CAMBRIDGE
International Education

Cambridge International AS & A Level

BIOLOGY **9700/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2025**

MARK SCHEME

Maximum Mark: 30

Published

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	‘List rule’ guidance For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

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6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	correct point or mark awarded
	correct awarding one mark from marking point or marking group 1. similar numbered ticks are used for marking point or marking groups 2, 3, 4 etc.
	incorrect point or mark not awarded
	working towards marking point
	information missing or insufficient for credit
	used to highlight part of an extended response
	used to highlight part of an extended response
	allow or accept
	benefit of the doubt given

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Annotation	Meaning
BP	blank page
CON	contradiction in response, mark not awarded
ECF	error carried forward applied
PAG	marking point already given
I	incorrect or insufficient point ignored while marking the rest of the response
IRRL	irrelevant material that does not answer the question
NBOD	benefit of doubt was considered, but the response was decided to not be sufficiently close for benefit of doubt to be applied
MR	maximum mark reached
O	or reverse argument
R	incorrect point or mark not awarded
SEEN	point has been noted, but no credit has been given or blank page seen

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Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
A	accept (for answers correctly cued by the question, or by extra guidance)
R	reject
I	ignore
( )	the word / phrase in brackets is not required, but sets the context
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
AVP	alternative valid point

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Question	Answer	Marks
1(a)(i)	*any **one** from:* 1 calibrate colorimeter **;** 2 use, a blank / AW, to set (colorimeter absorbance) to zero **;**	**1**
1(a)(ii)	1 *rate of change in absorbance at pH 2.0* **=** $0.0036 / 3.6 \times 10^{-3}$ **;** 2 *working:* (0.52–0.23) / (120–40) **or** 0.29 / 80 **;** 3 *units:* au s^{-1} **;**	**3**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(b)(i)</td><td>
any seven from:

1 prepare (at least) five solutions with stated pH values between pH 0 and 6.5 ;

2 same / stated, volume / concentration, of pepsin (solution) used ;

3 method to maintain a, constant / stated, temperature ;

4 equilibrate / AW, all (pepsin, pH / buffer / albumen) solutions separately (before mixing) ;

5 method to mix, pepsin and pH (buffer) albumen (solutions, before adding to colorimeter) ;

6 at each pH, measure / note / record / AW, absorbance at, set / stated, time intervals ;

7 use at least three replicates for each pH and calculate a mean rate (of change in absorbance / of protein hydrolysis, for each pH) ;

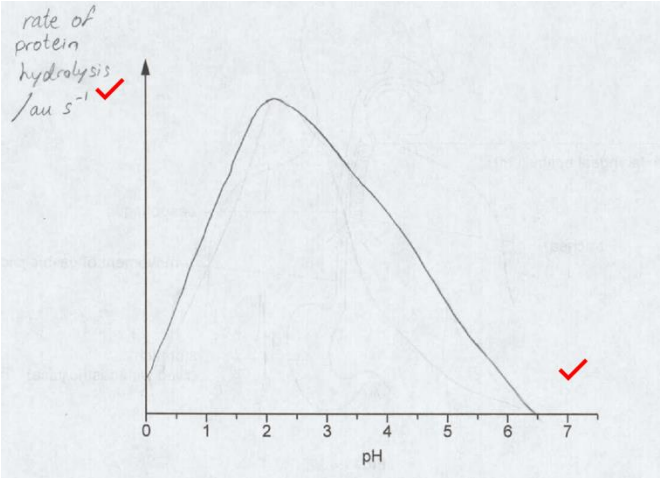
8 method to identify the optimum pH ;

9 idea that repeat experiment with smaller pH intervals around the optimum pH ;

10 safety comment with named hazard and risk and precaution ;

<table>
<tr><th>hazard</th><th>risk</th><th>precaution</th></tr>
<tr><td>albumen / eggs</td><td>allergy / irritant</td><td>gloves / goggles / mask / PPE</td></tr>
<tr><td>pH buffer</td><td>irritant / corrosive (at pH 0, 1, 2)</td><td>gloves / goggles / mask / PPE</td></tr>
<tr><td>pepsin</td><td>allergy / irritant</td><td>gloves / goggles / mask / PPE</td></tr>
</table>
</td><td>7</td></tr>
</table>

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Question	Answer	Marks
1(b)(ii)	1 correct *y*-axis label **;** e.g. rate of protein hydrolysis / au s^{-1} 2 appropriately shaped line **;** 	**2**

Question	Answer	Marks
1(c)(i)	*any **two** from:* 1 test condition **2**, decreases / hydrolyses / AW, CA3 and Sep70 **;** 2 *idea that* acid / pH 4.0, with no active pepsin, does not change CA3 and Sep70 **;** 3 (mass / size / AW of) CA3 is smaller than Sep70 **; ora**	**2**
1(c)(ii)	*any **two** from:* 1 *idea that* pepsin only causes damage (to the laryngeal epithelium) if (hydrochloric) acid / pH 4.0, is also present **;** 2 investigation, only carried out once / was not repeated **;** 3 *idea that* no information on species of mammal used (in investigation) **or** *idea that* investigation, not carried out in a person / carried out in a laboratory **;** 4 *idea that* a reduction in quantity of Sep70 and CA3 may not cause damage to the laryngeal epithelium **;**	**2**

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Question	Answer	Marks
2(a)(i)	number of insect attraction events (in 6 hours) **;**	**1**
2(a)(ii)	*any **two** from:* 1 size / length / AW (of model / body / legs) **;** 2 shape / AW (of model) **;** 3 material / AW (of models) **;** 4 thickness / weight / mass / density / AW (of models) **;** 5 yellow, colour / shade / tone / pigment / AW (of models) **;** 6 light, absorption / reflection / AW (of models) 7 size of spots (on model **A** and **B**) **;** 8 (models are) odourless / AW **;**	**2**
2(a)(iii)	(measure insect attraction rate of) web with no model **;**	**1**

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Question	Answer	Marks
2(b)(i)	*any **four** from:* *effect of colour and pattern:* 1 *idea that* yellow colour (models **A**, **C** and **D**), have high insect attraction rates **;** 2 *idea that* pattern (of spots) is less important than colour (for attracting insects) **; ora** *using information from Fig. 2.2:* 3 *idea that*, (standard) error bars for yellow (colour, models **A**, **C**, **D**) and not yellow (colour, models **B**, **E**), do not overlap, (therefore insect attraction rate may be) significantly different **;** 4 *idea that*, (standard) error bars for models **A**, **C**, and **D** overlap, (therefore insect attraction rate) is not significantly different (for yellow models with different patterns) **;** **or** *idea that*, (standard) error bars for models **B**, and **E** overlap, therefore insect attraction rate is not significantly different (for black models with no yellow colour) **;** 5 data quote, with units, to support **;**	**4**
2(b)(ii)	there is no difference between, the (mean) insect attraction rates, of the models **;**	**1**
2(b)(iii)	*any **two** from:* 1 data is continuous **;** 2 comparing (two) means **;** 3 fewer than 30 values **;** 4 data is (from populations that are) normally distributed **;**	**2**

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Question	Answer	Marks
2(c)	*any **two** from:* 1 do investigation in, more than one, forest / geographical area / AW **;** 2 *idea of* do investigation, at different times of the day / AW **;** 3 do investigation in, more than one, month / season / year **;** 4 *idea that* only count insects that touch the, model / web **;** 5 use (more) models with different, colours / patterns **or** use 3–dimensional model (instead of, flat / 2–dimensional, model) **;** 6 *idea of* (video) living spider on web **;**	**2**

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Question	Answer	Marks
1(a)	*any **two** from:* 1 mass of (mung bean) seedlings **;** 2 age / variety / type / cultivar (of mung bean) seedlings **;** 3 grinding time (using pestle and mortar) ; 4 speed of centrifuge / time in centrifuge **;**	**2**
1(b)(i)	*explanation* *idea of* the temperature (of, solutions / reactants) will not have reached 30 ºC / AW **or** the rate of (enzyme)reaction, will change / not be constant / AW **or** reaction will start before reaching 30 ºC / AW **;** *modification* equilibrate / AW, phosphatase/enzyme/extract **and** PPP/substrate, separately **or** equilibrate / AW , phosphatase / enzyme / extract **and** PPP / substrate before mixing **;**	**2**
1(b)(ii)	(sodium carbonate solution) denatures, the enzyme / phosphatase **;**	**1**

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<table>
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<tr><td>1(c)</td><td>1 five stated concentrations between 2 % and 0 % and units, % / percentage ;

2 correct method for dilution shown for two intermediates ;

<table>
<tr><th rowspan="2">concentrations %</th><th>2 % stock /
phenolphthalein / cm^3</th><th rowspan="2">distilled water / cm^3</th></tr>
<tr></tr>
<tr><td>2.0</td><td>50</td><td>0</td></tr>
<tr><td>1.6</td><td>40</td><td>10</td></tr>
<tr><td>1.5</td><td>37.5</td><td>12.5</td></tr>
<tr><td>1.2</td><td>30</td><td>20</td></tr>
<tr><td>1.0</td><td>25</td><td>25</td></tr>
<tr><td>0.8</td><td>20</td><td>30</td></tr>
<tr><td>0.5</td><td>12.5</td><td>37.5</td></tr>
<tr><td>0.4</td><td>10</td><td>40</td></tr>
<tr><td>0.25</td><td>6.25</td><td>43.75</td></tr>
<tr><td>0.0</td><td>0</td><td>50</td></tr>
</table>
</td><td>2</td></tr>
<tr><td>1(d)</td><td>1 absorbance / AW, for the dilutions and extract / reaction mixture ;

2 use the calibration, curve / graph (to determine phenolphthalein / extract concentration) ;</td><td>2</td></tr>
</table>

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Question	Answer	Marks
1(e)	*any **six** from:* 1 prepare five solutions with stated pH values up to pH 7 **;** 2 equilibrate / AW, PPP / substrate, and, phosphatase / enzyme / extract, and buffer solutions, separately / before mixing **;** 3 mix buffered, PPP / substrate, with, extract / enzyme solution **;** 4 calibrate colorimeter **or** use a blank / AW, to, set colorimeter (absorbance) to zero / reset colorimeter **;** 5 at each pH, stop the reaction / AW after a set time and, measure / note / record, absorbance **;** 6 suitable method to identify the optimum pH **;** 7 repeat experiment with smaller pH intervals around, the optimum pH / values with the highest absorbance / concentration (of phenolphthalein) **;** 8 repeat experiment at least twice and calculate the mean (absorbance), for each pH / their means **;** 9 named hazard and risk and precaution **;**	**6**

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<table>
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<tr><td>1(e)</td><td>
<table>
<tr><th>hazard</th><th>risk</th><th>precaution</th></tr>
<tr><td>phosphatase enzyme / mung bean / extract</td><td rowspan="4">allergy / irritant</td><td rowspan="4">gloves / eye protection / PPE</td></tr>
<tr><td>phenolphthalein phosphate (PPP)</td></tr>
<tr><td>sodium carbonate</td></tr>
<tr><td></td></tr>
<tr><td>pH buffer</td><td>irritant pH 3–7
or
corrosive below pH 4</td><td>gloves / eye protection / PPE</td></tr>
<tr><td rowspan="2">phenolphthalein</td><td>toxic / irritant / allergy</td><td>gloves / eye protection / PPE</td></tr>
<tr><td>flammable</td><td>keep away from naked flame</td></tr>
</table>
</td><td></td></tr>
<tr><td>1(f)(i)</td><td>point 6 on top line is circled ;

higher than, the V_{max} / 0.018 (mmol dm^{-3} s^{-1}) / the plateau ;</td><td>2</td></tr>
<tr><td>1(f)(ii)</td><td>(K_m with no inhibitor) 0.075
and
(K_m with inhibitor) 0.43 / 0.425
and
mmol dm^{-3} ;</td><td>1</td></tr>
<tr><td>1(f)(iii)</td><td>1 working
difference divided by K_m with no inhibitor (×100)

(0.425 – 0.075) / 0.075 (×100) ;

2 correct answer from working in mp1 ;</td><td>2</td></tr>
</table>

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Question	Answer	Marks
2(a)	*any **two** from:* 1 (same) time of the year **or** (same) seasons **or** (same) months **;** 2 (same) depth of, water / sea / sponge / (sea)bed / water pressure **;** 3 (same) orientation of transect **;**	**2**
2(b)	23 or 24 **;** correct working **;**	**2**
2(c)(i)	1 any use of correct data to qualify a statement **;** *supporting the conclusion 'human activity equals lower diversity'* 2 station **A** has highest, index / diversity **or** station **G** / thermal power station, has lowest index **or** natural habitat / **A**, **B**, **L**, have a higher, index / diversity **;** *not supporting the conclusion 'human activity does not equal lower diversity'* 3 housing / **D** and **A**, have a similar index **or** **D /** housing, has a higher index / (diversity) value than, **B** / **L** **or** **J** and **K** which have the same human activity have different, beta diversity indices / diversity **or** *idea that* the measure of diversity used just counts number of species and not number of individuals **or** did not, use / calculate, Simpson's diversity index **;**	**3**

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Question	Answer	Marks
2(c)(ii)	*answer must be in terms of the diversity of the sponges not diversity index (data) or beta diversity* **A** 'it' for 'species diversity' **I** biodiversity 1 correct index data quoted to support conclusion about species diversity **;** *any **two** from mp2–6:* *diversity in different locations in the bay:* 2 *idea that* (stations **A**, **B**, **L**) closest to open ocean / at the edges of the bay, have higher diversity **or** *idea that* (stations **E**, **F**, **G**, **H**, **I**, **J**) furthest from open ocean / within the bay, have lower diversity **or** in the (Algeciras) Bay the diversity is lower than the marine habitat / **ora ;** *diversity in industrial areas: (**E**,**G**, **H**, **I**)* 3 *idea that overall* industries / industrial activity, results in lower diversity **;** *diversity in tourist areas (**C**, **F**, **J**, **K**)* 4 *idea that tourism* results in varied impact (on diversity) and qualified with suitable examples **;** 5 other (stated) factor affects diversity illustrated with a suitable station **;** 6 impact of, housing / **D**, on diversity is, similar to natural habitats / less than other stations with human activity **;**	**3**

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Science-Specific Marking Principles

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Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

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Annotations

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	correct point or mark awarded
	correct awarding one mark from marking point or marking group 1. similar numbered ticks are used for marking point or marking groups 2, 3, 4 etc.
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	information missing or insufficient for credit
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	used to highlight part of an extended response
	allow or accept
	benefit of the doubt given

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Annotation	Meaning
BP	blank page
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MR	maximum mark reached
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;	separates marking points
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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)(i)</td><td>hazard and risk and precaution ;

<table>
<tr><th>hazard</th><th>risk</th><th>precaution</th></tr>
<tr><td>chemical / anaesthetic</td><td>toxic / allergy / irritant</td><td>use, gloves / goggles / mask / PPE / use fume cupboard</td></tr>
<tr><td>Drosophila / fruit flies</td><td>allergy /
(spread of) pathogens / biohazard</td><td>use gloves / goggles / mask / PPE</td></tr>
<tr><td>agar jelly / specimen tube, containing food</td><td>allergy / biohazard / pathogens</td><td>use gloves / goggles / mask / PPE / aseptic technique</td></tr>
</table></td><td>1</td></tr>
<tr><td>1(a)(ii)</td><td>any seven from:
1 (to produce heterozygotes)
(breed) brown-eyed /AAdd, females with, scarlet-eyed / aaDD, males
or
(breed) scarlet-eyed / aaDD, females with, brown-eyed / AAdd, males ;

2 method to maintain a, constant / stated, temperature ;

3 idea of remove parent (fruit flies) from their offspring, before they are adults / before day 10 / before eggs hatch ;

4 put (anaesthetised), double heterozygotes / offspring from first cross, into (new specimen) tube ;

5 (cross double heterozygotes to give) a large number of offspring ;

6 use, stated / same / recommended / correct, dose / volume / concentration, (of chemical / anaesthetic) ;

7 identify, phenotype / eye colour, using, microscope / magnifying glass / hand lens ;

8 count / record, the number of flies of each, phenotype / eye colour ;

9 idea of method to prevent double counting (of flies) ;</td><td>7</td></tr>
</table>

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Question	Answer	Marks
1(a)(iii)	9 : 3 : 3 : 1 **;** red : brown : scarlet : white **;**	**2**
1(b)	*any **three** from:* 1 critical value (at degrees of freedom = 3 and p = 0.05) is 7.815 **;** 2 calculated (χ^2) value / 4.798, is less than, critical value / 7.815 **;** 3 null hypothesis is accepted (at p = 0.05) **;** 4 there is no significant difference (at p = 0.05) **;**	**3**
2(a)	type of treatment (solution) **;**	**1**
2(b)	*any **two** from*: 1 volume of, treatment / EchAMP / bacitracin, solution **;** 2 concentration of, EchAMP / bacitracin, solution **;** 3 concentration / volume , of fluorescence (chemical) **;**	**2**
2(c)(i)	(to) compare (the effect of EchAMP and) no EchAMP on, bacterial / E. coli (population), growth **;**	**1**
2(c)(ii)	(to) compare (the effect of EchAMP to) bacitracin / antibiotic (on bacterial / E. coli (population), growth) **;**	**1**
2(d)(i)	1 axis labels with units on correct axes and completed key **;** 2 three correct data points plotted at 7 hours, with data points joined to the correct values at 6 hours **;**	**2**

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Question	Answer	Marks
2(d)(ii)	*any* ***two*** *from*: 1 bacitracin reduces (population growth of *E. coli*) more than EchAMP (after 6 hours / at 7 hours) **; ora** 2 no difference (in effect on *E. coli*) between 0 and 6 hours **;** 3 bacitracin and EchAMP reduce (population growth of *E. coli*) more than the negative control, after 3 hours / at 6 hours / at 7 hours **;**	**2**
2(e)(i)	there is no difference between the (mean) fluorescence (emitted by E. coli after seven hours when exposed to), the negative control and EchAMP **;**	**1**
2(e)(ii)	1 correct working **;** 2 *(t* =) 9.37 when rounded to 3 significant figures **;** 3 *(t* =) 9.370 **;** must be 4 significant figures	**3**
2(e)(iii)	*any* ***four*** *from*: 1 *idea that* experiment is, not carried out in a person / carried out in a laboratory **;** 2 *idea that* experiment, only used *E. coli* / did not use other bacteria **;** 3 EchAMP may kill beneficial bacteria (in the digestive system) **;** 4 EchAMP might not be as effective as other, treatments / antibiotics **;** 5 EchAMP could, cause side effects / be toxic / AW, in humans **or** experiment only carried out for 7 hours / no information about longer term effects **;** 6 EchAMP is a protein and would be digested (by enzymes in the digestive system) **;** 7 *idea that* the EchAMP did not kill all of the *E. coli* **;**	**4**

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CAMBRIDGE
International Education

Cambridge International AS & A Level

BIOLOGY **9700/54**

Paper 5 Planning, Analysis and Evaluation **May/June 2025**

MARK SCHEME

Maximum Mark: 30

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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Question	Answer	Marks
1(a)(i)	1 distilled / deionised / pure / AW, water (as diluent) **;** 2 (use) 0.264g ABA and (dissolve in) 1 dm^3 water **;**	**2**
1(a)(ii)	1 add, 10 cm^3 of, stock solution / 1×10^{-3} (mol dm^{-3} ABA), to 90 cm^3 (distilled) water (to make 1×10^{-4} mol dm^{-3} ABA) **;** 2 description, of one correct subsequent step of the serial dilution **;**	**2**
1(b)(i)	*independent variable:* concentration of ABA **;** *dependent variable:* number of grains germinated **or** length of shoot **;**	**2**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(b)(ii)</td><td>
any five from:

1 (use of a control for one group of 50 grains) replace the ABA solution with, distilled / deionised / pure / AW, water ;

2 ref. to (placing wheat grains in a container with) soil / paper / AW ;

3 carry out experiment in the dark ;

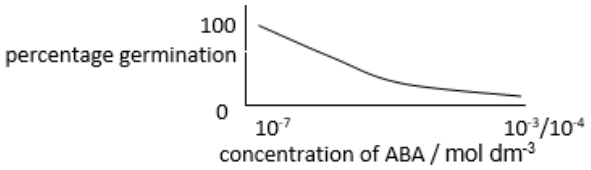
4 method to maintain a, constant / stated, temperature (for germination) ;

5 ref. to adding the, same / stated, volume / mass, of water (to container of wheat grains) ;

6 for each ABA concentration, count / record / AW, the <u>number</u> of (wheat) grains that have germinated, after a, same / stated, time
or
for each ABA concentration, measure / record / AW, the length of the shoot, after a, same / stated, time ;

7 safety comment with hazard and risk and precaution ;
<table>
<tr><th>hazard</th><th>risk</th><th>precaution</th></tr>
<tr><td>wheat grains</td><td>irritant / allergy</td><td>gloves / mask / PPE</td></tr>
<tr><td>ABA / GA</td><td>irritant / allergy / toxic</td><td>gloves / mask / PPE</td></tr>
<tr><td>soil</td><td>biohazard / pathogens / allergy / irritant</td><td>gloves / mask / PPE</td></tr>
</table>
</td><td>5</td></tr>
<tr><td>1(c)(i)</td><td><u>number</u> of germinated grains, divided by the, total number of grains, x 100 ;</td><td>1</td></tr>
</table>

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Question	Answer	Marks
1(c)(ii)	1 axes correctly orientated with labels and units **;** 2 correct values on *x*-axis **;** 3 line shows percentage germination decreases as ABA concentration increases **;**  	**3**
1(d)(i)	*any **two** from:* 1 *idea of* smaller standard error (SE) shows that (the mean is) more reliable **; ora** 2 *idea of* smaller SE shows that (calculated / sample) mean is closer to the, true / actual, mean **; ora** 3 suitable example from Table 1.1 **;** 4 correct *ref. to* overlap of SE from Table 1.1 **;** *for example:* *idea of*, SE for 1×10^{-7} ABA concentration **and** 1×10^{-6} ABA concentration do not overlap, (therefore mean shoot length may be) <u>significantly different</u> **or** *idea of*, SE for 1×10^{-6} ABA concentration and 1×10^{-4} ABA concentration overlap, (therefore mean shoot length) is <u>not significantly different</u>	**2**
1(d)(ii)	there is no difference, in the (mean) shoot length (of the seedlings grown from wheat grains with), no GA (treatment) and (1×10^{-5} mol dm^{-3}) GA (treatment) **;**	**1**

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Question	Answer	Marks
1(d)(iii)	1 use 38 degrees of freedom **;** 2 compare (calculated) *t*-value with, critical (*t*-) value at, (*p*) = 0.05 / 5% **;** 3 (if calculated) *t*-value is higher (than the critical *t*-value then) **and** reject null hypothesis / there is a significant difference **; ora**	**3**

Question	Answer	Marks
2(a)	*any **one** from:* 1 *idea that* (cold buffer) prevents, (mitochondrial) enzymes / proteins , denaturing **;** 2 *idea that* (cold temperature) prevents damage to mitochondria, by enzymes **;** 3 *idea that* (buffer) prevents (osmotic) lysis of mitochondria **;**	**1**
2(b)(i)	49.50 **;**	**1**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(b)(ii)</td><td>correct identification of anomalous results ;;
<table>
<tr><th></th><th colspan="5">rate of oxygen consumption</th></tr>
<tr><th></th><th>trial 1</th><th>trial 2</th><th>trail 3</th><th>trial 4</th><th>mean</th></tr>
<tr><td>mitochondria alone</td><td>0.03</td><td>0.02</td><td>0.03</td><td>0.01</td><td>0.02</td></tr>
<tr><td>succinate added</td><td>50.22</td><td>49.10</td><td>48.53</td><td>50.15</td><td>49.50</td></tr>
<tr><td>ADP and succinate added</td><td>139.23</td><td>170.10</td><td>142.67</td><td>138.10</td><td>147.53</td></tr>
<tr><td>ADP, succinate and cyanide added</td><td>0.00</td><td>0.10</td><td>0.00</td><td>0.01</td><td>0.03</td></tr>
</table></td><td>2</td></tr>
<tr><td>2(b)(iii)</td><td>1 do not include, anomalies and calculate (a more accurate) mean ;
2 calculate, standard deviation / standard error / 95% confidence limits (for each trial) ;</td><td>2</td></tr>
</table>

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Question	Answer	Marks
2(c)	*any **three** from:* 1 in mitochondria (alone): oxygen concentration does not change **or** do not use oxygen **or** rate of oxygen consumption is very low **;** 2 adding succinate (and no ADP) increases the rate of, aerobic respiration / Krebs cycle / oxidative phosphorylation **;** 3 adding succinate **and** ADP, gives a larger increase in the rate of, aerobic respiration / Krebs cycle / oxidative phosphorylation **;** 4 oxygen acts as the final electron acceptor (in aerobic respiration / oxidative phosphorylation) **;** 5 adding cyanide stops, (aerobic) respiration / oxidative phosphorylation **;**	**3**

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