chemicals. Different scientists may claim that they discovered or invented a certain chemical since they would not recognise that it had already been discovered. This might lead to problems with ownership and therefore patents etc. over the chemical.

3 **a** alkanes

b alkenes

c alkynes

4 Similarities: all have a backbone of carbon atoms with atoms of hydrogen attached to it, so all are hydrocarbons; all have covalent bonds holding the atoms together; each new member of each family differs from the previous one by a CH_2 unit.

Differences: alkanes only have single covalent bonds between their carbon atoms; alkenes have a double bond between two carbon atoms; alkynes have a triple bond between two carbon atoms; each has a different proportion of carbon and hydrogen atoms.

5 **a** $n = 12$ so $2n + 2 = 26$ so formula is $C_{12}H_{26}$.

b $2n = 2 \times 20 = 40$. Formula is $C_{20}H_{40}$.

c $2n - 2 = 2 \times 30 - 2 = 58$. Formula is $C_{30}H_{58}$.

6 Each alkane increases by 1 carbon atom and 2 hydrogen atoms, so you would need to add CH_2.

7 **a** CH_2

b CH_2

8 Alkenes have a double bond and alkynes have a triple bond between adjacent carbon atoms in the skeleton. Hence, alkenes and alkynes need at least two carbon atoms.

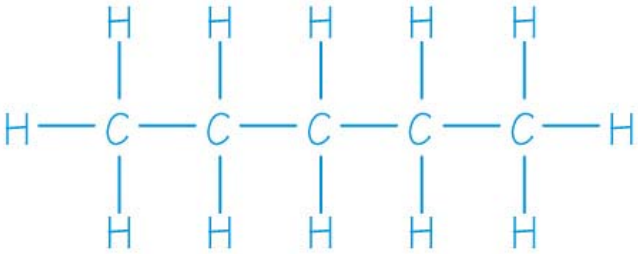
9 **a** butene (4 carbons and a double bond), formula C_4H_8

b hexyne (6 carbons and a triple bond), formula C_6H_{10}

c pentane (5 carbons and single bonds), formula C_5H_{12}

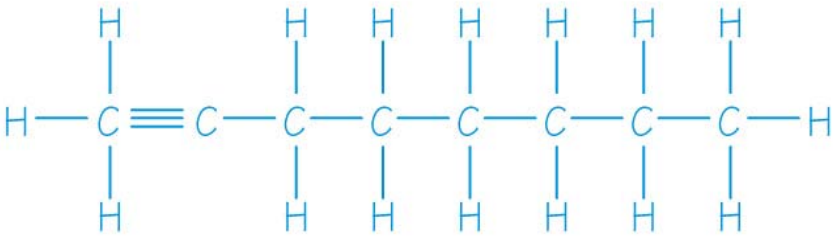
10 **a**

b



Note that any branched structure with 5 carbon atoms and single bonds should also be accepted …

c



… or any branched structure of 8 carbon atoms and one triple bond.

Unit 4.7

1 periods

2 actinides

3 lattice

4 configuration

5 ions

6 covalent

7 hydrogen

8 halogens

9 monatomic

10 atomic

11 transition

12 molecule

13 elements

14 allotropes

15 alkali

16 metallic

17 nucleus

18 ionic

19 groups

20 noble

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Chapter 5: Chemical reactions

Unit 5.1

1 **a** 3; 8; 5 × 2 = 10; 3; 4 × 2 = 8; (3 × 2) + 4 = 10; balanced

b 4; 1; 6; 2; 2; 1; 5; 2; unbalanced

2 **a** balanced

b unbalanced

c unbalanced

3 **a** 2

b 6

c 2

d 3; 3

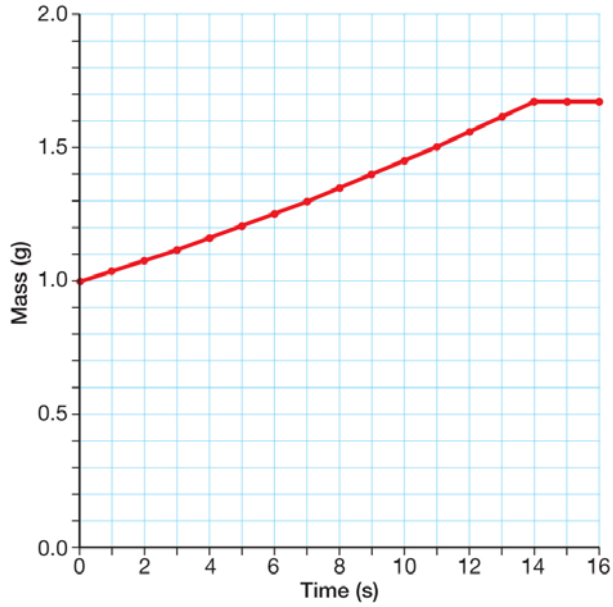
e 4; 3; 4

Unit 5.2

individual student response

Unit 5.3

1



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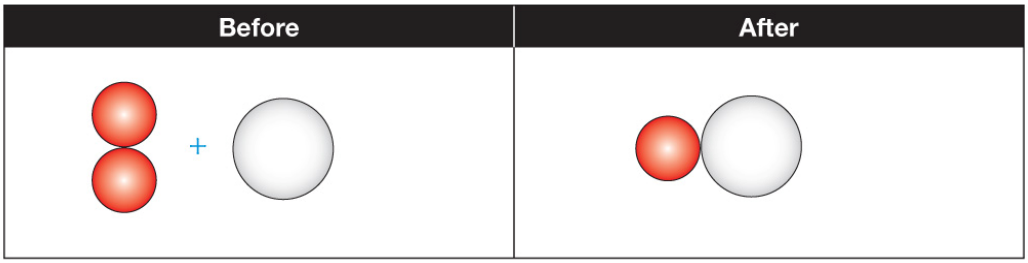


3 word equation: magnesium + oxygen → magnesium oxide

formula equation: $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

4 The mass increased steadily for 14 seconds, then remained constant.

5 **a** The reaction took 14 seconds.

b The reaction took 14 seconds because after this time there was no increase in mass.

6 **a** The law of conservation of mass states that atoms cannot be created or destroyed.

b In this experiment this means that the mass of the products (in this case MgO) is the sum of the mass of the reactants (in this case oxygen and magnesium).

7 (final mass of MgO) – (initial mass of Mg)

= 1.67 – 1.00

= 0.67 g

8 $\frac{1.00\text{ g}}{0.67\text{ g}}$ = 1.5 times heavier

9 atomic mass of Mg = 1.5 × 16 = 24

Unit 5.4

a decomposition

b precipitation

c combination

d metal displacement

e combination

f combination

g precipitation

h combination

i metal displacement

j precipitation

k decomposition

l metal displacement

Unit 5.5

1 crushing, grinding, froth flotation, carbon leaching, electrowinning

2 Grinding turns the rocks into a fine powder. This frees the small gold particles encased in the rock from the dirt and other minerals, allowing them to be separated by the froth flotation.

3 During froth flotation, the powdered rock containing the gold particles is put into a tank of liquid. The liquid contains a chemical similar to detergent, known as a surfactant. Air is then bubbled through the liquid. The fine rock particles and gold particles stick to the surfactant and the bubbles and float to the top. Larger rock particles sink to the bottom.

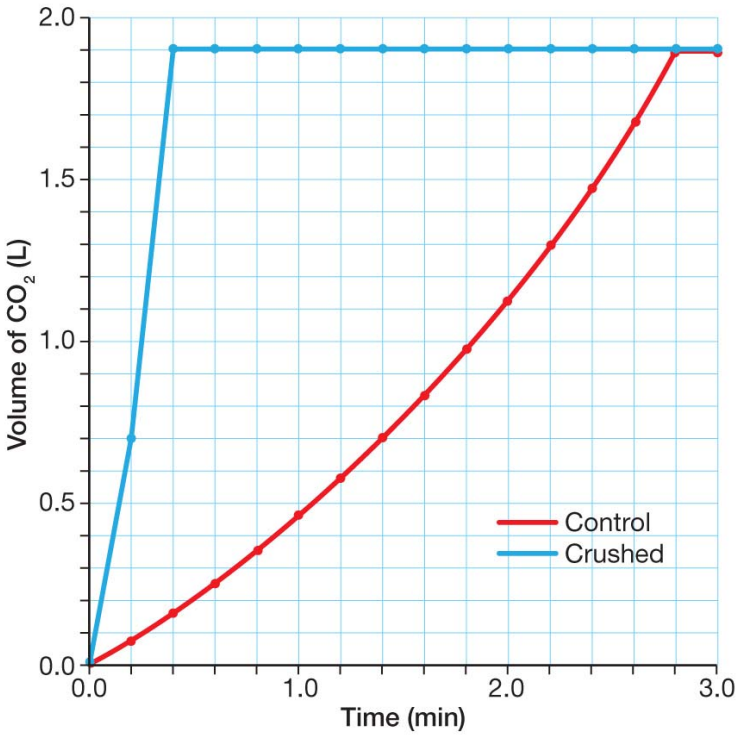
4 In CIL, the fine rock particles and gold particles are exposed to a solution of sodium cyanide. The cyanide is able to dissolve the gold, leaving the rock particles behind. The gold cyanide solution is then passed over carbon filters, which suck the gold cyanide particles from the solution.

5 elution (chemically cleaning the carbon columns) and electrowinning (passing an electrical current through the gold solution to recover the gold)

6 Positive and negative electrodes are placed into the elution solution, which contains dissolved gold, i.e. gold ions. These ions, being metal ions, are positive and so are attracted to the negative electrode where the gold ions are reduced to form gold atoms that deposit on the electrode.

Unit 5.6

1



2 The crushed tablet reacted very fast for a short amount of time before it stopped producing carbon dioxide gas. The control tablet reacted more slowly over a longer period of time.

3 They produced the same amount of carbon dioxide.

4 Both tablets produced a total of 1.9 L.

5 **a** 2.8 min

b 0.4 min

6 2.8 ÷ 0.4 = 7 times faster

7 If the crushed tablet was introduced into the stomach via a capsule, it would produce a large amount of gas very rapidly and cause the stomach to expand violently.

8 $NaHCO_3 + C_6H_80_7 \rightarrow NaC_6H_7O_7 + CO_2 + H_2O$

Unit 5.7

a increasing the temperature

b decreasing the temperature

c decreasing the temperature or reducing the concentration of oxygen

d increasing the surface area of reactants

e decreasing the temperature

f increasing the concentration of reactants, i.e. breathing more deeply and increased heart rate

g increasing the surface area of reactants, also increasing the temperature with an initial spark

h using a platinum catalyst

Unit 5.8

a chemical reactions; reactants; products; rearranged; created; destroyed; conservation; balanced

b decomposition, combination, precipitation; redox; single; several; solutions; insoluble; oxygen; electrons

c rate; explosion; rusting; enzymes

d temperature; concentration; area; agitation; catalysts

Chapter 6: Global systems

Unit 6.1

1 The Earth's four major carbon stores are the atmosphere, oceans, terrestrial ecosystems and the Earth's crust.

2 **a** between 100 050 000 and 66 050 000 gigatonnes

b

Carbon store	Percentage
marine sediments and sedimentary rocks	99.95
deep oceans	0.04
surface oceans	0.001
vegetation	0.006
soils and organic matter	0.016
coal	0.03
oil, gas	0.0003
atmosphere	0.008

3 **a** reserves in sedimentary rocks and fossil fuels

b Carbon is trapped in these reserves and has been unavailable to the carbon cycle for millions of years.

c Burning of fossil fuels is releasing carbon from those reserves. Using limestone to manufacture cement is also releasing carbon from long-term stores.

4 **a** Vegetation, soils and organic matter and ocean surface would all be changing rapidly.

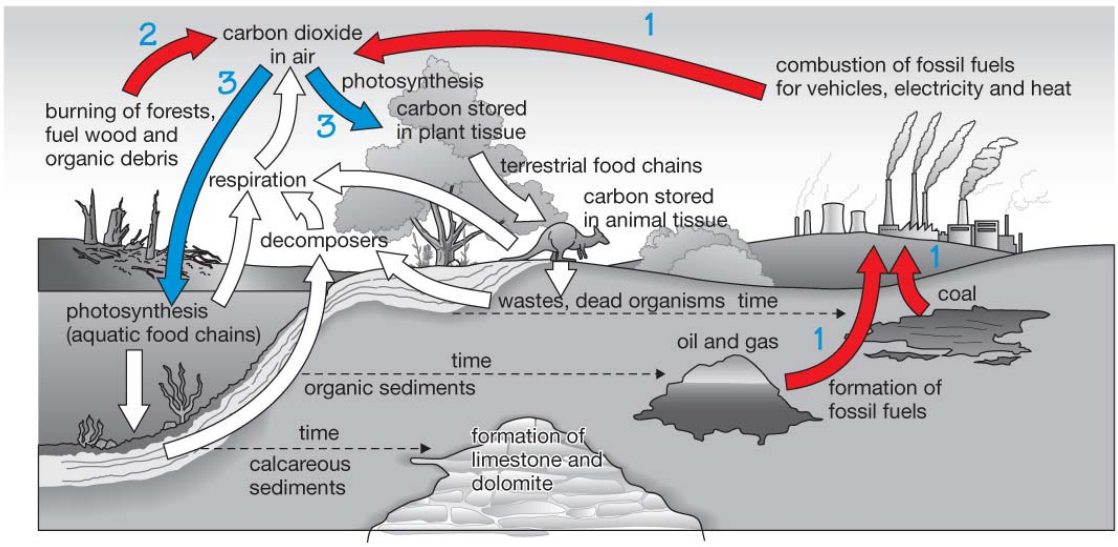
b Photosynthesis and respiration will be taking place and it is these processes that drive carbon through the carbon cycle.

5 Burning releases the carbon stored in the trees in the form of carbon dioxide. The carbon dioxide is then available for photosynthesis and the carbon is once again part of the carbon cycle.

6 Burning of fossil fuels is responsible for about three-quarters of the increased carbon emissions.

7 Cattle return carbon to the atmosphere as methane. Cultivating soils to produce feed for the cattle can increase the rate of breakdown of soil organic matter, resulting in higher emissions of carbon dioxide. Overgrazing may reduce the quality of the soil, which will store less carbon.

8 c



1. Burning fossil fuels releases carbon dioxide to the air. This becomes part of the carbon cycle again.
2. Burning trees returns stored carbon dioxide to the air. This becomes part of the carbon cycle again.
3. Reducing vegetation reduces photosynthesis, which takes carbon dioxide out of the atmosphere.

   Other parts of the cycle will be changed because of these changes.

Unit 6.2

1 A Air is pushed upwards, clouds form and it rains.

B Surface winds flow west towards Australia.

C Wind flows high in the atmosphere back towards South America.

D The cooler air sinks downwards to the ocean surface.

E Surface current flows west towards Australia.

2 In a La Niña event the water in central and eastern Pacific Ocean is cooler than normal and the water currents are stronger. The trade winds blow more strongly than usual and Australia experiences more cloud and wetter conditions than normal, especially in the north.

3 M warm ocean near Peru

N warm current towards Peru (El Niño)

O surface winds blow away from Australia

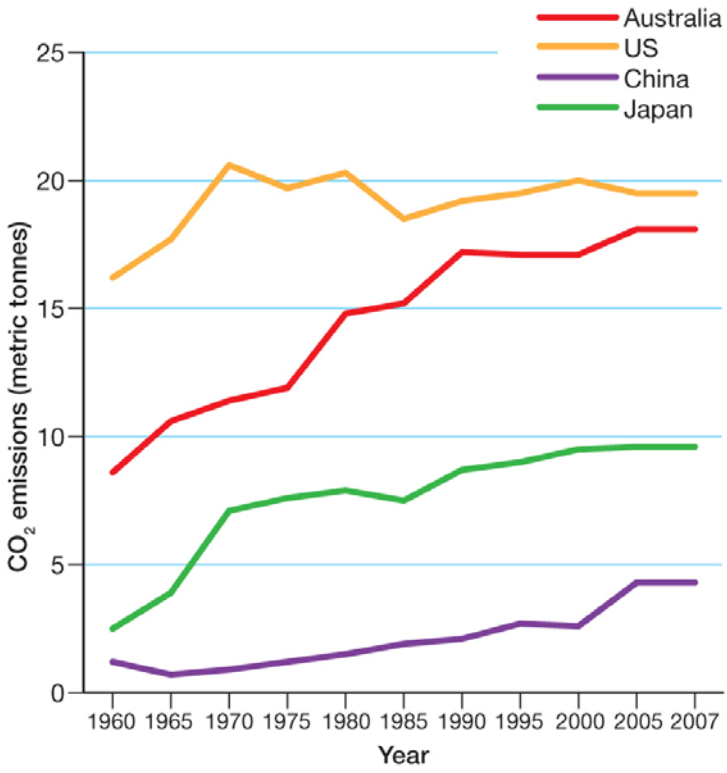
P cool ocean near Australia

Q warm air rising over Pacific Ocean

4 During El Niño years, difference in ocean temperature between the western and eastern Pacific is very small as is the air pressure difference. The trade winds weaken and the moist air they carry fails to reach Australia. Cool air descends over Australia, bringing little rainfall.

Unit 6.3

1



2 Comparing the emissions per head of the population is a way of being able to compare one country with another. It takes the total energy consumption of the country and divides it by the total population so the comparison can be made regardless of the total population of the country.

3 In 2007, the consumption per head of population in Australia was 18.1 tonnes, which is lower than the consumption in the USA, which is 19.5 tonnes. However, the consumption in Australia from 1960 to 2007 more than doubled. In the same time, in the USA consumption increased by only 20%.

4 Energy use in China decreased from 1960 to 1965. There was a 286% increase from 1965 to 1995 and then a slight fall in the next five years. From 2000 to 2005, consumption increased by a further 65% and was steady from 2005 to 2007. In total, the increase from 1965 to 2007 is 514%.

5 Emissions in the USA increased until 1970, then stabilised to some extent before falling. They have now stabilised at a rate lower than 1970 emissions. The other three countries all increased emissions from late 1960 until 2007.

6 **a** Japan has half the energy consumption per head of population when compared to Australia.

b A few people may have a lot of gadgets and use significant amounts of electricity, but a large number of people do not have access to the technology. Therefore, on balance the consumption is lower. Possibly the gadgets do not actually consume much electricity. Electricity used in manufacturing and other industries is accounted for in the per capita data. There could be less industry in Japan, or less energy is consumed by the industry. This could be due to the nature of the industry or that it is more energy efficient.

Unit 6.4

1 Ozone is a naturally occurring molecule made up of three atoms of oxygen (O_3).

2 Ozone absorbs ultraviolet (UV) radiation, which is emitted by the Sun. Too much exposure to UV radiation is a cause of skin cancers and eye disease.

3 Naturally occurring molecules that can break down ozone are chlorine (Cl), bromine (Br), nitric oxide (NO) and nitrous oxide (N_2O).

4 Chlorofluorocarbons (CFCs) and halons are manufactured chemicals that can destroy ozone.

5 The Montreal Protocol is a treaty that was signed in 1987 by 196 countries. This treaty was an agreement to stop production of CFCs and thereby protect the ozone layer. The treaty demonstrated the contribution science can make to environmental protection agreements.

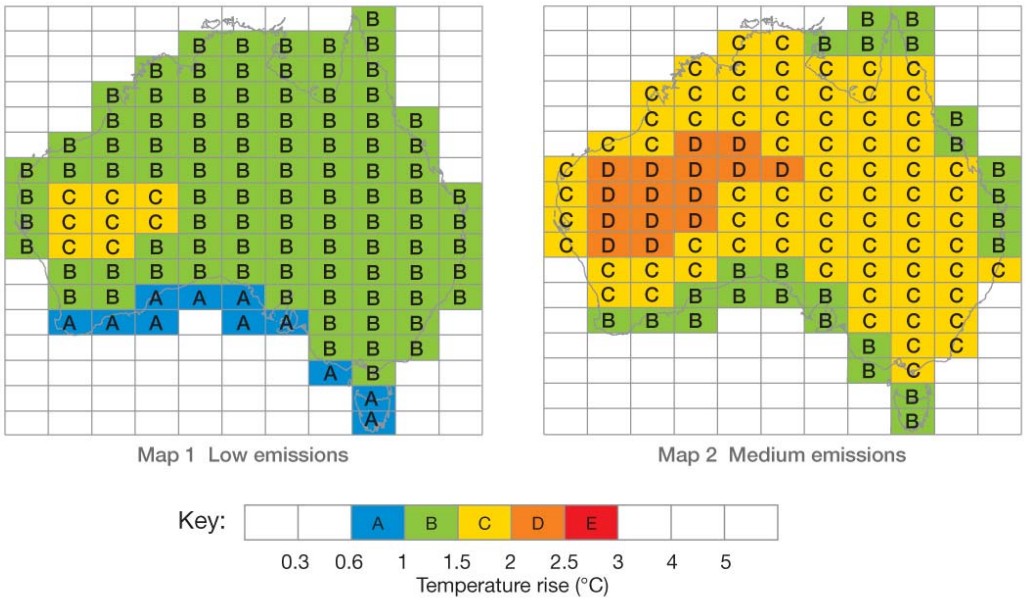
6 Over Antarctica the values are lowest during September to October when daylight returns after winter. In November prevailing winds carry ozone-rich air from other regions and replenish ozone levels over Antarctica, but leave lower ozone levels over Australia and New Zealand.

7 A *hole* occurs in the ozone when measurements show a value of less than 220 DU.

8 *Layer* is not a good description of ozone distribution. It is not concentrated in a layer where only ozone exists. It is dispersed throughout the atmosphere. In some areas the concentration is greater than others.

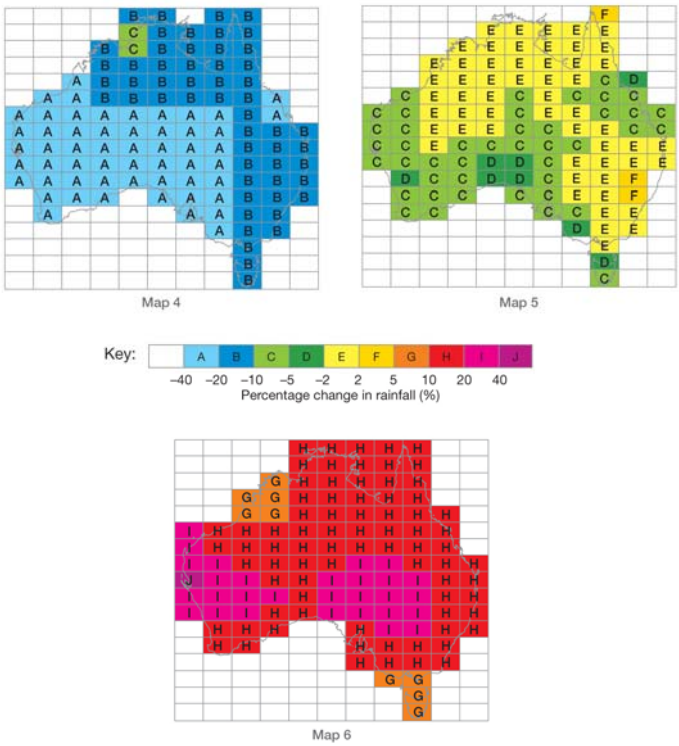
Unit 6.5

1



2 Scientists cannot know exactly what emissions there will be in the future. They are making hypotheses based on current data and ideas of what will happen in the future. Different groups of scientists will interpret the information differently.

3



4 Modern humans have not previously experienced global warming. Data on Australia's climate has been collected for only 200 years. This episode of climate change began

thousands of years ago. Scientists do not fully understand the interactions of ocean currents and winds that cause world weather. Therefore, accurate predictions of the effects of global warming on rainfall are difficult.

5 **a** Figure 6.5.2a suggests an overall and significant decrease in rainfall. Figure 6.5.2b suggests a decrease of 5–10% in about half the country with little change in most of the remainder. Figure 6.5.2c suggests that the whole of the country can expect increased rainfall.

b Using one scenario, the plans would deal with severe water shortages necessitating changes in agriculture and in water storage for domestic and industry use. At the other extreme there could be adequate water over the whole country with the potential for flooding in many areas. With significantly increased rainfall there could be a need to change agricultural crops and farming methods.

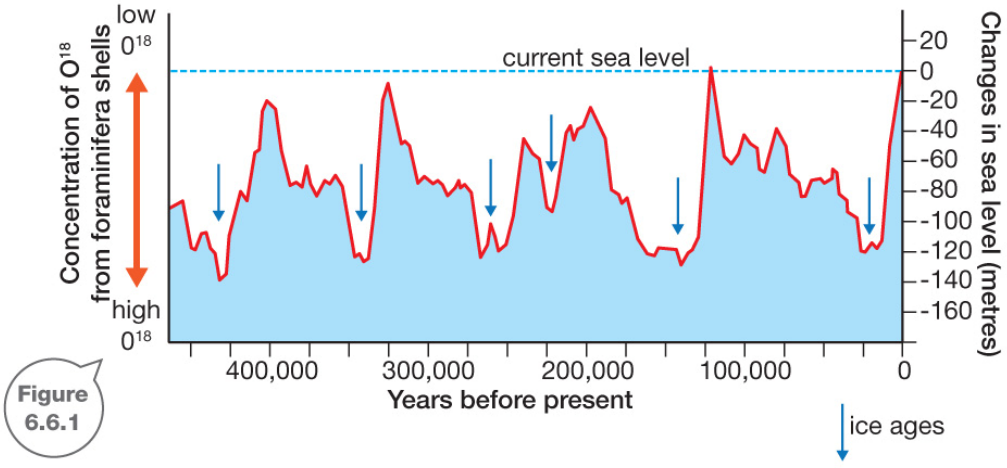
6 individual student response

7 individual student response

8 individual student response

Unit 6.6

1



2 Those are the times when the sea level was lowest. In ice ages the water is trapped in ice and sea levels fall.

3 about 20 000 years ago

4 **a** Figure 6.6.2 shows the changes in sea level over a much longer period of time from the present day to 542 million years ago.

Figure 6.6.1 shows the changes in only the last 450 000 years.

b The curves are different because the scales are very different. Figure 6.6.1 is able to show smaller changes.

5 Their suggestion is incorrect. Sea levels 450 million years ago were 400 metres higher on average than today's levels.

6 Sea levels in the past are derived from indirect information such as the placement of sedimentary rocks and the fossils found in them. Scientists interpret the information differently and reach different conclusions.

7 There have been significant fluctuations in sea level since 1984.

8 The scale on the vertical axis is in millimetres whereas the other graphs have shown sea level rises in metres.

9 about 30 mm

10 about 120 metres

Unit 6.7

a If the sea level rose by 1 metre, the wetlands and the resort and hotels would flood. Parts of the railway line would be under water, so trains would not run. This would affect the movement of materials into and out of the city and the tourism industry. Employment would also be affected. Crops and dairy farming would be affected too.

b All of the hotel area and the resort would be under water. Residential areas would be threatened or inundated. Therefore, more people would lose their jobs and their homes. The railway would be cut in more places. Some coastal roads would be cut and parts of the airport would be inundated, restricting access to the city. About one-third of the industrial area would be under water. So, more jobs would be lost.

c The city will be completely under water along with some of the farming land.

Unit 6.8

1 The low temperatures and snow cover in winter do not allow plants to photosynthesise enough carbon to produce woody growth.

2 The average temperature could increase above 10°C for the warmer months. So snow would not lie as thickly or for as long. Woody plants could flourish at higher altitudes and woody shrubs or trees could replace the alpine vegetation on the tops of the mountains. A change in the vegetation would mean a change in the animals that live there.

3 The broad-toothed rat eats 50–70% of its body weight in grass each day. They sleep in nests of shredded grass. If grassland was reduced, then the rat would have reduced resources to use for food and shelter. The number of rats the grass could support would be reduced and the population would decrease.

4 The unique species would be greatly reduced in number as their habitat decreased. Since there is nowhere for them to go to, they would eventually become extinct and the biodiversity of the area would decrease.

5 **a** In the past, the temperature increasing reduced its range. It is now restricted to living in the mountains above 1400 metres.

b The range will be further reduced and the species could become extinct. The possum will also face higher levels of predation as carnivores, such as the fox, come into the area. There may be less seed available for food as grazing animals move in. There will be increased competition from foxes for the possum's other food source—bogong moths.

6 Reduction of habitat and increased predation could cause many of the species unique to alpine areas to become extinct. This loss of species reduces the biodiversity of the area and of the Earth as a whole.

Unit 6.9

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

interglacials—periods between glaciations

Chapter 7: The universe

Unit 7.1

1 **a** Vega

b It is designated α.

2 Deneb would be Alpha Cygni and Albireo would be Beta Cygni.

3

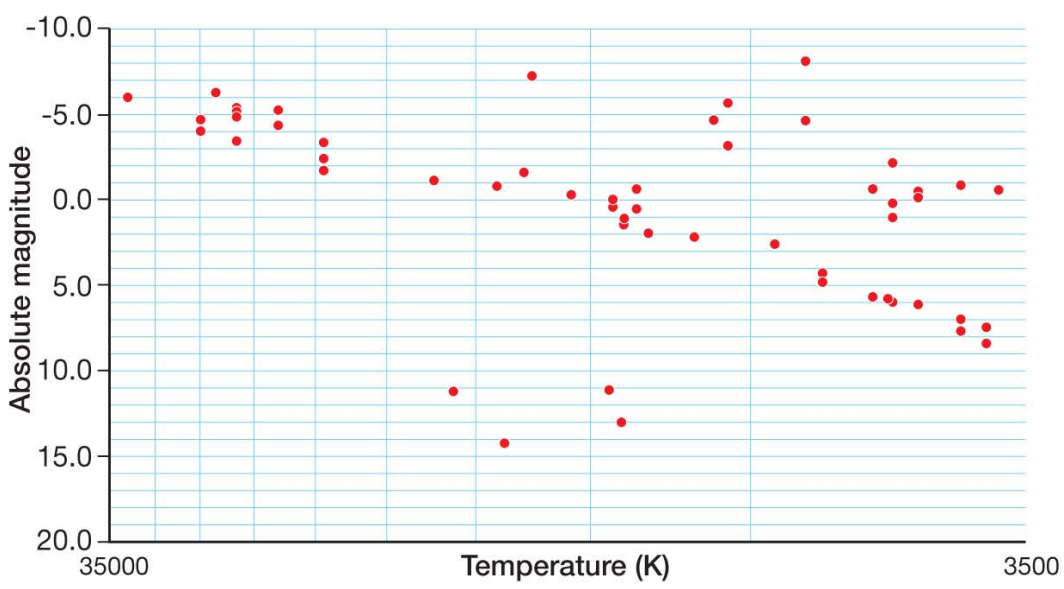
Common name	Bayer designation	Order of decreasing brightness
Alnilam	ε-Orionis	5
Alnitak	ζ-Orionis	6
Bellatrix	γ-Orionis	3
Betelgeuse	α-Orionis	1
Mintaka	δ-Orionis	4
Rigel	β-Orionis	2
Saiph	κ-Orionis	7

4 **a** 14, since omicron is the 15t^{h} letter of the Greek alphabet

b The constellation Perseus could not be seen from this planet. It would be the brightest star in their sky.

Unit 7.2

1



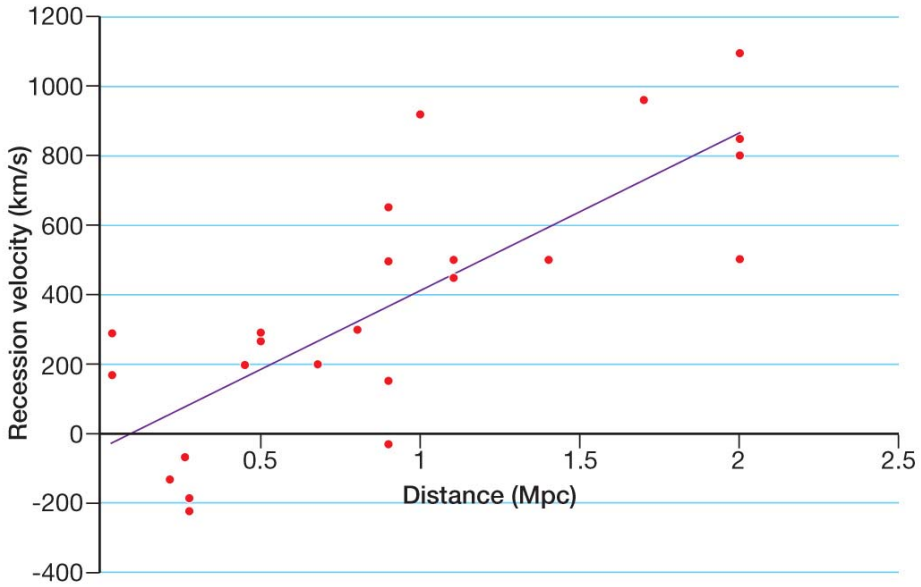
Unit 7.3

1 individual student response

2 individual student response

Unit 7.4

1, 2



3 Use gradient = $\boxed{\frac{\text{rise}}{\text{run}}} = \boxed{\frac{850 - 450}{2 - 1.1}} = \boxed{\frac{400}{0.9}} = 444 \text{ km s}^{-1} \text{ Mpc}^{-1}$

4 Galaxies close to the Milky Way are moving towards us due to the Milky Way's gravitational pull.

Unit 7.5

1 *Hadrons* are the group of particles that include protons and neutrons.

2 Pions, mesons and quarks

3 beneath the border between France and Switzerland

4 To find evidence for a Grand Unified Theory and to study the particles and particle interactions that may have existed just after the Big Bang.

5 particle accelerator

6 35 countries

7 There were concerns that it would create a microscopic black hole that would destroy the Earth. This did not occur.

Unit 7.6

1

Planet	*k*	Titius-Bode law distance (AU)	Real distance (AU)
Mercury	0	0.4	0.39
Venus	1	0.7	0.72
Earth	2	1.0	1.00
Mars	4	1.6	1.52
Ceres	8	2.8	2.77
Jupiter	16	5.2	5.20
Saturn	32	10.0	9.54
Uranus	64	19.6	19.2
Neptune	128	38.8	30.06
Pluto (dwarf planet)	256	77.2	39.44

2 Pluto

3 **a** Saturn

b 0.46

4 individual student response

Unit 7.7

1 accretion

Big Bang

cosmology

cyanobacteria

light year

magnitude

Milky Way

neutron star

panspermia

parallax

parsec

protostar

red giant

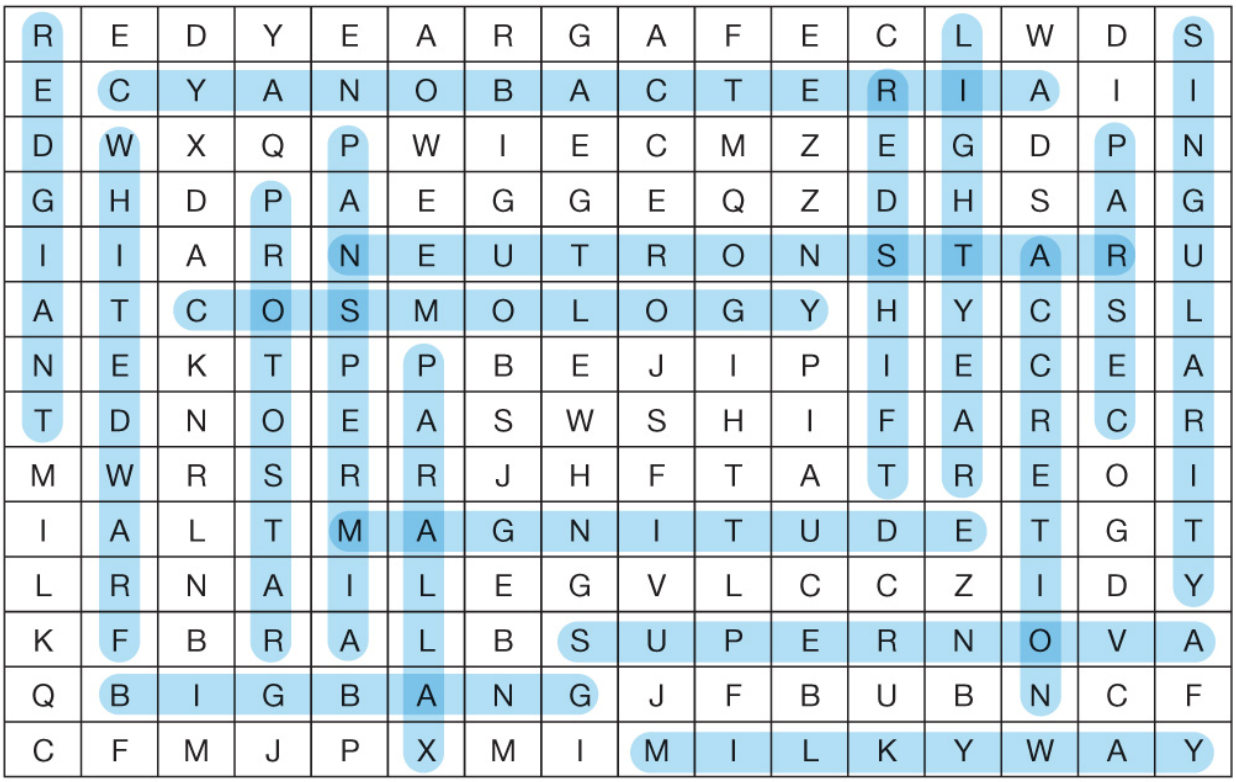
red shift

singularity

supernova

white dwarf

2



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

Chapter 8: Motion and energy

Unit 8.1

1 **a** Using a hands-free mobile device lengthens a driver's reaction time.

b Reaction times of young-adult drivers can be slowed to levels seen among senior citizens, and drivers using mobile telephones are as impaired as drivers who are legally drunk.

2 Drivers talking on a mobile phone were more likely to drift out of their lanes and to miss exits than drivers talking to a passenger.

3 When speaking to a person in the car, this person can act as a second set of eyes for the driver. Because they are aware of the driving situation, the passenger can assist the driver by navigating, can alert the driver of hazards or can pause their conversation when the driver needs to concentrate more fully.

4 A driver is four times more likely to be involved an accident within 10 minutes of using a mobile phone.

5

Advantages of using a hands-free mobile device while driving	Disadvantages of using a hands-free mobile device while driving
for example, making use of travel time by conversing with people	for example, not able to fully concentrate on the road
for example, assists in organising work schedules and appointments	for example, more likely to miss exits or hazards
for example, can check where you are meeting other people	

6 individual student responses

Unit 8.2

1 **a** Charlie

b **i** $\frac{100}{10}$ = 10 m/s

ii $\frac{100}{18}$ = 5.6 m/s

iii $\frac{100}{13}$ = 7.7 m/s

c Charlie and Jake both accelerated as they ran the race, with their speed increasing until they finished the race. Nasir ran at a fairly constant speed for the first 6 seconds of the race. He then stopped for 2 seconds, before increasing his speed to finish the race.

2 **a** the gradient of this section of the graph = $\frac{100}{20}$ = 5 m/s

b $\frac{100}{30}$ = 3.3 m/s

c **i** during intervals B–C (20–30 seconds) and D–E (60–80 seconds)

ii during intervals A–B (0–20 seconds) and C–D (30–60 seconds)

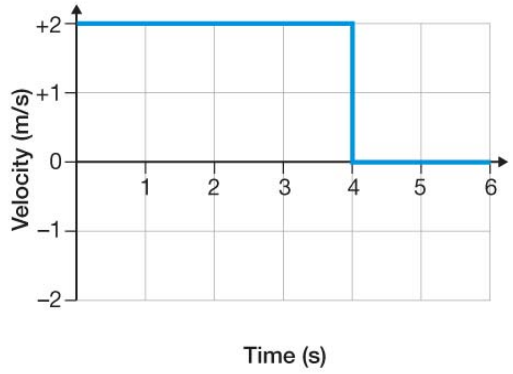
iii from E to F (80–110 seconds)

d $\frac{\textit{distance travelled}}{\textit{time taken}} = \frac{350}{110}$ = 3.2 m/s

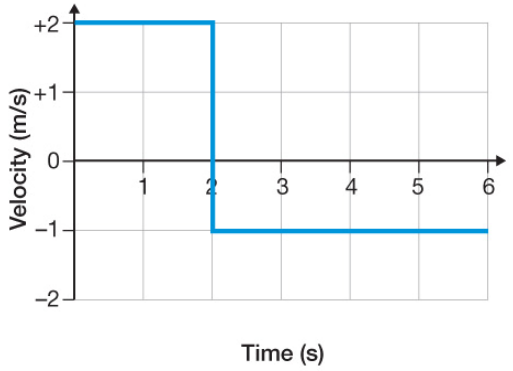
e For some intervals, such as A–B, Lucy was travelling faster than this average speed, but because she stopped twice on her journey, this average result is lower than much of her actual motion.

f 350 m north

3 a

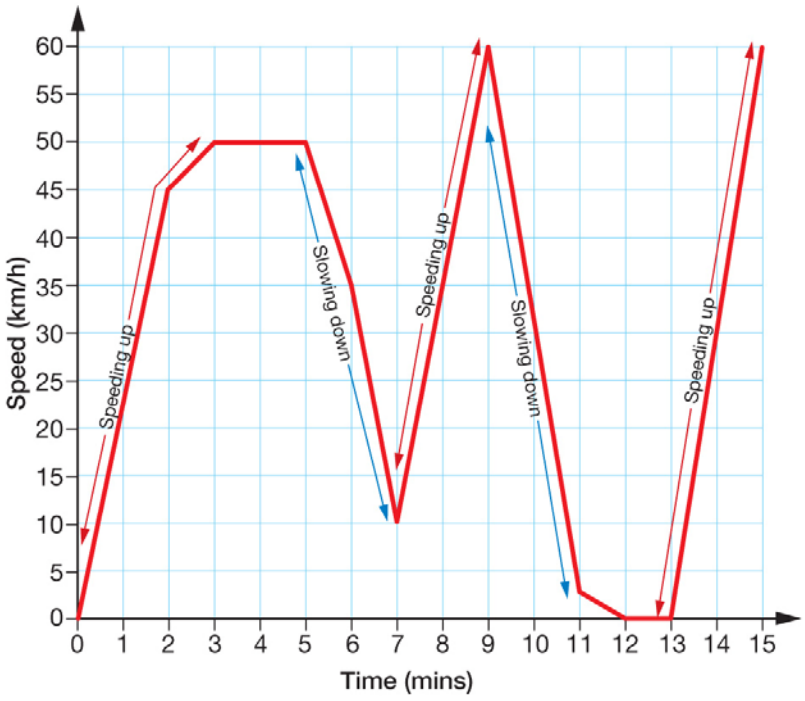


b



Unit 8.3

1 a, b



c **i** 7 minutes into the journey

ii 12 minutes into the trip

2 a **i** They accelerate over the first hour to reach 100 km/h. They then travel at a constant speed of 100 km/h for the next 3 hours.

ii They slow down and stop.

iii They have stopped for a meal.

iv They start moving again and increase their speed to 50 km/h.

v They travel for an hour at a constant 50 km/h, and then slow down to a stop.

b area below speed–time graph = (½ × 1 × 100) + (3 × 100) + (½ × 0.5 × 100) + (½ × 0.5 × 50) + (1 × 50) + (½ × 0.5 × 50)

= 50 + 300 + 25 + 12.5 + 50 + 12.5

= 450 km

Unit 8.4

1 a The numbers of people killed on Australian roads has decreased from the period of 1982 until 2008.

b Individual student response, for example: more speed cameras, mobile breathalyser testing units in force, many advertising campaigns discouraging speeding and drink driving and encouraging people to take a break from driving if fatigued.

2 a drivers

b Every car has a driver, but not always a passenger, so there are more drivers on the road. Also, there are more cars on the road than bikes or motorbikes so this result is not surprising.

c Individual student response, for example: males generally take greater risks than females, are easily influenced by their peer group and are more prone to showing off.

d More males ride motorbikes than females in total.

3 a 100 km/h or above

b The greater the speed of a vehicle in an accident, the greater the damage caused.

4 a Saturday or Sunday between midnight and 6 am

b afternoon, from midday until 6 pm

c For example, young people are more likely to take risks, such as driving under the influence of alcohol or drugs in the early hours of the morning, after a party on a

weekend. This is their time of greatest risk. Older drivers were involved in accidents at all times of day, but slightly more during the afternoon, probably due to the heavier traffic on the road during peak hour.

d evening, between 6 pm until midnight

e Reduced visibility of pedestrians crossing the road at night is likely to cause this result.

Unit 8.5

1 a 12.2

b 3.2

c 750

d 910.5

e 6.5

f 1250

2 a $F = m \times a = 1200 \times 3 = 3600$ N

A force of 3600 N is supplied by the car's engine.

b $m = \boxed{\frac{F}{a}} = \boxed{\frac{472}{8}} = 59$ kg

Sarah has a mass of 59 kg.

c $a = \boxed{\frac{F}{m}} = \boxed{\frac{1\ 525\ 000}{250\ 000}} = 6.1\ \text{m/s}^2$

The train accelerates at 6.1 m/s^2.

Unit 8.6

1 a $W = F \times s = 784 \times 2.1 = 1646.4$ J

The work done by the weightlifter in lifting the barbell is 1646.4 J.

b $W = F \times s = 280 \times 1.3 = 364$ J

Tayla does 364 J of work in lifting the sports bag.

2 a $E_k = \frac{1}{2}mv^2$

$= \frac{1}{2} \times 325 \times (8^2) = 10{,}400$ J (or 10.4 kJ)

Diego has a kinetic energy of 10 400 J.

b $E_k = \frac{1}{2}mv^2$

$= \frac{1}{2} \times 0.5 \times (12^2) = 36$ J

3 a $E_p = mgh = 18 \times 9.8 \times 20 = 3528$ J

Sophie has 3528 J of gravitational potential energy.

b $E_p = mgh = 0.2 \times 9.8 \times 1.5 = 2.94$ J

The paint tin has 2.94 J of gravitational potential energy.

4 a $E_k = \frac{1}{2}mv^2 = \frac{1}{2} \times 12\,100 \times (15^2) = 1\,361\,250$ J

When the car comes to a stop, its kinetic energy is zero.

b 1 361 250

c 1 361 250

d work done = $F \times s$ 1, 361 250 = 18 150 × s

$s = \boxed{\frac{1\,361\,250}{18\,150}} = 75$ m.

This means that the car came to a stop in 75 m.

5 a $E_p = mgh = 5 \times 9.8 \times 1 = 49$ J

b The increase in gravitational potential energy of each block is 49 J

c Because both blocks are raised the same vertical distance (1 m), both Mia and Amir do the same amount of work in shifting the blocks.
Amir applies a greater force over a smaller distance, while Mia supplies a smaller force over a greater distance.

6 a $E_p = mgh = 220 \times 9.8 \times 60 = 129\,360$ J

b As the girls ride through B on the track, half of their gravitational potential energy has been converted into kinetic energy.

c $E_p = mgh = 220 \times 9.8 \times 15 = 32\,340$ J

d Gravitational potential energy at C is 32 340 J.

So kinetic energy = 129 360 – 32 340 = 97 020 J

$E_k = ½mv^2$ = 97 020 J

v^2 = 882; so speed is approximately 29.7 m/s

Unit 8.7

1 displacement

scalar

vector

speed

velocity

acceleration

inertia

mass

reaction

work

power

joule

kinetic

gravitational

elastic

efficiency

 ISBN 978 1 4425 2366 1

2

	Symbol	Formula
Average speed	v	$v = \frac{s}{t}$
Average acceleration	a	$a = \frac{v - u}{t}$
Newton's second law	F_{net}	$F_{net} = ma$
Work done	W	$W = Fs$
Power	P	$P = \frac{W}{t}$
Kinetic energy	E_k	$E_k = \frac{1}{2}mv^2$
Gravitational potential energy	E_p	$E_p = mgh$
Efficiency	Efficiency	$\frac{\text{useful energy}}{\text{total energy}} \times 100\%$

Chapter 9: Structures

Unit 9.1

1 piles and slabs

2 If the forces on a structure weren't balanced, then the weight force was greater than the ground reaction force. That part of the structure would break, stretch or twist and the structure would fall or sink into the ground.

3 weight

4 ground reaction force

5 Pile foundations concentrate all the weight of a building into only a few spots underneath it. Stress is high. This would cause the sand or mud to shift. Slabs spread the weight force across a much wider area and so there is less force on any part of the ground underneath it. Stress is much lower.

6 Skyscrapers are much heavier than normal houses and so need a more solid base. Also skyscrapers will sway more. Deep piles will stop them toppling over.

7 Tall buildings are heavier and need stronger foundations underneath them than shorter buildings. The solid rock of Manhattan Island provides this support, whereas the mud of London (UK) does not. Hence, tall buildings are more difficult to build in London.

Unit 9.2

1 **a** Expand means to get larger or longer.

b Contract means to get smaller or shorter.

2 **a** Most solids expand when heated.

b Most solids contract when cooled.

3 A plate taken straight from the fridge to the oven will often crack because its outside is heating and expanding faster than its insides. The plate can’t withstand the forces inside it and so it shatters.

4 Expansion joints are small gaps used at the end of bridges. They allow the bridge to expand when heated and contract when cooled without buckling or cracking.

5 C

6 Concrete is good under compression but fails under tension. Steel mesh allows it to be strong under tension too, making the concrete far stronger.

7 C (the lower edge is under tension and therefore that is where the steel rod should be).

8 Steel expands the same as concrete when heated and contracts the same when cooled. It therefore moves with the concrete. Aluminium expands more than twice the amount of concrete and would cause it to crack.

9 **a** 1.2 mm

b 2 × 2.6 = 5.2 mm

c 3 × 1.2 = 3.6 mm

d 2 × 2.6 × 0.5 = 2.6 mm

Unit 9.3

1 **a** Elisha Otis

b 1853

2 People were unwilling to climb more than 10 storeys to their homes or offices. Buildings were therefore unlikely to go higher than 10 storeys.

3 If all the elevators in a very tall skyscraper stopped at every floor, then a trip to the bottom or top might involve 100 or so stops! This would make trips extremely slow.

4 **a** Sky lobbies were where people changed from one set of elevators to another.

b You could travel to the 44^{th} level sky lobby, change to another lift then travel to the $78t^{h}$ level sky lobby, then change to another lift and travel to the 90^{th} floor. You could also travel direct to the $78t^{h}$ level sky lobby, change lifts and then travel to the 90^{th} floor.

5 individual student response

Unit 9.4

1 Push the swing at just the right time, on its return to you.

2 Resonance is happening in a bottle whenever it produces its characteristic sound when blown across.

3 Different bottles produce different sounds, indicating that they resonate differently.

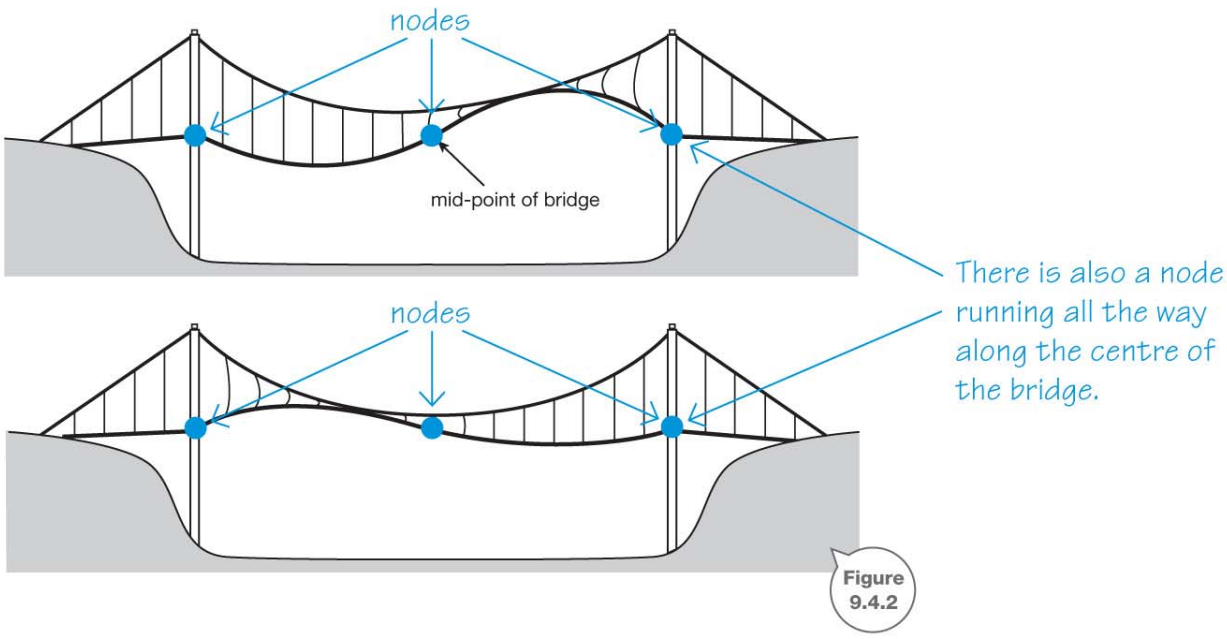
4 individual student response

5 4 months

6 The wind caused resonance that made the Tacoma Narrows Bridge buckle so far that the materials making it up cracked and it collapsed.

7 A node is a point that doesn't move.

8



9 He walked along the centre line of the bridge, which was acting as a node.

10 Buffy the dog

Unit 9.5

1 Individual student responses. For example, Paris (Eiffel Tower), New York City (Empire State Building), Sydney (Sydney Opera House).

2 In 1932, buildings were much, much smaller and shorter than today. There were no skyscrapers and the bridge towered over the city. Although the bridge is still impressive today, it is dwarfed by other structures in the city, making it look a little smaller.

3 to cope with the traffic of a busier city of the future

4 Being built over water, scaffolding and frames would have needed to be floated on pontoons. This would be almost impossible. Also, any framework would stop shipping from passing underneath.

5 Cables fixed into the rock on each shore kept the two halves in place before they met and were connected in 1930.

6 The two halves push against each other, stopping each from falling.

7 **a** Henri Mallard

b Grace Cossington-Smith

c J.J.C. Bradfield

d Jack Lang

e Captain Francis De Groot

8 The bridge was such an impressive structure and so large that it captivated the minds of everyone in the city, including photographers and artists.

9 The cross-harbour tunnel was opened in 1992, taking some of the traffic away from the bridge.

10 Sydney now has other icons such as the Opera House and Centrepoint Tower. Hence, the bridge has lost some of its importance as a symbol.

Unit 9.6

1 accelerates

decelerates

compression

tension

lintel

truss

Newton

dome

cantilever

structures

columns

superstructure

Gothic

Roman

buttress

failure

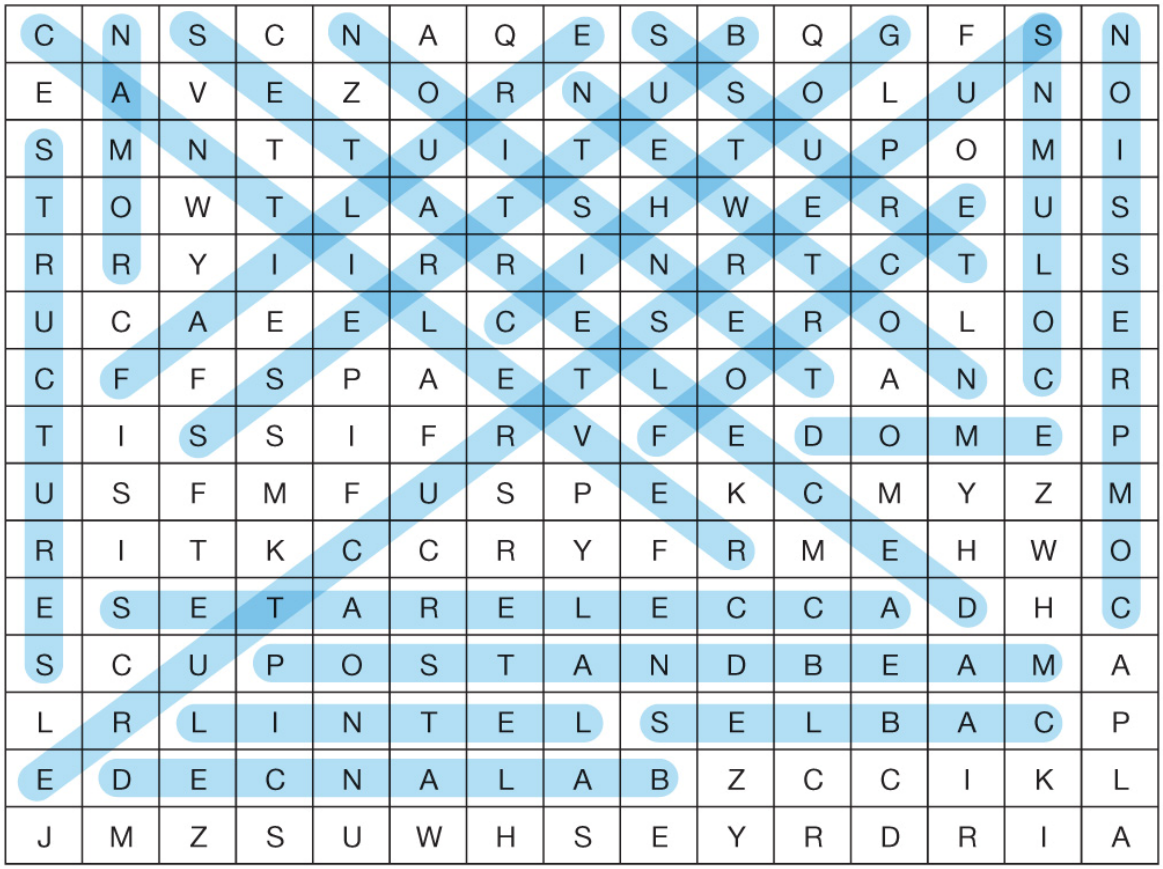
force

balanced

post and beam

cables

2



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

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Chapter 10: Forensic science

Unit 10.1

1 **a** stiffening of the muscles due to lactic acid build-up after death

b swelling due to the release of gases from within the body from internal decomposition

c immature insects (e.g. maggots are the larvae of flies, caterpillars are the larvae of butterflies and moths)

2 **a** 6–24 hours

b 6 hours

c 2 days

d 4–7 days

e 2–7 days

f 4–7 days

g more than a month

h around a month

i within a day, possibly only a few hours

j 6–12 hours

3 Blood is pumped to all parts of the body, often against gravity.

4 If the body was shifted, then pooling might appear on its upper surface.

5 Blood quickly becomes deoxygenated and changes in colour. As it does so, the skin pales and then becomes blue.

6 lactic acid

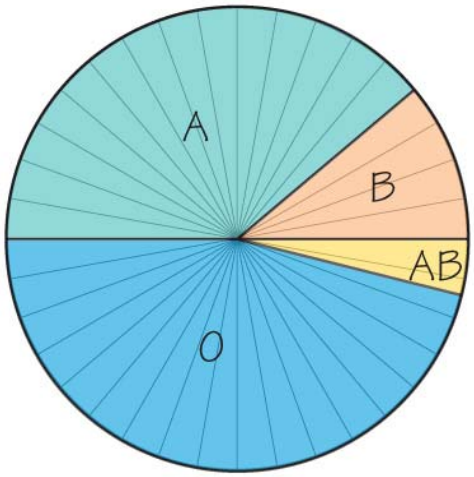
7 Gases from the decomposition of the insides of the body

8 The main organs of the digestive system are located near your waist. Undigested food and semi-processed food and faeces will provide the ideal environment for bacterial growth. Hence, discolouring tends to start there.

9 This is good because otherwise their remains would always be in the environment. By decomposing, the bodies return their elements to the earth, enriching it.

Unit 10.2

1



2 O+ (38%), A+ (32%), B+ (9%), O– (8%), A– (7%), AB+ (3%), B– (2%), AB– (1%)

3 **a** a protein that is either present or not on the surface of the cells in your body

b to clump, used to describe how blood cells clump together when foreign antibodies are introduced into the blood

4 The blood is tested because a negative test (i.e. one showing that the suspect does not have O or AB blood group) narrows the search to the more rare blood groupings.

5 The proportion of people of blood group O+ is spread across all racial groups. A+ mainly comes from Caucasian people. A test showing A+ therefore narrows the search away from people of Asian or African descent.

6 **a** 1%

b If other evidence points to a particular suspect, then the rarity of the blood group is likely to pinpoint the person who committed the crime. However, the rarity of the blood group will make it difficult to determine the pool of potential suspects.

7 **a** B

b O

c A

d AB

Unit 10.3

1

	Numbers of teeth	
	Child	Adult
Total number	20	32
Incisors	8	8
Canines	4	4
Premolars	2	8
Molars	8	12 (including 4 wisdom teeth)
Wisdom teeth	0	4

2 The skulls and jaws of children are much smaller than adults. This means that fewer teeth can fit into the jawline. Hence, there are fewer and smaller teeth.

3 Numbers will vary between 20 and 32.

4 individual student response

5 individual student response

6 It depends on how recently the person visited the dentist. If it has been a long time, then their teeth have probably changed (with new decay, cracks, chips etc.).

Unit 10.4

1 Raymond Towler

2 nearly 30 years

3 the rape of an 11-year-old girl

4 A park ranger stopped Towler on a traffic violation and noticed a resemblance to a sketch of the suspect. The victim and witnesses identified Towler from a photo.

5 around 22 years

6 skin cells and semen

7 semen

8 The DNA testing technology was not available in 1981.

9 the Ohio Innocence Project

10 6 years, from 2004 to 2010

11 35 years

12 Advantages: it would find people wrongly convicted and still in prison, allowing them to be released.

Disadvantages: it would be very expensive and time consuming, and some innocent people would remain in jail because appropriate samples might not have been collected at the time or may have been destroyed.

Unit 10.5

1 Advantages: poisons were relatively easy to obtain; were relatively easy to administer; often mimicked the symptoms of natural illnesses, allowing the murderer to get away before the crime became obvious.

2 Medical testing quickly detects the presence of foreign chemicals in the body, allowing little time for the murderer to escape.

3 Strychnine causes powerful muscle spasms that eventually rip muscles from bones.

4 **a** to give the people fresh water, instead of their normal supplies of bacteria-filled ponds and streams

b leaching from rocks into the underground water

5

	Date(s)	Poison	Estimated deaths
Bangladesh	now	arsenic	20 000 per year
Bhopal	1984	methyl isocyanate (MIC) gas	4000 then another 8000 to 25 000 later on
Trenches of World War I	1914–1918	mustard gas, phosgene and chlorine gases	100 000
Nazi Germany	1939–1945	zyclon B/Cyclon B	1.2 million
Iraq	1988	mustard and sarin gas	10 000
Tokyo	1995	sarin gas	12
USA	2001	anthrax	5

Unit 10.6

1 Living artists can check the painting and are likely to have photographs of it. If the artists are recently dead, then family or friends may be able to check a painting. If the artist is long dead, then no-one will be present who knew the artist personally or their work.

2 **a** the recorded history of ownership of a work of art

b ultraviolet light

c infrared light

d shine

3 The painting may have been stolen and kept by the thief or person who bought it from the thief for 30 years.

4 to show whether cracks are just on the surface paint layers (suggesting fake ageing) or pass through all the paint layers to the canvas below

to identify pigments, and so the age of painting

5 The painting is probably fake because an old painting would have cracks in its varnish and in its paint.

6 Most artists make a sketch of their subject first. Hence, a street scene should have a similar sketch of a street scene under it. Hence, the painting is most likely a fake.

7

Painter	Lived	Painting tested by	Evidence found	Real or fake?	Justification
Von Guerard	1811–1901	mass spectrometry	used acrylics	fake	acrylic = 20th century
Rembrandt	1606–69	X-ray scattering	includes Prussian blue	fake	Prussian blue was only used after 1704.
Jackson Pollock	1912–56	UV fluorescing	Pigments fluoresce blue-green	fake	Blue-green indicates the materials used came from the 1800s.
Ghirlandaio	1449–94	mass spectrometry	uses oils	may be real	Oils were used from the 1400s.
Tom Roberts	1856–1931	IR analysis	major features of a portrait were changed by painting over them	may be real but unlikely	Minor features might change but it is unlikely that major features would. Hence, it was probably a portrait changed by a forger.

Unit 10.7

1 forensics

arson

homicide

ballistics

eyewitness

autopsy

corpse

DNA

porous

diatoms

femur

fingerprints

chromatography

intaglio

iris

retina

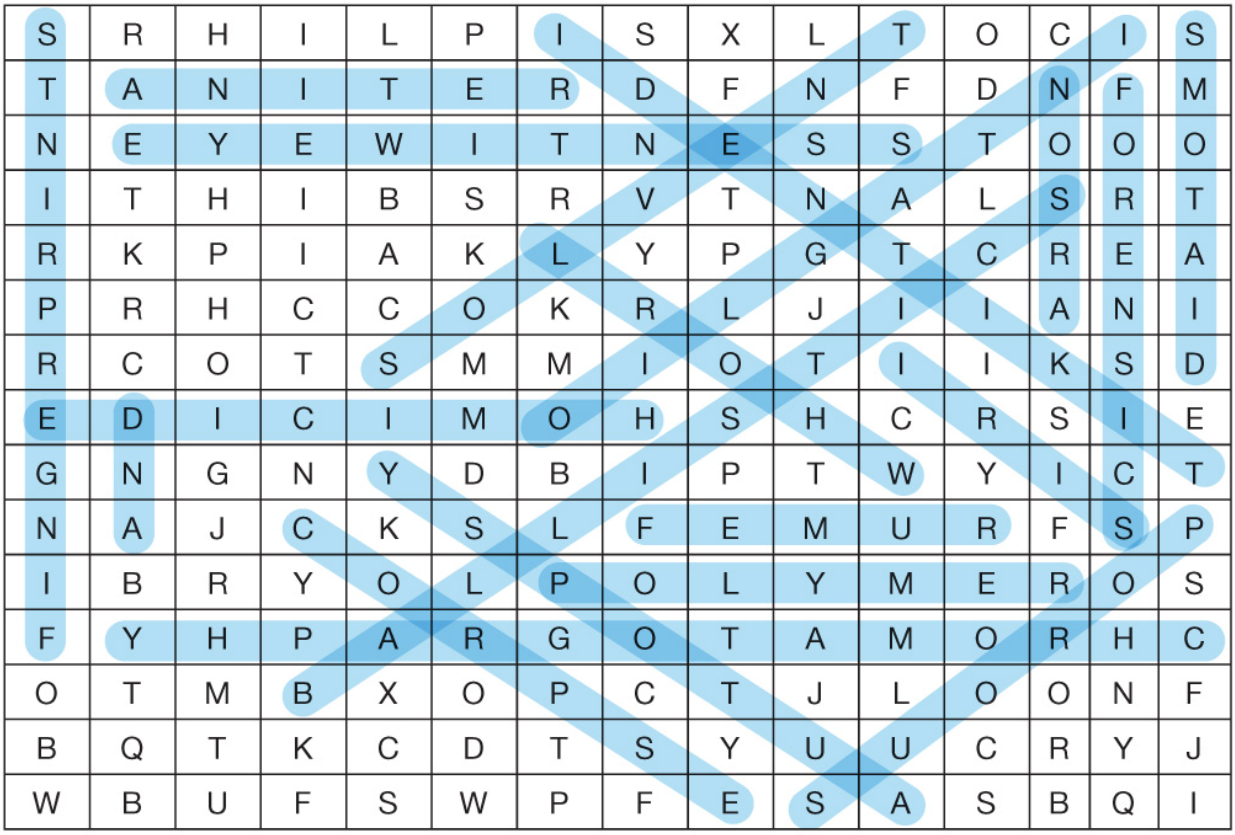
solvent

identikit

polymer

whorl

2



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

Language builder

1.4

1 **a** reclaimed

b regenerate

c retype

d refilled

e recharge

f reconstitute

1.8

Adverb	What it is modifying
genetically	modified
potentially	resistance to disease
quickly	improve crops
nutritionally	improved foods
actually	safer
successfully	taken up
naturally	antibiotic resistance

2.1

1 **a** different from

b In contrast to

c differs from

d In comparison to

e Unlike

f is different from

2.4

1 Sample responses include:

Bony limbs were an advantage for amphibians because they helped the animals to reach more breeding areas.

Bony limbs were an advantage for amphibians because they enabled the animals to grip onto the plants.

Bony limbs were an advantage for amphibians because they were better than fins for moving from pool to pool.

2.5

1 **a** A palaeontologist, Mike Lemmon, was sure he had discovered a Tiktaalik; however, no one else agreed with him.

b At the crime scene, the police found a body, which was cold; a gun, which was hidden behind the couch; and a bullet, which had been fired from the gun.

c Isaac Newton once said: ‘If I have seen further, it is by standing on the shoulder of giants’.

2.7

1 discover; were; developed; enabled; find; discovered; know; laid; study; tell

3.1

1 **a** Are moles different from horses?

b Is a bat’s limb the same as a rabbit’s?

c Is a whale’s bone different from a rabbit’s?

d Are the limbs of rabbits or bats similar to human limb structure?

3.2

1 Sample responses include:

Compound adjective	Meaning
sweet-seeded	a sweetly-tasting seed
bitter-seeded	a bitter-tasting seed
pinkish-brown	a colour halfway between pink and brown
s-shaped	a structure (spine) in the shape of an 'S'
wedge-shaped	a structure shaped like a wedge

2 **a** lobe-finned

b horse-like

c self-pollinating; cross-pollinating

d land-living

e single-celled

3.4

1 The first is that antibiotics are widespread in the environment because they are used often to treat animals and plants. As a result, they are appearing in the soil and water. They are also common in hospitals.

This mutation is causing them to withstand antibiotics. They are able to destroy the antibiotic molecules, alter bacterial cells and make it harder for antibiotic molecules to pass through. They can also pump the antibiotic molecules out of the cell to prevent them from building up.

It can pass information to non-resistant bacteria. It forms a tunnel or tube that joins them and the resistant DNA can then pass through to the other bacteria. This makes all the bacteria resistant.

Well, it means that the antibiotic treatment we give animals, plants and humans will not work as well or not work at all.

4.2

1 lowest; increases steadily; maximum; slightly decreases; steadily decreases; highest; remain relatively constant; steadily decrease; minimum; steadily increase; greatest

4.3

1 Sample response includes:

Antoine-Laurent de Lavoisier was born in 1743 and died in 1793. He lived for 50 years. De Lavoisier identified and named the existing 33 elements and proved that rusting involved oxygen bonding to iron. He also proved that fire combustion needed oxygen.

4.5

1 **a** an

b the

c the

d a

e a; a; the

f a; a; the; the

g an; a; a; the

5.5 (1)

conveyor	rubber belt that is flat; used to carry things
grinding	breaking down rock to a size smaller than sand
ball mill	cylinder that goes around in circles
slurry	mixture of rock particles and water
froth flotation cells	tanks where slurry is mixed with chemicals
surfactants	chemicals that stick to the fine rock particles
roasting	heating the substance to a high temperature
electrowinning	process that removes the gold from the gold solution and collects it on steel plates
cake	washed and dried gold material
elution	process that washes gold off the carbon surface
bullion	gold bars

5.5 (2)

1 First; Before; second; Next; third; While; After; Then; Finally; last

5.6

1 Sample responses include:

a Although the driver knows Melbourne well, he (the driver) got lost.

b August in Hobart is cold whereas in Darwin, it (August) is warm.

c Even though Mary criticised Jenny, she (Mary) is still Jenny's friend.

d Both my parents have blue eyes but I have brown eyes.

6.1

1 a principal

b principle

c principal

2 a knew/whole

b new/fair

c piece/there

d site/hole

6.5

1

Word	Synonym	Antonym
realistic	sensible/possible	unlikely
consistent	certain/representative	unpredictable/variant
simple	clear	complex
different	alternative	same
reliable	unchanging	changeable

6.6

1 a would

b would

c could

d could

e could

f would

2 Sample responses include:

a What would you do if you won one million dollars?

b When would you eat dinner?

c What would you do on a normal evening?

d What changes could happen if we did nothing about global warming?

7.5

1 formed; argue; expanded; forming; believed; have worked; built ; buried; hope; studying; can find

7.6 (1)

1 **a** Astronomy is a field of science that uses radio waves to learn about the stars and galaxies.

b Johann Titius was a German astronomer who discovered the Titius-Bode law.

c A civil engineer plans structures that help people to move around.

d Johann Bode lived in Berlin where he published an astronomy journal.

7.6 (2)

1 **a** are

b fascinates

c shows

d were

8.1 (1)

1 **a** effect

b effect

c affect

d affect

2 individual student response

8.1 (2)

1 individual student response

8.3

1 individual student responses

2 **a** often/always/never

b never

c very/really

d very/really

8.5

1 **a** calculate the train's acceleration

b The mass of the train is 250 000 kg.

9.1

1 Sample response includes:

a I must go to the doctor tomorrow.

b The students must wear their uniform to school.

c I must make an appointment to see the dentist.

d The foundation of a skyscraper must be built on rock.

9.4

The steps to follow	Notes
1 What happened?	Tacoma Narrows Bridge began to vibrate and sway during wind gusts.
2 When and where did it happen?	1940, Tacoma USA
3 Who was there?	the supervisor who went to investigate
4 What did they do?	He went to see what was happening and so had to leave his car to escape.
5 Why and how did it happen?	The swinging caused parts of the bridge to break up, causing it to fall in the water below.
	The bridge was like a playground swing in high wind gusts.
6 What was the result?	Parts of bridge collapsed and fell. His daughter's dog, Buffy, died because it was in the car.

10.1

1 **a** Forensic science is important to find people who commit murder.

b A series of changes in the body begins after death.

c The changes determine how long a body has been dead.

d This helps the police to narrow their range of suspects.

10.3

1 **a** where's

b mightn't

c should've

d who'll

e we've

f aren't

2 **a** Dental records will not always be accurate if the victim has not visited the dentist for a long time.

b The police have not arrived so they have been forced to wait.

c If that is Jackson's microscope, where is Sue Lin's?

d The scientist would have determined the blood group but it will not have arrived yet.

e They will record the lab demonstration for anyone who is not here today.

