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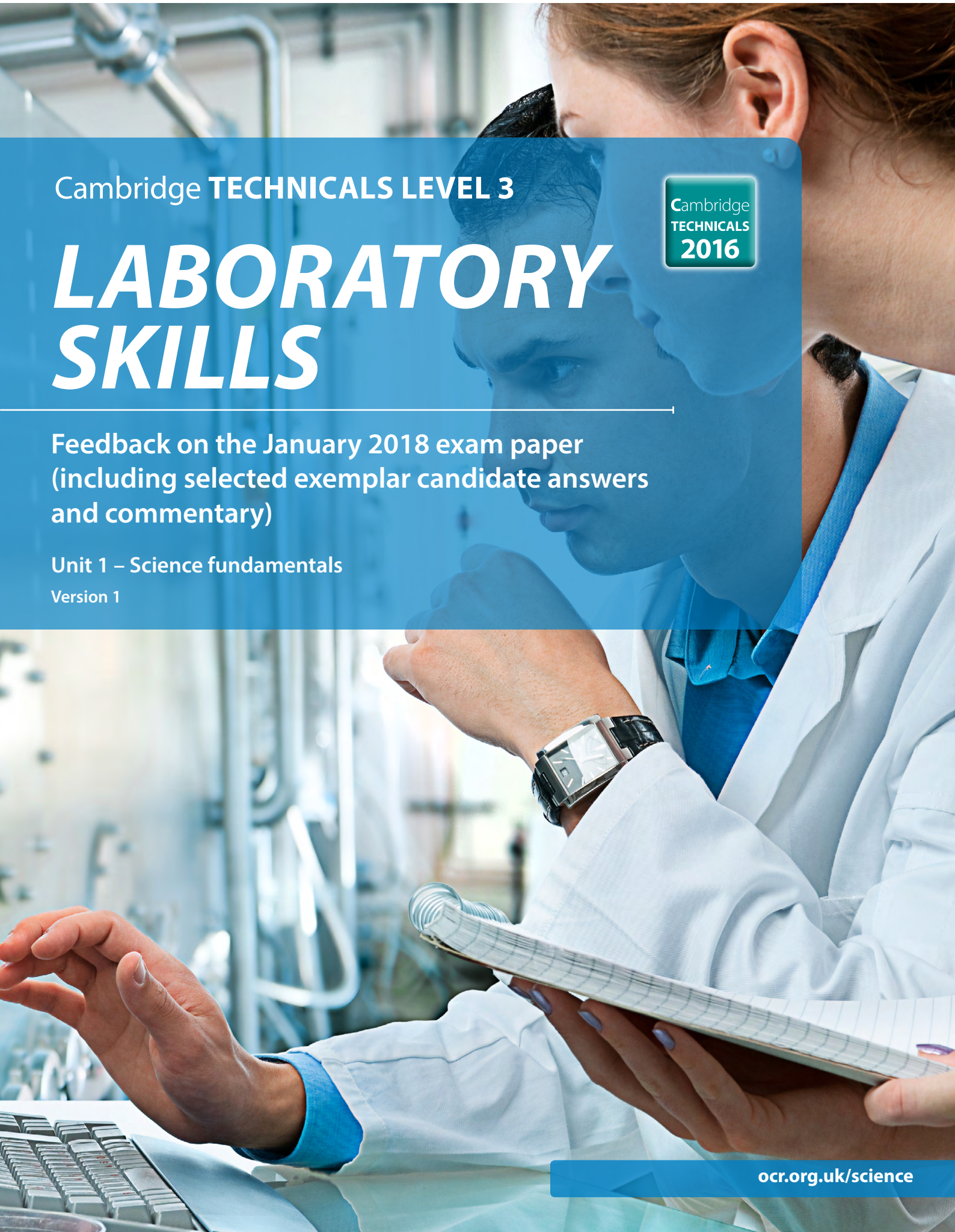

Cambridge **TECHNICALS LEVEL 3**

Cambridge TECHNICALS 2016

LABORATORY SKILLS

Feedback on the January 2018 exam paper (including selected exemplar candidate answers and commentary)

Unit 1 – Science fundamentals

Version 1

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CONTENTS

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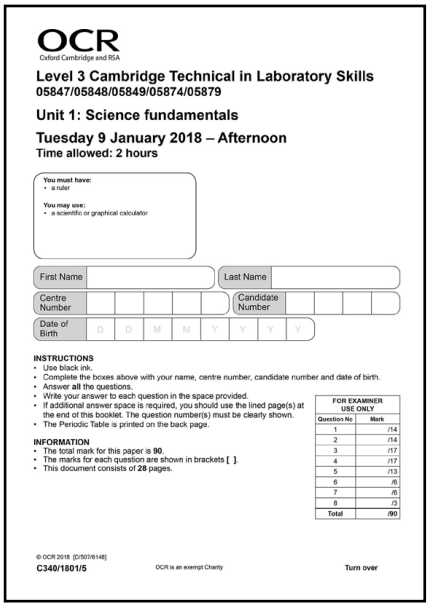
INTRODUCTION

This resource brings together the questions from the January 2018 examined unit (Unit 1), the marking guidance, the examiners comments and the exemplar answers into one place for easy reference.

We have also included exemplar candidate answers with commentary for Questions 2(a)(i), 2(a)(ii), 3(b)(iii) and 4(b)(i).

The marking guidance and the examiner's comments are taken from the Report to Centre for this question paper.

The Question Paper, Mark Scheme and the Report to Centre are available from:
https://interchange.ocr.org.uk/Modules/PastPapers/Pages/PastPapers.aspx?menuindex=97&menuid=250



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Level 3 Cambridge Technical in Laboratory Skills
05847/05848/05849/05874/05879

Unit 1: Science fundamentals

Tuesday 9 January 2018 – Afternoon
Time allowed: 2 hours

You must have:
- a ruler

You may use:
- a scientific or graphical calculator

First Name | Last Name
Centre Number | Candidate Number
Date of Birth (D D M M Y Y Y Y)

INSTRUCTIONS
- Use black ink.
- Complete the boxes above with your name, centre number, candidate number and date of birth.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- If additional answer space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- The Periodic Table is printed on the back page.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **28** pages.

FOR EXAMINER USE ONLY	
Question No	Mark
1	/14
2	/14
3	/17
4	/17
5	/13
6	/6
7	/6
8	/3
Total	/90

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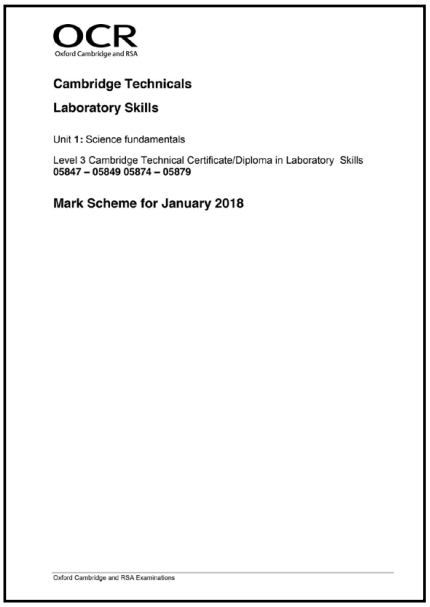

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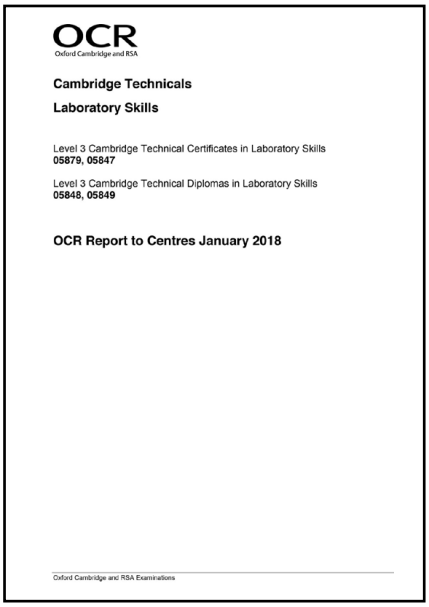
Cambridge Technicals
Laboratory Skills

Unit 1: Science fundamentals

Level 3 Cambridge Technical Certificate/Diploma in Laboratory Skills
05847 – 05849 05874 – 05879

Mark Scheme for January 2018

Oxford Cambridge and RSA Examinations



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Cambridge Technicals
Laboratory Skills

Level 3 Cambridge Technical Certificates in Laboratory Skills
05879, 05847

Level 3 Cambridge Technical Diplomas in Laboratory Skills
05848, 05849

OCR Report to Centres January 2018

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GENERAL EXAMINER COMMENTS ON THE PAPER

This paper was the second to be assessed for the new Level 3 Cambridge Technical in Laboratory Skills, Unit 1 Science Fundamentals. Candidates appeared to be increasingly well prepared for the themes/topics covered within the specification.

The depth of knowledge and understanding needed to successfully complete the objective format for some items was demonstrated by a number of candidates. It appeared that the use of this objective style provided increased access for some candidates.

The majority of candidates were able to respond to all questions in the time available, although it is noted that the final question was often incomplete. Some candidates used the additional pages in an appropriate manner but in most cases these pages were not required.

Resources which might help address the examiner comments:

From the link below, you'll find 'The OCR guide to examinations' (along with many other skills guides)
http://www.ocr.org.uk/i-want-to/skills-guides/

Command verbs definitions
http://www.ocr.org.uk/Images/273311-command-verbs-definitions.pdf

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Questions 1(a), (b) and (c)

Answer **all** the questions.

1 The nuclear notations for two of the isotopes of calcium are:

$^{20}_{40}Ca$ $^{20}_{51}Ca$

(a) State the number of protons and electrons in one atom of calcium.

Protons 20

Electrons .. 20

[2]

(b) Explain what is meant by the term **isotope**.

same number of protons/element **AND** different numbers of neutrons

[1]

(c) The nucleus of calcium-40 is stable.

The nucleus of calcium-51 disintegrates in 10 s.

Explain why the nucleus of calcium-40 does not disintegrate.

(extra) neutrons
outside of the valley of stability
(strong) nuclear force/nucleon-nucleon interaction
strong nuclear force greater than repulsion

[4]

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Mark scheme guidance

Question 1(b):

ALLOW mass/nucleon number/relative atomic mass = neutron number.

Question 1(c):

ALLOW statement to effect that Ca-40 and Ca-51 have same number of protons but different mass as AW neutrons.

ALLOW statement to effect linking mp1 to instability of Ca-51.

IGNORE strong force, unqualified.

ALLOW strong nuclear force not strong enough to hold the nucleus together/AW.M.

ALLOW weak (nuclear) force causes beta decay (to make the nucleus more stable).

Examiner comments

Question 1(a) – The majority of candidates were able to correctly identify the number of protons and electrons in one atom of calcium.

Question 1(b) – It was encouraging to see that most candidates were capable of explaining the term isotope.

Question 1(c) – Although a number of candidates obtained one mark for referring to neutrons, the majority did not consider nuclear force.

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Questions 1(d), (e)(i) and (ii)

(d) **Fig. 1.1** shows the relationship between the atomic number and the atomic radius for some of the elements in the Periodic Table.

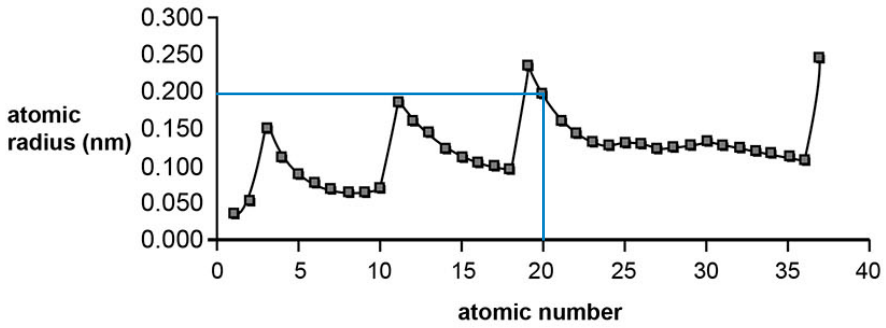

Fig. 1.1

Use **Fig. 1.1** to determine the atomic radius of calcium.

Show your working by drawing suitable lines on **Fig. 1.1**.

Give your answer in **standard form** and include **units**.

FIRST CHECK THE ANSWER ON THE ANSWER LINE
If answer = 2×10^{-10} m award 3 marks
on Fig. 1.1 vertical line at 20 and horizontal line to y-axis
2×10^{-10}
m

atomic radius = ... units = ...**[3]**

(e) **(i)** Calcium is in Group 2 of the Periodic Table.

Put a (ring) around the correct number of valence electrons in a calcium atom.

(**2**) **4** **20** **40**

[1]

(ii) The formula of calcium phosphate is $Ca_3(PO_4)_2$.

The calcium ion is Ca^{2+}.

Put a (ring) around the correct formula of the phosphate ion.

PO_4^{3+} PO_4^{4+} (PO_4^{3-}) PO_4^{4-}

[1]

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Mark scheme guidance

Question 1(d):

ALLOW $200 \times 10^{-12}/194 \times 10^{-12}$ m OR 2×10^{-8} cm OR 2×10^{-7} mm OR 2×10^{-1} nm = 3 marks

ALLOW 0.2 nm = 1 mark

Examiner comments

Question 1(d) – This item was generally well answered. The common error for candidates was to present the value without considering the standard form. This limited the full allocation of marks but candidates were credited for their clear use of Fig. 1.1 to show their working.

Question 1(e)(i) and (ii) – The introduction of an objective format enabled many candidates to cope well with parts (i) and (ii). However, a common error was seen with the choice of 20 rather than the correct value of 2 for the number of valence electrons in a calcium atom.

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Question 1(e)(iii)

(iii) Describe the type of bonding in a calcium phosphate molecule.

covalent **between** phosphorous and oxygen
ionic **between** calcium and phosphate/phosphorous and oxygen group

[2]

Mark scheme guidance

ALLOW covalent in the phosphate ion.

ALLOW symbols.

ALLOW for one mark max. – ionic between metal and non-metal **OR** covalent between non-metals.

Examiner comments

Part (iii) presented a challenge for a number of candidates, since they did not appreciate that both covalent and ionic bonds were involved.

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Question 2(a)

2 The biomass produced by the growth of algae, *Chlorella kessleri* (*C. kessleri*), contains lipids.

The lipids are suitable for biodiesel production.

The biomass of the alga is a product of the reaction photosynthesis.

Light intensity is one of the factors known to affect the rate of photosynthesis.

(a) Scientists investigated the effect of light intensity on biomass production of the algae.

The results of one investigation are shown in **Fig. 2.1**.

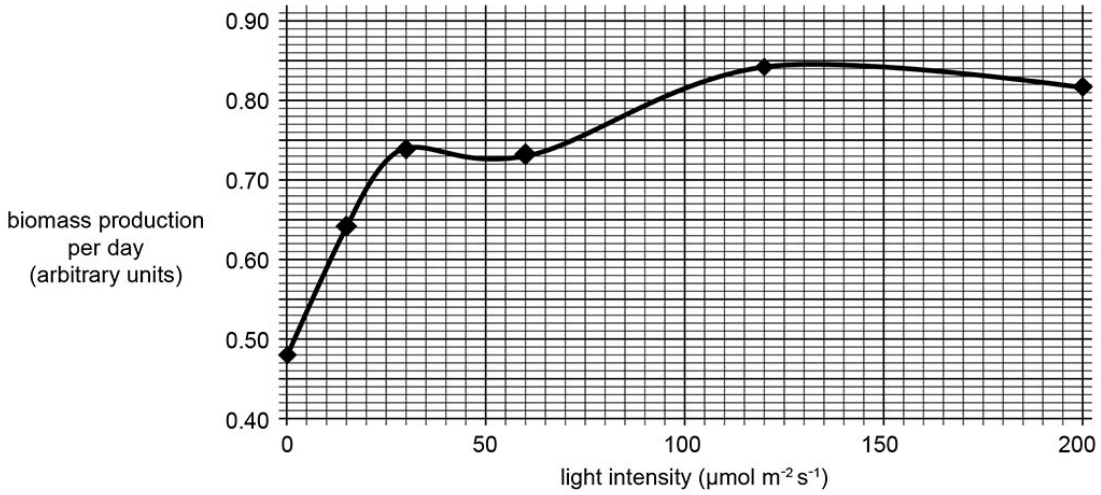

Fig. 2.1

(i) Describe the effect of light intensity on the rate of biomass production by the algae.

Any four from:
- increased light intensity linked to greater biomass (= **overall** observation)
- **initial increase** in rate of biomass production (0.48 to 0.74) as light intensity changes from 0 – 30 µmol m^{-2} s^{-1}
- **decrease** in rate of biomass production (0.74 to 0.73) as light intensity changes 30 – 60 µmol m^{-2} s^{-1}
- **increase** in rate of biomass production (0.74 to 0.84) as light intensity changes 30/60 – 120 µmol m^{-2} s^{-1}
- **peak** at biomass of 0.85 at light intensity 120/145 µmol m^{-2} s^{-1}
- **final decrease** in rate of biomass production (0.85 to 0.82) as light intensity changes 120 – 200 µmol m^{-2} s^{-1}

.....[4]

(ii) Name **four** other factors known to affect the rate of reactions.

1 .....
2 .....
3 .....
4 .....

Any four from:
- physical state
- temperature
- pressure
- solvents
- catalysts/enzymes
- surface area
- electromagnetic radiation
- concentration (of reactants)

[4]

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Mark scheme guidance

Question 2(a)(i):

ALLOW biomass differs/changes with increased light intensity.

ALLOW any value between 120 to 145 μmol m^{-2} s^{-1}

Question 2(a)(ii):

REJECT light intensity.

ALLOW heat = temperature.

ALLOW stirring/agitation.

Examiner comments

Question 2(a)(i) – This item enabled many candidates to do well and obtain 3 or 4 of the marks available.

General references to the initial increase, decrease etc. were creditworthy. It was encouraging to see that some candidates used values from Fig. 2.1 to support their statements.

Question 2(a)(ii) – The majority of candidates were familiar with the other factors known to affect the rate of reactions. The list is included in the specification for this unit and was used well. This was a straightforward, factual recall item.

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Exemplar Candidate Work

Question 2(a)(i) – Low level answer

2 The biomass produced by the growth of algae, *Chlorella kessleri* (*C. kessleri*), contains lipids.

The lipids are suitable for biodiesel production.

The biomass of the alga is a product of the reaction photosynthesis.

Light intensity is one of the factors known to affect the rate of photosynthesis.

(a) Scientists investigated the effect of light intensity on biomass production of the algae.

The results of one investigation are shown in **Fig. 2.1**.

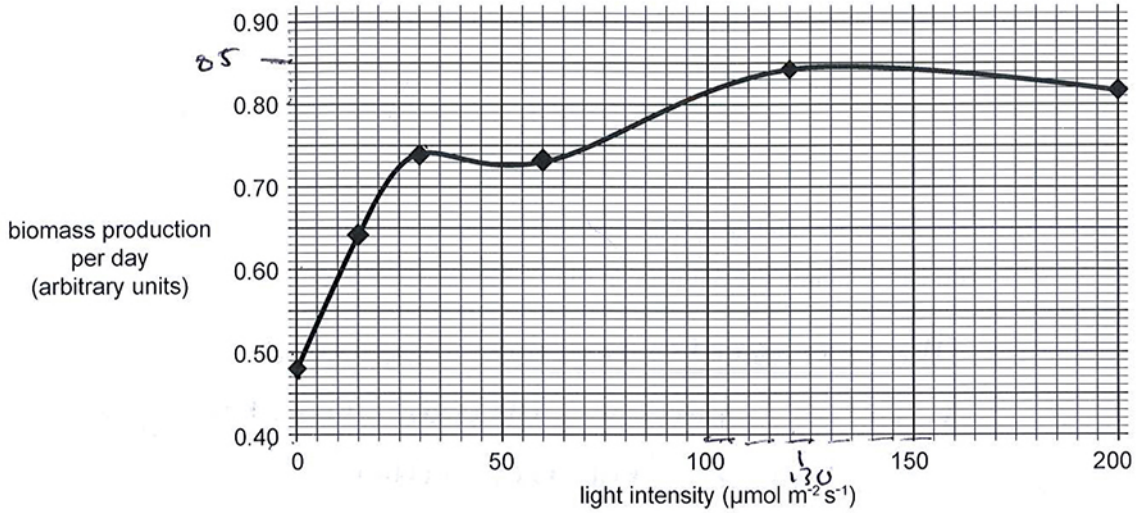

Fig. 2.1

(i) Describe the effect of light intensity on the rate of biomass production by the algae.

As the light intensity increases the biomass production increases. For example at 130 light intensity the biomass production was 0.85. The more the light intensity the faster the reaction of photosynthesis as alga need light to be able to make their own food. As light intensity decreases the biomass production process slow. Light → glucose [4]

Commentary

This low level answer contains a clear statement with regards to the overall correlation shown by the graph (Fig. 2.1). This was awarded one of the marking points. The remaining marking points were assigned to the different regions of the graph showing a change in the data. In this case, one other region was included within the response since the candidate stated that 0.86 (biomass production) was the fastest reaction. This was awarded a second mark although it was somewhat unclear. The statement was given the 'benefit of the doubt'. The response could have been improved with the addition of further references to changes in the data, such as the decrease in rate of biomass production as light intensity changed from 30 – 60 units.

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Exemplar Candidate Work

Question 2(a)(i) – Medium level answer

2 The biomass produced by the growth of algae, *Chlorella kessleri* (*C. kessleri*), contains lipids.

The lipids are suitable for biodiesel production.

The biomass of the alga is a product of the reaction photosynthesis.

Light intensity is one of the factors known to affect the rate of photosynthesis.

(a) Scientists investigated the effect of light intensity on biomass production of the algae.

The results of one investigation are shown in **Fig. 2.1**.

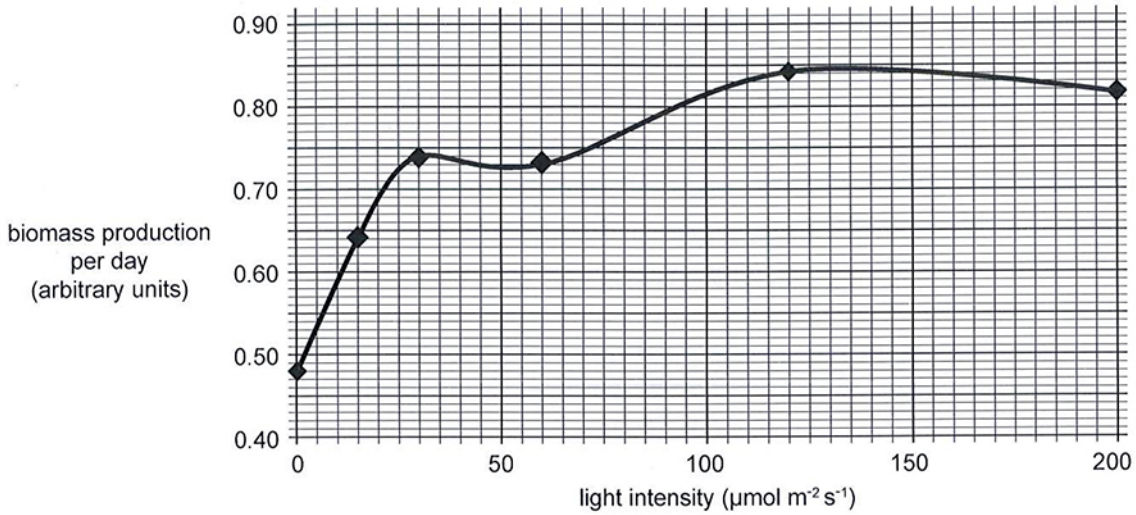

Fig. 2.1

(i) Describe the effect of light intensity on the rate of biomass production by the algae.

as light intensity increases from 0 the amount of biomass begins to sharply increase however the higher intensity leads to a point where it has an opposite effect. after 100μmol m^{-2} s^{-1} the biomass production gradually decreases.

[4]

Commentary

This response also obtained 2 marks but contained much clearer statements with regards to the marking points. There was no 'benefit of doubt' required. Two distinct statements were included in relation to change i.e. the initial sharp increase and a region of gradual decrease. The inclusion of any of the remaining statements listed in the mark scheme would have enhanced the level of this response. For example, the overall correlation could have been included.

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Exemplar Candidate Work

Question 2(a)(i) – High level answer

2 The biomass produced by the growth of algae, *Chlorella kessleri* (*C. kessleri*), contains lipids.

The lipids are suitable for biodiesel production.

The biomass of the alga is a product of the reaction photosynthesis.

Light intensity is one of the factors known to affect the rate of photosynthesis.

(a) Scientists investigated the effect of light intensity on biomass production of the algae.

The results of one investigation are shown in **Fig. 2.1**.

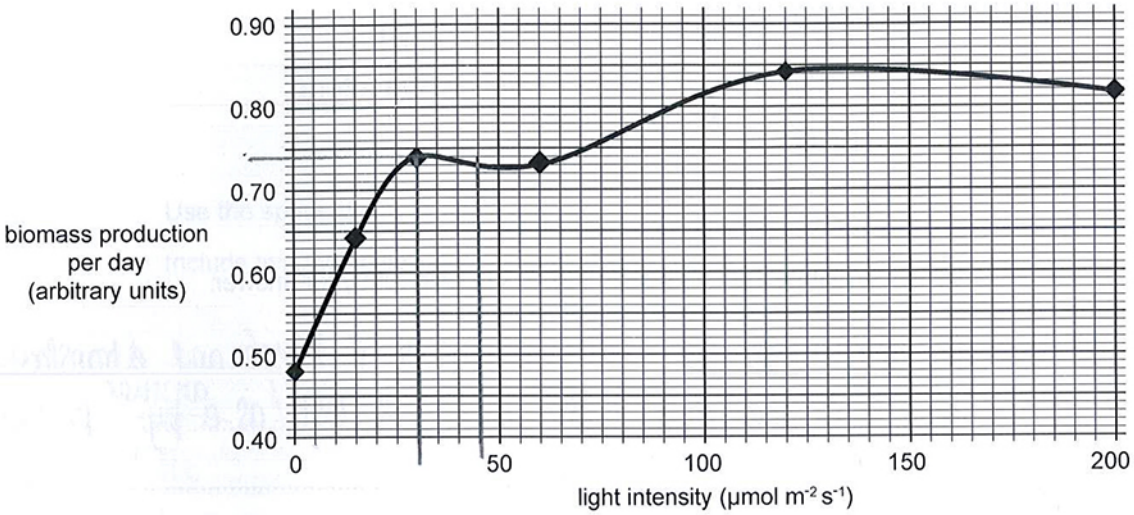

Fig. 2.1

(i) Describe the effect of light intensity on the rate of biomass production by the algae.

The more light that was ~~produced~~ available the more biomass that was produced, they had a positive correlation however when ~~it got to~~ the light intensity got to 90 $\mu m^{-2}s^{-1}$ then the graph started to dip and this happened all the way until the light intensity of 45 $m^{-2}s^{-1}$. This shows that the more light that was given meant that more algae was produced and this is shown however at one point the amount of algae produced did drop but then it rose again then it eventually flattened it's self. **[4]**

Commentary

This response obtained full marks. The overall positive correlation was included, followed by three different and correct references to various regions of the graph, supported by values quoted from the graph axes. It was not necessary to include an explanation for one of the regions and this was therefore ignored when allocating the marks. Only a description of the graph was required.

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Exemplar Candidate Work

Question 2(a)(ii) – Medium level answer

(ii) Name **four** other factors known to affect the rate of reactions.

1 Particle size
2 Surface area
3 temperature
4 mass.

[4]

Commentary

Two out of the expected list of factors were correctly included in this medium level response i.e. surface area and temperature. Particle size is not sufficiently precise and mass is not a factor. The response could become a high level answer if two other correct factors, such as pressure and catalysts, were included.

Question 2(a)(ii) – High level answer

(ii) Name **four** other factors known to affect the rate of reactions.

1 Concentration
2 catalyst
3 Surface area
4 Temperature

[4]

Commentary

This response was awarded full marks. All of the four factors listed were relevant and are considered to affect the rate of reactions. Other possible responses may have included factors such as pressure, solvents and physical state.

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Question 2(b)(i)

(b) A by-product of the biodiesel industry is glycerol.

The first stage of the process is the conversion of glycerol into dihydroxyacetone. This is shown in **Fig. 2.2**.

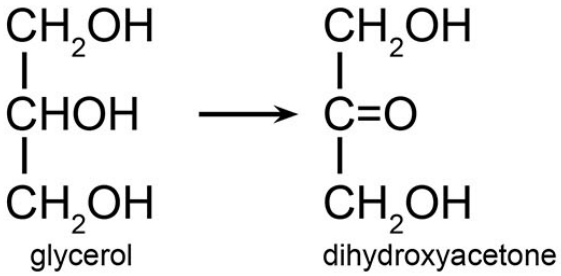

Fig. 2.2

(i) Describe the chemical reaction involved.

You can annotate the equation in **Fig. 2.2** to help with your answer.

oxidation/redox
2H removed
(to form) C = O/double bond/illustration of this.

[3]

Mark scheme guidance

ALLOW highlight of double bond on Fig. 2.2, as illustration.

Examiner comments

A number of candidates correctly referred to the loss of hydrogen and the formation of the double bond but failed to state the name of the chemical reactions. Some incorrectly stated reduction and displacement, instead of oxidation.

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Question 2(b)(ii)

(ii) More complex reactions may lead to the formation of synthetic material such as plastic. One important biodegradable plastic, polylactic acid (PLA), is made by the condensation polymerisation of lactic acid.

The structure of lactic acid is shown in **Fig. 2.3**.

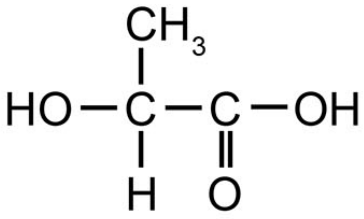
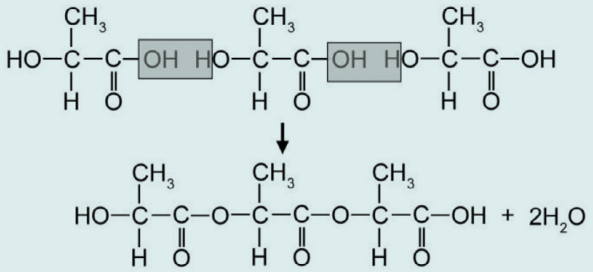


Fig. 2.3

Use the space below to show how this is polymerised to produce PLA.

Include two molecules of lactic acid in your diagram.

two correct reactants
correct bond (shown in product)
water molecule released



[3]

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Mark scheme guidance

NOTE – the models shown in the expected answer indicate the reaction for **three** lactic acid molecules BUT the response only requires **two** lactic acid molecules with the release of **one** water molecule.

Examiner comments

Many candidates failed to include two molecules in their diagram and chose to draw a residue of lactic acid surrounded by brackets with the letter 'n'. This was not acceptable since it did not respond correctly to the rubric of the question. Only a few candidates included the release of a water molecule in their diagram.

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Question 3(a)

3 John is a technician in the pathology department of a hospital.

He examines samples of human cervical tissue for signs of cancer.

(a) The cervix contains different types of epithelia.

Describe the structure of epithelial tissues in humans and relate this structure to the different functions of these tissues.

You may use diagrams to support your answer.

Valid points:
Basic structure
- Tissues are collections of similar/identical cells sharing a common function
- Epithelia are tissues that cover flat surfaces in the body
- Any correctly named example of epithelial tissue e.g. ciliated, alveolus, skin, (micro) villi and line cavities
- Cells of epithelia, are bound together/form sheets
- Supported by basement membrane/basal lamina

Different functions
- Can become specialised e.g. as sensory receptors
- Replicate to replace damaged/dead cells/striated epithelium to resist wear and tear
- Aid in transport/absorption e.g. intestinal epithelium
- Female reproductive organs/respiratory system lined with ciliated epithelium to remove foreign bodies
- Goblet cells in some epithelia secrete mucus for lubrication/protection.
- Epithelial cells slough off so dead cells are replaced e.g. skin surface, digestive tract

Detailed features
- Several types of interaction exist between adjacent cells (tight junctions, adherens, desmosomes, gap junctions)
- Tight junctions delineate and enable polarisation of cells
- Capillary bed below (basal lamina) and capillaries are not found within the tissue
- Can be innervated by neurons
- Nucleus in each cell is found towards basal surface
- Efficient barrier to external environment
- Can be difficult to penetrate by microorganism

[6]

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Mark scheme guidance

Level 3: (5 – 6 marks)

Candidate shows a high level of understanding and gives a good description of the structure of different types of epithelial tissue and how this is related to their function.

Level 2: (3 – 4 marks)

Candidate shows an understanding of the structure of some different functions of epithelial tissue and how this is related to their basic function.

Level 1: (1 – 2 marks)

Candidate shows a basic understanding of the structure of epithelial tissues and how this is related to their basic function, but with little or no explanation.

Level 0: (0 marks)

Candidate includes **fewer than two** valid points.

Examiner comments

Very few candidates were capable of describing the structure/function of epithelia tissues. This was unexpected because this tissue is listed in the unit specification, along with others such as muscle and connective tissue, in the context of structure and functional properties. It was not an essential feature of the response, but it was observed that candidates were generally unable to draw a diagram to show the features of this type of tissue.

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Questions 3(b)(i) and (ii)

(b) **Fig. 3.1** is an electron micrograph of an epithelial cell.

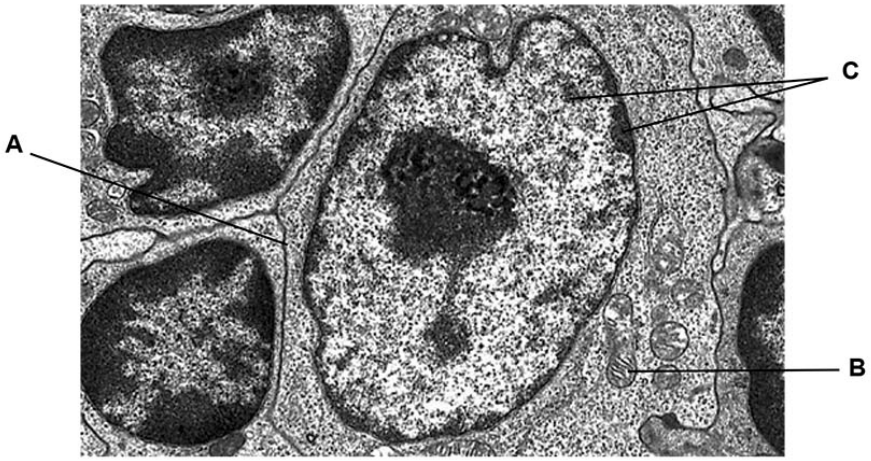

Fig. 3.1

(i) Identify the structures labelled **A** and **B** in **Fig. 3.1**.

Draw straight lines to join **A** and **B** to the correct name for the labelled parts.

	cell wall
A	plasma membrane
	cytoplasm
	mitochondrion
B	chloroplast
	Golgi apparatus

[2]

(ii) Identify the dense parts of the nucleus labelled **C**.

chromatin (material) .....**[1]**

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Mark scheme guidance

Question 3(b)(ii):

ALLOW euchromatin/DNA.

Examiner comments

Question 3(b)(i) – This objective item provided the options for labelling the electron micrograph shown in Fig. 3.1. Relatively few candidates recognised both the plasma membrane and mitochondrion. Since epithelial cells do not exist in plants and the characteristic features of plant cells were not shown in the image, it was surprising to note that some candidates considered the outer edge of the cell to be the cell wall, rather than the plasma membrane.

Question 3(b)(ii) – Few candidates appreciated that the dense parts of the nucleus represented chromatin (or DNA). Some considered the dense parts as nuclear pores. This was a good attempt but incorrect since nuclear pores were not visible in the image.

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Question 3(b)(iii)

(iii) For each structure, summarise its role in the cell.

A .....

.....

.....

B .....

.....

.....

C .....

.....

.....

A

*Any **two** from:*

- interface/barrier between the cell contents/cytosol and the external environment
- partially permeable
- (enables the cell to) move be fluid
- (enables cell to) change shape
- cell to cell recognition
- cell adhesion
- attachment of cytoskeleton
- holds receptors/receptor sites

B

*Any **two** from:*

- site of respiration
- aerobic (respiration)/Kreb's cycle
- ATP production
- holds (mitochondrial) DNA/mDNA
- correct reference to NADH/electron transfer chain

C

*Any **two** from:*

- package DNA into a smaller volume/fit nucleus
- condensation into/forms chromosomes
- protect/strengthen/prevent damage of DNA
- degree of condensation linked with transcription/involved in gene expression/regulation

[6]

Mark scheme guidance

ALLOW controls what goes in/out of the cell.

IGNORE 'powerhouse'.

REJECT production/creation of energy.

ALLOW a correct reference to histone modification.

Examiner comments

Many candidates obtained one mark for observing that structure A (although incorrectly referred to as the cell wall) was involved in the control of movement of molecules in and out of the cell. The expected answers focussed on the plasma membrane acting as a barrier and that it is partially permeable. The mitochondrion (structure B) was often identified correctly as the site of aerobic respiration and ATP generation. Reference to the 'creation of energy negated this marking point. The majority of candidates were unable to state the role of chromatin (structure C) within the nucleus.

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Exemplar Candidate Work

Question 3(b)(iii) – Low level answer

(b) Fig. 3.1 is an electron micrograph of an epithelial cell.

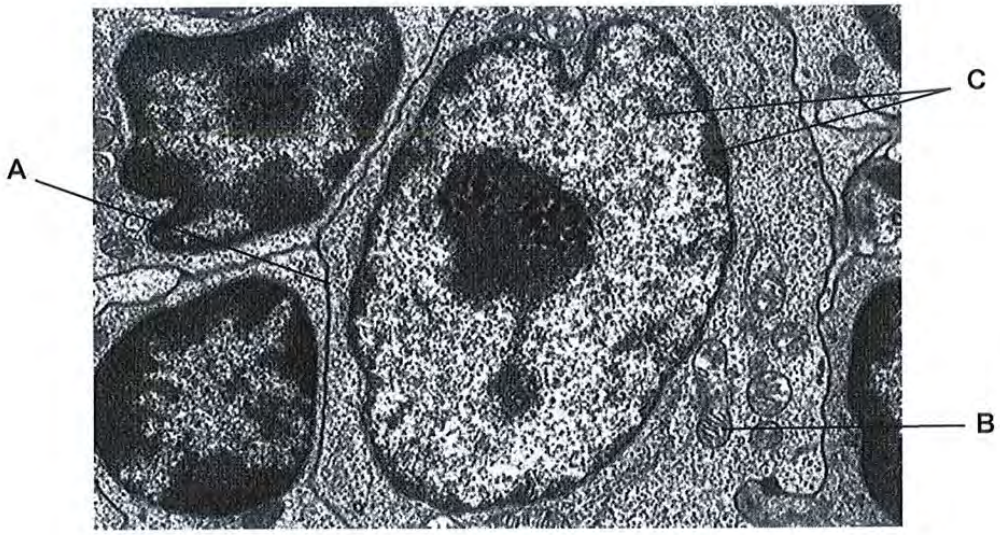

Fig. 3.1

(iii) For each structure, summarise its role in the cell.

A cell wall is to give structure to the cell to prevent it collapsing.

B mitochondria are there to ensure proteins are ~~fette~~ reused and food for the cell is made.

C DNA has genetic information that controls the cell.

[6]

Commentary

Structure A is the plasma membrane. Reference to this feature had already been assessed in the previous item [3(b)(ii)]. As a result, the incorrect inclusion of 'cell wall' was ignored and did not affect the awarding of marks. However, in this case it is clear that the plasma membrane does not prevent a cell from collapsing. This was an incorrect response to the role of structure A. The names of structures B and C were correct (although DNA was not the expected answer for chromatin) but their roles in cells were incorrect. Food is not made in the mitochondrion and DNA does not 'control the cell'. This is not sufficiently precise for a level 3 assessment. Improvements to enhance this response could include a clear reference to aerobic respiration or ATP production for the mitochondrion (B).

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Exemplar Candidate Work

Question 3(b)(iii) – Medium level answer

(b) Fig. 3.1 is an electron micrograph of an epithelial cell.

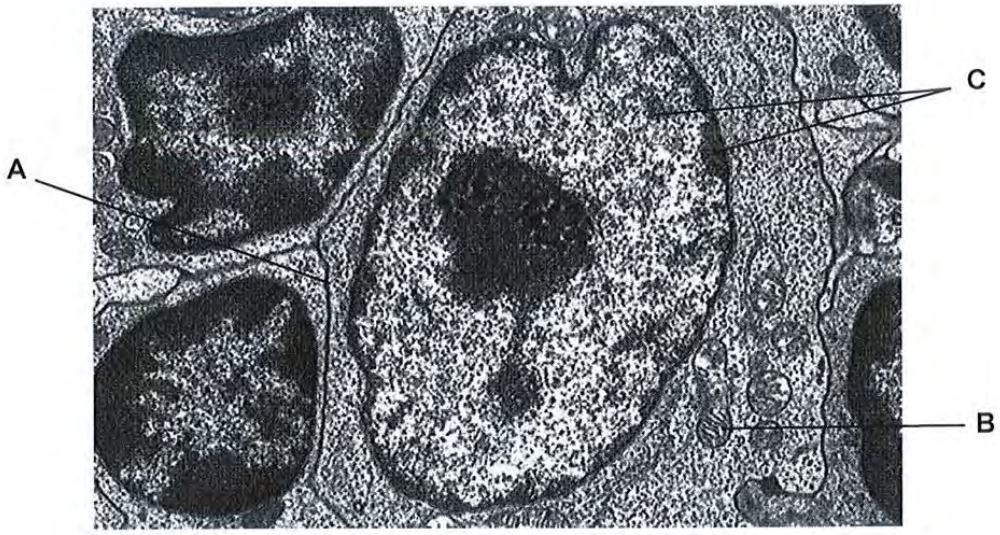

Fig. 3.1

(iii) For each structure, summarise its role in the cell.

A The cell wall controls what exits and enters the cell

B The mitochondrion controls and allows aerobic respiration in humans

C The nuclear envelope is what holds the nucleus together

[6]

Commentary

This medium level answer contained a correct reference to the plasma membrane (structure A) being responsible for the control of what exits and enters the cell. This response was accepted but expected answers should have more correctly referred to it acting as an interface/barrier between the cell contents and external environment, partial permeability, cell adhesion etc. Again, reference to the cell wall was ignored when marking this response. Correct references to 'aerobic' and 'respiration' enabled this candidate to obtain two marks for the mitochondrion (structure B). However, it was noted that the mitochondrion is the site of these reactions and does not necessarily control them. The response to the role of chromatin (structure C) was incorrect. The response could have been enhanced to a higher level if the role of chromatin had included references to the packaging of DNA, its condensation to form chromosomes or the protection of DNA from damage.

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Question 3(c)

(c) Fig. 3.2 shows two light micrographs:

- one with normal cervical epithelial cells
- one with cells showing the first signs of transformation into cancer cells.

Cervical smear with normal cells only

Cervical smear that includes cancerous cells

Fig. 3.2

Describe the differences, other than size, between the normal and cancerous cells.

Cancerous cells
*Any **two** from:*
- large nuclei
- (some) cells contain two/extra nuclei
- cells are less folded/more spread out/regular-shaped
- (may be) dividing

....
....
[2]

Mark scheme guidance

ALLOW visa versa for normal/non-cancerous cells.

ASSUME that response refers to normal cells if not qualified.

IGNORE less dense cells.

Examiner comments

This item was generally accessible to candidates. They successfully described the prominence of the nuclei in the cancerous cells, although reference to 'dots' was not acceptable. Some were also able to characterise the cancerous cells as in the state of mitosis/division, which appeared to be a useful link to general knowledge of such cells.

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Questions 4(a)(i), (ii) and (iii)

4 Carbohydrates, including starches and sugars, are important biochemicals in biological systems.

(a) The molecule in **Fig. 4.1** is a hexose, or six-carbon sugar.

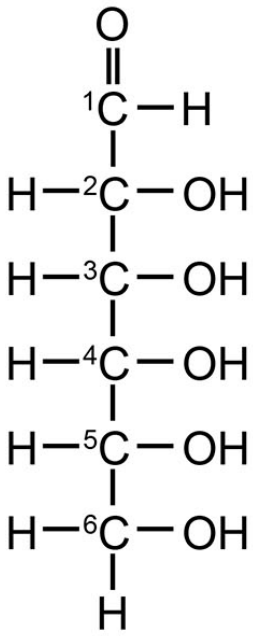

Fig. 4.1

(i) Name the functional group on carbon atom 1.

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

(ii) How many optical isomers will this molecule have? Explain your answer.

16
*Any **one** from:*
- (four) asymmetric/chiral carbon atoms
- number of isomers = 2^n (where n = number of asymmetric C atoms)

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

(iii) Draw **two** of these isomers.

any two correct isomers

[2]

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Mark scheme guidance

Question 4(a)(i):

ALLOW phonetic spellings.

Question 4(a)(ii):

MARK explanation independent of isomer number.

ALLOW an illustration of the chiral carbon atoms on Fig. 4.1 e.g. circles, ticks or arrows.

Question 4(a)(iii):

NOTE – the two isomers need to show any rotation around C atoms 2-5.

Examiner comments

Question 4(a)(i) –Although many correctly named the functional group as an aldehyde, some candidates referred to ketone or acetone.

Question 4(a)(ii) – Almost all candidates struggled to identify the correct number of optical isomers (16) for the hexose in Fig. 4.1. The asymmetry of the carbon atoms was not understood.

Question 4(a)(iii) – Very few candidates drew the correct isomer features. The geometry of bonding was not apparent in most responses.

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Question 4(a)(iv)

(iv) When dissolved in water, this type of hexose forms an oxygen bridge between carbon atoms 1 and 5 (**Fig. 4.2**).

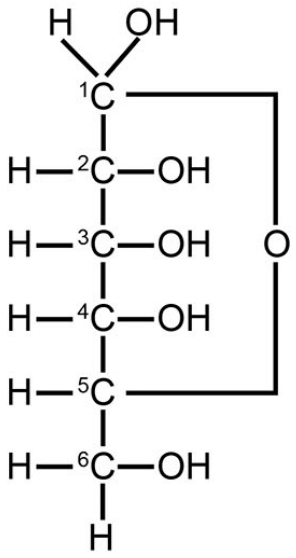

Fig. 4.2

How many isomers will this new hexose have? Explain your answer.

32
*Any **one** from:*
- **additional** asymmetric C atom/chiral centre
- on C atom 1

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

Mark scheme guidance

Question 4(a)(iv):

ALLOW 'C atom 1 is chiral too'.

ALLOW an illustration of the chiral property of C atom 1 on Fig. 4.2 e.g. circle, tick or arrow.

Examiner comments

Most candidates were also challenged by this item. The correct number of isomers (32) was rarely seen in candidate responses. This did mean that they were unable to include references to asymmetric carbon atoms or to the term 'chiral'.

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Question 4(b)(i)

(b) Waxy maize starch is one of the most recent 'sports carbohydrates' to be sold to athletes. The product claims to help fuel training and sporting events carried out by endurance athletes.

Waxy maize starch consists of a polymer of α-glucose. The structure of α-glucose is shown in **Fig. 4.3**.

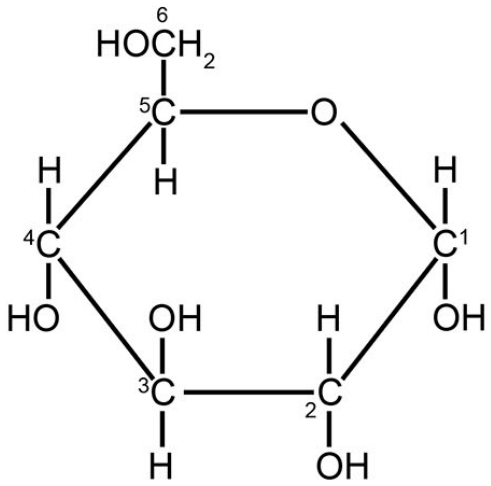
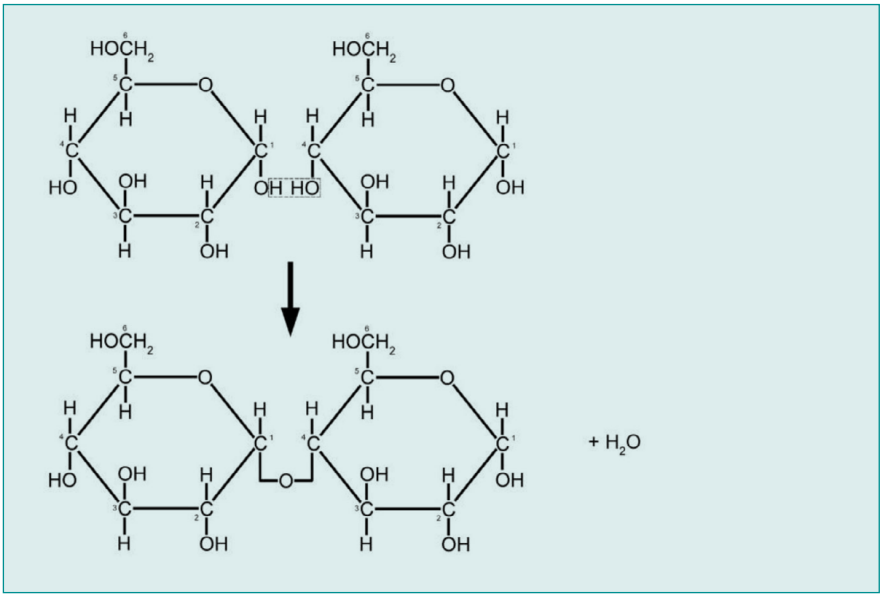


Fig. 4.3

(i) In waxy maize starch, the glucose molecules are linked with α1→4 and α1→6 linkages (bonds).

Using the formula of glucose in **Fig. 4.3**, show how two glucose molecules form an α1→4 linkage.



[4]

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Mark scheme guidance

Question 4(b)(i):

1 mark for reactants/correct alignment.

1 mark for products.

1 mark for showing how glycosidic linkage is formed/H and OH highlighted on carbons 1 and 4.

1 mark for release of water.

Examiner comments

Question 4(b)(i) – The formation of glycosidic 1-4 linkages was understood by relatively few candidates.

However, some responses were excellent and demonstrated knowledge of bond formation and the release of a water molecule. Many candidates did, however, obtain one mark for correctly including the two reactants.

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Exemplar Candidate Work

Question 4(b)(i) – Low level answer

(b) Waxy maize starch is one of the most recent 'sports carbohydrates' to be sold to athletes. The product claims to help fuel training and sporting events carried out by endurance athletes.

Waxy maize starch consists of a polymer of α-glucose. The structure of α-glucose is shown in **Fig. 4.3**.

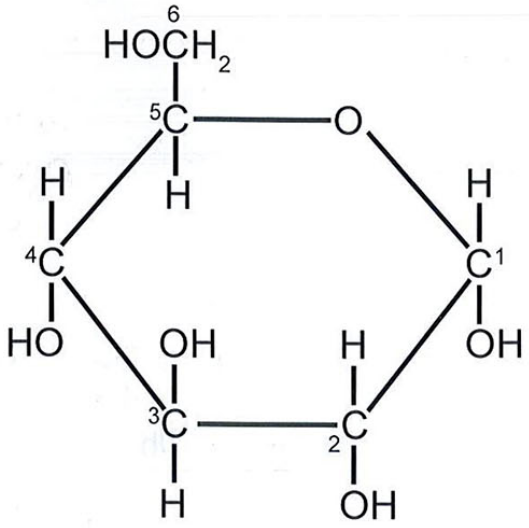
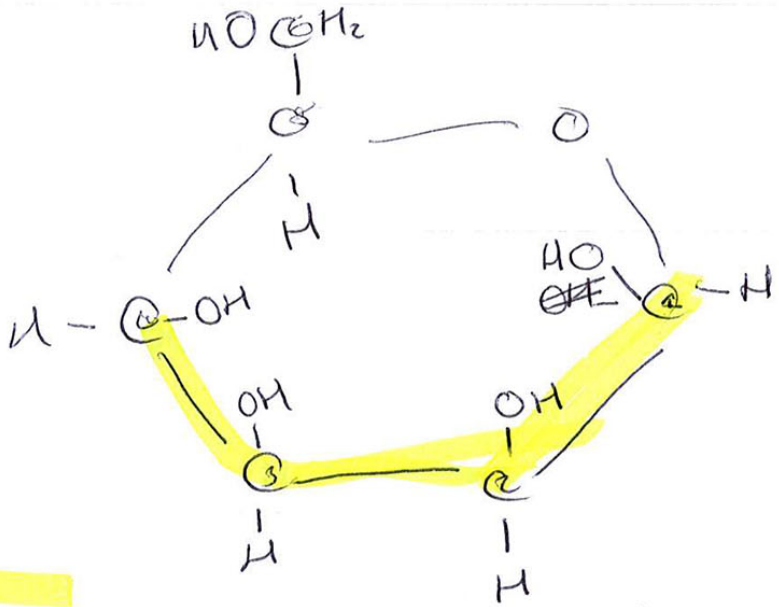


Fig. 4.3

(i) In waxy maize starch, the glucose molecules are linked with α1→4 and α1→6 linkages (bonds).

Using the formula of glucose in **Fig. 4.3**, show how two glucose molecules form an α1→4 linkage.



[4]

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Commentary

This response was limited to a low level (0 marks) because it did not include a diagram showing the two molecules or reactants, the combined product (disaccharide with an α 1 – 4 linkage), the correct glycosidic bond or the release of a water molecule. The inclusion of any one of these features would have enhanced this response to a medium level. It may be useful to note that the use of coloured, highlighted marks does not necessarily enhance the response.

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Exemplar Candidate Work

Question 4(b)(i) – Medium level answer

(b) Waxy maize starch is one of the most recent 'sports carbohydrates' to be sold to athletes. The product claims to help fuel training and sporting events carried out by endurance athletes.

Waxy maize starch consists of a polymer of α-glucose. The structure of α-glucose is shown in **Fig. 4.3**.

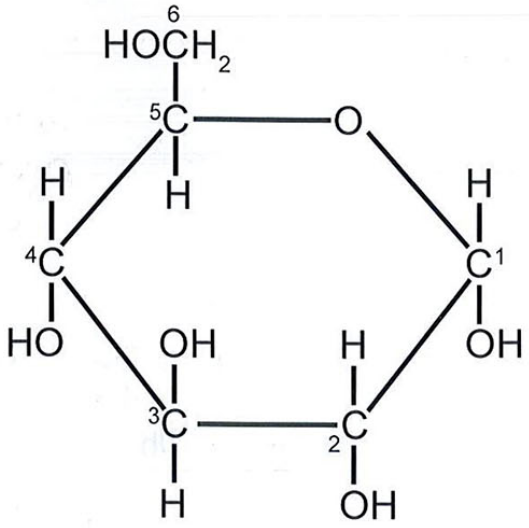
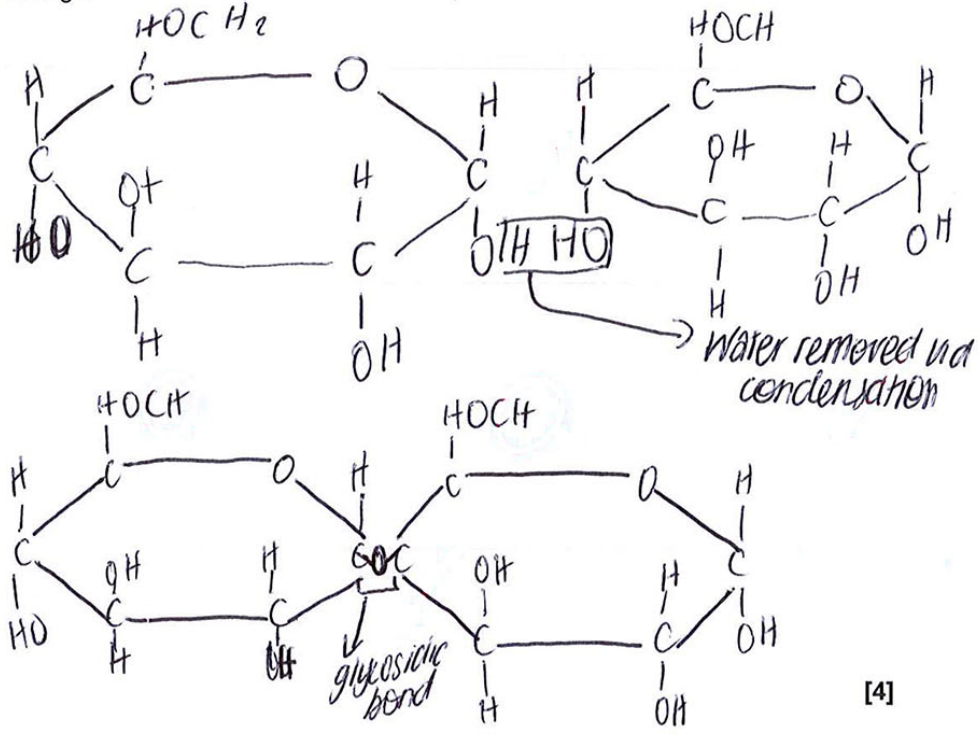


Fig. 4.3

(i) In waxy maize starch, the glucose molecules are linked with α1→4 and α1→6 linkages (bonds).

Using the formula of glucose in **Fig. 4.3**, show how two glucose molecules form an α1→4 linkage.



[4]

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Commentary

This medium level answer clearly showed the two reactants and the release of the water molecule. It was encouraging to see that the H and HO were also highlighted as a critical feature of the condensation reaction involved. The glycosidic bond was awarded a mark but this was a 'benefit of the doubt' mark because it was unclear, although labelled correctly as a glycosidic bond. This response could have been enhanced to a higher level if the product (disaccharide with an α 1 – 4 linkage), was drawn correctly. This response contained errors at $HOCH_2$.

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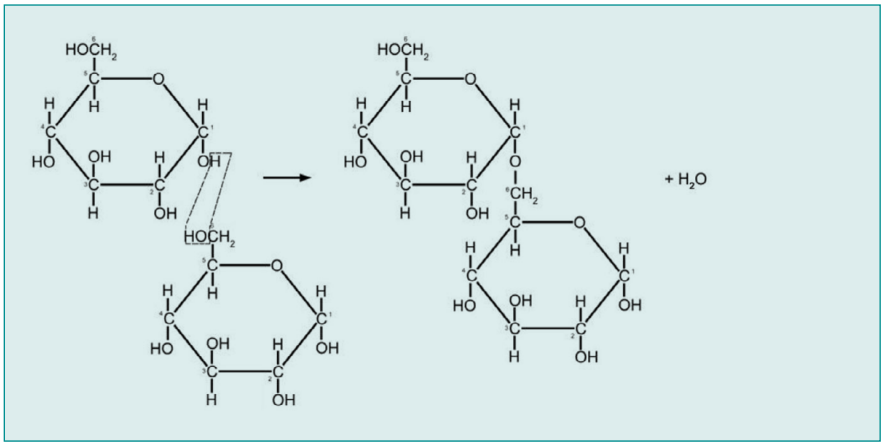
Question 4(b)(ii)

(ii) Using the formula of glucose in **Fig. 4.3**, show how two glucose molecules form an α1→6 linkage.



[4]

Mark scheme guidance

Question 4(b)(ii):

1 mark for reactants/correct alignment.

1 mark for products.

1 mark for showing how glycosidic linkage is formed/H and OH highlighted on carbons 1 and 6.

1 mark for release of water.

Examiner comments

Question 4(b)(ii) – The formation of glycosidic 1-6 linkages was equally challenging for most candidates.

Similar features were noted as for 4(b)(i).

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Questions 4(b)(iiii) and (c)

(iii) Which polymer of glucose is similar in structure to waxy maize starch and is found in animals?

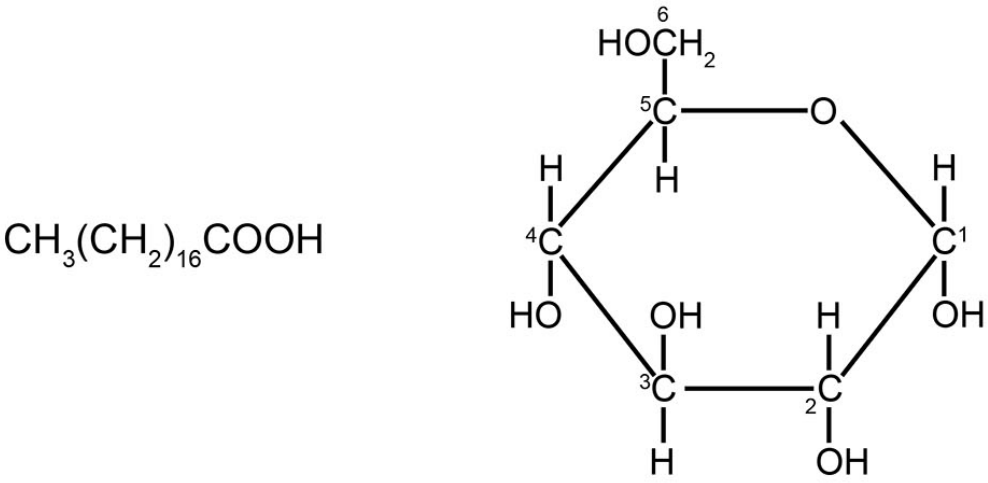
glycogen ..**[1]**

(c) In the past ten years, esters of glucose have become increasingly important chemicals.

They are used widely in the cosmetics industry, and in the food industry as surfactants and foam producers.

One ester bond is formed between the –OH group on carbon atom 6 of a glucose molecule, and the fatty acid, stearic (octadecanoic) acid.

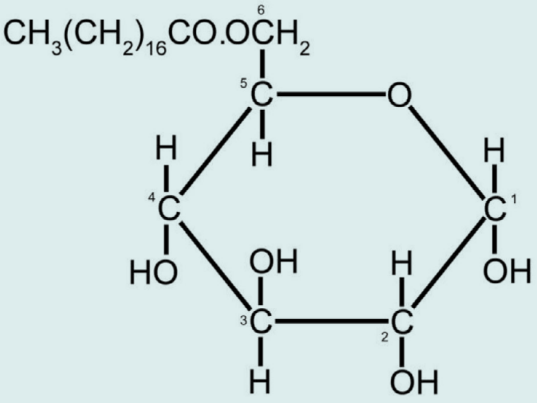
Fig. 4.4 shows stearic acid and a glucose molecule.



stearic acid **glucose**

Fig. 4.4

Using the formulae in **Fig. 4.4**, draw the structure of the ester formed.



[1]

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Mark scheme guidance

Question 4(b)(iii):

ALLOW phonetic spelling.

Question 4(c):

NOTE – care should be taken over correct alternative representations of ester link.

Examiner comments

Question 4(b)(iii) – It was surprising to see that candidates did not recall that glycogen is a polymer of glucose found in animals. Some incorrectly referred to starch (as outlined in the stem of this item) or to glucose.

Question 4(c) – The formation of the ester bond between stearic acid and a glucose molecule was poorly understood by the majority of candidates. The item was challenging but some were confused and redrew the stearic acid using the typical formation shown in textbooks and online, without reference to glucose.

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Question 5(a)(i)

5 Hydroponics is a method of cultivating plants. It uses a liquid growing medium instead of soil.

The use of hydroponics makes it easier to:

- control levels of nutrients given to plants
- vary these levels to meet the requirements of different plant species, and at various times during their development.

(a) The nutrient requirements for tomato plants at two different stages of development are shown in **Table 5.1**.

Element	Recommended concentration in hydroponic medium (parts per million)	
	Newly-transplanted tomato plant seedlings	Older tomato plants (forming their fifth cluster of fruit)
Nitrogen	70.00	150.00
Phosphorus	50.00	50.00
Potassium	120.00	200.00
Calcium	150.00	150.00
Magnesium	40.00	50.00
Iron	2.80	2.80
Copper	0.20	0.20
Manganese	0.80	0.80

Table 5.1

(i) In what form is nitrogen available to plants?

nitrate ...**[1]**

Mark scheme guidance

ALLOW NO_3^-

Examiner comments

Most candidates did not appreciate that nitrogen is available to plants as nitrate. There appeared to be some confusion, since some candidates referred to the route of availability such as the soil, air or as a liquid or gas.

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Questions 5(a)(ii),(iii),(iv) and (v)

(ii) Give **two** uses of nitrogen in plants.

Put a tick (✓) next to the **two** correct answers.

component of glucose	
component of DNA	✓
component of cellulose cell wall	
helps the transport of glucose	
helps the transport of water	
used in protein synthesis	✓

[2]

(iii) Compare the requirements for the different elements of newly-transplanted seedlings and plants forming their fifth cluster of tomatoes.

Use the information in **Table 5.1** in your answer.

- **increases** for nitrogen/potassium/magnesium
- **stays the same**/does not change for phosphorus,/calcium/iron/copper/ manganese

.....

.....

.....

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

(iv) Suggest which **two** elements are most important for the development of fruit clusters.

Justify your answer.

- nitrogen AND potassium
- requirement increases most/correct ref. to values (during fruit production)

.....

.....

.....

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

(v) Give **two** reasons why the element manganese is essential for plant growth.

1 .....

.....

2 .....

.....

*Any **two** from:*
- needed for photosynthesis
- photosynthesis is essential for plant growth
- involved in photosystem II/PSII/photolysis (of water)
- acts as a cofactor of various enzymes in (multiple steps) in the synthesis of fatty acids/acylglycerols/glycerides

[2]

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Mark scheme guidance

Question 5(a)(iii):

ALLOW 'trace elements' = iron, copper, and manganese.

Question 5(a)(iv):

ALLOW both increase by 80 ppm.

ALLOW answers relating to a correct, specific role during fruit development e.g. nitrogen for protein synthesis, cell growth/division or potassium for lycopene formation, transportation of sugars, flower number.

Question 5(a)(v):

Ignore answers related to deficiencies.

Allow oxygen production or photosynthetic electron transport = photosynthesis.

ALLOW water splitting = photolysis.

Examiner comments

Question 5(a)(ii) – Only some candidates appeared to understand that nitrogen is a component of DNA and is used in protein synthesis. No clear pattern of incorrect, alternative responses could be observed.

Question 5(a)(iii) – Many candidates successfully identified those elements showing an increase in 'fifth cluster' tomatoes and those elements with no change.

Question 5(a)(iv) – It was unfortunate that a number of candidates considered that calcium (along with nitrogen) were important for the development of fruit clusters. They had clearly focussed on the highest values, rather than those elements showing the greatest increase.

Question 5(a)(v) – Very few candidates were able to give two reasons why the element manganese is essential for plant growth. Reference to the role of manganese is provided in the exemplification section of the Unit 1 specification (LO 5.1). However, some were clearly aware that this element has some form of role in photosynthesis. This was a creditworthy response.

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Question 5(b)(i)

(b) A different method, aquaponics, involves the growth of plants in a liquid medium.

This technique utilises the waste water and organic matter from a fish farm.

The waste water provides an excellent source of nitrogen, and other elements, for growing plants.

Fig. 5.1 shows a typical aquaponics system.

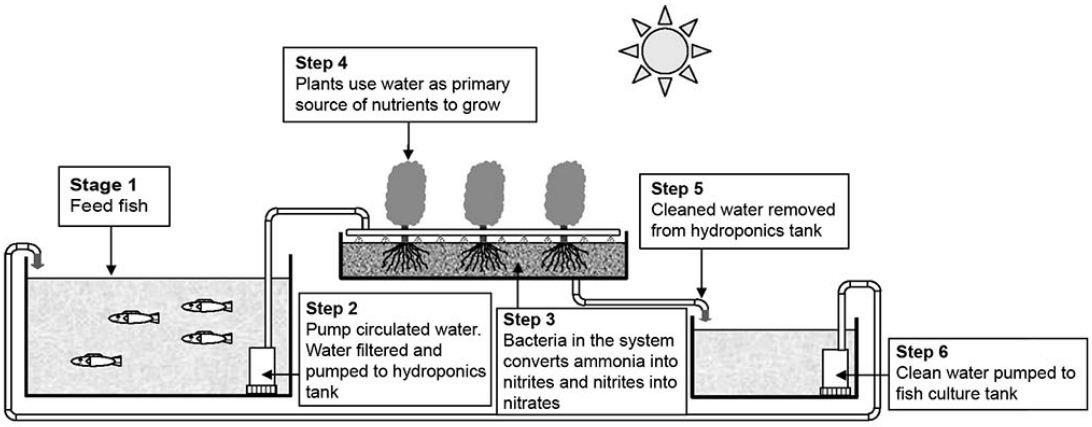

Fig. 5.1

(i) Ammonia produced by the fish is converted to nitrite, then nitrate, by bacteria in the aquaponics system.

The two reactions are shown below. The equations are unbalanced.

Balance the chemical equations.

$$\ldots NH_4^+ + \ldots O_2 \rightarrow \ldots NO_2^- + \ldots H_2O$$

$$\ldots NO_2^- + O_2 \rightarrow \ldots NO_3^-$$

$\mathbf{2}NH_4^+$	+	$\mathbf{4}O_2$	→	$\mathbf{2}NO_2^-$	+	$\mathbf{4}H_2O$	
$\mathbf{2}NO_2^-$	+	O_2	→	$\mathbf{2}NO_3^-$			

[2]

Mark scheme guidance

1 mark for each reaction correctly balanced.

Examiner comments

A number of candidates were able to balance the second chemical equation but struggled with the first in this item. No clear pattern of incorrect, alternative responses was observed.

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Question 5(b)(ii)

(ii) An aquaponics company is researching the use of waste matter from the Nile tilapia fish, *Oreochromis niloticus*, to grow lettuce plants.

The bar chart in **Fig. 5.2** shows the dry mass of the lettuce plants, harvested after 35 days.

The lettuce plants have been grown in the waste matter produced by rearing the fish at three different densities (kg of fish per m^2 of water).

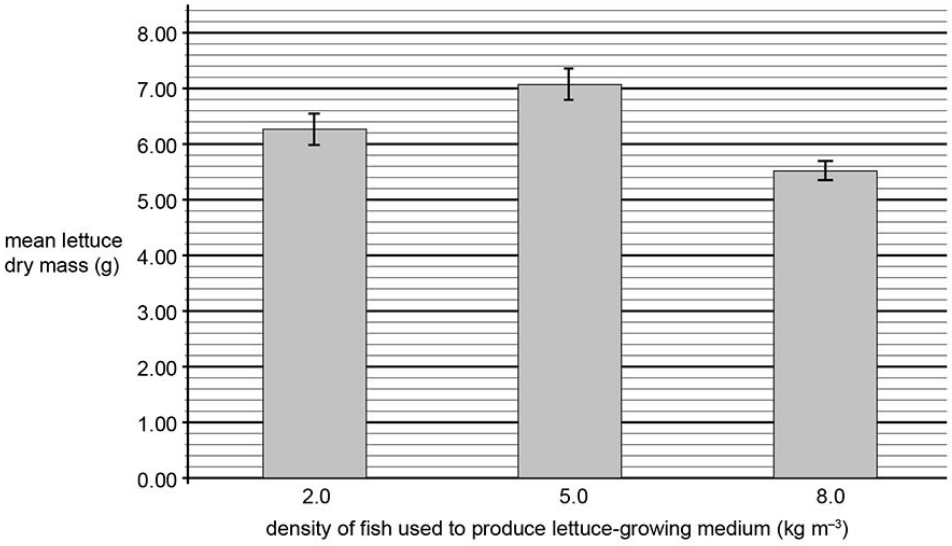

Fig. 5.2

Describe the effect of fish density on the growth of the lettuce plants.

*Any **one** from:*
- **greatest/highest** lettuce mass at 5 kg m^{-3}
- fish density from 2 to 5 kg m^{-3} **increases** lettuce growth/dry mass
- fish density from 5.0 to 8.0 kg m^{-3} **decreases** lettuce growth/dry mass.

*Any **one** from:*
- numerical description of 6.3 – 7.1 g
- numerical description of 7.1 – 5.65 g.

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

Mark scheme guidance

ALLOW one mark max. for direct reference to graph coordinates.

ALLOW mark for numerical description **ONLY** if linked correctly to the first marking point.

IGNORE references to limiting factors.

Examiner comments

A description of the effect of fish density on the growth of the lettuce plants was challenging for many. However, some candidates correctly referred to the overall pattern and included mention of the optimum (= best) performance at 5.0 kg m^{-3} and the underperformance at 8.0 kg m^{-3}. Others provided an unnecessary explanation, in addition to a description.

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Question 6(a)

6 **Fig. 6.1** shows a treadmill used by athletes to keep fit.

The athlete runs on a **moving belt** which is a composite made from layers of polymer materials.

The top layer of the belt is made from **polyurethane** and is in contact with the athlete's footwear.

The bottom layer of the belt is made from **polyester** fabric. It is in contact with steel rollers and an internal deck.

Both of the polymer materials, polyurethane and polyester, have very high wear resistance.

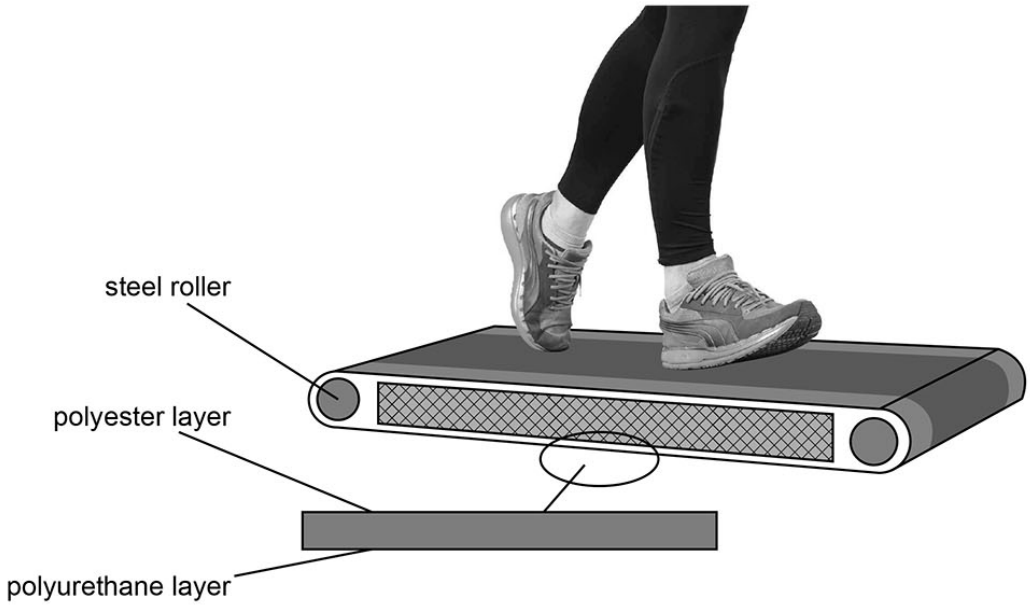

Fig. 6.1

(a) Suggest, **two other** similar and **two other** different properties of each polymer, polyurethane and polyester, that makes the composite material suitable for use as a treadmill belt.

Similar properties
*Any **two** from:*
- strength (tensile)
- elasticity
- flexibility
- chemical resistance
- durability/resistance to tearing/breaking.

Different properties
*Any **two** from:*
- friction/grip with sports shoe/slipping (on top surface)
- noise reduction (on bottom surface)
- water(sweat) resistant/no absorbency (on top surface)
- impact resistance (on top surface)
- discharge of static electricity (on top surface).

..... [4]

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Mark scheme guidance

IGNORE references to *wear resistance* (already in question stem).

IGNORE stretches.

IGNORE reference to static charge/electricity.

ALLOW reverse argument.

Examiner comments

Some candidates were capable of listing similar features of the two polymers, such as strength and flexibility. However, it was unfortunate that many repeated the feature of 'wear resistance' included within the stem of this item. The instruction for this item referred to 'two other' properties. Many candidates noted the special feature of the top surface (polyurethane) in relation to friction/grip. It was also interesting to see some correct references to the potential to discharge static electricity in the top surface. Reverse arguments were fully acceptable with reference to the different properties.

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Question 6(b)

(b) How can the arrangement of molecules in a polymer be changed to alter its mechanical properties?

Put a tick (✓) next to the **two** correct answers.

addition of metals	
addition of plasticizers	✓
cross-linking	✓
ploymerisation	
ionic bonding	
covalent bonding	

[2]

Examiner comments

This objective item provided six options for the selection of the two correct responses.

Some correctly selected cross-linking but very few considered that the addition of plasticizers would alter the mechanical properties of the polymers. 7(a) Responses to this question varied greatly. Candidates from some centres provided fully correct responses with clear calculations shown. Other candidates were very much challenged by this question and failed to identify potential difference, current or power.

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Question 7

7 **(a)** A charge of 0.04 C moves from point **A** to point **B** in a time of 0.02 s.
10 J of work is done in transferring this charge.

(i) Calculate the potential difference between point **A** and point **B**.
Show your working.

FIRST CHECK ANSWER ON ANSWER LINE
If answer = 250 (V) award 2 marks

(V =) E/Q **or** energy/charge **or** 10/0.04
250 (V)

potential difference = ...V
[2]

(ii) Calculate the current between point **A** and point **B**.
Show your working.

FIRST CHECK ANSWER ON ANSWER LINE
If answer = 2(A) award 2 marks

(I=) Q/t **or** charge ÷ time or 0.04/0.02
2 (A)

current = ... A
[2]

(iii) Calculate the power produced in moving the charge.
Show your working.

FIRST CHECK ANSWER ON ANSWER LINE
If answer = 500 (W) award 2 marks

(P=) VI or voltage × current or 250 × 2
500 (W)
OR
(P=) E/t or energy ÷ time **or** 10/0.02 (1)
500 (W)

power = ... W
[2]

Mark scheme guidance

ALLOW ecf for using voltage calculated in (a)(i).

ALLOW ecf for using current calculated in (a)(ii).

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Question 8

8 Three resistors, R_1 = 5.00 Ω, R_2 = 10.00 Ω and R_3 = 15.06 Ω are joined together in series and parallel arrangements to produce different combined resistances.

The combined resistances they produce are 11.00 Ω, 13.75 Ω and 18.30 Ω, respectively.

Describe the series and parallel arrangements of R_1, R_2 and R_3 that produce 11.0 Ω, 13.75 Ω and 18.3 Ω

11.0 Ω..... R_1 in series with R_2 and R_3 in parallel .....

13.75 Ω ... R_2 in series with R_1 and R_3 in parallel .....

18.3 Ω ..... Cannot be produced by any arrangement (of these 3 resistors) .....

[3]

Mark scheme guidance

ALLOW correctly drawn circuit diagrams.

ALLOW arrangement of the three resistors gives 18.39/18.4.

Examiner comments

Responses to this question varied greatly. Again, some centres included candidates achieving 2 or 3 marks whilst other candidates either failed to complete a response to the question or appeared to be very confused. Some candidates used the space below the question on page 25 to calculate their responses. This revealed that many candidates were struggling to determine the series and parallel arrangements of the three resistors.

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The small print

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