CAMBRIDGE TECHNICALS

Oxford Cambridge and RSA

CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

# APPLIED SCIENCE

05847–05849, 05879, 05874

## Unit 1 January 2021 series

Version 1

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# 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 OCR.

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# Unit 1 series overview

It was clear that many candidates were prepared for this examination and had revised sufficiently well. In addition, the candidates were mostly familiar with the rubric of the paper and answered all the questions. Some candidates did not respond to one or two items in the paper. There was not a specific pattern for this lack of response. It was encouraging to note that most candidates completed the question paper in full and within the 1 hour allowed.

As in the last series in January 2020, the cohort of candidates was increasingly familiar with the approach to be followed when answering the free-response (level of response/LOR-type item) question [Q6]. Most candidates achieved some marks for this question at Levels 1 or 2.

Most candidates were able to follow the expected rubric when completing the objective-format items, such as the completion of sentences, using tick-boxes for optional statements, filling the spaces in tables and joining concept boxes with lines. Some did struggle to resolve a calculation to three significant figures.

It was good to observe that most candidates used the space provided to show their calculations. Some did not do this so were unable to gain the marks allocated for intermediate steps. This happened most often with the electronics items in Question 8.

As in the most recent series, few candidates used the additional pages provided at the end of the paper. When they did use these pages, appropriate links were shown within the answer spaces in the paper.

| *Candidates who did well on this paper generally did the following:* | *Candidates who did less well on this paper generally did the following:* |
|---|---|
| • had acquired a range of skills and knowledge as outlined in the Unit 1 specification<br>• had clearly prepared well for the examination, with a focus on the details often provided via the 'exemplification' section of the specification.<br>• were confident about inorganic and organic chemistry, using correct symbols and terminology<br>• were able to interpret the rubric of the question paper to help them to respond well to the wide range of question format, from extended, free-response items to short, objective items<br>• used the information provided in the scenario/stem of each questions to identify the knowledge required<br>• were able to interpret graphs and images to formulate a realistic description or explanation.<br>• had a sound understanding of the final question on electricity, with the ability to rearrange equations (often provided in the paper or the insert data sheet) and to insert values from the stem of each item. | • occasionally did not respond to items and left a space without attempting to provide a response<br>• had struggled to acquire a suitable range of skills and knowledge as outlined in the Unit 1 specification<br>• had not necessarily prepared well enough for the examination and had not used the information available via the 'exemplification' section of the specification<br>• were less confident about inorganic and organic chemistry and struggled to use the correct symbols or to interpret the Periodic Table (available at the rear of the question paper)<br>• tended not to follow the rubric of the question paper, for example, applying the number of significant figures required in a response.<br>• struggled to interpret data presented via a graph<br>• did not have the skills and knowledge required to respond to items in the final question based on electricity. |

## Question 1 (a) (i)

1 Elements can be identified by their atomic structure.

**Table 1.1** shows the atomic structure of some elements, **V**, **W**, **X** and **Y**.

The letters **V**, **W**, **X** and **Y** are not the chemical symbols of the elements.

| Element | Electronic structure | Neutron number | Nucleon number (atomic mass number) | Proton number |
|---|---|---|---|---|
| **V** | ..................... | 10 | 19 | ..................... |
| **W** | 2,8,2 | 12 | ..................... | 12 |
| **X** | 2,8,4 | ..................... | 28 | 14 |
| **Y** | ..................... | 18 | 35 | 17 |

**Table 1.1**

**(a)** **(i)** Complete **Table 1.1**. **[4]**

Many candidates were able to identify the proton number of element V but struggled to state the electronic structure (often giving 2,8 instead of the correct answer of 2,7). Elements W and X did not present a problem for almost all candidates but the electronic structure for element Y was rarely identified correctly as 2,8,7.

## Question 1 (a) (ii)

**(ii)** Which **two** elements, **V**, **W**, **X** or **Y** are in the same Group of the Periodic Table?

............................................... and ...............................................

**[1]**

Most candidates successfully identify V and Y as members of the same Group in the Periodic Table. No clear alternative pattern of responses could be identified.

## Question 1 (a) (iii)

**(iii)** Use the information in **Table 1.1** and the Periodic Table to deduce the chemical symbols of **W** and **Y**.

**W** ...............................................

**Y**...............................................

**[1]**

Most candidates correctly noted that W was Mg and Y was C*l*. Some chose to write the words magnesium and chloride and could not be given the marks. The instruction was to 'deduce the chemical symbols…'.

## Question 1 (a) (iv)

**(iv)** What is the formula of the compound formed by elements **W** and **Y**?

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

Again, most candidates did well with this item. Most correctly wrote magnesium chloride as $MgCl_2$ but some did not include the necessary subscript of 2 for the chlorine symbol.

## Question 1 (a) (v)

**(v)** State the type of bonding between **W** and **Y**, and the charges on their ions by completing the sentences using the words below.

You may use each word once, more than once, or not at all.

**attraction** **ionic** **negative** **positive** **sharing**

The type of bonding between **W** and **Y** is ............................................... .

In the compound that is formed, **W** is a ............................................... ion and

**Y** is a ............................................... ion.

**[2]**

The sentence format for this objective item enabled candidates to succeed. They correctly identified the bonding as ionic and noted that W was a positive ion and Y was a negative ion. On a few occasions, candidates misinterpreted the two charges and did not obtain the second mark.

## Question 1 (b) (i)

**(b) (i)** Use nuclear notation to indicate the symbol of **X**, and its atomic number and mass number.

**[2]**

Most candidates successfully demonstrated that they could use nuclear notation correctly. Some selected an incorrect element symbol, such as X (instead of Si), but still obtained one mark for the correct mass and proton numbers (14 and 28).

## Question 1 (b) (ii)

**(ii)** The nucleus of **Y** has more protons and neutrons than the nucleus of **V**.

Compare the strength of the attractive and repulsive forces within the nuclei of **Y** and **V**.

Explain why both nuclei are stable.

..........................................................................................................................................

..........................................................................................................................................

..........................................................................................................................................

..........................................................................................................................................

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

This was a challenging topic for some candidates. Some referred incorrectly to electron shells, although this was ignored. Others found it difficult to compare the attractive and repulsive forces clearly. The explanation for stability was frequently difficult to follow. It was anticipated that candidates would appreciate that the strong nuclear/attractive force is greater than the repulsive force. This topic may benefit from further consideration for the preparation of future candidates.

| | | |
|---|---|---|
| | **AfL** | It is recommended that teachers identify some basic diagrammatic models to demonstrate these features, with reference to the Unit 1 specification Learning Outcome (LO) 1.1. |

## Question 2 (a) (i)

**2** Carbon compounds containing chlorine have many uses, but they are also known to cause problems for the environment.

**(a)** Chlorofluorocarbons (CFCs) in the upper atmosphere can destroy the ozone ($O_3$) layer.

The first two reaction steps in the breakdown of $O_3$ are outlined in **Table 2.1**.

| Step | Reaction |
|---|---|
| **1** | $CF_3Cl \rightarrow CF_3 + Cl$ |
| **2** | $Cl + O_3 \rightarrow ClO + O_2$ |

**Table 2.1**

**(i)** **Step 1** and **Step 2** involve free radicals.

Identify **three formulae** in **Table 2.2** that are free radicals.

Tick (✓) **three** boxes.

| Formula | Free radical |
|---|---|
| $CF_3Cl$ | |
| $CF_3$ | |
| $Cl$ | |
| $O_3$ | |
| $ClO$ | |
| $O_2$ | |

**Table 2.2**

**[3]**

For many candidates, there was a tendency to select three boxes at random. However, many correctly identified $Cl$ as one of their choices.

| | | |
|---|---|---|
| | **AfL** | The topic of free radicals could be explored further by teachers, using simple diagrammatic models. |

## Question 2 (a) (ii)

**(ii)** Ultraviolet radiation from the Sun is needed to start **Step 1** in **Table 2.1**.

Suggest how ultraviolet radiation can increase the rate of reaction in **Step 1**.

............................................................................................................................................

............................................................................................................................................

............................................................................................................................................

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

Many candidates did not clearly identify that an increase in the rate of reaction was linked to an increase in the amount or intensity of radiation. It was not enough to rewrite the wording provided in the stem of the question. Candidates should check that they have not simply rewritten the words provided.

## Question 2 (b) (i)

**(b)** Chloroethene is a useful organic compound and has the formula $CHCl = CH_2$.

Chloroethene is made from ethane in two reaction steps.

**Step 1** $CH_3CH_3 + 2Cl_2 \rightarrow CH_2ClCH_2Cl + 2HCl$

**Step 2** $CH_2ClCH_2Cl \rightarrow CHCl = CH_2 + HCl$

**(i)** Identify the type of reaction shown in **Step 1**.

Tick (✓) **one** box.

| | |
|---|---|
| **Addition** | ☐ |
| **Substitution** | ☐ |
| **Oxidation** | ☐ |
| **Reduction** | ☐ |

**[1]**

Some candidates were not challenged by this topic and correctly selected 'substitution' for the type of reaction. However, some candidates chose 'addition'.

| | | |
|---|---|---|
| | **AfL** | The range of reaction types listed in the specification at LO 2.2 could be reinforced for future candidates, perhaps using the examples provided via the exemplification section |

## Question 2 (b) (ii)

**(ii)** $CH_2Cl CH_2Cl$ has a structural isomer.

Draw the structural formula for the isomer of $CH_2Cl CH_2Cl$.

**[1]**

The construction of structural formulae is often a difficult skill. In this case, the presentation of three single bonds to hydrogen at one carbon atom, singled bonded to a second carbon atom with two single bonds to chlorine and one to hydrogen was key to the correct response. Many candidates struggled to complete this correctly.

## Question 2 (b) (iii)

**(iii)** $CH_2Cl CH_2Cl$ and $CHCl = CH_2$ do not have geometrical isomers.

Give **one** reason why each molecule does **not** have geometrical isomers.

$CH_2Cl CH_2Cl$ ........................................................................................................

........................................................................................................................

$CHCl = CH_2$ ........................................................................................................

........................................................................................................................

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

Geometric and other forms of isomer is a challenging concept for many candidates. A relatively wide range of candidates was able to successfully give a reason for the first molecule. The lack of a double bond was frequently identified. The second molecule was more difficult to determine. Again, it may be wise for teachers to rehearse this topic on a regular basis, with reference to the details in the Unit 1 specification at LO 4.3. Some candidates started to refer to 'rotation' but could not follow this through with the explanation required.

## Question 2 (c) (i)

**(c)** Polyvinyl chloride is a polymer that can be made by the addition of many monomers of $CHCl = CH_2$.

**(i)** What is the empirical formula of polyvinyl chloride?

Tick (✓) **one** box.

| | |
|---|---|
| $\mathbf{CHCl}$ | ☐ |
| $\mathbf{CH_2Cl}$ | ☐ |
| $\mathbf{C_2H_2Cl}$ | ☐ |
| $\mathbf{C_2H_3Cl}$ | ☐ |

**[1]**

Few candidates successfully identified the final option for the correct empirical formula of polyvinyl chloride. No clear pattern of alternative responses could be identified.

## Question 2 (c) (ii)

**(ii)** Draw a section of polyvinyl chloride which contains **three** repeat units.

**[1]**

Many candidates correctly identified the chain of 6 carbon atoms, and some included the alternating pattern of C*l* and H atoms with that of two H atoms. However, many did not show the 'exposed' single bonds at the two ends of the chain. The use of brackets and 'n' was not necessary for this model. As a result, this feature was ignored when marking the model drawn by the candidate.

## Question 2 (c) (iii)

**(iii)** Polylactate is a different type of polymer compared to polyvinyl chloride.

The structural formula for the repeat unit of polylactate is shown in **Fig. 2.1**.

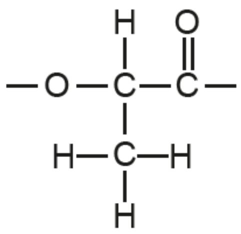


**Fig. 2.1**

Explain how the monomer and the polymerisation reaction that forms polylactate are **different** to those of polyvinyl chloride.

Difference in monomers ......................................................................................................

...........................................................................................................................................

Difference in polymerisation reactions ..................................................................................

...........................................................................................................................................

...........................................................................................................................................

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

The presence of C=C within the monomer of PVC was frequently identified as one difference with polylactate. Very few candidates identified the alternative difference based on the –OH and –COOH groups found in polylactate monomers. Some candidates adopted a 'spot the difference' approach to the comparison of the two monomers (with unqualified references to presence/absence of oxygen or chloride). This could not be credited. It was assumed that condensation reactions between polylactate monomers would be identified by candidates, but this was not the case.

## Question 3 (a) (i)

**3** Bone is a type of tissue found in the human body.

**(a)** An osteocyte is a specialised cell which is found in bone tissue.

**Fig. 3.1** shows a diagram of an osteocyte.

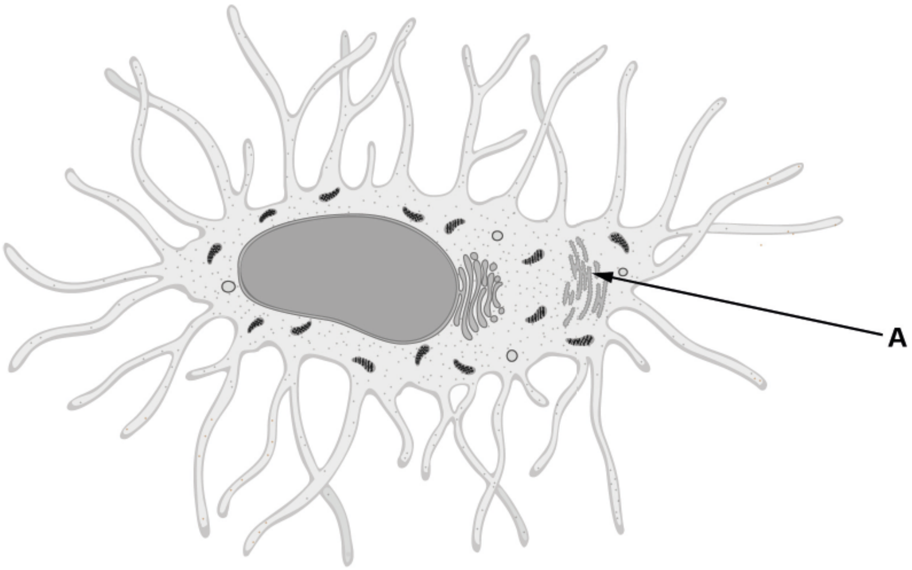



**Fig. 3.1**

**(i)** Give the name of the organelle labelled **A** in **Fig. 3.1**.

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

Most candidates appreciated that structure A was the endoplasmic reticulum (ER). It is quite distinct from the Golgi body/apparatus shown adjacent to the nucleus.

## Question 3 (a) (ii)

**(ii)** Organelle **A** can either appear as rough or smooth when observed on an electron micrograph.

Complete the following sentences.

You may use each word once, more than once, or not at all.

| | | | |
|---|---|---|---|
| **carbohydrate** | **chloroplasts** | **DNA** | **lipid** |
| **mitochondria** | **protein** | **RNA** | **ribosomes** |

The rough type of organelle **A** has ……………………...…. attached.

This means that the rough type is involved in ……………………...……. synthesis.

However, the smooth type of organelle **A** is the site of ………………………….. and

……………………...…….. synthesis.

**[3]**

Many candidates realised correctly that ribosomes are attached to the endoplasmic reticulum (thereby forming the rough type) and protein synthesis was linked to these cellular structures. However, some were confused about the molecules synthesised at the smooth type of the endoplasmic reticulum. The molecules are lipids and carbohydrates. While many candidates were aware of lipid synthesis, they often attached this to protein (instead of carbohydrate) synthesis.

Candidates appear to benefit from this type of objective item. The provision of terms to complete the sentences is a useful form of scaffolding.

## Question 3 (b) (i)

**(b)** A key function of bone tissue is mineral ion storage.

**(i)** Which mineral ion is stored and used to form the matrix in bone tissue?

Put a ring around the correct answer.

$Ca^{2+}$ $K^{+}$ $Na^{+}$ $Ni^{2+}$

**[1]**

| | | |
|---|---|---|
| i | **OCR support** | This topic is directly linked to the Unit 1 specification at LO 3.3 for the calcified matrix and LO 5.1 for calcium as a structural component of bone. Some candidates incorrectly chose potassium as the mineral ion. It is recommended that the link between inorganic chemistry and tissue/organ structure and function is explored further with candidates. |

## Question 3 (b) (ii)

**(ii)** Osteoporosis is a condition that affects bones.

The images in **Fig. 3.2** show normal bone and bone with osteoporosis.

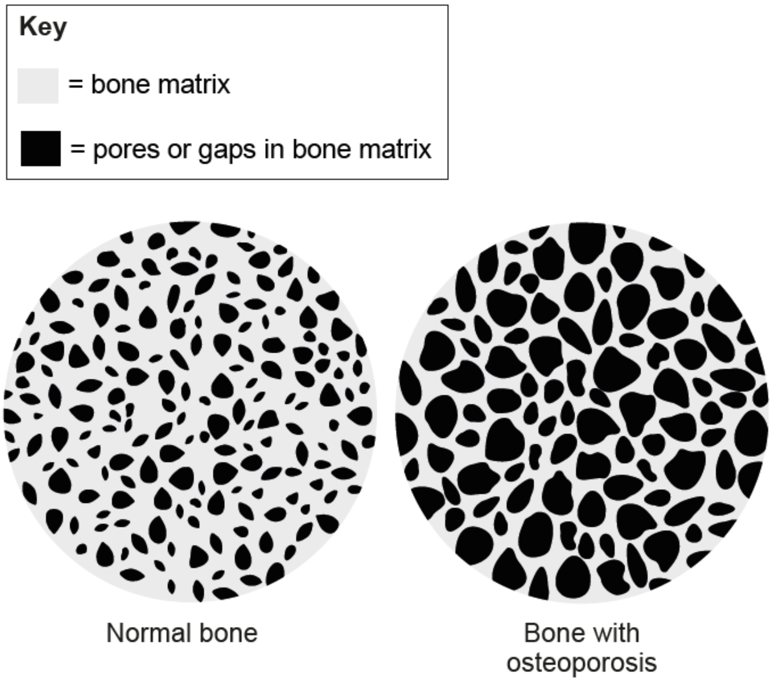



**Fig. 3.2**

Use **Fig. 3.2** to suggest the link between osteoporosis and the mineral ion identified in **(b)(i)**, and the effect of osteoporosis on bone function.

Link ..............................................................................................................

..............................................................................................................

Effect ..............................................................................................................

..............................................................................................................

..............................................................................................................

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

Most candidates used their knowledge of calcium and bone matrix to determine the 'link' between calcium deficiency and osteoporosis. The 'effect' section was also straightforward for almost all candidates to complete, using the appearance of normal bone versus bone with osteoporosis to refer correctly to gaps in the matrix and the resulting weakness of bones. Some of the responses were presented in a logical and clear manner. However, some candidates presented a reverse argument, stating that osteoporosis caused a lack of calcium and led to the larger gaps. This could not be credited.

## Question 3 (c) (i)

**(c)** Magnesium is another mineral ion needed for healthy bones.

It can be taken into the body via magnesium oxide supplements or in foods with a high amount of magnesium.

**Table 3.1** shows some foods and the amount of magnesium that they contain.

| Food | Amount of magnesium (mg per 100 g portion) |
|---|---|
| Almonds | 300 |
| Banana | 29 |
| Brazil nuts | 225 |
| Pumpkin seeds | 532 |
| Spinach | 80 |

**Table 3.1**

**(i)** The recommended daily amount of magnesium is **320 mg** for women.

A woman eats four 100 g portions of **one** of the foods in **Table 3.1**.

Using the information in **Table 3.1**, identify which food she would need to eat to meet her recommended daily amount of magnesium.

Food = ................................................ **[1]**

Candidates found this item was very straightforward, leading to a successful choice of 'spinach'. The mathematical skills required were not challenging for most candidates.

## Question 3 (c) (ii)

**(ii)** The recommended daily amount of magnesium is **420 mg** for men.

A man eats a 50 g portion of almonds.

Using the information in **Table 3.1**, calculate how much more magnesium a man would need to reach his recommended daily amount.

Amount of magnesium needed = ............................................ mg **[2]**

Again, the numerical skills required to solve this calculation were accessible to many candidates. Most candidates determined that 270 mg of magnesium was needed. No clear pattern of alternative responses was noted.

## Question 3 (d)

**(d)** Some enzymes need metal ions, such as magnesium, so that they can function.

What is the role of metal ions in enzyme function?

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

This topic is directly linked to the specification at LO 5.1. It should be noted that metal ions act as 'cofactors' for enzyme activity. The details of this role are not required. However, some candidates attempted to outline how metal ions act. This was unnecessary and they struggled to provide an explanation.

## Question 4 (a)

**4** Carboxylic acids are a family of organic compounds with the functional group –COOH.

**(a)** Butanoic acid ($C_4H_8O_2$) has a hydrocarbon chain and a –COOH group.

Draw the structural formula for butanoic acid, showing all the bonds.

**[1]**

Some candidates constructed the fully correct structural formula for butanoic acid. The inclusion of –HO instead of –O-H was acceptable. Many did not present the correct number of atoms ($C_4H_8O_2$) within the formula. No clear pattern of alternative responses was identified.

## Question 4 (b)

**(b)** Ethanoic acid, $CH_3COOH$, reacts with sodium hydroxide to form a salt and water.

Complete the equation for this reaction.

$CH_3COOH + NaOH \rightarrow$ ………………………………… + …………………………………

**[2]**

Most candidates read the stem of the item carefully and noted that water was one of the products. They therefore included $H_2O$ almost exclusively in the right-hand space provided. Most struggled to resolve the equation to create the other product, $CH_3COONa$. Again, no clear pattern of alternative responses was observed.

## Question 4 (c)

**(c)** Ethanoic acid can be reduced to other organic compounds.

$CH_3COOH + 4[H] \rightarrow CH_3CH_2OH + H_2O$

What type of organic compound is formed?

Tick (✓) **one** box.

**Alcohol** ☐

**Aldehyde** ☐

**Alkyne** ☐

**Ketone** ☐

**[1]**

The organic compound formed in this reaction is ethanol, structural formula $CH_3CH_2OH$. This is classified as one of the first four alcohols (see specification at LO 4.1).

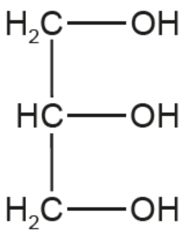
## Question 4 (d) (i)

**(d)** Fatty acids are carboxylic acids with a long hydrocarbon chain.

Fatty acids are found in the human body.

Fatty acids react with glycerol to form a lipid. A lipid contains one or more ester groups.

**Glycerol**



**Fatty acid**

$C_{17}H_{35}COOH$

**Fig. 4.1**

**(i)** Draw the structural formula of a lipid that forms from the reaction of glycerol and **one** molecule of the fatty acid shown in **Fig. 4.1**.

Clearly show the structure of the ester group.

**[2]**

It was assumed that the structural formulae of monoglycerides and triglycerides were familiar to candidates, as outlined in specification LO 4.4. However, most candidates struggled to draw the structural formula and were unable to show the ester group. The relationship between mono, di and triglycerides should be appreciated by candidates.

## Question 4 (d) (ii)

**(ii)** The lipid drawn in **(d)(i)** is also known as a monoglyceride.

State how a triglyceride is different from a monoglyceride.

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

As noted above for 4(d)(i), there appeared to be a lack of understanding in relation to the structure of mono, di and triglycerides. Some candidates were confident with this topic and recalled that three fatty acids are found in triglycerides.

| | | |
|---|---|---|
| ? | **Misconception** | Some candidates incorrectly thought that three glycerol molecules were present or that three atoms were present in a triglyceride. |

| | | |
|---|---|---|
| | **AfL** | It is suggested that diagrammatic models are shared with candidates so that they can readily visualise the differences between these commonly found molecules. |

## Question 4 (d) (iii)

**(iii)** State what is released when lipids are broken down to reform glycerol and fatty acids.

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

Energy is released and many candidates were aware of this. Some considered that water was released, and this implied that they may be confused about hydrolysis versus condensation reactions (see specification LO 2.2 with regards to condensation polymerisation). Any reference to the 'creation' or 'production' of energy discounted the marking point for this item.

## Question 4 (d) (iv)

**(iv)** Explain the importance of lipids for nerve transmission in the human body.

..........................................................................................................................................

..........................................................................................................................................

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

It is expected that candidates will understand the role of lipids in nerve transmission. This is clearly outlined in the exemplification section of the specification at LO 4.4. Some candidates rewrote the words provided in the stem of this item. It is suggested that this should be avoided so that candidates focus on expressing what they may well already know.

| | | |
|---|---|---|
| | **AfL** | Simple diagrams are readily available via a range of websites and textbooks to show the myelin sheath. This is helpful to encourage candidates to visualise the structure and purpose of the layer of Schwann cells forming this sheath. |

## Question 4 (d) (v)

**(v)** Give **one** other function of lipids in the human body.

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

Many candidates correctly referred to lipids acting as an energy store. Some also gave acceptable suggestions such as protection and insulation. One or two candidates were even aware that lipids can be used to generate glucose molecules. Although this role is not listed on the specification, it was interesting to see that such candidates knew that this occurred (via the process of gluconeogenesis).

## Question 4 (e) (i)

**(e)** Sundip is a science student. She is studying the effect of temperature on the rate of reaction between a fatty acid and glycerol.

She chooses two temperatures: Temperature 1 and Temperature 2.

She plots a graph of her results for both temperatures.

The graph is shown in **Fig 4.2**.

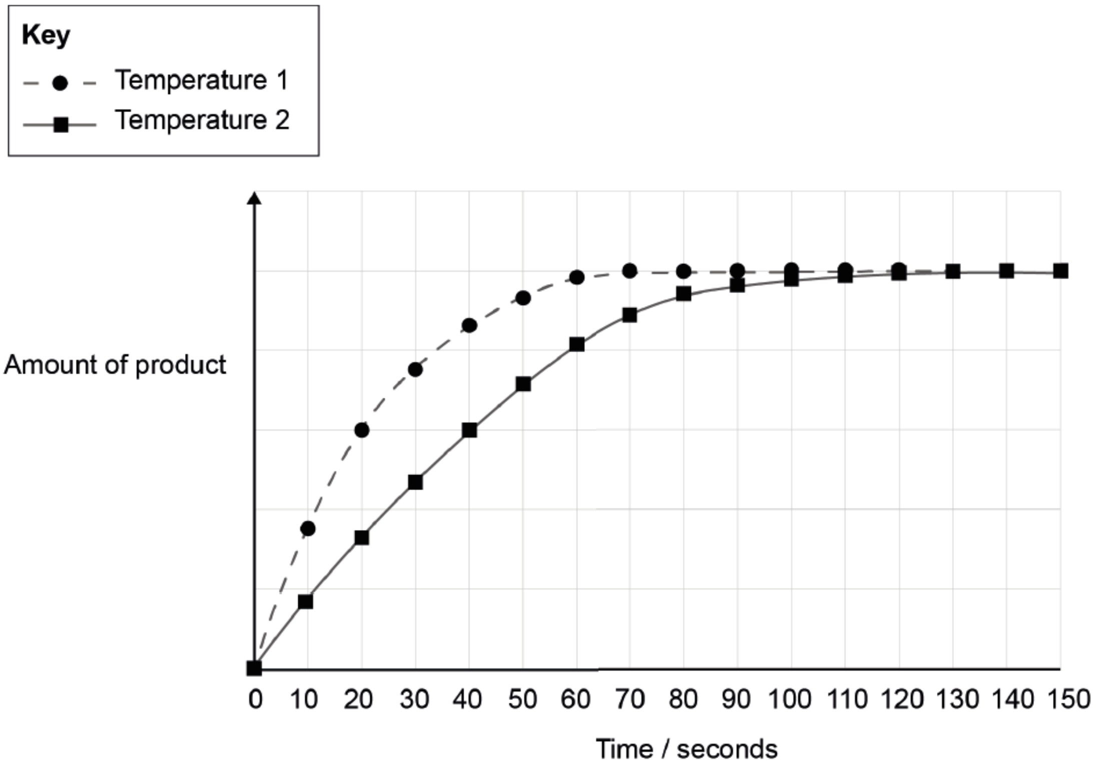



**Fig. 4.2**

**(i)** Use the graph to deduce which temperature is higher, giving reasons for your answer.

.......................................................................................................................

.......................................................................................................................

.......................................................................................................................

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

Most candidates were able to interpret the graph shown in Fig. 4.2. The data were relatively straightforward and demonstrated that temperature 1 was the higher temperature. The reason for this was sometimes less clear and this prevented candidates from being given the second marking point. A clear statement about the steep gradient of temperature 1 or a reference to more products being generated in a given time was expected.

## Question 4 (e) (ii)

**(ii)** Explain the effect of temperature on the rate of reaction.

..........................................................................................................................

..........................................................................................................................

..........................................................................................................................

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

| |
|---|
| Almost all candidates realised that the rate of reaction increased as a result of an increase in temperature. Many candidates also correctly described the impact on the collision rate between molecules, with one or two referring to kinetic energy. |

## Question 5 (a)

**5** Phosphate is a component of phospholipids DNA and RNA.

**(a)** Phospholipids are an essential part of the membranes found around organelles in cells, such as the nuclear envelope.

Complete the following sentences.

Use the words from the list. You may use each word once, more than once, or not at all.

| | | | | |
|---|---|---|---|---|
| **double** | **eukaryotic** | **flexible** | **photosynthetic** | |
| **porous** | **prokaryotic** | **single** | **triple** | **thin** |

The nuclear envelope surrounds the nucleus and consists of a ................................

membrane.

The membrane is ................................ to allow protein molecules to be

transported across the nuclear envelope.

The presence of a nuclear envelope indicates that the type of cell is

................................ .

**[3]**

| |
|---|
| The key feature of the nuclear envelope (as opposed to a single cell membrane) is that it is a double membrane. Many candidates appreciated this and obtained the first marking point. Equally, they correctly recalled that the envelope is porous to enable protein molecules to be transported. There was some confusion with regards to the type of cell containing a nuclear envelope. |

| | | |
|---|---|---|
| ? | **Misconception** | Some candidates incorrectly assumed that the nuclear envelope is found in a prokaryotic cell. This is one of the important differences between eukaryotic and prokaryotic cells. Eukaryotic cells contain a 'true nucleus' and hence, a nuclear envelope. This misconception prevented some candidates from being given the third marking point. |

## Question 5 (b)

**(b)** Name **one** membrane-bound organelle found in cells, other than the nucleus.

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

Although some candidates successfully identified membrane-bound organelles such as the mitochondrion or chloroplast, some selected the 'nucleus'. This indicated that some candidates had not read the stem of this item carefully enough.

## Question 5 (c) (i)

**(c)** DNA and RNA are nucleic acids.

They are made of nucleotides.

Each nucleotide contains a phosphate, a sugar and a base.

**(i)** Identify the correct phosphate link between nucleotides.

Tick (✓) **one** box.

**Base – Phosphate – Base** ☐

**Base – Phosphate – Sugar** ☐

**Sugar – Phosphate – Base** ☐

**Sugar – Phosphate – Sugar** ☐

**[1]**

| | | |
|---|---|---|
| ? | **Misconception** | Many candidates did not understand the structure of DNA or RNA sufficiently well. They frequently selected base-phosphate-sugar or sugar-phosphate-base; probably because these are the three components of a single nucleotide. However, this item was focused on the link between different nucleotides (along the polynucleotide chain). Relatively few candidates obtained the mark. |

## Question 5 (c) (ii)

**(ii)** The bases found in some nucleotides can pair with other bases.

Draw a line to link **Base 1** with its complementary **Base 2**.

| **Base 1** | **Base 2** |
|---|---|
| | Adenine |
| Guanine | Cytosine |
| Thymine | Guanine |
| | Thymine |

**[2]**

Base-to-base pairing is a fundamental feature of the DNA molecule. A schematic view of this unique pattern often appears on the front of academic, biological textbooks and is in common use via the media or even via the packaging of pharmaceutical products. It was assumed that candidates would be familiar with this arrangement and that the pairs were arranged as TA and GC. The format of this objective item provided suitable scaffolding for the candidates to make the correct links. However, a few candidates drew two lines stemming from each of the two boxes in the Base 1 column. This prevented them from obtaining any marks because they did not demonstrate a clear response.

## Question 5 (c) (iii)

**(iii)** Although the phosphate group is always the same, the sugars and bases are different in DNA compared to RNA.

Complete the table to compare the sugars and bases found in **DNA** and **RNA**.

| Feature | DNA | RNA |
|---|---|---|
| Type of sugar found | | |
| Four bases found | | |

**[4]**

Relatively few candidates appreciated that the sugars found in DNA and RNA are deoxyribose and ribose respectively. No clear pattern of alternative responses could be determined for this row in the table. Since the list of four bases was presented in the previous item (via the Base 2 column), most candidates used this information of successfully identified the four bases found in DNA. The key difference with the RNA molecule (the replacement of thymine with uracil) was frequently missed in the table.

| | | |
|---|---|---|
| i | **OCR support** | It is recommended that the differences between DNA and RNA molecules are reinforced, as outlined in the exemplification section of the specification at LO 3.2. |

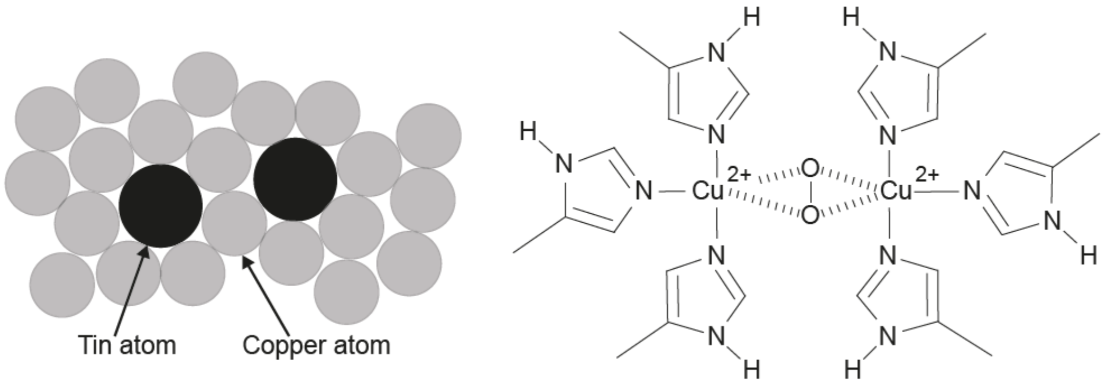
## Question 6

**6** Copper and its ions have uses in metallic structures such as bronze, and in biological molecules such as haemocyanin.

Bronze is an alloy of copper and tin, and is used to make coins and statues.

Haemocyanin is a protein found in the bodies of invertebrates such as insects. Its function is to carry oxygen in a similar way to haemoglobin in vertebrates such as humans.

The structure of bronze and the oxygenated form of haemocyanin are shown in **Fig. 6.1**.




**Bronze** **Haemocyanin (oxygenated form)**

**Fig. 6.1**

Describe the structures of bronze and haemocyanin as shown in **Fig 6.1** and how these determine their properties and function or uses.

..........................................................................................................................................

..........................................................................................................................................

..........................................................................................................................................

..........................................................................................................................................

..........................................................................................................................................

..........................................................................................................................................**[6]**

This was a free-response or level of response (LOR) item. This means that the list of valid points (in the guidance column of the mark scheme) were checked against the candidate responses and the overall response was marked in a holistic manner. The approach adopted for each example of this question format is standardised and operated at three levels. In this case, the most successful responses functioned at Level 3 and could obtain 5 or 6 marks, Level 2 for 3 or 4 marks and Level 1 for 1 or 2 marks. At least two valid points must be included in the response to engage with this marking system. For this particular question, much information was provided in the written text and supported by labelled diagrams (Fig. 6.1). Candidates were directed to consider the structure and function/uses of both bronze and haemocyanin. This was challenging to many candidates and some limited the marks given due to a focus on only one of the two materials/substances. The interpretation of haemocyanin was the most challenging aspect of this question.

| | | |
|---|---|---|
| i | **OCR support** | Mixtures and alloys (including bronze) are considered in the specification at LO 2.1 and the basic features of haemocyanin are noted on the exemplification section at LO 5.1. |

## Question 7 (a) (i)

**7** Different metals have different physical properties such as strength, hardness and density.

**(a)** The Vickers Hardness Test is used to determine the hardness of materials such as metals.

In this test, a diamond pyramid is pressed into the surface of a sample of the material.

**Fig. 7.1** shows the laboratory instrument that is used, and a diagram of the test.

**Item removed due to third party copyright restrictions**

**Fig. 7.1**

**(i)** Use the information in **Fig 7.1** to suggest how the Vickers Hardness Test is used to compare the hardness of different metals.

......................................................................................................................

......................................................................................................................

......................................................................................................................

......................................................................................................................

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

Many candidates were able to use the information provided in the stem of this item along with the image and diagrams of Fig. 7.1 to good effect. They were able to determine that a force was applied to each sample metal via the apparatus and that an indentation/impression was formed. The harder the metal, the smaller the indentation at a set force. Some candidates struggled to articulate a clear response but, at least, referred correctly to the application of a force. No clear pattern of alternative responses was identified.

## Question 7 (a) (ii)

**(ii)** Suggest why a diamond pyramid is used in the machine.

........................................................................................................................................

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

Most candidates appreciated that diamond is the hardest material know. No clear pattern of alternative responses or misconceptions could be determined.

## Question 7 (b) (i)

**(b)** An important property of a metal is its strength to weight ratio.

This is a number which can be calculated by dividing the strength (in MPa) of the metal by its density in g $cm^{-3}$.

**Table 7.1** shows the strength and density of four metal alloys.

**(i)** Use the information to calculate the strength to weight ratio for each alloy.

Write down the values in the table.

Give your answers to **3** significant figures.

| Metal | Strength / MPa | Density / g $cm^{-3}$ | Strength to weight ratio |
|---|---|---|---|
| Aluminium alloy | 310 | 2.70 | |
| Stainless steel | 505 | 8.00 | |
| Titanium alloy | 1250 | 4.81 | |
| Low-carbon steel | 365 | 7.87 | |

**Table 7.1** **[2]**

Many candidates successfully used the table of data to determine the ratio. They divided the strength of each metal by its density to obtain the correct ratio. This enabled the candidates to obtain at least the first marking point. However, some candidates did not present their values to 3 significant figures. This suggested that they had either not noticed the instruction or did not understand what was required.

| | | |
|---|---|---|
| | **AfL** | It is suggested that calculating significant figures, together with the use of correct decimal points, is rehearsed on a regular basis with candidates. |

## Question 7 (b) (ii)

**(ii)** Which metal alloy in **Table 7.1** would be most suitable for constructing a racing bike?

Tick (✓) **one** box.

| | |
|---|---|
| **Aluminium** | ☐ |
| **Stainless steel** | ☐ |
| **Titanium** | ☐ |
| **Low-carbon steel** | ☐ |

Explain why you have chosen this metal alloy.

.......................................................................................................................................

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

Almost all candidates correctly assumed that titanium would be most suitable for constructing a racing bike. However, some candidates struggled to articulate an explanation. It was expected that they would refer to the highest strength to weight ratio (as indicated in Table 7.1).

## Question 7 (b) (iii)

**(iii)** Suggest **two** other factors which you would need to consider when selecting the best material for a racing bike.

1.............................................................................................................................

.............................................................................................................................

2.............................................................................................................................

.............................................................................................................................

**[2]**

Most candidates adopted a common sense approach to this item and correctly realised that features such as the cost and availability of the material and structural properties including stiffness, brittleness or corrosion (rust) resistance were involved. Some candidates misinterpreted the stem of this item and referred to factors already covered in the earlier part of the question. However, the stem of this item stated, 'Suggest two other factors…'.

## Question 8 (a)

**8** The potential difference across a resistor **X** is 5.0 V.

The current in the resistor is 0.5 A.

**(a)** Calculate the resistance $R_x$ of resistor **X**.

Use the equation: potential difference = current × resistance

$R_x$ = ........................................ Ω **[2]**

This item did not present a challenge to most candidates. They were confident in rearranging the equation (to 'resistance = potential difference ÷ current') and using the values provided in the stem. Very few candidates did not get a value of 10 Ω.

## Question 8 (b)

**(b)** Resistor **Y** is placed in series with resistor **X**. The potential difference across both resistors is 5.0 V.

The current in the resistors is 0.087 A.

Calculate the resistance $R_y$ of resistor **Y**.

$R_y$ = ...................................... Ω **[2]**

| |
|---|
| Although most candidates were able to resolve the first calculation for $R_t$ (via 5 ÷ 0.087), and so obtain the first marking point, few progressed successfully on to the second calculation of<br><br>$R_y = R_t – R_x$. This may have been the result of a misunderstanding or limited knowledge about the principle of resistors, as outlined in the specification at LO 6.1. |

## Question 8 (c)

**(c)** Resistor **X** is now placed in parallel with resistor **Y**.

Calculate the combined resistance $R_t$ of **X** and **Y** in parallel.

Use the equation: $\frac{1}{R_t} = \frac{1}{R_x} + \frac{1}{R_y}$

$R_t$ = ...................................... Ω **[2]**

| |
|---|
| Most candidates struggled to fully complete the calculation required for this item. However, it was possible for them to be credited with the first marking point on the mark scheme. A mark was given if candidates presented the equation as $1/R_t = 1/R_x + 1/R_y$, where $R_x$ is 10 and $R_y$ is the value presented in response to Q8(b). As a result, candidates were given one mark for an 'error carried forward' (generally annotated as ecf by examiners) for transposing their value for $R_y$ [from Q8(b)] in their calculation. |

| | | |
|---|---|---|
| | **AfL** | The marking of this item reinforced the need for candidates to show their working for calculations in the space provided. Candidates should be reminded of this principle when responding to similar items in the future. |

## Question 8 (d)

**(d)** A lamp is placed in the circuit so that resistor **X**, resistor **Y** and the lamp are all in parallel.

The total current in the circuit is 0.75 A.

Show that the charge Q transferred through the lamp in one minute is about 8.6 C.

**[3]**

This was a very challenging topic. Very few candidates were able to work through the various steps required to show that charge *Q* of the lamp was 8.6C per minute. Some candidates chose not to respond to this item. This may have been an unwise choice because some candidates did obtain one mark, at least, for showing the final step of 0.15 A x 60 s = 9.0 C.

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