CAMBRIDGE TECHNICALS

Oxford Cambridge and RSA

CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

APPLIED SCIENCE

05847–05849, 05879, 05874

Unit 1 January 2024 series

Version 1

ocr.org.uk/cambridgetechnicals

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from Teach Cambridge.

Would you prefer a Word version?

Did you know that you can save this PDF as a Word file using Acrobat Professional?

Simply click on **File > Export to** and select **Microsoft Word**

(If you have opened this PDF in your browser you will need to save it first. Simply right click anywhere on the page and select **Save as . . .** to save the PDF. Then open the PDF in Acrobat Professional.)

If you do not have access to Acrobat Professional there are a number of **free** applications available that will also convert PDF to Word (search for PDF to Word converter).

Unit 1 series overview

As in the 2023 series, it was clear that many candidates were well-prepared for this paper and it appears that much of the specification content had been encountered by the candidates. They were also familiar with the rubric of the paper and this enabled them to make the most of the scaffolding available for a number of items. With exception of a minority of candidates, a full range of questions were completed and within the time allocated. For those candidates who did not respond to one or two items in the paper, no pattern of 'nil response' could be identified across the paper.

The majority of candidates engaged with the various objective-format items within the paper. This included the addition of missing words in sentences, completion of tick-boxes for optional statements, completing missing sections of tables and joining concept boxes with lines. As noted during earlier series, a number of candidates did not use the calculation spaces available [with particular reference to Question 6(d)(i), Question 6(d)(ii) and Question 8 (a)(i) to (iv)]. In some cases, this restricted the allocation of mid-stage calculation marks.

Candidates rarely used the additional pages provided at the end of the paper. For those who chose this option, it was good to observe easy-to-use links within the answer spaces in the paper. Some candidates referred to the additional page numbers while others used asterisks to make the link.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• had clearly considered and applied the 'exemplification' section of the specification, covering a wide range of topics from geometric isomers **[Q4(c)(ii)]** to the effect of pressure on reaction rates **[Q2(a)(iii)]** • showed the skills and knowledge needed to cope well with challenging topics, including the reactivity of halogens **[Q2(b)]** and the interaction of actin and myosin filaments during muscle contraction **[Q3(d)(ii)]** • had a sound understanding of inorganic and organic chemistry, with topics including the concept of melting point **[Q1(c)(iii)]** and the properties of cellulose **[Q4(a)(iv)]** • showed greater confidence with the biology-related topics, including the structure and function of the heart **[Q3(f)]** and the process of hydrolysis in living organisms **[Q6(c)(i)]** • interpreted a stress-strain graph to calculate the Young's modulus **[Q7(a)(ii)].**	• did not recall features of the 'exemplification' section of the specification, including enzymes as catalysts **[Q6(a)]** and aldehydes and ketones **[Q5]** • struggled to acquire a range of skills and knowledge, including the basis of redox reactions **[Q2(c)]** and structural/functional features of the mitochondrion **[Q3(a)]** • found the correct use of symbols and terminology and the interpretation of the Periodic Table to be challenging **[Q1(b)(i)** and **Q1(d)]** • misinterpreted the scaffolding provided for some questions, including the table used to compare monomers and polymers **[Q4(b)(i)]** and the circuit diagram designed to enable the completion of a power calculation **[Q8(a)(i)]** • struggled to demonstrate the knowledge and skills required to respond effectively to the extended free-response question **[Q5].**

Question 1 (a) (i)

1

(a) Sulfur is a common element in the Earth's crust. A sample of sulfur produced by a volcano contains two isotopes of sulfur, ^{32}S and ^{34}S.

(i) Explain what **isotopes** means.

....

....

.... **[1]**

The majority of candidates did well with this question and provided a clear explanation of the term 'isotope', with reference to both neutron and proton numbers.

Question 1 (a) (ii)

(ii) Use the Periodic Table to show the number of protons, neutrons and electrons in an atom of ^{34}S.

Isotope	Number of protons	Number of neutrons	Number of electrons
^{34}S	....	....	....

[1]

Although many candidates responded correctly with the 16, 18, 16 pattern, some struggled and wrote various combinations of numbers. No clear pattern of alternative responses was noted.

Question 1 (a) (iii)

(iii) Oxygen is in the same group of the Periodic Table as sulfur.

Explain why oxygen and sulfur are placed in the same group.

....

.... **[2]**

This question was also accessible to the majority of candidates. They noted that the same number of outer/valence electrons was found in oxygen and sulfur. There was a tendency not to refer to the similarity of chemical properties.

Question 1 (b) (i)

(b) Sodium (atomic number 11) reacts with oxygen (atomic number 8) to form sodium oxide, Na_2O.

(i) Write down the electron configurations of the elements sodium and oxygen.

- sodium ....
- oxygen ....

[2]

Candidates frequently provided the correct configurations (2, 8, 1 and 2, 6 consecutively), and a clear pattern of alternative responses was not observed.

Question 1 (b) (ii)

(ii) Sodium oxide has ionic bonding.

Using outer shells only, draw a *dot and cross* diagram to show the bonding in sodium oxide.

[3]

Some candidates mistakenly drew a dot and cross diagram for covalent bonding, not for ionic bonding. This prevented candidates from being given marks. However, some candidates did well and correctly presented part or full expected response.

Misconception

A common misconception for candidates was to draw a dot and cross diagram for covalent bonding, not for ionic bonding.

Question 1 (c) (i)

(c) Sulfur reacts with oxygen to form a covalent compound called sulfur dioxide, SO_2.

(i) Complete the following sentence using words from the list.

atoms **ions** **molecules** **particles** **shared** **transferred**

A covalent bond is the attraction between a .... pair of

electrons and the nuclei of the bonded ....

[2]

The majority of candidates used the scaffolding effectively and obtained full marks. There was a trend for some candidates to identify the 'shared' pair of electrons but to struggle with identifying the bonded 'atoms'.

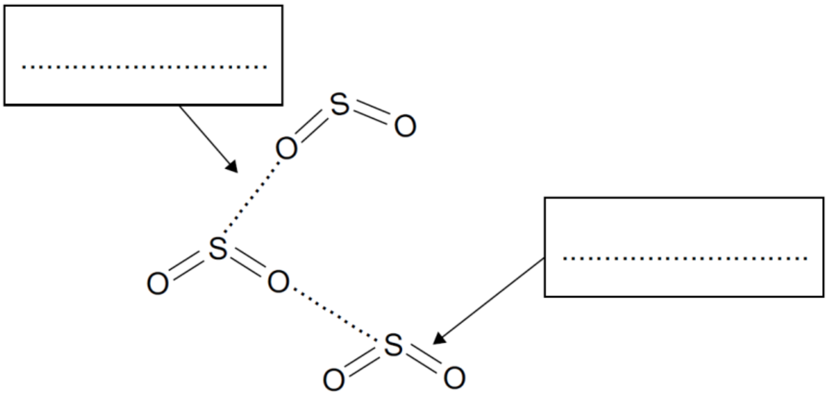
Assessment for learning

It is suggested that candidates are presented with various simple models to distinguish ionic and covalent bonding. This could be achieved via online images or the drawing of models within lessons.

Question 1 (c) (ii)

(ii) Solid SO_2 has a simple molecular lattice structure with a low melting point.

In the diagram below complete the boxes to indicate which is a covalent bond and which is an intermolecular force of attraction (IMF).



[1]

This topic was accessible to the majority of candidates. They were able to recognise and label the IMF and covalent bond within the diagram. The rubric of this question did not present a challenge for candidates.

Question 1 (c) (iii)

(iii) Explain why solid SO_2 has a low melting point.

....

....

....

.... **[2]**

A varied response was seen for this question. Although many candidates correctly observed that the IMF were weak, they did not link this to less energy needed to break the bonds. Some candidates struggled and did not achieve the marking points. No clear pattern of alternative responses was seen.

Question 1 (c) (iv)

(iv) Sulfur dioxide molecules are polar.

Explain in terms of electrons why SO_2 is polar.

....

.... **[1]**

Polarity within molecules appears to be a challenging concept for many candidates. Most candidates did not refer to the unequal sharing of electrons/charges or to the feature of electronegativity.

Assessment for learning

It is proposed that candidates consider polarity across a range of molecules, including water. This could be done via simple diagrams.

Question 1 (d)

(d) Magnesium, silicon and argon are three elements in Period 3 of the Periodic Table.

They are in the same period because they all have three electron shells.

The table below shows the atomic number and atomic radius of the three elements.

Element	**Atomic number**	**Atomic radius (nm)**
Mg	12	0.160
Si	14	0.118
Ar	18	0.095

Describe and explain the change in atomic radius as the atomic number increases.

....

....

....

.... **[2]**

Some candidates did very well and correctly included both marking points in their responses. A number of candidates overlooked the stem reference to 'describe'. This prevented them from obtaining both marking points, although they gave clear explanations for the change in atomic radius.

Assessment for learning

The reinforcement of 'describe' and 'explain' within the stem of such questions would be most appropriate when preparing candidates for this examined unit.

Question 2 (a) (i)

2 Chlorine, Cl_2, can undergo several different types of reaction.

(a) **Equation 2.1** shows the reaction of chlorine with a hydrocarbon, $(CH_3)_3CH$.

Equation 2.1

$Cl_2 + (CH_3)_3CH \rightarrow (CH_3)_3CCl + HCl$

(i) What type of reaction is shown in **Equation 2.1**?

Tick (✓) **one** box.

addition

condensation

polymerisation

substitution

[1]

Although many candidates correctly selected 'substitution' as the type of reaction in **Equation 2.1,** some considered that the reaction was 'addition'.

OCR support

It may be advisable to rehearse the different types of reaction, as outlined in the specification at **LO2.2**.

Question 2 (a) (ii)

(ii) Draw a (circle) around the word(s) that complete each sentence.

Chlorine molecules can be split into **ions / radicals** by exposing them to

infrared / ultraviolet radiation.

If the light **wavelength / intensity** of the radiation is increased, the rate of reaction

will increase.

[2]

Many candidates were confident with the splitting of chlorine molecules and the impact of light intensity. A clear pattern of alternative responses was not observed for this question.

Question 2 (a) (iii)

(iii) The reactants in **Equation 2.1** are gases.

Explain how increasing the pressure affects the rate of this reaction.

....

....

....

....

....

.... **[3]**

It was clear that many candidates were fully aware of the changes in the reaction rate related to an increase in pressure. A common response included a correct statement about the increase in reaction rate, indicating that candidates had understood the rubric of the stem.

Misconception

Some candidates incorrectly referred to levels of energy in the context of increased collisions, rather than relating the collision rate to the smaller space created by the increased pressure.

Question 2 (b)

(b) The elements in Group 17 (group 7) of the Periodic Table are called halogens.

A student is investigating displacement reactions of chlorine, bromine and iodine.

A displacement reaction occurs when a more reactive halogen displaces a less reactive halogen from a solution of one of its salts.

The student adds a solution of chlorine to separate portions of aqueous potassium bromide and aqueous potassium iodide and records the colour of the solutions.

The student repeats the experiment for solutions of:

- bromine with potassium chloride and potassium iodide,
- iodine with potassium chloride and potassium bromide.

The table below shows the results from this experiment.

Halogen	**Colour of aqueous solution**	**Addition of potassium chloride (aq)**	**Addition of potassium bromide(aq)**	**Addition of potassium iodide(aq)**
Chlorine	Pale Green		Orange	Brown
Bromine	Orange	Orange		Brown
Iodine	Brown	Brown	Brown	

If a colour change has occurred, displacement has taken place.

Explain how the student can use the results to determine the order of reactivity of the halogens.

....

....

....

....

....

.... **[4]**

Most candidates struggled with this question. There appeared to be some confusion with regards to the three halogens listed and the use of less reactive halogens. Some appeared to incorrectly assume that fewer displacements indicated that the halogen was 'more' reactive. This may have been the result of misreading the details given in the text above the table of results. No clear pattern of errors was observed.

Question 2 (c)

(c) When fluorine reacts with aqueous sodium chloride, chlorine and sodium fluoride are produced.

The ionic equation for the reaction is shown in **Equation 2.2**.

Equation 2.2

$F_2(g) + 2Cl^-(aq) \rightarrow 2F^-(aq) + Cl_2(g)$

Complete the sentences using the following words.

gained **lost** **oxidised** **reduced**

Fluorine is .... because electrons are

....

Chloride ions are .... because electrons are

....

[2]

Although many candidates obtained both marking points for this question, there was a tendency for others to confuse reduction with the loss, rather than gain, of electrons.

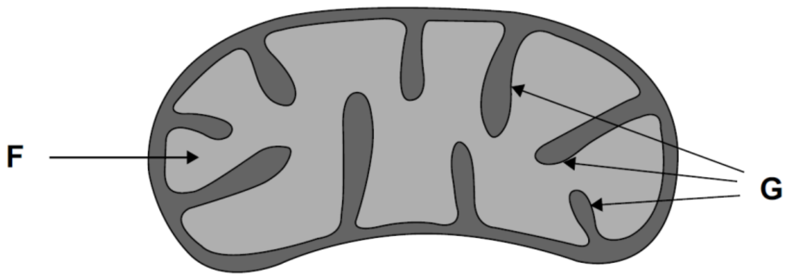
OCR support

Characteristics of reduction and oxidation reactions are outlined in the specification at **LO2.2**.

Question 3 (a)

3

(a) A diagram of a mitochondrion is shown below.



Draw a **line** to link each label to its structure.

Label	**Structure**
	Cristae
	Chromatin
F	Matrix
G	Stroma
	Thylakoid

[2]

Many candidates responded correctly to this question and correctly linked label F to 'matrix' and G to 'cristae'. The diagram was a useful form of scaffolding and was designed to reinforce the identification of mitochondrial features. The rubric of this objective-format did not present any issues for candidates.

Misconception

A number of candidates appeared to confuse the features of the mitochondrion with the chloroplast. As a result, they included the selection of 'stroma' and 'thylakoid' when drawing their linked lines.

Assessment for learning

Many simple diagrams are available online to clarify the structural differences between these two organelles.

Question 3 (b)

(b) Explain why mitochondria are found in large quantities in muscle cells.

....

....

....

.... **[2]**

The majority of candidates were able to recall that mitochondria are the site of (aerobic) respiration and that muscle cells require lots of energy. Some candidates referred to energy and were able to achieve one of the marking points if they described release or provision of energy, but not for 'production of energy'. This latter response negated the marking point.

OCR support

The function and abundance of mitochondria in cells is described via the specification at **LO3.2.**

Question 3 (c)

(c) Muscle tissue can be striated or unstriated.

What is the function of striated muscle in the human body?

.... **[1]**

The function of striated muscle is generally for the movement of the human body (as a component of the musculoskeletal system). This was appreciated by a number of candidates but some referred solely to 'contraction', preventing them from obtaining the marking point.

Question 3 (d) (i)

(d) The cells in striated muscle are also called fibres.

Muscle fibres contain filaments of actin and myosin.

(i) Describe the arrangement of actin and myosin filaments inside a muscle fibre.

....

.... **[1]**

Few candidates were able to articulate a clear description for the arrangement of actin and myosin. Some chose to describe how they slide over each other. This response was the basis of the next question [**Question 3(d)(ii)**]**.** No clear pattern of alternative descriptions was observed.

Question 3 (d) (ii)

(ii) What happens to these filaments when a muscle contracts?

....

....

.... **[2]**

Some candidates successfully described the sliding filament theory, including the use of the myosin head. This was not the case for all responses.

Misconception

There was a tendency to incorrectly assume that the filaments became shorter. This does not happen.

Question 3 (e) (i)

(e)
(i) The sarcoplasmic reticulum is an organelle which releases a metal ion to enable muscle contraction.

Which metal ion enables muscle contraction?

Tick (✓) **one** box.

Ca^{2+}	☐
Li^{+}	☐
Na^{+}	☐
Pt^{2+}	☐

[1]

Most candidates correctly recalled that Ca^{+} ions are needed to complete muscle contraction. No clear alternative response was identified.

Question 3 (e) (ii)

(ii) The sarcoplasmic reticulum is a specialised form of smooth endoplasmic reticulum (SER).

SER is responsible for the production and storage of essential biological molecules.

Draw a (circle) around **two** types of biological molecules that are produced and stored by SER.

carbohydrate **DNA** **lipid**

protein **RNA**

[2]

Many candidates appreciated that both carbohydrate and lipid are produced and stored in the smooth endoplasmic reticulum (SER).

Misconception

?

Lipid was sometimes selected alongside protein. This may reflect some confusion between the function of rough endoplasmic reticulum (RER) and SER, since RER is the site of protein synthesis (via the attached ribosomes) and protein storage/processing. Alternatively, other candidates incorrectly selected DNA and RNA (again, perhaps confusing the activity of these nucleic acids with ribosome function at the RER).

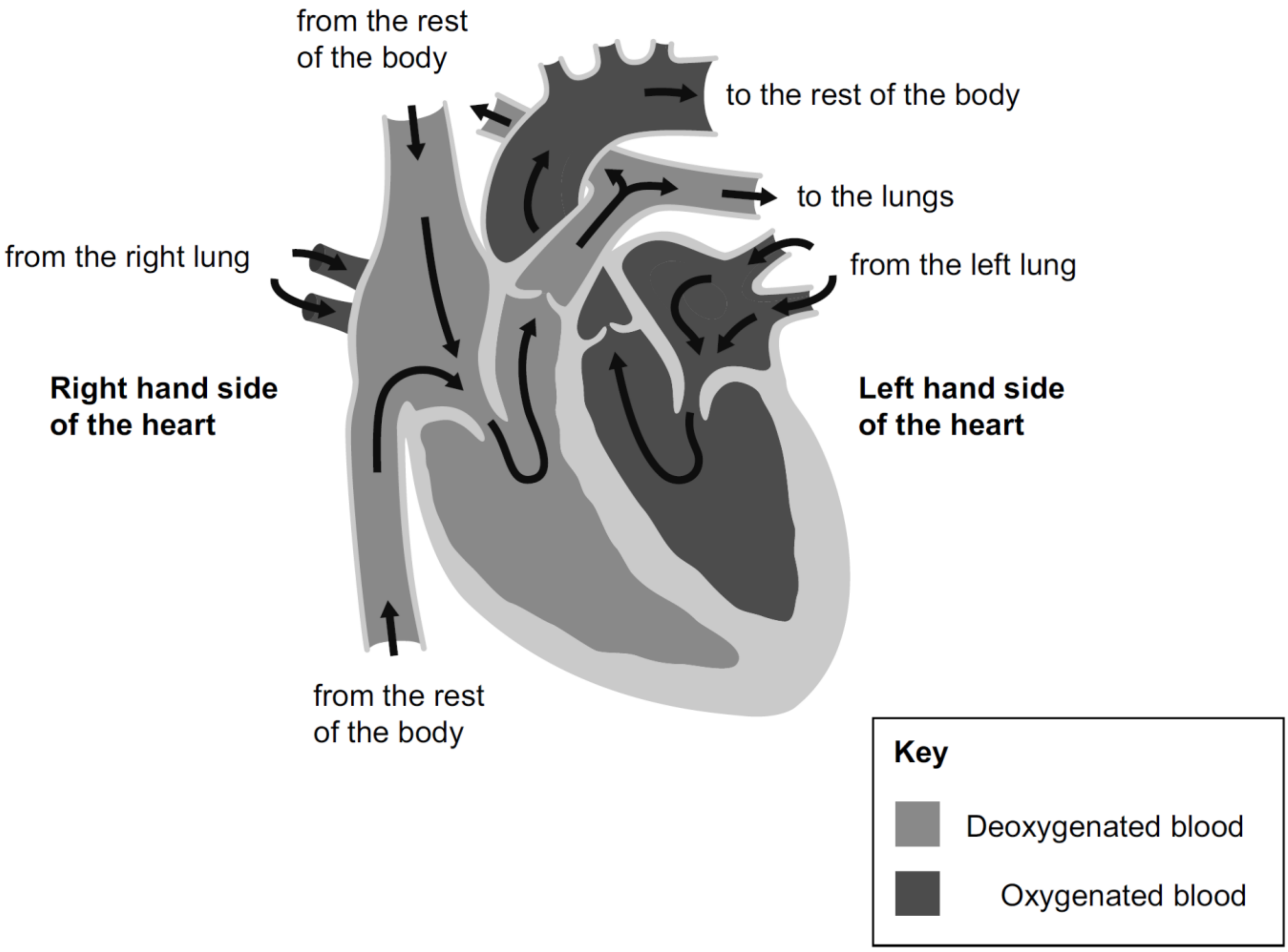
OCR support

i

The functional differences between RER and SER are outlined in the specification at **LO3.2**.

Question 3 (f) (i)

(f) The figure shows how blood flows through the heart.



(i) Which metal ion is responsible for carrying oxygen in the blood?

Tick (✓) **one** box.

Cu^{2+} ☐

Fe^{2+} ☐

K^{+} ☐

[1]

The majority of candidates correctly selected Fe^{2+} as the ion responsible for the carriage of oxygen in the blood. No common error was noted.

Question 3 (f) (ii)

(ii) The wall of the heart contains muscle tissue.

Name the type of muscle tissue found.

.... **[1]**

A range of responses was seen for this question, but a number of candidates correctly named the type of muscle as 'cardiac'. Some candidates appeared to randomly select a term related to muscle, e.g. striated, unstriated or another type of tissue, e.g. epithelial or connective.

Question 3 (f) (iii)

(iii) Suggest why the muscle tissue in the wall on the left hand side of the heart in the figure is thicker than on the right hand side.

....

....

....

.... **[2]**

Many candidates did well with this topic and used the labelling provided in the diagram/figure to correctly observe that the blood on the left side of the heart was transported to the rest of the body and that greater strength or force was needed via the muscle wall (myometrium). References to oxygenated and/or deoxygenated blood were ignored.

Misconception

Some candidates appeared to be confused when explaining the reason for the thicker left hand side. There was a tendency to consider that the muscle was thicker as a result of the greater blood pressure, rather than the cause of this increased pressure.

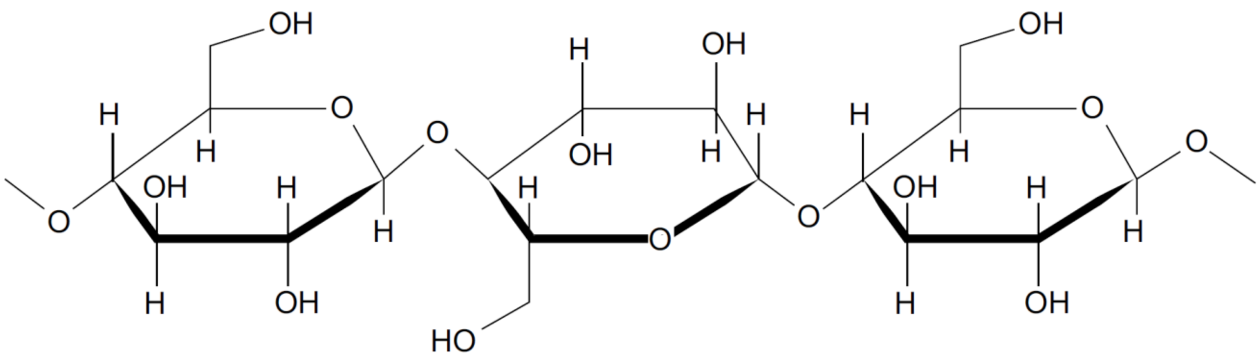
Assessment for learning

It is suggested that candidates would benefit from the provision of unlabelled diagrams of the vertical section (VS) of the heart as seen from the ventral view, for which they could add labels and describe the flow of blood. It is understood that not all candidates wish to take part in heart dissections within the classroom or online.

Question 4 (a) (i)

4 Polymers are long chain molecules made of small monomer molecules.

(a) The figure below shows part of the structure of the naturally occurring polymer, cellulose.



(i) What type of polymer is shown in the figure?

Tick (✓) **one** box.

polyglyceride ☐

polypeptide ☐

polysaccharide ☐

[1]

Many candidates correctly identified 'polysaccharide' as the type of polymer in the figure. No clear pattern of common error was noted.

Question 4 (a) (ii)

(ii) Name the type of link that holds the monomers together in this polymer.

.... **[1]**

Only some candidates recalled that the type of link was 'glycosidic'. Many alternative, incorrect responses were seen, ranging from 'oxygen bond' to 'covalent bond'.

Question 4 (a) (iii)

(iii) Which type of reaction forms the polymer shown in the figure?

Tick (✓) **one** box.

addition	☐
condensation	☐
reduction	☐
substitution	☐

[1]

Although many candidates correctly selected 'condensation' as the type of reaction, some chose 'addition'.

OCR support

Condensation reactions for the formation of polymers are outlined in the specification at **LO4.4**, while other reactions are described at **LO2.2**.

Question 4 (a) (iv)

(iv) Suggest **three** reasons why cellulose is suitable as a material in plant cell walls.

1 ....

2 ....

3 ....
[3]

Apart from correct references to the strength/support/shape provided by cellulose within plant cell walls, many candidates struggled to include other reasons. No clear pattern of alternative responses was noted.

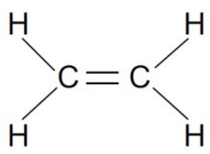
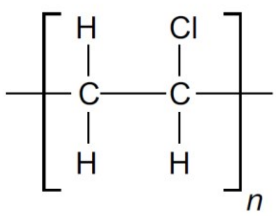
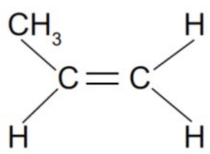
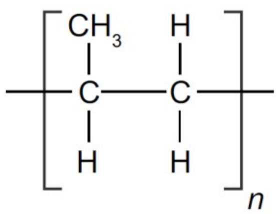
Assessment for learning

It is recommended that an outline of cellulose structure and function is given to candidates via the use of simple models.

Question 4 (b) (i)

(b) Alkenes are used extensively in industry to make polymers.

The table shows the names and structures of some polymers and the structures of their monomers.

Monomer	**Polymer**	
Structural formula	**Name**	**Structural formula**
	Polyethene	
	Polyvinyl chloride (PVC)	
		

(i) Complete the table to show the missing structures and the missing name.

[3]

The provision of scaffolding via the table in this question enabled many candidates to do very well and to construct the structural formulae correctly. However, only some candidates determined that the name of the missing polymer was polypropene. Overall, this question did not present a challenge for most candidates.

Question 4 (b) (ii)

(ii) Draw a section of PVC showing **three** repeat units.

[1]

This question was also mostly accessible for candidates. They were able to construct a section of PVC showing three repeat units. Some candidates were not given the marking point because they added terminal hydrogen at the far right and/or left of the diagram. Others incorrectly included double bonds between carbons.

Question 4 (c) (i)

(c) But-2-ene, $CH_3CH{=}CHCH_3$, is an alkene which shows geometric isomerism.

(i) Draw the structure of the **two** geometric isomers of but-2-ene in the boxes below.

Clearly show the shape of each isomer.

[1]

This question was challenging for most candidates. Few were given the marking point. No clear pattern of common error was seen for this question.

OCR support

The features of geometric isomers are outlined in the specification at **LO4.3**.

Question 4 (c) (ii)

(ii) Explain why but-2-ene shows geometric isomerism.

....

....

....

.... **[2]**

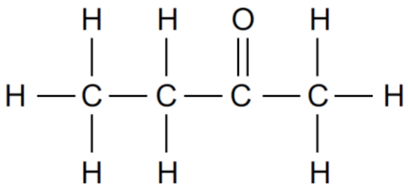
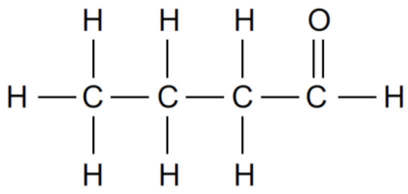
Some candidates correctly referred to the inability of atoms/groups to rotate around the double bond. However, most struggled to articulate a clear explanation for this question.

Assessment for learning

It is suggested that the construction of simple models/diagrams would reinforce the features of geometric isomerism (alongside structural and optical isomerism).

Question 5

5 The figure shows the structures of two organic compounds, **Q** and **R**.

	
Q	**R**

Compare and contrast the two organic compounds in terms of:

- the name and type of compound
- the molecular and skeletal formulae
- how they are formed from alcohols

[6]

Some candidates did very well with this free-response (Level of Response [LoR]) question. They were able to identify similarities and differences between the two organic compounds and to use conventional naming in the correct manner. However, other candidates struggled and were unable to use the scaffolding provided by the models to articulate a clear response. No common errors were observed for this question.

Assessment for learning

It is suggested that the features of chemical and molecular formulae are considered via the construction of simple models (of a wide range of organic compounds) and access to further details via various websites.

Question 6 (a)

6 Enzymes containing nickel, such as hydrogenase and hydrolase, are important biological molecules.

(a) What is the definition of an enzyme?

.... **[1]**

Many candidates recalled that enzymes speed up reactions but they did not note that they are defined as biological or organic. This level of detail eliminates any confusion with inorganic catalysts. Some candidates included further details such as activation sites and the protein composition of enzymes. Such descriptions were credited.

OCR support

The definition of enzymes as biological catalysts is included within the specification at **LO2.3**.

Question 6 (b)

(b) Hydrogenase promotes the formation and utilisation of hydrogen in living organisms as shown in **Equation 6.1**.

Equation 6.1

$H_2 \leftrightarrows 2H^+ + 2e^-$

Identify whether the statements about **Equation 6.1** are true or false.

Put a tick (✓) in the correct boxes.

	True	**False**
Hydrogenase is a reactant		
The reaction is reversible		
H_2 is oxidised to H^+		
Electrons are gained by H_2		

[3]

Most candidates obtained full marking points or two out of the three marking points. It was clear that candidates were confident about the nature of **Equation 6.1**. No pattern of alternative responses was observed. The rubric of this question enhanced access to this topic.

Question 6 (c) (i)

(c) Hydrolase is a type of enzyme which promotes hydrolysis reactions in living organisms.

(i) Explain what **hydrolysis** means.

....

.... **[1]**

Very few candidates correctly explained hydrolysis. No clear pattern of alternative responses was observed but a number of candidates did include a reference to water without further clarification.

OCR support

Hydrolysis in the context of the enzyme hydrolase is included in the exemplification column of the specification at **LO5.1**.

Assessment for learning

It is recommended that hydrolysis is compared to condensation via simple models of different polymers including polypeptides, polysaccharides and triglycerides.

Question 6 (c) (ii)

(ii) In the human body hydrolase is needed in the breakdown of waste products such as urea (H_2NCONH_2).

Complete **Equation 6.2** to show the breakdown of urea.

Equation 6.2

H_2NCONH_2 + ... → CO_2 + 2 ....

[2]

Although a number of candidates correctly identified H_2O as the missing reactant for **Equation 6.2**, few included NH_3 as the missing product. No clear pattern of alternative responses was observed.

Question 6 (d) (i)

(d) Nickel ions are required in very small amounts by the human body.

The table shows two food types that contain nickel.

Food type	**Mass of nickel in μg per 100 g of food type**
Cashew nuts	510
Kidney beans	45

(i) A person's average daily intake of nickel from food and drink should be between 200 and 300 μg.

Calculate the mass of cashew nuts a person would need to eat to have an intake of 250 μg of nickel.

.... g **[2]**

Many candidates successfully calculated the mass of cashew nuts as 49 (g). Some candidates did not include their working for this calculation, thereby missing the opportunity to access a mark for an appropriate calculation, even though they may have presented the incorrect value for the mass.

Assessment for learning

It is recommended that candidates are advised to show their working in the space provided for such calculations.

Question 6 (d) (ii)

(ii) The percentage of nickel absorbed by the human body from food is no more than 15%.

Calculate the maximum amount of nickel the human body will absorb from eating 150 g of kidney beans.

.... µg **[2]**

This calculation question was also accessible to many candidates and they achieved full marks. No clear pattern of alternative incorrect answers was observed.

Assessment for learning

It is recommended that candidates are advised to show their working in the space provided for such calculations.

Question 7 (a) (i)

7 Alloys of aluminium are commonly used in making parts for aircraft engines.

(a) An aerospace engineer tests the strain of a sample of an aluminium alloy (alloy **X**) by applying different levels of stress.

Fig. 7.1 shows the stress−strain graph that the engineer obtains for alloy **X**.

Item removed due to third party copyright restrictions

(i) Use the graph to deduce the breaking stress of alloy **X**.

.... MPa **[1]**

The majority of candidates correctly deduced that the breaking stress of alloy X was 700 +/- 20 (MPa). No clear set of incorrect values was recorded for this question, although some values were out of the acceptable range of +/- 20 (MPa).

Question 7 (a) (ii)

(ii) Use the graph to determine the Young's modulus of alloy **X**.

Show your working on the graph and in the space below.

Young's modulus = ... MPa **[2]**

It was clear that the determination of Young's modulus was challenging for almost all candidates. Some candidates showed their working on the graph and this enabled them to obtain the mark, if correctly presented. However, most candidates struggled to respond correctly.

Assessment for learning

It is suggested that Young's modulus is considered in detail when supporting candidates to appreciate the mechanical properties of materials. The reasons for drawing a triangle on the straight region of a graph can be rehearsed via the construction of simple diagrams.

Question 7 (b) (i)

(b) Alloy **X** contains 95% aluminium and 5% magnesium by mass.

(i) Alloy **X** has a density of 2.71×10^3 kg m^{-3}.

Calculate the volume of 25.0 kg of alloy **X**.

volume = ... m^3 **[1]**

Many candidates correctly calculated the volume of 25.0 kg of alloy X and expressed their value to an appropriate decimal point or power of 10^{-3}. No pattern of incorrect calculations was determined.

Question 7 (b) (ii)

(ii) Calculate the mass of magnesium needed to make 25.0 kg of alloy **X**.

mass = ... kg **[1]**

A number of candidates were not challenged by this question and were able to successfully calculate the mass of magnesium as 1.25 (kg). Again, no pattern of incorrect responses was apparent.

Question 7 (b) (iii)

(iii) Suggest two benefits of using alloy **X** for aircraft parts rather than pure aluminium.

....

....

....

....

.... **[2]**

A number of benefits could be linked to the use of alloy X rather than pure aluminium as an aircraft part. These ranged from greater strength and more durability to less malleability. Most candidates were able to correctly identify one such benefit but most struggled to identify two.

Misconception

? Some candidates incorrectly assumed that the alloy would be cheaper to obtain and that it was generally lighter in weight. Such suggestions were not accredited.

Question 7 (c)

(c) Alloy **Y** is also an alloy of aluminium. It has a Young's modulus less than alloy **X**. It undergoes brittle fracture at a stress of 640 MPa.

On **Fig. 7.1** draw a line to show the possible stress–strain graph for this material.

Label this line **Y**.

[2]

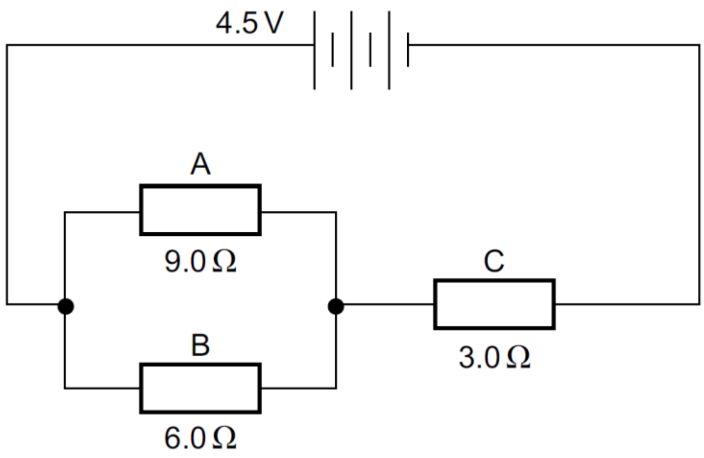
Many candidates did well with this question and used the graph to good effect. They drew a line correctly to show the stress-strain graph for this material, starting at coordinate 0,0, below the original curve/line and ending at 640 MPa.

Misconception

Some candidates were less successful and tended to draw a line above the original or drew a horizontal line. Some candidates did not respond to the question.

Question 8 (a) (i)

8 A battery of electromotive force (e.m.f.) 4.5 V is connected to three resistors **A**, **B** and **C** as shown in the circuit diagram.



(a) Use the following steps to determine the power dissipated in the circuit:

(i) **Step 1** Calculate the combined resistance R_D of resistors **A** and **B**.

Use the equation: $\frac{1}{R_D} = \frac{1}{R_A} + \frac{1}{R_B}$

R_D = ... Ω **[1]**

Some candidates successfully calculated the combined resistance using the equation provided.

There was a tendency for candidates to misinterpret the equation, thereby giving an incorrect value. This appeared to be the result of applying incorrect arithmetic, perhaps due to the values presented as fractions.

Assessment for learning

It is suggested that some candidates may need further guidance for calculating the addition of fractions.

Question 8 (a) (ii)

(ii) **Step 2** Calculate the total resistance R_t of the circuit.

Use the equation: $R_t = R_D + R_C$

R_t = ... Ω **[1]**

The majority of candidates were capable of using the equation correctly. For some candidates, this continued to result in an incorrect value due to the use of an incorrect answer to **Question 8(a)(i)**. However, such answers were accredited due to the application of 'error carried forward' (ECF).

Assessment for learning

This question reinforced the need for candidates to show their working in the space provided for the calculation.

Question 8 (a) (iii)

(iii) **Step 3** Use Ohm's Law ($V = I \times R_t$) to calculate the current I, in the circuit.

I = ... A **[1]**

Many candidates were able to apply Ohm's Law, for which the equation was provided. As for **Question 8(a)(ii)**, those candidates carrying incorrect answers had the potential to obtain the mark if they correctly used their value for **Question 8(a)(ii)**, due the application of 'error carried forward' (ECF).

Assessment for learning

This question reinforced the need for candidates to show their working in the space provided for the calculation.

Question 8 (a) (iv)

(iv) **Step 4** Calculate the power dissipated in the circuit and give the units.

Use the equation: Power = potential difference × current (P = V × I)

P = ... Units .... **[1]**

Some candidates obtained the mark for this question, again often following the application of 'error carried forward' (ECF). The units had to be correctly identified as W/Watts to achieve the marking point.

Assessment for learning

This question reinforced the need for candidates to show their working in the space provided for this calculation.

Question 8 (b) (i)

(b) The resistors **A**, **B** and **C** are wires of the same material and have the same length.

(i) Suggest why resistors **A**, **B** and **C** have different resistances.

....

.... **[1]**

This question was challenging for most candidates. A reference to the thickness or cross-sectional area of the wires was not included in candidate responses. No clear pattern of alternative responses was observed for this question.

Question 8 (b) (ii)

(ii) The voltage across the parallel combination of resistors **A** and **B** is 2.45 V.

Explain why the current in resistor **B** is 1.5 times more than the current in resistor **A**.

....

....

....

.... **[2]**

Relatively few candidates obtained both marks for this question. It was rare to observe calculations used to support an explanation. However, some candidates did correctly note the increased resistance at resistor A in relation to resistor B. Potential difference and voltage across the resistors were not considered by candidates. No clear pattern of incorrect responses was observed.

Copyright information

Question 3(f) Image showing flow of blood through the heart, Modified Shutterstock image 1276518334 by Olga Bolbot

Supporting you

Teach Cambridge

Make sure you visit our secure website **Teach Cambridge** to find the full range of resources and support for the subjects you teach. This includes secure materials such as set assignments and exemplars, online and on-demand training.

Don't have access? If your school or college teaches any OCR qualifications, please contact your exams officer. You can forward them this link to help get you started.

Reviews of marking

If any of your students' results are not as expected, you may wish to consider one of our post-results services. For full information about the options available visit the OCR website.

Keep up-to-date

We send a monthly bulletin to tell you about important updates. You can also sign up for your subject specific updates. If you haven't already, sign up here.

OCR Professional Development

Attend one of our popular CPD courses to hear directly from a senior assessor or drop in to a Q&A session. Most of our courses are delivered live via an online platform, so you can attend from any location.

Please find details for all our courses for your subject on **Teach Cambridge**. You'll also find links to our online courses on NEA marking and support.

Signed up for ExamBuilder?

ExamBuilder is the question builder platform for a range of our GCSE, A Level, Cambridge Nationals and Cambridge Technicals qualifications. Find out more.

ExamBuilder is **free for all OCR centres** with an Interchange account and gives you unlimited users per centre. We need an Interchange username to validate the identity of your centre's first user account for ExamBuilder.

If you do not have an Interchange account please contact your centre administrator (usually the Exams Officer) to request a username, or nominate an existing Interchange user in your department.

Need to get in touch?

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our customer support centre.

Call us on
01223 553998

Alternatively, you can email us on
support@ocr.org.uk

For more information visit
- **ocr.org.uk/qualifications/resource-finder**
- **ocr.org.uk**
- **facebook.com/ocrexams**
- **twitter.com/ocrexams**
- **instagram.com/ocrexaminations**
- **linkedin.com/company/ocr**
- **youtube.com/ocrexams**

We really value your feedback

Click to send us an autogenerated email about this resource. Add comments if you want to.
Let us know how we can improve this resource or what else you need. Your email address will not be used or shared for any marketing purposes.

I like this **I dislike this**

Please note – web links are correct at date of publication but other websites may change over time. If you have any problems with a link you may want to navigate to that organisation's website for a direct search.

CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT