

Qualification accredited

Sample Assessment Material

A Level

Biology A

Cambridge OCR Level 3 Advanced GCE in Biology A

H420/03

Version 3.0

ocr.org.uk/alevelbiologya

Introduction

This is Sample Assessment Material (SAM). It is an example exam paper that we publish alongside a specification to help illustrate the intended style and structure of our question papers.

During the lifetime of the qualification, updates to the question paper template may happen. We always recommend you look at the most recent set of past papers where available.

We also produce two further specific resources to support you with using this SAM:

- An assessment story where we explain the research we have undertaken during the development of the qualification and how consultation with teachers, students and schools has helped shape our assessment approach.
- Annotated SAMs in which we take you through the key points of the assessment and highlight the different types of questions your students will experience in the exam.

Summary of updates		
Date	Version	Change
January 2019	2.0	Minor accessibility changes to the paper: i) Additional answer lines linked to Level of Response questions ii) One addition to the rubric clarifying the general rule that working should be shown for any calculation questions
July 2024	2.1	Removed watermark and updated copyright statement.
February 2026	3.0	Accessibility changes Updated the marking instructions Creation of Sample Assessment Material wrapper pages.



CAMBRIDGE OCR

A Level Biology A H420/03 Unified biology Sample Question Paper

Date – Morning/Afternoon

Version 3.0

Time allowed: 1 hour 30 minutes



You can use:

- a scientific or graphical calculator
- a ruler (cm/mm)



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name (s)

Last name

INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.

INFORMATION

- The total mark for this paper is **70**.
- The marks for each question are shown in brackets [].
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **24** pages.

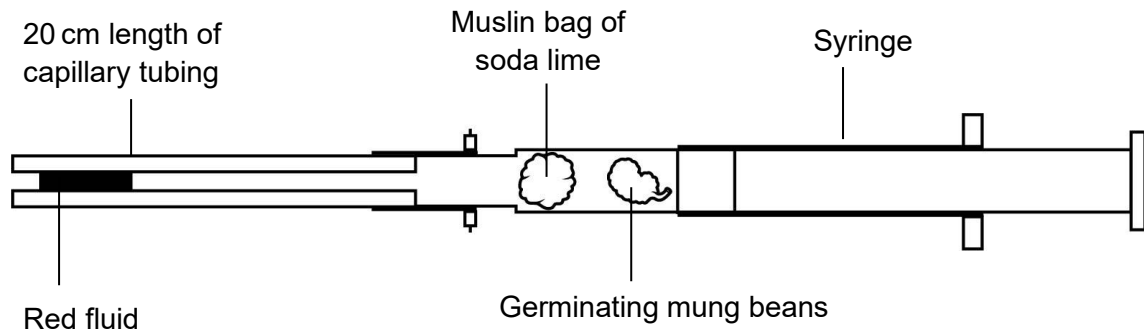
ADVICE

- Read each question carefully before you start your answer.

1 A group of students investigate the rate of respiration in germinating mung beans.

This is the method they use:

- Place a small muslin bag of soda lime into the syringe and then add five germinating mung beans, which are held in place with the syringe plunger.
- Measure the movement of the red fluid in the capillary tube.
- After each set of readings, reset the plunger to return the fluid to its original position.



The results are shown in the table.

Time (s)	Distance moved by the red fluid in capillary tube (mm)		
	1	2	3
0	0.0	0.0	0.0
30	11.5	12.0	12.5
60	22.5	21.5	17.5
90	31.0	32.0	32.5
120	41.5	42.0	42.5
150	53.0	54.0	53.5
180	63.0	63.0	64.0
210	72.5	71.0	71.5
240	78.5	79.5	79.0
270	87.5	88.5	87.0

(a) Give **one** limitation of using this method to investigate rate of respiration.

.....

..... [1]

- (b) Identify **one** variable that has not been controlled in this experiment **and** suggest an improvement to control that variable.

Variable

.....

Improvement

.....

[2]

- (c) Describe how you would add the red fluid to the capillary tube at the start of the experiment.

.....

..... [1]

- (d) The data shows an anomalous result at 60 seconds.

Explain why the result is considered to be anomalous **and** describe **one** correct way of dealing with this type of result.

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..... [2]

- (e) Calculate the mean rate of respiration for germinating mung beans between 90 and 150 seconds, using the data in the table.

Mean rate = [1]

- (f) (i) State what additional information is needed to calculate the volume of oxygen used by the mung beans.

..... [1]

- (ii) State what additional information is needed to calculate the oxygen needed for these mung beans to allow you to compare them with the oxygen needed by another type of bean.

..... [1]

2 Many different chemicals and microorganisms can harm plants and animals.

(a) Salts that a plant needs, such as nitrates and phosphates, are taken into root hair cells by active transport.

(i) State the name of a macromolecule that contains nitrogen **and** phosphorus.

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

(ii) Flooding of fields by seawater can damage crops. Seawater contains dissolved salts, including sodium chloride.

State how flooding by seawater would affect soil water potential.

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

(iii) Sodium chloride in solution breaks down into Na^+ and Cl^- .

Explain how the Casparian strip prevents these ions from reaching the xylem of the plant by the apoplast pathway.

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

(b) Herbicides work in a number of different ways.

(i) Some herbicides, known as phenoxy herbicides, mimic the action of auxin.

State the role of auxin in plant cells.

..... [1]

(ii) The herbicide atrazine works by disabling plastoquinone, one of the proton pumps in photosystem 2.

Explain why a plant exposed to atrazine would die.

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..... [4]

(c) Plague is a disease caused by the bacterium *Yersinia pestis* and effects animals.

(i) *Y. pestis* is a rod-shaped cell that is approximately 3µm long.

Y. pestis is viewed using a light microscope with a magnification of ×1250.

Calculate the length of the *Y. pestis* cell in the image produced by this microscope in mm.

Length = mm [2]

(ii) Images obtained by the light microscope could be further enlarged using a projector.

Suggest why the enlarged image might **not** give any additional information about the structure of *Y. pestis*.

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

(iii) Outbreaks of plague still sometimes occur. Plague is transmitted by several methods including droplet infection, close contact between people and fleas moving between infected rats and people.

Suggest **two** ways to minimise the spread of an outbreak of plague.

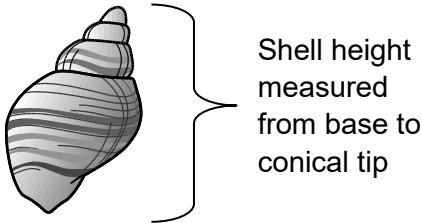
.....
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.....
.....
..... [2]

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DO NOT WRITE ON THIS PAGE
Turn over for the next question

3 Students investigate the effect of wave action on the height of the shells of the dog whelk, *Nucella lapillus*, by comparing an exposed shore and a sheltered shore.

- The students use a random sampling technique to collect 50 shells from an exposed shore.
- The shell height is measured from the base to the conical tip. The whelk is returned to its original location.
- The process is repeated for the sheltered shore.



The table shows the students' results.

Location	Height of shell (mm)										Range	Mean	Standard deviation
Sheltered shore	26	28	27	26	28	23	28	23	26	28	16	31.3	4.1
	29	29	29	29	29	28	29	29	29	29			
	30	31	30	29	32	29	30	29	30	32			
	33	35	34	32	35	32	34	32	33	35			
	37	39	38	37	39	35	38	36	37	39			
Exposed shore	15	17	16	15	23	15	23	16	13	15	15	20.0	4.2
	17	24	18	17	17	14	17	18	16	17			
	19	19	20	24	18	20	19	20	18	20			
	23	14	24	14	21	20	23	17	21	23			
	25	25	28	26	25	27	25	28	25	27			

- (a) The Student's *t*-test can be used to determine the significance of the differences between shell height on the exposed shore and the sheltered shore.
- (i) Calculate the *t* value for the data using the formula:

$$t = \frac{|\bar{X}_A - \bar{X}_B|}{\sqrt{\frac{S^2_A}{n_A} + \frac{S^2_B}{n_B}}}$$

where,

$|\bar{X}_A - \bar{X}_B|$ is the difference in mean values of sample 1 and sample 2

S^2_A and S^2_B are the squares of the standard deviations of the samples

n_A and n_B are the sample sizes.

Give your answer to 2 decimal places.

$t = \dots\dots\dots$ [3]

- (ii) The null hypothesis is that there is no difference between the means of the shell heights in the two populations.

The critical values at 98 degrees of freedom are shown in the table.

Degrees of freedom	$p = 0.10$	$p = 0.05$	$p = 0.01$	$p = 0.001$
98	1.67	2.00	2.64	3.41

Explain whether the student would be able to accept or reject the null hypothesis as a result of the t value you calculated in part (i).

.....

.....

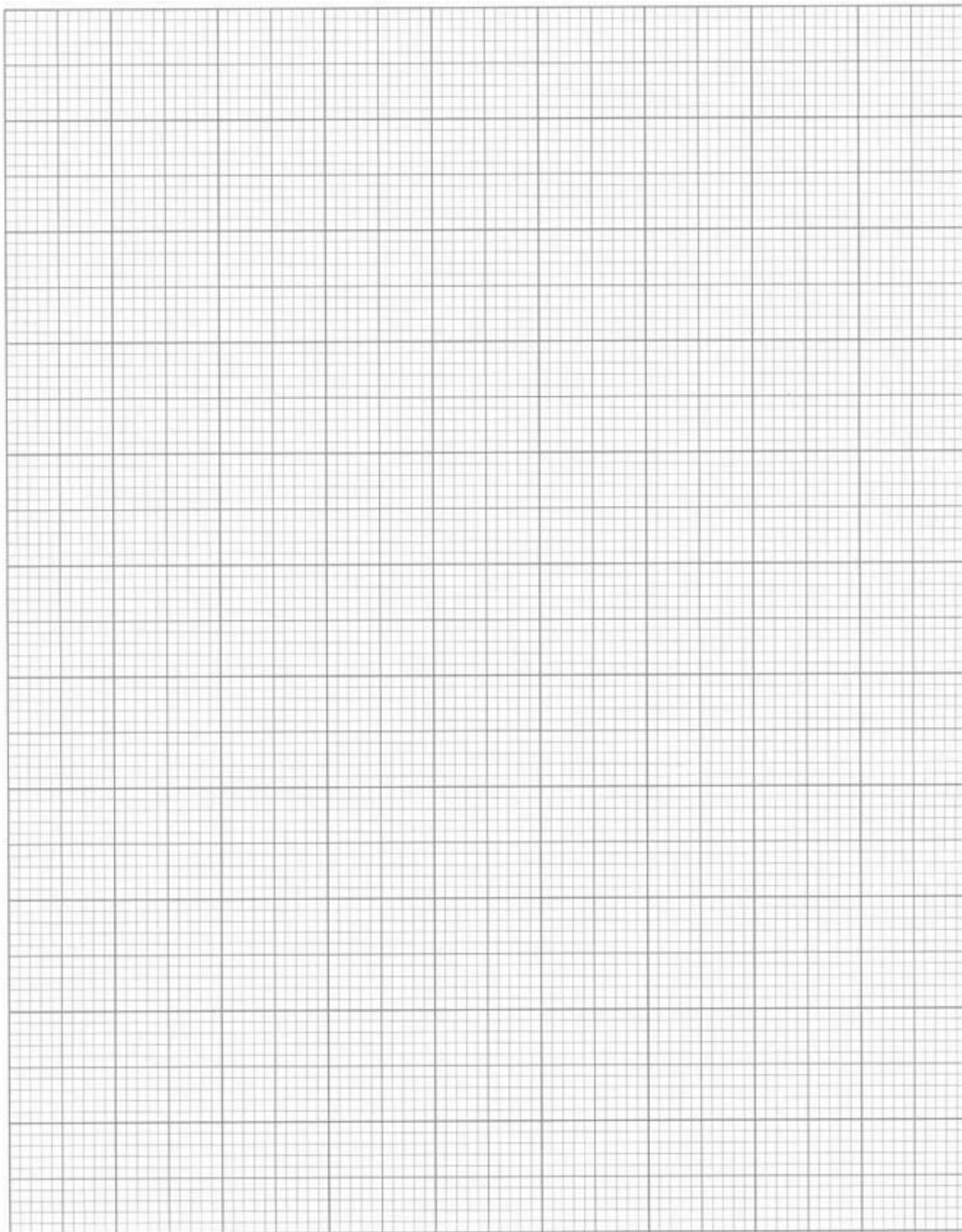
..... [1]

- (b) The students organise their data into classes.

The organised data is shown in the table.

Sheltered shore			Exposed shore		
Height (mm)	Tally	Total	Height (mm)	Tally	Total
23–26	III	5	11–14	IIII	4
27–30	IIII IIII II	22	15–18	IIII II	7
31–34	IIII IIII I	11	19–22	IIII IIII II	12
35–38	IIII IIII	9	23–26	IIII IIII II	12
39–42	III	3	27–30	IIII	4

Plot the most suitable graph of the data given in the table.



[4]

4 Botulism is a condition resulting from the action of botulinum toxin. The main symptom of botulism is skeletal muscle weakness, which can be fatal.

(a) Botulinum toxin is produced by the anaerobic bacterium *Clostridium botulinum*.

(i) State why *C. botulinum* is described as anaerobic.

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

(ii) Botulinum toxin is initially produced as a large single polypeptide that has low toxicity. After the toxin has been acted on by a protease, two chains are produced. The two chains remain connected by a disulfide bond. In this form the toxin is far more toxic.

Describe the action of the protease when it acts on the toxin.

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

(b) An experiment with mice was used to determine the median lethal dose of the toxin.

99 mice were used in the experiment.

(i) Suggest what is meant by the term **median lethal dose**.

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

(ii) The median lethal dose of the toxin ranges from 5 – 50 μgkg^{-1} body mass, depending on the toxin type and the method of introduction into the body.

Calculate the probable lethal dose of the **least toxic** botulinum toxin for an individual with a body mass of 85kg.

Give your answer in μg .

Dose = μg [2]

- (iii) The botulinum toxin acts at the cholinergic nerve terminals of motor neurones. Part of the toxin molecule binds irreversibly to receptors on the presynaptic membrane of motor neurones.

The toxin–receptor complex is then taken into the cytoplasm of the neurone and the disulfide bond in the toxin is broken. A section of the toxin molecule is released. The section of the molecule acts to block the release of the neurotransmitter.

Explain why botulism can be fatal.

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..... [2]

5 Termites are highly social insects. They are thought to have evolved from earlier forms of insect at least 150 million years ago. Termites are related to cockroaches.

(a)

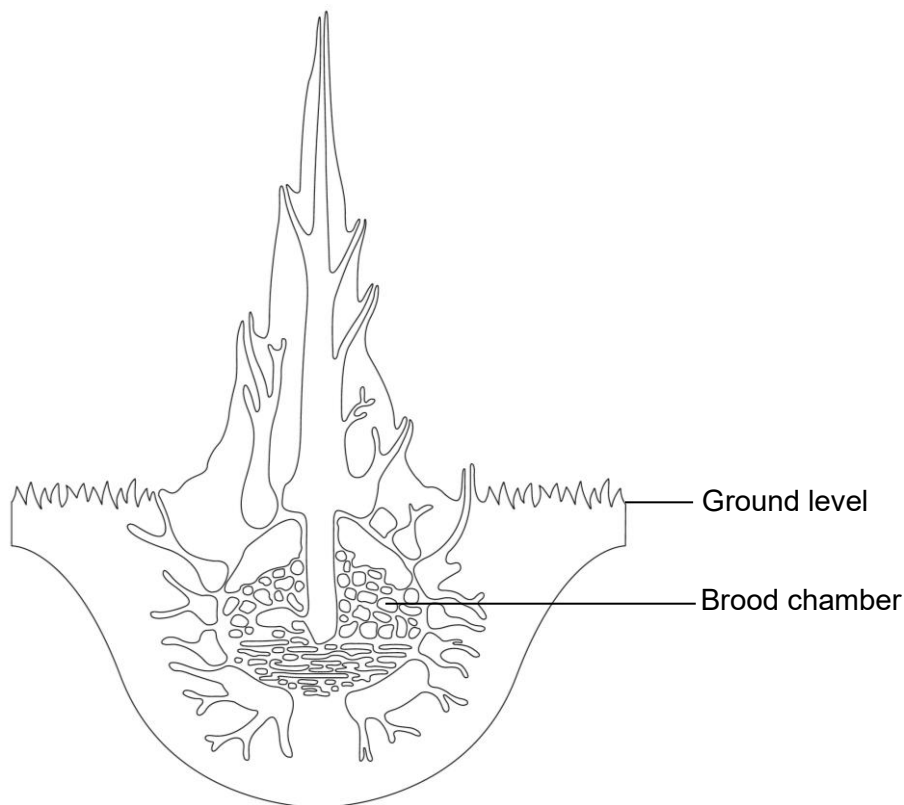
(i) Suggest how scientists working more than a century ago could have estimated when termites evolved.

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

(ii) State what new source of evidence would help scientists today to estimate how closely related termites are to cockroaches.

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

- (ii) In Africa, closer to the equator, the mounds built by some species of termite are blade-shaped, with the long axis pointing North–South.



Suggest why the African termites need to build mounds in this shape and orientation.

.....

.....

.....

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..... [2]

- (c) Most termites eat only dead vegetable material, so their main food source is cellulose. Cellulose is a polymer.

State the name of the monomer in cellulose.

..... [1]

(d) Some scientists categorise termites as keystone species.

Suggest **one** reason for termites being categorised as keystone species **and one** reason for them not being categorised as keystone species.

.....

.....

.....

.....

..... [2]

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

A large area of lined paper for writing answers. It features a vertical margin line on the left side and horizontal dotted lines for writing. The lines are evenly spaced and extend across the width of the page.

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

A large area of the page is filled with horizontal dotted lines for writing. A solid vertical line runs down the left side of this area, creating a margin. The dotted lines are spaced evenly and extend across the width of the page.

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

The page contains a large rectangular area filled with horizontal dotted lines. A solid vertical line runs down the left side of this area, creating a margin. This area is intended for students to write their answers to questions, with the question numbers to be written in the margin.

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

A large rectangular area with a solid vertical line on the left side and horizontal dotted lines extending across the page, providing space for writing answers.



CAMBRIDGE
OCR

Sample Assessment Material

A Level Biology A

H420/03 Unified biology

SAMPLE MARK SCHEME

MAXIMUM MARK 70

Duration: 1 hour 30 minutes

Version – 3.0
Last updated: February 2026

This document consists of 21 pages

MARKING INSTRUCTIONS

Preparation For Marking

1. RM Assessor

- Access and complete the on-screen marking training packages: OCR Examiner Training (RMA3).
- Read the mark scheme and question paper for this component or unit.
- The mark scheme and question paper are available in RM Assessor or on your Component Page if you use the Training Platform for standardisation.
- Log in to RM Assessor and mark the **required number** of practice scripts and the **required number** of standardisation scripts.

Marking

2. General Guidance

- Mark strictly to the mark scheme.
- Marks awarded must relate directly to the marking criteria.
- If you are in any doubt about applying the mark scheme, consult your Team Leader by phone, email or via the RM Assessor messaging system.
- It is **essential** that you meet the RM Assessor 50% and 100% batch deadlines. For traditional marking this will be 40% and 100%. If you experience problems, contact your Team Leader without delay.
- Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, then add the annotation '**SEEN**' to confirm that the work has been seen and mark any responses using the annotations.
- The RM Assessor **comments box** is used by your Team Leader to explain the marking of the practice responses. Use these comments when checking your practice responses. **Do not use the comments box for any other reason.**
- **Before the end of the marking period send a *brief report on the performance of candidates to your Team Leader via email. The report should contain notes on strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.***

3. No Response and Crossed-out Answers

Using the No Response (NR) option. Only mark as NR if:

- the answer space is blank
- there is only a comment not related to the question (e.g., 'can't do', 'don't know')
- there is only a mark (e.g., a dash, a question mark) which is not an attempt at the question.

Note: Enter 0 marks for an attempt that earns no credit (including copying out the question). Do **not** use NR.

Crossed-out answers

If a candidate has crossed out an answer and written a clear alternative, do **not** mark the crossed-out answer.

If a candidate has crossed out an answer and **not** written a clear alternative, mark the crossed-out answer if it is readable.

4. Responses with more answers than needed

• **Multiple-choice question answers**

When a multiple-choice question has only **one** correct answer and a candidate has written two or more answers (even if one of these answers is correct), do **not** award a mark.

When a multiple-choice question asks candidates to select **more than** one option the marking guidance from your Principal Examiner will ensure consistency of approach.

• **Contradictory answers in points-based questions**

Do **not** award any marks, even if one of the answers is correct.

• **Rubric error answers – optional questions**

Where candidates have a choice of question/s and they provide more answers than required, all responses are marked and entered into RM Assessor. The highest mark allowable within the rubric will automatically be selected.

- **Questions that ask for a set number (including 1) of short answers or points**

Mark only the **first set number** of answers/points. (e.g. **two** reasons for something)

First mark the answers/points against printed numbers on the answer lines. Mark the first answer/point against each printed number. **Second**, if candidates have not followed the printed numbers, mark the answers/points from left to right on each line. **Third**, mark line by line until the set number of answers/points have been marked. Do **not** mark any remaining answers/points.

Examiners should use their own judgement to decide if a 'second answer' on the same line is adding more detail to the first answer, or if it is a completely separate answer.

- **Short Answer Questions (requiring a more developed response, worth two or more marks)**

If the candidates are required to provide a description of, for example, three items and four items are provided, mark line by line until the set number of descriptions have been marked (it is unlikely a candidate will provide more than one response on each line in this scenario).

- **Longer Answer Questions (requiring a developed response)**

If a candidate has written two or more answers to a question that only requires one (developed) answer, only mark the first answer (which has not been crossed out).

5. Questions using levels of response (LOR):

Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.

Once the level is located, award the higher or lower mark:

The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.

The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.
















In summary:

The skills and science content determines the level.

The communication statement determines the mark within a level.

Level of response questions on this paper are **1(g)** and **4(c)**

6. Annotations available in RM Assessor

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
	Benefit of doubt given
	Contradiction
	Rounding error
	Error in number of significant figures
	Error carried forward
	Level 1
	Level 2
	Level 3
	Benefit of doubt not given
	Noted but no credit given
	Ignore
	Blank page

7. Abbreviations, annotations and conventions used in the mark scheme (including subject-specific conventions).

Abbreviation / Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
()	Words which are not essential to gain credit
<u>—</u>	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

8. Subject-specific Marking Instructions

Introduction

Your first task is to familiarise yourself with:

- the specification, especially the assessment objectives
- the question paper and any inserts or resource booklets
- the mark scheme, including annotation requirements
- the administrative procedures related to the marking process.

The administrative procedures are set out in the OCR booklet **Instructions for Examiners**.

If you are examining for the first time, please read **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

All relevant training materials are accessed from the Training Platform.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

Question		Answer	Marks	Guidance
1	(a)	<p><i>idea that</i> the oxygen will leak from the connectors so reduce the gas movement ✓</p> <p>oxygen uptake may not be a good representation of respiration rate in germinating seedlings ✓</p> <p>a small volume of gas is being measured in the capillary ✓</p> <p>measurements only taken every 30 seconds ✓</p> <p>difficult to read the meniscus (may be subjective) ✓</p>	<p>max 1</p>	<p>ALLOW seal not air tight so will not prevent gas escaping during the experiment or <i>the idea</i> that gas leakage is a problem and needs to be prevented.</p> <p>ALLOW the respiratory substrate stored in the seed will affect the oxygen needed or the idea that if photosynthesis has begun oxygen uptake will be disrupted.</p> <p>ALLOW need to record the maximum volume of gas taken up during the experiment</p> <p>ALLOW alternative wording e.g. 'more frequent readings are needed'.</p>

Question	Answer	Marks	Guidance
(b)	<p><i>Variable</i> the mass of the seeds is not given ✓ <i>Improvement</i> take the mass of the seedlings at the start ✓</p> <p><i>Variable</i> the volume / mass of soda lime is not specified ✓ <i>Improvement</i> use a known mass/volume of soda lime each time ✓</p> <p><i>Variable</i> the size of the syringe is not given ✓ <i>Improvement</i> use a 2 cm³ syringe ✓</p> <p><i>Variable</i> the capillary tube internal diameter is not given ✓ <i>Improvement</i> use a capillary tube of length 20 cm and a 1 mm internal diameter ✓</p> <p><i>Variable</i> temperature not controlled ✓ <i>Improvement</i> allowing apparatus to, stabilise / equilibrate to temperature, before taking readings ✓</p> <p>AVP ✓</p>	<p>max 2</p>	<p>The improvement must be linked to the variable.</p> <p>ALLOW suggested mass values.</p> <p>ALLOW suggested mass/volume values.</p> <p>ALLOW alternative size if suitable for the activity.</p> <p>ALLOW <i>idea that</i> only a linear measurement is obtained not a volume. ALLOW alternative size if suitable for the activity.</p> <p>ALLOW use of a water bath and thermometer to stabilise the temperature.</p> <p>Must be explicit to provide valid data e.g. no scale on the capillary tube, no timing, no details of how to take the readings. Details must be workable and suitable to provide valid results e.g. scale on the capillary tube, use of timing devices, description of how to take readings from the scale etc.</p>

Question		Answer	Marks	Guidance
	(c)	dipped into a small beaker and allowed to run ✓	1	ALLOW suitable details of how the red fluid is added.
	(d)	<p><i>Explanation, one mark</i> it is more than 10% from the mean ✓</p> <p>it is different from the other data at 60 seconds ✓</p> <p>it does not follow trend for the times for replicate 3 ✓</p> <p><i>Action, one mark</i> anomaly should be identified and excluded from processing ✓</p> <p>anomaly must be identified but could be included in calculations ✓</p> <p>repetition to obtain another reading ✓</p>	max 2	<p>ALLOW 'it is out of line'</p> <p>ALLOW anomaly can be excluded if this is due to an error or different conditions</p> <p>ALLOW anomaly can be included if there is no evidence that this is due to an error or different conditions</p>
	(e)	<p>Mean for 90s = $(31 + 32 + 32.5)/3 = 31.83\dots$</p> <p>Mean for 150s = $(53 + 54 + 53.5) / 3 = 53.5$</p> <p>$53.5 - 31.83 = 21.67 / 60s$</p> <p>$0.36 \text{ mm s}^{-1}$ ✓</p>	1	Rate and units required for the mark.
	(f) (i)	the internal diameter of the capillary tube ✓	1	
	(ii)	the mass of the bean seeds ✓	1	

Question	Answer	Marks	Guidance
(g)*	<p>Level 3 (5–6 marks) Describes a clear and detailed experiment that has been effectively adapted for use with chosen invertebrate to allow for the comparison of the rate of respiration with that of mung beans. Includes detailed statements on expected results and conclusions.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3–4 marks) Describes an experiment to compare the rate of respiration of chosen invertebrate with mung beans but there is insufficient detail of the procedure to allow a valid comparison. Includes statements on expected results and conclusions.</p> <p>OR Describes a clear and detailed experiment that has been effectively adapted for use with chosen invertebrate to allow for the comparison of the rate of respiration with that of mung beans. There are no statements outlining expected results or conclusions.</p> <p><i>There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.</i></p> <p>Level 1 (1–2 marks) An attempt to describe an experiment to investigate the respiratory rate of an invertebrate but little comparison with mung beans. If results or</p>	6	<p>Indicative scientific points may include (but not limited to):</p> <p>Experiment</p> <ul style="list-style-type: none"> • mass of invertebrate and mass of beans the same • safe and ethical use of invertebrates e.g. add screen so that animal(s) cannot touch the muslin bag • bigger syringe needed (5 – 10 cm³) • keep temperature constant / same for both assays • keep light constant / same for both assays • use same mass of soda lime in both assays • measuring distance moved by coloured, red liquid (fluid) at regular time intervals • repeat experiments. <p>Results and conclusions</p> <ul style="list-style-type: none"> • invertebrates rate of respiration is expected to be higher than the rate of respiration of the beans <i>because</i> • invertebrates are moving around • metabolic processes require energy / generate heat.

		<p>conclusion suggested, likely to be muddled or inaccurate.</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 marks No response or no response worthy of credit.</p>		
		Total	15	

Question			Answer	Marks	Guidance
2	(a)	(i)	DNA / RNA / nucleic acid ✓	1	ALLOW deoxyribonucleic acid / ribonucleic acid
		(ii)	lower / reduce / make more negative ✓	1	
		(iii)	1 strip is impervious to, water / solutions ✓ 2 forces water / solutions, to pass through, <u>plasma</u> / <u>cell surface</u> , membrane ✓ 3 phospholipid (bilayer), repels / AW, ions / charged particles ✓	max 2	1 IGNORE ref to suberin 3 The idea of charge / ion impermeability is wanted here. ALLOW answer in terms of ions / charged particles needing channels because phospholipid bilayer does not allow charged particles through
	(b)	(i)	FIRST CHECK ANSWER ON ANSWER LINE If answer = 3.75 (mm) award 2 marks 3µm × 1250 = 3750 µm ✓ 3750 / 1000 = 3.75 ✓	2	ALLOW 3,750 µm or 0.375 cm for one mark. ALLOW 1 mark for correct working e.g. 3 × 1250
		(ii)	(with light microscope) no further resolution (at ×1250) ✓	1	IGNORE ref to further detail, as implied in question ALLOW ref to resolution not the same as magnification
		(iii)	stay indoors / increase ventilation / wear masks ✓ measures to, exclude / not attract / kill, rats/fleas ✓ strict / immediate quarantine for persons with symptoms ✓	max 2	ALLOW (longer term) measures to reduce overcrowding
	(c)	(i)	(stimulates) cell, elongation / division ✓	1	IGNORE ref to action outside the cell, or to unqualified “growth” etc.

Question		Answer	Marks	Guidance
	(ii)	<p>1 reduced / no, proton pumping / proton motive force / chemiosmosis ✓</p> <p>2 <u>photophosphorylation</u> stops ✓</p> <p>3 less / no, ATP produced ✓</p> <p>4 less / no, reduced NADP produced ✓</p> <p>5 no, Calvin cycle / carbon fixation / light independent stage ✓</p> <p>6 no, TP / (hexose) sugars, made ✓</p> <p>7 no respiratory substrate / respiration ceases ✓</p>	<p>max 4</p>	<p>3 ALLOW cessation of vital process that needs ATP IF ATP mentioned but IGNORE respiration (as credited in mp 7).</p>
		Total	14	

Question			Answer	Marks	Guidance
3	(a)	(i)	<p>FIRST CHECK ANSWER ON ANSWER LINE If answer = 13.61 award 3 marks</p> $\frac{[31.3 - 20.0]}{50} = 11.3 \checkmark$ $\frac{4.1^2}{50} + \frac{4.2^2}{50} = \frac{16.81}{50} + \frac{17.64}{50} = 0.3362 + 0.3528 = 0.689 \checkmark$ $= 11.3 / \sqrt{0.689}$ $= 11.3 / 0.830 = 13.61 \checkmark$	3	<p>If answer is not in 2 decimal places award 2 marks</p> <p>ALLOW correct working for 1 mark</p>
		(ii)	<p>calculated <i>t</i> value is greater than the critical value at 0.05 and the null hypothesis can be rejected \checkmark</p>	1	<p>ALLOW 0.01 or 0.001 instead of 0.05</p> <p>ECF from answer to (a)(i)</p>
	(b)		<p>histogram correctly plotted for the values \checkmark</p> <p>two sets of data distinguished by a key or other suitable method to identify them \checkmark</p> <p>x axis labelled 'height (mm)' and y axis labelled 'number of dog whelks / <i>Nucella lapillus</i> / shells / class' \checkmark</p> <p>makes good use of the graph paper and both axes are correctly scaled with ascending equidistant intervals \checkmark</p>	4	<p>DO NOT ALLOW a bar chart or a line graph as neither would represent the data correctly</p> <p>ALLOW a frequency polygon</p> <p>ALLOW '% of the sample' or 'Frequency density' for the y axis if this has been calculated</p>

Question	Answer	Marks	Guidance
(c)	<p>positive correlation (between the height of the whelk shell and the type of the shore) ✓</p> <p>(histogram / data, indicates that) shore exposure has an impact on height ✓</p> <p><i>Nucella</i> show adaptation to harsher wave action ✓</p> <p>shells measured may not all be exposed to wave action ✓</p>	max 3	<p>ALLOW correlation is strong or a reference to relationship such as: taller shell height and sheltered shore or shorter shell height and exposed shore</p> <p>ALLOW little overlap on the histogram bars</p> <p>ALLOW the idea that the differences may be due to direct wave action or adaptation</p>
(d)	<p>Limitation: no detail for the random sampling technique was given / <i>Nucella</i> from the whole population may not have been sampled ✓</p> <p>Improvement: use (two) metre tapes to set out a grid and use randomly generated coordinates ✓</p> <p>Limitation: no measuring instrument specified ✓</p> <p>Improvement: use vernier callipers with a precision of more than 0.5 mm ✓</p> <p>Limitation: incorrect identification of <i>Nucella</i> / several types of shelled molluscs that are similar to <i>Nucella</i> ✓</p> <p>Improvement: use a seashore key to correctly identify the whelk ✓</p> <p>Limitation: classification of the shore as sheltered or exposed was subjective ✓</p> <p>Improvement: use an approved shore classification (such as Ballantine's) ✓</p>	max 2	<p>The improvement mark should be awarded only when linked to the correct limitation</p>

	(e)	<p>increase the number of, <i>Nucella</i> used in the data collection / samples ✓</p> <p>replicate / repeat, the entire experiment again and calculate the mean ✓</p>	max 1	<p>ALLOW a value given such as increasing number to 100 from each shore</p> <p>ALLOW an understanding of the <i>idea</i> that the procedure has only been carried out once for each shore</p>
	(f)	<p><i>not valid:</i></p> <p>a small percentage of <i>Nucella</i> sampled from each area ✓</p> <p>some areas not sampled at all which would lead to skewed data ✓</p> <p>age of <i>Nucella</i> sampled was not considered ✓</p> <p>genetic variations or sub species not taken into account ✓</p> <p><i>valid:</i></p> <p>random sampling techniques mean no bias in collection ✓</p> <p>100 <i>Nucella</i> sampled in total (50 in each area) so large sample size ✓</p> <p>precise instructions for consistent measurement of shell height ✓</p>	max 3	<p>ALLOW reverse arguments made</p> <p><i>idea that</i> conclusion will be distorted</p>
Total			17	

Question			Answer	Marks	Guidance
4	(a)	(i)	it (only) respire in the absence of oxygen ✓	1	Must imply that the absence of oxygen is the preferred/essential condition e.g. 'can respire in the absence of oxygen' does not really imply this, as this statement also applies to aerobic organisms
		(ii)	it <u>hydrolyses</u> a peptide bond between two amino acids (residues) which are joined by a disulfide bond ✓	1	
	(b)	(i)	amount that is required to kill the 50 th mouse when they are arranged in order of lethal dose ✓	1	
		(ii)	FIRST CHECK ANSWER ON ANSWER LINE If answer = 4.25 (µg) award 2 marks 50 x 85 = 4250 ✓ 425 / 1000 = 4.25 µg ✓	2	ALLOW 1 mark for correct working using, least lethal dose is 50 ng kg ⁻¹
		(iii)	intercostal muscles are / diaphragm muscle is, weakened / paralysed ✓ <i>idea that</i> ventilation and oxygenation of blood is, reduced / compromised ✓ cells / (named) organ(s), cannot, obtain oxygen for respiration/ carry out aerobic respiration ✓	max 2	

Question	Answer	Marks	Guidance
(c)*	<p>Level 3 (5–6 marks) A full explanation of why strains are immunologically distinct AND a description of more than one method of action of the immune system.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3–4 marks) A full explanation of why strains are immunologically distinct AND an attempt to describe a method of action of the immune system.</p> <p>OR A description of more than one method of action of the immune system AND an attempt to explain why strains are immunologically distinct.</p> <p><i>There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.</i></p> <p>Level 1 (1–2 marks) An attempt to explain why strains are immunologically distinct AND an attempt to describe a method of action of the immune system.</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 marks No response or no response worthy of credit.</p>	6	<p>Indicative scientific points may include (but are not limited to):</p> <p>Immunologically distinct</p> <ul style="list-style-type: none"> • toxins produced by each strain will be (slightly) different • each (botulinum) toxin will have different 3D shape / amino acid sequence / DNA nucleotide coding sequence • toxin acts as / is antigen • immune response determined by shape of antigen • different compounds will have different shapes <p>Immune system</p> <ul style="list-style-type: none"> • antigen presenting cells ingest antigen and display antigen on their surfaces • interaction between APCs and T-helper cells causes production of interleukins • B cells activated by T-helper cells • clonal selection and clonal expansion • B cells differentiate into plasma cells • plasma cells produce antibodies / immunoglobulins • by protein synthesis antibodies bind to and neutralise toxins.
	Total	13	

Question			Answer	Marks	Guidance
5	(a)	(i)	fossils in, known-age / 150 years old, strata / rocks ✓	1	
		(ii)	DNA / cytochrome c ✓	1	
	(b)	(i)	carbon dioxide diffuses down concentration gradient out of the respiring cell ✓ carried through body from cell (to tracheoles) by haemolymph ✓ passing out via tracheoles / trachea / spiracles ✓ <u>respiration</u> generates heat ✓ hot gases expand and are less dense so rise up by <u>convection</u> through the mound to vents at mound-top ✓	4	
	(b)	(ii)	<i>shape</i> , large or increased surface area to volume ratio ✓ smallest area exposed to greatest heat ✓	2	Response must be linked to context of avoiding overheating / needing to get rid of heat.
	(c)		β / beta glucose ✓	1	
	(d)		<i>reason for</i> important, (N or C) recyclers / saprotrophs ✓ <i>reason against</i> not a predator ✓ or large in abundance/ biomass (so effect on environment not disproportionate) ✓	2	
Total				11	

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