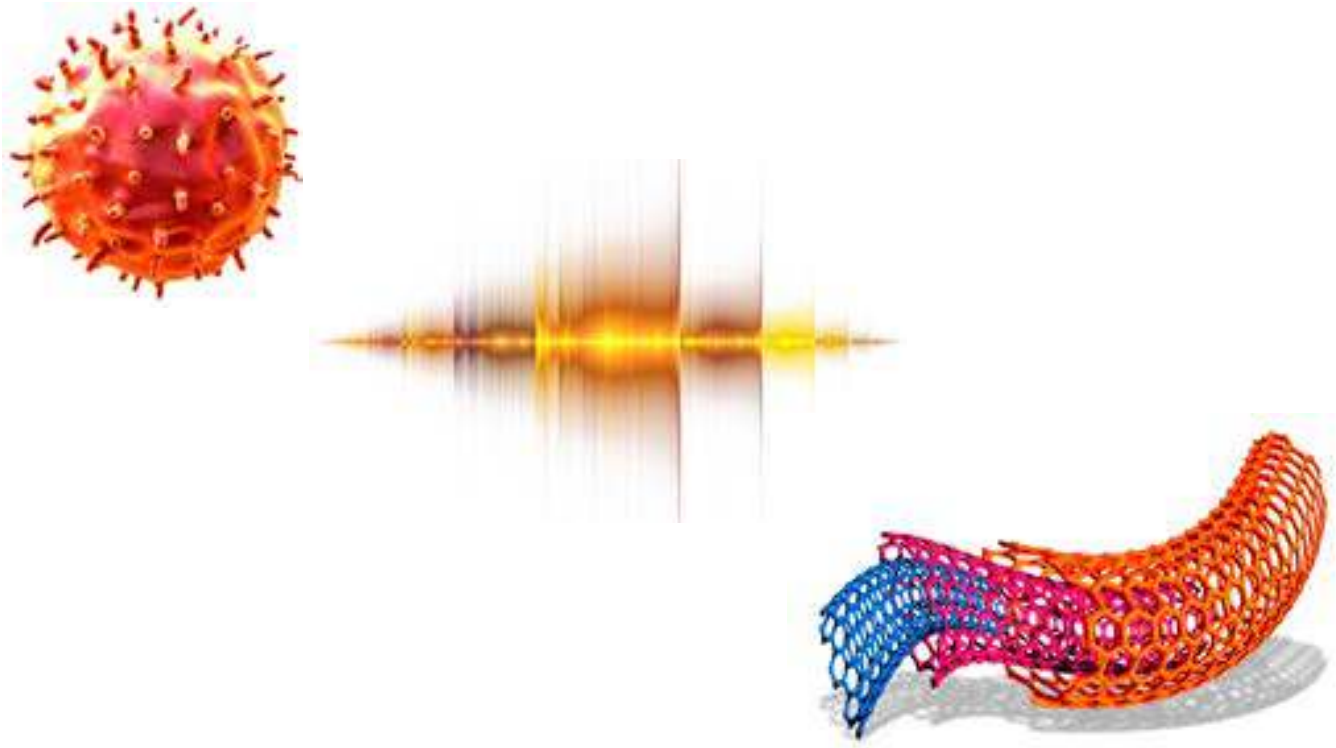
Cambridge Assessment International Education

Example Candidate Responses
Paper 3

Cambridge IGCSE™
Combined Science 0653

Cambridge O Level
Combined Science 5129

For examination from 2019



Version 1

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Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge IGCSE Combined Science 0653 and Cambridge O Level Combined Science 5129, and to show how different levels of candidates' performance (high, middle and low) relate to the subject's curriculum and assessment objectives.

In this booklet candidate responses have been chosen from June 2019 scripts to exemplify a range of answers.

For each question, the response is annotated with a clear explanation of where and why marks were awarded or omitted. This is followed by examiner comments on how the answer could have been improved. In this way, it is possible for you to understand what candidates have done to gain their marks and what they could do to improve their answers. There is also a list of common mistakes candidates made in their answers for each question.

This document provides illustrative examples of candidate work with examiner commentary. These help teachers to assess the standard required to achieve marks beyond the guidance of the mark scheme. Therefore, in some circumstances, such as where exact answers are required, there will not be much comment.

The questions and mark schemes and pre-release material used here are available to download from the School Support Hub. These files are:

June 2019 Question Paper 31

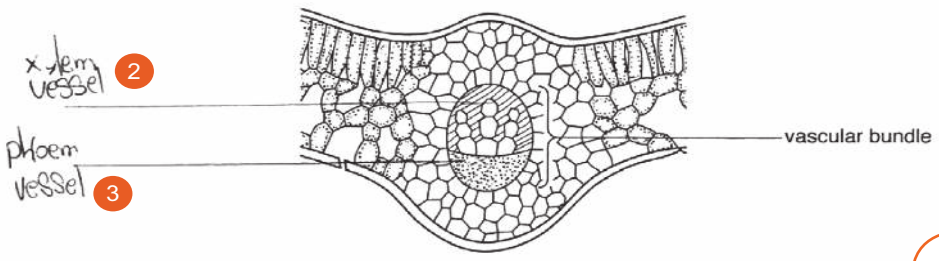
June 2019 Paper 31 Mark Scheme

Past exam resources and other teacher support materials are available on the School Support Hub:

www.cambridgeinternational.org/support

How to use this booklet

This booklet goes through the paper one question at a time, showing you the high-, middle- and low-level response for each question. The candidate answers are set in a table. In the left-hand column are the candidate answers, and in the right-hand column are the examiner comments.

Example Candidate Response – Question 1, high	Examiner comments
The vascular bundle is shown in the middle of the midrib in Fig. 1.2.  Fig. 1.2 (i) On Fig. 1.2 use a label line and the letter **X** to label any part of the xylem.	2 The candidate identifies a part of the xylem correctly. Full credit is awarded, although a letter was requested, because the candidate demonstrates knowledge of the location of the xylem. Mark for (b)(i) = 1 out of 1 3 The candidate identifies a

Answers are by real candidates in exam conditions. These show you the types of answers for each level. Discuss and analyse the answers with your learners in the classroom to improve their skills.

Examiner comments are alongside the answers. These explain where and why marks were awarded. This helps you to interpret the standard of Cambridge exams so you can help your learners to refine their exam technique.

How the candidate could have improved their answer

- This candidate could have improved their answer to **(b)(iii)** if they had known that the vascular bundle contained the phloem and xylem. Candidates should have been able to identify the phloem and xylem in a leaf. The labelled vascular bundle in Fig. 1.2 should have helped in this question.

This section explains how the candidate could have improved each answer. This helps you to interpret the standard of Cambridge exams and helps your learners to refine their exam technique.

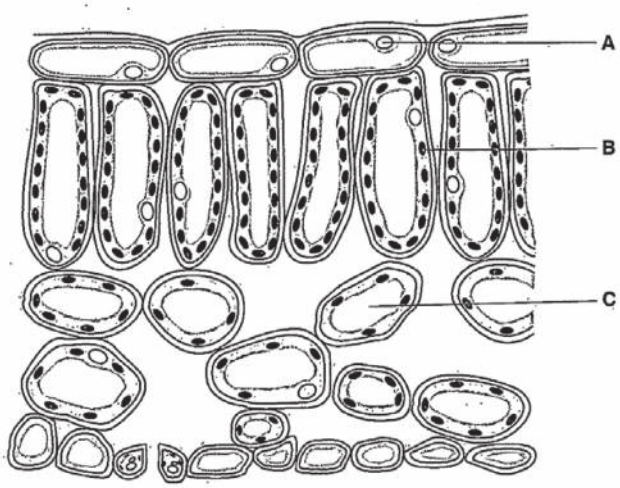
Common mistakes candidates made in this question

- **(a)** Some candidates labelled the cell layers of the leaf instead of the parts of the cells as required. These candidates did not read the stem of the question correctly.

Often candidates were not awarded marks because they misread or misinterpreted the questions.

Lists the common mistakes candidates made in answering each question. This will help your learners to avoid these mistakes and give them the best chance of achieving the available marks.

Question 1

Example Candidate Response – high	Examiner Comments
1 (a) Plants make their own food in leaves by the process of photosynthesis. Fig. 1.1 shows a cross-section of a leaf.  Fig. 1.1 Name cell parts **A**, **B** and **C** shown in Fig. 1.1. A Palis Nucleus 1 B Chloroplast C Vacuole [3]	1 The candidate identifies all three cell parts correctly. Mark for (a) = 3 out of 3

Example Candidate Response – high, continued

(b) Fig. 1.2 shows a cross-section of the central structure of a leaf, known as the midrib.

The vascular bundle is shown in the middle of the midrib in Fig. 1.2.

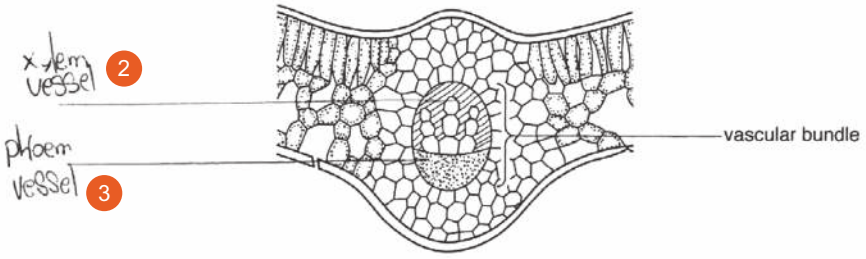


Fig. 1.2

(i) On Fig. 1.2 use a label line and the letter **X** to label any part of the xylem. [1]

(ii) On Fig. 1.2 use a label line and the letter **P** to label any part of the phloem. [1]

(iii) State the function of the phloem.

Transport minerals around the plant. 4

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[1]

(c) Glucose and oxygen are produced by cells in the leaves during photosynthesis. 5

Plant cells can use these products to carry out respiration.

Complete the word equation for respiration.

glucose	+	oxygen	→	Water	+	Carbon Dioxide

[1]

(d) State **two** uses for the energy released by respiration in the bodies of humans.

1. Used for growth

2. Used for maintaining body temperature 6

[2]

[Total: 9]

Examiner Comments

2 The candidate identifies a part of the xylem correctly. Full credit is awarded, although a letter was requested, because the candidate demonstrates knowledge of the location of the xylem.

Mark for (b)(i) = 1 out of 1

3 The candidate identifies a part of the phloem correctly. Full credit was awarded, although a letter was requested, because the candidate demonstrates knowledge of the location of the phloem.

Mark for (b)(ii) = 1 out of 1

4 The candidate does not score credit in this question because the transport of minerals is stated and not the transfer of food substances.

Mark for (b)(iii) = 0 out of 1

5 The candidate gains full credit for completing the word equation correctly.

Mark for (c) = 1 out of 1

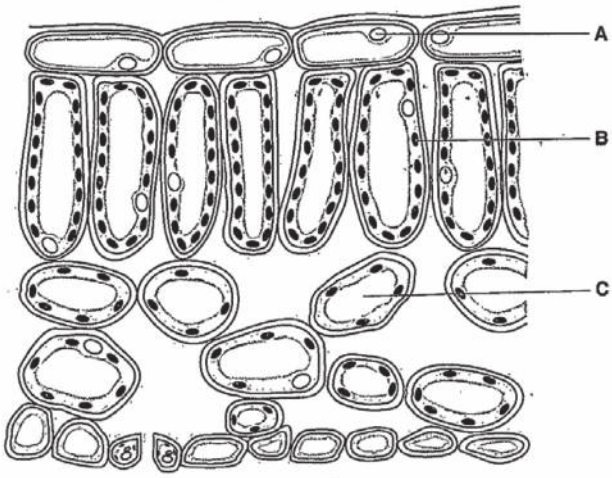
6 The candidate supplies two correct uses for the energy released by respiration.

Mark for (d) = 2 out of 2

Total mark awarded = 8 out of 9

How the candidate could have improved their answer

The candidate should have read the question carefully and followed the instructions given. In **(b)(i)** and **(b)(ii)**, a letter was requested, not a name. This was not penalised on this occasion, but it could have been important in a different question. The candidate could have improved their answer in **(b)(iii)** by stating that the function of the phloem was to transport food substances in the plant.

Example Candidate Response – middle	Examiner Comments
1 (a) Plants make their own food in leaves by the process of photosynthesis. Fig. 1.1 shows a cross-section of a leaf.  Fig. 1.1 Name cell parts **A**, **B** and **C** shown in Fig. 1.1. A Nucleus B Chloroplasts C Vacuole 1 [3]	1 The candidate identifies the three cell parts correctly. Mark for (a) = 3 out of 3

Example Candidate Response – middle, continued

(b) Fig. 1.2 shows a cross-section of the central structure of a leaf, known as the midrib.

The vascular bundle is shown in the middle of the midrib in Fig. 1.2.

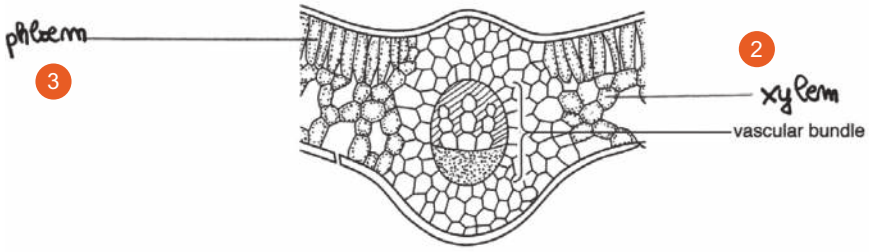


Fig. 1.2

(i) On Fig. 1.2 use a label line and the letter **X** to label any part of the xylem. [1]

(ii) On Fig. 1.2 use a label line and the letter **P** to label any part of the phloem. [1]

(iii) State the function of the phloem.

Carrying dissolved sugar upwards and downwards 4 [1]

(c) Glucose and oxygen are produced by cells in the leaves during photosynthesis.

Plant cells can use these products to carry out respiration.

Complete the word equation for respiration. 5

glucose	+	oxygen	→	carbon dioxide	+	water

[1]

(d) State **two** uses for the energy released by respiration in the bodies of humans.

1. Oxygen exchange with ~~eat~~ the air
2. Photosynthesis to happen 6

[2]

[Total: 9]

Examiner Comments

2 The candidate labels a mesophyll cell instead of the xylem so no credit is awarded. The xylem is found in the upper part of the vascular bundle in the diagram.

Mark for (b)(i) = 0 out of 1

3 The candidate labels a palisade cell instead of the phloem so no credit is awarded. The phloem is found in the lower part of the vascular bundle.

Mark for (b)(ii) = 0 out of 1

4 The candidate correctly describes the function of the phloem.

Mark for (b)(iii) = 1 out of 1

5 The candidate successfully completes the word equation for respiration.

Mark for (c) = 1 out of 1

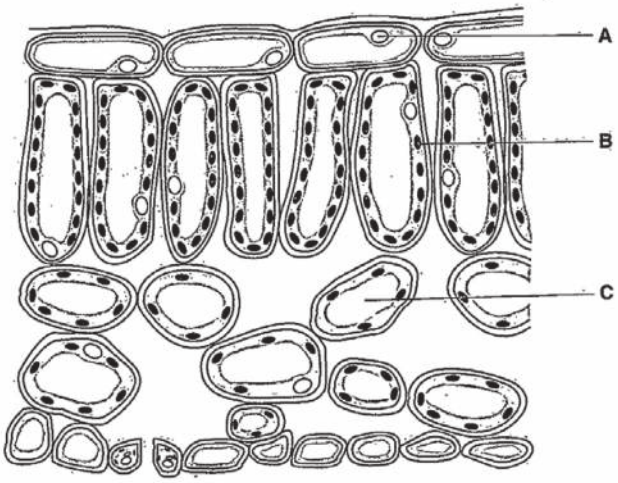
6 No credit is awarded for this response. The candidate clearly confuses cellular respiration with gas exchange.

Mark for (d) = 0 out of 1

Total mark awarded = 5 out of 9

How the candidate could have improved their answer

- This candidate could have improved their answer to **(b)(iii)** if they had known that the vascular bundle contained the phloem and xylem. Candidates should have been able to identify the phloem and xylem in a leaf. The labelled vascular bundle in Fig. 1.2 should have helped in this question.
- **(d)** They could have improved their answer if they had referred to cellular respiration. The uses of the energy released by respiration were clearly shown in the syllabus. The candidate's answer did not describe uses of energy. Instead, they were referring to consequences of gaseous exchange.

Example Candidate Response – low	Examiner Comments
1 (a) Plants make their own food in leaves by the process of photosynthesis. Fig. 1.1 shows a cross-section of a leaf.  Fig. 1.1 Name cell parts **A**, **B** and **C** shown in Fig. 1.1. A Nucleus 1 B Mitocondria C Cytoplasm [3]	1 The candidate gains credit for identifying **A**, the nucleus, correctly. No credit is awarded for label **B**. The candidate confuses mitochondria with chloroplasts. Mitochondria are not mentioned in the specification and are not seen in this level of magnification of the leaf. The candidate is not awarded credit for label **C** because they have incorrectly identified the vacuole of the cell as cytoplasm. Mark for (a) = 1 out of 3

Example Candidate Response – low, continued

(b) Fig. 1.2 shows a cross-section of the central structure of a leaf, known as the midrib.

The vascular bundle is shown in the middle of the midrib in Fig. 1.2.

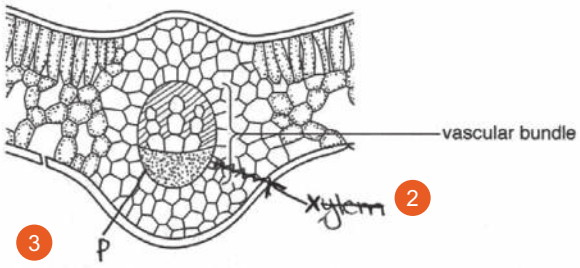


Fig. 1.2

(i) On Fig. 1.2 use a label line and the letter **X** to label any part of the xylem. [1]

(ii) On Fig. 1.2 use a label line and the letter **P** to label any part of the phloem. [1]

(iii) State the function of the phloem.

water and oxygen flow through the phloem [1]

4

(c) Glucose and oxygen are produced by cells in the leaves during photosynthesis.

Plant cells can use these products to carry out respiration.

Complete the word equation for respiration.

5

glucose	+	oxygen	→	carbon dioxide	+	water

[1]

(d) State **two** uses for the energy released by respiration in the bodies of humans.

1. carbon dioxide

2. heat

6

[2]

[Total: 9]

Examiner Comments

2 The candidate does not gain credit for labelling the xylem because they have labelled the lower epidermis.

Mark for (b)(i) = 0 out of 1

3 The candidate is awarded credit for labelling the phloem correctly.

Mark for (b)(ii) = 1 out of 1

4 No credit is awarded because the candidate does not state that phloem transports food substances.

Mark for (b)(iii) = 0 out of 1

5 The candidate completes the equation for respiration correctly.

Mark for (c) = 1 out of 1

6 The candidate does not gain credit in this answer. Although 'heat' is stated there is no explanation of how the heat (energy) is used.

Mark for (d) = 0 out of 2

Total mark awarded = 3 out of 9

How the candidate could have improved their answer

- **(a)** The candidate could have improved their answer by learning to recognise the parts of the plant cell as were stated in the syllabus. In Fig. 1.1, the chloroplasts were clearly visible, with more being found in the palisade cells; this should have enabled **B** to be answered correctly. With better knowledge of plant cell structure, the candidate would have excluded the cytoplasm from their answer to **C**. In these cells, the cytoplasm surrounded the large central vacuole of the cell.
- **(b)(i)** The candidate could have improved their answer having known that the xylem was contained in the vascular bundle, and then identified the xylem tissue from its characteristic appearance in Fig. 1.2. In **(b)(ii)**, the label line for **P**, the phloem, should have extended further into the tissue to have made the candidate's intention clear. The line, as it stood, was on the borderline of being acceptable.
- **(d)** The candidate acknowledged that heat energy was released, but they should have described the role of heat energy in maintaining body temperature. For the second mark, the candidate could have stated growth, muscle contraction or protein synthesis.

Common mistakes candidates made in this question

- **(a)** Some candidates labelled the cell layers of the leaf instead of the parts of the cells as required. These candidates did not read the stem of the question correctly.
- Many candidates could not identify the xylem and phloem in Fig. 1.2. Most of the incorrect responses showed labels for the phloem and xylem at various locations outside the vascular bundle. A minority of incorrect answers had the phloem and xylem labelled the wrong way round.
- **(b)(iii)** The function of the phloem was not widely known. Most candidates stated incorrectly that the function of the phloem was to transport water and mineral ions. The use of the word 'nutrients' was considered ambiguous and was not acceptable because its use usually refers to mineral ions.
- **(c)** A minority of candidates gave formulae instead of words to complete the equation. Words should be used when requested to complete a word equation.
- Many candidates interpreted respiration as breathing in **(d)**, and wrote responses which explained how the exhaled products of breathing could be useful to plants. Other responses were too vague to gain credit, for example 'to keep you alive', 'to increase the rate of body processes'.

Question 2

Example Candidate Response – high

2 (a) The composition of clean air is shown in Fig. 2.1.

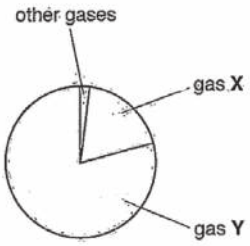


Fig. 2.1

Methane, carbon dioxide and water vapour are three of the other gases.

Identify gas **X** and gas **Y**.

gas **X** Oxygen

gas **Y** Nitrogen 1

[2]

(b) Methane is the main constituent of a fossil fuel.

(i) Name this fossil fuel.

~~oil~~ coal 2 [1]

(ii) State the formula of methane. [1]

CH_4 3

(iii) State the name of the group of saturated hydrocarbons that includes methane.

alkanes 4 [1]

(iv) Identify the products of the complete combustion of methane.

carbon dioxide and water 5 [1]

(c) Compound **X** contains only calcium, carbon and oxygen.

When it is heated it decomposes to form carbon dioxide and calcium oxide.

Identify compound **X**.

Calcium Carbonate 6 [1]

(d) Describe a chemical test for water and state the result that shows the presence of water.

test cobalt chloride paper

result turns pink 7

[2]

[Total: 9]

Examiner Comments

1 The candidate identifies gases **X** and **Y** correctly.
Mark for (a) = 2 out of 2

2 The candidate states coal instead of natural gas so no credit is awarded.
Mark for (b)(i) = 0 out of 1

3 The candidate writes the correct formula for methane.
Mark for (b)(ii) = 1 out of 1

4 The candidate names the group of hydrocarbons correctly.
Mark for (b)(iii) = 1 out of 1

5 The candidate successfully identifies the products of combustion of methane.
Mark for (b)(iv) = 1 out of 1

6 The candidate identifies calcium carbonate correctly.
Mark for (c) = 1 out of 1

7 The candidate gives a correct chemical test and result for water.
Mark for (d) = 2 out of 2

Total mark awarded = 8 out of 9

How the candidate could have improved their answer

The candidate could have improved their answer in **(b)(i)** by stating that the fossil fuel containing methane was natural gas.

Example Candidate Response – middle

2 (a) The composition of clean air is shown in Fig. 2.1.

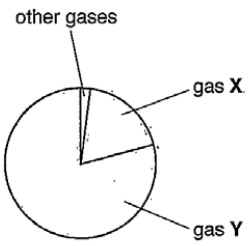


Fig. 2.1

Methane, carbon dioxide and water vapour are three of the other gases.

Identify gas **X** and gas **Y**.

gas **X** Oxygen 1

gas **Y** Nitrogen

[2]

(b) Methane is the main constituent of a fossil fuel.

(i) Name this fossil fuel.

Oil 2 [1]

(ii) State the formula of methane. [1]

CH_4 3

(iii) State the name of the group of saturated hydrocarbons that includes methane.

Alkanes 4 [1]

(iv) Identify the products of the complete combustion of methane.

Carbon and hydrogen [1] 5

(c) Compound **X** contains only calcium, carbon and oxygen.

When it is heated it decomposes to form carbon dioxide and calcium oxide.

Identify compound **X**. 6

Calcium carbonate. [1]

(d) Describe a chemical test for water and state the result that shows the presence of water.

test heating

result Water vapour released leaving hydrogen and oxygen 7

[2]

[Total: 9]

Examiner Comments

1 Full credit is awarded for identifying gases X and Y correctly.

Mark for (a) = 2 out of 2

2 The candidate states that oil is the fossil fuel containing methane instead of natural gas so no credit is awarded.

Mark for (b)(i) = 0 out of 1

3 The candidate writes the correct formula for methane.

Mark for (b)(ii) = 1 out of 1

4 The candidate states the correct group of hydrocarbons.

Mark for (b)(iii) = 1 out of 1

5 Two incorrect responses are given here. For complete combustion of a hydrocarbon to take place, both the carbon and the hydrogen react with oxygen to produce carbon dioxide and water.

Mark for (b)(iv) = 0 out of 1

6 The candidate identifies compound **X** successfully.

Mark for (c) = 1 out of 1

7 The candidate is not familiar with either of the required chemical tests for water. Therefore, no credit is awarded.

Mark for (d) = 0 out of 2

Total mark awarded = 5 out of 9

How the candidate could have improved their answer

- The candidate could have improved their answer in **(b)(i)** by naming the correct fossil fuel, natural gas.
- **(b)(iv)** They could have named carbon dioxide and water as the products of complete combustion of methane.
- The correct description of one chemical test for water, and its positive result would have enabled credit to be awarded for **(d)**. There was a choice of two tests stated in the syllabus, one with copper(II) sulphate and the other with cobalt(II) chloride.

Example Candidate Response – low

2 (a) The composition of clean air is shown in Fig. 2.1.

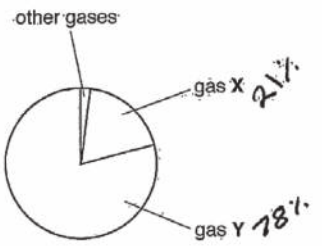


Fig. 2.1

Methane, carbon dioxide and water vapour are three of the other gases.

Identify gas **X** and gas **Y**.

gas **X** Oxygen 1

gas **Y** Nitrogen

[2]

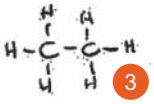
(b) Methane is the main constituent of a fossil fuel.

(i) Name this fossil fuel.

Gas 2 [1]

(ii) State the formula of methane. [1]

C_2H_6 3



(iii) State the name of the group of saturated hydrocarbons that includes methane.

Alkanes 4 [1]

(iv) Identify the products of the complete combustion of methane.

oxygen and hydrogen 5 [1]

(c) Compound **X** contains only calcium, carbon and oxygen.

When it is heated it decomposes to form carbon dioxide and calcium oxide.

Identify compound **X**.

Carbonate 6 [1]

(d) Describe a chemical test for water and state the result that shows the presence of water.

test Add sodium hydroxide

result Clear substance left 7

[2]

[Total: 9]

Examiner Comments

1 The candidate identifies both gases correctly.

Mark for (a) = 2 out of 2

2 Gas alone is not sufficient. The response must explicitly state *natural* gas.

Mark for (b)(i) = 0 out of 1

3 The candidate states the formula for ethane, not methane, so they are not awarded credit.

Mark for (b)(ii) = 0 out of 1

4 The candidate names the group of hydrocarbons successfully.

Mark for (b)(iii) = 1 out of 1

5 The candidate gives two incorrect responses for the products of complete combustion of methane. During complete combustion of a hydrocarbon the hydrogen and carbon both react with oxygen to give water and carbon dioxide respectively.

Mark for (b)(iv) = 0 out of 1

6 The candidate is not awarded credit here because they omit to include calcium in the name of their formula.

Mark for (c) = 0 out of 1

7 The candidate does not describe either of the chemical tests for water as stated in the specification.

Mark for (d) = 0 out of 2

Total mark awarded = 3 out of 9

How the candidate could have improved their answer

- This candidate could have improved their answer in **(b)(i)** by giving the full name of the fossil fuel containing methane, natural gas. Gas on its own was not sufficient.
- **(b)(ii)** The response given by the candidate was similar to that required, showing the candidate had some knowledge of the alkanes. However, the response given was ethane, not methane. If the correct formula had been given the candidate would have improved their answer.
- It was stated in the syllabus that when methane was burned in air, carbon dioxide and water were produced. The candidate could have improved their answer to **(b)(iv)** by stating these two products.
- Part **(c)** could have been improved if the candidate had included calcium in the name of their compound to have given the correct answer, calcium carbonate.
- Knowledge of either of the chemical tests for water, with copper(II) sulphate or cobalt(II) chloride would have enabled the candidate to be awarded credit.

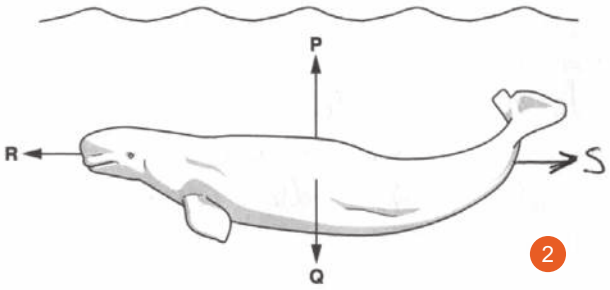
Common mistakes candidates made in this question

- **(a)** The most common mistake was naming the gases the wrong way round. These responses labelled gas **Y** as oxygen and gas **X** as nitrogen.
- Very few candidates stated that natural gas was the fossil fuel containing large amounts of methane. Coal and oil were the most common incorrect responses for **(b)(i)**. Petroleum was also seen in smaller numbers.
- **(b)(ii)** There were many candidates who did not know the formula for methane. Common incorrect answers included Me, CHMe and different variations of these letters.
- There were many candidates who were unfamiliar with the term *alkanes* requested in **(b)(iii)**. There were many incorrect answers, which showed no pattern. Several candidates referred to groups in the Periodic Table or non-metals, not taking into account that the hydrocarbons are compounds, not elements.
- Common mistakes in **(b)(iv)** were stating that carbon dioxide was the only product of combustion, and that oxygen gas was a product. Other mistakes, seen less frequently, included stating that hydrogen or heat energy were products of combustion.
- The most common errors in **(c)** included answers that did not contain all of the elements listed. Examples of these compounds were calcium oxide and carbon dioxide.
- Most candidates were unfamiliar with the chemical tests for water, as stated in the syllabus. The most common errors were boiling point and freezing point measurements, but since these were physical properties, they were not acceptable for **(d)**.

Question 3

Example Candidate Response – high	Examiner Comments

3 Fig. 3.1 shows a whale swimming underwater.



2

Fig. 3.1

(a) (i) The force arrows labelled **P** and **Q** show the vertical forces acting on the whale.

Name force **Q**. 1

Gravity ..... [1]

(ii) The whale is swimming at constant depth, using a force **R** to push itself forward.

On Fig. 3.1 draw a force arrow to show the frictional force opposing the motion of the whale, and label it **S**. [1]

(iii) When force **R** is 500 N, the whale moves at a constant speed of 5.0 km/h.

State the value of force **S**.

500 ÷ 5 = 100 force **S** = 100 3 N [1]

(iv) Force **R** decreases to 400 N. Force **P** increases.

Describe how these **two** changes affect the motion of the whale.

the whale will slow down .....

.....

The whale will begin to rise to the surface. ..... [2]

4

1 The candidate is awarded credit for their response. The force of gravity acting on the mass of the whale gives it weight, which is also a correct answer.

Mark for (a)(i) = 1 out of 1

2 The arrow labelled **S** is pointing in the correct direction and touches the whale, showing that the frictional force is acting directly on the whale.

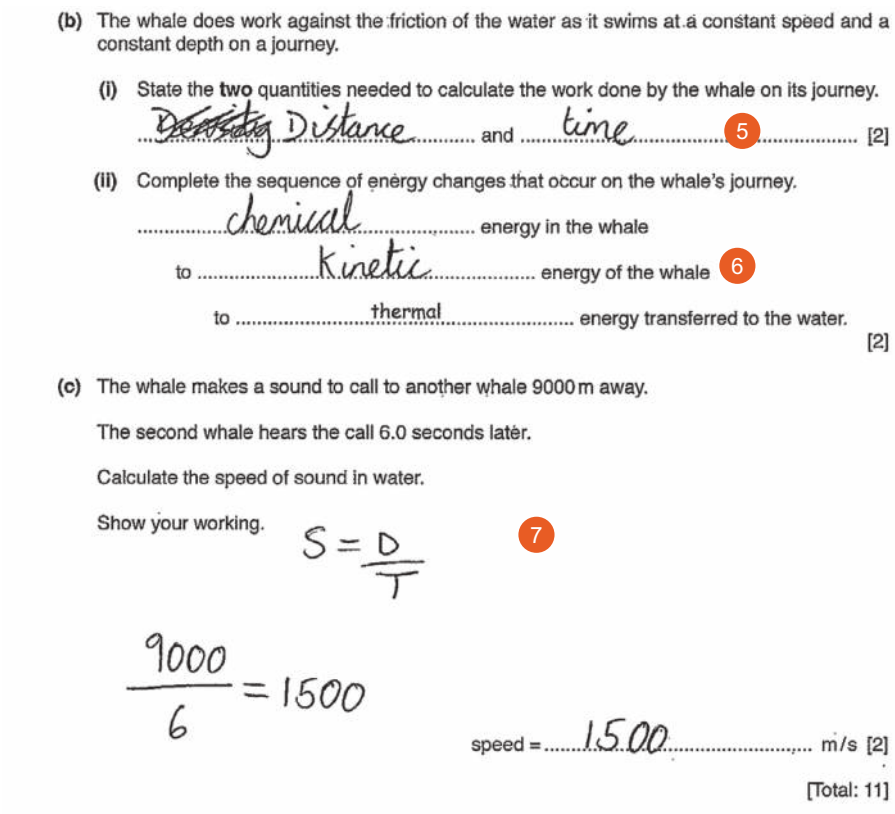
Mark for (a)(ii) = 1 out of 1

3 No credit is awarded. When the speed is constant the forces on the whale are balanced, so force **S** is 500N.

Mark for (a)(iii) = 0 out of 1

4 The candidate is awarded full credit here. They have considered the effects of the two forces separately and stated two changes to the motion of the whale.

Mark for (a)(iv) = 2 out of 2

Example Candidate Response – high, continued	Examiner Comments
	5 Partial credit is awarded for this response. Distance is correct, but they have stated time as the other quantity. The force against friction is the other quantity required to calculate the work done. Mark for (b)(i) = 1 out of 2 6 The candidate is awarded full credit in this question. The chemical energy in the muscles of the whale is transferred to kinetic energy as the whale moves. Mark for (b)(ii) = 2 out of 2 7 The candidate is awarded full credit for substituting the distance, 9000 m, and the time, 6s, into the equation to give the correct answer, 1500 (m/s). Mark for (c) = 2 out of 2 **Total mark awarded = 9 out of 11**

How the candidate could have improved their answer

- The candidate could have improved their answer in **(a)(iii)** by ignoring the speed of 5.0 km/h given in the stem. The forces on the whale must have been balanced to have given a constant speed, so the value of **S** must have been 500 N.
- **(b)(i)** The candidate wrote *distance* and *time* for the two quantities needed to calculate the work done; time was not correct. Their answer could have been improved by stating *force* instead *time*.

Example Candidate Response – middle	Examiner Comments

3 Fig. 3.1 shows a whale swimming underwater.

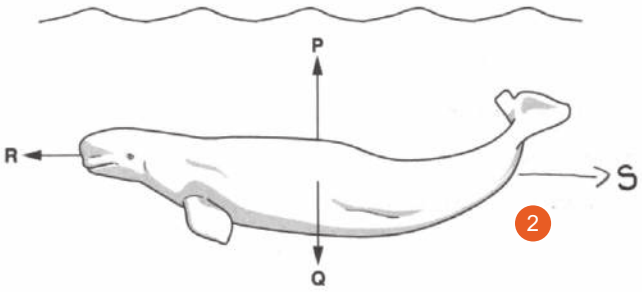


Fig. 3.1

(a) (i) The force arrows labelled **P** and **Q** show the vertical forces acting on the whale.

Name force **Q**. 1

Gravitational energy [1]

(ii) The whale is swimming at constant depth, using a force **R** to push itself forward.

On Fig. 3.1 draw a force arrow to show the frictional force opposing the motion of the whale, and label it **S**. [1]

(iii) When force **R** is 500 N, the whale moves at a constant speed of 5.0 km/h.

State the value of force **S**. 3

force **S** = 500 N [1]

(iv) Force **R** decreases to 400 N. Force **P** increases.

Describe how these **two** changes affect the motion of the whale.

The whale will slow down a bit and rise up to the surface of the water slightly. 4 [2]

1 The candidate is not awarded credit for this response. Gravitational energy is not a force.

Mark for (a)(i) = 0 out of 1

2 The force arrow does not touch the whale; therefore, no credit is awarded.

Mark for (a)(ii) = 0 out of 1

3 Correct answer. The candidate has shown knowledge that forces **R** and **S** must be equal and opposite for the whale to move at constant speed.

Mark for (a)(iii) = 1 out of 1

4 The candidate is awarded full credit for considering the effect of each force separately.

Mark for (a)(iv) = 2 out of 2

Example Candidate Response – middle, continued	Examiner Comments

(b) The whale does work against the friction of the water as it swims at a constant speed and a constant depth on a journey.

(i) State the **two** quantities needed to calculate the work done by the whale on its journey. 5

.....force..... and .....distance mass... [2]

(ii) Complete the sequence of energy changes that occur on the whale's journey.

.....Potential..... energy in the whale

to .....Gravitational..... energy of the whale 6

to .....thermal..... energy transferred to the water.

[2]

(c) The whale makes a sound to call to another whale 9000 m away.

The second whale hears the call 6.0 seconds later.

Calculate the speed of sound in water.

Show your working.

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

$$\text{speed} = \frac{9000}{6.0}$$

$$\text{Speed} = 1500$$

speed = ...1500..... m/s [2]

7

[Total: 11]

5 Only partial credit is awarded here. While *force* is correct, mass is incorrect.

Mark for (b)(i) = 1 out of 2

6 The first answer is awarded credit because the energy in the whale, which is converted is chemical potential energy, transferred to kinetic energy while the whale is moving. Credit is not awarded for 'gravitational' because the whale is swimming at a constant depth, as stated in the stem of the question.

Mark for (b)(ii) = 1 out of 2

7 The candidate is awarded full credit for the correct equation, substitution and calculation in this question.

Mark for (c) = 2 out of 2

Total mark awarded = 7 out of 11

How the candidate could have improved their answer

- **(a)(i)** The candidate could have improved their answer by stating the correct force. The force of gravity was acting on the mass of the whale to give it weight, so either *gravity* or *weight* would have been acceptable.
- The candidate would have improved their response in **(a)(ii)** by drawing the tail of the arrow of force **S** so that it touched the whale. As it stood, force **S** was acting on the water near the whale.
- The candidate could have improved their answer to **(b)(i)** by leaving their original answer, distance. The force was the frictional force against which the whale was moving, and the distance the whale travelled was also needed to calculate how much work was done.
- **(b)(ii)** The whale transferred chemical (potential) energy into kinetic energy as it moved. The chemical energy was contained in glucose and this was released during respiration to enable the muscle contraction needed for the whale to move. Therefore, the candidate could have improved their answer by stating that the (chemical) potential energy in the whale was transferred to kinetic energy.

Example Candidate Response – low	Examiner Comments

3 Fig. 3.1 shows a whale swimming underwater.

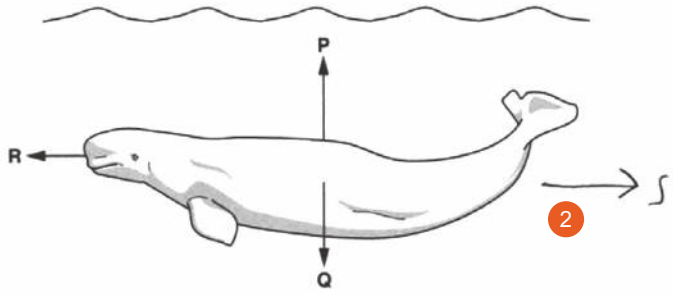


Fig. 3.1

(a) (i) The force arrows labelled **P** and **Q** show the vertical forces acting on the whale.

Name force **Q**.

Gravity weight 1 [1]

(ii) The whale is swimming at constant depth, using a force **R** to push itself forward.

On Fig. 3.1 draw a force arrow to show the frictional force opposing the motion of the whale, and label it **S**. [1]

(iii) When force **R** is 500 N, the whale moves at a constant speed of 5.0 km/h.

State the value of force **S**.

force **S** = 2500 3 N [1]

(iv) Force **R** decreases to 400 N. Force **P** increases.

Describe how these **two** changes affect the motion of the whale.

The faster the whale swims the less force P has an effect on its buoyancy

4 [2]

1 The candidate is awarded credit for a correct answer.

Mark for (a)(i) = 1 out of 1

2 Although the arrow is pointing in the correct direction it does not touch the whale so no credit is awarded.

Mark for (a)(ii) = 0 out of 1

3 The candidate is not awarded credit in this question. The opposing forces, **R** and **S** are equal and opposite if the whale is moving at a constant speed.

Mark for (a)(iii) = 0 out of 1

4 The candidate is not awarded credit here. This response states that the whale swims faster instead of slower. They have also not considered the effects of the two forces separately, and the effect of an increase in Force **P**.

Mark for (a)(iv) = 0 out of 2

Example Candidate Response – low, continued

(b) The whale does work against the friction of the water as it swims at a constant speed and a constant depth on a journey.

(i) State the **two** quantities needed to calculate the work done by the whale on its journey.

~~Kg~~ km/h and ~~N~~ N 5 [2]

(ii) Complete the sequence of energy changes that occur on the whale's journey.

chemical energy in the whale

to ~~kinetic~~ potential energy of the whale 6

to thermal energy transferred to the water.

[2]

(c) The whale makes a sound to call to another whale 9000 m away.

The second whale hears the call 6.0 seconds later.

Calculate the speed of sound in water.

Show your working. $S = \frac{t}{D}$

$9000 \div 6 = 1500$ 7

speed = 1500 m/s [2]

[Total: 11]

Examiner Comments

5 The candidate gives units instead of the terms *force* and *distance*.

Mark for (b)(i) = 0 out of 2

6 The candidate is awarded credit for stating that it is chemical energy in the whale that is converted to enable the whale to move. Therefore, the second answer should be *kinetic energy* so no credit is given for this part of the question.

Mark for (b)(ii) = 1 out of 2

7 The candidate is awarded full credit in this question. Although the equation given is incorrect, in this case, this is ignored because the candidate has carried out a correct calculation and arrived at the correct answer.

Mark for (c) = 2 out of 2

Total mark awarded = 4 out of 11

How the candidate could have improved their answer

- The candidate could have improved their answer in **(a)(ii)** by drawing the tail of the arrow of force **S** touching the whale. The candidate's response showed force **S** acting on the water near the whale.
- The candidate could have improved their answer in **(a)(ii)** by stating that Force **S** was 500N. The candidate had done an unnecessary calculation to arrive at an incorrect answer. If the whale was going at a constant speed, the forces **R** and **S** would have been equal and opposite.
- **(a)(iv)** The effects of each of the forces **R** and **P** should have been considered separately since they were at 90° to each other. The response could have been improved by the correct interpretation of the information about force **R**, which should have caused the whale to slow down, not to speed up.
- **(b)(i)** The candidate would have improved their answer by giving their response in words and not units.
- The candidate could have improved their response to **(b)(ii)** by stating that the chemical energy was converted to kinetic energy in the whale. This was the type of energy the whale had due to its movement.
- **(c)** The candidate could have improved their answer by stating the correct equation, in this case speed = distance / time.

Common mistakes candidates made in this question

- The most common mistake seen in **(a)(i)** were 'gravitational potential energy'. This was not a force.
- Candidates who were not awarded credit in **(a)(ii)** frequently did not make the tail of the arrow touch the whale. The tail of the arrow must have touched the whale to have shown that the force was acting on the whale, and not on the water near the whale.
- **(a)(iii)** The most common mistakes were calculations done including the speed of 5.0 km / hr, either multiplying or dividing. Therefore, instead of the correct answer of 500 N many candidates wrote either 100 N or 2500 N.
- Common errors in **(a)(iv)** included candidates who just considered the effect of the change of one of the forces, not of both. Less frequently, candidates interpreted the information incorrectly, to make the whale speed up or sink.
- **(b)(i)** The most common error made by candidates was stating 'speed' as one of the quantities.
- The most common mistake in **(b)(ii)** was stating 'gravitational potential' as one of the forms of energy involved in the conversion. This energy was not relevant to the question because the whale was swimming at a constant depth. 'Movement energy' was stated by several candidates instead of kinetic energy. This was not a term specific enough; term required was *kinetic energy*.
- The most common error in **(c)** occurred because the candidates used the incorrect form of the equation. Therefore, 54000 m / s resulted from speed = distance × time.

Question 4

Example Candidate Response – high	Examiner Comments

4 (a) Fig. 4.1 is a diagram of the male reproductive system.

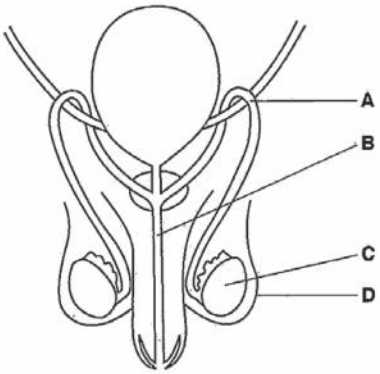


Fig. 4.1

Complete Table 4.1 to show the names and the functions of parts **A**, **B**, **C** and **D** shown in Fig. 4.1.

Table 4.1

letter of structure	name of part	function
A	sperm duct	sperm transfers through here
B	urethera	carries urine and semen out of the body
C	testicle	production of male gametes (sperm)
D	scrotum	protects the testicles

[4]

1

1 The candidate is awarded full credit for this response. Although the spelling of urethra is not accurate the candidate's response is close enough to the correct spelling, and cannot be confused with any other term in the specification. The term testicle is allowed as an alternative to testis, the term which is used in the syllabus. The candidate is rewarded for correct science.

Mark for (a) = 4 out of 4

Example Candidate Response – high, continued	Examiner Comments

(b) Fig. 4.2 shows the changes to the thickness of the uterus lining during the menstrual cycle.

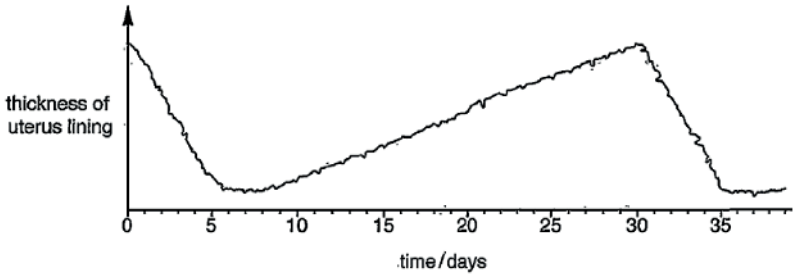


Fig. 4.2

(i) State what happens to the uterus lining during the first five days.

It is getting thinner 2 [1]

(ii) Use Fig. 4.2 to determine the number of days in a complete menstrual cycle.

number of days = ~~28~~ 30 3 [1]

(iii) Suggest why the uterus lining becomes thicker between days 7 and 30.

because it is repairing itself and creating 4
a good atmosphere for fertilisation to take place [1]

(c) Describe the process of fertilisation of a sperm cell and an egg cell.

the sperm cell penetrates and goes into the egg cell in which both pairs will join together [2]

5 [Total: 9]

2 The candidates uses Fig. 4.2 to answer the question correctly.

Mark for (b)(i) = 1 out of 1

3 The candidate uses the information in Fig. 4.2 to determine the length of time until the cycle repeats, in this case 30 days.

Mark for (b)(ii) = 1 out of 1

4 The candidate shows that they know the uterus lining is preparing for something. However, fertilisation takes place in the fallopian tube and the lining of the uterus is being prepared for the implantation of the growing embryo. Therefore, no credit is awarded.

Mark for (b)(iii) = 0 out of 1

5 The candidate is awarded credit for the joining of the egg cell with the sperm cell. In the second part of the sentence, it is not clear whether the candidate is referring to the nuclei of the cells. This ambiguity means they cannot be awarded credit for rest of this question.

Mark for (c) = 1 out of 2

Total mark awarded = 7 out of 9

How the candidate could have improved their answer

- Although the candidate was not penalised on this occasion, they could have improved their response to **(a)** by making sure they used the correct spelling for scientific terms. Incorrect spelling could sometimes cast doubt on the candidate's intended answer, especially if there were terms with similar spelling. Examples of words that could have been confused were *glycerol* and *glycogen*, *ion* and *iron*, and *reflection* and *refraction*. This candidate could also have improved their question by using the names for biological structures, as was shown in the syllabus. Therefore, they should have used testis instead of testicle.
- **(b)(iii)** The candidate's response could have been improved by stating that the thickening of the uterus lining was to prepare for implantation of the embryo after fertilisation.
- The candidate could have improved their answer to **(c)** by stating that the nuclei of the egg and sperm cells fuse after the sperm cell had entered the egg.

Example Candidate Response – middle	Examiner Comments

4 **(a)** Fig. 4.1 is a diagram of the male reproductive system.

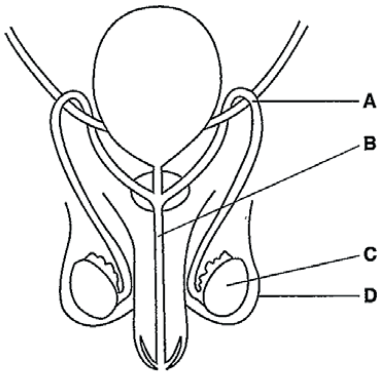


Fig. 4.1

Complete Table 4.1 to show the names and the functions of parts **A**, **B**, **C** and **D** shown in Fig. 4.1.

Table 4.1

letter of structure	name of part	function
A	sperm duct	transports sperms
B	penis	carries urine and semen out of the body
C	testes	production of male gametes (sperm)
D	scrotum	covers/shield/protects the testes

[4]

1 The candidate is awarded credit for three out of the four structures. They are not awarded credit for their incorrect naming of structure **B**. The correct name, the urethra, runs through the penis and this is the name that should have been written.

Mark for (a) = 3 out of 4

Example Candidate Response – middle, continued	Examiner Comments

(b) Fig. 4.2 shows the changes to the thickness of the uterus lining during the menstrual cycle.

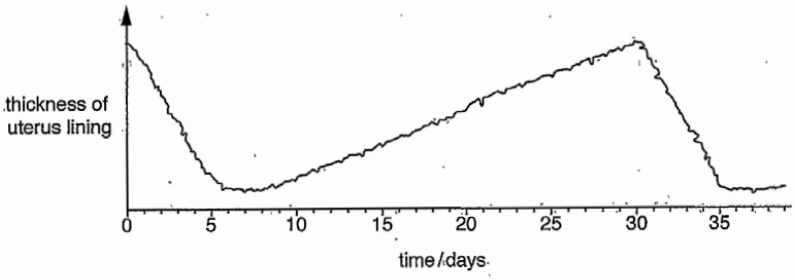


Fig. 4.2

(i) State what happens to the uterus lining during the first five days.

the uterus lining is broken down [1]

2

(ii) Use Fig. 4.2 to determine the number of days in a complete menstrual cycle.

number of days = ##30 [1]

3

(iii) Suggest why the uterus lining becomes thicker between days 7 and 30.

because the egg has left the cervix/uterus and has not been fertilised so oestrogen is no longer provided to the uterus [1]

4

(c) Describe the process of fertilisation of a sperm cell and an egg cell.

when the sperm cell fertilises an egg cell they form the haploid which is then divided and forms an embryo [2]

5

[Total: 9]

2 The candidate is awarded credit in this question. They correctly interpret the rapid thinning of the uterus lining as the uterus breaking down (as in menstruation).

Mark for (b)(i) = 1 out of 1

3 The candidate uses the information in Fig. 4.2 to determine the length of time until the cycle repeats, in this case 30 days.

Mark for (b)(ii) = 1 out of 1

4 The lining of the uterus becomes thicker to prepare for the implantation of an embryo if fertilisation occurs. The candidate has not stated this so no credit is awarded.

Mark for (b)(iii) = 0 out of 1

5 The candidate is not awarded credit in this question. There is no detail of the sperm and cells fusing. The term *haploid* describes the nuclei of the egg and sperm. The zygote becomes diploid after fertilisation.

Mark for (c) = 0 out of 2

Total mark awarded = 5 out of 9

How the candidate could have improved their answer

- The candidate could have improved their answer in **(a)** by stating that structure **B** was the urethra instead of the penis. The urethra is the tube that carried sperms and urine through the penis to the outside, and that was the structure shown in Fig.1.1.
- **(b)(iii)** The candidate could have improved their answer by stating that the uterus lining became thicker between days 7 and 30 to prepare for the implantation of an embryo. Candidates entered for this examination were not expected to have knowledge about sex hormones so there was no credit for references to oestrogen.
- The candidate could have improved their answer to **(c)** by describing fertilisation as the fusion of the egg and sperm cells, including their nuclei. If they had stated that a diploid cell was formed, they would have been awarded credit because this would have implied that the two (haploid) nuclei fuse.

Example Candidate Response – low

4 (a) Fig. 4.1 is a diagram of the male reproductive system.

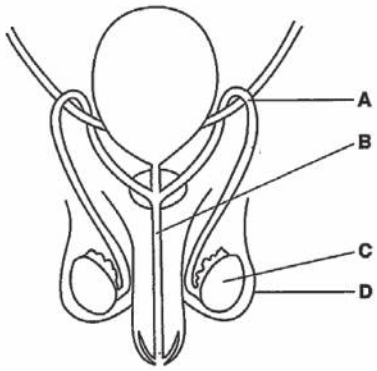


Fig. 4.1

Complete Table 4.1 to show the names and the functions of parts **A**, **B**, **C** and **D** shown in Fig. 4.1.

Table 4.1

letter of structure	name of part	function
A	sperm duct	where the sperm is carried around.
B	Penis	carries urine and semen out of the body
C	Testies	production of male gametes (sperm)
D	scrotum	its the sacke, keeps the testics in place

[4]

1

Examiner Comments

1 The candidate is awarded credit for three out of the four definitions. They are not awarded credit for their incorrect naming of structure **B**. The correct name, the urethra, runs through the penis and this is the name that should have been written.

Mark for (a) = 3 out of 4

Example Candidate Response – low, continued

(b) Fig. 4.2 shows the changes to the thickness of the uterus lining during the menstrual cycle.

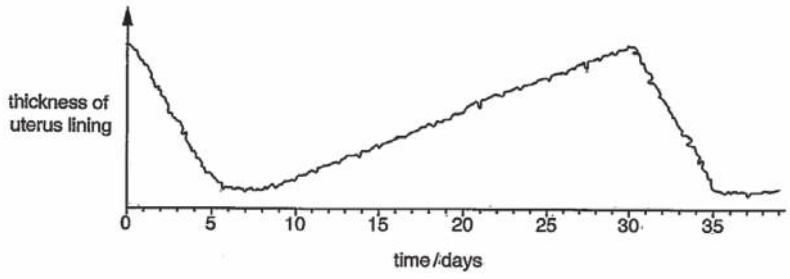


Fig. 4.2

(i) State what happens to the uterus lining during the first five days.

It decreased 2 [1]

(ii) Use Fig. 4.2 to determine the number of days in a complete menstrual cycle.

number of days = 39 3 [1]

(iii) Suggest why the uterus lining becomes thicker between days 7 and 30.

it loses all it chemicals and reactions 4

[1]

(c) Describe the process of fertilisation of a sperm cell and an egg cell.

The sperm cell swims until it reached the egg cell and it then fertilising in the egg to a male a baby. [2]

5 [Total: 9]

Examiner Comments

2 The candidate was not awarded credit for this answer because they omitted to say that the thickness of the uterus lining decreases.

Mark for (b)(i) = 0 out of 1

3 The candidate is not awarded credit because they have not looked for the repetition of events, starting off on day 0, and repeating on day 30.

Mark for (b)(ii) = 0 out of 1

4 The candidate does not demonstrate any knowledge of the uterus lining becoming thicker to prepare for implantation of an embryo.

Mark for (b)(iii) = 0 out of 1

5 The candidate does not describe the fusion of the sperm and egg cells and their nuclei so no credit is awarded.

Mark for (c) = 0 out of 2

Total mark awarded = 3 out of 9

How the candidate could have improved their answer

- The candidate could have improved their answer in **(a)** by stating that structure **B** was the urethra instead of the penis. The urethra is the tube that carried sperms and urine through the penis to the outside, and that was the structure shown in Fig.1.1.
- The candidate could have improved their answer to **(b)(i)** by referring to the thickness of the uterus lining, the label applied to the *y*-axis.
- The candidate had taken the number of days from the *x*-axis as their answer to **(b)(ii)**. They could have improved their answer having studied the graph in Fig. 4.2 to find when the uterus lining thinned rapidly again. This happened on day 30 and therefore the length of the complete menstrual cycle was 30 days.
- The candidate could have improved their answer to **(b)(iii)** by suggesting that the uterus lining was preparing for the implantation of an embryo.
- The candidate could have improved their answer by describing the process of fertilisation in terms of the fusion of the egg and sperm cell and their nuclei. The journey of the sperm cell towards the egg cell was not relevant and the candidate could have left this out.

Common mistakes candidates made in this question

- **(a)** A common mistake was to state that the sperm duct **A** carried semen. The sperms had substances added to them by other glands after they had left the sperm duct on their way out of the penis. These substances and the sperm together made up the semen. Some candidates stated that the sperm duct carried sperm towards the testes. This was not awarded credit because the direction of travel was away from the testes.
- Most candidates incorrectly identified **B** as the penis instead of the urethra.
- **(b)(i)** The most common error was the statement that the uterus lining decreased instead of using the information in the graph to conclude that the uterus lining goes thinner.
- There were many common mistakes given in response to **(b)(ii)**. Some candidates did not use the graph to determine when the cycle repeated, and stated 28 days. Other candidates used the timescale of the graph to arrive at the time of 38 days.
- **(b)(iii)** The most common mistake seen was the statement that the uterus lining must be building up in preparation for the next menstrual cycle instead of preparing for implantation.
- For **(c)**, the candidates had to describe the fusion of the egg cell with the sperm cell and their nuclei. Many candidates described the journey of the sperm cell towards the egg cell and stopped their explanations once the sperm had reached the egg cell. The meeting of these cells alone was not enough for credit to be awarded. Many sperm cells reach the egg cell, but only one fertilises the egg by entering it.

Question 5

Example Candidate Response – high	Examiner Comments

5 A student investigates the reactivities of four metals, calcium, magnesium, tin and zinc.

She reacts 1 g pieces of each metal separately with excess dilute hydrochloric acid.

She collects and measures the gas from each reaction using a measuring cylinder, as shown in Fig. 5.1.

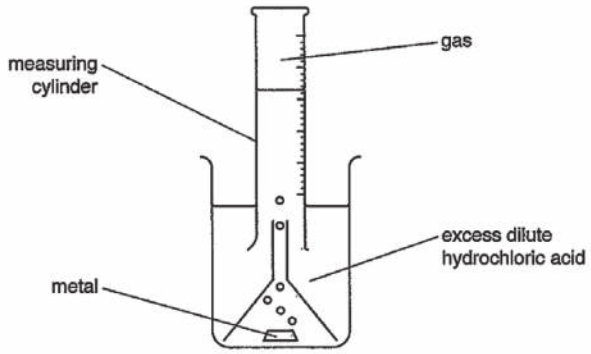


Fig. 5.1

The time taken to collect 20 cm^3 of gas in each experiment is recorded in Table 5.1.

Table 5.1

metal	time taken/s
calcium	20
magnesium	55
tin	more than 300
zinc	100

(a) (i) Deduce the order of reactivity of the four metals, calcium, magnesium, tin and zinc, from most reactive to least reactive.

calcium
magnesium
zinc
tin

most reactive

1

least reactive

[2]

1 The candidate places the four metals in descending order of reactivity.

Mark for (a)(i) = 2 out of 2

Example Candidate Response – high, continued	Examiner Comments

(ii) Suggest **two** changes that can be made to increase the rate of reaction of a metal with hydrochloric acid.

1. increase temperature 2

2. increase the concentration of hydrochloric acid

[2]

(b) (i) Identify the gas produced when zinc reacts with dilute hydrochloric acid.

hydrogen. 3 [1]

(ii) Fig. 5.2 shows some gases and tests for gases.

The boxes on the left show the gases. The boxes on the right show the tests.

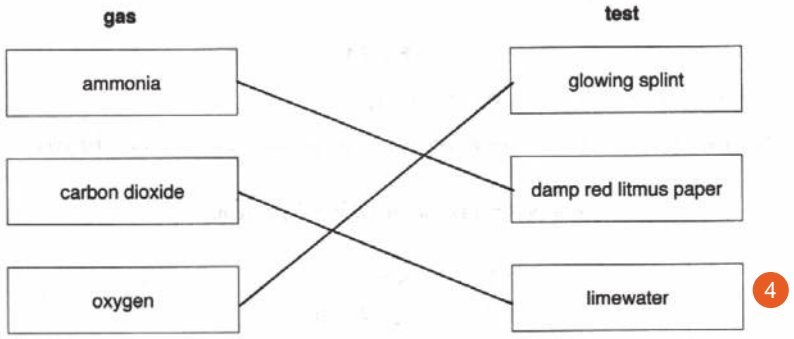


Fig. 5.2

On Fig. 5.2 draw **one** line from each gas to the test used for the gas. [2]

(c) The four metals, calcium, magnesium, tin and zinc, have high melting points and high boiling points.

Suggest **two** other physical properties of these metals.

1. conductor of electricity

2. 5

[2]

[Total: 9]

2 This response describes two changes to the experiment that would increase the rate of reaction.

Mark for (a)(ii) = 2 out of 2

3 The candidate identifies hydrogen successfully.

Mark for (b)(i) = 1 out of 1

4 The candidate draws lines between the gases and the tests correctly.

Mark for (b)(ii) = 2 out of 2

5 The candidate has stated only one correct physical property of these metals.

Mark for (c) = 1 out of 2

Total mark awarded = 8 out of 9

How the candidate could have improved their answer

(c) The candidate could have improved their response by stating one other physical property of metals. Examples of acceptable properties were malleability and good conductors of heat.

Example Candidate Response – middle	Examiner Comments

5 A student investigates the reactivities of four metals, calcium, magnesium, tin and zinc.

She reacts 1 g pieces of each metal separately with excess dilute hydrochloric acid.

She collects and measures the gas from each reaction using a measuring cylinder, as shown in Fig. 5.1.

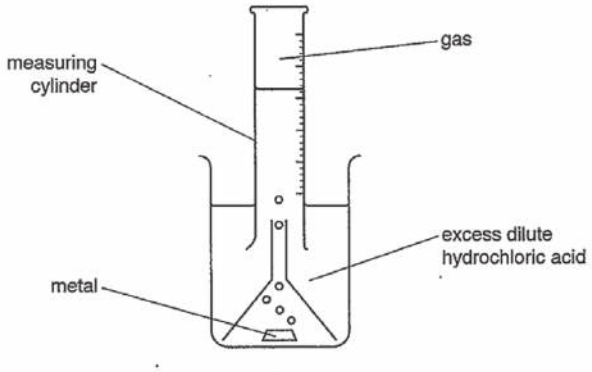


Fig. 5.1

The time taken to collect 20 cm^3 of gas in each experiment is recorded in Table 5.1.

Table 5.1

metal	time taken/s
calcium	20
magnesium	55
tin	more than 300
zinc	100

(a) (i) Deduce the order of reactivity of the four metals, calcium, magnesium, tin and zinc, from most reactive to least reactive.

calcium
Magnesium
Zinc
Tin

most reactive

1

least reactive

[2]

1 The candidate successfully places the metals in the correct order of reactivity.

Mark for (a)(i) = 2 out of 2

Example Candidate Response – middle, continued	Examiner Comments

(ii) Suggest **two** changes that can be made to increase the rate of reaction of a metal with hydrochloric acid.

1. Temperature increased

2. Making the metal into powder (more surface area). [2]

(b) (i) Identify the gas produced when zinc reacts with dilute hydrochloric acid.

Chlorine. [1]

(ii) Fig. 5.2 shows some gases and tests for gases.

The boxes on the left show the gases. The boxes on the right show the tests.

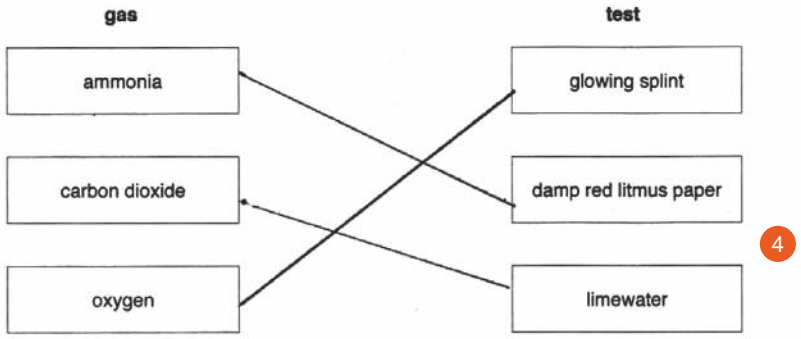


Fig. 5.2

On Fig. 5.2 draw **one** line from each gas to the test used for the gas. [2]

(c) The four metals, calcium, magnesium, tin and zinc, have high melting points and high boiling points.

Suggest **two** other physical properties of these metals.

1. Light

2. Soft [2]

[Total: 9]

2 The candidate states two correct changes to the experiment which will increase the rate of reaction.

Mark for (a)(ii) = 2 out of 2

3 The candidate states chlorine instead of hydrogen, so no credit is awarded.

Mark for (b)(i) = 0 out of 1

4 The candidate draws lines between the gases and their tests correctly.

Mark for (b)(ii) = 2 out of 2

5 The two properties stated by the candidate do not apply to all four metals, so no credit is awarded.

Mark for (c) = 0 out of 2

Total mark awarded = 6 out of 9

How the candidate could have improved their answer

- **(b)(i)** The candidate could have improved their answer by stating that hydrogen was the gas produced in the reaction.
- **(c)** The candidate could have improved their answer by stating two physical properties that applied to all metals, for example, good conductors of heat and electricity. The list included tin and zinc, both transition metals, which had high densities and were not soft.

Example Candidate Response – low	Examiner Comments

5 A student investigates the reactivities of four metals, calcium, magnesium, tin and zinc.

She reacts 1g pieces of each metal separately with excess dilute hydrochloric acid.

She collects and measures the gas from each reaction using a measuring cylinder, as shown in Fig. 5.1.

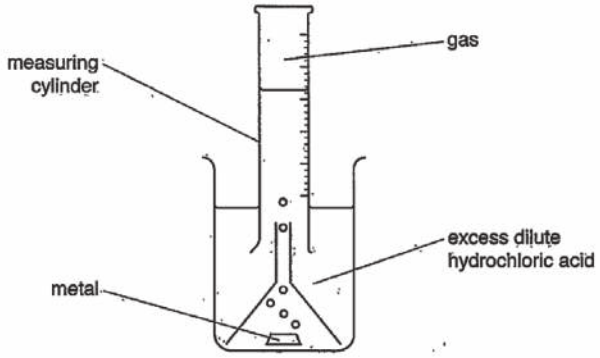


Fig. 5.1

The time taken to collect 20 cm^3 of gas in each experiment is recorded in Table 5.1.

Table 5.1

metal	time taken/s
calcium	20
magnesium	55
tin	more than 300
zinc	100

(a) (i) Deduce the order of reactivity of the four metals, calcium, magnesium, tin and zinc, from most reactive to least reactive.

calcium ..... most reactive

magnesium .....

zinc .....

tin ..... least reactive

1

[2]

1 The candidate places the metals in the correct order of descending reactivity.

Mark for (a)(i) = 2 out of 2

Example Candidate Response – low, continued	Examiner Comments

(ii) Suggest **two** changes that can be made to increase the rate of reaction of a metal with hydrochloric acid.

1. increase the amount of metal
2. add a larger volume of hydrochloric acid 2

[2]

(b) (i) Identify the gas produced when zinc reacts with dilute hydrochloric acid.

zinc chloride 3 [1]

(ii) Fig. 5.2 shows some gases and tests for gases.

The boxes on the left show the gases. The boxes on the right show the tests.

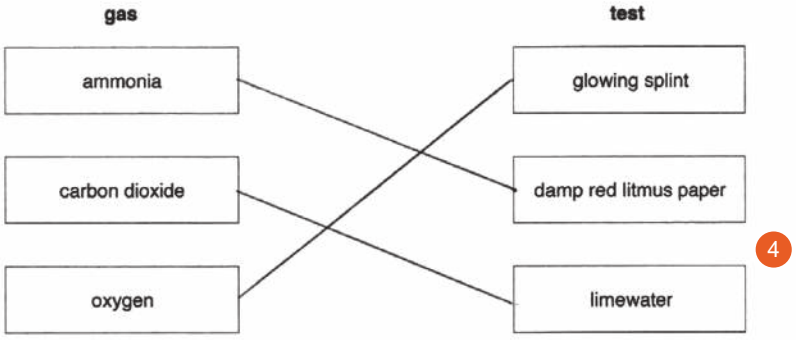


Fig. 5.2

On Fig. 5.2 draw **one** line from each gas to the test used for the gas. [2]

(c) The four metals, calcium, magnesium, tin and zinc, have high melting points and high boiling points.

Suggest **two** other physical properties of these metals.

1. are acidic
2. all react with hydrochloric acid 5

[2]

[Total: 9]

2 The candidate is not awarded credit here. The suggested changes should be to the same quantities of the original reactants. The hydrochloric acid is in excess so adding a larger volume will not increase the rate of reaction.

Mark for (a)(ii) = 0 out of 2

3 The candidate states the name of the salt produced in the reaction, not a gas, so no credit is awarded.

Mark for (b)(i) = 0 out of 1

4 The candidate successfully matches each gas with its test.

Mark for (b)(ii) = 2 out of 2

5 No credit is awarded in this question because the candidate describes chemical properties.

Mark for (c) = 0 out of 2

Total mark awarded = 4 out of 9

How the candidate could have improved their answer

- **(a)** The candidate should have adjusted the variables in the given experiment to increase the rate of reaction. Therefore, they could have used smaller pieces of metal with the same total mass to increase the surface area for reaction. The hydrochloric acid was present in excess, so adding more would not have altered the rate of reaction. The candidate could have increased the concentration of the hydrochloric acid to increase the rate of reaction.
- The candidate could have improved their answer to **(b)(i)** by stating the gas hydrogen. Zinc chloride, the other product of the reaction, was not a gas.
- The candidate stated two (incorrect) chemical properties of metals for **(c)** instead of physical properties as required. Suitable physical properties of metals were good conductors of heat, good conductors of electricity and malleability.

Common mistakes candidates made in this question

- **(a)(i)** Some candidates gave the reactivities of the metals in the reverse order. They wrongly interpreted the longer times taken as an indication that the metals were more reactive.
- For **(a)(ii)**, candidates had to change the variables in the given experiment to increase the rate of reaction. Some candidates identified the variables that could be adjusted but did not say how they could be changed. For example, 'the temperature' and 'the concentration of the acid' were stated by many candidates. These responses were not accepted. Another common mistake in this question was made by candidates who suggested changing the quantity of the acid. The acid is present in excess, so doing this would not increase the rate of reaction. Although responses referring to dividing the metal into smaller pieces were acceptable, using a smaller piece of metal was not accepted because this suggested reducing the amount of metal used.
- **(b)(i)** Common mistakes included stating that chlorine, oxygen or carbon dioxide were produced in the reaction, instead of hydrogen.
- The majority of candidates matched the boxes correctly in **(b)(ii)**. The most common mistake was confusion between the tests for oxygen and carbon dioxide.
- **(c)** Many candidates described chemical properties of metals instead of physical properties.

Question 6

Example Candidate Response – high	Examiner Comments

6 Fig. 6.1 shows an electrical device used in kitchens to kill insects. Insects can spread disease by contaminating food.

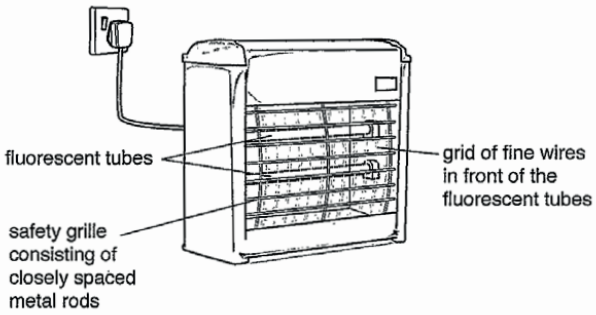


Fig. 6.1

The device is connected to the electricity supply.

(a) The two fluorescent tubes emit both visible light and ultraviolet radiation. This attracts insects to the device.

(i) Fig. 6.2 shows an incomplete electromagnetic spectrum.

	X-rays	Ultra-violet	visible light		micro-waves	radio waves

Fig. 6.2

On Fig. 6.2 place visible light and ultraviolet radiation in their correct boxes in the spectrum. [2]

(ii) The level of ultraviolet radiation emitted by the device is kept as low as possible when the device is used where people are present.

Explain why this precaution is needed.

high level of ultraviolet radiation can cause damage to such as skin burning [2]

1 The candidate places visible light and ultraviolet radiation in the correct boxes in the electromagnetic spectrum.

Mark for (a)(i) = 2 out of 2

2 Full credit is awarded here. The candidate explains that ultraviolet radiation causes damage (to the body), and provides acceptable further detail.

Mark for (a)(ii) = 2 out of 2

Example Candidate Response – high, continued	Examiner Comments

(b) Fig. 6.1 shows a grid of fine wires in front of the two fluorescent tubes. The insects have to fly between the wires as they go towards the light.

A potential difference of 2000 V exists between each pair of wires.

When an insect touches a pair of wires, an electrical circuit is completed. An electric current flows through the insect.

(i) State what is meant by *electric current*.

It is a flow of electricity 3 ..... [1]

(ii) The current in the wires when an insect touches them and completes the circuit is 0.5 A.

Calculate the resistance of the insect.

Show your working and state the unit of your answer.

$R = \frac{V}{I}$

$= \frac{2000}{0.5}$

$= 4000$

resistance = 4000 unit Ω [3] 4

(c) Suggest one safety hazard when operating any electrical device in a kitchen.

Water should not be near the when operating on the electrical device ..... [1] 5

[Total: 9]

3 This is incorrect so no credit is awarded.

Mark for (b)(i) = 0 out of 1

4 Full credit is awarded. The candidate writes the correct equation, substitutes the data and calculates the correct answer. They state the correct unit.

Mark for (b)(ii) = 3 out of 3

5 Credit is awarded for stating one possible hazard in the kitchen.

Mark for (c) = 1 out of 1

Total mark awarded = 8 out of 9

How the candidate could have improved their answer

The candidate could have improved their response to **(b)(i)** by stating that an electric current was a flow of charge.

Example Candidate Response – middle

6 Fig. 6.1 shows an electrical device used in kitchens to kill insects. Insects can spread disease by contaminating food.

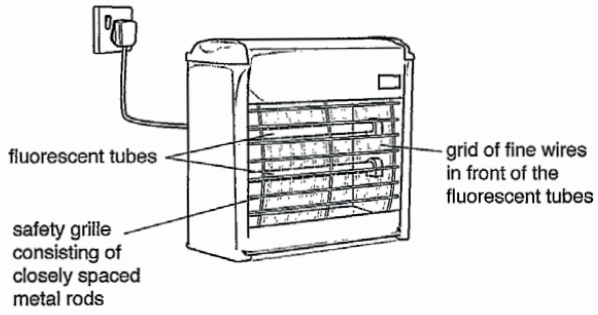


Fig. 6.1

The device is connected to the electricity supply.

(a) The two fluorescent tubes emit both visible light and ultraviolet radiation. This attracts insects to the device.

(i) Fig. 6.2 shows an incomplete electromagnetic spectrum.

Gamma Rays	X-rays	Ultra Violet	Visible Light	Infra-red	micro-waves	radio waves

1

Fig. 6.2

On Fig. 6.2 place visible light and ultraviolet radiation in their correct boxes in the spectrum. [2]

(ii) The level of ultraviolet radiation emitted by the device is kept as low as possible when the device is used where people are present.

Explain why this precaution is needed.

Ultra Violet ray & radiation can be harmful ~~to the skin~~ when exposed to too much 2

..... [2]

1 The candidate is awarded full credit for placing visible light and ultraviolet (radiation) in the correct boxes of the electromagnetic spectrum.

Mark for (a)(i) = 2 out of 2

2 Partial credit is awarded here. The candidate states that ultraviolet radiation can be harmful but does not provide further detail.

Mark for (a)(ii) = 1 out of 2

Example Candidate Response – middle, continued	Examiner Comments
(b) Fig. 6.1 shows a grid of fine wires in front of the two fluorescent tubes. The insects have to fly between the wires as they go towards the light. A potential difference of 2000 V exists between each pair of wires. When an insect touches a pair of wires, an electrical circuit is completed. An electric current flows through the insect. **(i)** State what is meant by *electric current*. The amount of electrons which is flows through a certain point 3 ..... [1] **(ii)** The current in the wires when an insect touches them and completes the circuit is 0.5 A. Calculate the resistance of the insect. Show your working and state the unit of your answer. $R = \frac{I}{V}$ resistance = 1000 ..... unit Ω 4 ..... [3] **(c)** Suggest one safety hazard when operating any electrical device in a kitchen. Can cause an electrical shock when it comes in contact with water or something highly conductive like metal 5 ..... [1] [Total: 9]	3 Credit is awarded for stating the flow of electrons. Mark for (b)(i) = 1 out of 1 4 The candidate uses a wrong equation in the calculation so no credit is awarded. Credit is given for the correct unit. Mark for (b)(ii) = 1 out of 2 5 Full credit is awarded for showing an awareness of the danger of operating an electrical device near water. Mark for (c) = 1 out of 1 **Total mark awarded = 6 out of 9**

How the candidate could have improved their answer

- The candidate could have improved their answer to **(a)(i)** by including only the two types of radiation stated in the question. The extra information was ignored in this question, but if a candidate gave incorrect extra information in a different question it could have contradicted a previously correct part of the response.
- **(a)(ii)** The candidate could have improved their answer by giving a specific example of the harm caused by ultraviolet radiation.
- The candidate could have improved their answer to **(b)(i)** by stating a more general definition, that an electric current is the flow of charge. This included the flow of electrons in a wire and the flow of electricity during electrolysis. In the context of the question, the electric current flowed in a metal, so the flow of electrons was acceptable.
- **(b)(ii)** The candidate could have improved their question by using the correct equation, $R = V/I$. This would have given the correct answer, 4000 Ω.

Example Candidate Response – low	Examiner Comments

6 Fig. 6.1 shows an electrical device used in kitchens to kill insects. Insects can spread disease by contaminating food.

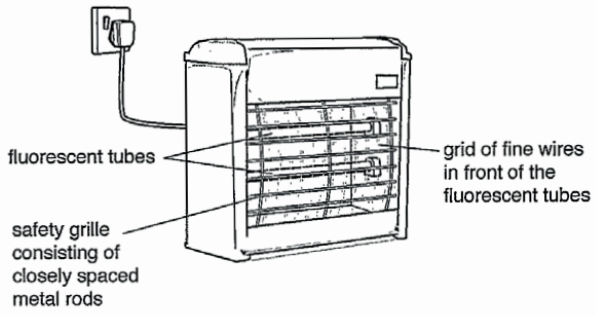


Fig. 6.1

The device is connected to the electricity supply.

(a) The two fluorescent tubes emit both visible light and ultraviolet radiation. This attracts insects to the device.

(i) Fig. 6.2 shows an incomplete electromagnetic spectrum.

ultraviolet ~~rays~~ radiation	X-rays	~~sate~~light rays	visible light	sound waves	micro-waves	radio waves

Fig. 6.2

On Fig. 6.2 place visible light and ultraviolet radiation in their correct boxes in the spectrum. [2]

(ii) The level of ultraviolet radiation emitted by the device is kept as low as possible when the device is used where people are present.

Explain why this precaution is needed.

Because the light is very strong and bright and ultraviolet radiation is deadly because it can be radioactive [2]

1 The candidate places visible light in the correct box. Ultraviolet radiation is incorrectly placed, so only partial credit is awarded.

Mark for (a)(i) = 1 out of 2

2 No credit is awarded. The candidate does not demonstrate knowledge of the ultraviolet radiation.

Mark for (a)(ii) = 0 out of 2

Example Candidate Response – low, continued	Examiner Comments

(b) Fig. 6.1 shows a grid of fine wires in front of the two fluorescent tubes. The insects have to fly between the wires as they go towards the light.

A potential difference of 2000 V exists between each pair of wires.

When an insect touches a pair of wires, an electrical circuit is completed. An electric current flows through the insect.

(i) State what is meant by *electric current*.

electric shock 3 [1]

(ii) The current in the wires when an insect touches them and completes the circuit is 0.5 A.

Calculate the resistance of the insect.

Show your working and state the unit of your answer.

$\frac{2000V}{0.5}$

A = Ampbcr
V = volts
Ω =

resistance = 4,000 unit Ω 4 [3]

(c) Suggest one safety hazard when operating any electrical device in a kitchen.

that the Voltage is too high and could cause a fire or explosion 5 [1]

[Total: 9]

3 The candidate does not show understanding of the nature of an electric current.

Mark for (b)(i) = 0 out of 1

4 Full credit is awarded for the calculation. However, the unit is incorrect so only partial credit is awarded for this question.

Mark for (b)(ii) = 2 out of 3

5 This answer is not acceptable because the voltage for appliances in the kitchen is the same as in the rest of the house.

Mark for (c) = 0 out of 1

Total mark awarded = 3 out of 9

How the candidate could have improved their answer

- The candidate could have improved their answer in **(a)(i)** by having a more secure knowledge of the electromagnetic spectrum and placing ultraviolet radiation in the correct box. They should not have included additional irrelevant detail because in a different question, incorrect additional material could have contradicted a previously correct response.
- **(a)(ii)** The candidate could have improved their answer with better knowledge of ultraviolet radiation. They should have known that ultraviolet radiation was not radioactive, and the damage was more likely to harm vulnerable parts of the body than to kill them.
- The candidate could have improved their response to **(b)(i)** by stating that an electric current was a flow of charge.
- Knowledge of the correct unit of resistance would have improved the response to **(b)(ii)**.
- **(c)** The candidate could have improved their answer by considering how the environment in the kitchen was different from other parts of the house. The voltage of the electrical devices in the kitchen was the same as the rest of the house. They could have described the presence of water as a hazard.

Common mistakes candidates made in this question

- The most common mistake in **(a)(i)** was filling the required boxes the wrong way round.
- **(a)(ii)** The candidates knew that ultraviolet radiation could be harmful, but many answers did not give further information. The mark allocation of two for this question should have indicated that more explanation was needed.
- Most candidates stated that an electric current was a flow of electricity in **(b)(i)**. The syllabus stated that an electric current was a flow of charge, and this was what was required.
- **(b)(ii)** The most common mistakes occurred when candidates used the incorrect form of the equation, $R=VI$ or $R=I/V$. Another common mistake was use of the wrong unit for resistance. Incorrect units seen included volts, amps and watts.
- The most common mistake in **(c)** was when candidates stated that you could get an electric shock, without describing the circumstances for this to happen. Many candidates wrote about general safety precautions, not hazards. Therefore, responses such as ‘wear gloves’, ‘tie hair back’, don’t put too many plugs in one socket’, without explanation, were not awarded credit. Responses had to be relevant to the special environment of the kitchen.

Question 7

Example Candidate Response – high

7 **(a)** Cell membranes are partially permeable. They allow small molecules to pass through by diffusion, but not large molecules.

Underline **one** molecule from the list of molecules which can diffuse across a cell membrane.

cellulose **fat** **glycogen** **oxygen** **protein** 1

[1]

(b) Fig. 7.1 shows a bag which acts like a cell membrane. It is partially permeable.

The bag contains a mixture of glucose and starch solutions. The bag is placed in a beaker of water.

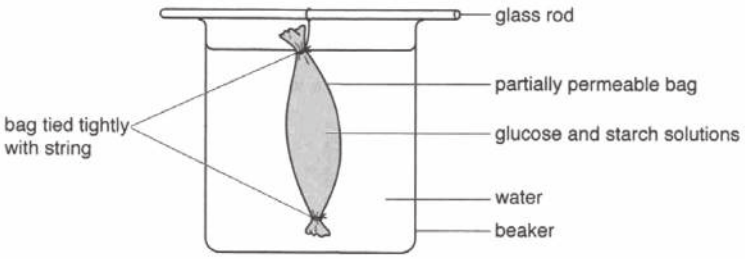


Fig. 7.1

After 30 minutes the water in the beaker is tested for starch and glucose.

The results of these tests are shown in Table 7.1.

Table 7.1

test solution	molecule tested for	result	final colour of test solution
iodine solution	starch	negative	brick red
Benedict's solution	glucose	positive	orange

2

(i) Complete Table 7.1 with the final colour of the test solutions. [2]

(ii) State where the starch molecules are at the end of the experiment.

inside the bag tied with string 3 [1]

Examiner Comments

1 The candidate circles the correct answer. In this case, full credit is awarded even although the question requests the candidate to underline the correct answer; the candidate has demonstrated their knowledge that oxygen is the smallest molecule.

Mark for (a) = 1 out of 1

2 The candidate is awarded partial credit. They give a correct colour of the final test solution for glucose, but an incorrect colour for the negative result for starch.

Mark for (b)(i) = 1 out of 2

3 The candidate states the correct location of the starch molecules at the end of the experiment.

Mark for (b)(ii) = 1 out of 1

Example Candidate Response – high, continued	Examiner Comments
(iii) Describe what has happened to the glucose molecules during the experiment. The glucose molecules filtered through the bag and went into the solution in the beaker 4 [2] (iv) Use the information in Table 7.1 to compare the sizes of the glucose molecule and the starch molecule. Explain your answer. sizes of molecules ... glucose was really small starch was not so small explanation The glucose was able to go through because it was smaller and the starch was to big to fit through. 5 [2] (c) The plasma is the component of blood which carries soluble nutrients around the body. Name **one** other substance that is transported by the plasma. ~~ant bodys~~ adrenaline 6 [1] [Total: 9]	4 The candidate correctly describes that the glucose molecules have gone out of the bag and into the beaker. They have not mentioned that this is by diffusion, or through the membrane, so only partial credit is awarded. Mark for (b)(iii) = 1 out of 2 5 The candidate states a correct comparison of the relative sizes of the glucose and starch molecules. They provide acceptable supporting evidence, so they gain full credit. Mark for (b)(iv) = 2 out of 2 6 The candidate gives an example of a hormone carried in the plasma. This is an acceptable answer. Mark for (c) = 1 out of 1 **Total mark awarded = 7 out of 9**

How the candidate could have improved their answer

- **(a)** The candidate could have improved their answer by underlining the correct answer, instead of circling it. Candidates should always read and follow the instructions in the question paper carefully. In this case, credit was still awarded.
- The candidate could have improved their answer to **(b)(i)** by stating the correct colour, brown, for the negative test for starch with iodine.
- **(b)(iii)** The candidate's explanation was sufficient to be awarded partial credit because they described what happened to the glucose molecules. If the candidate had written 'diffused' instead of filtered they would have provided some further detail to obtain full credit.
- Although the candidate was awarded full credit in **(b)(iv)**, the explanation could have been clearer. They could have stated that the glucose **molecules** were able to go through the bag, and the starch **molecules** were too big to have gone through the bag.

Example Candidate Response – middle

7 **(a)** Cell membranes are partially permeable. They allow small molecules to pass through by diffusion, but not large molecules.

Underline **one** molecule from the list of molecules which can diffuse across a cell membrane.

cellulose **fat** **glycogen** **oxygen** **protein** 1 [1]

(b) Fig. 7.1 shows a bag which acts like a cell membrane. It is partially permeable.

The bag contains a mixture of glucose and starch solutions. The bag is placed in a beaker of water.

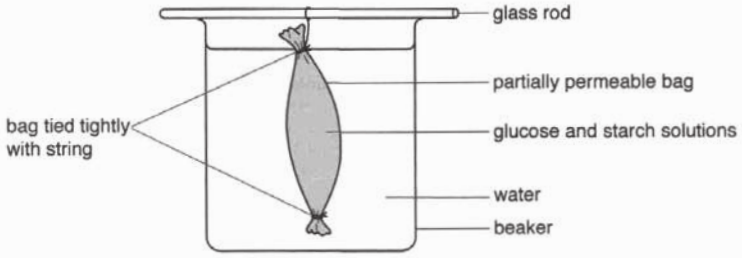


Fig. 7.1

After 30 minutes the water in the beaker is tested for starch and glucose.

The results of these tests are shown in Table 7.1.

Table 7.1

test solution	molecule tested for	result	final colour of test solution
iodine solution	starch	negative	white
Benedict's solution	glucose	positive	purple

2

(i) Complete Table 7.1 with the final colour of the test solutions. [2]

(ii) State where the starch molecules are at the end of the experiment.

in the partially permeable bag. 3 [1]

Examiner Comments

1 No credit is awarded here because glycogen molecules are too big to pass through the membrane.

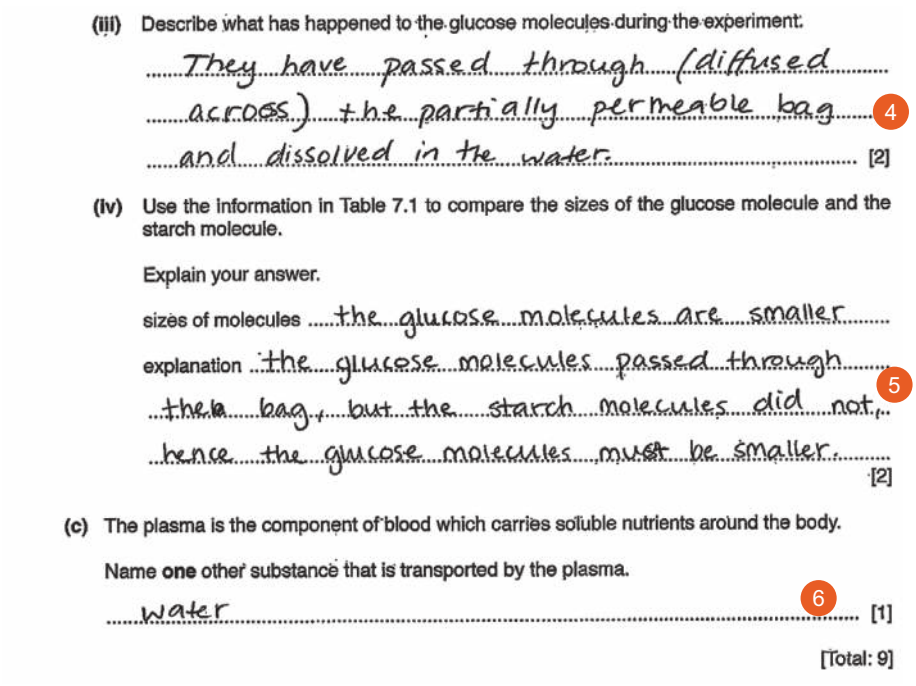
Mark for (a) = 0 out of 1

2 No credit is awarded because two incorrect colours are given for the final colours of the test solutions.

Mark for (b)(i) = 0 out of 2

3 The candidate has stated correctly that the starch molecules are inside the bag.

Mark for (b)(ii) = 1 out of 1

Example Candidate Response – middle, continued	Examiner Comments
	4 Full credit is awarded, as the candidate states that the glucose molecules have moved across the partially permeable bag by diffusion. Mark for (b)(iii) = 2 out of 2 5 The candidate identifies the relative sizes of the molecules correctly, and provides an acceptable explanation for their conclusion so full credit is awarded. Mark for (b)(iv) = 2 out of 2 6 No credit is awarded here because plasma is mainly water. Mark for (c) = 0 out of 1 **Total mark awarded = 5 out of 9**

How the candidate could have improved their answer

- **(a)** The candidate could have improved their answer by underlining oxygen. The remaining molecules on the list were too large to pass across a cell membrane.
- The candidate could have improved their answer to **(b)(i)** by having stated the correct colours of the final test solutions, the negative test for the starch with iodine, and the positive test for glucose having used Benedict's solution.
- **(c)** The candidate's answer could have been improved by stating one of the dissolved substances transported by the plasma was stated in the syllabus. The plasma transported substances from where they were added to the blood, to where they were removed from the blood. An example of this was carbon dioxide, which was added to the blood at the tissues, and it was removed from the blood at the lungs.

Example Candidate Response – low

7 (a) Cell membranes are partially permeable. They allow small molecules to pass through by diffusion, but not large molecules.

Underline **one** molecule from the list of molecules which can diffuse across a cell membrane.

cellulose **fat** **glycogen** **oxygen** **protein** 1 [1]

(b) Fig. 7.1 shows a bag which acts like a cell membrane. It is partially permeable.

The bag contains a mixture of glucose and starch solutions. The bag is placed in a beaker of water.

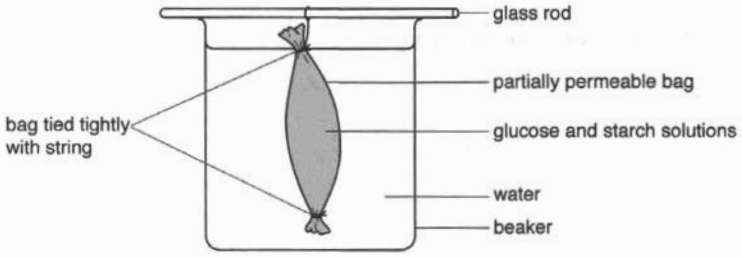


Fig. 7.1

After 30 minutes the water in the beaker is tested for starch and glucose.

The results of these tests are shown in Table 7.1.

Table 7.1

test solution	molecule tested for	result	final colour of test solution
iodine solution	starch	negative	dark red
Benedict's solution	glucose	positive	purple/blue

2

(i) Complete Table 7.1 with the final colour of the test solutions. [2]

(ii) State where the starch molecules are at the end of the experiment.

in the bag still [1]

3

Examiner Comments

1 No credit is awarded for this answer. Glycogen is a polymer and the molecules are too big to pass through a cell membrane.

Mark for (a) = 0 out of 1

2 No credit is awarded because two incorrect colours are given for the final colours of the test solutions.

Mark for (b)(i) = 0 out of 2

3 The candidate is awarded full credit because they have stated the correct location of the starch molecules at the end of the experiment.

Mark for (b)(ii) = 1 out of 1

Example Candidate Response – low, continued	Examiner Comments
(iii) Describe what has happened to the glucose molecules during the experiment. they escaped through the bag and mixed with the water. 4 [2] (iv) Use the information in Table 7.1 to compare the sizes of the glucose molecule and the starch molecule. Explain your answer: sizes of molecules glucose, small. Starch, larger explanation the bag only lets small molecules through so the glucose must be smaller than starch as it is the only one that got through 5 [2] (c) The plasma is the component of blood which carries soluble nutrients around the body. Name **one** other substance that is transported by the plasma. Nutrients 6 [1] [Total: 9]	4 Partial credit is awarded as the candidate correctly describes that the glucose molecules have escaped through the bag. Mark for (b)(iii) = 1 out of 2 5 In this response, the candidate makes a correct comparison of the sizes of the two molecules. They follow this comparison with an acceptable explanation, so full credit is awarded. Mark for (b)(iv) = 2 out of 2 6 This answer is not acceptable because soluble nutrients are excluded by the stem of the question. Mark for (c) = 0 out of 1 **Total mark awarded = 4 out of 9**

How the candidate could have improved their answer

- The candidate could have improved their answer to **(a)** by underlining oxygen. Oxygen was the smallest of the molecules listed and it was the only molecule from the list which could diffuse across a cell membrane. The candidate should have read the instructions carefully. They were asked to underline their answer not to circle it. In this case, the candidate's chosen response was unambiguously shown and it could be marked. This may not be the case in another question.
- The candidate could have improved their answer to **(b)(i)** by stating the correct colours of the final test solutions; the negative test for the starch with iodine, and the positive test for glucose having used Benedict's solution.
- **(b)(iii)** The candidate could have improved their answer by using the word 'diffused' instead of 'escaped' to add further information to their response.
- The candidate could have improved their answer to **(c)** by stating one of the molecules in the syllabus. Therefore, carbon dioxide, ions or hormones would have been credited. Nutrients had already been excluded in the stem of the question.

Common mistakes candidates made in this question

- The words on the list in **(a)** were chosen by candidates in roughly equal proportions. This showed that many candidates did not have a firm understanding about the sizes of the molecules.
- The most common mistake in **(b)(i)** was a lack of knowledge of the colours of the tests for starch and glucose. Most candidates knew the range of possible acceptable colours for a positive test with Benedict's solution. Fewer were familiar with the negative test for starch with iodine.
- The most common mistake in **(b)(ii)** was the statement that the starch molecules were at the bottom of the beaker, or in the water. Candidates who wrote this disregarded the evidence in Table 7.1. This clearly showed that the starch was not in the water, so it must have been in the bag. Other candidates stated that the starch had been broken down, so it had gone into the water. There was no enzyme present that could have done this.
- **(b)(iii)** The candidates had to use Table. 7.1 again to find where the glucose molecules ended up at the end of the experiment. Most candidates concluded that the glucose molecules had moved out of the bag. A common mistake was not to add further information. There were two marks for this part of the question, so two points had to be made. Some candidates made reference to the process of osmosis in their responses. Osmosis involves the movement of **water** from a high concentration of water to a lower concentration of water across a partially permeable membrane. In the experiment, some water will move into the bag, but this was irrelevant to the question. It was the diffusion of glucose out of the bag which was important. Candidates were awarded credit if they stated that the glucose molecules moved by osmosis.
- **(b)(iv)** Most candidates produced good answers. Some candidates stated that starch molecules were smaller than glucose molecules. Others stated that there had been a reaction and both molecules were the same size. These candidates had difficulty in bringing all the evidence together.
- The main mistakes in **(c)** resulted from the interpretation of the word *substance*. The question was looking for an example of a small molecule, apart from any nutrients, that was carried in the plasma. Therefore, red blood cells, white blood cell and platelets were not correct.

Question 8

Example Candidate Response – high

8 (a) An atom of aluminium is represented by the symbol:.

$^{27}_{13}Al$

State the number of protons and the number of neutrons in this atom.

protons 13

neutrons 14 (1)

[2]

(b) Aluminium is extracted from aluminium oxide.

Aluminium oxide is obtained from the ore bauxite.

(i) State the method of extraction used.

Electrolysis (2) [1]

(ii) State the type of bonding in aluminium oxide.

Ionic (3) [1]

(iii) Suggest **one** reason, other than cost, why aluminium is recycled.

It is not an unlimited resources on earth. (4)

[1]

(c) Copper forms coloured compounds, but aluminium does not.

Explain this observation.

Copper is an 'every-day' metal (transversal?) ~~Not good~~ Aluminium is more like an alkali metal ~~and forms~~ [1] (5)

(d) Copper is extracted from copper oxide by heating with a non-metallic element.

(i) Name this non-metallic element.

Carbon (6) [1]

(ii) State whether the copper oxide is oxidised or reduced during this process.

Explain your answer.

copper oxide is reduced (7)

explanation it loses oxygen to carbon.

[1]

[Total: 8]

Examiner Comments

1 The candidate states the correct number of protons and neutrons.

Mark for (a) = 2 out of 2

2 The candidate states the correct answer, electrolysis.

Mark for (b)(i) = 1 out of 1

3 Full credit is awarded to the candidate for stating the correct type of bonding in aluminium oxide.

Mark for (b)(ii) = 1 out of 1

4 The candidate is awarded full credit for stating that there the resource (in this case aluminium ore) is limited in quantity.

Mark for (b)(iii) = 1 out of 1

5 No credit is awarded because the candidate has written 'transversal' instead of transitional. Aluminium is not an alkali metal.

Mark for (c) = 0 out of 1

6 The candidate states the correct non-metallic element.

Mark for (d)(i) = 1 out of 1

7 Full credit is awarded, as the candidate states that the copper oxide is reduced because it loses oxygen.

Mark for (d)(ii) = 1 out of 1

Total mark awarded = 7 out of 8

How the candidate could have improved their answer

The candidate could have improved their answer to **(c)** by stating that copper is a transition metal. The alternative way in which they could have answered was by stating that aluminium was not a transition metal. Both of these answers showed knowledge that transition metals, in this case copper, form coloured compounds.

Example Candidate Response – middle

8 (a) An atom of aluminium is represented by the symbol:

$^{27}_{13}Al$

State the number of protons and the number of neutrons in this atom.

protons 13

neutrons 14 (1)

[2]

(b) Aluminium is extracted from aluminium oxide.

Aluminium oxide is obtained from the ore bauxite.

(i) State the method of extraction used.

heating the aluminium in a blast furnace then redoxise it. (2) [1]

(ii) State the type of bonding in aluminium oxide.

ionic bonding (3) [1]

(iii) Suggest **one** reason, other than cost, why aluminium is recycled.

so that the amount of waste material can be decreased (4) [1]

(c) Copper forms coloured compounds, but aluminium does not.

Explain this observation.

copper is a transition element and aluminium is not (5) [1]

(d) Copper is extracted from copper oxide by heating with a non-metallic element.

(i) Name this non-metallic element.

carbon (6) [1]

(ii) State whether the copper oxide is oxidised or reduced during this process.

Explain your answer.

copper oxide is reduced

explanation because carbon is oxidised which makes it carbon dioxide and copper is reduced. (7)

[1]

[Total: 8]

Examiner Comments

1 Full credit is awarded for stating the correct number of protons and neutrons in the atom of aluminium.

Mark for (a) = 2 out of 2

2 The method of extraction is incorrect so no credit is awarded.

Mark for (b)(i) = 0 out of 1

3 The candidate states the correct type of bonding in aluminium oxide.

Mark for (b)(ii) = 1 out of 1

4 No credit is awarded as there is inefficient detail. Reference to preventing the waste from going to landfill is needed in this response.

Mark for (b)(iii) = 0 out of 1

5 The candidate is awarded full credit for stating that copper is a transition element.

Mark for (c) = 1 out of 1

6 The candidate states the correct non-metallic element, carbon.

Mark for (d)(i) = 1 out of 1

7 The candidate does not state that the copper oxide loses oxygen. The source of the oxygen which reacts to form carbon dioxide is not stated.

Mark for (d)(ii) = 0 out of 1

Total mark awarded = 5 out of 8

How the candidate could have improved their answer

- The candidate's response to **(b)(i)** could have been improved if they had stated *electrolysis*. Aluminium was too reactive to be extracted using a blast furnace.
- **(b)(iii)** There were several acceptable answers. In the candidate's response they had to state that the waste material would not go to landfill. They could have improved their response by stating that there was a finite amount of metals available to be extracted, and recycling helped to preserve this resource.
- The candidate could have improved their response in **(d)(ii)** by stating that reduction of the copper oxide was caused by removing oxygen from the compound.

Example Candidate Response – low

8 (a) An atom of aluminium is represented by the symbol:

$^{27}_{13}Al$

State the number of protons and the number of neutrons in this atom.

protons 13

neutrons 14 (1)

[2]

(b) Aluminium is extracted from aluminium oxide.

Aluminium oxide is obtained from the ore bauxite.

(i) State the method of extraction used.

fractional distilation (2) [1]

(ii) State the type of bonding in aluminium oxide.

some covalent (3) [1]

(iii) Suggest **one** reason, other than cost, why aluminium is recycled.

recycled because it is renewable so can generally be used again (4) [1]

(c) Copper forms coloured compounds, but aluminium does not.

Explain this observation.

because copper is more reactive (5) [1]

(d) Copper is extracted from copper oxide by heating with a non-metallic element.

(i) Name this non-metallic element.

oxygen (6) [1]

(ii) State whether the copper oxide is oxidised or reduced during this process.

Explain your answer.

copper oxide is reduced (7)

explanation because the oxygen is taken from copper oxide to be left with only copper [1]

[Total: 8]

Examiner Comments

1 The candidate successfully states the number of protons and neutrons in an atom of aluminium.

Mark for (a) = 2 out of 2

2 No credit is awarded because the candidate states the wrong method of extraction.

Mark for (b)(i) = 0 out of 1

3 The candidate states the wrong type of bonding present in aluminium chloride, so no credit is awarded.

Mark for (b)(ii) = 0 out of 1

4 The candidate is not awarded credit for this answer. The term *renewable* is applied to energy sources which are constantly being regenerated.

Mark for (b)(iii) = 0 out of 1

5 No credit is awarded here because the candidate has not made any reference to transition metals.

Mark for (c) = 0 out of 1

6 The candidate states the wrong non-metallic element so no credit is awarded.

Mark for (d)(i) = 0 out of 1

7 Full credit is awarded for a correct answer.

Mark for (d)(ii) = 1 out of 1

Total mark awarded = 3 out of 8

How the candidate could have improved their answer

- The candidate could have improved their answer to **(b)(i)** by stating electrolysis as the method of extraction of aluminium. Fractional distillation was used to separate the fractions of petroleum.
- **(b)(ii)** The candidate should have stated ionic, instead of covalent for the type of bonding in aluminium oxide. This was because the bonding in aluminium oxide was between a metal and a non-metal.
- The candidate could have improved their answer to **(b)(iii)** by stating that there was only a finite amount of aluminium (ore) available and recycling preserved this resource.
- The candidate could have improved their response to **(c)** by stating that copper was a transition metal, which could form coloured compounds.
- **(d)(i)** The candidate could have improved their answer by stating carbon. Oxygen would not cause the carbon to lose its oxygen. It had to be a different non-metal, in this case carbon.

Common mistakes candidates made in this question

- The most common mistakes in **(a)** resulted from incorrect interpretations of the atomic symbol. Incorrect answers included 14 or 27 protons and 13 or 27 neutrons.
- Many candidates stated the wrong method of extraction in **(b)(i)**. The most common mistakes were heating, reduction, redox and fractional distillation.
- **(b)(ii)** Most candidates stated the wrong type of bonding. Incorrect responses included covalent bonding and chemical bonds.
- The most common mistake in **(b)(iii)** occurred when candidates just described recycling; that the metal could be used again. These candidates often did not go further to suggest the advantages of this in terms of preserving a limited resource, or reduced the energy use when recycling was compared to extraction.
- In **(c)**, many candidates did not know that transition metals can form coloured compounds. The most common mistakes included ‘copper is a metal and aluminium is not’ and ‘copper rusts and aluminium does not’.
- The most common mistakes in **(d)(i)** included the names of metals instead of carbon. The candidates recognised that the extraction described was a displacement reaction, but the question asked for a non-metallic element.
- Common mistakes in **(d)(ii)** occurred when candidates identified reduction correctly but did not explain why the copper oxide was reduced. Many candidates stated that the oxide was removed, rather than the oxygen.

Question 9

Example Candidate Response – high	Examiner Comments

9 Fig. 9.1 shows a laboratory water-bath used to keep experiments at a constant temperature.

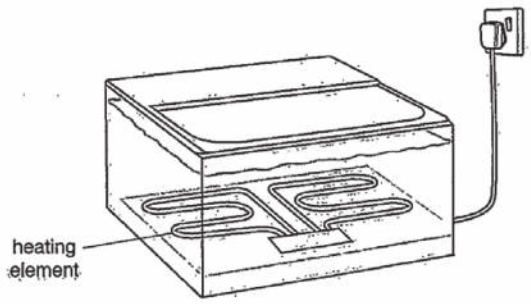


Fig. 9.1

The water is heated by an electric heating element at the bottom of the water-bath.

Fig. 9.2 shows the structure inside the tube of the heating element.

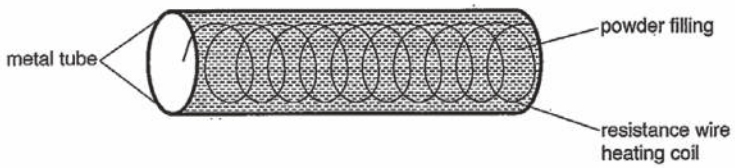


Fig. 9.2

(a) The water-bath is filled with cold water at 10 °C. The heating element is turned on to heat the water to 40 °C.

(i) State the electrical property that the powder surrounding the hot resistance wire should have.

It should be an insulator 1 [1]

(ii) Explain why the powder filling must be a good thermal conductor.

In order to create the most heat possible in the tube to heat the water quickly and efficiently 2

[1]

1 The candidate states that the powder should be an insulator so full credit is awarded.

Mark for (a)(i) = 1 out of 1

2 The candidate understands that the thermal energy (heat) must be able to get through the metal tube in order to heat the water.

Mark for (a)(ii) = 1 out of 1

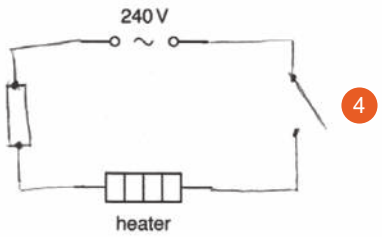
Example Candidate Response – high, continued	Examiner Comments

(iii) Describe how the thermal energy is transferred by the water to raise the water temperature to 40 °C.

The water is heated by convection and a convection current takes place as the hot water (is) towards the surface and the colder water comes down towards the heating element. 3 [2]

(b) The electrical circuit in the water-bath contains a switch, a heater and a fuse.

(i) On Fig. 9.3 complete the circuit diagram for the water-bath, including the symbols for a switch and a fuse.



4

Fig. 9.3

[2]

(ii) The current through the heater when switched on is 3A. A 5A fuse is used in the circuit.

Explain why a 3A fuse would **not** be suitable for use in this circuit.

Because a 3A fuse ~~wont~~ is not sufficient to ensure the safety of the user at the heater. A higher ampage fuse is required. [1]

5 [Total: 7]

3 Full credit is awarded for a correct description of convection.

Mark for (a)(iii) = 2 out of 2

4 The candidate is awarded partial credit. They draw the correct symbol for the switch, but draw the wrong symbol for the fuse.

Mark for (b)(i) = 1 out of 2

5 No credit is awarded here. The candidate does not give an acceptable reason why the 3A fuse is not sufficient.

Mark for (b)(ii) = 0 out of 1

Total mark awarded = 5 out of 7

How the candidate could have improved their answer

- **(b)(i)** The candidate could have improved their answer by drawing the symbol for the fuse instead of a resistor. The candidate should have ensured that connecting wires were drawn using a ruler, and that there were no gaps in the circuit.
- The candidate could have improved their answer to **(b)(ii)** by explaining that the 3A fuse would blow with normal usage, which included occasions when the current was slightly above 3A.The issue of the safety of the user did not arise because the fuse would blow with a small increase in current above 3A and no current would flow.

Example Candidate Response – middle	Examiner Comments

9 Fig. 9.1 shows a laboratory water-bath used to keep experiments at a constant temperature.

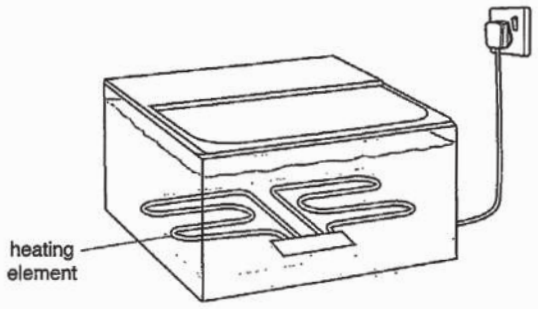


Fig. 9.1

The water is heated by an electric heating element at the bottom of the water-bath.

Fig. 9.2 shows the structure inside the tube of the heating element.

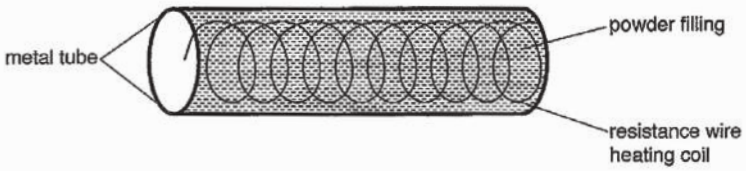


Fig. 9.2

(a) The water-bath is filled with cold water at 10 °C. The heating element is turned on to heat the water to 40 °C.

(i) State the electrical property that the powder surrounding the hot resistance wire should have.

electrical conductivity to allow the current to flow. 1 [1]

(ii) Explain why the powder filling must be a good thermal conductor.

because it stops the resistance wire heating coil from overheating 2

[1]

1 No credit is awarded in this question. If the powder is a good conductor of electricity, the current would be conducted into the water.

Mark for (a)(i) = 0 out of 1

2 The candidate has not given a correct explanation. The powder filling must be a good thermal conductor to transfer the thermal energy to the tube so that the water can be heated.

Mark for (a)(ii) = 0 out of 1

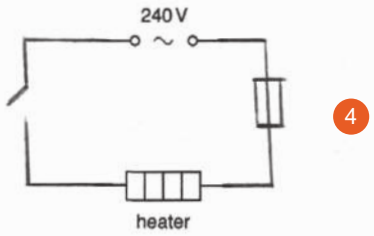
Example Candidate Response – middle, continued	Examiner Comments

(iii) Describe how the thermal energy is transferred by the water to raise the water temperature to 40 °C.

the thermal energy is transfered by the water through the process of ~~conduction~~ convection. The less dense, more energetic and hot water molecules rise as they are bumping off the cold one providing them with thermal energy as well 3 [2]

(b) The electrical circuit in the water-bath contains a switch, a heater and a fuse.

(i) On Fig. 9.3 complete the circuit diagram for the water-bath, including the symbols for a switch and a fuse.



4

Fig. 9.3

[2]

(ii) The current through the heater when switched on is 3A. A 5A fuse is used in the circuit.

Explain why a 3A fuse would **not** be suitable for use in this circuit.

because the fuse will overheat if the current is more than 3A and it will get damaged 5 [1]

[Total: 7]

3 Full credit is awarded for stating that the heat transfer is by convection and providing further information about this in terms of the hot water molecules rising.

Mark for (a)(iii) = 2 out of 2

4 Full credit is awarded for a complete circuit containing the correct symbols for a switch and a fuse.

Mark for (b)(i) = 2 out of 2

5 The candidate has stated that the current may go above 3A but they have not stated that the fuse would blow or the fuse wire would melt, so no credit is awarded.

Mark for (b)(ii) = 0 out of 1

Total mark awarded = 4 out of 7

How the candidate could have improved their answer

- The candidate could have improved their answer to **(a)(i)** by stating that the powder surrounding the heating coil should be an insulator. This would ensure that electric current did not escape into the water.
- **(a)(ii)** The candidate could have explained that the thermal energy generated by the resistance wire must be able to get out of the tube in order to heat the water, so the powder must be a thermal conductor.
- The candidate was awarded full credit in **(a)(iii)**. The candidate attempted an explanation of convection in terms of density; this was not recorded for the Core syllabus. However, it was worth pointing out that the hot water molecules became less densely packed. The molecules themselves do not change in density, but their arrangement can change the density of the water by being further apart or closer together.
- The candidate could have improved their answer to **(b)(ii)** by stating that the fuse would blow/melt if the current exceeded 3A. The responses 'overheat' and 'get damaged' were too vague to be acceptable.

Example Candidate Response – low	Examiner Comments

9 Fig. 9.1 shows a laboratory water-bath used to keep experiments at a constant temperature.

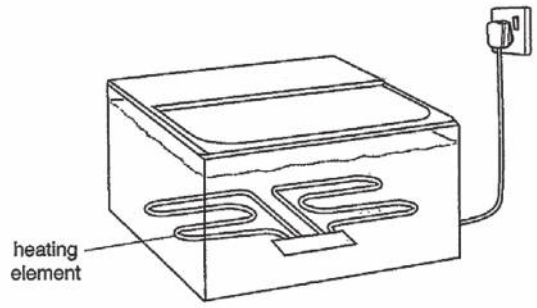


Fig. 9.1

The water is heated by an electric heating element at the bottom of the water-bath.

Fig. 9.2 shows the structure inside the tube of the heating element.

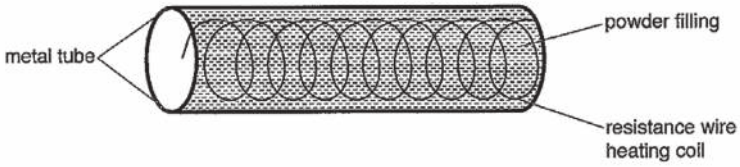


Fig. 9.2

(a) The water-bath is filled with cold water at 10 °C. The heating element is turned on to heat the water to 40 °C.

(i) State the electrical property that the powder surrounding the hot resistance wire should have.

Convection 1 [1]

(ii) Explain why the powder filling must be a good thermal conductor.

To conduct very well to the ~~heat~~ metal tube

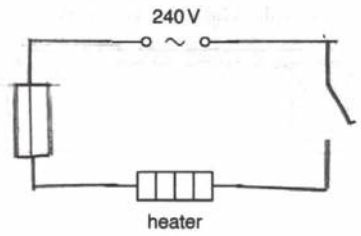
2 [1]

1 The candidate states an incorrect answer so no credit is awarded.

Mark for (a)(i) = 0 out of 1

2 This response is awarded credit because the candidate shows understanding that the thermal energy has to reach the metal tube.

Mark for (a)(ii) = 1 out of 1

Example Candidate Response – low, continued	Examiner Comments
(iii) Describe how the thermal energy is transferred by the water to raise the water temperature to 40 °C. Through the CONDUCTION of thermal energy so heat, upwards to the water bath 3 [2]	3 No credit is awarded here because the candidate has stated the wrong method of heat transfer. Mark for (a)(iii) = 0 out of 2
(b) The electrical circuit in the water-bath contains a switch, a heater and a fuse. (i) On Fig. 9.3 complete the circuit diagram for the water-bath, including the symbols for a switch and a fuse.  4 Fig. 9.3 [2]	4 Full credit is awarded for a complete circuit containing correct symbols for the fuse and switch. Mark for (b)(i) = 2 out of 2
(ii) The current through the heater when switched on is 3A. A 5A fuse is used in the circuit. Explain why a 3A fuse would **not** be suitable for use in this circuit. It wouldn't be strong enough to support the current 5 [1] [Total: 7]	5 No credit is awarded here. Not enough explanation is given to show understanding of how the fuse works. Mark for (b)(ii) = 0 out of 1 **Total mark awarded = 3 out of 7**

How the candidate could have improved their answer

- **(a)(i)** The candidate could have improved their answer by stating that the powder should have been an (electrical) insulator.
- The candidate could have improved their answer to **(a)(iii)** by describing convection, which occurs in water. Conduction occurs in solids, and convection was the main method of heat transfer within liquids and gases.
- **(b)(ii)** The candidate could have improved their response by explaining that the fuse would blow or melt (with normal usage). 'Not strong enough' did not demonstrate knowledge of how a fuse worked and there was no explanation as to why the fuse would be inadequate.

Common mistakes candidates made in this question

- The most common mistakes in **(a)(i)** were that the powder was either a thermal conductor or an electrical conductor.
- **(a)(ii)** The most common mistake occurred when candidates stated that the heat had to be conducted away from the heating coil to prevent it from overheating. This missed the point of the heating element, that the heat produced in the coil had to be conducted through the powder and the tube to the water so that the water bath can heat up.
- **(a)(iii)** The most common mistake was a description of the heat transfer through water as conduction instead of convection. Some candidates stated that electricity moved through the water to heat it. These candidates did not understand the point of the element; to use the heat generated by the resistance coil to heat up the water but making sure that the electricity is isolated from the water.
- The most common mistake in **(b)(i)** occurred when candidates drew the symbol for a resistor instead of a fuse. Also, diagrams were often drawn without using a ruler, and sometimes there were gaps where the connecting wires had not been joined up to the components.
- **(b)(ii)** Most candidates did not have an understanding of how a fuse works. Many responses referred to the voltage across the fuse rather than the current through it. Candidates also wrote responses such as 'the fuse isn't strong enough' or 'the fuse can't handle the current'. These responses did not show any understanding of the fluctuation of current that might occur in normal usage, or that the fuse would blow, or the fuse wire would melt if the current becomes too high.

Cambridge Assessment International Education
The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA, United Kingdom
t: +44 1223 553554
e: info@cambridgeinternational.org www.cambridgeinternational.org