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CAMBRIDGE
International Education

Cambridge International AS & A Level

BIOLOGY **9700/54**

Paper 5 Planning, Analysis and Evaluation **May/June 2026**

MARK SCHEME

Maximum Mark: 30

Published

This mark scheme contains the instructions and marking guidance that our examiners used to mark candidate responses for this component.

Before they start marking, examiners complete a standardisation process. They review a range of candidate responses and discuss the mark scheme in detail to agree which answers can and cannot be accepted. Examiners award marks where it is clear that candidate responses have met the requirements of the mark scheme. These requirements may vary between different components or different versions of the same component, depending on the exact requirements of the question and the candidate responses seen during the standardisation process.

Sometimes, our mark schemes may allow marks to be awarded to responses which contain elements that are factually incorrect or for content not covered by the syllabus. We do this in response to the demands of a specific question to support candidates and make sure that our assessments are fair. However, these allowances should not be used as a guide for teaching and learning.

We cannot discuss the mark scheme with schools, and we recommend that schools read the mark scheme together with the assessment material and the Principal Examiner Report for Teachers.

This document consists of **18** printed pages.

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General marking principles

All examiners must apply these marking principles when marking candidate responses.

1	Examiners must award marks for each response in line with: • the specific **content** defined in the mark scheme • the specific **skills** defined in the mark scheme or in the level descriptions • the **standard of response** required as exemplified by the standardisation scripts.
2	Examiners must award **whole marks** (not half marks, or other fractions).
3	Examiners must award marks **positively**. This means that: • marks are not deducted for errors or omissions • marks are awarded for correct/valid answers as defined in the mark scheme and also for **other valid answers** which go beyond the scope of the syllabus and mark scheme referring to your team leader as appropriate • the quality of spelling, punctuation and grammar are judged **only** when the mark scheme indicates that these features are **specifically assessed** in the question. However, the meaning of all responses must be unambiguous.
4	Examiners must **consistently** apply the requirements of the mark scheme and any rules for what to do when candidates have not followed instructions correctly.
5	Examiners must use the **full range of marks** defined in the mark scheme, unless limited by the quality of the candidate responses seen.
6	Examiners must award marks according to the mark scheme and **must not** award marks with grade thresholds or grade descriptions in mind.

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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	<u>'List rule' guidance</u> 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
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	Guidance
1(a)	*pigment 1:* carotene **;** *pigment 2:* chlorophyll a **;**	**2**	
1(b)(i)	*any **eight** from:* *collect leaves from stinging nettles growing in direct sunlight and in the shade:* 1 <u>method</u> to select <u>plants</u> growing in direct sunlight **and** in the shade, using, random / systematic, sampling **or** <u>method</u> to grow <u>plants</u> in direct sunlight **and** in the shade **;** 2 collect / cut / AW, <u>leaves</u> (from plants growing) in direct sunlight **and** in the shade **;**	**8**	**allow** standardised / controlled / fixed / constant as AW for same **ignore** known **allow:** direct sunlight = high light intensity shade = low light intensity **ignore** no light / dark as AW for shade 1 should be 2 or more different plants **allow** sample plants at, coordinates / grid / quadrats, chosen using a random number generator **allow** sample plants at a fixed / set distance along a, line / transect **R** throwing quadrats **ignore** quadrants **allow** lab-based method to grow plants in different light intensities (e.g. lamp at different distances) **ignore** ref to controlled variables **ignore** ref to time (for growth) but **R** if less than 24 hours 2 **allow** if leaves are from (different parts) of same plant (in different light intensities)

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Question	Answer	Marks	Guidance
1(b)(i)	3 select leaves from, same / stated, position / part / AW, of plant **;**		3 **A** apical leaf / same height from ground **ignore** same species / type / variety **ignore** size / number / age / colour, of leaves
	use chromatography to separate the chloroplast pigments present in the leaves: 4 apparatus to grind leaves (to prepare leaf extract)		4 **A** use pestle and mortar / blender / suitable description **ignore** cutting (leaves) **ignore** (use of) solvent / water **ignore** filtering / centrifuge **A** roll coin across leaf (onto paper / TLC plate)
	5 use pencil (and ruler) to draw, origin / line / AW (on paper / TLC plate) **;**		5 **R** pen / ink *needs to be a method*
	6 method to add a concentrated spot of leaf extract (to paper / TLC plate) **;**		6 **A** use, capillary tube / melting point tube / pipette / glass rod / AW, to add leaf extract **and** repeat / reapply (to same position)
	7 use, same / stated, solvent (for chromatography) **or** use, same type of (chromatography) paper / TLC plate **;**		7 **ignore** solvent used for extraction **allow** any named organic solvent **R** water and **ecf** **ignore** concentration / volume
	8 add (chromatography) paper / (TLC) plate (with spot of leaf extract), to a beaker / AW, of solvent **and** ensure solvent is below the, origin / line / AW **;**		8 **A** from diagram **allow** chromatogram as AW for paper / TLC plate

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Question	Answer	Marks	Guidance
1(b)(i)	9 remove, chromatogram / AW, from beaker / solvent, when solvent front is close to top (of paper / TLC plate) **or** after, set / stated, time **;** 10 (use pencil to) mark position of solvent front (before the solvent evaporates) **;** *collect the data needed to identify each chloroplast pigment:* 11 use a, ruler / AW, to, measure / note / record / AW, distance (from origin) to solvent front **and** distance (from origin) to, (each) spot / pigment / AW **;** 12 *idea of* measure to the, centre / AW, of (each) spot of pigment **;** 13 note / record / AW, colour of <u>each</u> spot of pigment;		9 **allow** paper / (TLC) plate as AW for chromatogram **allow** solvent / front as AW for solvent front **ignore** time if stated 10 **A** take photo of chromatogram 11 **ignore** calculate R_f / R_f formula unqualified **ignore** *ref. to* repeats

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>1(b)(ii)</td><td>hazard and risk and precaution ;
<table>
<tr><th>hazard</th><th>risk</th><th>precaution</th></tr>
<tr><td>environment / woodland / gardens / farmland / AW</td><td>getting lost / trip hazard / injury</td><td>(wear protective) shoes / clothes / PPE

stay, in a group / with expert / ranger
use GPS</td></tr>
<tr><td>animals</td><td>allergy / irritation / injury</td><td>(wear protective) shoes / clothing / PPE

stay, with expert / ranger</td></tr>
<tr><td>pollen / spores</td><td>allergy / irritation</td><td>mask / goggles / PPE
take, anti-histamines / hayfever medication</td></tr>
<tr><td>knife / scalpel / AW</td><td>cuts / injury (skin / hand / AW)</td><td>cut away from the hand
or
cut onto a, board / tile / AW</td></tr>
<tr><td>(named) solvent</td><td>flammable

fumes / vapour:
irritant / toxic
damage to,
lungs / AW</td><td>no naked flames

use fume cupboard / use well-ventilated room / keep containers covered / safety glasses / goggles / mask / PPE</td></tr>
</table></td><td>1</td><td>ignore low / medium / high, risk
R no risk
ignore harmful unqualified

ignore plants / stinging nettles / trichomes as hazard
ignore wearing gloves as a precaution

allow check yourself / immunise (as precaution against ticks)
allow epipen as precaution for allergies

NOTE: allow away from body
ignore cuts clothing / AW
ignore cutting leaves / plant unqualified for hazard

ignore water as hazard
ignore allergy / corrosive as risk for solvent</td></tr>
</table>

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Question	Answer	Marks	Guidance
2(a)	*first experiment:* rate of oxygen production **;** *second experiment:* time taken to change colour (from blue-green to green) / rate of DCPIP reduction **;**	**2**	**ignore** rate of photosynthesis **allow** volume / number of moles / AW, of oxygen produced, in a set time **ignore** rate of NADP reduction
2(b)	*any **one** from:* 1 mass / concentration, of *A. doliolum* (cells in suspension) **;** 2 concentration of enzyme **;** 3 time, in enzyme solution / for hydrolysis of cell walls **;** 4 concentration of DCPIP **;**	**1**	**ignore** light intensity / temperature **ignore** volume (of solutions) **ignore** ref to colour **ignore** pH **ignore** carbon dioxide **ignore** stirring **R** concentration of sodium chloride 1 **allow** *A. doliolum* / cells / *Anabaena* / prokaryote as AW for *A. doliolum* cells **ignore** size 3 **ignore** time unqualified **R** time taken to change colour
2(c)	*idea that* (enzyme partially hydrolysed the bacterial cell walls so): (more) DCPIP can, diffuse / enter, cells **or** diffusion / AW, of DCPIP (into cells) is, faster / AW **or** permeability of cell <u>wall</u> increases **;**	**1**	**ignore** *ref. to* sodium chloride / NaCl **ignore** *ref. to* NADP / H^+ **ignore** enter chloroplast **ignore** easier

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>2(d)</td><td>Table 2.1 completed with correct volumes ;
<table>
<tr><th>concentration of sodium chloride solution / moldm^{-3}</th><th>volume of stock solution of sodium chloride / cm^3</th><th>(volume) water ; (/ cm^3)</th></tr>
<tr><td>0.25</td><td>10</td><td>10</td></tr>
<tr><td>0.20</td><td>8</td><td>12</td></tr>
<tr><td>0.15</td><td>6</td><td>14</td></tr>
<tr><td>0.10</td><td>4</td><td>16</td></tr>
<tr><td>0.05</td><td>2</td><td>18</td></tr>
<tr><td>0.00</td><td>0</td><td>20</td></tr>
</table></td><td>2</td><td>ignore decimals

ignore working / $C_1V_1 = C_2V_2$</td></tr>
</table>

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Question	Answer	Marks	Guidance
2(e)	1 highest / AW, (mean rate of) oxygen production is at a lower sodium chloride concentration than the highest AW, (mean rate of) DCPIP reduction **;** **ora** 2 highest / AW, (mean rate of) oxygen production is at 0.10 mol dm^{-3} (sodium chloride) **and** highest / optimum / AW, (mean rate of) DCPIP reduction is at 0.20 mol dm^{-3} (sodium chloride) **;**	**2**	**ignore** rate of photosynthesis unqualified **ignore** first / second experiment **allow** NaC*l* as AW for sodium chloride **allow** peak / optimum / greatest / maximum as AW for highest **ignore** any comparison between y-axis values **ignore** y-axis data quotes **ignore** *ref. to* lines crossing **ignore** comparisons between gradients of lines (e.g. fast decrease / slight decrease) 2 need units for concentration at least once

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Question	Answer	Marks	Guidance
3(a)	*any **two** from:* 1 (infection / treatment with) GM *M. pingshaense,* reduces / AW, the (percentage of mosquitoes that) produce eggs **;** 2 error bars for control **and** GM (*M. pingshaense*) do not overlap, therefore (mean percentage of mosquitoes that produce eggs) is significantly different **;** 3 *conclusion for non-GM M. pingshaense:* error bars for non-GM (*M. pingshaense*) **and** control overlap, therefore (mean percentage of mosquitoes that produce eggs) (may be) not significantly different **or** error bars for non-GM (*M. pingshaense*) **and** GM (*M. pingshaense*) overlap, therefore (mean percentage of mosquitoes that produce eggs) (may be) not significantly different **or** large / AW, error bar for non-GM (*M. pingshaense*) shows that (calculated / sample) mean is (likely to be) further from the, true / actual, mean **or** *idea that* error bar, for non-GM (*M. pingshaense*) are, large / AW, **and** the mean is less reliable **;**	**2**	**allow** fungus as AW for *M. pingshaense* **allow** *A. coluzzii* / *Anopheles* as AW for mosquitoes **allow** uninfected *A. coluzzii* as AW for control 1 **ignore** *ref. to* non-GM *M. pingshaense* **ignore** kills mosquitoes 2 **allow** (95%) confidence intervals / CI / standard error bars as AW for error bars **ignore** standard deviation / SE / standard error unqualified **allow** significant, decrease / AW (implies a difference) **allow** may be significantly different **ignore** 'results are significant' 3 **allow** (95%) confidence intervals / CI / standard error bars as AW for error bars **ignore** standard deviation / SE / standard error unqualified **allow** is not significantly different **ignore** no significant decrease **ignore** insignificant **ignore** data / results / values as AW for mean **ignore** accurate / valid / precise

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3(b)(i)</td><td>idea of placing a, net / glasshouse / AW, over the experimental area ;</td><td>1</td><td>allow web / mesh
ignore (use) black fabric / curtain
ignore close doors / windows of hut
ignore insect repellent

R insecticide</td></tr>
<tr><td>3(b)(ii)</td><td>1. Table 3.2 completed and correct values of $(O–E)^2 / E$;

2. (χ^2 =) 2390 when rounded to 3 significant figures ;

3. (χ^2 =) 2390 ; must be to <u>3 significant figures</u>

<table>
<tr><th>repeat</th><th>O</th><th>E</th><th>O - E</th><th>(O – E) ²</th><th>$\frac{(O-E)^2}{E}$</th></tr>
<tr><td>1</td><td>13</td><td>1396</td><td>–1383</td><td>1912689</td><td>1370.1</td></tr>
<tr><td>2</td><td>61</td><td>731</td><td>–670</td><td>448900</td><td>614.1</td></tr>
<tr><td>3</td><td>12</td><td>429</td><td>–417</td><td>173889</td><td>405.3</td></tr>
<tr><td>total:</td><td></td><td></td><td></td><td></td><td>2390</td></tr>
</table>
</td><td>3</td><td>1. A as fractions / any decimal places

2. correct value of χ^2 to 3 or more sig figs use calculation guidance – give mp2 if their value of χ^2 rounds to 2390 (e.g. 2389.5, 2389.4, 2389)

2. and 3. allow ecf to max 2 from incorrect $(O–E)^2/E$</td></tr>
</table>

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Question	Answer	Marks	Guidance
3(b)(iii)	*critical value:* 5.991 (p = 0.05 and df = 2) **and** *explanation:* yes / student was correct / reject null hypothesis / difference is significant **and** calculated value / χ^2 / 2390, is greater than, critical value / 5.991 **; ora**	**1**	**allow** critical value from table (e.g. underlined / circled) **allow** 9.210 (p = 0.01 and df = 2) **allow ecf** if incorrect χ^2 must give correct statistics for **ecf**: e.g. calculated value, is less than 5.991 **and** null hypothesis is accepted / student is incorrect
3(c)	*supports the conclusion:* *using Table 3.1:* 1 (total) number of, *A. coluzzii* / mosquitoes is, lower / AW, with (GM) *M. pingshaense* **; ora** *using calculated value of χ^2:* 2 there is a <u>significant difference</u> **;**	**4**	**allow** fungus as AW for (GM) *M. pingshaense* **allow** *A. coluzzii* / *Anopheles* as AW for mosquitoes 1 **ignore** *ref. to* egg production / reproduction 2 **ignore** reject null hypothesis **A** significant decrease **R** correlation / relationship **A** less than, 5% / 0.05 / 1% / 0.01, probability that, difference is due to chance **A ora** greater than, 95% / 0.95 / 99% / 0.99, probability that difference is not due to chance **ecf** from incorrect χ^2 **A ecf** there is no <u>significant difference</u> (if calculated value of χ^2, is less than 5.991)

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Question	Answer	Marks	Guidance
3(c)	*further information needed (max 3):*		**ignore** repeat investigation unqualified **ignore** larger sample size **ignore** do a control **ignore** *ref. to* statistical test **ignore** do investigation in other areas / countries **ignore** *ref. to* cost
	3 carry out investigation in other years **;**		3 **ignore** longer time unqualified **ignore** carry out investigation in other seasons
	4 carry out investigation with other species of (*Anopheles*) mosquito **;**		4 **allow** other types / varieties / AW, of (*Anopheles*) mosquito
	5 *idea of* checking if, (GM) *M. pingshaense* could be, harmful / toxic / AW, to humans **;**		5 and 6 **ignore** (GM) *M. pingshaense* could be harmful unqualified
	6 *idea of* checking if (GM) *M. pingshaense* could be harmful / toxic / AW, to, livestock / ecosystems / biodiversity / (native) species / AW **;**		
	7 *idea of* checking if, *A. coluzzii* / mosquitoes, become resistant to GM *M. pingshaense* **;**		
	8 *idea of* checking how long (GM) *M. pingshaense* survives (on the black cotton fabric) **;**		8 **A** checking how often (GM) *M. pingshaense* should be applied (to the black cotton fabric)

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