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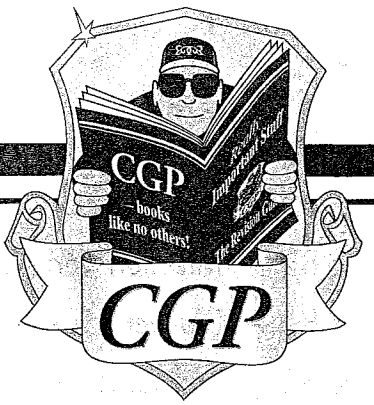

GCSE Combined Science

For AQA (Grade 9-1)

New!

Exam Practice Answer Book

Foundation Level

For the new AQA Trilogy course.

Contents

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Answers

Topic B1

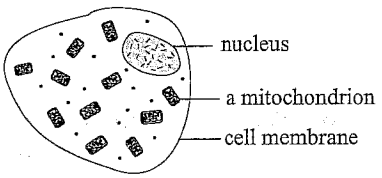
Topic B1 — Cell Biology

Page 1 — Cells

Warm-Up

These cells have a nucleus. — Eukaryotic cells
These are the smallest type of cells. — Prokaryotic cells
These cells can be bacteria. — Prokaryotic cells

1.1



[3 marks — 1 mark for each correct label]

1.2 Cell membrane — controls what goes in and out of the cell *[1 mark]*.
Mitochondria — where most aerobic respiration happens *[1 mark]*.
Nucleus — controls what the cell does / contains genetic material *[1 mark]*.

1.3 E.g. cytoplasm *[1 mark]*, ribosomes *[1 mark]*.

1.4 There is no cell wall/vacuole. / There are no chloroplasts. *[1 mark]*

Page 2 — Microscopy

1.1 24 mm *[1 mark]*

1.2 $24 \div 0.012 = \times$ **2000** *[1 mark]*

2.1 real size = 10 mm ÷ 1000 = **0.01 mm** *[1 mark]*

2.2 1 mm = 1000 µm
0.01 mm × 1000 = **10 µm**
[1 mark. Allow 1 mark for an incorrect answer to 2.1 × 1000.]

2.3 Electron microscopes have a higher magnification and resolution than light microscopes *[1 mark]*.

2.4 E.g. more subcellular structures can be seen under an electron microscope. / Subcellular structures can be seen with greater detail. *[1 mark]*

Page 3 — More on Microscopy

1.1 To make the specimen easier to see *[1 mark]*.

1.2 × 4 *[1 mark]*

Remember, you should always start with the objective lens with the lowest magnification — this makes it easier to get your specimen into view.

1.3 They bring the sample into focus by moving the stage up and down *[1 mark]*.

1.4 She should select the × 40 or × 10 objective lens *[1 mark]* and use the adjustment knobs to bring the sample back into focus *[1 mark]*.

1.5 Any two from: e.g. she should use a pencil with a sharp point. / She should make sure her drawing takes up at least half of the space available. / She should not colour or shade her diagram. / She should include a title. / She should write down the magnification that it was observed under. / She should label the important features of her drawing using straight, uncrossed lines.
[2 marks — 1 mark for each correct answer]

Page 4 — Cell Differentiation and Specialisation

Warm-Up

differentiation

1 root hair cell — Long, hair-like shape. They absorb water and mineral ions.
xylem — Long hollow cells joined end to end.
They transport water.
phloem — Long cells joined end to end, with very few subcellular structures. They transport food.
[2 marks for all three correct answers, otherwise 1 mark for one correct answer]

2.1 To carry the male DNA to the egg *[1 mark]*.

2.2 The tail helps the sperm to swim to the egg *[1 mark]*.

2.3 Mitochondria give the sperm energy for swimming *[1 mark]*.

Page 5 — Chromosomes and Mitosis

1.1 The chromosomes are being copied *[1 mark]*.

1.2 The number of mitochondria is increasing *[1 mark]*.

1.3 The cytoplasm is dividing *[1 mark]*.
The cell membrane is dividing *[1 mark]*.

1.4 They are genetically identical *[1 mark]*.

Page 6 — Stem Cells

1.1 A stem cell is an undifferentiated cell *[1 mark]*.

1.2 meristems *[1 mark]*

1.3 E.g. rare species can be cloned to prevent them from being wiped out. Crop plants with useful features (e.g. plants that aren't killed by a disease) can be grown quickly/cheaply.
[2 marks — 1 mark for each correct answer]

2.1 E.g. diabetes / paralysis *[1 mark]*

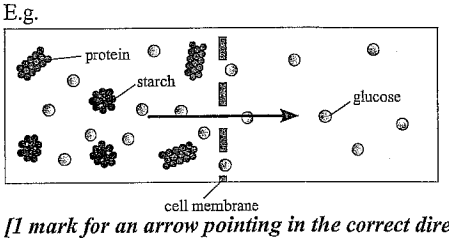
2.2 E.g. human embryos *[1 mark]*

2.3 E.g. some people think embryos shouldn't be used for research because each one could be a human life *[1 mark]*.

2.4 E.g. the stem cells may become infected with a virus that may then be passed on to the patient *[1 mark]*.

Page 7 — Diffusion

1.1 E.g.



[1 mark for an arrow pointing in the correct direction.]

Remember, molecules diffuse from an area of higher concentration (where there are more of them) to an area of lower concentration (where there are fewer of them).

1.2 They are too big to fit through the membrane *[1 mark]*.

1.3 A decrease in the concentration gradient will decrease the rate of diffusion *[1 mark]*.

2.1 The ink will diffuse / spread out through the water *[1 mark]*.
This is because the ink particles will move from where there is a higher concentration of them (the drop of ink) to where there is a lower concentration of them (the surrounding water) *[1 mark]*.

2.2 The ink particles will diffuse/spread out faster *[1 mark]*.

Page 8 — Osmosis

1.1 water *[1 mark]*, less *[1 mark]*, more *[1 mark]*

1.2 A plant is absorbing water from the soil *[1 mark]*.

2.1 $\frac{(6.58 - 5.73)}{5.73} \times 100$
= **14.8 %** (3 s.f.) *[2 marks for the correct answer, otherwise 1 mark for correct working.]*

2.2 The concentration of the salt solution in beakers 4 and 5 must have been higher than the concentration of the solution inside the potato cells *[1 mark]* so the chips lost mass as water moved out of the cells by osmosis *[1 mark]*.

Page 9 — Active Transport

1.1 The movement of a substance from a less concentrated solution to a more concentrated solution (against a concentration gradient) *[1 mark]*.

1.2 For energy/respiration *[1 mark]*.

1.3 It needs energy from respiration *[1 mark]*.

2.1 For healthy growth *[1 mark]*.

2.2 Because the concentration of minerals is usually higher inside the plant cells than in the soil (outside the plant cells) *[1 mark]* so the minerals won't move into the plant cells by diffusion *[1 mark]*.

2.3 Active transport occurs against a concentration gradient but diffusion occurs down a concentration gradient *[1 mark]*. Active transport needs energy from respiration but diffusion doesn't *[1 mark]*.

Topic B2

Page 10 — Exchanging Substances

Warm-Up
1 — blue whale, 2 — tiger, 3 — bacterium
1.1 125 μm^3 ***[1 mark]***
The volume of a cube is just length × width × height (5 × 5 × 5 in this case).
1.2 150 μm^2 ***[1 mark]***
The surface area of a cube is the area of one face (length × width) × the number of faces. So here it is (5 × 5) × 6.
1.3 3:1 ***[1 mark]***
The surface area of the cube is 24 μm^2 and the volume is 8 μm^3. This gives the cube a surface area to volume ratio of 24:8. To get the answer here, you need to simplify the ratio by dividing both sides by the volume.
2 The Arctic hare ***[1 mark]*** because it is smaller than the polar bear ***[1 mark]***. This means it will have a larger surface area to volume ratio, so it will lose heat the fastest ***[1 mark]***.

Pages 11-12 — More on Exchanging Substances

Warm-Up
a thin membrane, a large surface area, a good blood supply, being ventilated
1 Villi increase the surface area of the small intestine ***[1 mark]***.
2.1 A = carbon dioxide ***[1 mark]***
B = oxygen ***[1 mark]***
2.2 diffusion ***[1 mark]***
2.3 gases a short distance to move — the walls of the alveoli are thin ***[1 mark]***
a large surface area — lots of alveoli ***[1 mark]***
3.1 Oxygen diffuses from the water into the blood ***[1 mark]***.
Carbon dioxide diffuses from the blood into the water ***[1 mark]***.
3.2 They give a large surface area for gas exchange ***[1 mark]***.
3.3 E.g. it has a good blood supply ***[1 mark]***, which speeds up diffusion ***[1 mark]***. / It has a thin layer of surface cells ***[1 mark]***, which means gases only have a short distance to diffuse ***[1 mark]***.
4 How to grade your answer:
Level 0: There is no relevant information. ***[No marks]***
Level 1: Adaptations of the leaf for gas exchange are described but not explained. ***[1 to 2 marks]***
Level 2: A full explanation is given of the different adaptations of the leaf for gas exchange. ***[3 to 4 marks]***
Here are some points your answer may include:
The lower surface of the leaf is a gas exchange surface.
It is covered in small holes called stomata.
Gases (such as carbon dioxide and oxygen) diffuse into and out of the leaf through the stomata.
The leaf has a flattened shape.
This increases its surface area for gas exchange.
The walls of the cells inside the leaf are another gas exchange surface.
Air spaces inside the leaf increase the area of this surface for gas exchange.

Topic B2 — Organisation

Page 13 — Cell Organisation

Warm-up
Organ system – 4, Tissue – 2, Cell – 1, Organ – 3
1.1 X — liver ***[1 mark]***
Y — large intestine ***[1 mark]***
Z — small intestine ***[1 mark]***
1.2 A group of different tissues that work together to perform a certain function ***[1 mark]***.
1.3 A group of organs working together to perform a function ***[1 mark]***.
1.4 A group of similar cells that work together to carry out a function ***[1 mark]***.
1.5 It breaks down and absorbs food ***[1 mark]***.

Page 14 — Enzymes

1.1 active site ***[1 mark]***
1.2 B ***[1 mark]***
Remember, the substrate has to fit into the active site (like a key fitting into a lock).
2.1 The rate of reaction increases as temperature increases ***[1 mark]***.
2.2 The temperature is too high ***[1 mark]***, so the enzyme has been denatured / has changed shape so that the substrate no longer fits in the active site ***[1 mark]***. This means the enzyme will no longer catalyse the reaction ***[1 mark]***.

Page 15 — Investigating Enzymatic Reactions

1.1 Amylase helps to break down starch into sugar ***[1 mark]***.
1.2 The iodine solution will turn from browny-orange ***[1 mark]*** to blue-black ***[1 mark]***.
2.1 E.g. by using a water bath ***[1 mark]***.
2.2

Test tube	Time (s)	Rate of reaction
X	110	9.1
Y	40	**25**
Z	190	**5.3**

[2 marks — 1 mark for each correct answer]
2.3 per second (s^{-1}) ***[1 mark]***

Page 16 — Enzymes and Digestion

1.1 carbohydrate — sugars ***[1 mark]***
lipid — glycerol ***[1 mark]*** + fatty acids ***[1 mark]***
protein — amino acids ***[1 mark]***
1.2 lipids ***[1 mark]***
1.3 E.g. pancreas ***[1 mark]***, small intestine ***[1 mark]***
2.1 Bile is produced by the **liver**. It is stored in the **gall bladder**. It has an **alkaline** pH, so it **neutralises** acid from the stomach. It also **emulsifies** fats.
[5 marks — 1 mark for each correct answer in bold.]
2.2 Tiny droplets will have a larger surface area for enzymes to work on ***[1 mark]***.

Page 17 — Food Tests

Warm-up
Benedict's test should be ticked.
1 Benedict's — turns brick-red ***[1 mark]***
Biuret — turns pink or purple ***[1 mark]***
2 How to grade your answer:
Level 0: There is no relevant information. ***[No marks]***
Level 1: There is a brief description of how the sample could be prepared or tested for protein. ***[1 to 2 marks]***
Level 2: There is some description of how the sample could be prepared and tested for protein, but some details are missing. ***[3 to 4 marks]***
Level 3: There is a clear and detailed description of how the sample could be prepared and tested for protein. ***[5 to 6 marks]***
Here are some points your answer may include:
To prepare a sample, the student could first break up the beans using a pestle and mortar.
He could then dissolve the mixture in distilled water.
Finally, he could filter out any solid bits using a filter funnel lined with filter paper.
To test for proteins in the sample, the student should add biuret solution to the sample.
He should then mix the contents by gently shaking the test tube.
If the beans contain protein, the solution will change from blue to pink or purple.

Page 18 — The Lungs

1.1 trachea ***[1 mark]***
1.2 bronchus ***[1 mark]***

Topic B2

2 Breathing rate = 495 ÷ 12 = 41.25
= **41.3** breaths per minute (3 s.f.)
[2 marks for the correct answer written to 3 s.f., otherwise 1 mark for 41.25.]

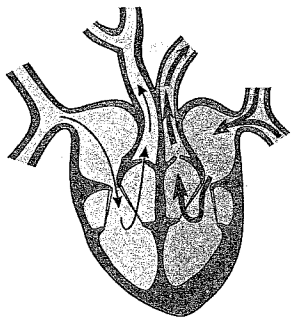
3

	Oxygen concentration	Carbon dioxide concentration
X	High	Low
Y	Low	**High**
Z	**High**	**Low**

[3 marks — 1 mark for each correct answer.]

Page 19 — Circulatory System — The Heart

1.1 pulmonary artery *[1 mark]*
1.2 C *[1 mark]*
1.3 E.g.



[1 mark for an arrow or arrows indicating the direction of blood flow into and out of the heart as shown.]
2.1 It controls the resting heart rate *[1 mark]*.
2.2 E.g. because they have an irregular heartbeat *[1 mark]*.
3 Because it consists of two circuits joined together *[1 mark]*. The first circuit pumps deoxygenated blood to the lungs to take in oxygen (and returns oxygenated blood to the heart) *[1 mark]*. The second circuit pumps oxygenated blood around all the other organs of the body (and returns deoxygenated blood to the heart) *[1 mark]*.

Page 20 — Circulatory System — Blood Vessels

1 A *[1 mark]*
Reason: e.g. A has much thicker walls than either B or C, so it's more likely to be an artery *[1 mark]*.

2.1

Feature	Capillary	Artery	Vein
Elastic fibres in blood vessel walls		✓	
Large lumen			✓
Thin walls, with gaps between the cells	✓		
Valves			✓

[3 marks — 1 marks for each column in the table correctly filled in]
2.2 To carry blood close to every cell in the body *[1 mark]*, so that substances can be exchanged with them *[1 mark]*.
2.3 Because they have different functions *[1 mark]*. Arteries carry blood away from the heart at high pressure, while veins carry blood back to the heart at a lower pressure *[1 mark]*.

Page 21 — Circulatory System — Blood

1.1 nucleus *[1 mark]*
1.2 plasma *[1 mark]*
1.3 platelets *[1 mark]*
2.1 It gives them a large surface area for absorbing oxygen *[1 mark]*.
2.2 This increases the space available for carrying oxygen in the cell *[1 mark]*.
2.3 E.g. they contain haemoglobin *[1 mark]*.

Page 22 — Cardiovascular Disease

Warm-up
heart, blood vessels (in any order)
1.1 They lower blood cholesterol levels *[1 mark]*.
1.2 E.g. statins must be taken regularly over a long time but a person could forget to take them. / Statins can cause unwanted side effects. / It takes time for their effect to work. *[1 mark]*
2.1 Stents are put inside coronary arteries to keep them open *[1 mark]*. This allows blood carrying oxygen to reach the heart muscle *[1 mark]*.
2.2 E.g. that the patient could have a heart attack during the operation / develop an infection after the surgery / develop blood clots near the stent *[1 mark]*.

Page 23 — More on Cardiovascular Disease

1.1 Leaky heart valves allow blood to flow in both directions through the heart *[1 mark]*.
1.2 E.g. a valve might not open properly *[1 mark]*.
1.3 E.g. the surgeons could replace the valve with another biological valve / a valve from another human/mammal. / The surgeons could replace the valve with a mechanical valve *[1 mark]*.
2.1 Because they have heart failure *[1 mark]*.
2.2 E.g. artificial hearts are less likely to be attacked by the body's immune system than a donor heart *[1 mark]*.
2.3 E.g. artificial hearts don't work as well as healthy donor hearts. / Blood doesn't flow through artificial hearts as smoothly as through natural hearts, which can cause blood clots. / Unlike with natural hearts, a patient with an artificial heart has to take drugs to thin their blood, which can mean they bleed more than usual if they have an accident. *[1 mark]*

Page 24 — Health and Disease

1.1 A state of physical and mental wellbeing *[1 mark]*.
1.2 Any two from: e.g. a poor diet. / Being under constant stress. / Your life situation.
[2 marks — 1 mark for each correct answer.]
1.3 Only communicable diseases can spread between people *[1 mark]*.
2.1 The immune system helps to fight off pathogens *[1 mark]*. So having a weakened immune system will mean that they are more likely to be infected with other pathogens / develop communicable diseases *[1 mark]*.
2.2 E.g. a pathogen may cause an immune system reaction that leads to an allergic reaction. / Some viruses can lead to certain types of cancer. *[1 mark]*
2.3 A communicable disease because it can spread between people / it is caused by a pathogen *[1 mark]*.

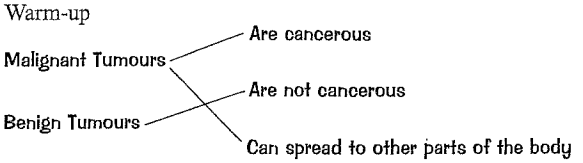
Page 25 — Risk Factors for Non-Communicable Diseases

1.1 Risk factors are things that are linked to an increased chance of getting a certain disease *[1 mark]*.
1.2 E.g. parts of a person's lifestyle *[1 mark]*. Substances in the body *[1 mark]*.
1.3 E.g. type 2 diabetes *[1 mark]*
2.1 Any two from: e.g. a high fat diet / a lack of exercise / smoking *[2 marks — 1 mark for each correct answer]*.
2.2 E.g. it can be expensive for individuals if they have to move/ adapt their home. / If someone has to give up work because of a non-communicable disease, their income will reduce. *[1 mark]*
2.3 E.g. a reduction in the number of people able to work may affect a country's economy. / The cost of researching / treating non-communicable diseases is huge. *[1 mark]*

Topic B3

Page 26 — Cancer

Warm-up



1.1 E.g. smoking *[1 mark]*.
1.2 E.g. genetic factors / having genes that make you more likely to get cancer *[1 mark]*.
2.1 uncontrolled cell division *[1 mark]*
2.2 Cells can break off from malignant tumours and travel in the bloodstream *[1 mark]*. Secondary tumours form when cells get into healthy tissues and form tumours *[1 mark]*.

Page 27 — Plant Cell Organisation

1.1 epidermal — covers the upper and lower surface of the leaf *[1 mark]*
meristem — causes growth at the tips of roots and shoots *[1 mark]*
xylem — transports water into the leaf *[1 mark]*
1.2 A *[1 mark]*
2.1 They get more light near the top of the leaf *[1 mark]*, which the cells need to carry out photosynthesis *[1 mark]*.
2.2 E.g. they have lots of chloroplasts *[1 mark]*.
2.3 spongy mesophyll *[1 mark]*

Page 28 — Transpiration and Translocation

Warm-up
A: phloem tube
B: xylem tube
1.1 mineral ions *[1 mark]*, water *[1 mark]*
1.2 It moves sugar around the plant *[1 mark]*.
2 The process by which water is lost from a plant is called **transpiration**. It is caused by the **evaporation** and diffusion of water from a plant's surface. The transport of sugars around the plant is called **translocation**.
[3 marks — 1 mark for each correct answer in bold.]

Page 29 — Transpiration and Stomata

1.1 X = stomata *[1 mark]*
Y = guard cells *[1 mark]*
1.2 They are responsible for opening and closing the stomata *[1 mark]* in order to control gas exchange and water loss from a leaf *[1 mark]*.
2.1 $2.0 + 1.8 + 2.3 + 1.9 + 1.7 = 9.7$
$9.7 \div 5 = 1.94 =$ **1.9** (2 s.f.) *[2 marks for correct answer, otherwise 1 mark for mean = 1.94]*
2.2 The greater the air flow around the plant, the greater the transpiration rate *[1 mark]*.
2.3 E.g. increasing air flow means that more water vapour is swept away from the plant / reduces the concentration of water vapour outside the leaves *[1 mark]*. This increases the rate of diffusion of water out of the leaves *[1 mark]*.

Topic B3 — Infection and Response

Page 30 — Communicable Disease

Warm-up
'insects' should be circled
1 A microorganism that causes disease *[1 mark]*.
2.1 E.g. they can be killed / their habitats can be destroyed to stop them from breeding *[1 mark]*.
2.2 E.g. be hygienic/wash hands / isolate infected individuals / get vaccinated *[1 mark]*.
3.1 A communicable disease is a disease that can spread (between people and/or animals) *[1 mark]*.
3.2 The cold virus/pathogen is carried in the droplets made when he coughs/sneezes *[1 mark]*. A tissue will catch the droplets, so other people don't breathe them in *[1 mark]*.

Page 31 — Bacterial Diseases

1.1 toxins *[1 mark]*
1.2 E.g. eating food products from animals that were infected with *Salmonella* bacteria when they were alive *[1 mark]*. Eating food that has been made in unclean conditions / made in conditions where the bacteria are present *[1 mark]*.
1.3 The vaccination prevents the spread of the disease in poultry *[1 mark]*. This means that the poultry that humans eat won't be contaminated with the *Salmonella* bacteria *[1 mark]*.
2.1 Through sexual contact *[1 mark]*.
2.2 E.g. pain when urinating *[1 mark]*. A thick yellow or green discharge from the vagina *[1 mark]*.
2.3 penicillin *[1 mark]*
2.4 Strains of the gonorrhoea bacteria have become resistant to it *[1 mark]*.
2.5 condoms *[1 mark]*

Page 32 — Viral Diseases

1.1 fever *[1 mark]*, red skin rash *[1 mark]*
1.2 a vaccination *[1 mark]*
2.1 E.g. tomato plant *[1 mark]*
2.2 C *[1 mark]*
Tobacco mosaic virus causes a mosaic pattern of discolouration on the leaves of the plant, so there would be discoloured patches, rather than the whole leaf turning yellow or falling off.
3.1 antiretroviral drugs *[1 mark]*
3.2 the immune system *[1 mark]*
3.3 Viruses reproduce inside cells *[1 mark]*. Eventually, this causes the cell to burst open *[1 mark]*.

Page 33 — Fungal and Protist Diseases

Warm-up
protist, vectors, fever
1.1 rose black spot *[1 mark]*
1.2 In water / by the wind *[1 mark]*.
1.3 Treat the disease using fungicides *[1 mark]*. Strip the affected leaves off the plant *[1 mark]* and then destroy these leaves *[1 mark]*.

Page 34 — Fighting Disease

1 Some white blood cells engulf and **digest** pathogens. This is called **phagocytosis**. Other white blood cells produce proteins that lock onto invading pathogens. These proteins are called **antibodies**.
[3 marks — 1 mark for each correct answer.]
2 How to grade your answer:
Level 0: There is no relevant information. *[No marks]*
Level 1: There is a brief mention of one or two defences which reduce the number of pathogens entering the body. *[1 to 2 marks]*
Level 2: There is some explanation of how at least three of the body's defences reduce the number of pathogens entering the body. *[3 to 4 marks]*
Level 3: There is a full and clear explanation of how at least four defences reduce the number of pathogens entering the body. *[5 to 6 marks]*
Here are some points your answer may include:
The skin stops pathogens entering the body.
It also releases substances that kill pathogens.
Nose hairs trap particles that could contain pathogens.
This reduces the number of pathogens that can enter the airways through the nose.
The trachea and bronchi secrete mucus to trap pathogens.
The mucus is then swept up to the back of throat (where it can be swallowed) by tiny hair-like structures called cilia. This further reduces the number of pathogens entering the airways.
The stomach produces hydrochloric acid, which kills pathogens that have been swallowed.

Topic B4

Page 35 — Fighting Disease — Vaccination

Warm-up
To stop them getting ill in the future.

1.1 dead or inactive pathogens *[1 mark]*
1.2 They should produce antibodies *[1 mark]*.
2 Antibody production after infection in the vaccinated child happens much faster than in the unvaccinated child *[1 mark]* and more antibodies are also produced *[1 mark]*.

Page 36 — Fighting Disease — Drugs

Warm-up
heart conditions, foxgloves

1.1 Yes, because antibiotics don't destroy viruses *[1 mark]*.
1.2 E.g. a painkiller *[1 mark]*
2.1 The number of antibiotic-resistant infections increased between 2013 and 2015 *[1 mark]*.
2.2 E.g. antibiotic-resistant infections are hard to treat *[1 mark]* so if the trend continues more people may die from bacterial infections / more people may suffer serious effects from bacterial infections *[1 mark]*.

Page 37 — Developing Drugs

1.1 cells, tissues and live animals *[1 mark]*
In preclinical trials, animals are used to test the drug on a whole body or multiple body systems, so the animal needs to be alive. You wouldn't want to test on humans at this stage, just in case the drug is dangerous.
1.2 toxicity *[1 mark]*, dosage *[1 mark]*
1.3 A substance that's like the drug being tested but doesn't do anything *[1 mark]*.
1.4 So that doctors are able to compare the two groups *[1 mark]* to see if the drug makes a real difference to their condition *[1 mark]*.
1.5 C *[1 mark]*

Topic B4 — Bioenergetics

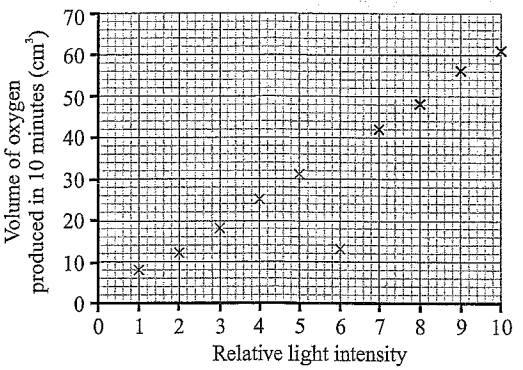
Page 38 — Photosynthesis

1.1 starch — storage *[1 mark]*, fats and oils — storage *[1 mark]*, amino acids — making proteins *[1 mark]*, cellulose — making cell walls *[1 mark]*
1.2 respiration *[1 mark]*
2.1 chloroplasts *[1 mark]*
2.2 **carbon dioxide** *[1 mark]* + water → glucose + **oxygen** *[1 mark]*
2.3 Energy is transferred from the environment during photosynthesis *[1 mark]*.

Pages 39-40 — The Rate of Photosynthesis

Warm-Up
carbon dioxide concentration, light intensity, temperature, amount of chlorophyll

1.1 Carbon dioxide stops being a limiting factor at a concentration of 0.10 units *[1 mark]*.
1.2 0.06 units *[1 mark]*
2.1 Dependent variable — volume of oxygen produced in 10 minutes *[1 mark]*.
Independent variable — relative light intensity *[1 mark]*.
2.2 Any two from: e.g. carbon dioxide concentration in the water / temperature / the plant being used *[2 marks — 1 mark for each correct answer]*.
2.3



[2 marks for all four points plotted correctly, otherwise 1 mark for at least two points plotted correctly.]
2.4 6 *[1 mark]*
2.5 The rate of photosynthesis increases as light intensity increases *[1 mark]*.

Page 41 — Respiration and Metabolism

1.1 glycerol *[1 mark]*
1.2 nitrate *[1 mark]*
1.3 cellulose *[1 mark]*
Cellulose is a component of plant cell walls.
1.4 urea *[1 mark]*
2.1 Respiration is a reaction carried out by **all** *[1 mark]* living organisms. Respiration is an **exothermic** *[1 mark]* reaction. It transfers energy **to** *[1 mark]* the environment.
2.2 E.g. to build up larger molecules from smaller ones. / To move about. / To keep warm. *[1 mark]*

Page 42 — Aerobic and Anaerobic Respiration

Warm-Up
glucose — $C_6H_{12}O_6$
carbon dioxide — CO_2
water — H_2O
1

Statement	Aerobic respiration	Anaerobic respiration
It transfers more energy.	✓	
It uses O_2.	✓	
It can produce ethanol and CO_2 as products.		✓
It is the incomplete breakdown of glucose.		✓

[3 marks for all four answers correct, otherwise 2 marks for three correct answers or 1 mark for two correct answers.]
2.1 The snail released carbon dioxide as it respired *[1 mark]*.
2.2 It will have decreased *[1 mark]* because the snail will have used up oxygen as it respired *[1 mark]*.

Pages 43 — Exercise

1 During exercise your **muscles** may respire anaerobically. This causes a build up of **lactic acid**. It also leads to an **oxygen** debt. *[3 marks — 1 mark for each correct answer]*
2.1 (12 + 11 + 12) ÷ 3 = 11.6... = **12** breaths per minute *[1 mark]*
2.2 To get more oxygen into the blood *[1 mark]*, which was needed for increased respiration in the muscles *[1 mark]*.
2.3 The student had an oxygen debt / didn't get enough oxygen to the muscles during the exercise *[1 mark]*.
2.4 It would have increased *[1 mark]*.

Topics B5 and B6

Topic B5 — Homeostasis and Response

Page 44 — Homeostasis

Warm-up
The control systems **are** automatic.
If a control system detects the level of something is too high, it will **decrease** the level.
If a control system detects the level of something is too low, it will **increase** the level.

1 allowing large changes in conditions inside the body *[1 mark]*
2.1 E.g. to provide the right temperature for enzymes to work properly / the optimum temperature for enzymes *[1 mark]*.
2.2 The increase in body temperature is detected by **receptors**. Information is then sent to **a coordination centre**. The information is processed and a signal is sent to **effectors**, which produce a response. The man's body temperature is brought back to normal. *[3 marks — one mark for each correct answer.]*
2.3 the hormonal/endocrine system *[1 mark]*

Page 45 — The Nervous System

1.1 motor neurone *[1 mark]*
1.2 Muscles — contract *[1 mark]*
Glands — secrete hormones *[1 mark]*
2.1 X — brain *[1 mark]*
Y — spinal cord *[1 mark]*
2.2 central nervous system/CNS *[1 mark]*
2.3 It receives information from receptors and coordinates a response *[1 mark]*.

Page 46 — Synapses and Reflexes

Warm-up
Dropping a hot plate.

1 Reflex reactions are rapid and automatic. *[1 mark]*
2.1 X — sensory neurone *[1 mark]*
Y — relay neurone *[1 mark]*
2.2 flame/fire *[1 mark]*
2.3 synapse *[1 mark]*
2.4 The stimulus is detected by receptors (in the hand) *[1 mark]*. The receptors send electrical impulses along structure X / the sensory neurone *[1 mark]*. When the impulses reach structure A / the synapse, chemicals are released *[1 mark]*. The chemicals move across structure A and trigger new electrical impulses in structure Y *[1 mark]*.

Page 47 — Investigating Reaction Time

1.1 Mean = (0.16 + 0.15 + 0.18 + 0.17) ÷ 4 = 0.165
= **0.17 s** (2 s.f.) *[2 marks for correct answer or 1 mark for 0.165]*
1.2 Reaction time was faster after caffeine. *[1 mark]*
1.3 The results are repeatable. *[1 mark]*
1.4 Any two from: e.g. the amount of caffeine/the amount of drink that the volunteer was given. / The test used to measure reaction time. / The time between the volunteer having the caffeine and the test being done. / The time of day the tests were carried out. *[2 marks — 1 mark for each correct answer.]*

Page 48 — The Endocrine System

1 B *[1 mark]*
2.1 Glands secrete hormones directly into the blood. *[1 mark]*
2.2 Hormones are chemicals. *[1 mark]*
2.3 E.g. the effects of the endocrine system are slower *[1 mark]*. The effects of the endocrine system are longer lasting *[1 mark]*.
3.1 pituitary gland *[1 mark]*
3.2 They act on other glands *[1 mark]* to make them release other hormones that bring about change *[1 mark]*.

Page 49 — Controlling Blood Glucose

1.1 pancreas *[1 mark]*
1.2 insulin *[1 mark]*
1.3 When there is too much glucose in the blood, some of it moves into the **liver**. The glucose is then changed into **glycogen** so it can be stored. *[2 marks — 1 mark for each correct answer.]*
2.1 The body produces little or no insulin. *[1 mark]*
2.2 With insulin injections *[1 mark]*.
2.3 E.g. eat a carbohydrate-controlled diet *[1 mark]*. Get regular exercise *[1 mark]*.
2.4 being overweight / obesity *[1 mark]*

Page 50 — Puberty and the Menstrual Cycle

1.1 testosterone *[1 mark]*
1.2 testes *[1 mark]*
1.3 stimulating sperm production *[1 mark]*
2.1 oestrogen *[1 mark]*
2.2 ovulation *[1 mark]*
2.3 Every 28 days. *[1 mark]*
2.4 luteinising hormone *[1 mark]*
3 The progesterone level will fall *[1 mark]*. Progesterone helps to maintain the uterus lining *[1 mark]*, so when the level falls the uterus lining will break down and the woman will bleed *[1 mark]*.

Page 51 — Controlling Fertility

Warm-up
contraceptive injection, contraceptive patch

1.1 As a tablet taken by mouth. *[1 mark]*
1.2 The hormones stop FSH production. *[1 mark]*
1.3 progesterone *[1 mark]*
1.4 It stops eggs maturing. / It stops eggs being released from the ovaries. *[1 mark]*
1.5 E.g. a woman doesn't have to think about using the implant every day (unlike taking an oral contraceptive) *[1 mark]* because the effects of the implant lasts for several years *[1 mark]*.

Page 52 — More on Controlling Fertility

Warm-up
diaphragm — worn over the entrance to the uterus
male condom — worn over the penis
female condom — worn inside the vagina

1.1 They stop sperm from getting to an egg. *[1 mark]*
1.2 condom *[1 mark]*
1.3 Spermicides kill or disable sperm *[1 mark]*. This prevents the sperm from being able to fertilise the egg, so the woman doesn't get pregnant *[1 mark]*.
1.4 E.g. not having intercourse when the woman is at the stage in her menstrual cycle when she is most likely to get pregnant *[1 mark]*.

Topic B6 — Inheritance, Variation and Evolution

Page 53 — DNA

1.1 DNA is found in the nucleus of animal and plant cells *[1 mark]*.
1.2 The structures that contain DNA *[1 mark]*.
2.1 A DNA molecule is made up of two strands of DNA coiled together *[1 mark]* into a double helix *[1 mark]*.
2.2 Genes code for particular sequences of amino acids *[1 mark]*, which are put together to make specific proteins *[1 mark]*.
2.3 The genome is all the genetic material in an organism *[1 mark]*.
2.4 E.g. it allows scientists to find genes that are linked to different types of diseases *[1 mark]*.

Topic B6

Page 54 — Reproduction

1 sperm — male gamete in animals
egg — female gamete
pollen — male gamete in plants
[2 marks for all three correct answers, otherwise 1 mark for 1 correct answer.]

2.1 meiosis ***[1 mark]***

2.2 mitosis ***[1 mark]***

2.3 They are genetically identical to the parent cell ***[1 mark]***.

3

	Asexual reproduction	Sexual reproduction
There is only one parent.	✓	
There is no mixing of genes.	✓	
It results in genetic variation in the offspring.		✓
There is fusion of gametes.		✓

[3 marks for all four correct answers, otherwise 2 marks for three correct answers or 1 mark for two correct answers.]

You need to get two answers correct for 1 mark here. If you only get one answer correct (or you don't get any answers correct) you won't get any marks.

Page 55 — Meiosis

1.1 the reproductive organs ***[1 mark]***

1.2 It is copied ***[1 mark]***.

1.3 two ***[1 mark]***

1.4 Four gametes are produced ***[1 mark]***, each with only a single set of chromosomes ***[1 mark]***. Each of the gametes is genetically different from the others ***[1 mark]***.

2.1 mitosis ***[1 mark]***

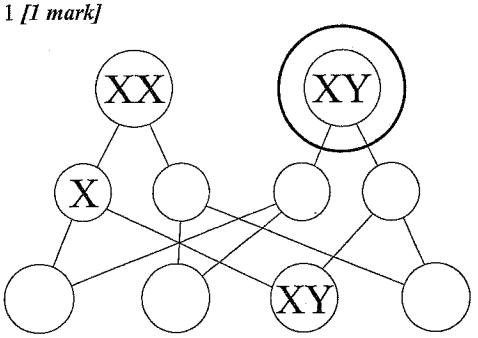
2.2 They differentiate into different types of specialised cell ***[1 mark]***.

Page 56 — X and Y Chromosomes

1.1 23 ***[1 mark]***

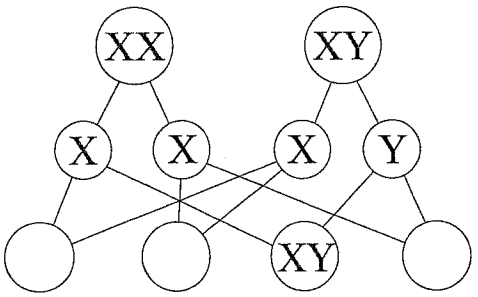
1.2 1 ***[1 mark]***

2.1



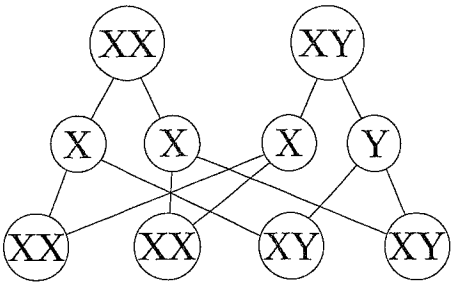
[1 mark]

2.2



[1 mark for all gametes correct]

2.3



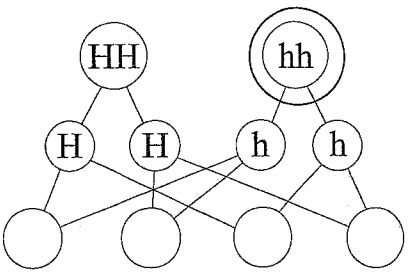
[1 mark if all the offspring genotypes are correct.]

2.4 50:50 / 1:1 ***[1 mark]***

Page 57 — Genetic Diagrams

Warm-up
alleles, homozygous, multiple genes

1.1



[1 mark]

1.2 Hh ***[1 mark]***

1.3 The offspring all have short hair ***[1 mark]***.

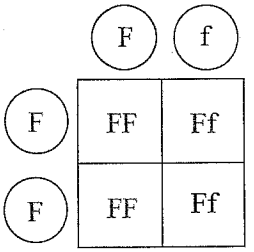
All the offspring have the genotype Hh. This means they all have the dominant allele (H), so they all have short hair.

Page 58 — Inherited Disorders

1.1 extra fingers or toes ***[1 mark]***

1.2 It is caused by a dominant allele ***[1 mark]***.

2.1



[1 mark for correct genotypes of gametes. 1 mark for correct genotype of offspring.]

2.2 half / 1 in 2 ***[1 mark]***

2.3 none / 0 ***[1 mark]***

Remember, cystic fibrosis is caused by a recessive allele, so two copies of the allele are needed for an individual to have it. None of the offspring in the Punnett square have two copies so none of them have it.

Page 59 — Family Trees and Embryo Screening

1.1 Hilda ***[1 mark]***

Using the key next to the family tree, you can see that Freddy, Zelda and Buster are all carriers of the disease, whereas Hilda is not affected by it.

1.2 dd ***[1 mark]***

The disorder is caused by a recessive allele. That means a person must have two copies of the recessive allele to be affected by it. Arthur is affected by the disorder, so he must have the genotype dd.

1.3 Dd ***[1 mark]***

Zelda is a carrier of the disorder. This means she has one copy of the recessive allele and one copy of the dominant allele.

Topic B6

2.1 E.g. it could lead to people with genetic disorders being treated unfairly. / It could mean that one day people will screen embryos for features that they prefer. / Screening embryos is expensive. *[1 mark]*

2.2 E.g. it will help to stop people suffering. / Treating genetic disorders is expensive. *[1 mark]*

Page 60 — Variation

1.1 A random change in an organism's DNA that can be inherited *[1 mark]*.

1.2 B *[1 mark]*

2 E.g. flower shape / leaf shape / the size of the leaves/flowers / flower colour *[1 mark]*.

3 The difference in weight must be caused by the environment *[1 mark]*, because the twins have exactly the same genes *[1 mark]*.

In this case, the environment can mean the amount of food each twin eats or the amount of exercise they each do.

Page 61 — Evolution

1 Evolution is a change in the **inherited** characteristics of a population over time. According to the theory of evolution by natural selection, **all** organisms evolved from simple life forms that first evolved over **three** billion years ago. *[3 marks — 1 mark for each correct answer.]*

2.1 No individuals of the species are left *[1 mark]*.

2.2 Any two from: e.g. the environment changes too quickly. / A new predator kills them all. / A new disease kills them all. / They can't compete with another new species for food. / A catastrophic event happens that kills them all. *[2 marks — 1 mark for each correct answer.]*

3 How to grade your answer:

Level 0: There is no relevant information. *[No marks]*

Level 1: There is a brief explanation of how a population of hares with large ears could have evolved, but key information is missing. *[1 to 2 marks]*

Level 2: There is some explanation of how a population of hares with large ears could have evolved, but some detail is missing. *[3 to 4 marks]*

Level 3: There is a full explanation of how a population of hares with large ears could have evolved. *[5 to 6 marks]*

Here are some points your answer may include:

The original population of hares would have had variation in the sizes of ears.

Those with larger ears would lose more heat. This would make them more likely to survive and reproduce in the warm climate than hares with smaller ears. So the genes for larger ears would be more likely to be passed on to offspring than genes for smaller ears.

Over time, the genes for larger ears would become more common in the population until all the hares in the population had larger ears.

Page 62 — Antibiotic-Resistant Bacteria

Warm-up

False, True, False

1 C *[1 mark]*

2.1 Going down the table: 4, 2, 1, 3 *[2 marks for all four stages in the correct order, otherwise 1 mark for three stages in the correct order.]*

2.2 The person is less likely to be immune to MRSA than to a non-resistant strain of *S. aureus* *[1 mark]* and there is less likely to be an effective treatment for their illness *[1 mark]*.

Page 63 — More on Antibiotic-Resistant Bacteria

1 By restricting the amount of antibiotics they give to their livestock *[1 mark]*.

2 E.g. the rate of development of new antibiotics is slow *[1 mark]*. The process of development is expensive *[1 mark]*.

3.1 By only prescribing antibiotics when they are needed. / By not prescribing antibiotics for non-serious conditions/infections by viruses *[1 mark]*.

3.2 It makes sure that all of the bacteria are destroyed *[1 mark]* and none are left to mutate and develop into antibiotic-resistant strains *[1 mark]*.

Page 64 — Selective Breeding

1.1 When humans choose which plants or animals are going to breed *[1 mark]*.

1.2 artificial selection *[1 mark]*

1.3 B and C *[1 mark]*

1.4 E.g. to get cows that produce more milk *[1 mark]*.

2.1 It's less likely that individuals in an inbred population will have alleles that make them resistant to a disease *[1 mark]*, so if one individual gets a disease, the rest are also likely to get it *[1 mark]*.

2.2 E.g. genetic defects are more likely *[1 mark]*.

Page 65 — Genetic Engineering

1.1 The transfer of a gene from one organism's DNA into another organism's DNA *[1 mark]*.

1.2 They can be made to produce insulin *[1 mark]*.

2.1 It can increase crop yield *[1 mark]*.

2.2 Any two from: e.g. to be resistant to disease. / To be resistant to insects. / To produce bigger fruit. *[2 marks — 1 mark for each correct answer.]*

3.1 To find out whether a GM crop affects the number of wild flowers growing in a nearby area *[1 mark]*.

3.2 E.g. they could repeat their experiment with other meadows *[1 mark]*.

Page 66 — Fossils

Warm-up

False, True, True

1 C *[1 mark]*

2.1 Decay microbes need moisture and oxygen to survive *[1 mark]*. If these conditions are not present then decay can't happen *[1 mark]*.

2.2 Any two from: e.g. footprints / burrows / rootlet traces. *[2 marks — 1 mark for each correct answer.]*

2.3 They may be formed when parts of the organism are replaced by minerals when they decay *[1 mark]*.

Page 67-68 — Classification

Warm-up

kingdom, **phylum**, class, **order**, family, genus, **species**

1.1 kingdom *[1 mark]*

1.2 physical characteristics *[1 mark]*

2.1 Carl Woese *[1 mark]*

2.2 Archaea *[1 mark]*

2.3 Any two from: protists / fungi / plants / animals. *[2 marks — 1 mark for each correct answer.]*

3 *Lophornis* *[1 mark]*

Remember, the binomial system puts the genus name followed by the species name, so the black-crested coquette's genus is Lophornis.

4 Our understanding of the internal structures of organisms has improved *[1 mark]*. Our understanding of the processes taking place inside organisms has improved *[1 mark]*.

5.1 E.g. current classification data *[1 mark]*. Information from the fossil record *[1 mark]*.

5.2 B *[1 mark]*

If you follow the lines from G and J back, you'll find that they meet at B, so B is their most recent common ancestor.

5.3 G and H *[1 mark]*

If you follow both of their lines back, G and H meet at B, and J and K meet at I. It's a shorter distance from J and K to I than it is for G and H to B, so G and H are more distantly related.

Topic B7

Topic B7 — Ecology

Page 69 — Competition

1.1 population *[1 mark]*
1.2 B *[1 mark]*
2.1 All the organisms in **Figure 1** are interdependent *[1 mark]*.
2.2 E.g. shelter *[1 mark]*
2.3 E.g. territory *[1 mark]*, mates *[1 mark]*

Page 70 — Abiotic and Biotic Factors

Warm-up
'predators', 'pathogens' and 'competition' should be circled.
1.1 Light intensity and carbon dioxide level are examples of abiotic factors. *[1 mark]*
1.2 E.g. oxygen level *[1 mark]*
1.3 Any two from: e.g. moisture level / soil pH / soil mineral content / carbon dioxide level *[2 marks — 1 mark for each correct answer.]*
2.1 A new pathogen is likely to lead to a decrease in the population size of the flowering plants *[1 mark]*.
2.2 The bee population is likely to decrease *[1 mark]* because there will be fewer flowers available for them to feed from *[1 mark]*.

Page 71 — Adaptations

1.1 extremophiles *[1 mark]*
1.2 E.g. bacteria *[1 mark]*
1.3 E.g. high pressure *[1 mark]*
2.1 structural adaptation: long eyelashes / large surface area to volume ratio *[1 mark]*
These are both examples of physical features of the camel's body. So they are both structural adaptations.
behavioural adaptation: drinks large quantities of water when available *[1 mark]*
2.2 Functional adaptations are processes inside an organism's body *[1 mark]* that make the organism suited to its environment *[1 mark]*.
2.3 It prevents the camel losing too much water in its urine *[1 mark]*.
Remember to use the information that you are given in the question. It tells you that camels live in hot and dry conditions, so it is likely that concentrated urine is a way of coping with a lack of water.

Page 72 — Food Chains

Warm-up
The producer is seaweed.
1.1 photosynthesis *[1 mark]*
1.2 primary consumer *[1 mark]*
1.3 blue tits / sparrowhawk *[1 mark]*
Remember, only animals that eat other animals are predators. The greenflies are only consumers.
2.1 The population of the rabbits would decrease *[1 mark]* because there would be more foxes eating them *[1 mark]*.
2.2 If the number of rabbits decreases due to disease *[1 mark]*, then the number of foxes could decrease as there would be less food for them to eat *[1 mark]*.

Page 73 — Using Quadrats

1.1 mean = total number of organisms ÷ number of quadrats
= (26 + 23 + 18) ÷ 3 = 67 ÷ 3 = 22.33...
= **22** (2 s.f.) *[2 marks for correct answer to 2 significant figures, otherwise 1 mark for mean = 22.33...]*
1.2 Yes. If you arrange the results from quadrats 1 to 3 in order from smallest to largest, then 14 is the middle value *[1 mark]*.
Watch out: you get the mark for your explanation here, not just saying 'yes'.
1.3 E.g. yes, because the mean number of buttercups in Area 1 is lower than the mean number of buttercups in Area 2 *[1 mark]*. / No, because there could be other factors affecting the growth of the buttercups, that haven't been investigated *[1 mark]*.
1.4 total number of buttercups = mean per quadrat × total area
14 × 1750 = **24 500** buttercups *[1 mark]*.
The size of the quadrat is 1 m^2 so all you have to do is multiply the mean number of buttercups per quadrat by the total area of Area 1. If the quadrat had a different size, then you would first have to divide the area of the habitat by the size of the quadrat.

Page 74 — Using Transects

1.1 B and C *[1 mark]*
1.2 A *[1 mark]*
1.3 E.g. a quadrat / a tape measure *[1 mark]*
2 56 squares are more than half covered by the grass species.
(56 ÷ 100) × 100 = **56%** *[2 marks — otherwise 1 mark for estimating 56 squares covered.]*
You should count a square if it's more than half covered.

Page 75 — The Water Cycle

Warm-up

g	h	a	v	o	u	p	s	d
r	a	i	n	z	x	q	n	k
f	d	e	g	t	h	y	o	r
s	f	j	h	l	p	e	w	e
p	h	a	i	l	w	e	a	a

1.1 evaporation *[1 mark]*
1.2 Water that falls from the clouds *[1 mark]*.
1.3 It provides fresh water for plants and animals *[1 mark]*.
1.4 By animals eating the plants *[1 mark]*.

Page 76 — The Carbon Cycle

1 A: decay *[1 mark]*
B: eating *[1 mark]*
C: respiration *[1 mark]*
2.1 Microorganisms break down dead matter *[1 mark]*. As they break it down, they release carbon dioxide back into the air through respiration *[1 mark]*.
2.2 Plants take in carbon dioxide from the air during photosynthesis *[1 mark]*. They use the carbon in carbon dioxide to make glucose *[1 mark]*. This glucose is used to make carbon compounds (e.g. carbohydrates) in the plant *[1 mark]*.

Page 77 — Biodiversity and Waste Management

1 Biodiversity is the variety of different **species** in an ecosystem. An ecosystem with a high biodiversity is **more** stable than an ecosystem with a low biodiversity.
[2 marks — 1 mark for each correct answer.]
2.1 The human population is growing *[1 mark]*.
The standard of living is increasing *[1 mark]*.
2.2 Air — e.g. acidic gases *[1 mark]*
Land — e.g. herbicides / household waste *[1 mark]*
Water — any two from: e.g. sewage / toxic chemicals / fertilisers / pesticides / herbicides *[2 marks — 1 mark for each correct answer]*
2.3 Pollution kills animals and plants *[1 mark]*, therefore it reduces biodiversity *[1 mark]*.

Page 78 — Global Warming

Warm-up
carbon dioxide, methane, increasing, heating up
1.1 E.g. the butterfly is present in more places in 2016 compared to 1986 *[1 mark]*. In 2016, the butterfly is present further up Britain/further north than in 1986 *[1 mark]*.
1.2 E.g. data on temperatures between 1986 and 2016 *[1 mark]*.

Topic C1

Page 79 — Deforestation and Land Use

1.1 as a compost *[1 mark]*
1.2 carbon dioxide *[1 mark]*
1.3 global warming *[1 mark]*
2.1 Any two from: e.g. building / quarrying / farming / dumping waste *[2 marks — 1 mark for each correct answer.]*
2.2 E.g. so it can be used to graze cattle / grow rice / grow crops for biofuels. *[1 mark]*
2.3 Effect: it reduces biodiversity *[1 mark]*.
Reason: e.g. forests contain many species of plants and animals, which would no longer be able to live there once the forest had been cut down *[1 mark]*.

Page 80 — Maintaining Ecosystems and Biodiversity

1 Replace the fences around her fields with hedgerows.
Allow wild flowers and grasses to grow around the edges of her fields. *[2 marks — 1 mark for each correct answer.]*
2.1 Reducing deforestation. *[1 mark]*
2.2 E.g. this could reduce the amount of land taken over for landfill *[1 mark]*, leaving ecosystems in place *[1 mark]*.
2.3 E.g. individuals could be bred in zoos, then released into the wild *[1 mark]*. This could increase biodiversity in areas where the species being released has low numbers/has been wiped out *[1 mark]*.

Topic C1 — Atomic Structure and the Periodic Table

Page 81 — Atoms

Warm-up
Protons and **neutrons** are found in the nucleus of an atom.
Electrons move around the nucleus in shells.
Compared to electrons, protons and neutrons are **heavy**.

1.1

Particle	Relative Charge
Proton	+1
Neutron	0
Electron	–1

[3 marks — 1 mark for each correct answer]
1.2 neutral *[1 mark]*
2.1 39 *[1 mark]*
2.2 19 *[1 mark]*
2.3 protons = 19 *[1 mark]*
neutrons = mass number – atomic number
= 39 – 19 = **20** *[1 mark]*
electrons = 19 *[1 mark]*

Page 82 — Elements

1 Atoms are the smallest part of an element that can exist *[1 mark]*.
2.1 Number of neutrons for isotope A
= mass number – number of protons = 79 – 35 = **44** *[1 mark]*
Number of neutrons for isotope B
= mass number – number of protons = 81 – 35 = **46** *[1 mark]*
2.2 35 *[1 mark]*
The number of electrons is equal to the number of protons.
2.3 abundance of isotope A × mass number of isotope A
= 51 × 79 = 4029 *[1 mark]*
abundance of isotope B × mass number of isotope B
= 49 × 81 = 3969 *[1 mark]*
2.4 Relative atomic mass

$$= \frac{\text{sum of(isotope abundance} \times \text{isotope mass number)}}{\text{sum of abundances of all the isotopes}}$$

$$= \frac{4029 + 3969}{51 + 49} = \frac{7998}{100} = 79.98 = \mathbf{80.0}\ (1\text{ d.p.})$$

[2 marks — 1 mark for correct answer, 1 mark for correct number of decimal places]

Page 83 — Compounds

1.1 It contains two elements held together by chemical bonds *[1 mark]*.
1.2 4 *[1 mark]*
A molecule of ammonia contains 1 nitrogen atom and 3 hydrogen atoms making a total of 4 atoms altogether.
2.1 sodium chloride *[1 mark]*
2.2 Any two from: B/NaCl *[1 mark]* / C/C_2H_4 *[1 mark]* / E/SO_2Cl_2 *[1 mark]*
2.3 1 *[1 mark]*
2.4 S: 1, O: 2, Cl: 2 *[2 marks for all 3 correct, otherwise 1 mark for 2 correct]*

Page 84 — Chemical Equations

Warm-up
1) True 2) False 3) True 4) True
1.1 calcium and water *[1 mark]*
1.2 calcium hydroxide and hydrogen *[1 mark]*
2.1 sodium + chlorine → sodium chloride *[1 mark]*
2.2 $2Na + Cl_2 \rightarrow 2NaCl$ *[1 mark]*
2.3 $4Na + O_2 \rightarrow 2Na_2O$ *[2 marks — 1 for each correct number]*

Page 85 — Mixtures

1 crude oil *[1 mark]*
2.1 2 *[1 mark]*
2.2 The chemical properties of the different parts in a mixture **don't change** *[1 mark]* when they're added together. The different parts can be separated from the mixture using **physical** *[1 mark]* methods.
3.1 Type of substance: mixture *[1 mark]*.
Reason: air consists of two or more elements or compounds *[1 mark]* that aren't chemically combined together *[1 mark]*.
3.2 No *[1 mark]*. The chemical properties of argon are not changed by being part of a mixture *[1 mark]*.

Page 86 — Chromatography

1.1 Place the sheet in the solvent so that the solvent is just below the pencil line *[1 mark]*.
1.2 Pencil marks are insoluble (so won't dissolve into the solvent) *[1 mark]*.
2.1 solvent front *[1 mark]*
2.2 The different dyes in the ink move up the paper at different speeds *[1 mark]*.
2.3 insoluble *[1 mark]*

Page 87 — More Separation Techniques

1.1 Filtration is used to separate **insoluble** *[1 mark]* solids from **liquids** *[1 mark]*.
1.2 Filter paper *[1 mark]*, funnel *[1 mark]*.
2.1 crystallisation *[1 mark]*
You can't just use evaporation here — the substance would break down if you heated it too much.
2.2 How to grade your answer:
Level 0: Nothing written worthy of credit *[No marks]*.
Level 1: A brief method is given, but there are steps missing *[1 to 2 marks]*.
Level 2: A method is given, but it is lacking in detail, or steps are out of order *[3 to 4 marks]*.
Level 3: A clear and detailed method is given *[5 to 6 marks]*.
Here are some points your answer may include:
Gently heat the solution in the evaporating dish.
Stop heating once some of the solvent has evaporated or when crystals start to form.
Leave the solution to cool until crystals have formed.
Put the filter paper in the funnel and place the funnel in a beaker.
Pour the mixture into the filter paper.
The liquid passes through the filter paper, but the solid crystals will be left behind on the filter paper.
After all the liquid has passed through the filter paper leave the crystals to dry out.

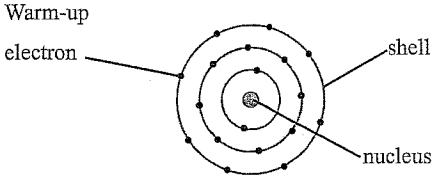
Topic C1

Page 88 — Distillation

1 Fractional distillation *[1 mark]*
2.1 condenser *[1 mark]*
2.2 It changes from a gas to a liquid / it condenses *[1 mark]*.
2.3 E.g. the thermometer will read 118 °C *[1 mark]*.
2.4 Butanol has a boiling point greater than 100 °C / greater than the boiling point of water *[1 mark]*. So it would not evaporate when heated by a water bath *[1 mark]*.

Pages 89 — The History of The Atom

Warm-up



1.1 Tiny solid spheres *[1 mark]*.
1.2 Nuclear model: 2, Bohr's nuclear model: 3, Plum pudding model: 1 *[2 marks for all 3 correct, otherwise 1 mark for 1 correct]*
2.1 Plum pudding model — A positively charged 'ball' with negatively charged electrons in it *[1 mark]*.
Bohr's nuclear model — Electrons in fixed orbits surrounding a small positively charged nucleus *[1 mark]*.
Nuclear model — A small positively charged nucleus surrounded by a 'cloud' of negative electrons *[1 mark]*.
2.2 neutron *[1 mark]*

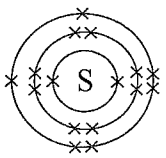
Page 90 — Electronic Structure

1

Electron shell	Number of electrons it can hold
1st	2
2nd	8
3rd	8

[3 marks — 1 mark for each correct answer]

2.1 2,8,8,2 *[1 mark]*
2.2 E.g. this shell can hold a maximum of two electrons *[1 mark]*.
3.1 Chlorine: 2,8,7 *[1 mark]*
Boron: 2,3 *[1 mark]*
3.2



[1 mark for correct number of electrons, 1 mark for correct arrangement]

You don't have to have the electrons paired up on the diagram. As long as there is the same number of electrons on the same shells you get the marks.

Page 91 — Development of The Periodic Table

1.1 E.g. protons (neutrons and electrons) had not been discovered / atomic numbers weren't known *[1 mark]*.
1.2 E.g. they weren't complete *[1 mark]* / some elements were put in the wrong groups/columns *[1 mark]*.
2.1 So that elements with similar properties were in the same group *[1 mark]*.
2.2 The properties of the elements that were found after Mendeleev made his table fitted with the gaps that he'd left in the table *[1 mark]*.
2.3 isotopes *[1 mark]*

Page 92 — The Modern Periodic Table

1.1 By atomic number / proton number *[1 mark]*.
1.2 groups *[1 mark]*
1.3 non-metals *[1 mark]*
2.1 Group: 2 *[1 mark]*.
Reason: The atom has 2 outer shell electrons. *[1 mark]*.
2.2 Period: 3 *[1 mark]*.
Reason: The atom has 3 shells of electrons *[1 mark]*.
2.3 X and Z *[1 mark]*

Elements X and Z both have 3 shells of electrons, so they're in the same period.

2.4 Element: A *[1 mark]*
Reason: Element A has the same number of outer electrons as element X / element A is in the same group as element X *[1 mark]*.

Page 93 — Metals and Non-Metals

1.1 Metals: Towards the left and bottom *[1 mark]*.
1.2 Conductors of electricity *[1 mark]*. Can be bent or hammered into different shapes *[1 mark]*.
2.1 A^{2+}: metal X^{2-}: non-metal *[1 mark if both correct.]*
2.2 When metals react, they **lose** *[1 mark]* electrons.
When this happens they end up with a **full** *[1 mark]* outer shell of electrons.
2.3 Any three from: e.g. dull / brittle / poor conductors of electricity / low density / not always solids at room temperature *[1 mark for each]*.

Page 94 — Group 1 Elements

1.1 +1 *[1 mark]*
1.2 ionic *[1 mark]*
2.1 lithium (least dense), sodium, potassium (most dense) *[1 mark]*
2.2 Melting point — decreases *[1 mark]*
Boiling point — decreases *[1 mark]*
3.1 sodium + water → **sodium hydroxide** + **hydrogen**
[2 marks — 1 mark for each correct answer]
3.2 E.g. potassium has more electron shells than sodium so the outer electron of potassium is further away from the nucleus than the outer electron of sodium *[1 mark]*. This means the outer electron of potassium is less attracted to the nucleus *[1 mark]* and more easily lost *[1 mark]*.

Pages 95 — Group 7 Elements

1 The Group 7 elements all have **seven** *[1 mark]* electrons in their outer shell. They can react to form ions with a **1–** *[1 mark]* charge. These ions are called **halides** *[1 mark]*.
2.1 They are non-metals that exist as molecules of two atoms *[1 mark]*.
2.2 fluorine *[1 mark]*
3.1 Chlorine is more reactive than bromine *[1 mark]*. This is because chlorine has fewer electron shells than bromine so its outer shell is closer to the nucleus *[1 mark]*. This means it's easier for chlorine to gain an electron when it reacts *[1 mark]*.

Because of the increasing distance between the nucleus and the outer shell, reactivity decreases down the group. Bromine is further down the group than chlorine, it's outer shell is further away from the nucleus and therefore it's less reactive than chlorine.

3.2 H *[1 mark]*
Reason: e.g. hydrogen is a non-metal / halogens form molecular compounds with non-metals *[1 mark]*.

Page 96 — Group 0 Elements

1.1 gases *[1 mark]*
1.2 single atoms *[1 mark]*
1.3 They have a stable electron arrangement / full outer shell of electrons *[1 mark]*.
2.1 Any value above –108 °C and below 25 °C *[1 mark]*.

Boiling point increases down the group, so Radon will boil at a higher temperature than xenon. All the Group 0 elements are gases at room temperature, so radon must have a boiling point below 25 °C.

2.2 E.g. as you go down the group, the elements have more electrons *[1 mark]*. This means the forces between the atoms get stronger *[1 mark]*. So more energy is needed to break the forces / the boiling points increase *[1 mark]*.

Topic C2

Topic C2 — Bonding, Structure and Properties of Matter

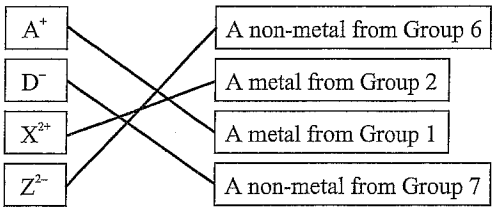
Page 97 — Formation of Ions

1.1 atoms *[1 mark]*

1.2 1 *[1 mark]*

2.1 Metal atoms usually lose electrons to become positive ions *[1 mark]*.

2.2



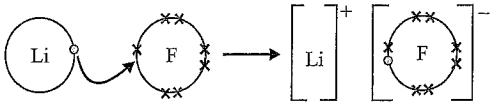
[2 marks if all four correct, otherwise 1 mark if two correct]

Page 98 — Ionic Bonding

1.1 positively *[1 mark]*, negatively *[1 mark]*, opposite *[1 mark]*

1.2 Magnesium ion: Mg^{2+} *[1 mark]*
Oxygen ion: O^{2-} *[1 mark]*

2.1



[1 mark for arrow showing electron transfer from Li to F, 1 mark for correct electronic structure of fluoride ion (seven crosses and one dot), 1 mark for correct charges on the ions.]

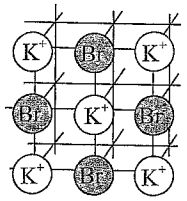
2.2 electrostatic attraction / electrostatic force *[1 mark]*

2.3 E.g. the particles in the compound are oppositely charged ions/ have opposite charges / the bond is formed by electrons being transferred from one atom to another *[1 mark]*.

Page 99 — Ionic Compounds

Warm-up:
In an ionic compound, the particles are held together by **strong** forces of attraction. These forces are called ionic bonds and act **in all directions**.

1.1 E.g.



[1 mark for correct structure, with alternating ions]

You'd also get the marks if you labelled all the white circles as Br^- and all the grey circles as K^+.

1.2 Disadvantage: Any one of, e.g. the diagram doesn't correctly represent the sizes of ions / it shows gaps between the ions *[1 mark]*.

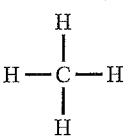
2.1 conduct electricity in the solid state *[1 mark]*

2.2 giant ionic lattice *[1 mark]*

Page 100 — Covalent Bonding

1 non-metal *[1 mark]*, share *[1 mark]*, electrons *[1 mark]*

2.1



[1 mark]

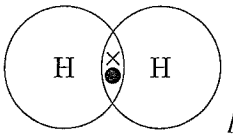
[1 mark]

Each line represents one covalent bond.

2.2 A: Cl_2 *[1 mark]*
B: CH_4 *[1 mark]*
C: H_2O *[1 mark]*

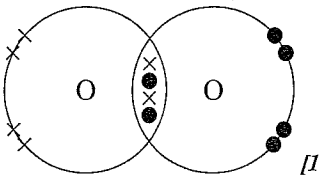
Pages 101-102 — Simple Molecular Substances

1.1



[1 mark]

1.2

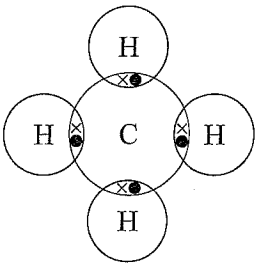


[1 mark]

2.1 A *[1 mark]*

2.2 E.g. molecule A/HCl has covalent bonding and all simple molecular substances contain covalent bonds *[1 mark]*.

3.1



[1 mark for the correct layout of atoms and shells, 1 mark for the correct number of electrons in each bond]

3.2 E.g. they don't show how the atoms are arranged *[1 mark]* / how big the atoms are compared to each other *[1 mark]*.

4.1 The bonds between the atoms are strong *[1 mark]*. The forces between the molecules are weak *[1 mark]*.

4.2 The forces between the molecules / the intermolecular forces *[1 mark]*.

4.3 As these substances get larger, the forces between molecules/ intermolecular forces get stronger *[1 mark]*. As methane is larger than hydrogen this means that more energy is needed to break the stronger forces in methane *[1 mark]*, so it will have a higher boiling point than hydrogen *[1 mark]*.

Page 103 — Polymers and Giant Covalent Structures

Warm-up:
In a polymer lots of **small** units are joined together to form a **long** molecule.

1 C *[1 mark]*

2.1 ammonia *[1 mark]*

Ammonia has a simple covalent structure — it forms small molecules.

2.2 They don't contain charged particles *[1 mark]*.

3.1 $(C_2H_4)_n$ *[1 mark]*

3.2 covalent bonds *[1 mark]*

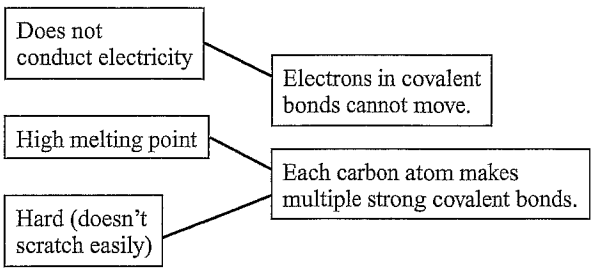
3.3 At room temperature there isn't enough energy to break the intermolecular forces between polymer molecules *[1 mark]*.

Page 104 — Structures of Carbon

1 Buckminsterfullerene: B *[1 mark]*
Nanotube: C *[1 mark]*
Graphene: A *[1 mark]*

2.1 4 *[1 mark]*

2.2



[2 marks if all three correct, otherwise 1 mark if one correct]

Topics C3 and C4

2.3 Carbon atoms are arranged in hexagons / rings of six carbon atoms *[1 mark]*.

2.4 Each carbon atom in graphite has one electron that's free to move *[1 mark]*. This means that graphite can conduct electricity, which is useful in electronics *[1 mark]*.

Page 105 — Metallic Bonding

Warm-up:

The following should be circled: copper, tin, magnesium, aluminium.

1 Metal X *[1 mark]*. Metal X contains two different sizes of atoms / it doesn't have clear layers of atoms *[1 mark]*.

2.1 electrons *[1 mark]*

2.2 There are strong forces of attraction between the positive metal ions and the negative electrons *[1 mark]*. These forces of attraction hold the ions together in a regular pattern *[1 mark]*.

2.3 Metallic bonds are very strong *[1 mark]* so lots of energy is needed to break them *[1 mark]*.

2.4 E.g. metal A would be easier to bend *[1 mark]*. Metal A is made from layers of atoms that are all the same size *[1 mark]*. This means they can easily slide over each other and allow the metal to bend *[1 mark]*.

Page 106 — States of Matter

1.1 A *[1 mark]*

1.2 C *[1 mark]*

1.3 B *[1 mark]*

2.1 C *[1 mark]*

2.2 The particles in a substance *[1 mark]*

3.1 solid (strongest) → liquid → gas (weakest) *[1 mark]*

3.2 Solids have a fixed shape *[1 mark]*.

Page 107 — Changing State

1.1 freezing *[1 mark]*

1.2 melting *[1 mark]*

2.1 boiling / evaporating *[1 mark]*

2.2 The bonds are strong *[1 mark]*.

3.1 sodium chloride *[1 mark]*

At 900 °C, water would be a gas and copper would be a solid.

3.2 Sodium chloride *[1 mark]* and water *[1 mark]*.

At 1500 °C, copper would be a liquid.

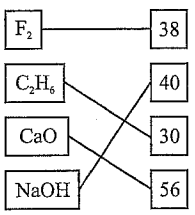
Topic C3 — Quantitative Chemistry

Page 108 — Relative Formula Mass

1.1 relative formula mass of HCl = 35.5 + 1 = **36.5** *[1 mark]*

1.2 relative formula mass of Cl_2 = 35.5 + 35.5 = **71** *[1 mark]*

2



[2 marks if all four correct, otherwise 1 mark if two correct]

3.1 $M_r(MgO) = 24 + 16 = 40$ *[1 mark]*

3.2 percentage mass of magnesium $= \frac{A_r(Mg) \times 1}{M_r(MgO)} \times 100$

$= \frac{24 \times 1}{40} \times 100 =$ **60%**

[2 marks for correct answer. Otherwise, 1 mark for correctly using the equation.]

You still get all the marks for this part if you got the answer to 3.1 wrong, but used it correctly here.

Pages 109-110 — Conservation of Mass

Warm-up:

1) Magnesium and hydrochloric acid should be circled.

2) Boxes should be drawn around magnesium chloride and hydrogen.

3) hydrogen

4) hydrogen

1.1 The mass of the reactants will be the same as the mass of the products *[1 mark]*.

1.2 44 g of iron sulfide *[1 mark]*.

2.1 Total mass of reactants = 80.0 + 73.0 = 153 g

Mass of sodium chloride = 153 – 36.0 = **117 g** *[1 mark]*

2.2 Total mass of products = 175.5 + 54.00 = 229.5 g

Mass of sodium hydroxide = 229.5 – 109.5 = **120 g** *[1 mark]*

3.1 $2Mg + O_2 \rightarrow 2MgO$ *[1 mark]*

3.2 Mass of oxygen = 20 – 12 = **8 g** *[1 mark]*

4.1 23.2 – 25.4 = **–2.2 g** *[1 mark]*

4.2 E.g. the student is correct that no mass is lost or gained in a chemical reaction *[1 mark]*. The student isn't correct that the measurements must be wrong *[1 mark]*. Carbon dioxide has escaped from the reaction container *[1 mark]* so hasn't been counted in the final measurement *[1 mark]*.

Page 111 — Concentrations of Solutions

Warm-up

Unit	Mass	Volume
g	✓	
cm^3		✓
dm^3		✓
kg	✓	

1 When a solid is **dissolved** *[1 mark]* in a liquid, a solution is formed. The greater the mass of the solid, the **more** *[1 mark]* concentrated the solution. The larger the volume of liquid, the **less** *[1 mark]* concentrated the solution.

2.1 Conc. of calcium chloride = 28 g ÷ 0.4 dm^3 = **70 g/dm^3**

[1 mark for correct answer and 1 mark for correct units]

2.2 The concentration of a solution is the amount of a substance in a given volume of a solution *[1 mark]*.

2.3 Mass = conc. × volume = 50 g/dm^3 × 0.2 dm^3 = 10 g ***[2 marks for correct answer, otherwise 1 mark for using the correct equation.]***

Topic C4 — Chemical Changes

Page 112 — Acids and Bases

Warm-up

Substances with a pH of less than 7 are **acids**.

Substances with a pH of more than 7 are **bases**.

Substances with a pH of 7 are **neutral**.

1.1 beer *[1 mark]*

1.2 blue / blue-green *[1 mark]*

2.1 H^+ *[1 mark]*

2.2 0 *[1 mark]* – 14 *[1 mark]*

3.1 acid + alkali → salt + water *[1 mark]*

3.2 $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$ *[1 mark]*

You still get the mark if you didn't include state symbols.

3.3 7 *[1 mark]*

Pages 113-114 — Reactions of Acids

1 Hydrochloric acid — chloride

Nitric acid — nitrate

Sulfuric acid — sulfate ***[2 marks for all three correct, otherwise 1 mark for 1 correct]***

2.1 hydrogen *[1 mark]*

2.2 carbon dioxide *[1 mark]*

3.1 water *[1 mark]*

3.2 $2LiOH + H_2SO_4 \rightarrow Li_2SO_4 + 2H_2O$ *[1 mark]*

Topics C5 and C6

4.1

		Acid	
		Hydrochloric acid	Sulfuric acid
Metal hydroxide	Calcium hydroxide	Calcium chloride	**Calcium sulfate**
	Copper hydroxide	**Copper chloride**	**Copper sulfate**
	Magnesium hydroxide	**Magnesium chloride**	**Magnesium sulfate**

[2 marks for 5 correct answers, otherwise 1 mark for 3 correct answers]

4.2 hydrochloric acid + calcium hydroxide → calcium chloride + water *[1 mark]*

4.3 $Ca(OH)_2 + 2HCl \rightarrow \mathbf{CaCl_2} + 2\mathbf{H_2O}$ *[1 mark for correct formulas, 1 mark for correct balancing]*

5.1 zinc chloride *[1 mark]*

5.2 Add zinc oxide to hydrochloric acid until the reaction stops/ the excess metal oxide sinks to the bottom *[1 mark]*. Filter the excess solid from the solution using a filter funnel *[1 mark]*. Heat the zinc chloride solution to evaporate some of the water and then leave to cool *[1 mark]*. Filter and dry the crystals that form *[1 mark]*.

Page 115 — The Reactivity Series and Extracting Metals

1.1 potassium *[1 mark]*

1.2 copper *[1 mark]*

Metals below carbon in the reactivity series can be extracted by reduction with carbon.

1.3 potassium *[1 mark]*

2.1 Reduction is the loss of oxygen *[1 mark]*.

2.2 Element: carbon *[1 mark]*
Reason: It gains oxygen during the reaction *[1 mark]*

2.3 Magnesium is more reactive than carbon *[1 mark]*.

Page 116 — Reactions of Metals

1 metal + acid → salt + hydrogen *[1 mark]*

2.1 calcium + water → calcium hydroxide + hydrogen *[1 mark]*

2.2 Lithium, calcium, magnesium, copper *[2 marks for correct answer, otherwise 1 mark for 2 metals in the correct places]*

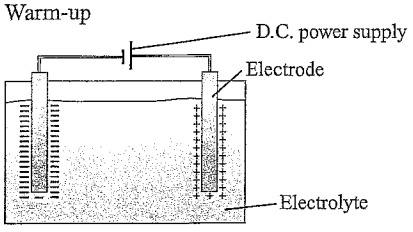
2.3 E.g. use the same volume of water / use the same amount of metal / use the same surface area of metal *[1 mark]*.

2.4 Magnesium chloride *[1 mark]* and copper *[1 mark]*

2.5 A more reactive metal will displace a less reactive metal from its compound *[1 mark]*.

Pages 117-118 — Electrolysis

Warm-up



1.1 So the ions can move to the electrodes *[1 mark]*.

1.2 In electrolysis, the anode is the **positive** *[1 mark]* electrode. **Negative** *[1 mark]* ions move towards the anode and **lose** *[1 mark]* electrons. The cathode is the **negative** *[1 mark]* electrode. **Positive** *[1 mark]* ions move towards the cathode and **gain** *[1 mark]* electrons.

2.1 A liquid or solution that can conduct electricity *[1 mark]*.

2.2 lead bromide → lead + bromine *[1 mark]*

3.1 molten aluminium *[1 mark]*

3.2 To lower the melting point of the electrolyte *[1 mark]*.

3.3 Carbon in the electrode reacts with oxygen to form carbon dioxide *[1 mark]*, so it breaks down over time *[1 mark]*.

4.1 O^{2-} *[1 mark]*

4.2 Iron is more reactive than hydrogen *[1 mark]*.

4.3 chlorine *[1 mark]*

Topic C5 — Energy Changes

Page 119 — Exothermic and Endothermic Reactions

1 An exothermic reaction is one that **gives out** *[1 mark]* energy. This is shown by a **rise** *[1 mark]* in the temperature of the surroundings.

2.1 The products have less energy than the reactants *[1 mark]*.

2.2 thermal decomposition *[1 mark]*

3.1 The temperature of the surroundings goes down *[1 mark]*.

3.2 From the surroundings *[1 mark]*.

3.3 It stays the same *[1 mark]*.

3.4 E.g. a sports injury pack *[1 mark]*.

Page 120 — Measuring Energy Changes

1.1 Change: e.g. put the polystyrene cup in a beaker filled with cotton wool / add a lid to the polystyrene cup *[1 mark]*.
Reason: e.g. to reduce the amount of energy lost to the surroundings *[1 mark]*.

1.2 4, 2, 1, 3 *[2 marks for all four correct, otherwise 1 mark for 2 correct answers]*

1.3 31 – 18 = **13 °C** *[1 mark]*

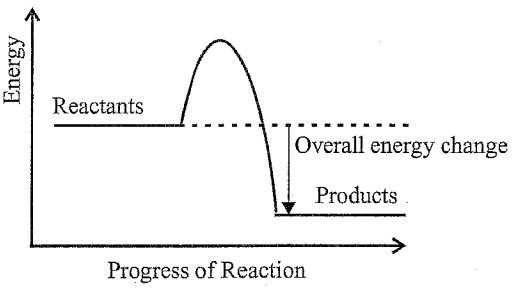
1.4 Independent: concentration of acid *[1 mark]*
Dependent: temperature change *[1 mark]*

Page 121 — Reaction Profiles

1.1 activation energy *[1 mark]*

1.2 A *[1 mark]*

2.1



[1 mark]

2.2 Type of reaction: exothermic *[1 mark]*
Reason: e.g. the products have less energy than the reactants / the reaction gives out energy to the surroundings *[1 mark]*.

Topic C6 — The Rate and Extent of Chemical Change

Page 122 — Rates of Reaction

1.1 The particles colliding more often *[1 mark]*.
The particles colliding with more energy *[1 mark]*.

1.2 At the start *[1 mark]*

2.1 reaction B *[1 mark]*

2.2 The reaction has finished / no more product is being formed *[1 mark]*.

Page 123 — Factors Affecting Rates of Reaction

Warm-up

You should have circled the reaction that uses the lump of calcium carbonate.

1 Decreasing the pressure of the reaction will cause the rate of reaction to **decrease** *[1 mark]*. This is because the same number of particles are in a **larger** *[1 mark]* space, so they will collide **less** *[1 mark]* frequently.

2.1 Using a larger volume of the solution, but keeping the concentration the same *[1 mark]*.

Topic C6

2.2 Adding a catalyst decreases the activation energy needed for the reaction to occur *[1 mark]*.

Page 124 — Measuring Rates of Reaction

1 Gas syringe *[1 mark]*
Mass balance *[1 mark]*

2.1 Concentration: B *[1 mark]*
Reason: More gas was produced in the same period of time *[1 mark]*.

2.2 Dependent variable: volume of gas produced *[1 mark]*
Independent variable: concentration of acid *[1 mark]*

2.3 Any one from: e.g. the volume of the acid / the mass of the marble chips / the surface area of the marble chips / the temperature *[1 mark]*.

Page 125 — More on Measuring Rates

1 If the rate is higher than the rate of the original reaction, the cross will disappear **more quickly** *[1 mark]*.
If the rate is lower than the rate of the original reaction, the cross will disappear **more slowly** *[1 mark]*.

2.1

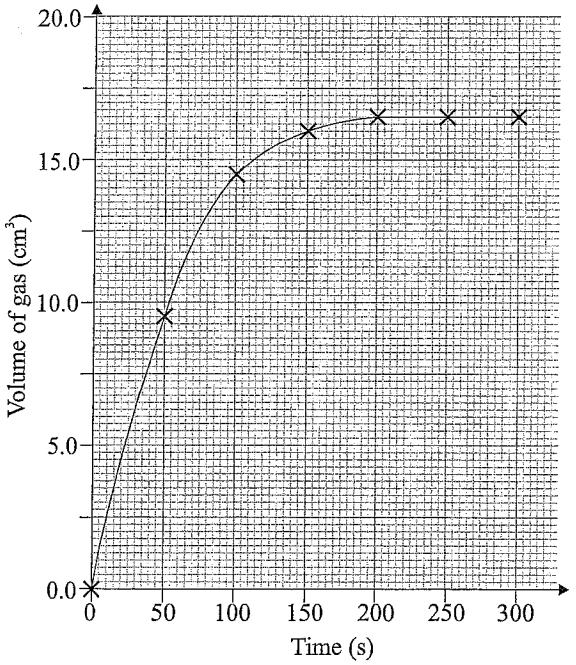
Concentration of hydrochloric acid (g/dm^3)	15	30	45	**60**	75
Time taken for mark to disappear (s)	**194**	187	**181**	174	168

[3 marks — 1 mark for each correct answer]

2.2 The results are subjective / they may not have agreed over the exact point when the mark disappears *[1 mark]*.

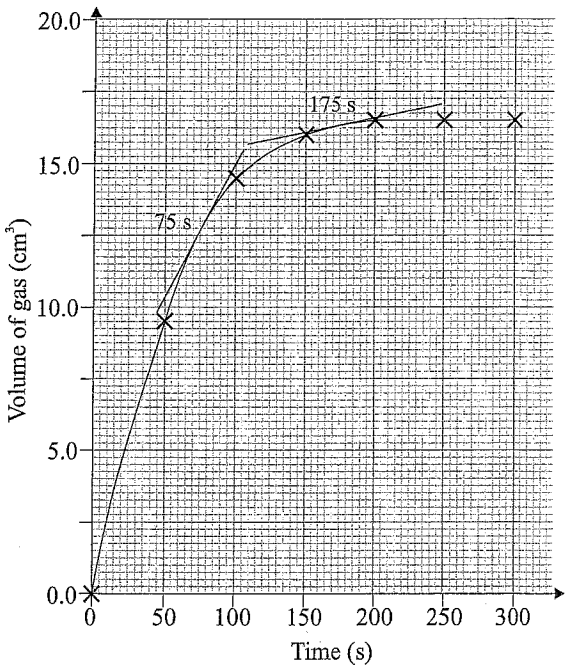
Page 126 — Graphs of Reaction Rate Experiments

1.1



[2 marks for all points plotted correctly, or 1 mark for at least 5 points plotted correctly, 1 mark for line of best fit]

1.2



[2 marks — 1 mark for each correct tangent]

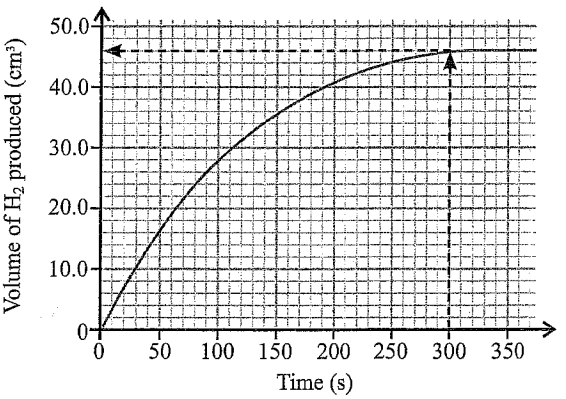
1.3 Time: 75 s *[1 mark]*
Reason: The tangent at 75 s is steeper than the tangent at 175 s *[1 mark]*.

Page 127 — Working Out Reaction Rates

1.1 $40 \div 125 = \mathbf{0.32}$ units *[2 marks for correct answer, otherwise 1 mark for correct working]*

1.2 cm^3/s *[1 mark]*

2.1

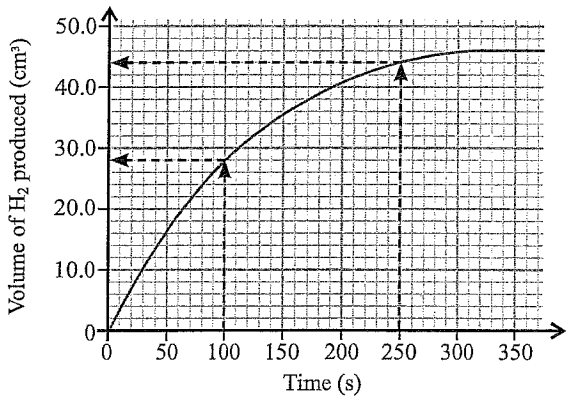


mean rate = amount of product formed ÷ time
$= 46.0 \div 300 = 0.1533... = \mathbf{0.153\ cm^3/s}$
[2 marks for correct answer, otherwise 1 mark for correct working]

You can work out from a graph when a reaction has finished by finding the point where the line goes flat.

Topics C7 and C8

2.2



volume of H_2 produced = 44.0 – 28.0 = 16 cm^3
time difference = 250 – 100 = 150 s
mean rate = amount of product formed ÷ time
= 16.0 ÷ 150 = 0.10666... = **0.107 cm^3/s**
[4 marks for correct answer, otherwise 1 mark for working out the volume of H_2 produced, 1 mark for calculating the time difference and 1 mark for correct working when calculating the mean rate]

Page 128 — Reversible Reactions

1 ⇌ *[1 mark]*
2 1 When the reaction is going in the forward direction, there will be more **products** *[1 mark]* than **reactants** *[1 mark]*.
2 The energy **taken in** *[1 mark]* by the endothermic reaction is **the same as** *[1 mark]* the amount **given out** *[1 mark]* during the exothermic reaction.
3.1 At equilibrium, the rate of the forward reaction is equal to the rate of the backwards reaction *[1 mark]*.
3.2 A closed system stops the reactants and products from escaping and prevents anything else getting in *[1 mark]*.

Topic C7 — Organic Chemistry

Page 129 — Hydrocarbons

1.1 **A** *[1 mark]*
1.2 **B** *[1 mark]*
2.1 A compound that is formed from hydrogen and carbon atoms *[1 mark]* only *[1 mark]*.
2.2 alkane + oxygen → **carbon dioxide** + **water** *[1 mark]*
2.3 oxidation *[1 mark]*
3.1 **B**, **D**, and **E** *[1 mark]*. They fit the general formula for the alkanes / of C_nH_{2n+2} *[1 mark]*.
3.2 butane *[1 mark]*
3.3 $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$ *[3 marks — 1 mark for each correct number]*

Page 130 — Crude Oil

Warm-up
diesel oil, petrol, liquefied petroleum gas and kerosene should be circled.
1.1 Crude oil is formed from **plankton** *[1 mark]* and the remains of other plants and animals that were buried in **mud** *[1 mark]* millions of years ago. Crude oil is being used up much more quickly than it's being made, so it's a **finite** *[1 mark]* resource.
1.2 Any two from: e.g. polymers / solvents / lubricants / detergents *[1 mark for each]*.
2.1 Carbon atoms bond together to form different groups of compounds *[1 mark]*.
2.2 it increases *[1 mark]*
2.3 E.g. how flammable it is / how viscous it is *[1 mark]*.

Page 131 — Fractional Distillation

1.1 A *[1 mark]*
1.2 E *[1 mark]*
1.3 B *[1 mark]*
2.1 Change of state: condensation / the vapour turns from a gas to a liquid *[1 mark]*
Explanation: fractionating column becomes cooler as you go up it so the gases condense / change from a gas to a liquid *[1 mark]*.
2.2 How to grade your answer:
Level 0: Nothing written that answers the question *[No marks]*.
Level 1: Basic outline of how fractional distillation works is given but it lacks detail. No link is made between the boiling points and the chain lengths of hydrocarbons *[1 to 2 marks]*.
Level 2: Some explanation of how the separation of hydrocarbons is linked to their chain length is given. The explanation is not complete *[3 to 4 marks]*.
Level 3: A full explanation of why hydrocarbons separate into fractions depending on chain length is given. The explanation includes details of the change in temperature in the fractionating column, the link between chain length and boiling point, and the changes of state in the fractionating column *[5 to 6 marks]*.
Here are some points your answer may include:
The fractionating column is hot at the bottom and gets cooler as you go up.
Hydrocarbons of similar chain lengths have similar boiling points.
So they will condense at similar temperatures.
Longer hydrocarbons have high boiling points.
They'll only stay a gas when it's very hot. So they condense and drain out of the fractionating column near the bottom where the temperature is still high.
Shorter hydrocarbons have low boiling points.
They stay gases even at lower temperatures. So they condense and drain out of the fractionating column near the top where the temperature is cooler.

Page 132 — Cracking

1.1 cracking *[1 mark]*
1.2 alkanes *[1 mark]*, alkenes *[1 mark]*
1.3 E.g. shorter chain hydrocarbons are more useful/can be used for more applications than long chain hydrocarbons *[1 mark]*.
2.1 The long-chain hydrocarbons are vaporised *[1 mark]*. The hydrocarbon vapour is mixed with steam and heated to a high temperature *[1 mark]*.
2.2 E.g. in catalytic cracking the hydrocarbon vapour is passed over a catalyst rather than being mixed with steam *[1 mark]*.
2.3 C_5H_{10} *[1 mark]*
2.4 $C_{12}H_{26} \rightarrow C_6H_{14} + C_3H_6$ *[2 marks — 1 mark for each correct number]*
2.5 Add orange bromine water to each sample you are testing *[1 mark]*. If the sample is an alkene (pentene), it will react with the bromine water and turn colourless *[1 mark]*. If the sample is an alkane (hexane), it won't react with the bromine water and it will remain orange *[1 mark]*.

Topic C8 — Chemical Analysis

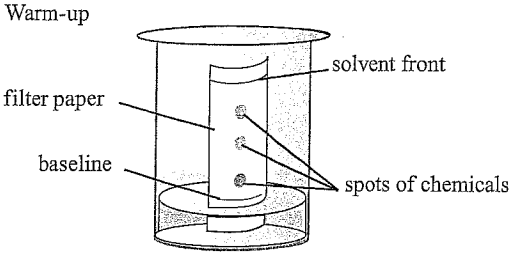
Page 133 — Purity and Formulations

1.1 The mixture is made up of less than five parts *[1 mark]*.
1.2 Any one from: e.g. medicines / cleaning products / fuels / cosmetics / fertilisers / metal alloys *[1 mark]*.
2.1 A single element or compound not mixed with any other substance *[1 mark]*.
2.2 Sample **A** *[1 mark]* because it melts at a specific temperature whereas sample B melts over a range of temperatures / sample A melts at a higher temperature than sample B *[1 mark]*.
2.3 It will increase the boiling point *[1 mark]*.

Topic C9

Page 134 — Paper Chromatography

Warm-up



1.1 The dyes moved in the mobile phase *[1 mark]*.

1.2 E.g. different substances are dissolved in the solvent/mobile phase for different amounts of time *[1 mark]*.

1.3 They're all pure substances *[1 mark]*.

Page 135 — Using Chromatograms

1.1 A *[1 mark]*

1.2 C *[1 mark]*

1.3 Repeat the experiment in different solvents *[1 mark]*. If they are made of the same substances, the spots on the chromatograms for the two food colourings will have matching R_f values in each solvent *[1 mark]*.

1.4 R_f = distance moved by substance ÷ distance moved by solvent
$R_f = 9.0 \div 12.0 = \mathbf{0.75}$
[2 marks for correct answer, otherwise 1 mark for correct working]

1.5 The scientist could run a reference/pure sample of the substance against food colouring A in different solvents *[1 mark]*. If a chemical spot in food colouring A matches the R_f of the substance in more than one solvent, then the substance is probably in food colouring A *[1 mark]*.

Page 136 — Tests for Gases

1.1 litmus paper *[1 mark]*

1.2 chlorine/Cl_2 *[1 mark]*

2.1 E.g. the gas could be toxic/an irritant *[1 mark]*

2.2 carbon dioxide *[1 mark]*

2.3 The gas was not hydrogen *[1 mark]*.

2.4 oxygen *[1 mark]*

Topic C9 — Chemistry of the Atmosphere

Page 137 — The Evolution of the Atmosphere

Warm-up

Animals evolved — 4

The early atmosphere formed — 1

The oceans formed — 2

Plants evolved — 3

1.1 One-fifth oxygen and four-fifths nitrogen *[1 mark]*.

1.2 Any two from: e.g. carbon dioxide / water vapour / named noble gas *[2 marks — 1 mark for each correct answer]*

1.3 By algae and plants photosynthesising *[1 mark]*.

1.4 By volcanic activity *[1 mark]*.

2 How to grade your answer:

Level 0: There is no relevant information. *[No marks]*

Level 1 There is a brief description of how carbon dioxide was originally released into the atmosphere and one point briefly describing how it was later removed. *[1 to 2 marks]*

Level 2: There is some description of how carbon dioxide was originally released into the atmosphere and at least two points describing how it was later removed. *[3 to 4 marks]*

Level 3: There is a good description of how carbon dioxide was originally released into the atmosphere and detailed points describing how it was later removed. *[5 to 6 marks]*

Here are some points your answer may include:
In the first billion years of Earth, carbon dioxide was released by erupting volcanoes that covered the Earth's surface.
The early atmosphere contained mostly carbon dioxide.
Over time, carbon dioxide was removed from the atmosphere.
Much of the carbon dioxide dissolved in the oceans.
Dissolved carbon dioxide formed carbonates that precipitated as sediments.
As sedimentary rocks, oil and gas were formed, carbon was trapped within them.
Green plants and algae took in carbon dioxide through photosynthesis.
There is now less than 1% carbon dioxide in the atmosphere.

Page 138 — Greenhouse Gases and Climate Change

1.1 Nitrogen *[1 mark]*

1.2 The sun gives out **short** *[1 mark]* wavelength radiation.
The Earth reflects this as **long** *[1 mark]* wavelength radiation.
This radiation is **absorbed** *[1 mark]* by greenhouse gases and then given out in all directions.
Some heads back to Earth and **warms** *[1 mark]* the Earth's surface.

2.1 The graph shows an increase in carbon dioxide levels in the atmosphere between 1960 and 2015 *[1 mark]*.

2.2 E.g. deforestation / burning fossil fuels / agriculture / producing waste *[1 mark]*

2.3 The Earth's climate is very complex so it's hard to make models that aren't oversimplified *[1 mark]*.

2.4 E.g. rising sea levels / certain areas getting too much or too little rain / more frequent and severe storms / temperature and rainfall changes affecting food production *[1 mark]*.

Page 139 — Carbon Footprints

1.1 Governments are worried that reducing carbon footprints could lead to sea levels rising *[1 mark]*.

1.2 Producing more waste — increase.
Using more renewable energy resources — decrease.
Using more fossil fuels — increase.
Using processes that require more energy — increase.
Capturing carbon dioxide and storing it underground — decrease.
[3 marks for all 5 correct, otherwise 2 marks for 4 correct and 1 mark for 2 correct]

2.1 A measure of the amount of carbon dioxide and other greenhouse gases *[1 mark]* released over the full life cycle of something *[1 mark]*.

2.2 Any two from, e.g. lack of education / reluctance to change their lifestyle / cost of changing lifestyle *[2 marks — 1 mark for each correct answer]*.

Page 140 — Air Pollution

1 Sulfur dioxide — combustion of fossil fuels that contain sulfur impurities.
Nitrogen oxides — reaction of gases in the air caused by the heat of burning fossil fuels.
Particulates — incomplete combustion of hydrocarbons.
[2 marks, otherwise 1 mark for one correct answer]

2.1 Sulfur dioxide / nitrogen oxides/nitrogen monoxide/nitrogen dioxide/dinitrogen monoxide *[1 mark]*

2.2 Any two from: e.g. damage to plants / buildings / statues / metals *[2 marks — 1 mark for each correct answer]*.

3.1 Nitrogen oxides cause respiratory problems *[1 mark]* and contribute to acid rain *[1 mark]*.

3.2 E.g. they can cause respiratory problems *[1 mark]*.

3.3 Name: carbon monoxide *[1 mark]*.
Reason: it is colourless and odourless *[1 mark]*.

Topics C10 and P1

Topic C10 — Using Resources

Page 141 — Finite and Renewable Resources

1.1 Resource: coal *[1 mark]*
Reason: e.g. it does not form as fast as humans can use it *[1 mark]*.

1.2 A resource that can be remade/replaced as fast it is being used *[1 mark]*.

1.3 E.g. natural rubber / wool / fresh water / food *[1 mark]*

2.1 E.g. the development of fertilisers has meant more crops can be grown in a given area *[1 mark]*.

2.2 E.g. synthetic rubber has replaced natural rubber / poly(ester) has replaced cotton in clothes / bricks are used instead of timber in construction *[1 mark]*.

Page 142 — Reuse and Recycling

1.1 Different metals must always be completely separated before they can be recycled *[1 mark]*.

1.2 Glass products are **crushed** *[1 mark]* and then **melted** *[1 mark]*. They are then **reshaped** *[1 mark]* to make other products for a different use. This process uses **less** *[1 mark]* energy than making new glass.

2.1 Raw material: paper *[1 mark]*
Reason: e.g. plant fibre is a renewable source *[1 mark]*.

2.2 Any one from: e.g. reusing a stainless steel mug would mean less waste would end up in landfill compared to using paper cups only once / overall less energy would be needed to make one stainless steel mug compared to making lots of paper cups *[1 mark]*.

Page 143 — Life Cycle Assessments

Warm-up
Getting the Raw Materials — Coal being mined from the ground.
Manufacture and Packaging — Books being made from wood pulp.
Using the Product — A car using fuel while driving.
Product Disposal — Plastic bags going to landfill.

1 It looks at every stage of a product's life to assess the impact on the environment *[1 mark]*.

2.1 E.g. mining metals can damage the environment / extracting/processing metals uses lots of energy / extracting/processing metals causes pollution *[1 mark]*.

2.2 Burning fossil fuels releases greenhouse gases/harmful substances *[1 mark]*.

2.3 E.g. landfill sites take up space / landfill sites pollute land and water / transporting waste to landfill sites takes lots of energy / transporting waste to landfill sites can release pollutants *[2 marks — one mark for each correct answer]*.

Page 144 — Using Life Cycle Assessments

1 selective life cycle assessment *[1 mark]*

2.1 E.g. less waste is produced during the manufacture / they can be reused several times *[2 marks — 1 mark for each correct answer]*.

2.2 Any two from: e.g. energy used in extraction / energy used in manufacture / energy used in transportation of materials/bags/waste / pollutants produced during extraction / pollutants produced during manufacture / pollutants produced during transportation of materials/bags/waste *[2 marks — 1 mark for each correct answer]*.

Page 145 — Potable Water

Warm-up
rivers, lakes, reservoirs

1.1 Water that is safe to drink *[1 mark]*.

1.2 groundwater/water trapped in rocks underground *[1 mark]*

2.1 passing water through filter beds — solid waste *[1 mark]*
sterilisation — microbes *[1 mark]*

2.2 E.g. chlorine / ozone / ultraviolet light *[3 marks — 1 mark for each correct answer]*.

Page 146 — Desalination

1 **A**: Bunsen burner *[1 mark]*
B: round bottom flask *[1 mark]*
C: thermometer *[1 mark]*
D: condenser *[1 mark]*

2.1 The membrane lets water molecules pass through but traps the salts *[1 mark]*.

2.2 E.g. processing fresh water takes less energy than desalination processes *[1 mark]* which makes it less expensive *[1 mark]*.

Page 147 — Waste Water Treatment

1.1 organic matter *[1 mark]*, harmful microbes *[1 mark]*

1.2 It may contain harmful chemicals which need to be removed *[1 mark]*.

2.1 To remove grit *[1 mark]* and large bits of material/twigs/plastic bags *[1 mark]*.

2.2 Substance **A**: sludge *[1 mark]*
Substance **B**: effluent *[1 mark]*

2.3 anaerobic digestion *[1 mark]*

Topic P1 — Energy

Page 148 — Energy Stores and Systems

1 A car slowing down without braking. — kinetic energy store
A mug of hot tea cooling down. — thermal energy store
A stretched spring returning to its original shape. — elastic potential energy store
A battery in a circuit. — chemical energy store
[3 marks for all four correct, otherwise 2 marks for two correct and 1 mark for one correct]

2.1 An object or a group of objects *[1 mark]*.

2.2 From top to bottom: false, true, false.
[1 mark for each correct answer]

Page 149 — Conservation of Energy and Energy Transfers

1 Energy can be created.
Energy can be destroyed.
[1 mark for each correct answer, otherwise no marks if more than two boxes have been ticked]

2.1 Energy is transferred from: the apple's gravitational potential energy store *[1 mark]*
Energy is transferred to: the apple's kinetic energy store *[1 mark]*

2.2 As the apple falls, **work** is done on the apple by the **gravitational** force. This means energy is transferred **mechanically**. *[1 mark for each correct answer]*

3 Energy is transferred mechanically *[1 mark]* from the bicycle's kinetic energy store *[1 mark]* to the thermal energy store of the brake pads *[1 mark]*.

Page 150 — Kinetic and Potential Energy Stores

1 $E_e = \frac{1}{2}ke^2 = \frac{1}{2} \times 20 \times 0.01^2$ *[1 mark]* = **0.001 J** *[1 mark]*

2.1 $E_p = mgh$ *[1 mark]*

2.2 $E_p = 0.50 \times 9.8 \times 2.0$ *[1 mark]* = **9.8 J** *[1 mark]*

2.3 To rearrange the equation for speed, multiply both sides by 2:
$2 \times \text{kinetic energy} = \text{mass} \times (\text{speed})^2$
Then divide both sides by mass:
$(2 \times \text{kinetic energy}) \div \text{mass} = (\text{speed})^2$
Then take the square root of both sides to get:
$\text{speed} = \sqrt{(2 \times \text{kinetic energy}) \div \text{mass}}$ *[1 mark]*
$= \sqrt{(2 \times 9.8) \div 0.50}$ *[1 mark]*
$= 6.260...$ = **6.3 m/s (to 2 s.f.)** *[1 mark]*

If you got a different answer in question 2.2, you would still get the marks here if you used your answer and the correct method.

Topic P1

Page 151 — Energy Transfers by Heating

Warm-up

The energy needed to raise the temperature of 1 kg of a substance by 1 °C.

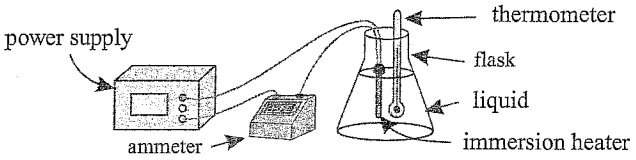
1 An electric kettle is used to heat some water. When the kettle is on, energy is transferred **electrically** to the thermal energy store of the kettle's heating element. The energy is then transferred **by heating** to the water. The energy is transferred to the water's **thermal** energy store.
[3 marks —1 mark for each correct answer]

2.1 First convert 200 g into kg:
$200 \div 1000 = 0.2$ kg *[1 mark]*
Then rearrange the equation $\Delta E = mc\Delta\theta$ for the change in temperature:
$\Delta\theta = \Delta E \div (mc)$
$= 9000 \div (0.2 \times 900)$ *[1 mark]*
$=$ **50 °C** *[1 mark]*

2.2 The amount of energy needed to heat the copper block is **less than** the amount of energy needed to heat the aluminium block. *[1 mark]*

Page 152 — Investigating Specific Heat Capacity

1.1



[3 marks for all correct labels, otherwise 2 marks for three correct labels and 1 mark for two correct labels]

1.2 From top to bottom: liquid C, liquid B, liquid A. *[1 mark]*

1.3 Putting insulation around the flask. *[1 mark]*

Page 153 — Power

Warm-up

Power is the **rate of** energy transfer or **work done**.
It is measured in **watts**.

1 B *[1 mark]*

2.1 Rearrange the equation for work done:
$W = Pt$ *[1 mark]* $= 35 \times 600$ *[1 mark]* $=$ **21 000 J** *[1 mark]*

2.2 $P = E \div t$ *[1 mark]*
so $t = E \div P$ *[1 mark]* $= 16\,800 \div 35$ *[1 mark]*
$=$ **480 s** *[1 mark]*

Page 154 — Reducing Unwanted Energy Transfers

1 Energy is **always** wasted when the handle is turned. The bucket rises faster when **less** energy is wasted. The speed at which the bucket rises will be increased by **lubricating** the **axle**. *[4 marks — 1 mark for each correct answer]*

2 D *[1 mark]*. Bricks that are thicker and with a lower thermal conductivity will transfer energy through them more slowly *[1 mark]*. So the rate of cooling of the house is lower, which means the house is more efficient *[1 mark]*.

3 Some of the energy transferred to the phone is dissipated/wasted *[1 mark]* to the thermal energy store of the phone *[1 mark]*.

Page 155 — Efficiency

1.1 Whenever energy is transferred, some energy is wasted. *[1 mark]*

1.2 B *[1 mark]*

1.3 Kettle *[1 mark]*

In order to compare the efficiencies, it's best to convert one of the values so they're both a percentage, or both a decimal. To find the efficiency of the kettle as a percentage: 0.75 × 100 = 75%. To find the efficiency of the toaster as a decimal: 68 ÷ 100 = 0.68.

2 $(16\,000 \div 20\,000) \times 100$ *[1 mark]*

3.1 Efficiency = Useful power output ÷ Total power input *[1 mark]*

3.2 Efficiency = 75% = 0.75
Total power input = Useful power output ÷ Efficiency *[1 mark]*
$= 57 \div 0.75$ *[1 mark]* $=$ **76 W** *[1 mark]*

Page 156 — Energy Resources and Their Uses

Warm-up

Renewable — bio-fuel, solar, tidal, geothermal, wave power, hydro-electricity, wind
Non-renewable — oil, coal, gas, nuclear fuel

1.1 coal, oil, (natural) gas
[3 marks — 1 mark for each correct answer]

1.2 E.g. generating electricity / heating
[2 marks — 1 mark for each correct answer]

1.3 Bio-fuel *[1 mark]*

2 E.g. non-renewable energy resources will run out one day *[1 mark]* but renewable energy resources will never run out *[1 mark]*.

Page 157 — Wind, Solar and Geothermal

1.1 Advantage:
Any one from: e.g. they produce no pollution once they're built / they do no permanent damage to the landscape
[1 mark for a correct answer].
Disadvantage:
Any one from: e.g. they're not reliable as they don't produce electricity when there's no wind/if it's too windy / supply of electricity can't be increased when there's extra demand
[1 mark for a correct answer].

1.2 E.g. geothermal power is reliable as the hot rocks are always hot *[1 mark]*.

2 How to grade your answer:
Level 0: There is no relevant information. *[No marks]*
Level 1: There is a brief description of how the reliability of each energy resource varies throughout the year. The answer uses at least one piece of data from the table. *[1 to 2 marks]*
Level 2: There is a detailed description of how the reliability of each energy resource varies throughout the year. A sensible conclusion as to why the university would choose both options has been made. At least two pieces of data from the table are used to provide evidence for the answer. *[3 to 4 marks]*

Here are some points your answer may include:
The average wind speed between October and March was higher than the average wind speed between April and September.
So wind turbines will be able to generate more electricity between October and March than between April and September.
Between April and September, the average number of daylight hours was higher than the average number of daylight hours between October and March.
So solar panels will be able to generate more electricity between April and September than between October and March.
So when one of the methods of generating electricity is producing less, the other method will be producing more.
By installing both, the university will have a more constant and reliable electricity supply throughout the year.

Page 158 — Hydro-electricity, Waves and Tides

1.1 They must be built near the coast. *[1 mark]*
They can disturb the habitats of animals. *[1 mark]*

1.2 Any one from: e.g. they can't respond straight away when there's extra demand for electricity / they're not as reliable because the waves die down when the wind drops.
[1 mark for one correct answer]

Topic P2

2 How to grade your answer:
Level 0: There is no relevant information. *[No marks]*
Level 1: There is a brief description of the reliability or environmental impact of one of the energy resources. *[1 to 2 marks]*
Level 2: There is a clear and detailed comparison of the reliability and environmental impacts of both energy resources, including similarities and differences between them. *[3 to 4 marks]*
Here are some points your answer may include:
Both energy resources are reliable.
We can predict the tides as the tides come in and out at known times.
Except in countries where it doesn't rain regularly, there is always water available for a hydro-electric power plant to work.
However, rain is less reliable than the tides.
Hydro-electric power plants can provide a constant supply of electricity.
There are times during the day when tidal barrages aren't producing electricity, as the water level on both sides of the barrage are the same.
Hydro-electric power plants can also increase their supply when there's extra demand, but tidal barrages can't.
Hydro-electric power plants require the flooding of valleys, which causes a loss of habitat for any animals and plants living there.
Tidal barrages also affect local wildlife — they change the habitat of nearby animals.
When hydro-electric power plants flood the valley, plants in the valley die and rot.
This releases gases that contribute to global warming.
Using tides to generate electricity creates no pollution.

Page 159 — Bio-fuels and Non-renewables

Warm-up
The waste produced is difficult to dispose of.
It is a non-renewable energy resource.
The radiation produced when using nuclear power is dangerous to humans.

1 From top to bottom: both, bio-fuels, fossil fuels.
[3 marks — 1 mark for each correct answer]

2 How to grade your answer:
Level 0: There is no relevant information. *[No marks]*
Level 1: There is a brief explanation of an advantage or a disadvantage of fossil fuels. *[1 to 2 marks]*
Level 2: There is some explanation of both advantages and disadvantages of fossil fuels. *[3 to 4 marks]*
Level 3: There is a clear and detailed explanation of the advantages and disadvantages of using fossil fuels. *[5 to 6 marks]*
Here are some points your answer may include:
Advantages:
Fossil fuels are reliable.
Power plants can respond quickly to changes in demand.
Disadvantages:
Fossil fuels are slowly running out / they are a non-renewable energy resource.
Burning fossil fuels releases carbon dioxide into the atmosphere.
Carbon dioxide in the atmosphere contributes to global warming.
Burning coal and oil also releases sulfur dioxide, which causes acid rain.
Acid rain can damage soil and trees. This can damage or destroy the habitats of animals.
Coal used for generating electricity is obtained by coal mining.
Coal mining can spoil the landscape by damaging it.
When drilling for oil to use to generate electricity, there is a risk of oil spills. Oil spillages kill sea life, birds and mammals that live near to the sea.

Page 160 — Trends in Energy Resource Use

1.1 56 + 10 + 16 = 82 %
[2 marks for correct answer, otherwise 1 mark for reading all three values correctly from the graph]

1.2 E.g. the country is using a larger percentage of renewable energy resources to generate electricity in 2015 than 1995 / overall, they are using a smaller percentage of fossil fuels to generate their electricity in 2015 than they were in 1995 / the percentage of electricity generated from nuclear power is lower in 1995 compared to 2015 *[1 mark]*.

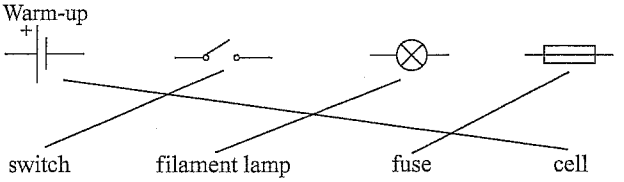
2.1 Any one from: e.g. we now know that burning fossil fuels is bad for the environment *[1 mark]*, so more people want to use renewable energy resources that damage the environment less *[1 mark]* / fossil fuel reserves will run out *[1 mark]*, so we have to find an alternative for them *[1 mark]* / pressure from the public and other countries has lead to government targets for the use of renewable energy resources *[1 mark]*, which puts pressure on energy providers to build power plants that use renewable energy resources *[1 mark]*.

2.2 How to grade your answer:
Level 0: There is no relevant information. *[No marks]*
Level 1: At least two factors are given that slow down the rate at which renewable energy resource use is increasing. A brief explanation for one of the factors is given. *[1 to 2 marks]*
Level 2: There is a clear and detailed explanation of at least two factors that slow down the rate at which renewable energy resource use is increasing. *[3 to 4 marks]*
Here are some points your answer may include:
Building new power plants to replace existing fossil fuel powered ones is expensive.
Some renewable energy resources are less reliable than fossil fuels.
So a mixture of different resources would need to be used, which is also more expensive than just using fossil fuels.
Research into improving renewable energy resources costs money and will take time.
Energy companies are unlikely to pay for all these costs, so this extra cost needs to be paid through energy bills or taxes.
Governments may not want to raise taxes as it may make them unpopular with the public.
Some people don't want to or can't afford to pay the extra cost.
Personal products that use renewable energy resources, like hybrid cars, are generally more expensive than similar ones that use fossil fuels.

Topic P2 — Electricity

Page 161 — Current and Circuit Symbols

Warm-up



1.1 There is no source of potential difference *[1 mark]*
1.2 Current is the rate of flow of **electrical charge** *[1 mark]*.
2.1 charge flow = current × time *[1 mark]*
2.2 time = 2 × 60 = 120 s *[1 mark]*
charge = 0.5 × 120 *[1 mark]*
= **60** *[1 mark]* **coulombs** *[1 mark]*

Topic P2

Page 162 — Resistance and V = IR

1 potential difference = current × resistance
potential difference = 3 × 6 *[1 mark]* = **18 V** *[1 mark]*

2 At a fixed temperature, the **resistance** of an ohmic conductor will remain **constant** as the current though it is **changed**.
[3 marks — 1 mark for each correct answer]

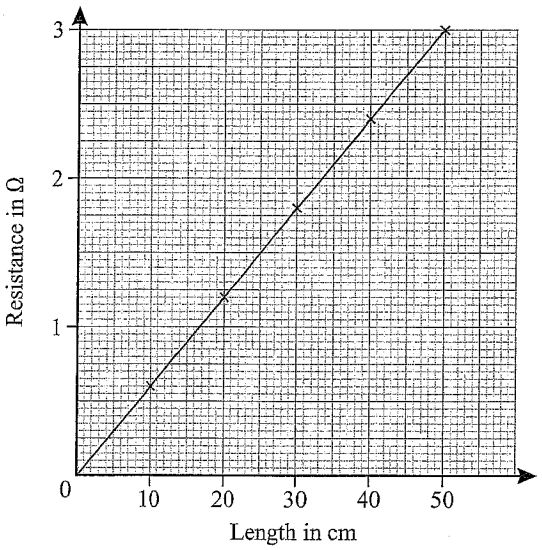
3.1 rearrange potential difference = current × resistance for resistance:
resistance = potential difference ÷ current *[1 mark]*
resistance = 25 ÷ 3 *[1 mark]*
= 8.333...Ω
= **8.3 Ω (to 2 s.f.)** *[1 mark]*

3.2 As the temperature of the filament lamp increases, its resistance increases *[1 mark]*. The higher the resistance, the lower the current through the lamp (for a fixed potential difference) *[1 mark]*.

Page 163 — Investigating Resistance

1.1 To calculate the resistance of each length of wire, the student **divided** the reading on the voltmeter by the reading on the **ammeter**. *[2 marks – 1 mark for each correct answer]*

1.2



[1 mark for plotting the point at 40 cm correctly, 1 mark for plotting the point at 50 cm correctly, 1 mark for a straight line of best fit passing through all points and the origin]

1.3 Resistance is directly proportional to length. *[1 mark]*

Page 164 — I-V Characteristics

1.1 B *[1 mark]*
B is the only graph that is a straight line, so it must be of the linear component.

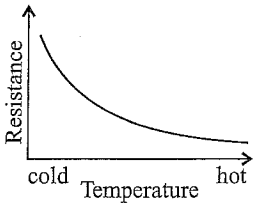
1.2 E.g. a fixed resistor *[1 mark]*

2.1 E.g. set the resistance of the variable resistor *[1 mark]*. Take readings of the current through and the potential difference across the component *[1 mark]*. Then change the resistance of the variable resistor and take readings of current and potential difference. Repeat this for a range of values *[1 mark]*.

2.2 Read potential difference, when current is 2.0 A, off the graph
potential difference = 6 V *[1 mark]*
potential difference = current × resistance *[1 mark]*
so, resistance = potential difference ÷ current
= 6 ÷ 2.0 *[1 mark]*
= **3 Ω** *[1 mark]*

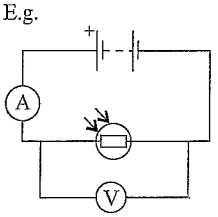
Page 165 — Circuit Devices

1



[1 mark]
Thermistors have a high resistance at low temperatures, and their resistance decreases as temperature increases.

2.1 E.g.



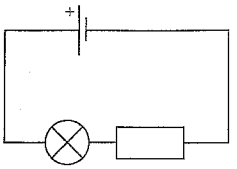
[1 mark for LDR, ammeter and battery in series, 1 mark for voltmeter in parallel across LDR]

2.2 It decreases *[1 mark]*.

2.3 E.g. automatic night lights (turning on a light when it gets dark) / burglar detectors *[1 mark]*

Page 166 — Series Circuits

1



[1 mark]

2.1 60 Ω *[1 mark]*
The total resistance in a series circuit is the sum of all the resistances in the circuit ($R_{total} = R_1 + R_2$).

2.2 Current = 0.05 A *[1 mark]*
The current is the same everywhere in a series circuit.

2.3 total potential difference = 3 V
potential difference = 3 – (1.2 + 0.6) *[1 mark]*
= **1.2 V** *[1 mark]*

Page 167 — Parallel Circuits

Warm-up
B

1.1 6 A *[1 mark]*
The total current in the circuit is split between the two branches, so the current through A_1 is found by adding the current through R_1 and R_2.

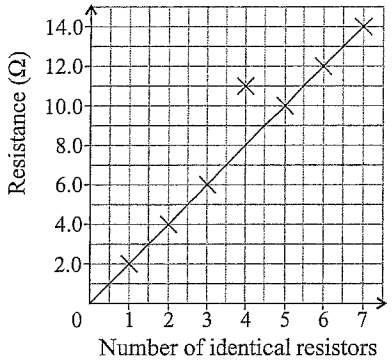
1.2 9 V *[1 mark]*
The total potential difference across each branch of a parallel circuit is the same.

1.3 The total resistance of the circuit in Figure 1 is smaller than in Figure 2. *[1 mark]*
Adding resistors in parallel decreases the total resistance of a circuit, so removing a resistor increases the resistance.

Topic P3

Page 168 — Investigating Circuits

1.1



[1 mark for straight line going through the origin and through all points except the anomalous result]

1.2 Resistance = 8.0 Ω

[1 mark for any correct answer read from your line of best fit for four resistors]

2 How to grade your answer:

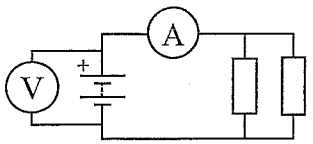
Level 0: There is no relevant information. ***[No marks]***

Level 1: There is a brief description of the method used to measure resistance of the circuit. The steps mentioned are not in a logical order. ***[1 to 2 marks]***

Level 2: There is a good description of the method used to measure the resistance of the circuit. Most steps are given in a logical order. A correct circuit diagram may be included. ***[3 to 4 marks]***

Level 3: A logical and detailed description is given. The method for investigating the effect of adding resistors in parallel is fully described. A correct circuit diagram may be included. ***[5 to 6 marks]***

Here are some points your answer may include:
Assume the potential difference is the same as the potential difference of the battery.
Measure the current through the circuit using the ammeter.
Calculate the resistance of the circuit using $R = V \div I$.
Connect a second identical resistor in parallel with the first resistor.
The second resistor should not be in parallel with the ammeter.
Measure the current and use this to calculate the resistance of the circuit.
Repeat this for several identical resistors.
A correct circuit diagram, similar to:



A correct diagram with at least two resistors in parallel is correct. You could also draw your circuit with several resistors in parallel, all separated with switches.

Page 169 — Electricity in the Home

Warm-up
Mains electricity is a supply of **alternating** current.
It is at **230** V and has a frequency of **50** Hz.

1.1 three-core cable ***[1 mark]***

1.2 neutral — blue
earth — green and yellow
live — brown
[2 marks for all three correct, 1 mark for one or two correct]

1.3 When an appliance is working normally, **current** flows to the appliance through the **live** wire, and away through the **neutral** wire. The **earth** wire will only carry current if there is a fault. ***[4 marks – 1 mark for each correct answer]***

1.4 They could get an electric shock ***[1 mark]***.

Page 170 — Power of Electrical Appliances

1 Electrically to the kinetic energy store of the car's motor. ***[1 mark]***

2 The **power** of an appliance is the energy transferred **per second**. Energy is transferred because the **charges** do work against the appliance's resistance. ***[3 marks – 1 mark for each correct answer]***

3.1 energy transferred = power × time ***[1 mark]***

3.2 rearrange energy transferred = power × time for time:
time = energy transferred ÷ power ***[1 mark]***
so time = 140 000 ÷ 700 ***[1 mark]*** = **200 s** ***[1 mark]***

3.3 Power is the rate of energy transfer, so the larger the power, the more energy it transfers per second ***[1 mark]***. So the 900 W microwave will transfer the same amount of energy in less time than the 700 W microwave ***[1 mark]***.

Page 171 — More on Power

1.1 power = 6 × 2 ***[1 mark]*** = **12 W** ***[1 mark]***

1.2 energy transferred = charge flow × potential difference ***[1 mark]***

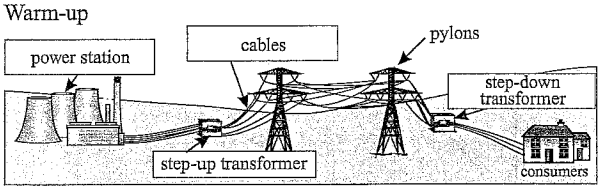
1.3 energy transferred = 4 × 6 ***[1 mark]*** = **24 J** ***[1 mark]***

2 current = $\sqrt{\frac{1500}{70}}$ ***[1 mark]***

Remember, 1.5 kW is equal to 1500 W.

Page 172 — The National Grid

Warm-up



1 It increases the output current and decreases the output potential difference. ***[1 mark]***

2 Transmitting electricity with a high current causes a lot of energy to be wasted due to heating ***[1 mark]***. The national grid uses step-up transformers to increase the potential difference of the electricity ***[1 mark]***. For a given power, increasing the potential difference decreases the current. ***[1 mark]***. This decreases the energy lost by heating which increases the efficiency of the national grid ***[1 mark]***.

Topic P3 — Particle Model of Matter

Pages 173 — The Particle Model and Motion in Gases

Warm-up
From left to right: liquid, solid, gas

1 The energy stored by the particles ***[1 mark]***.

2 The tyre pressure on a hot day will be higher than the tyre pressure on a cold day ***[1 mark]***.

3 The average energy in the kinetic energy stores of the gas particles decreases ***[1 mark]***. This decreases the average speed of the gas particles ***[1 mark]***.

Pages 174 — Density of Materials

1 a eureka can ***[1 mark]***

2.1 $\rho = m \div v$ ***[1 mark]***

2.2 $\rho = 28\,875 \div 1.5$ ***[1 mark]*** = 19 250
= **19 000 kg/m^3 (to 2 s.f.)** ***[1 mark]***

Topic P4

3 Level 0: There is no relevant information. ***[No marks]***
Level 1: There is some reference to finding the mass and volume of the liquid. There is no mention of how to calculate density. ***[1 to 2 marks]***
Level 2: There is a description of how to measure the volume and mass using the equipment given. There is a description of how these are used to find the density. ***[3 to 4 marks]***
Here are some points your answer may include:
Place the empty measuring cylinder on the mass balance.
Zero the mass balance.
Pour some acid into the measuring cylinder.
Write down the mass of the acid shown on the mass balance.
Read the volume of the acid from the scale on the measuring cylinder.
Use the equation density = mass ÷ volume to calculate the density of the acid.

Page 175 — Internal Energy and Changes of State

1 When a system is heated, the internal energy of the system **increases**. This either increases the **temperature** of the system or causes a change of state. During a change of state the temperature and the **mass** of the substance remain constant. ***[3 marks — 1 mark for each correct answer]***
2.1 Gas to liquid: condensing ***[1 mark]***
Liquid to gas: evaporating/boiling ***[1 mark]***
2.2 E.g. a change where you don't end up with a new material / you end up with the same material in a different form ***[1 mark]***.
3.1 E.g. the energy stored in a system by its particles. / The total energy in the kinetic and potential energy stores of the particles of a system ***[1 mark]***.
3.2 30 – 20 = 10 g ***[1 mark]***. E.g. because when a substance changes state, its mass doesn't change. So the mass of the water vapour equals the mass of the water that is no longer a liquid ***[1 mark]***.

Page 176 — Specific Latent Heat

1.1 Between 3 and 8 minutes. — Substance is melting. ***[1 mark]***
Between 24 and 35 minutes. — Substance is boiling. ***[1 mark]***
Between 8 and 24 minutes. — Substance is a liquid being heated. ***[1 mark]***
1.2 $E = mL$ so $L = E \div m$ ***[1 mark]***
$L = 34\,000 \div 0.50$ ***[1 mark]*** = **68 000 J/kg** ***[1 mark]***

Topic P4 — Atomic Structure

Pages 177 — The Current Model of the Atom

Warm-up
1×10^{-10} m
1.1 An atom is made of a **positively**-charged nucleus, surrounded by **electrons**. The nucleus contains **protons** and **neutrons**. The nucleus takes up most of the **mass** of the atom. ***[5 marks — 1 mark for each correct answer]***
You can swap protons and neutrons in the answer and you will still get the marks.
1.2 10 000 ***[1 mark]***
2.1 If an an atom absorbs electromagnetic radiation an electron moves to a higher energy level/away from the nucleus ***[1 mark]***. If an atom emits electromagnetic radiation an electron moves to a lower energy level/closer to the nucleus ***[1 mark]***. If an outer electron absorbs enough energy it can leave the atom ***[1 mark]***.
2.2 Positively-charged ***[1 mark]***. There are now more positively-charged protons than negatively-charged electrons ***[1 mark]***.

Page 178 — Isotopes and Nuclear Radiation

1.1 Isotopes — Atoms with the same number of protons but different numbers of neutrons.
Gamma — Nuclear radiation made up of electromagnetic waves.
Alpha particles — Particles made up of two neutrons and two protons.
[2 marks — 1 mark for one correct line drawn, 2 marks for all 3 correct lines drawn]
1.2 beta decay ***[1 mark]***
2.1 23 ***[1 mark]***
Remember that the mass number is the top number. It's the total number of protons and neutrons in the nucleus.
2.2 23 – 11 = 12 neutrons ***[1 mark]***
The number of neutrons is the difference between the mass number and the atomic number.
2.3 $^{24}_{11}Na$ ***[1 mark]***
An isotope has the same number of protons (so the same atomic number, the bottom number), but a different number of neutrons (so a different mass number).
3 E.g. alpha particles can't pass through paper ***[1 mark]***.
Gamma rays can pass through paper easily so the count-rate would not change much with the thickness of the paper ***[1 mark]***.

Page 179 — Nuclear Equations

Warm-up
$^{99}_{44}Ru \rightarrow {}^{99}_{44}Ru + {}^{0}_{0}\gamma$
1.1 Mass number: Doesn't change ***[1 mark]***.
Atomic number: Increases by 1 ***[1 mark]***.
1.2 It increases ***[1 mark]***.
2.1 $^{4}_{2}He$ / alpha particle ***[1 mark]***
2.2 a = 226 – 4
= 222 ***[1 mark]***
b = 88 – 2
= 86 ***[1 mark]***
2.3 $^{222}_{86}Rn \rightarrow {}^{218}_{84}Po + {}^{4}_{2}He$ ***[1 mark for correct mass numbers, 1 mark for correct atomic numbers and 1 mark for helium nucleus symbol]***

Page 180 — Half-life

1 The **half-life** is the time taken for the number of nuclei of a radioactive isotope in a sample to halve. The rate of decay of a radioactive isotope is called its **activity** and it is measured in **becquerels**. ***[3 marks — 1 mark for each correct answer]***
2.1 75 ***[1 mark]***
The initial count-rate is 60 cps. Half of this is 30 cps, which corresponds to 75 seconds on the time axis.
2.2 After 1 half-life, there will be 800 ÷ 2 = 400 undecayed nuclei remaining. After 2 half-lives, there will be 400 ÷ 2 = 200 undecayed nuclei remaining.
So 800 – 200 = **600** nuclei will have decayed.
[2 marks for correct answer, otherwise 1 mark for calculating the number of decayed/undecayed nuclei after one half-life]

Page 181 — Irradiation and Contamination

1 Work behind barriers that absorb radiation ***[1 mark]***.
2.1 Contamination is when unwanted radioactive particles get onto or into an object ***[1 mark]***. Irradiation is when an object is exposed to radiation ***[1 mark]***.
2.2 Any two from: e.g. wearing protective gloves / using tongs / wearing a protective suit or mask ***[2 marks]***.
3 Contamination ***[1 mark]***. Alpha particles cannot pass through skin, so the irradiation risk is lower ***[1 mark]***. However, as they are very ionising they could cause lots of damage inside the clockmaker's body if he was contaminated ***[1 mark]***.

Topic P5

Topic P5 — Forces

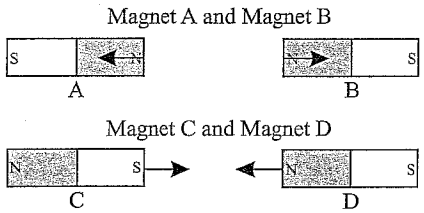
Page 182 — Contact and Non-Contact Forces

Warm-up
Scalar — mass, time, temperature
Vector — acceleration, weight, force

1 Vector quantities have both magnitude and direction *[1 mark]*.

2 Contact force: e.g. friction / tension / normal contact force *[1 mark]*
Non-contact force: e.g. weight / gravitational force *[1 mark]*

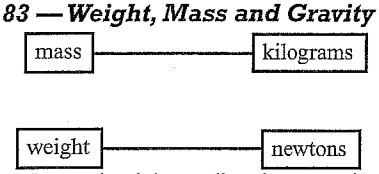
3



[1 mark for correct arrow length, 1 mark for correct direction]

Page 183 — Weight, Mass and Gravity

1



2 Mass and weight are directly proportional *[1 mark]*.

3.1 $W = mg$ *[1 mark]*

3.2 $W = 185 \times 9.8$ *[1 mark]*
$= 1813 =$ **1800 N (to 2 s.f.)** *[1 mark]*

3.3 $W = mg$ so $g = W \div m$ *[1 mark]*
$= 703 \div 185$ *[1 mark]*
$=$ **3.8 N/kg** *[1 mark]*

Page 184 — Resultant Forces and Work Done

1 C *[1 mark]*

The resultant force is the sum of the forces acting on each runner.
For runner C, the resultant force is 130 N − 100 N = 30 N.

2 $15 - 10 =$ **5 N** *[1 mark]*.
to the right *[1 mark]*

3.1 Work done = Force × distance $= 50 \times 15$ *[1 mark]*
$=$ **750 Nm** *[1 mark]*

3.2 The temperature of the wheels increases *[1 mark]*. This is because doing work causes some energy to be transferred to the thermal energy stores of the wheels *[1 mark]*.

Page 185 — Forces and Elasticity

1.1 One force would just make the spring move not change shape *[1 mark]*.

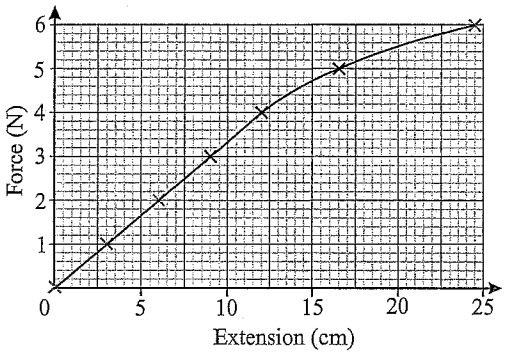
1.2 Elastic deformation *[1 mark]*

1.3 Inelastic deformation *[1 mark]*

2 force = spring constant × extension
so spring constant = force ÷ extension *[1 mark]*
spring constant $= 240 \div 0.2$ *[1 mark]* = **1200** *[1 mark]*
Unit = **N/m** *[1 mark]*

Page 186 — Investigating Springs

1.1



[2 marks for 3 points plotted correctly, otherwise 1 mark for 1-2 points plotted correctly. 1 mark for correct line of best fit.]

1.2 The limit of proportionality *[1 mark]*

2 Work done on spring = energy stored in the spring's elastic potential energy store
8 cm = 0.08 m *[1 mark]*
$E = \frac{1}{2}ke^2 = \frac{1}{2} \times 25 \times 0.08^2$ *[1 mark]* = **0.08 J** *[1 mark]*

Page 187 — Distance, Displacement, Speed and Velocity

1.1 7 m *[1 mark]*

1.2 12 m *[1 mark]*

1.3 2 m *[1 mark]*

As the scale is 1 cm = 1 m the number of metres measured is equal to the number of centimetres measured.

2.1 1.5 m/s (accept 1–2 m/s) *[1 mark]*

2.2 Any three from: e.g. fitness / age / distance travelled / terrain *[3 marks — 1 mark for each correct answer]*

2.3 $s = vt$ / distance = speed × time *[1 mark]*

2.4 time = distance travelled ÷ speed *[1 mark]*
distance travelled = 6 km = 6000 m *[1 mark]*
so time $= 6000 \div 1.5$ *[1 mark]*
$=$ **4000 s (accept 3000–6000 s)** *[1 mark]*

Page 188 — Acceleration

Warm-up
9.8 m/s^2

1 Moving with decreasing velocity *[1 mark]*

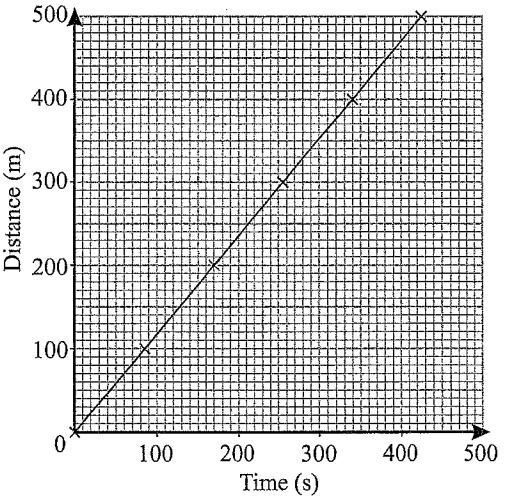
2.1 $a = \Delta v \div t$ *[1 mark]*

2.2 $a = \Delta v \div t = 4 \div 1$ *[1 mark]* = **4 m/s^2** *[1 mark]*

3 $v^2 - u^2 = 2as$ so
$a = (v^2 - u^2) \div 2s$ *[1 mark]*
$= (32^2 - 18^2) \div (2 \times 350)$ *[1 mark]*
$=$ **1.0 m/s^2** *[1 mark]*

Page 189 — Distance-Time Graphs

1.1



[2 marks for 3 points plotted correctly, otherwise 1 mark for 1-2 points plotted correctly. 1 mark for straight line through all points.]

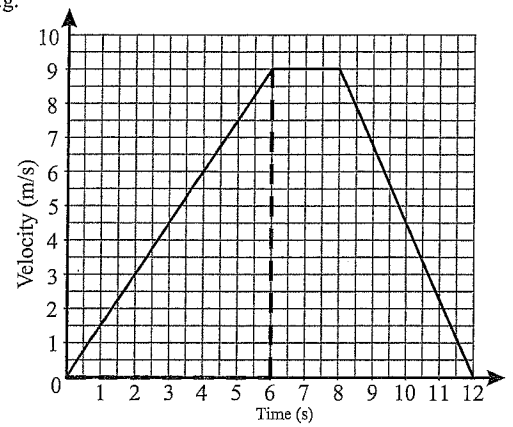
Topic P6

1.2 360 m (accept 350–370 m) *[1 mark]*
1.3 210 s (accept 200–220 s) *[1 mark]*
1.4 The boat's speed stays constant *[1 mark]*

Page 190 — Velocity-Time Graphs and Terminal Velocity

1 The resultant vertical force on an object falling at its terminal velocity is zero.
Terminal velocity is the maximum velocity an object can fall at. *[1 mark for both correct]*

2.1 E.g.



$a = \Delta v \div t$ / gradient of line *[1 mark]*
acceleration = $(9 - 0) \div (6 - 0)$ *[1 mark]* = **1.5 m/s²** *[1 mark]*

2.2 6 s and 8 s *[1 mark]*

Page 191 — Newton's First and Second Laws

1 If the resultant force on a stationary object is zero, the object will remain stationary *[1 mark]*.

2 Newton's Second Law states that the acceleration of an object is directly proportional to the **resultant** force acting on the object. Newton's Second Law also says that the acceleration is inversely proportional to the **mass** of the object.
[2 marks — 1 mark for each correct answer]

3 $F = ma$ so $a = F \div m$ *[1 mark]*
F = 2400 N, m = 400 kg
so $a = 2400 \div 400$ *[1 mark]* = **6** *[1 mark]*
Unit = **m/s²** *[1 mark]*

Page 192 — Newton's Third Law

Warm-up
When two objects interact, they exert equal and opposite forces on each other.

1 100 N *[1 mark]*
2.1 320 N *[1 mark]*
2.2 640 N *[1 mark]*

Page 193 — Investigating Motion

1.1 The mass of the hook and the trolley *[1 mark]*.
1.2 The acceleration of the trolley is directly proportional to the force acting on it / As force increases, the acceleration of the trolley increases *[1 mark]*.
1.3 E.g. at a force of 2.0 N, the acceleration is 1.0 m/s²
So $m = F \div a$ *[1 mark]* = 2.0 ÷ 1.0 *[1 mark]*
= **2 kg** *[1 mark]*
You'll still get the marks if you took readings from a different part of the graph, so long as you get the correct final answer.
1.4 The acceleration will be smaller / The acceleration will decrease *[1 mark]*.

Page 194 — Stopping Distance and Thinking Distance

1 36 m *[1 mark]*
Stopping distance = thinking distance + braking distance
2.1 The distance travelled during the driver's reaction time *[1 mark]*
2.2 The distance travelled under the braking force of the vehicle *[1 mark]*
3 Any three from: tiredness / alcohol / drugs / distractions
[3 marks — 1 mark for each correct answer]
4 Slower reaction times results in a longer thinking distance / stopping distance *[1 mark]*. This means the car is more likely to hit the object it's trying to avoid before stopping *[1 mark]*.

Page 195 — Braking Distance

Warm-up
Circled answers: Smooth road surface, Ice on the road, Bald tyres
Snow on the road

1 The brakes may overheat *[1 mark]*,
the driver may lose control *[1 mark]*.
2 The temperature of the brakes increases *[1 mark]*. Energy is transferred from the kinetic energy store of the vehicle to the thermal energy stores of the brakes *[1 mark]*.
3 Level 0: There is no relevant information. *[No marks]*
Level 1: There is a brief explanation of why good tyres are important. There is some explanation as to the safety implications of poor tyres. *[1 to 2 marks]*
Level 2: A detailed and clear explanation of the importance of having the tyres in good condition. The effects on stopping distance and overall safety are clearly stated. *[3 to 4 marks]*
Here are some points your answer may include:
Bald tyres cannot get rid of water on the road.
This can lead to them skidding on the water.
So having tyres in a good condition helps to stop your car skidding in wet conditions.
Skidding increases the stopping distance.
This decreases the overall safety.
So having tyres in a good condition increases the safety of driving in wet conditions.

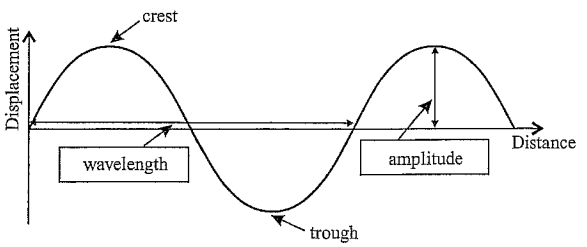
Pages 196 — Reaction Times

1 0.2 - 0.9 s *[1 mark]*
2.1 E.g. clicking a mouse when a computer screen changes colour *[1 mark]*
2.2 Student A: $(7.0 + 7.1 + 6.9) \div 3$ = **7.0 cm** *[1 mark]*
Student B: $(8.4 + 8.2 + 8.3) \div 3$ = **8.3 cm** *[1 mark]*
2.3 Student C *[1 mark]*.
2.4 Any two from: e.g. use the same ruler / always have the same person dropping the ruler / test the students at the same time of day / remove distractions for all students.
[2 marks — 1 mark for each correct answer]
2.5 Their reaction times are likely to get longer *[1 mark]*.

Topic P6 — Waves

Page 197 — Transverse and Longitudinal Waves

Warm-up
sound waves — L
ripples on water — T
light — T
1.1



[2 marks — 1 mark for each correct answer]
1.2 The number of complete waves which pass a point in one second *[1 mark]*.
1.3 The vibrations in longitudinal waves are in the same direction as the energy transfer *[1 mark]*. Whereas in transverse waves, the vibration is perpendicular (at right angles) to the direction of energy transfer *[1 mark]*.

Topic P6

2 She's incorrect *[1 mark]*. It is the wave, not the water, that moves so the leaf will just move up and down *[1 mark]*.

Page 198 — Frequency, Period and Wave Speed

1 frequency = 1 ÷ period
= 1 ÷ 2 *[1 mark]*
= **0.5 Hz** *[1 mark]*

2.1 Correct order = D, E, B, A, C
[3 marks for all in correct order, 2 marks for three in correct order, 1 mark for two in correct order.]

2.2 wave speed = frequency × wavelength *[1 mark]*

2.3 wave speed = frequency × wavelength
= 50.0 × 6.80 *[1 mark]*
= **340 m/s** *[1 mark]*

Page 199 — Investigating Waves

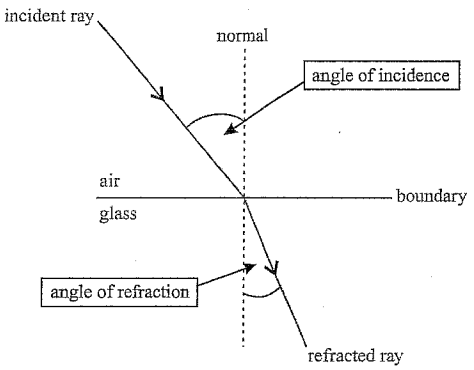
1.1 3 *[1 mark]*

1.2 The student should divide distance *d* by the number of wavelengths on the string (3) *[1 mark]*.

2 E.g. turn on the lamp and set the signal generator to a fixed frequency *[1 mark]*. Then measure the length of 10 waves *[1 mark]*. Divide this distance by 10 to find the wavelength of one water wave *[1 mark]*. Then multiply this wavelength by the frequency of the signal generator (which equals the frequency of the waves) *[1 mark]*.

Page 200 — Refraction

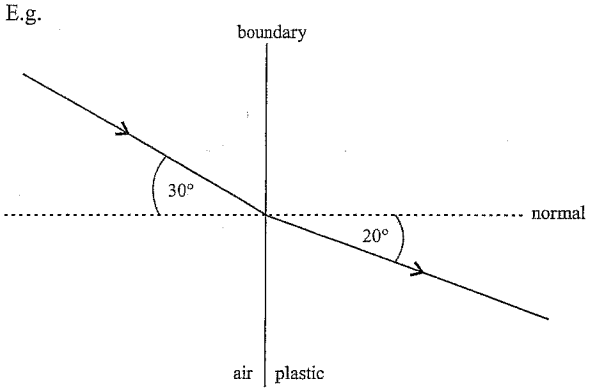
1.1



[1 mark for both correct]

1.2 90° *[1 mark]*

2 E.g.



[1 mark for incident ray drawn on the left of the boundary and refracted ray drawn on the right of the boundary with correct arrows on both rays, 1 mark for correctly drawn normal, 1 mark for incident ray at 30° to the normal (on either side of the normal), 1 mark for refracted ray at 20° to the normal on the opposite side of the normal to the incident ray]

You don't need to have labelled the angles in your diagram, we've just included them here to make it clearer.

Page 201 — Electromagnetic Waves

1 gamma rays *[1 mark]*

2.1 In this order: Microwaves *[1 mark]*, X-rays *[1 mark]*.

2.2 Arrow must point to the left (i.e. from gamma rays to radio waves) *[1 mark]*.

2.3 All waves in the electromagnetic spectrum are **transverse** waves. All electromagnetic waves travel at the same speed in **a vacuum**.
[2 marks — 1 mark for each correct answer]

2.4 gamma rays *[1 mark]*.

Page 202 — Uses of EM Waves

Warm-up:
1 - Radio waves can be used to...
2 - ...transmit TV signals...
3 - ...and radio signals.
4 - Some wavelengths...
5 - ...can send signals very long distances.

1.1 When food is cooked in a microwave oven, water in the food **absorbs** microwaves.
This causes the temperature of the food to **increase**.
[2 marks — 1 mark for each correct answer]

1.2 E.g. satellite communications *[1 mark]*

2.1 A *[1 mark]*

2.2 E.g. electric heaters, toasters. ***[2 marks — 1 mark for each correct answer]***

Page 203 — More Uses of EM Waves

1.1 fibre-optic cables for communication *[1 mark]*

1.2 energy efficient lamps *[1 mark]*

1.3 Any one from: e.g. suntanning / security marking *[1 mark]*

2.1 X-rays *[1 mark]*, gamma rays *[1 mark]*

2.2 E.g. gamma rays or X-rays in medical imaging / gamma rays as medical tracers / gamma rays to sterilise equipment *[1 mark]*

Page 204 — Investigating IR Radiation

1.1 Suggestion: e.g. bar chart
Reason: e.g. the independent variable comes in clear categories.
[1 mark for a sensible suggestion and 1 mark for a valid reason]

1.2 Best emitter Matt black surface
Shiny black surface
Matt silver surface
Worst emitter Shiny silver surface
[1 mark for all surfaces in the correct order]

Page 205 — Investigating IR Absorption

1 How to grade your answer:

Level 0: There is no relevant information. ***[No marks]***

Level 1: There is a brief description of an experiment that could be performed with the equipment.
The points made are basic and poorly structured.
[1-2 marks]

Level 2: There is a description of an experiment which can be performed with the equipment.
An explanation of how to determine which surface is better at absorbing IR radiation is given.
The answer has a clear structure. ***[3-4 marks]***

Level 3: There is a clear and detailed description of an experiment which can be performed with the equipment. An explanation of how to determine which surface is better at absorbing IR radiation is given. The answer has a clear and logical structure.
[5-6 marks]

Topic P7 and Biology Mixed Questions

Here are some points your answer may include:
Place the Bunsen burner in the centre of the heat-proof mat.
Stand one plate either side of the Bunsen burner.
Stand the plates so that the side with the ball attached is facing away from the Bunsen burner.
Make sure that the two plates are an equal distance away from Bunsen burner.
Light the Bunsen burner.
Observe which metal ball falls first.
Make a note of which plate it fell from.
This plate absorbed more IR radiation.
So the temperature of this plate increased faster causing the wax to melt faster.
So the surface facing the flame on this plate is the better absorber.

Page 206 — Dangers of Electromagnetic Waves

Warm-up
1000 mSv

1.1 The type of radiation absorbed *[1 mark]*.

1.2 E.g. skin aging prematurely / increased risk of skin cancer *[2 marks — 1 mark for each correct]*

2 How to grade your answer:
Level 0: There is no relevant information. *[No marks]*
Level 1: There is a brief description of the health effects of exposure to X-rays. Little or no comparison is made between the two procedures. The points made are basic and poorly structured. *[1-2 marks]*
Level 2: There is a full description of the health effects of exposure to X-rays. A detailed comparison is made between the two procedures that is clearly linked to the health risks of each procedure. The answer has a clear and logical structure. *[3-4 marks]*
Here are some points your answer may include:
The radiation dose for the lower spine X-ray is 20 times larger than the radiation dose for the skull X-ray.
This means the risk of harm to the patient from the spine X-ray is twenty times larger than risk caused by the skull X-ray.
X-rays can cause gene mutations, which can lead to cancer.
They can also kill off healthy cells in the patient's body.
The risk of killing cells or causing genes to mutate is larger for the spine X-ray than for the skull X-ray.

Topic P7 — Magnetism and Electromagnetism

Page 207 — Permanent and Induced Magnets

Warm-up
From left to right: attractive, repulsive

1 the force between them is always attractive *[1 mark]*

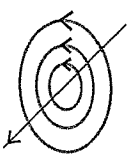
2 Magnetic forces are examples of **non-contact** forces. The direction of the magnetic field shows the direction that the force would act on a **north** pole at that point. The field is **strongest** at the poles of the magnet.
[3 marks — 1 mark for each correct answer]

3.1 The magnetic material becomes an induced magnet *[1 mark]* when it's placed in the magnetic field of the permanent bar magnet *[1 mark]*.

3.2 Any one from: e.g. iron / steel / nickel / cobalt *[1 mark]*

Page 208 — Electromagnetism

1.1



[1 mark for three anticlockwise arrows, one on each field line]

1.2 Y *[1 mark]*
The magnetic field is stronger the closer to the wire you are.

1.3 The wire carrying 0.5 A *[1 mark]*. Its higher current means a stronger magnetic field *[1 mark]*.

2.1 E.g. strong *[1 mark]* and uniform *[1 mark]*.
Uniform means it's the same at any point.

2.2 Change 1 — It reverses *[1 mark]*
Change 2 — It increases *[1 mark]*

2.3 An electromagnet *[1 mark]*

Mixed Questions

Page 209-213 — Biology Mixed Questions

1.1 muscle cell *[1 mark]*
The features of this cell (tissues that contract, lots of mitochondria) suggest it's a muscle cell. If it was a sperm cell, it would have an obvious tail and if it was a nerve cell it would have branched endings to connect it to other cells. It can't be a xylem cell, as that's a plant cell and the question tells you it's an animal cell.

1.2 To provide the energy the cell needs to carry out its function *[1 mark]*.

1.3 E.g. it has got a nucleus / it doesn't have any plasmids *[1 mark]*.

1.4 *E. coli* bacterium *[1 mark]*

2.1 a protein *[1 mark]*

2.2 E.g. making bile / converting excess glucose to glycogen *[1 mark]*.

2.3 kidney *[1 mark]*

3.1 glucose + **oxygen** → **carbon dioxide** + water
[2 marks — 1 mark for each correct answer in bold]

3.2 plasma *[1 mark]*

3.3 From top to bottom, the steps should be numbered:
2, 4, 3, 1 *[2 marks for all four steps in the correct order, otherwise 1 mark for two steps in the correct order.]*

4.1 photosynthesis *[1 mark]*
The reactants of photosynthesis (carbon dioxide and water) are going into the subcellular structure and the products of photosynthesis (glucose and oxygen) are leaving it — this suggests that photosynthesis is happening inside the subcellular structure.

4.2 chloroplast *[1 mark]*

4.3 45 000 μm *[1 mark]*
Remember, 1 mm = 1000 μm, so 45 mm will equal 45 000 μm.

4.4 Carbon dioxide diffuses into a leaf from the atmosphere *[1 mark]*, through the stomata *[1 mark]*.

4.5 transpiration *[1 mark]*

4.6 translocation *[1 mark]*

5.1 Enzymes speed up chemical reactions in living organisms. *[1 mark]*

5.2 9 *[1 mark]*

5.3 The enzyme will not work *[1 mark]* because the acid will change the shape of its active site/denature the enzyme *[1 mark]* and the substrate will no longer fit *[1 mark]*.

5.4 Alcohol can cause liver damage. *[1 mark]*

5.5 anaerobic respiration / fermentation *[1 mark]*

6.1 A producer produces its own food (using energy from the Sun) *[1 mark]*.

6.2 E.g. increased competition from other plants / increase in grasshopper numbers *[1 mark]*.

6.3 E.g. the population of snakes may decrease *[1 mark]* because they would be competing with the owls for mice *[1 mark]*.

6.4 E.g. the scientist could mark out a transect line across the ecosystem *[1 mark]*. He/she could then place quadrats along the line *[1 mark]* and estimate the percentage cover of grasses in each quadrat *[1 mark]*.

6.5 All the species and environmental factors are in balance *[1 mark]* so the population sizes stay about the same *[1 mark]*.

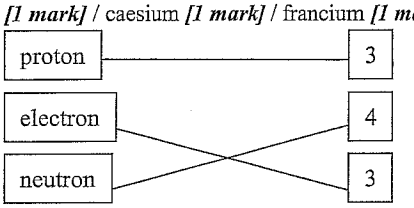
Chemistry Mixed Questions

Pages 214-219 — Chemistry Mixed Questions

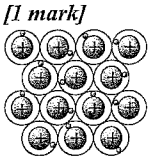
1.1 lithium *[1 mark]*

1.2 Any one from: sodium *[1 mark]* / potassium *[1 mark]* / rubidium *[1 mark]* / caesium *[1 mark]* / francium *[1 mark]*

1.3



[1 mark]

1.4  *[1 mark]*

1.5 hydrogen *[1 mark]*

1.6 When a Group 1 element reacts with water a metal **hydroxide** *[1 mark]* is formed.

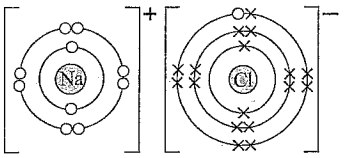
2.1 mean = (35.60 + 35.90 + 35.75) ÷ 3 = **35.75 cm^3** *[2 marks for correct answer, otherwise 1 mark for correct method]*

2.2 range = 35.90 – 35.60 = 0.30
uncertainty = 0.30 ÷ 2 = **0.15 cm^3** *[2 marks for correct answer, otherwise 1 mark for calculating range]*

2.3 **HCl** + NaOH → **NaCl** + H_2O *[1 mark for HCl, 1 mark for NaCl]*

2.4 E.g. the pH would start high/above pH 7 *[1 mark]*. As the hydrochloric acid is added it would decrease *[1 mark]* until it reached pH 7/falls below pH 7 *[1 mark]*.

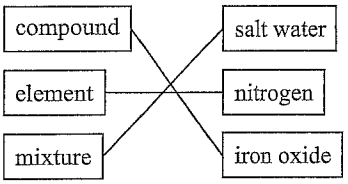
2.5



[1 mark for adding seven crosses and one dot to outer shell of Cl^- ion, 1 mark for correct charge on both ions]

2.6 ionic *[1 mark]*

3.1



[2 marks if all three correct, otherwise 1 mark if 1 correct]

3.2 Calcium, carbon and oxygen *[2 marks for all three correct, 1 mark for 2 correct]*

3.3 Pure water contains only water molecules *[1 mark]* whereas potable water is a mixture containing water and other dissolved substances *[1 mark]*.

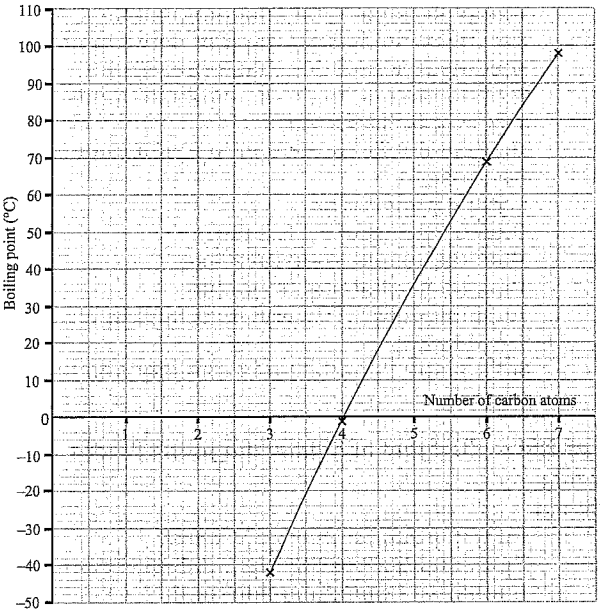
3.4 Any two from, e.g: filtration / evaporation / crystallisation / chromatography / simple distillation / fractional distillation *[2 marks — 1 mark for each correct answer]*

4.1 Group: 6 *[1 mark]*
Explanation: There are 6 electrons in the outer shell *[1 mark]*.

4.2 Charge: 2– *[1 mark]*
Reason: Oxygen atoms need to gain two electrons to get a full outer shell *[1 mark]*.

4.3 oxidation *[1 mark]*

5.1



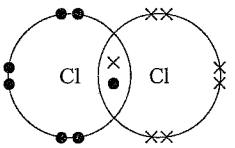
[1 mark for all four points correctly plotted, 1 mark for a smooth curve that passes through all the points]

5.2 **36 °C** *[1 mark for any answer in the range 34-38 °C]*

5.3 C_nH_{2n+2} *[1 mark]*

5.4 M_r of C_3H_8 = (C × 3) + (H × 8) = (12 × 3) + (1 × 8) = 36 + 8 = **44** *[1 mark]*

6.1



[1 mark for shared pair of electrons, 1 mark for six further electrons in the outer shell of each chlorine atom]

6.2 E.g. isotopes are atoms with the same number of protons / of the same element / with the same atomic number *[1 mark]* that have different numbers of neutrons / different mass numbers *[1 mark]*.

6.3 Hold a piece of damp litmus paper in the unknown gas *[1 mark]*. It will be bleached white in the presence of chlorine *[1 mark]*.

6.4 Chlorine is more reactive than iodine *[1 mark]*, so would displace iodine from sodium iodide solution / the solution would go from colourless to brown *[1 mark]*.

7.1 endothermic *[1 mark]*

7.2 higher *[1 mark]*

7.3 Effect: the rate of reaction will increase *[1 mark]*.
Reason: there will be more particles of ethanoic acid in the same volume *[1 mark]* so collisions between the reactant/ethanoic acid and sodium hydrogen carbonate particles will be more frequent *[1 mark]*.

8.1 Extraction process: electrolysis *[1 mark]*
Reason: electrolysis uses lots of energy *[1 mark]*. This energy often comes from burning fossil fuels *[1 mark]* which releases greenhouse gases *[1 mark]*.

8.2 Any two from: e.g. it helps save some of the finite amount of metal in the earth / it cuts down on the waste getting sent to landfill *[2 marks]*.

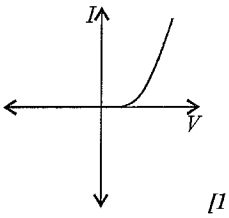
Physics Mixed Questions

9 How to grade your answer:
Level 0: There is no relevant information. *[No marks]*
Level 1: A brief attempt is made to explain one or two of the properties in terms of structure and/or bonding. *[1 to 2 marks]*
Level 2: Some explanation of all three properties, in terms of structure and/or bonding, is given, or a complete explanation of one or two of these properties is given. *[3 to 4 marks]*
Level 3: Clear and detailed explanation of all three properties, in terms of both structure and bonding, is given. *[5 to 6 marks]*
Here are some points your answer may include:
Diamond
Each carbon atom in diamond forms four covalent bonds in a rigid giant covalent structure, making it very hard.
Because it is made up of lots of covalent bonds, which take a lot of energy to break, diamond has a very high melting point.
There are no free/delocalised electrons in the structure of diamond, so it can't conduct electricity.
Graphite
Each carbon atom in graphite forms three covalent bonds.
The carbon atoms are arranged in layers of hexagons.
There are no covalent bonds between layers, so the layers can slide over each other.
This makes graphite soft and slippery.
The covalent bonds between the carbon atoms take a lot of energy to break, giving graphite a very high melting point.
Each carbon atom has one electron which is free to move, so graphite has lots of free/delocalised electrons and can conduct electricity.

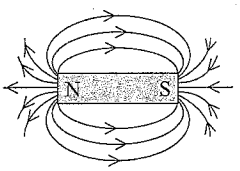
Pages 220-225 — Physics Mixed Questions

1.1 solid to liquid — melting *[1 mark]*
liquid to solid — freezing *[1 mark]*
1.2 Gases are usually **less dense than** liquids. *[1 mark]*
2.1 3 cm *[1 mark]*
2.2 330 m/s *[1 mark]*
3.1 6 m/s *[1 mark]*
3.2 Change in velocity = 6 m/s – 0 m/s = 6 m/s
so, acceleration = 6 ÷ 10 *[1 mark]* = **0.6 m/s^2** *[1 mark]*
If you ticked a different answer for 3.1 you will still get the marks if your calculation is correct.
4.1 E.g. a quantity that only has a size / a quantity that has a size but not a direction *[1 mark]*.
4.2 The force on an object due to gravity is called its **weight**.
It is measured in **newtons**. You can think of weight as acting from a single point on an object. This point is called the centre of **mass**.
[3 marks — 1 mark for each correct answer]
4.3 newtonmeter *[1 mark]*
4.4 No, she is incorrect. A smaller gravitational field strength will lead to a smaller weight of an object *[1 mark]*.
5.1 speed *[1 mark]*
5.2 5 mins = 5 × 60 = 300 seconds *[1 mark]*
speed = 420 ÷ 300 *[1 mark]* = **1.4 m/s** *[1 mark]*
5.3 mechanically *[1 mark]*
6.1 E.g. medical imaging / medical tracers / killing cancer / sterilising medical equipment *[1 mark]*
6.2 A = 99 *[1 mark]*
B = 0 *[1 mark]*
When a gamma ray is emitted, it doesn't change the charge or mass of the nucleus. Emitting a gamma ray is a way of getting rid of excess energy.
6.3 lead / concrete *[1 mark]*

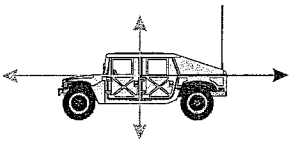
7.1



[1 mark]
7.2 $V = IR$ *[1 mark]*
7.3 $R = V \div I$ *[1 mark]*
$= 2.4 \div 0.4$ *[1 mark]*
$= \mathbf{6\ \Omega}$ *[1 mark]*
8.1 Heater B *[1 mark]*. It transfers the same amount of energy in half the time so has twice the power *[1 mark]*.
8.2 change in thermal energy = mass × specific heat capacity × temperature change
Change in temperature = 50 °C – 20 °C = 30 °C *[1 mark]*
Change in thermal energy = 0.50 × 4200 × 30 *[1 mark]*
= **63 000 J** *[1 mark]*
9.1 gravitational potential energy = mass × gravitational field strength × height *[1 mark]*
9.2 mass = gravitational potential energy ÷ (gravitational field strength × height) *[1 mark]*
= 440 ÷ (9.8 × 9.0) *[1 mark]*
= 4.988... kg
= **5.0 kg (to 2 s.f.)** *[1 mark]*
9.3



[1 mark for correct shape, 1 mark for arrows pointing from north to south]
9.4 The Earth has a magnetic field *[1 mark]*. The needle points in the direction of the Earth's north pole *[1 mark]*.
9.5 E.g. permanent magnet always have a magnetic field around them *[1 mark]*. Induced magnets only have one when in another magnetic field *[1 mark]*.
10.1



[1 mark for an arrow in the right direction, 1 mark for it being the same length as the driving force arrow]
10.2 kinetic energy = 0.5 × mass × (speed)^2 *[1 mark]*
10.3 kinetic energy = 0.5 × mass × (speed)^2
so mass = (2 × kinetic energy) ÷ (speed)^2 *[1 mark]*
mass = (2 × 7.5) ÷ (5.0)^2 *[1 mark]*
= 0.6 kg *[1 mark]*
10.4 Energy is transferred (mechanically) from the kinetic energy store *[1 mark]* of the car to it's gravitational potential energy store *[1 mark]*.
10.5 efficiency = useful output energy transfer ÷ total input energy transfer
so useful output energy transfer = efficiency × total input energy transfer *[1 mark]*
useful output energy transfer = 0.65 × 700 *[1 mark]*
= 455 J *[1 mark]*
energy wasted = 700 – 455 = **245 J** *[1 mark]*

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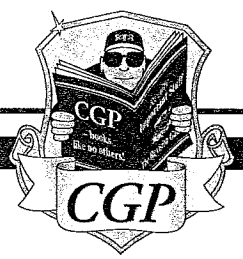

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