

9A WORKBOOK ANSWERS

9Aa Monsters and myth

- 1 A
- 2 a animal
b *Neofelis* (note that technically this word should be underlined or in italics)
c It is a difference between the cats that has been caused by a factor in its surroundings.
d The coat patterns are different. (Accept other answers on their merits.)
- 3 a No longer living.
b Any one sensible suggestion, such as change in environmental conditions, disease or the introduction of a predator/humans.
- 4 Suggestions are likely to include that some of the original pine trees were resistant to the disease and survived to reproduce. Or that seeds from other pine trees (from outside the forest) have been dispersed into the forest and have grown. (Note that students will be asked this question again at the end of the unit in the Workbook, where they are expected to provide a fuller answer in terms of natural selection.)

9Aa Environmental variation

- 1 Description of any two physical environmental factors in the environment of the student when answering the question. Ensure that the factors are both physical.
- 2 a 100–119 g = 3; 120–139 g = 7; 140–159 g = 12; 160–179 g = 6; 180–199 g = 2
b Students bar charts should include:
 - scales chosen to fill as much of the paper as possible
 - axes lines drawn in
 - axes labelled
 - divisions on the scales evenly spaced
 - numbers on the vertical axis written in
 - units in brackets (g) on the vertical axis label
 - groups on the horizontal axis written in
 - a title
 - accurate plotting
 - drawn in (sharp) pencil
 - no gaps between the bars.
c Students' own responses. The list above could be shared with groups to aid discussion for points of improvement.
d Any sensible suggestion for a cause of environmental variation in plants (e.g. amount of water, amount of mineral salts, amount of light the parent plants received, position of the potato in the soil).
e The results can be any number (between two points).

9Ab Inherited variation

- 1 a 48%
b 60% ($3 \times 20\%$)
c discontinuous; inherited
- 2 genetic; inherited; fuse; fertilisation; zygote; information; parents; characteristics; offspring

9Ab More variation

- 1 Being able to speak more than one language – environment;
length of hair – environment;
human height – genes & environment;
natural eye colour – genes
- 2 **a** Sensible suggestion, such as height of plant, size of tomatoes, colour of tomatoes; these are affected by growing conditions and by genes.
b Students' own responses. It is more likely that students can make improvements to their explanations than their examples.
- 3 **a** Whale X is a beluga whale.
b Whale Y is a blue whale.

9Ab Probability (WS)

- 1 average – a single value used to represent the other values in a set; mean – the sum of the values divided by the number of values; median – the middle value in a set of values; mode – the most common value in a set of values
- 2 The chance of something happening.
- 3 **a** 0%
b 1/4
c 0.5
d 75%
e 1
- 4 B
- 5 **a** $5/50 = 1/10$
b 0.1
c 10%

9Ac DNA

- 1 Students' own responses. Ideas may include:
Francis Crick – helped to build the double helix model in 1953; Rosalind Franklin – took very clear photos of DNA using X-rays; Maurice Wilkins – tested and made corrections to the DNA model; James Watson – saw from a photo that DNA was a spiral.
- 2 **a** 1
b 1
c 2
- 3 **a** Missing chromosome 1, both missing chromosomes 15 and missing chromosome 20 drawn in. For 1 and 20 the drawn chromosomes should match the other in height and the position of the pinch point. For 15, the chromosomes should not be taller than 14 or smaller than 16 but the position of the pinch point does not matter.
b They are from a female because there are two X sex chromosomes.
c It is the biggest.
- 4 **a** 23
b 46
c 23
d 46
- 5 **a** A bar chart should be drawn. This is discontinuous data and so there should be gaps between the bars. Other points that should be included are:

scales chosen to fill as much of the paper as possible
axes lines drawn in
axes labelled
divisions on the scales evenly spaced
numbers on the vertical axis written in
names on the horizontal axis written in
a title
accurate plotting
drawn in (sharp) pencil.

b Because chromosomes come in pairs in body cells.

c No, it is not a good conclusion. There is too little data on birds/the sample size of the birds is too small.

9Ac Genetic counselling (STEM)

1 a R

b The disorder may cause lasting damage; so finding the disorder earlier means that less damage may be caused.

2 One (25% is 25/100 which is 1 in 4)

3 There is one fewer chromosome 21. And one chromosome 14 has an extra bit. (This is actually the other copy of chromosome 21.)

4 a Students need to show some evidence that they have researched the effects of Down's syndrome (such as flat facial features, an upward slant to the eyes, small ears, protruding tongue, slower physical and mental development).

b Two or more from:

the person is a man (because photo D shows an X and Y chromosome)

so he will not cause an increase in the risk of having a Down's syndrome baby

his partner/wife could also be tested, to make sure that her chromosomes are normal

he may pass on his chromosomes to his child, and if that child is female, she would be at greater risk of having a Down's syndrome baby.

9Ad Genes and extinction

1 environment – an organism's surroundings; environmental factor – a part of the surroundings that changes organisms; physical factor – another term for an abiotic factor; abiotic factor – another term for a physical factor; biotic factor – activities of other organisms; environmental variation – changes caused by the surroundings

2 a Any sensible adaptations supported by reasoning/justification (e.g. large wingspan to support its mass/size, sharp talons/claws to attack moas/pull meat off moas, sharp beak to attack moas/pull meat off moas).

b The humans killed the moas, and so the eagles had too little to eat.

3 adaptations; habitats; inherited; desert; camouflaged; camouflaged; endangered

4 Any three from: light, air/carbon dioxide, water, nutrients/mineral salts, space.

9Ad Adaptation and biodiversity

- 1 The increase in temperature would dry up the bog. The plants do not have enough roots to absorb enough water and so they would dry out.
- 2 The population will decrease. Ideas could include: the lack of snow means that they will not be so well camouflaged and so their prey will see them coming and they will not get enough to eat; the lack of sea ice means that there is less space for them to live and breed, putting them into competition with one another and/or meaning that supplies of food in the areas around land will become depleted more quickly by larger numbers of bears; higher temperatures will mean that the bears overheat.
- 3
 - a The number of different species (in an area).
 - b Any sensible suggestion, e.g. preserves ecosystems (since organisms depend on one another); preserves a source of undiscovered substances for human use; allows a habitat to recover faster if disaster strikes; preserves beauty for future generations.
 - c Ideas could include: banning hunting certain animals; ban the trade in certain organisms; ban picking of certain plants; setting up nature reserves; using breeding programmes; saving tissues/gametes/seeds in gene banks.
- 4 D
- 5 A

9Ae Natural selection

- 1 genes/genetic information
- 2 From top: 4, 3, 2, 5, 1.
- 3 Students' own responses. For example: Some birds naturally have longer legs. When there are fewer fish in the lake, those birds get more of the fish and so are more likely to survive. Their offspring also have longer legs. So, in the next generation, more of the birds have longer legs. This process of natural selection repeats over and over again.

9Ae Recreating animals

- 1
 - a Students' own responses.
 - b Students' own responses but they must mention an abiotic factor (e.g. wind, rainfall, sunshine) and a matching variation.
 - c Different genes come in slightly different versions and so cause variation in characteristics.
- 2 B
- 3 From left: 1, 3, 4, 2.
- 4
 - a DNA
 - b 29
- 5
 - a One or more from: long hair to help stop energy being transferred to the surroundings by heating (helping them to stay warm); large size meaning that energy was transferred to the surroundings less quickly; large feet to stop them sinking into the snow; large tusks to push snow out of the way.
 - b See answer to question 4 from 9Aa Monsters and myth. At this point, students should include variation and natural selection in their answers, pointing out that some of the pine trees may have survived the disease because they were naturally resistant to it. This allowed them to produce offspring that were also resistant to the disease.

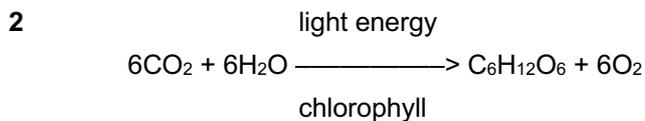
9B WORKBOOK ANSWERS

9Ba On a farm

- 1 a Students' own selections of facts from previous learning, but could include:
- photosynthesis: water + carbon dioxide → glucose + oxygen; requires energy transferred by light; requires chlorophyll in chloroplasts to capture energy from light; glucose from photosynthesis is used in respiration and in other processes e.g. to make proteins, build plant tissues; provides food for most food chains/webs on Earth; only happens when enough light
- aerobic respiration: breakdown of glucose using oxygen to release energy; glucose + oxygen → carbon dioxide + water; takes place inside mitochondria in cells; occurs all the time in living cells unless not enough oxygen
- plant nutrients: absorbed through plant roots from soil; used to convert glucose from photosynthesis to other substances; found in fertilisers and compost
- plant adaptations: cactus has no leaves to reduce water loss in desert; cactus (and others) have spines to deter herbivores; Venus fly trap (and other carnivorous plants) have adaptations for catching and digesting small animals; coniferous trees have needle-like leaves to shed snow in winter.
- b Students' own answers.
- c Students' own answers.
- 2 Less sunlight for photosynthesis means that the plants will grow less well and there will be a reduction in useful crop produced (yield).

9Ba Reactions in plants

1 A



(Students do not need to include 'light energy' or 'chlorophyll'.)

3 photosynthesis; sugars; phloem; respiration; energy

4 a oxygen = red; carbon dioxide = blue

b From top to bottom:

The gas (oxygen) increases in concentration because: rate of photosynthesis increases as light intensity increases.

The gas (oxygen) decreases in concentration because: rate of photosynthesis decreases as light intensity decreases.

The gas (carbon dioxide) increases in concentration because: rate of photosynthesis decreases so less carbon dioxide is converted to glucose.

5 chloroplasts

9Bb Plant adaptations

1 a

Substance	Where it comes from in the environment	How plants use it
oxygen	air	aerobic respiration to break down glucose
carbon dioxide	air	photosynthesis to produce glucose
nitrate salts	soil	to make amino acids/proteins from glucose
magnesium salts	soil	to make chlorophyll
potassium salts	soil	to help root cells absorb water properly
water	soil	for dissolving substances for transport, photosynthesis, keeping leaves cool, filling cells to keep them firm

- 2 palisade cells – contain many chloroplasts where they receive most light; xylem – carries water and mineral salts from the roots; stomata – allow gases to enter and leave the leaf; phloem – carries dissolved sugars from the leaf to other plant parts
- 3 a They are hollow (so can form tubes).
b They have a large surface area (and so can absorb water quickly).
- 4 broad leaf: large surface area for capturing as much light as possible (for photosynthesis);
thin leaf: short distance for gas exchange increases rate of diffusion/helps efficient gas exchange

9Bb Gas exchange

- 1 a To open and close the stoma (by changing shape).
b Any two from: oxygen, carbon dioxide, water vapour.
c Closed, because stomata close at night.
d Stomata open during the day to allow rapid diffusion of oxygen into the leaf for photosynthesis. Stomata close at night to reduce water loss (when photosynthesis is not happening).
- 2 photosynthesis; concentration; fall; rapidly
- 3 increases; increase; increase; a decrease; more

9Bc Plant products

- 1 a iodine
b The metal foil prevents light from reaching some of the leaf, but clear plastic would not.
c Drawing should show dark/black areas where green is visible in the left-hand diagram and white areas where the leaf was covered by stencil.
d Light cannot get through the stencil, so no photosynthesis occurs in those cells. So, no glucose is made there, which means no starch is produced.
- 2 As a store of energy (for respiration).
- 3 a Glucose from photosynthesis is combined with nitrates to make amino acids, which form proteins.
b Enzymes break down starch to glucose, which is used in respiration and to make new substances for growth.
- 4 Benedict's reagent should change from blue to orange or red when heated with the crushed seed.

9Bd Growing crops

- 1 **a**
 - i They dissolve in soil water and are quickly available for plants to absorb.
 - ii They can easily move into nearby water (e.g. streams, rivers) away from crop roots.
- b**
 - i Any suitable answer, such as: more quickly available to plants for absorption; easier to judge the amount of nutrients that are available to plants.
 - ii Manure contains large organic molecules that need to be broken down by decomposers before plants can absorb the nutrients, which takes time. The nutrients in artificial fertilisers are available as soon as they have dissolved in soil water.
- c** Clay: holds water so provides water to crops for longer; can keep too much water around roots after a lot of rain causing waterlogging/damaging plant roots.
Sand: water drains quickly after rain so no waterlogging of roots, but plants more likely to die if no rain.
- 2 Any one from: too expensive; lack of availability; not suitable for the crops they grow.
- 3 The liquid contains sugars that are a source of energy for the plant. Killing the aphids means more sugars/energy available to the plant for respiration and growth.
- 4 Cross-breeding can produce varieties (or breeds) that have good characteristics inherited from both parents.
- 5 **a** Height increases with number of drops used because more fertiliser means more nutrients for plant growth.
b Anything similar to: do not use more fertiliser than plants can absorb, because it can reduce growth (get washed away/be a waste of money).
c Any suitable change to method with reason, such as: make sure the plants are grown in same conditions of light and temperature, because they can both affect growth; plant the beans in clean sand so the only nutrients come from fertiliser not from soil as well.
- 6 (The two parent plants are) crossed and new plants grown.
(The breeder selects) plants that produce the yellowest and sweetest apples (to breed from).
(This process is repeated) many times/over many generations (to produce the new variety).
- 7 Farmers use better fertilisers, higher yielding varieties, more efficient machinery and more pesticides than they did in 1973.

9Bd Protecting wild plants (STEM)

- 1 Any suitable reason such as: it contains many endemic plant species; area of high biodiversity of species, including at risk of damage by human activities.
- 2 Any three suitable such as: number of species in area; abundance of species; number of endemic species; IUCN Red List information on how endangered species are; changing land uses in area (now and proposed).
- 3 Template should include:
 - site reference data/description, e.g. geographical coordinates, height above sea level, environmental conditions (e.g. rainfall, temperature range, soil type)
 - summary of data from audit, including: plant species found, abundance, range, whether endemic or not, current and future land use
 - assessment of risk to biodiversity or endemic species, with reference to criteria used to judge risk
 - recommendation based on assessment.
- 4 Using a plant identification guide/database.

9Be Farming problems

- 1
 - 1 Nutrients from the fertiliser dissolve in soil water.
 - 2 Soil water with extra nutrients leaks into nearby stream or river.
 - 3 Extra nutrients in water cause rapid growth of algae and water plants.
 - 4 Algae and water plants at surface block light so deeper plants die.
 - 5 Decomposers break down dead plants using oxygen from the water.
 - 6 Fish die because of too little oxygen in water.
- 2
 - a Spraying with insecticide to kill the insect pest.
 - b Any suitable such as: they are also killed by the insecticide/ the insects they eat have been killed by the insecticide so they have no food.
 - c Any suitable such as: if they feed on the crop or on insects that feed on the crop then population will increase; if they feed on other plants or animals then they may starve as there will be less of everything else in the area.
 - d Decrease because of reduction in yield through loss of pollinating insects.

9Be The carbon cycle

- 1
 - a A – photosynthesis; B – respiration; C – combustion/burning
 - b Any suitable explanation such as: combustion of wood after trees cut down; decrease in amount of carbon dioxide taken from air by trees for photosynthesis and 'locked-in' carbon compounds in wood.
 - c During combustion the carbonate in limestone is broken down to carbon dioxide, which is released into the air.
- 2
 - a Anything similar to: it traps energy from the Sun in the atmosphere causing heating.
 - b Anything similar to: it adds carbon dioxide more rapidly to the air than it is removed by photosynthesis.
 - c Any two suitable consequences of global warming such as: increased temperatures at ground level; sea level rise due to melting glaciers and polar ice; increasingly frequent storms due to heating of oceans.
- 3 Any two from: using less fuel/more efficient machinery (which would reduce carbon dioxide emissions); plant trees and hedgerows (to increase biodiversity, to take up carbon dioxide from the atmosphere); use less fertiliser (to avoid eutrophication and killing aquatic organisms); using less pesticide (to avoid killing non-target organisms).

9Be Bias and validity (WS)

- 1
 - a D
 - b The conclusion matches the pattern in all of the data.
 - c Any two variables other than amount of fertiliser that could affect growth, such as: temperature, amount of light, amount of water, soil/compost.
- 2 systematic error – a mass balance is not set at zero before an experiment; random error – the stop clock was not stopped at the exact moment in one test during an experiment; valid experiment – all variables are controlled so the dependent variable is only affected by changes in the independent variable; intentional bias – only data that support a particular view are quoted
- 3 Insects that live in other places may not be showing the same decline; insects that do not fly may not be affected.

9Be Organic farming

1 Any suitable facts learned in the topic such as:

photosynthesis: symbol equation $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$; rate of photosynthesis is controlled by limiting factors such as light intensity, temperature and carbon dioxide concentration; photosynthesis only happens in daylight; glucose from photosynthesis is converted to sugars which are transported round the plant in phloem.

aerobic respiration: symbol equation $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$ (+ energy); respiration occurs in plant cells all the time.

plant nutrients: plants need nitrates to make proteins; magnesium is needed to make chlorophyll; potassium is needed by plant roots to absorb water properly.

plant adaptations: some plants capture insects to get mineral salts; root hair cells have a large surface area to absorb water and mineral salts quickly; xylem vessels form long tubes that carry water and dissolved mineral salts around the plant; palisade cells just below the upper epidermis have the most chloroplasts to capture as much light as possible; stomata (pores) in the lower epidermis allow gas exchange between the leaf and air.

2 **a** Intensive farming because artificial fertilisers/pesticides easily dissolve in water and can be washed into streams and rivers more quickly.

b An organic farm is likely to attract more insect-eating birds because of lower use of insecticide and more habitats near to fields for birds to live in.

c Intensive farming because of a larger area of farm under crop/less damage caused by pests through use of pesticides/more rapid growth of crops due to more accurate measure of nutrients added in fertiliser.

3 Bees are important pollinators and so help fruits/seeds to form (increasing yields); or students may answer in terms of a helpful organism controlling the numbers of pest organisms.

9C WORKBOOK ANSWERS

9Ca Threat from disease

- 1 A
- 2 **a** Disease-causing microorganism
b Keeping things clean by removing microorganisms/pathogens.
c Giving someone a vaccine that will make them immune to an infectious disease.
d A drug that kills bacteria (inside the human body).
- 3 Nerves carry signals/impulses to muscles to control them. If nerves are damaged the signals/impulses may not reach the muscles.
- 4 Diffusion is the movement of small particles from an area where there are more of them to an area where there are fewer. This can happen across a partially permeable membrane such as a cell membrane.

9Ca Diseases

- 1 deficiency disease – scurvy due to lack of vitamin C in diet; infectious disease – flu caused by flu virus; lifestyle disease – cardiovascular disease due to too little exercise; genetic disease – sickle cell disease inherited from parents
- 2 **a** Any one non-infectious disease such as rickets; sickle cell disease; cancer or diabetes.
b The disease cannot be passed from person to person and is caused by (as appropriate) a poor diet or a change in the immune system; is inherited from parents; may be linked to factors in the way we live.
c Any suitable caused by the way we live, such as type 2 diabetes linked to obesity and overeating; liver cancer due to alcohol damage; asthma due to air pollution; lung cancer due to smoking.
- 3 **a** autoimmune disease
b Any suitable such as type 1 diabetes.
- 4 Any two from: prokaryotes (bacteria), protocist, fungi (virus not suitable as there is no virus kingdom).
- 5 Any two symptoms such as high body temperature, rash, aches/headache, which are signs of an infection.
- 6 pathogen, phagocytes, lymphocytes, antibodies, pathogen, stick, ingested
- 7 **a** It takes time for the lymphocytes to respond to infection and produce enough antibodies to kill all the pathogens.
b After the first infection memory lymphocytes remain in your blood, and respond to any other infection by the measles pathogen too quickly for the pathogens to cause symptoms.
c The memory lymphocytes produced in response to the measles pathogen do not recognise the chicken pox pathogen and will not attack it.
d Vaccination causes the body to produce memory lymphocytes against measles which attack the measles pathogen if it gets into the child's body.
- 8 Vaccinations make people immune to diseases, so that they cannot get them. If fewer people in a community are likely to get a disease, then it is more difficult for the disease to spread.

9Ca Veterinary science (STEM)

- 1 **a** The amount of antibiotic given at a time.
b The time it takes for half the antibiotic molecules in the body to be broken down.
- 2 Work out how many half-lives are needed to reduce from 10 to 2.5 (= 2 half-lives); multiply number of half-lives by length of half-life (= $2 \times 64 = 128$ hours); convert answer to days by dividing by 24 ($128 \div 24 = 5.33$ or 5 days 8 hours).
- 3 **a, b** Students' own models: should include definition of half-life, and an example of calculating the half-life with at least one species from the table.

9Cb Control systems

- 1 eye, ear, skin
- 2 Any two from: brain, spinal cord, nerves, any sense organ.
- 3 **a** Receptor cells in skin respond to touch by sending electrical impulses to brain → brain sends impulses to spinal cord → impulses travel from spinal cord into nerves → impulses travel along nerves to muscles that control hand movements → muscles respond by moving muscles to lift hand.
b Students' own answers.
- 4 hormones; glands; blood; target
- 5 **a** pancreas
b Causes them to take glucose from the blood.
- 6 Nervous system, because a rapid response is needed to avoid harm.

9Cc Treating diseases

- 1 Medicines change the way the body works.
- 2 medicines – drugs used to treat or prevent disease; antibiotics – drugs that kill bacteria; antivirals – drugs that prevent viruses replicating; vaccines – drugs that make us immune to particular diseases
- 3 **a** An organism that contains DNA/genetic material from another/more than one species.
b The gene for making growth hormone is taken from a human cell and placed in a bacterium so the bacterium makes the hormone.
- 4 **a** To provide oxygen for aerobic respiration.
b Any two from: temperature controlled so at best level for rapid growth; pH controlled so at best level for rapid growth; nutrients added that microorganisms need for growth; paddles stir mixture so microorganisms always suspended in nutrient solution.
c All surfaces are sterilised to kill microorganisms.
d So that other microorganisms are not introduced into the fermenter, as these could compete with the microorganisms being grown or produce unwanted substances.

9Cc Medians and quartiles (WS)

1 **a**

Foot length	25.1– 25.5	25.6– 26.0	26.1– 26.5	26.6– 27.0	27.1– 27.5	27.6– 28.0	28.1– 28.5	28.6– 29.0	29.1– 29.5
Number of students	1	3	4	6	7	5	5	4	1

b, c Students' own bar charts including the following:

axes should be labelled to say what they show, units included after each axis label

chart title

numbers correctly written on scales

divisions on scales should be evenly spaced

chart should fill as much of the grid as possible

bars plotted accurately, with no spaces between bars

drawn in (sharp) pencil.

d 27.1–27.5

e Yes, because the most frequent values are in the middle of the range, with frequency decreasing the further you get from the middle.

2 **a** median = 17, lower quartile = 11, upper quartile = 25

b 25 – 11 = 14

9Cd Ecology

- abundance – the number of organisms in a population; distribution – how organisms are grouped in the environment; sample – a small selected part of the total number; estimate – an approximate calculation of something
- Pitfall trap because they would run along the ground and fall into the trap.
 - A sweep net that brushes them off the long grass and traps them in the net.
- It would take a long time to survey the whole field.
 - Placed randomly/using random coordinates to avoid bias in data from choosing particular places.
 - Area of quadrat is $0.5 \times 0.5 = 0.25 \text{ m}^2$ so total sampled area = $8 \times 0.25 \text{ m}^2 = 2 \text{ m}^2$; total area of field is $30 \times 25 = 750 \text{ m}^2$, total number of snails sampled = 10
abundance = $10 \times 750/2 = 3750$
 - This would make the estimate less accurate because it would be easier for all quadrats to miss clumps (producing an underestimate) or several quadrats to sample clumps (producing an overestimate).
- Place quadrats randomly in the field and count the number of plants of each species inside the quadrat (or calculate the percentage cover of the quadrat by each species). Data from samples used to calculate the population size for each species (or average coverage per quadrat or 1 m^2) The largest population size (or average percentage cover) indicates the most abundant species.
- Total number of species in an area.
 - Any one from: to sample species in a large area; to show how abundance or distribution varies along transect.
 - Any two suitable suggestions, such as: take same time to walk each transect; count at specific distances along transect for specific length of time; repeat transects several times and calculate mean values; repeat transects at different times of day.
 - In the plantation because the environment is similar all the way through/the habitats are not as varied in different areas.

9Ce In and out

- random; gradient; higher; lower; diffusion
 - B
 - Random particle movement happens all the time (dependent on temperature), but there is no concentration gradient in the right side so no diffusion.
- Particles move faster as temperature increases.
 - Wind blows oxygen molecules away from the leaf faster so increases the concentration gradient between the inside and just outside the leaf.
- SA : V ratio decreases as size increases.
 - As the organism increases in size, its volume increases more rapidly than its surface area. This will make it more difficult for the organism to absorb all that its volume needs. Splitting in two reduces the volume in relation to surface area again.
- Osmosis is the diffusion of water molecules through a partially permeable membrane from the side of their higher concentration/where there are more of them to the side of their lower concentration/where there are fewer of them.
 - The cytoplasm of the cells has a lower concentration of water molecules/has a higher solute concentration/contains fewer water molecules than the soil solution.
 - A large surface area means more water molecules can cross the cell membrane into the cell at the same time.
- The cell is surrounded by water that has a higher concentration of water molecules/is a more dilute solution than its cytoplasm. So, water continually enters by osmosis. If the water was not removed from the cell, it would swell and burst.

9Ce Combatting pandemics

- A

2 D

3 B

4 B

5 C

6 C

7 People can travel quickly between countries and may be infected even if they do not yet feel ill. This means that the disease could spread to other countries very quickly.

8 a There will be no change (because the sugar molecules cannot go through the membrane).

b The number of water molecules on the left will increase slightly and the number of water molecules on the right will decrease slightly. There will be an overall flow of water molecules from where they are more concentrated to where they are less concentrated (or towards the place in which the solute is more concentrated).

c osmosis

9E WORKBOOK ANSWERS

9Ea Materials of the future

- 1 New substance(s)
- 2 **a** atoms
b A strong attraction between atoms.
- 3 carbon nanotubes – light, strong, conduct electricity; copper metal – excellent electrical conductor, ductile; aerogels – can support loads over 1000 times its mass; polystyrene – waterproof, thermal insulator
- 4 **a** water + carbon dioxide (in either order)
b calcium sulfate (accept CaSO_4)
c bubbles/fizzing/effervescence OR calcium carbonate disappears/dissolves
- 5 A number of possible answers e.g. plastics for packaging, fabric for clothes, wood for building materials, stone for building materials etc.

9Ea About ceramics

- 1 porcelain, pottery, brick
- 2 **a** Any two from: hard, rigid, heat resistant, insulating.
b brittle/fragile/break easily
- 3 Any two from: transparent/see-through, rigid, hard, chemically unreactive.
- 4 **a** A
b B
- 5 **a** The molten ceramic for porcelain X was cooled more quickly than the ceramic for porcelain Y.
b Larger crystals form on slow cooling as the atoms have more time to form the lattice structure.

9Eb Polymers

- 1 Lots of (small) molecules/monomers joined in a long chain.
- 2 Many possible answers, e.g.
pen – bright colour, rigid
ruler – transparent, strong
chair – rigid, strong
elastic/rubber band – stretchy, flexible.
- 3 polymer; trees; glue; soft; tyres; properties; vulcanisation; sulfur; molecules; harder; temperature
- 4 **a** Many smaller molecules (of polychloroethene) have joined together to form a long chain.
b Diagram showing: 2 carbon atoms connected by a line (in fact this will be a double bond but that is beyond students at this stage); one carbon atom also connected to 2 hydrogen atoms; other carbon atom connected to 1 hydrogen atom and 1 chlorine atom.

9Eb More about polymers

- 1 It is exothermic because energy is transferred from the reaction to the environment (not 'surroundings get warmer', as this is in the question).
- 2 **a** Low density poly(ethene) because it can be stretched over fruit; it is transparent so you can see the fruit through the packaging.
b Vulcanised rubber because it is hard and tough so will not wear out on the road; it is heat resistant so will not be damaged when it heats up due to friction.
c Poly(propene) because it is flexible so can be woven into rope; it is hard-wearing so will cope with heavy loads; it is waterproof so can be used outside.
- 3 **a** styrene
b Any one from: lightweight, good at absorbing shocks, insulator.
- 4 C
- 5 Students' own responses.

9Eb Peer review (WS)

- 1 Any two from: scientific journals, websites, interview with scientist (e.g. transcript/recording), original records/results.
- 2 papers; evaluated; scientists; reviewers; method; original; valid
- 3 Possible answers include: not all papers are published in reputable journals; not all journals carry out the review process; some reviewers may not do the job carefully/properly.
- 4 **a** Possible answers include: have they worked in the same field / done the same kind of research; how experienced they are; do they have time to review carefully; do they have a vested interest (e.g. scientists should not review their own work or be a close colleague or someone whose work they are reviewing); do they have any conflicts of interest (e.g. might they be working in a field that would benefit from the work being held up/unpublished).
b, c Students' own answers.

9Ec Composite materials

- 1 **a** False
b True
c True
d False
e True
- 2 A composite of glass fibres in a polyester resin.
- 3 concrete – building houses and office buildings; glass-reinforced plastic – building and repairing boats; composite safety glass – car windscreens; Kevlar® composite – racing car body parts
- 4 It is too expensive.
- 5 **a** Exothermic
b Energy is being transferred from the resin to the surroundings.

9Ec Concrete

- a** calcium carbonate → calcium oxide + carbon dioxide (products in any order)
b (The reaction is) endothermic (because) it needs to be heated/needs heat supplied from surroundings.
c In order: s, s, g
d l = liquid (state); aq = aqueous/dissolved in water
- Any two from: avoid skin contact; wear gloves; wear eye protection; wear other protective clothing, e.g. long sleeves, strong shoes with closed toes, etc.
- a** Possible reasons for choosing MDF: very strong, rigid, holds shape, cheap(er than wood), does not warp, can be easily painted.
 Possible reasons for choosing natural wood: appearance, natural effect, may be longer-lasting, pleasing wood smell.

b Students' own answers.

9Ec Materials for cars (STEM)

- A composite material made from paper and glue.
- Answer will depend on method followed, generally: tear/cut same-size strips of newspaper; mix flour and water until you get a smooth paste; dip the strips in the paste and press them together/around model; repeat with increasing numbers of strips.
- Heading will depend on variable measure, e.g. mass supported in grams.
- Conclusion depends on results, e.g. the more strips we added, the more weight our sample could support.
- a, b** Answers will depend on method followed and variable tested.

9Ed Problems with materials

- Completed table is as follows:

Name of pollutant	Formula	Where it comes from	Why it's a problem
carbon monoxide	CO	incomplete combustion in e.g. vehicle engines	<i>poisonous gas</i>
<i>carbon dioxide</i>	CO ₂	burning hydrocarbon fuels	contributes to global warming
sulfur dioxide	SO ₂	<i>sulfur impurities in fuels reacting with oxygen</i>	causes acid rain; irritates lungs
<i>nitrogen dioxide</i>	NO ₂	nitrogen reacting with oxygen at high temps in, for example, vehicle engines	causes acid rain; irritates lungs

- sulfur + oxygen → sulfur dioxide (also accept 'sulfur oxide')
- calcium carbonate + sulfuric acid → calcium sulfate + carbon dioxide + water
- Carbon dioxide (in the atmosphere) is causing global warming; carbon capture traps carbon dioxide from the air in rocks/underground, which reduces the levels of carbon dioxide in the atmosphere.
- Diagram should show:
 - tannery workers throwing out scraps of animal hide
 - scraps being added to animal feed
 - feed being given to chickens
 - humans eating chicken meat/eggs and being poisoned.

9Ed More problems with materials

- 1 Something that can be broken down by living organisms / something that breaks down naturally in the environment.
- 2 Advantage: no landfill; energy produced can be used for e.g. heating.
Disadvantage: causes air pollution; produces carbon dioxide emissions.
- 3 **a** Lots of possible answers e.g. plastic bag/cloth bag; plastic biro/refillable pen; plastic-coated coffee cup/ceramic cup; plastic packaging/paper packaging etc.
b Paper goes soggy / is not as strong as plastic.
- 4 **a** Possible answers include (but not limited to):
 - i** soot (others are gases); carbon monoxide (others are not poisonous); carbon dioxide (others formed in incomplete combustion)
 - ii** sulfur dioxide (only one containing sulfur); nitrogen oxide (only one that is not a dioxide); nitrogen dioxide (forms in the air when nitrogen oxide is oxidised)
 - iii** methane (only chemical); combustion (only description of a chemical process); greenhouse effect (only description of an environmental process)**b i, ii, iii** Students' own answers.

9Ee Recycling materials

- 1 A, C, D
- 2 We cannot make new metal / metal ores; there is only so much rock that contains metal ore on the Earth.
- 3 **a** Flow chart showing the following steps:
collection > separation by colour > crushed > melted > moulded into new objects
b Students' own answers.
- 4 Any two from: unsightly, smelly, takes up space, produces harmful gases, might contaminate soil/water, could harm wildlife.
- 5 **a** Any two from: symbols are hard to see; symbols are hard to find; symbols are difficult to tell apart; symbol may have been removed/covered up; plastic may be mixed with other materials / not obviously a plastic (e.g. fibres).
b Students' own responses.

9Ee Material failures

- 1 **a** fire extinguishers, aerosols, refrigeration
b Damage to the ozone layer/reduced ozone levels (resulting in more harmful UV radiation reaching the Earth's surface).
- 2 Suggested answers (example can be any appropriate material):
 - a** ceramics – natural materials made from clay and sand – mugs, plates, bottles
 - b** polymers – lots of smaller molecules joined in long chains – polyethene bags, packaging
 - c** composites – combinations of two or more materials – cement, Kevlar® composite, GRP
- 3 Possible answers include:
glass bottles – to save energy and resources
plastics – to prevent landfill, to save energy
composites are very difficult to recycle
- 4 **a, b** Students' own answers.

9F WORKBOOK ANSWERS

9Fa Demolition

- 1 B, C, G
- 2 Risk of being hit by debris; building may not completely collapse and the remaining parts become a risk as they may fall; and danger if there are unexploded explosives.
- 3 Ideas may include: increase in pressure, temperature, volume.
- 4 a single sulfur atom added (in yellow); oxygen molecule added (in red)
b B

9Fa Types of explosion

- 1 a A
b D
- 2 Some bonds between atoms in the reactants are broken. New bonds are formed to make the products.
- 3 carbon + oxygen → carbon dioxide (addition of heat is ok)
 $C + O_2 \rightarrow CO_2$ (state symbols may have been added but this is not necessary)
- 4 a gas
b physical change; because no new substances are made
c i D
ii A
- 5 Ideas may include: increase in pressure, temperature, volume, transfer of energy.

9Fb Reactivity

- 1 A list of metals in order of reactivity, with the most reactive at the top.
- 2 a Metal X is likely to be magnesium (calcium or lithium are also acceptable answers).
Metal Y is likely to be zinc (aluminium, iron, tin, lead are also acceptable answers).
Metal Z is likely to be sodium (potassium is also an acceptable answer).
b Reactivity increases as you go down the group.
- 3 a potassium hydroxide, hydrogen
b calcium, hydrogen
c magnesium, oxygen
d lithium nitrate, hydrogen
e water, hydrogen
f $MgSO_4$, H_2 (state symbols may be included but are not required)

9Fb Atoms

- 1 a C
b B
c C
d B
- 2 Students should try to get all parts of question 1 correct, with the help of teacher/others.
- 3 The number of protons and neutrons in an atom.
- 4 a upper box 4, lower box 2.
b The diagram should have 7 circles in the centre, 3 protons and 4 neutrons.

9Fc Energy and reactions

- a** A reaction with oxygen, or a reaction in which a substance gains oxygen.

b A substance that causes oxidation to happen or a substance that releases oxygen easily.
- a** D

b A
- a** Ensure that students' graphs have:

 - scales chosen to fill as much of the paper as possible
 - divisions on the scales evenly spaced
 - axes lines drawn in
 - numbers on the axes written in
 - axes titles, which include units
 - a title
 - accurate plotting
 - been drawn in (sharp) pencil.

b 40 °C

c Smooth curve of best fit drawn (ignoring the anomalous result).

d The higher the temperature, the faster the rate of the reaction.

e The higher the concentration, the faster the rate of the reaction.

9Fc Energy transfer

- Relights a glowing splint.
- endothermic; decrease; decrease; thermal decomposition; exothermic; increase; increase; combustion and decomposition (final two can be in either order)
- It is endothermic.
- a** Using a spark or flame.

b An energy input is needed.
- It is endothermic.

9Fc Percentage change (WS)

- a** D

b B
- a** $7 - 5 = 2 \text{ cm}^3$

b $2/5 \times 100 = 40\%$
- a** B

b C

9Fc Working out percentage changes (WS)

- a** $30 - 14 = 16 \text{ g}$

b $16/30 \times 100 = 53.33\%$
- $4 - 2.4 = 1.6 \text{ g}; 1.6/2.4 \times 100 = 66.7\%$
- $10/100 \times 15 = 1.5 \text{ g}; 15 - 1.5 = 13.5 \text{ g}$
- a** $96 - 76 = 20 \text{ cm}^3$

b 20.8%

c 21%

9Fd Displacement

- a** aluminium oxide + iron
b displacement reaction
- a** chlorine or fluorine (although, note that fluorine is not used in reality as it is a dangerous gas)
b chlorine; sodium chloride
- Y, W, Z, X
- a** wrong
b wrong
c correct
d correct

9Fe Extracting metals

- a** They are unreactive.
b A metal compound found in the Earth's crust.
- a** B, D
b iron + carbon dioxide
- a** water
b carbon dioxide
c carbon dioxide
d water
- Any one from: they are more reactive and form very stable compounds (which requires a more powerful method of reduction); those metals are above carbon in the reactivity series and so carbon cannot displace them from their compounds.
- Electricity not invented/discovered.

9Fe Materials management (STEM)

- a** Any two from: coal, wood, natural gas, cotton, metal ores, salts, minerals (more examples exist).
b A rock that contains metal or metal compounds that can be mined.
- a** Include items such as: milk, juice, eggs, butter, yogurt, meat.
b A list showing the approximate fridge shelf-life of items mentioned in **a**.
c A description of a spreadsheet with items and fridge shelf-life.
d The spreadsheet as described in **c**, but may also contain approximate time it takes to consume each item, and an alert system for when items run low.
e Students' own designs.

9Fe Alfred Nobel

- aluminium oxide → aluminium + oxygen – reduction
copper carbonate → copper oxide + carbon dioxide – decomposition
lithium + oxygen → lithium oxide – oxidation
tin oxide + carbon → tin + carbon dioxide – redox
zinc + copper sulfate → zinc sulfate + copper – displacement
- A list of metals in order of reactivity, with the most reactive at the top.
- a** Electrolysis
b $204 - 108 = 96$ g; $96/204 \times 100 = 47\%$
- a** i true ii false iii false iv true v false vi true
b Students' own responses.

9G WORKBOOK ANSWERS

9Ga Art and chemistry

- 1 a red; iron; oxygen
white; lead, carbon, oxygen
red; mercury, sulfur
b Metals: iron, lead, mercury
- 2 a neutralisation
b sulfuric acid + copper oxide → copper sulfate + water. Some students may have written a symbol equation instead: $\text{H}_2\text{SO}_4 + \text{CuO} \rightarrow \text{CuSO}_4 + \text{H}_2\text{O}$
c bonds
- 3 a different
b five
c one; four
d exothermic
- 4 B

9Ga Ions

- 1 nucleus; negative; positively; atom; loses
- 2 Diagram showing a lithium atom becoming a lithium ion by losing an electron, which is transferred to the fluoride ion, formed from a fluorine atom. (The diagram could resemble the one in the Student Book 9Ga.)
- 3 The negative charge of the electrons is balanced by an equal and opposite positive charge from the nucleus.
- 4 a The diagram is labelled with the positive circles labelled as metal ions and the negative charges labelled as electrons.
b i (Electrons are able to move) freely (and randomly) in all directions.
ii (The electrons are shared) between the metal ions.
iii (The structure is held together due to attraction) between negative electrons and positive metal ions.
- 5 When a voltage is applied, the electrons in a metal move in the same direction, transferring energy and forming an electric current.
- 6 ionic (bond)
- 7 B, C
- 8 a In a solid, the ions are held in place and cannot move. When molten or in solution, the ions can move to carry the current.
b Students' own answers.
- 9 a sodium chloride
b Br^-
c S^{2-}
d 2^-
- 10 a argon, Ar
b sulfur, S
c helium, He

9Ga Weather control (STEM)

- 1 Condensation
- 2 An atom that has a tiny electrical charge.
- 3 **a** Metals
b Ionic
c It contains a metal bonded to a non-metal.
- 4 **a** Table should include benefits such as water available for growing crops and drinking water; disadvantages – such as may cause flooding or damage to structures.
b Answer should include information in support of the student's decision.

9Gb Energy transfers

- 1 **a** C
b B
- 2 Aluminium, because there are more free electrons.
- 3 **a** ionic
b The melting points of ionic compounds (sodium nitrate and potassium nitrate) are higher, so more energy is needed to break them.
- 4 To break the bonds holding the particles near to each other.

9Gb Endothermic, exothermic

- 1 Endothermic column ticked for: evaporation and melting, temperature of surroundings falls, requires energy input.
Exothermic column ticked for: condensation and freezing, temperature of surroundings rises, energy given out.
- 2 **a** B
b C
- 3 **a** Endothermic, because energy is being removed from the surroundings, which causes their temperature to fall.
b Physical change – no new substances have been formed.
c One or more from: they slow down; (stronger) bonds form between the particles/molecules; they lose energy.

9Gc Rates of reaction

- 1 Possible answers include: explosions, fireworks, precipitation (of lead iodide), paint oxidising, rusting.
- 2 **a** P
b U
c Mean rate = $38/4 = 9.5$ g/minute (accept $36-40/4 = 9-10$ g/minute)
- 3 **a** In either order: $\text{H}_2\text{O} + \text{CO}_2$.
b Measuring the amount of gas formed.
- 4 They must collide (some students may add that they need to collide hard enough or with enough energy).
- 5 **a** Area of one side of the cube $4 \text{ cm} \times 4 \text{ cm} = 16 \text{ cm}^2$; the cube has 6 sides so $6 \times 16 = 96 \text{ cm}^2$.
b None.
c Increases.

9Gc Changing rates

- a, b** One possible answer: If we increase the surface area of a reactant, then there are more particles at the surface and the surface area to volume ratio increases. This makes it more likely for collisions to occur and the rate of reaction increases.
- D
- B and C are correct.

9Gd Chemical equations

- An ionic compound produced in a neutralisation reaction.
- a** potassium hydroxide + hydrochloric acid → potassium chloride + water
b Products – potassium chloride and water; reactants – potassium hydroxide and hydrochloric acid.
c potassium chloride
- H₂SO₄ should be labelled as follows H = hydrogen; 2 hydrogen; S sulfur; O oxygen; 4 oxygen.
- Aq (aqueous)
- MgCO₃ + H₂SO₄ → MgSO₄ + H₂O + CO₂
- The total mass of reactants is the same as the total mass of products because atoms cannot be created or destroyed.
- a** $2 \text{Mg(s)} + \text{O}_2\text{(g)} \rightarrow 2 \text{MgO(s)}$
b $\text{Mg(s)} + 2\text{HCl(aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$
c $\text{H}_2\text{SO}_4\text{(aq)} + 2\text{NaOH(aq)} \rightarrow \text{Na}_2\text{SO}_4\text{(aq)} + 2\text{H}_2\text{O(l)}$
- a** Either MgCl₂(aq) or Na₂SO₄(aq)
b Any from MgCl₂(aq) or Na₂SO₄ or MgO or NaOH
c NaOH

9Gd Standard form (WS)

- a** m
b nm
c mm
d cm
- a** Index or power.
b How many times to multiply something.
- a** 4³
b 10⁵
c 2⁴
d 10⁷
- 0.001
- 4.6 × 10⁹ years
- a** 6.5 × 10³ nm
b 6.5 × 10⁻³ mm
- Students' own answers.

9Ge Equilibria

- $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$
- Reactants are becoming products and products are becoming reactants at the same rate, or the rate of the forward and backwards reactions are the same.
- The percentages of different substances in the reaction mixture.
- a** anhydrous copper sulfate + water \rightleftharpoons hydrated copper sulfate (the reactants and products may be reversed)
b It turns blue.
c The forward reaction (where water is added) is exothermic and the reverse reaction (thermal decomposition) is endothermic.
- a** $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$
b Endothermic/energy is transferred to the substances that are reacting.
- a** Iodine vaporises (or becomes gas)/sublimation.
b hydrogen iodide
c By heating.

9Ge Frescoes

- a** calcium sulfate
b Calcium to sulfur to oxygen in the ratio 1:1:4.
- a** Graph with the temperature on the x-axis, labelled 'temperature ($^{\circ}\text{C}$)' and time for cross to disappear on y-axis, labelled 'time for cross to disappear (s)'. The scale should be linear and points plotted accurately. The line joining the points should be a smooth curve.
b The time taken for the cross to disappear decreases or the rate of the reaction increases.
c Increasing the temperature gives the particles more energy, so they collide more often and that increases the rate of reaction. Reference may also be made to the particles colliding with more energy, making a reaction more likely.

9I WORKBOOK ANSWERS

9Ia Moving things

- 1 **a** Friction acts to slow the movement down. Students should avoid using terminology such as 'tries to slow it down' if possible.
b Make the surfaces smoother; use a lubricant between the surfaces.
- 2 **a** food
b the Sun
c nuclear, Sun, light, chemical, chemical
Note that students are not expected to be able to provide full answers to this question at this stage in the unit.
- 3 **a** Large scissors act as longer levers, and help to magnify the force from your hands (the effort) to produce a larger force (load) where the card is to be cut. Accept any similar explanations.
b The energy is the same, because although it takes a smaller force to push the object up the ramp, the force has to move through a greater distance.
- 4 Students' own answers.

9Ia Forces and movement

- 1 accelerate, drag, balanced, resultant, friction, unbalanced
- 2 **a** C
b A
- 3 Any three from: speed it up; slow it down (or change speed); change direction; change shape.
- 4 **a** weight
b force from wind pushing on sails
c water resistance
- 5 2000 N. The upthrust balances the weight.
- 6 It increases, because more of the water has to be pushed out of the way each second.
- 7 Correct words are:
a 0, zero, accelerating, smaller
b 100, increasing, the same as before, accelerating, smaller than
c 200, equal to her weight, the same as before, falling at a constant speed, the same as

9Ib Energy for movement

- 1 chemical energy – food; gravitational potential energy – a box on a high shelf; kinetic energy – a football flying through the air; elastic potential energy – a stretched elastic band; internal energy – a pan of hot water; nuclear energy – energy stored inside atoms
- 2 Coal is made from the remains of plants. These plants originally got their energy from the Sun.
- 3 **a** As elastic potential (strain) energy in the bent bow.
b It is transferred to the arrow, where it is stored as kinetic energy.
- 4 **a** NR
b R
c R
d NR
e R
f NR
- 5 Correct words are: conservation, destroyed, useful, total, less, heating
- 6 As the swing moves, air resistance acts to slow it down. Some of the kinetic energy is transferred to the surroundings and ends up stored as thermal energy. There will also be friction between the moving and stationary parts of the swing.

9Ib Operating ships (STEM)

- 1 Most expensive: either rotors or solar cells are acceptable answers. The rotors are large and new technology. Solar cells and electric motors are both established technologies, but this system involves having two sets of engines to drive propellers, so might be expensive to install.
Least expensive: the kite is likely to be the cheapest solution. Acceptable reasons include: it is relatively small; it only has to be tethered to the ship rather than built into it.
- 2 **a** kite and rotors
b solar cells
- 3 Students' own responses. Refer to Student Book answers for the activity for possible comments.
- 4 **a** More hours of daylight in the summer, fewer in the winter.
b Sunshine will not feel as strong/intense as near the equator.
- 5 Any answer is acceptable as long as it is accompanied by sensible reasoning. However, the expected answer is spinning rotors, as the Baltic is too far north for solar power to be reliable and provide a lot of energy, and lots of stops are involved so launching and retrieving the kite for each leg would be time consuming.

9Ic Speed

- 1 m/s, km/h, mph
- 2 **a** $54 \text{ km} \div 9 \text{ h} = 6 \text{ km/h}$
b Unless the horse kept a constant speed throughout the whole journey, it would have been travelling faster than this some of the time and slower some of the time.
- 3 **a** Ali – that line is the steepest/that line shows him covering 100 m in the shortest time.
b Thom – that line becomes horizontal.
c Line added to graph joining (0, 0), (10, 40), (15, 40), (25, 100)
d **i** 100 m
ii 100 m in 20 s = 5 m/s
- 4 **a** 70 km/h
b 10 km/h
c Students' own responses.

9Ic Equations and graphs (WS)

- 1 **a** $40 \text{ km/h} \times 0.5 \text{ h} = 20 \text{ km}$
b $90 \text{ km} \div 60 \text{ km/h} = 1.5 \text{ h}$
- 2 **a, b** Calculate the gradient by finding the vertical distance between D and E (the distance moved) and the time between D and E; divide the distance by the time.
c vertical difference = $80 - 60 = 20 \text{ m}$
horizontal difference = $10 - 8 = 2 \text{ s}$
speed = $20 \text{ m} \div 2 \text{ s} = 10 \text{ m/s}$
- 3 vertical difference = $20 - 0 = 20 \text{ m}$
horizontal difference = $4 - 0 = 4 \text{ s}$
speed = $20 \text{ m} \div 4 \text{ s} = 5 \text{ m/s}$

9Ic Speed–time graphs (WS)

- 1 **a** C written on horizontal section of graph.
b I written on first two sections of graph.
c D written on last section of graph.
- 2 **a** $40 \text{ s} - 20 \text{ s} = 20 \text{ s}$
b distance = speed \times time = $40 \text{ m/s} \times 20 \text{ s} = 800 \text{ m}$
- 3 Lines added to graph joining points (0,5), (4,5), (4,20), (6,20), (6,0), (8,0). (8,10), (10,10)
Ensure that students' graphs have:
scales chosen to fill as much of the provided graph grid as possible
divisions on the scales evenly spaced
axes lines drawn in
numbers on the axes written in
axes titles, which include units
a title.
- 4 Students' own answers.

9ld Turning forces

- 1 distance multiplier – a lever where the load moves further than the effort.
effort – the force put on a lever or other simple machine.
force multiplier – a lever where the load is bigger than the effort.
fulcrum – a point about which something turns. Another name for pivot.
load – a weight or force being moved by a machine.
pivot – a point about which something turns. Another name for fulcrum.
- 2 From left to right: effort, effort distance, load distance, load
- 3 **a** Correct words are:
load, effort
effort, load
effort, load
b, c In a distance multiplier, the effort is bigger than the load, and the effort distance is smaller than the load distance. The effort moves further than the load. (Accept equivalent answers.)
- 4 **a** Any other force multiplier, such as scissors, nutcracker, crowbar, spade.
b Any other distance multiplier, such as legs, sugar tongs, fishing rod.

9ld Moments and equilibrium

- 1 turning, moment, force, pivot, metres
- 2 $20 \text{ N} \times 0.2 \text{ m} = 4 \text{ N m}$
- 3 **a** $500 \text{ N} \times 0.5 \text{ m} = 250 \text{ N m}$
b $200 \text{ N} \times 1.5 \text{ m} = 300 \text{ N m}$
c The moment of the effort is greater than the moment of the load.
- 4 It is balanced/not moving.

9le More machines

- 1 Any uses of pulleys, such as on cranes, in lifts, some weights machines in gyms, raising blinds (although these usually do not change the force required, only its direction).
- 2 Any uses of ramps, such as loading lorries or ships; emergency escape chutes from aeroplanes (which reduce the downward force on exiting passengers, so they do not hit the ground as fast); zig-zag roads up hillsides; wheelchair ramps into buildings (although this is also connected with the need for wheels to move easily on the ramp).
- 3 **a** $1000 \text{ N} \times 2 \text{ m} = 2000 \text{ J}$
b $500 \text{ N} \times 4 \text{ m} = 2000 \text{ J}$
- 4 **a** The force has to move further (accept 'because of conservation of energy').
b There will be some friction between the block and the ground as the block is pushed up the ramp. This means that the force needed will be a little more than 500 N, so the total energy transferred (work done) will be more than 2000 J.
c Students' own responses.

9le Supplying the energy

- 1 **a** Large scissors act as longer levers, and help to magnify the force from your hands (the effort) to produce a larger force (load) where the card is to be cut. Accept any similar explanations.
b, c Students' own answers.
- 2 **a** weight, air resistance
b They are the same size (but acting in opposite directions).
c It will increase, because they now have a bigger area/the parachute has a larger area.
d The increased air resistance will make them slow down. As they get slower, their air resistance decreases. They will reach a new terminal velocity when the air resistance is equal to their weight.
- 3 $1 \text{ min} = 1/60 \text{ hours} = 0.0167 \text{ h}$
 $\text{distance} = 200 \text{ km/h} \times 0.0167 \text{ h} = 3.34 \text{ km}$
- 4 **a** gravitational potential energy
b kinetic energy

9J WORKBOOK ANSWERS

9Ja Mission to mars

- 1
 - a Series
 - b Series, Parallel
 - c Series
 - d Parallel
 - e Parallel
 - f Series
- 2
 - a A cell and a complete circuit made of conducting material/wire.
 - b Using an ammeter connected in series in a circuit.
 - c The voltage from a cell pushes the current around the circuit. The voltage across a component is a measure of the energy transferred by the current to that component.
 - d Using a voltmeter connected across/in parallel to the cell or other component.
- 3 Students have only studied magnetic fields, and at this stage in the unit are not expected to know details of gravitational or electric fields, or to name electric fields.
Students should be able to give fuller answers when this question is revisited in **9Je**.
Full answers could include:
 - A gravitational field exists around all objects with mass. Objects with mass are attracted to each other.
 - An electric field exists around objects with an electric charge. Electric fields can attract other objects, and can attract or repel other charged objects.

9Ja Force fields

- 1
 - a Two bar magnets drawn with N and S ends together.
 - b Two bar magnets drawn with N and N together, or with S and S together.
- 2
 - a Closest to the poles of the magnet.
 - b At the sides of the magnet.
- 3 C
- 4
 - a C, D, A, B
 - b C has the biggest masses, closest to each other. D has a big mass and a small one, so the force will be greater than between the two small masses in A. B has the smallest masses furthest apart. Accept equivalent reasoning. A good answer will start with a statement that the force is greatest when the objects have a large mass and are close together.
 - c Students' own answers.
- 5 weight = mass \times gravitational field strength
= 50 kg \times 10 N/kg = 500 N

9Jb Static electricity

- 1 Left: nucleus; right (top to bottom): proton, neutron, electron.
- 2 They have the same number of positive and negative charges.
- 3 They are on the outside. The positive charges are inside the nucleus and cannot move.
- 4 **a** Electrons have moved from the cloth to the rod, leaving the cloth with more protons than electrons (or similar explanation).
b Same charge but with opposite sign.
c All the electrons lost from the cloth have moved to the rod.
- 5 **a** **i** Arrows drawn pointing towards each other; arrows should be of equal size.
ii, iii Arrows drawn pointing away from each other; arrows should be of equal size.
b Students' own responses.
- 6 The way a positive charge would move.

9Jc Current electricity

- 1 **a** ammeter
b volt
c (electric) current
d voltage (or potential difference)
e amp (or ampere)
f voltage (or potential difference)
g series circuit
- 2 A cell/power supply; a continuous loop of wire.
- 3 **a** It will increase, because it is easier for the current to go through one bulb than through two or because the resistance is less.
b It will be brighter, because the current is bigger
- 4 When all three switches are closed, the current through the extra two bulbs will be the same as the current through the single bulb when only one switch is closed. The current in the main part of the circuit/through the cell will be three times the original amount.
- 5 **a** **i** Switch added in the top part of the circuit, near the cell.
ii Voltmeter shown connected across the cell; 4 V written next to it.
iii Voltmeter shown connected across bulb C; 4 V written next to it.
iv Ammeter added in the top part of the circuit, where it will measure the current through the cell; 0.6 A written next to it.
v Ammeter drawn in the part of the circuit that includes bulb A.
b It will show 0.2 A, because the current flowing in the main part of the circuit/through the cell divides up to go through the different parallel branches (or similar explanation).
- 6 **a** 6 V; the voltage of the cell is divided between the components in a series circuit
b **i** B
ii C
- 7 **a** It will increase/it will double.
b They will both double (OR the bulb will have 8 V and the motor 4 V across them), because the higher voltage of the cell is divided between the components in the same ratio.

9Jc Working with electricity (STEM)

- 1 A wire should have a very low resistance. If the resistance is high, there is probably a break in the wire.
- 2 Electric shock, causing fires.
- 3 **a** Possible reasons include: broken bulb(s), faulty/broken wires, poor connections between wires and components, faulty switch, flat cells.
b Students' own responses. The most likely faults are probably broken bulbs or flat batteries.
c Equipment could include multimeter, working cell, working bulb, connecting wires.
d Students' own answers.

9Jd Resistance

- 1 **a** amps
b volts
- 2 **a** **i** correct
ii wrong
iii wrong
iv correct
v correct
vi wrong
b **ii** Change 'increased' to 'decreased'.
iii Change one 'higher' to 'lower'.
vi Change 'low' to 'high', or change 'insulating' to 'conducting'.
- 3 Any three insulators, such as glass, plastic, wood.
- 4 **a** From top to bottom: 4, 1, 5, 3, 2.
b For the three long wires, the thinnest one has the highest resistance, and the thickest one the lowest. The two shorter, thick wires have lower resistances than the long, thick wire.

9Jd Calculating resistance

- 1 ohms, Ω
- 2 Correct words are: increase, increase, low, low.
- 3 voltage = $5 \text{ A} \times 20 \Omega = 100 \text{ V}$
- 4 current = $15 \text{ V} / 5 \Omega = 3 \text{ A}$
- 5 resistance = $18 \text{ V} / 3 \text{ A} = 6 \Omega$
- 6 B has the higher resistance. For any particular voltage, B has the lower current flowing through it, so it must have the higher resistance.

9Jd Rounding numbers (WS)

- 1 **a** **i** 3
ii 1
iii 2
b **i** 4
ii 1
iii 4
- 2 **a** 0.3 kg
b 0.258 kg
- 3 Any two between 0.65 A and 0.74 A. (Note that the upper limit could actually be 0.7499999 recurring – but the examples in the text are only given to 2 d.p. so 0.74 is acceptable as an answer.)

4 a, b A possible answer is:

Count the first three figures in A, then look at the next figure. If this is 5 or more, increase the 3rd figure. Add enough zeroes to make sure the first number is still in the millions position.

Do the same for B, but count from the first number after the zeroes.

c A = 5 240 000 to 3 s.f.

B = 0.001 58 to 3 s.f.

5 a 500 000 kg to 1 s.f.

b 510 000 kg to 2 s.f.

c Engineers working out fuel needed or how long to fire the engines would use the accurate value. Journalists or reporters might use one of the rounded values.

9Je Electromagnets

1 a Change the direction of the current.

b Increase the size of the current.

2 a N written near the top of the coil (Note that this question is a revision from 9Ja.)

b The lines are closest together.

c Increase the number of coils of wire; increase the current; use a core made of a magnetic material.

3 a When a current flows in the low current circuit, the coil becomes an electromagnet and attracts the iron block. This closes the contacts on the high current circuit and allows a current to flow there. Relays are used for safety/so people can switch on a high current without touching any part of the high current circuit.

b Students' own responses.

4 a M written on each magnet.

b C written on each brush.

c To make an electrical contact between the circuit/power supply and the moving coil.

d So the current changes direction every half turn.

5 a motor effect

b Change the direction of the current; change the direction of the magnetic field.

c Use a bigger current; use stronger magnets/a stronger magnetic field.

6 a Make it go faster because a larger current will produce a bigger force.

b Make it go slower because a weaker field will produce a smaller force.

c Make the coil spin in the opposite direction because changing the current will change the direction of the force.

9Je Humans in space

1 a To control/limit the current in a circuit.

b Measure the current flowing through it and the voltage across it. Use the formula $\text{resistance} = \text{voltage}/\text{current}$ to calculate the resistance.

2 $\text{voltage} = 4 \text{ A} \times 20 \text{ } \Omega = 80 \text{ V}$

3 Electrons from the rod are transferred to the cloth.

4 a A coil of wire on a core made from magnetic materials, and a magnetic field produced by permanent magnets or electromagnets.

b Increase the current in the coil; increase the strength of the magnetic field.

5 a A gravitational field exists around all objects with mass. Objects with mass are attracted to each other.

An electric field exists around objects with an electric charge. Electric fields can attract other objects, and can attract or repel other charged objects.

b Students' own answers.

9K WORKBOOK ANSWERS

9Ka Physicists

- a** a question, hypothesis, prediction, investigation, data

b A new hypothesis is needed.

c The hypothesis is accepted as correct.
- Astronomers can only make observations as they cannot carry out investigations. Particle physicists carry out practical investigations and are not limited to only making observations.
- a** experiment

b observation

c observation

d experiment

e observation
- a** Survey the rocks in different mountains and record their heights. See if there is a correlation between rock type and height.

b Students' own answers.

9Ka Differences

- a** A cell or power pack.

b How much energy is being transferred by the component (for a given current).
- The air in the room is warmer than the drink, so energy is transferred from the air to the drink until both are at the same temperature.
- a** latent heat

b In order: 4, 1, 5, 2, 3

c A

d A line rising towards the dashed line, going along the line for a time and then rising again.
- expands; increase; density; liquid; less; rise; convection
- a** both

b latent heat

c both

d specific heat capacity
- At night the land cools down faster than the sea because it has a lower specific heat capacity, so the air above the land is cooler than the air above the sea. The air above the sea is less dense than the air above the land, and so it tends to rise and create lower air pressure over the sea. Air above the land is at higher pressure, so it flows out over the sea. The breeze blows from land to sea, and is called a land breeze.
- Students' own answers.

9Kb Fields

- 1 **a** gravitational potential energy = $80 \text{ kg} \times 1500 \text{ m} \times 10 \text{ N/kg} = 1\,200\,000 \text{ J}$
b The energy of the skydiver will be greater, because the value for g on Earth is higher than g on the Moon (or because gravity is stronger on the Earth than on the Moon).
- 2 **a** A mass anywhere in the field would move towards the centre of the Earth. The field is stronger closer to the Earth.
b How strong the force is (quantitatively).
- 3 **a** electric field
b The direction a positive charge would move.
c The lines are closer together where it is strongest.
d Students' own answers.

9Kc Cause and effect

- 1 B, because this person uses data from experiments to form ideas and to test them.
- 2 **a** When two things happen together/or when two variables appear to be linked/when a graph of two variables gives a line.
b No. The apparent link might be coincidence, or might be caused by some other variable connected to both of them.
c Try to find out how one variable could affect the other.
- 3 **a** The weight of the mass has produced a downward force on the bottom of the spring, which has stretched it.
b If the mass is no longer moving, there must be an upward force on it that exactly balances its weight.
c Equal sized up and down arrows added to the diagram.

9Kd Links between variables

- 1 **a** i A, B, D
ii A
iii C
b Students' own answers.
- 2 **a** direct proportion
b inverse proportion
c inverse proportion
d direct proportion
- 3 A directly proportional relationship produces a straight line on a graph that passes through (0,0).
An inversely proportional relationship produces a curve with a particular shape. It is easier to see if a line is straight than to see whether a curve is exactly the right shape.

9Kd Information from graphs (WS)

- 1 **y** – pressure
x – temperature
m – the gradient of the line (accept the change in pressure for each degree change in temperature)
c – pressure at 0 °C (or the point where the line crossed the **y**-axis/pressure axis)
- 2 **a** linear
b **x** is the force on the spring, **y** is the length of the spring, **m** is the gradient of the line (which tells you how stiff the spring is), and **c** is the unstretched length of the spring. For **m**, accept an answer in terms of the extra extension for each additional newton of force applied to the spring.
- 3 **a** 1.5 and 2 hours
b 0 and 0.5 hours; the line is the steepest
c speed = distance/time = 50 km/1 hour = 50 km/h

9Kd Speed–time graphs (WS)

- 1 **a** C marked next to the three horizontal sections of the line.
b SU marked on the first sloping section.
c SD marked on the three downward sloping sections.
- 2 **a** 50 km/h
b Just after the 2 hour point.
c Line joining (0,0), (1, 80), (4,80), (5,120)
- 3 **a** **i** C the acceleration
ii B 50 m
iii B 25 m
iv C 6.25 m/s (Total distance travelled = 50 m + 50 m + 25 m = 125 m; in 20 s; 125/20 = 6.25 m/s)
b Students' own responses.

9Ke Models

- 1 **a** lunar eclipse – When the Moon moves into the shadow of the Earth.
partial eclipse – An eclipse when the Moon only blocks light from part of the Sun.
solar eclipse – When the Moon is between the Sun and the Earth, and casts a shadow on part of the Earth.
total eclipse – An eclipse when the Moon completely blocks out light from the Sun.
b Any sensible suggestion, such as two balls and a light source, arranged to represent the Sun, Moon and Earth.
- 2 **a** It is an abstract model.
b Diagram similar to diagram B in the Student Book, but with the Moon on the side of the Earth furthest from the Sun.
c, d, e Students' own answers.
- 3 Possible answers include: 9La Differences – graph B (abstract); 9Lb Fields – formula for GPE (abstract), field diagrams (abstract); 9Lc Cause and effect – force arrows on diagrams (abstract); 9Ld Links between variables & Information from graphs – graphs (abstract), formulae (abstract); 9Le Models – eclipse with lamp and model Earth/Moon (physical), ball used to model an atom (physical).

9Ke Atom and wave models

- 1 **a** Particle theory/states of matter. Accept chemical reactions, or any other sensible suggestion where atoms can be modelled as solid spheres.
b Static electricity.
- 2 **a** The lines of the waves bouncing off a surface like a wall.
b The waves changing direction or bending.
c We can hear echoes.
- 3 Sound waves are longitudinal; waves on the surface of water are transverse. Sound waves travel from a source in three dimensions; the waves on the water surface travel only in two dimensions.
- 4 **a** true
b true
c false
d false

9Ke Computer game design (STEM)

- 1 Students' own answers.
- 2 **a, b** Student's own answers. For example:
For the concept:
We will show: a drawing of the two main characters.
The statement will be: these characters appeal to me.

9Ke Physics research

- 1 **a** basic
b applied
c basic
d applied
e applied
f basic
- 2 **a** They need to gather data to check/test their models.
b When water condenses it releases latent heat.
- 3 **a** Correlation is when one variable changes as another changes. Causation is when it can be shown that the change in one variable causes the change in the other.
b Students' own answers.