CAMBRIDGE TECHNICALS

OCR
Oxford Cambridge and RSA

Examiners' report

CAMBRIDGE TECHNICALS LEVEL 3 (2016)

APPLIED SCIENCE

OCR Level 3 Cambridge Technical in Applied Science

Certificate: 05879

Extended Certificate: 05847

Foundation Diploma: 05848

Diploma: 05849

Extended Diploma: 05874

Unit 1 Summer 2025 series

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.

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Unit 1 series overview

Many candidates responded well to this paper and a range of marks was achieved from Pass to Distinction levels. Most candidates completed the paper within the time allocated and no single question could be identified as a common 'nil response'. It is clear that many candidates were supported effectively by their teachers and had prepared well for the examination, as indicated by the factual recall and skills demonstrated across a number of questions. The paper further showed that candidates were increasingly familiar with the rubric required to complete the objective-style questions, ranging from circling the correct term and ticking the optional box, to completing sentences using words provided.

A number of candidates used the scaffolding/scenario provided to good effect. This was seen, in particular, for the Level of Response (LoR) topic (Question 7). Candidates applied their understanding of resistant materials to describe and explain events taking place at a diving board. The candidates were supported with text with reference to 'resistance' of materials within the stem of the question and a drawing of a person on a diving board. Some candidates also chose to use their mathematical skills to interpret an equation provided, although this was not critical to their overall performance. Other questions with extra scaffolding included the two biology-based topics of cell structure and function and epithelial/connective tissues. In general, candidates tend to find such topics to be more accessible than some of the chemistry-based questions.

Some candidates were more confident than others when constructing chemical diagrams/models. For example, although a diagram was given to show two monomers within a polysaccharide, many candidates were challenged to add the location of the glycosidic link/bond. However, some candidates were much more successful when drawing a dot-and-cross model for an ionic bond.

As in earlier series, many candidates did not need to use the additional pages to supplement their responses. However, when such pages were used on this occasion, they tended to be for extended responses to the LoR topic, Question 7. Links between items within the question paper and those on the additional pages were clear.

Finally, it is interesting to note that many candidates made the most of the working spaces provided for calculation questions. This was particularly important for those candidates who obtained an incorrect value for a question but continued to obtain marks based on errors carried forward (ecf) from earlier calculations within the same question, e.g. Question 8. Such effective use of working spaces enabled the students to obtain more marks overall.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• showed a good range of skills and knowledge when responding to some of the more challenging topics, including the construction of a dot-and-cross diagram for an ionic bond **[Question 1 (d) (ii)]** and comparing the difference between solutions/suspensions and colloids **[Question 2 (b) (ii)]** • used the details provided in the exemplification column of the specification to answer questions ranging from an explanation of a lower melting point for a solder **[Question 2 (d) (ii)]** to the reformation of amino acids via the hydrolysis of the peptide bond **[Question 5 (b) (i)]** • had the confidence to interpret biology-based topics, including the identification of the organelle common to both eukaryotic and prokaryotic cells **[Question 4 (c) (i)]** and the presence of fibres found in connective tissues **[Question 6 (b) (i)]** • showed an effective understanding of chemistry-based topics ranging from an explanation of atomic radius decrease within the Periodic Table **[Question 1 (c)]** to completing equations for the breakdown of urea **[Question 3 (c) (ii)]** • gave a good explanation of stiffness of resistant materials in the context of a diving board **[Question 7]**.	• were challenged by some of the chemistry-based questions, including the balancing of an equation **[Question 2 (a) (ii)]** and an explanation of metallic lattice **[Question 2 (d) (i)]** • misinterpreted some of the basic features of biological models, ranging from the roles of components found in plant and animal cells **[Question 4 (a)]** to an understanding of epithelial cells in human skin **[Question 6 (a) (ii)]** • did not apply the extra details provided in the exemplification column of the specification to support topics including the features of an ionic bond **[Question 1 (d) (i)]** and the properties of geometric isomers **[Question 5 (b) (iii)]** • misinterpreted terms used in some chemistry-based topics, such as atomic number versus atomic mass **[Question 1 (b)]** and in biology-based topics, such as cofactors **[Question 3 (a)]** • found a number of the mathematical skills challenging, ranging from calculating the mass of tin in two solders **[Question 2 (c) (iii)]** to showing the combined resistance in a circuit **[Question 8 (a) (ii)]**.

Question 1 (a)

1

(a) There are three forces in the nucleus of an atom.

Complete the table by placing **one** tick (✓) in each row to match each force with what it is responsible for.

	Electromagnetic force	Strong nuclear force	Weak nuclear force
Keeping nuclei stable			
Radioactive decay			
Repulsion between protons			
Binding protons and neutrons together			

[4]

The majority of candidates showed a sound understanding of forces in the nucleus of an atom. No common error was observed.

Question 1 (b)

(b) Complete the sentences about the Periodic Table.

Use words from the list.

atomic	**compounds**	**elements**	**groups**
mass	**number**	**periods**	**shells**

The Periodic Table is an arrangement of the chemical ..... ordered by

increasing ....

The rows are called ..... and the columns are called ..... .

[4]

Most candidates showed the knowledge required to complete the sentences about the Periodic Table.

Some misunderstanding was seen between the correct use of atomic number in relation to the incorrect use of atomic mass.

Question 1 (c)

(c) The table below shows the electron configurations and atomic radii of magnesium, silicon and chlorine.

	Magnesium	Silicon	Chlorine
Electron configuration	2,8,2	2,8,4	2,8,7
Atomic radius / nm	0.160	0.118	0.099

Explain why the atomic radius **decreases** from magnesium to silicon to chlorine.

.....

.....

.....

.....

.....

..... **[3]**

Although some candidates provided a full explanation of the decrease in atomic radius, many did not correctly refer to the number of shells or the position of magnesium, silicon and chlorine in the same period. The more successful responses included the increase in atomic number or number of protons and the greater attraction/force between the outer electrons and nucleus.

Some candidates incorrectly assumed that atomic radius was linked to reactivity.

Exemplar 1

As you go down the periods (left to right) the atomic radius decreases as the nuclear charge (amount of protons) increases, therefore pulling the electron shells closer to the nucleus.

This response to Question 1 (c) shows the inclusion of two of the three marking points. The candidate has referred correctly to the increased number of protons and to the pulling of electron shells closer to the nucleus. The statements include 'words to the effect' [OWTTE] as listed in the expected answers on the mark scheme. It is an interesting exemplar because it shows that a reference to the number of shells, or the location of the three elements in the same period, is missing.

Question 1 (d) (i)

(d) Magnesium reacts with chlorine to form an ionic compound, magnesium chloride $MgCl_2$.

(i) Explain what is meant by an ionic bond.

.....

.....

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

As observed in earlier series, candidates referred to the combination of metal and non-metal ions, rather than the electrostatic attraction between positive and negative ions.

OCR support

It is recommended that teachers draw the attention of candidates to the exemplification given in the specification at **LO1.3**, supported by simplified models (including the comparison of ionic with covalent bonds).

Question 1 (d) (ii)

(ii) Draw a dot and cross diagram to show the ionic bonding in magnesium chloride.

Show outer electrons only.

[3]

Candidates are often challenged with the construction of dot-and-cross diagrams, particularly if the question does not provide extra scaffolding. This was the case for this question. Only those students who generally did well on this paper were able to show the Mg (without electrons or with 8 electrons), two separate Cl ions (or one with x2 indicated) and the correct charges. No clear pattern of alternative responses was seen, although a number of diagrams of covalent bonding were observed.

Question 2 (a) (i)

2 An understanding of the chemical reactivity and physical properties of metals is essential because they have a vast range of applications.

(a) The position of a metal in the reactivity series can be determined by adding the metal to a solution of metal ions and observing whether there is a reaction or not.

The table shows the results when copper, gold and tin are added to solutions of different metal compounds.

Key:
✓ = reaction occurs
✘ = no reaction occurs

Solution	Metal		
	Copper	Gold	Tin
Copper(II) sulfate		✘	✓
Gold(III) chloride	✓		✓
Tin(II) chloride	✘	✘	

(i) Deduce the order of reactivity shown by the results in the table.

Write the names of the metals in order of **decreasing** reactivity.

..... > ..... > ..... **[1]**

Most reactive **Least reactive**

The majority of candidates were not challenged by this question. They used the table to good effect and successfully determined the increasing levels of reactivity from tin to gold.

Some candidates misread the table and instruction and referred to the three solutions, rather than metals. This was not creditworthy of the mark.

Question 2 (a) (ii)

(ii) Copper, Cu, reacts with gold(III) chloride, $AuCl_3$.

Complete the chemical equation so that it is balanced.

.....Cu + ...$AuCl_3$ → .....$CuCl_2$ + ...Au **[2]**

Many candidates were able to successfully balance the chemical equation, showing the pattern of 3 and 2 on both sides of the equation. For those candidates who struggled with this question, a number obtained one mark for showing at least the correct balance for one element (often Cu or Au).

Assessment for learning

It is suggested that the balancing of equations is rehearsed and tested on a regular basis with candidates, using a range of examples.

Question 2 (a) (iii)

(iii) Identify the type of reaction shown in the reaction between copper and gold(III) chloride.

Put a (ring) around the correct answer.

addition **displacement** **substitution** **[1]**

Some candidates correctly identified displacement as the reaction between copper and gold (III). Others were not able to do this. No preference for either of the wrong answers was observed.

Question 2 (a) (iv)

(iv) The rate of reaction between copper and gold(III) chloride depends on a number of factors.

Which change causes an **increase** in the rate of reaction?

Tick (✓) **one** box.

- Decrease in pressure ☐
- Decrease in surface area of the metal ☐
- Increase in light intensity ☐
- Increase in temperature of the solution ☐

[1]

The majority of candidates appreciated that an increase in temperature of the solution caused an increase in the rate of reaction. No pattern of alternative choices was seen.

Question 2 (b) (i)

(b) Gold is found in a colloidal medicine used to relieve some types of skin inflammation.

The colloid is a mixture of gold particles dispersed in water.

(i) Identify the type of colloid from the description of gold in water.

Tick (✓) **one** box.

- Emulsion ☐
- Foam ☐
- Gel ☐
- Sol ☐

[1]

Although the students who tended to do well with this paper tended to correctly select sol as the type of colloid, many of the others struggled to identify sol. A common, incorrect alternative was emulsion but this was not seen for all candidates.

Assessment for learning

Teachers may wish to consider a detailed comparison of the terms listed for colloids (ranging from emulsion to sol) via the use of diagrammatic models and simple explanations. It may also be useful to demonstrate the differences in the laboratory or through the use of videos.

Question 2 (b) (ii)

(ii) Colloids are different from solutions and suspensions.

State **one** way in which a colloid is different from:

- a solution .....

.....

- a suspension .....

.....

[2]

A common description seen for solution included a correct reference to a solute/particle dissolving in a medium (or alternative term). This enabled candidates to obtain the first marking point. However, many candidates were challenged by the comparison of suspension with colloid. Relatively few candidates referred to the size of particles involved. No clear pattern of alternative responses for suspension was seen.

Question 2 (c) (i)

(c) Copper (Cu) and tin (Sn) are metals that are often used in mixtures known as alloys.

(i) Identify the alloy that is 90% by mass of Cu and 10% by mass of Sn.

Tick (✓) **one** box.

Brass ☐

Bronze ☐

Steel ☐

[1]

A number of candidates correctly identified bronze as the alloy with Cu (90% mass) and Sn (10% mass).

A common error was seen with the incorrect selection of brass as the alloy.

Question 2 (c) (ii)

(ii) Copper and tin are also found in amalgam alloys that are used for tooth fillings.

Identify another metal that is present in amalgam.

Put a (ring) around the correct answer.

lead **mercury** **sodium** **[1]**

Although a number of candidates correctly selected mercury as the alloy found in amalgam for tooth fillings, many chose one of the two other options. No clear pattern of incorrect options was observed. However, it could be assumed that some candidates considered that mercury is too toxic to be used in this way.

OCR support

The common use of alloys in amalgam is noted in the exemplification column of the specification at **LO2.1**.

Question 2 (c) (ii)

(iii) Solder is an alloy which is used in electronics.

The table shows information about two different types of solder.

Solder **A** is an alloy of tin and copper.

Solder **B** is an alloy of tin and lead.

	Percentage by mass of tin (%)	**Melting point (°C)**
Solder **A**	99.3	227
Solder **B**	61.9	183

Calculate the difference in mass of tin in 5 g of solder **A** and in 5 g of solder **B**.

Difference in mass of tin = ... g **[2]**

Many candidates did well with this calculation and obtained the correct value of 1.87 (g). Some candidates did not achieve this value but did use the working space effectively on the paper to show the correct first step of the calculation (99.3 – 61.9). This enabled them to obtain the first marking point. It is helpful for teachers to remind candidates to show their calculations in the working space provided, even if they have chosen to use a calculator to complete such tasks.

Question 2 (d) (i)

(d) Pure tin has a metallic lattice structure and a melting point of 232 °C.

(i) Explain what is meant by a metallic lattice in terms of the types and arrangement of particles present.

.....

.....

.....

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

Many candidates clearly had a good understanding of what constitutes a metallic lattice. They confidently referred to particles/ions arranged in a regular way, including rows, lines or layers, interspersed with delocalised or free-moving electrons. Not all candidates considered the electrons. Some candidates continued to describe the relevance of this to melting points but this topic was covered in the following item [Question 2 (d) (ii)]. This did not generally distract from the marks given.

Question 2 (d) (ii)

(ii) Explain why solder **A** has a **lower** melting point than tin.

.....

.....

.....

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

A number of candidates appreciated that lower melting points were related to weakened bonds. Some correctly expressed this as less energy required to break the bonds. Relatively few candidates, however, understood that alloy composition disrupts the lattice arrangement due to the presence of different sized atoms. Only those candidates who performed particularly well on this paper accessed the marks for this observation.

Question 3 (a)

3 Metal ions have different roles in cell function.

(a) State the term used for an ion that activates an enzyme.

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

Relatively few candidates correctly identified the term as cofactor. Many incorrectly referred to other aspects of enzyme structure/function, with responses ranging from catalyst and active site to activation energy. No other clear pattern of alternative responses was seen.

Assessment for learning

It is recommended that teachers consider the use of simple, diagrammatic models to demonstrate the location and function of ions as cofactors of enzymes via a range of examples.

Question 3 (b) (i)

(b) Nickel ions are found in the enzyme hydrogenase within living cells.

Hydrogenase catalyses the reaction:

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

(i) State what the symbol $\rightleftharpoons$ indicates about the reaction.

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

Almost all candidates recalled that the symbol indicated that the reaction was reversible. Some gave a correct statement, such as 'can work in both directions'. No clear pattern of alternative, incorrect responses was observed.

Question 3 (b) (ii)

(ii) Identify the type of reaction which occurs when hydrogen molecules are converted to hydrogen ions.

Tick (✓) **one** box.

- Addition ☐
- Condensation ☐
- Oxidation ☐
- Reduction ☐

[1]

Many candidates correctly selected oxidation as the type of reaction involved in this process. No clear pattern of alternative responses was seen.

Question 3 (c) (i)

(c) Nickel ions are found in enzymes that use water to break bonds in organic molecules.

(i) Identify this type of enzyme.

Tick (✓) **one** box.

- Hydrolase ☐
- Lactase ☐
- Oxidase ☐
- Protease ☐

[1]

Many candidates also correctly selected hydrolase as the type of enzyme. It could be assumed that the 'use of water to break bonds' was a sufficient steer in the stem to support candidates to make this choice. No clear pattern of alternative responses was observed.

Question 3 (c) (ii)

(ii) Urease is another type of enzyme activated by nickel.

Urea is broken down in the human body by water in the presence of urease.

Complete the equations to show the complete breakdown of urea, NH_2CONH_2.

$NH_2CONH_2 + H_2O \rightarrow$ ..... + NH_2CO_2H

$NH_2CO_2H + H_2O \rightarrow NH_4^+ +$ .....

[2]

In general, only those candidates who performed well overall on this paper were fully successful when completing the equations. The majority of correct responses included the insertion of NH_3 for the first step of the breakdown of urea. Although a few candidates did present the correct elements in the product in the second equation they did not show the correct charge, i.e. HCO_3^-.

Question 3 (d)

(d) Sodium ions exchange places with another metal ion in order to maintain an isotonic balance within body cells.

Identify this metal ion.

Tick (✓) **one** box.

- Calcium ☐
- Lithium ☐
- Manganese ☐
- Potassium ☐

[1]

Many candidates appeared to correctly associate potassium ions with sodium ions when considering the concept of isotonic balance. This enabled them to gain the mark for a correct selection. However, other candidates did not make this association and incorrectly chose one of the other three ions. No pattern of incorrect responses was noted.

Question 3 (e) (i)

(e) Some compounds containing metal ions are used to treat conditions in humans.

(i) Name **one** condition which can be treated with lithium carbonate.

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

Some candidates correctly recalled that conditions such as depression and bipolar (affective disorder) can be treated with lithium carbonate. Other candidates were given the mark for referring to hypertension, although this is treated directly with lithium. Incorrect responses ranged from heart conditions to cancer.

An outline of biological functions of lithium and a range of other metal ions is found in the exemplification column of the specification at **LO5.1**.

Question 3 (e) (ii)

(ii) Cisplatin is a compound of platinum.

Cisplatin is used in cancer treatment.

Explain how cisplatin affects cancer cells.

.....

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

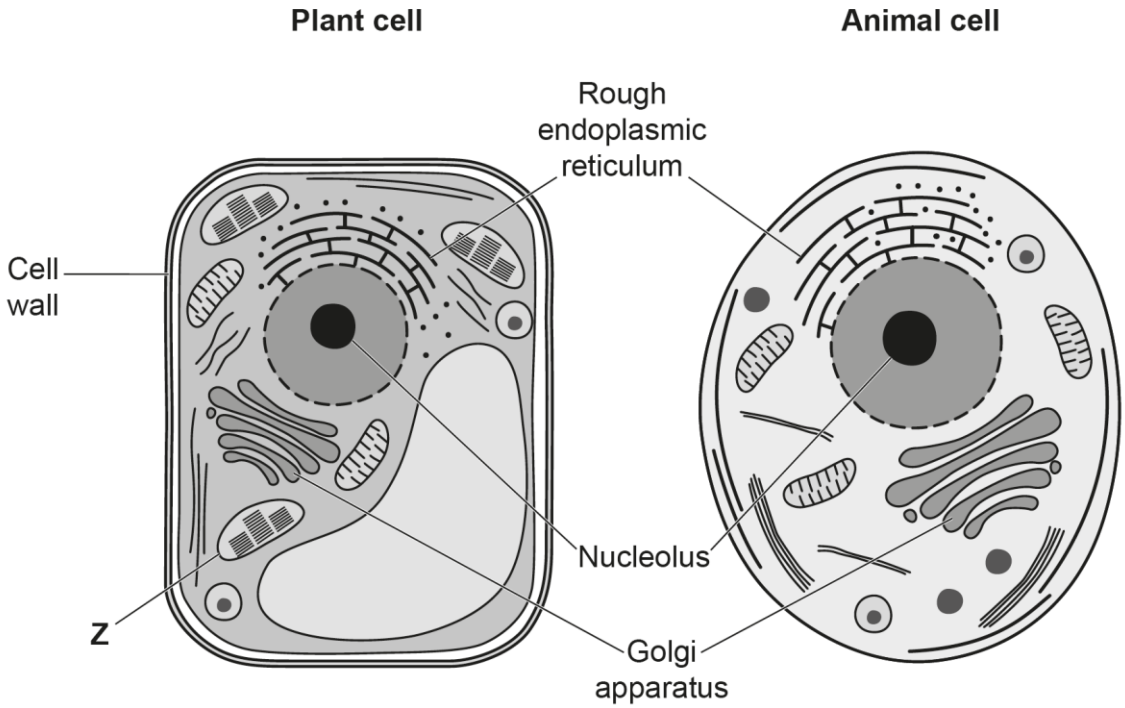
It was clear that many candidates were aware that cisplatin affects cancer cells via the disruption of DNA or cell replication. Some candidates described the killing of such cells or the control of cancer spread. This type of unqualified response was insufficient to explain the affect in the correct way.

Question 4 (a)

4 Eukaryotic cells share many of the same organelles but there are some differences between plant and animal cells.

Fig. 4.1 shows a plant cell and an animal cell.

Fig. 4.1



(a) Draw lines to link each **organelle** to its **function**.

Organelle	Function
Golgi apparatus	production of proteins
nucleolus	production of lysosomes
rough endoplasmic reticulum	production of ribosomes

[2]

Although the majority of candidates were able to link the three cellular components to their correct functions, some candidates were challenged by this question. Those candidates who performed less well in this paper appeared to draw the links at random.

It is recommended that teachers rehearse and test the topic of cell organelle structure and function via simplified models.

Question 4 (b) (i)

(b) **Fig. 4.1** shows some organelles in the plant cell that are **not** found in the animal cell.

(i) Identify organelle **Z** in the plant cell.

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

Some candidates used the diagram of the plant cell to good effect and correctly identified the organelle as the chloroplast. No clear pattern of alternative responses was seen, but such incorrect responses ranged from organelles such as the mitochondrion or nucleus to non-organelle components such as the cytoplasm or cell membrane.

Question 4 (b) (ii)

(ii) Plant cells also have cell walls which are **not** found in animal cells.

State **one** function of the plant cell wall.

.....

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

The majority of candidates correctly stated that the function of the cell wall was for support, structure or shape. Other candidates were also correct with reference to cell protection or turgidity. No clear pattern of alternative responses was observed, although some candidates referred incorrectly to the function of the cell surface membrane.

Question 4 (b) (iii)

(iii) Identify the name of the polysaccharide found in a plant cell wall.

Tick (✓) **one** box.

Cellulose ☐

Glycogen ☐

Starch ☐

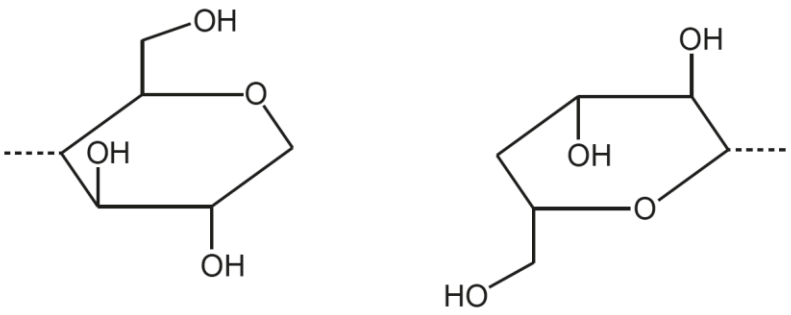
[1]

Many candidates correctly identified cellulose as the polysaccharide found in the plant cell wall. No dominant pattern was seen for the two remaining choices. It is also appreciated that many teachers refer to the 'cellulose cell wall' when describing the components of plant cells.

Question 4 (b) (iv)

(iv) The monomers in the polysaccharide forming the plant cell wall are connected by glycosidic links.

Draw a glycosidic link between the two monomer residues shown below.



[1]

Although some candidates successfully drew a partial glysosidic bond/link between the two monomers of the polysaccharide (cellulose), many struggled to include the oxygen. This was clearly a challenging question and only those candidates who did well with this paper overall were fully successful. Some candidates incorrectly drew a bond/link between two of the hydroxide (OH) groups.

Question 4 (c) (i)

(c) Many of the organelles found in eukaryotic cells are membrane-bound. These are **not** found in prokaryotic cells.

(i) Which organelle is found in **both** eukaryotic and prokaryotic cells?

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

Some candidates correctly recalled that the organelle found in both types of cell is the ribosome.

Many candidates incorrectly referred to the mitochondrion or nucleus or selected non-organelle components such as cytoplasm of cell membrane.

Question 4 (c) (ii)

(ii) The nucleus is a membrane-bound organelle. It is found in eukaryotic cells but **not** in prokaryotic cells.

The nucleus contains the following three structures:

chromosome **gene** **nucleotide**

Write the names of the three structures in order of **increasing** size.

....

Smallest **Largest**

[2]

Although a number of candidates fully appreciated the size differences between the three components of the nucleus, many made an error. However, the size links were marked independently and, as a result, candidates were given one mark for achieving one of the links correctly, e.g. gene-chromosome, even though the other link was incorrect in the sequence.

Question 5 (a) (i)

5 Isomers are molecules with the same molecular formula but different arrangements of atoms.

(a) There are two structural isomers with the molecular formula C_4H_{10}.

(i) What is the name of the straight chain isomer of C_4H_{10}?

Tick (✓) **one** box.

Butane ☐

Ethane ☐

Methane ☐

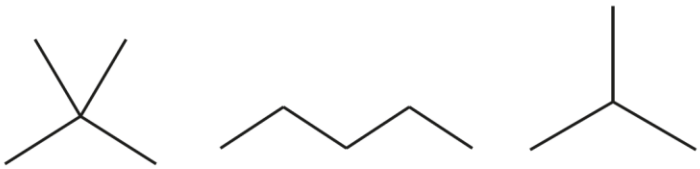
Propane ☐

[1]

Many candidates completed the correct selection of butane. No clear pattern of incorrect responses for the remaining three options was observed.

Question 5 (a) (ii)

(ii) Put a (ring) around the skeletal formula of the **other** isomer of C_4H_{10}.



[1]

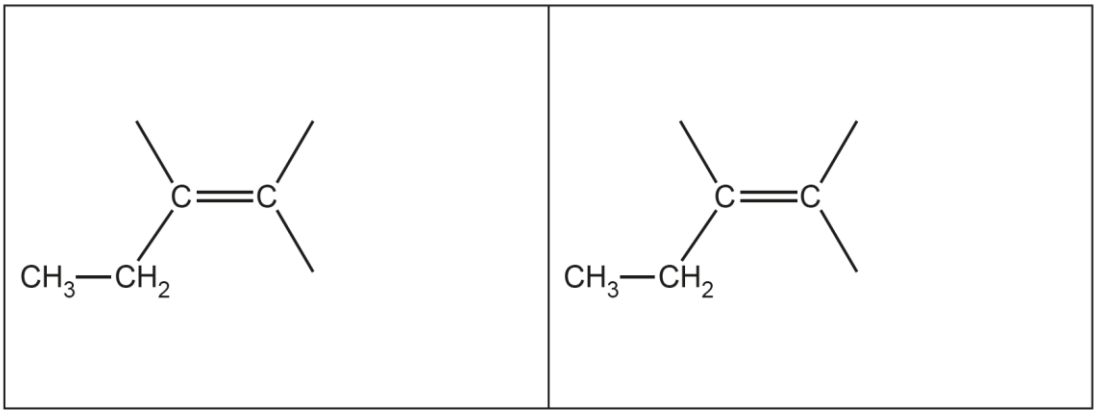
Some candidates correctly identified the skeletal formula for the other isomer (far right). No pattern of incorrect responses was seen.

Question 5 (b) (i)

(b) Two structural isomers of C_5H_{10} are pent-1-ene and pent-2-ene.

(i) Pent-2-ene has two geometric isomers.

Complete the **two** structural formulae to show the two geometric isomers.



[2]

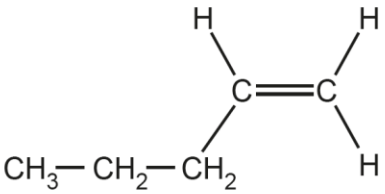
This was a challenging question for many candidates. However, although a number of candidates did not fully show the correct pattern, they obtained one mark for drawing CH_3 at one position for both geometric isomers.

Assessment for learning

Teachers are advised to encourage candidates to learn more about different forms of isomer in detail. This could be supported via a range of chemical models of various isomer types.

Question 5 (b) (ii)

(ii) The structural formula of pent-1-ene is shown below.



Explain why pent-1-ene does **not** have geometric isomers even though it has a double bond.

.....

.....

.....

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

Most candidates found responding to this question challenging. They did not consider the pattern of different groups expected in geometric isomers in contrast to the location of 2H atoms on one carbon of C=C in the structural formula of pent-1-ene. No clear pattern of common misconceptions was observed for this question.

Question 5 (c) (i)

(c) Methanol and propanoic acid react to form an ester and water.

(i) Complete the word equation for this reaction.

methanol + propanoic acid → ..... + water

[1]

Some candidates were sufficiently confident to use the names of the two reactants, methanol plus propanoic acid, to identify the product as methyl propanoate. Many candidates incorrectly included methanol in the name of the product or referred to a range of other names, including propanol, ethanol or ester.

Question 5 (c) (ii)

(ii) Identify the structural formula of the ester formed.

Tick (✓) **one** box.

$CH_3CH_2CH_2COOH$ ☐

$CH_3CH_2COOCH_3$ ☐

$CH_3COOCH_2CH_3$ ☐

$HCOOCH_2CH_2CH_3$ ☐

[1]

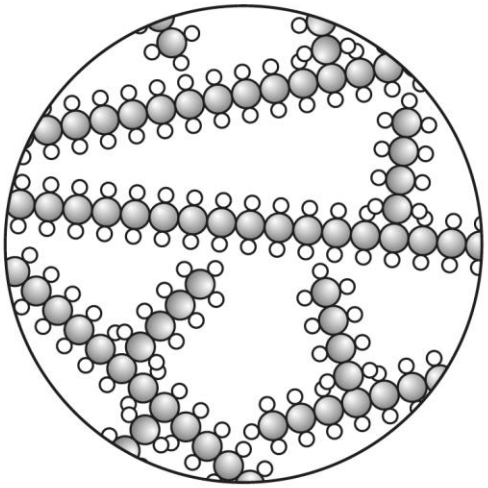
Most candidates successfully selected the second option as the structural formula of the ester formed. Although no single option was identified as an incorrect choice, a number of candidates did select the first option.

Question 5 (d)

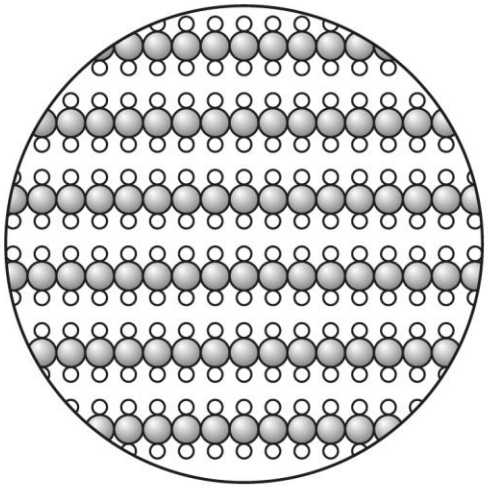
(d) Poly(ethene) exists as branched and unbranched structures as shown below.

Key:
- Carbon atom
- Hydrogen atom

Branched poly(ethene)



Unbranched poly(ethene)



The two types of poly(ethene) have different densities.

Identify which type of poly(ethene) has the higher density.

Use the diagrams to explain your answer.

.....

.....

.....

.....

.....

..... **[3]**

The diagrams were clearly found to be an essential form of scaffolding for this question. Most candidates successfully chose the unbranched form as the option with the higher density. Such responses were supported with reference to the straight chain rows/lines/layers and their compact nature.

Exemplar 2

unbranched polyemene has a larger density as it has a uniform structure and multiple rows on polyemene that are close togemer. branched polyemene has a lower density as it has fewer layers of poly emene and it does not have a uniform structure.

This exemplar demonstrates an effective response for Question 5 (d). The candidate has correctly identified the unbranched poly(ethene) as the option with the higher density. This is justified with a clear reference to both the 'uniform structure and multiple rows' and 'close together'. It was not essential for responses to refer to the atoms in the polymer because they were clearly indicated in the diagrams provided, via a key.

Question 6 (a) (i)

6 Different types of tissue in the human body are found in organs to perform specific functions. The skin is an organ.

Epithelial and connective tissues are found in skin and work together to protect the body.

(a) The upper layer of skin is made of epithelial tissue.

(i) Identify this type of epithelial tissue.

Tick (✓) **one** box.

Ciliated ☐

Squamous ☐

Striated ☐

[1]

Although many candidates correctly identified squamous epithelium as the type of tissue forming the upper layer of skin, some candidates incorrectly chose one of the other options. No pattern of incorrect, alternative response was recorded.

Question 6 (a) (ii)

(ii) Complete the following sentences.

Put a (ring) around each correct option.

The layers of epithelial cells provide protection for the human body because the cells are **thin / thick** and **large / small** .

The presence of many layers of these cells on the surface of the skin restricts the movement of molecules passing through by **diffusion / translation** .

[2]

A number of candidates correctly determined that the layers of epithelial cells contain cells that are thin, small and limit diffusion. No clear pattern of alternative responses was seen but it was noted that some candidates appreciated that the movement of molecules was through diffusion, but with an incorrect identification of cell property.

Assessment for learning

It is suggested that teachers encourage candidates to explore a range of different forms of epithelial tissue (as outline in the specification at **LO3.3**) via the use of drawings and photographic images (photomicrographs), including associated tissues, e.g. connective tissue.

Question 6 (b) (i)

(b) Epithelial tissue in skin is supported by connective tissue.

Fig. 6.1 shows a light microscope image of connective tissue.

Fig. 6.1

(i) Name the **two** types of fibres found in the connective tissue shown in **Fig. 6.1**.

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

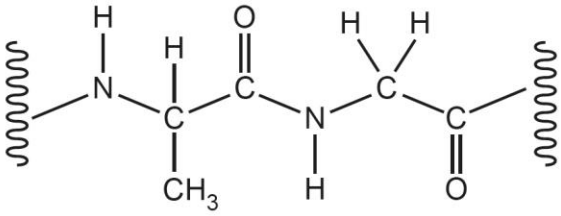
Many candidates selected incorrect types of fibrous tissues found in the human body, ranging from muscle (myosin and actin) to nervous (neuron fibres). However, some candidates correctly stated elastin and collagen (fibres).

Question 6 (b) (ii)

(ii) Both types of fibres in **Fig. 6.1** are polypeptides.

Fig. 6.2 shows a section of a polypeptide.

Fig. 6.2



Polypeptides are chains of amino acids joined by peptide bonds.

Draw the structures of the **two** separate amino acids that make up this section of the polypeptide.

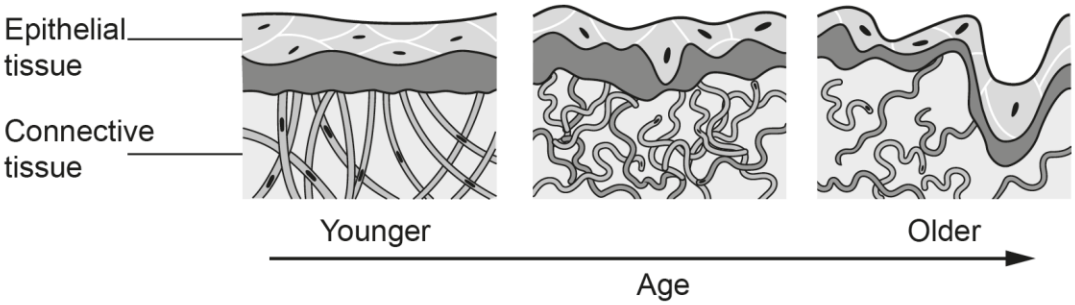
[2]

This question was challenging for many candidates. Some candidates were able to draw the reconstructed monomers (amino acids) following the breakdown or hydrolysis of the peptide bond. However, most candidates tended not to include the reformed carboxyl group on the left hand molecule and the amine group on the right hand molecule at the original position of the peptide bond.

Question 6 (b) (iii)

(iii) **Fig. 6.3** shows a diagram of human skin tissue at different ages.

Fig. 6.3



Use **Fig. 6.3** to describe how skin changes with age.

.....

.....

.....

.....

.....

..... **[3]**

The majority of candidates successfully used the diagrams to present a clear and detailed description of changes taking place in the epithelial and connective tissues as human skin ages. Some candidates provided further, creditworthy statements about the poor maintenance of collagen fibres and the lack of elasticity related to the poor maintenance of elastin fibres. A number of the responses were very impressive.

Question 6 (c) (i)

(c) Blood can be described as a special type of tissue.

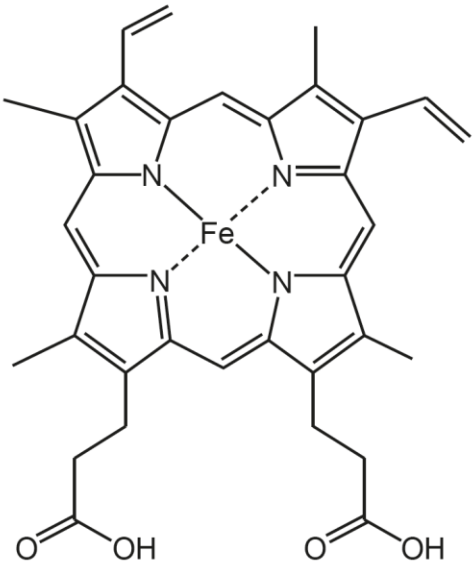
Blood is composed of red and white blood cells moving around in watery plasma within blood vessels.

(i) Red blood cells contain haemoglobin. This molecule can bind with and transport oxygen molecules.

Each haemoglobin molecule contains haem groups.

Fig. 6.4 shows the structure of a haem group.

Fig. 6.4



Identify the charge on the iron ion in the centre of the structure.

Tick (✓) **one** box.

1+ ☐

2+ ☐

3+ ☐

4+ ☐

[1]

Many candidates selected 2+ for the charge on the iron ion. No clear pattern of incorrect options was observed.

Question 6 (c) (ii)

(ii) Haem groups are also found in another molecule in the human body.

Name the molecule and state the location of this molecule in the human body.

Name .....

Location .....

[2]

Relatively few candidates correctly identified the other molecule with haem groups as myoglobin and that it is located in muscle (tissue) in the human body. Some candidates obtained one mark because they successfully recalled the location as muscle, but this was rarely seen.

It is recommended that teachers use simple, biological models or drawings to outline the structure and property of myoglobin, alongside the more well-known haemoglobin molecule.

Question 6 (c) (iii)

(iii) Haemocyanin is also a type of molecule known to carry oxygen.

Complete the sentences using words from the list.

calcium	**copper**	**fungi**	**humans**
invertebrates	**iron**	**manganese**	**plants**

Oxygen is carried by ..... within haemocyanin.

Haemocyanin is found in ..... .

[2]

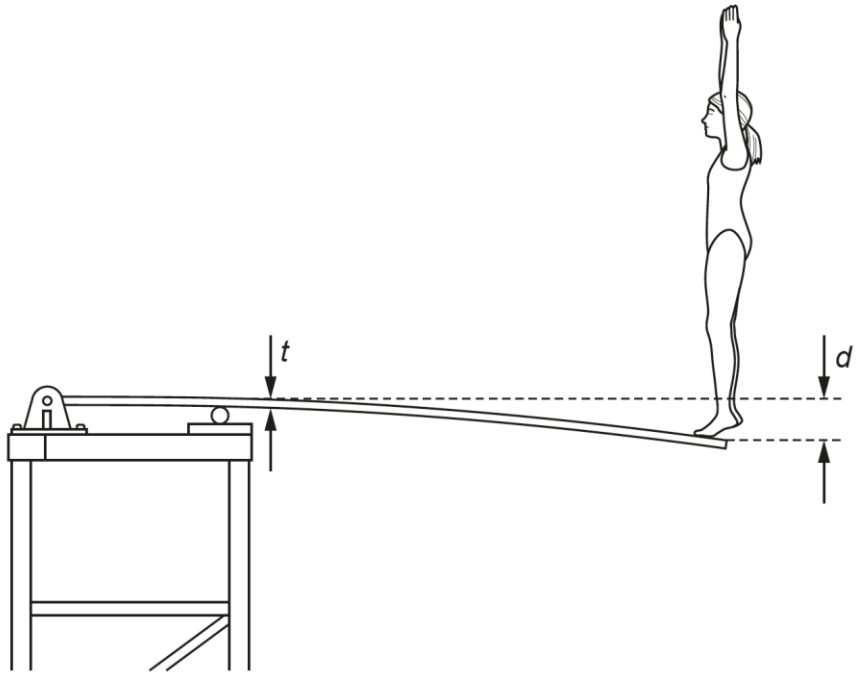
Relatively few candidates successfully recalled that copper is the respiratory pigment found in haemocyanin and that this is found in invertebrates. Although no clear pattern of incorrect responses was noted, the random choice of plants was not expected for this topic focused on animals.

Question 7

7 A diving board is made from a material with special mechanical properties.

The material must resist the effect of repeated loading and unloading cycles when divers use the board.

The diagram below shows a diver at the end of a diving board.



The end of the diving board has moved down by distance *d*.

The distance *d* is given by the equation:

$$d = \frac{4FL^3}{Swt^3}$$

where:

- *S* is the stiffness of the material used to make the board
- *F* is the force exerted by the diver
- *L* is the length of the diving board
- *w* is the width of the board
- *t* is the thickness of the board.

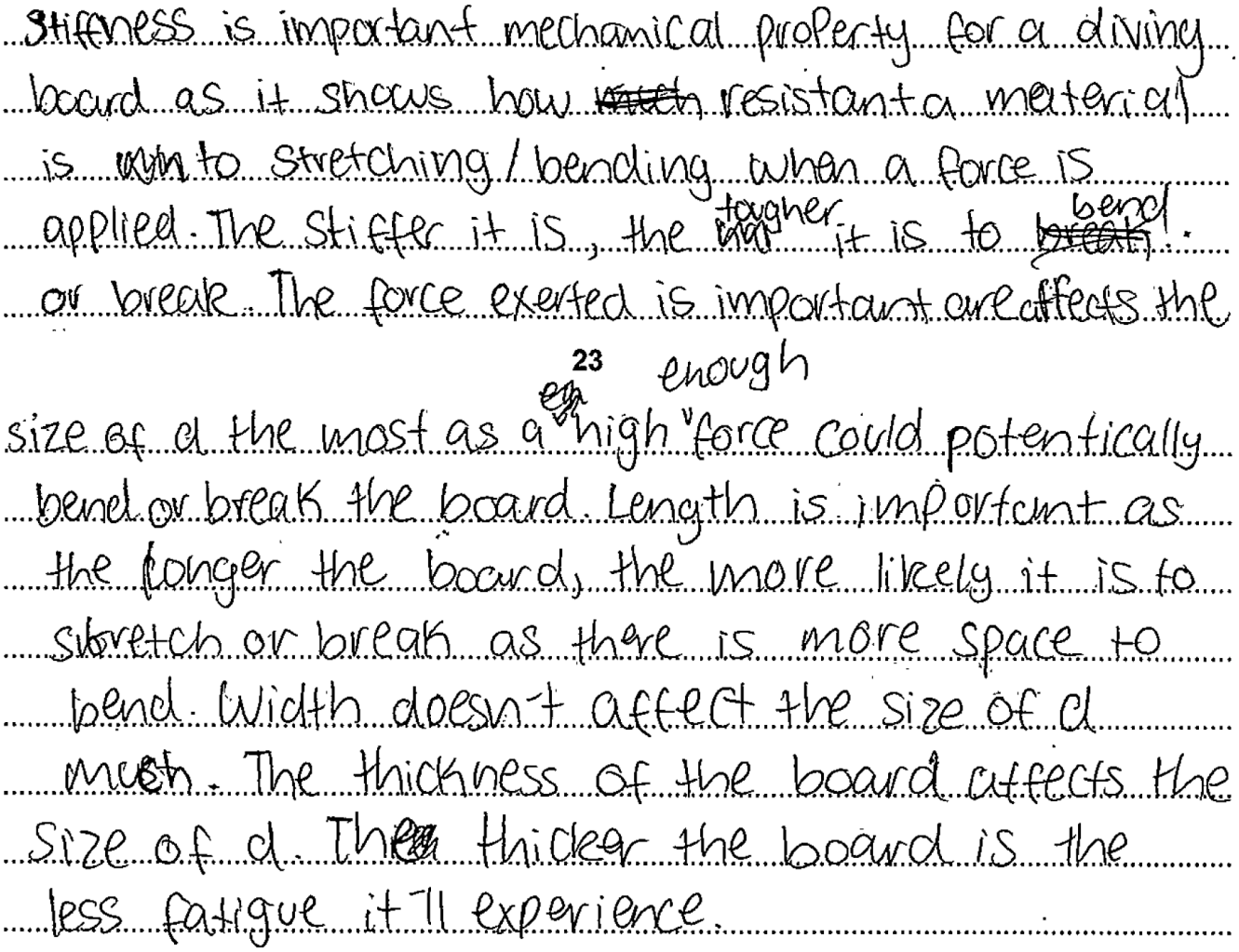
Explain why stiffness is an important mechanical property for a diving board.

Describe how changes in *S*, *F*, *L*, *w* and *t* affect the size of *d* and explain which of these factors affect the size of *d* the most. **[6]**

Many candidates did well with this Level of Response (LoR) question and obtained marks at Level 2 (3 or 4 marks). Some were even more successful and progressed onto Level 3 because they provided much more detail about not only the stiffness of the resistant material found in the diving board, but other factors ranging from the force of the diver and length of the board to the thickness of the board. Although some candidates chose to refer to the equation for the distance of movement/bounce, many were able to explain which of the factors affect the size of *d* the most without the use of this equation. A clear

justification for the candidates' choice of the most impactful factor(s) was sufficient to obtain higher marks for this question.

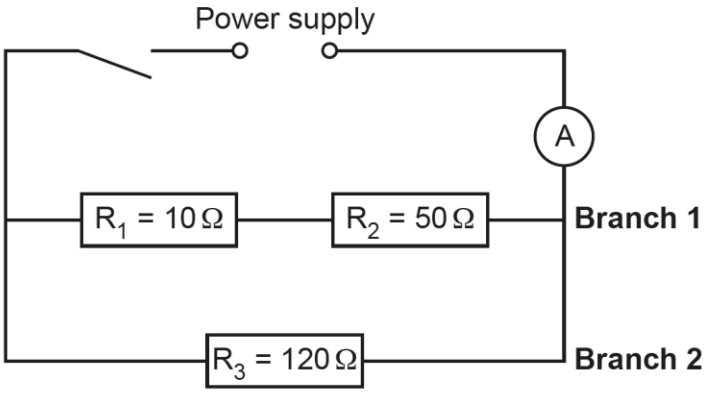
Exemplar 3


Stiffness is important mechanical property for a diving board as it shows how ~~much~~ resistant a material is ~~with~~ to stretching / bending when a force is applied. The Stiffer it is, the tougher it is to bend or break. The force exerted is important are affects the size of d the most as a high force could potentically bend or break the board. Length is important as the longer the board, the more likely it is to stretch or break as there is more space to bend. Width doesn't affect the size of d much. The thickness of the board affects the size of d. The thicker the board is the less fatigue it'll experience.

This exemplar shows a typical response for Question 7. The candidate performed well and achieved marks at Level 2 for this Level of Response (LoR) question, getting three marks. The concept of stiffness was considered at a 'basic' level with clear references to the stretching and bending properties of the diving board and the potential to break if too stiff. In addition, the response included clear descriptions of the relationship between most of the other factors (force, length, width and thickness) and the distance (*d*) shown by the diving board. The overall response therefore contained some of the valid points listed in the guidance column of the mark scheme but did not demonstrate a 'good' explanation of stiffness.

Question 8 (a) (i)

8 Resistors R_1, R_2 and R_3 are connected in a circuit as shown in the diagram below.



You will need to use the following equations in your answers.

- Resistors in series $R_t = R_1 + R_2 + R_3$
- Resistors in parallel $\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
- Potential difference (V) = current (A) × resistance (Ω)
- Charge (C) = current (A) × time (s)
- Power (W) = potential difference (V) × current (A)

(a)
(i) Calculate the combined resistance of the resistors that are connected in series in **Branch 1**.

Combined resistance = ...Ω **[1]**

The majority of candidates were able to access this question and successfully calculated the combined resistance of the resistors in series in Branch 1 as 60 (Ω). No pattern of incorrect, alternative values was noted.

Question 8 (a) (ii)

(ii) Show that the combined resistance of the circuit is 40 Ω.

[1]

The full use of the working space was essential for a successful response. Many candidates appreciated that to show that the combined resistance of the circuit is 40(Ω) as a result of the calculation 1/60 + 1/120. There was an observable trend for an incorrect calculation of [1/10 + 1/50 + 1/120] or [50 – 40]. Both of these responses indicated a misunderstanding of how to determine the combined resistance based on the information provided in the electrical circuit and the equations listed in the stem of the question.

Question 8 (b) (i)

(b) The current reading on the ammeter is 0.3A.

(i) Calculate the potential difference of the power supply.

Potential difference = ... V **[1]**

Most candidates successfully calculated the potential difference as 12 (V). No clear pattern of incorrect responses was observed but some candidates did show 54 in their response. This incorrect value became a feature of the error carried forward (ecf) marks given later at Question 8 (b) (ii) and (b) (iv).

Question 8 (b) (ii)

(ii) Use your answer in **(b)(i)** to calculate the power produced in the circuit.

Power = ... W **[1]**

A number of candidates were able to complete this calculation and successfully determine the value as 3.6 (W). For those candidates who obtained an incorrect value, an error carried forward (ecf) mark was available if they used their incorrect value from Question 8 (b) (ii) x 0.3. This reinforced the need for candidates to show their working as fully as possible in the space provided. No pattern of alternative, incorrect values, was observed.

Question 8 (b) (iii)

(iii) Calculate the charge transferred in the circuit in one minute.

Charge transferred in one minute = ... C **[1]**

Most candidates were able to complete this calculation successfully and showed that the charge transferred in one minute was 18 (C). No pattern of incorrect responses was noted.

Question 8 (b) (iv)

(iv) Determine the current in each branch of the circuit.

Current in **Branch 1** = ... A

Current in **Branch 2** = ... A

[2]

This was challenging for many candidates but those who performed well across the paper were often successful and concluded that the current in Branch 1 was 0.2 (A) and that for Branch 2 was 0.1 (A). On occasion the values were correct but presented in the incorrect sequence. As noted earlier, the use of the working space was valuable for this question. If candidates showed incorrect values for the two currents, they were able to obtain the error carried forward (ecf) marks for showing their calculated answers for Question 8 (b) (i) ÷60 [for Branch 1] and Question 8 (b) (i) ÷120 [for Branch 2]. This enabled such candidates to obtain full marks for this question.

Question 8 (c)

(c) The current in a wire can also be calculated using the equation I = nAvq.

Use the equation I = nAvq to suggest **two** properties of the wire in resistor R_3 which would cause it to have a higher resistance than resistor R_1.

1. .....

.....

2. .....

.....

[2]

The candidates who had clearly performed well across the paper, with particular reference to Question 8, showed the potential to make appropriate suggestions. For such candidates, a mark was more likely to be given for suggesting the cross-sectional area of the wire. The density of charge carriers appeared to be less well-understood.

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