

Cambridge International AS & A Level

MARINE SCIENCE**9693/41**

Paper 4 A Level Data-handling & Investigative Skills

October/November 2025

MARK SCHEME

Maximum Mark: 75

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 October/November 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

This document consists of **20** printed pages.

PUBLISHED**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.

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.

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.











Annotations guidance for centres






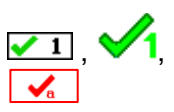



Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the 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
	incorrect point or mark not awarded
	information missing or insufficient for credit
	allow or accept
	incorrect or insufficient point ignored while marking the rest of the response
	contradiction in response, mark not awarded
	benefit of the doubt given
	error carried forward applied
	maximum mark reached
	point already given

Annotation	Meaning
	power of ten error
	incorrect point or mark not awarded
	rounding error
	point has been noted, but no credit has been given or blank page seen
	response is too vague or there is insufficient detail in response
	marking point 1 or marking point a is awarded. Used to mark against a particular marking point from an extended answer MS
	used to highlight parts of an answer / incorrect idea / irrelevant to question
	used to highlight parts of an extended response / incorrect idea / irrelevant to question
	key point attempted / working towards marking point / incomplete answer / response seen but not credited / blank page seen
ruler	allows lengths to be measured
multi-line overlay	overlays graphs
Highlighted text	Highlighting areas of text
On-page comment box	Allows comments to be entered on the page
Off-page comment box	Allows comments to be entered at the bottom of the RM Assessor marking window and then displayed when the associated question item is navigated to

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This mark scheme will use the following abbreviations:

;	separates marking points
/	alternative responses for the same marking point
R	reject the response
A	accept the response
I	ignore the response
ECF	error carried forward
AVP	any valid point / alternative valid point
ORA	or reverse argument
AW	alternative wording
underline	actual word given must be used by candidate (grammatical variants accepted)
dashed underline	the phrase underlined must be used by the candidate (similar wording accepted)
()	the word / phrase in brackets is not required but sets the context
MAX	indicates the maximum number of marks that can be given
+ AND	statements on both sides of the + or AND are needed for that mark
OR	separates two different routes to a mark point and only one should be awarded

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Question	Answer	Marks
1(a)	<i>any 3 of:</i> 1 act as a, substrate (for sessile organisms) / habitat ; 2 create food <u>webs</u> / food <u>chains</u> ; 3 more food availability / more niches / AW ; 4 shelter for fish / protection from predators / AW ; 5 nursery / breeding, grounds / AW ;	3

Question	Answer	Marks
1(b)(i)	<p> $1.40 - 0.67 = 0.73$; $0.73 / 0.67 - 100 = 108.958\dots$; 110(%) ;;; (3 marks) 108.958... (2 marks) A 1 mark for 0.73, 1.40–0.67, or division by 0.67 OR $1.40 - 0.67 = 0.73$; $0.73 / 1.40 - 100 = 52.14\dots(\%)$; 52(%) ;;; (3 marks) 0.5214... ;; (2 marks) A 1 mark for 0.73, 1.40–0.67, or division by 1.40 OR $0.73 / 1.035 \times 100 = 70.53\dots$; A 70(%) ;;; (3 marks) 70.53... ;; (2 marks) A 1 mark for 0.73, 1.40–0.67, or division by 1.035 </p>	3

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Question	Answer	Marks
1(b)(ii)	<p><i>any 3 of:</i></p> <p>1 higher in all (on ship compared with control) / ORA ;</p> <p>2 zinc has highest levels (compared with chromium and lead) / lead has lowest levels / AW ;</p> <p>3 chromium and lead are <u>significantly</u> higher / zinc is <u>not significantly</u> higher ;</p> <p>4 <i>correct ref</i> to s.d. overlaps ;</p> <p>5 credit correct manipulation of data ;</p> <p>6 chromium has, highest relative / percentage increase ;</p>	3
1(c)(i)	<p>increase / positive correlation / as lead increases in mussels, lead increases in consumers ;</p> <p>steep increase then levels off ;</p>	2
1(c)(ii)	answer between 0.64–0.65 ;	1

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Question	Answer	Marks
1(c)(iii)	<p><i>any 4 of:</i></p> <ol style="list-style-type: none">1 mussels / low trophic level organisms, absorb heavy metal ions / absorb chromium / absorb lead / absorb zinc / AW ;2 heavy metal ions are (often) toxic / AW ;3 (heavy metal ions) bioaccumulate in organisms ;4 (heavy metal ions) are not excreted / cannot be broken down / non-biodegradable ;5 (lead / chromium / heavy metal ions) passed onto consumers / AW ;6 biomagnification occurs along food chain / AW ;7 because consumers eat several of lower levels ;8 AVP ;	4

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Question	Answer	Marks
2(a)	<p><i>any 3 of:</i></p> <p>1 chlorophyll absorbs light energy / is photoactivated ;</p> <p>2 in the lamellae / grana / thylakoid, of chloroplasts ;</p> <p>3 ATP made ;</p> <p>4 reduced NADP made / NADPH / AW ;</p> <p>5 photolysis of water occurs / AW ;</p> <p>6 oxygen released ;</p>	3
2(b)(i)	<p>lower light intensity (at 15 m) / AW / ORA ;</p> <p>less longer wavelength light (at 15 m) / less red light / more blue light / more green light / AW / ORA ;</p>	2
2(b)(ii)	<p>(A)</p> <p>temperature ;</p> <p>because increasing temperature increased the rate / higher temperature increases kinetic energy of substrates / AW ;</p> <p>(B)</p> <p>light intensity / wavelengths ;</p> <p>because increasing light intensity / having more wavelengths available, increases rate / AW ;</p>	4
2(b)(iii)	<p>73 ;; (2 marks)</p> <p>1 mark for 68 OR 5 in working ;</p> <p>$\mu\text{g (O}_2\text{) min}^{-1}$;</p>	3

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Question	Answer	Marks
2(b)(iv)	<p><i>any 3 of:</i></p> <ol style="list-style-type: none">1 at surface <u>photosynthesis</u> increases AND, at 15 m / in deeper water, <u>photosynthesis</u> will, not increase (as much) / AW ;2 light (intensity / wavelength) limits photosynthesis in, deeper water / 15 m / AW / ORA ;3 respiration increases with temperature (at both depths) / AW ;4 productivity / growth, at surface, increases / is high, AND in deeper water / 15 m, decreases / drops / AW ;5 other factors may affect algal growth ;	3

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Question	Answer	Marks
3(a)(i)	<p><i>any 2 of:</i></p> <p>mean length of grouper increases in (area with) restrictions / AW ;</p> <p>increases (above area with no ban) after, 2005 / from 2006 ;</p> <p>AVP ;</p>	2
3(a)(ii)	<p><i>any 3 of:</i></p> <p>1 mean length of fish population increases / AW / ORA ;</p> <p>2 more older fish present / fish live longer / fish have time to grow / AW / ORA ;</p> <p>3 more fish reaching reproductive maturity / fish allowed to reproduce / more breeding stocks / more reproduction / more gametes / AW / ORA ;</p> <p>4 increased recruitment / higher population / higher fish stocks / AW / ORA ;</p> <p>5 AVP ;</p>	3
3(b)(i)	<p>1 linear y axes for CPUE and mean daily income, labelled with units, and horizontal axis as year ;</p> <p>2 all three scales enable plots to cover at least half grid ;</p> <p>3 plots correct $\pm \frac{1}{2}$ square for CPUE ;</p> <p>4 plots correct $\pm \frac{1}{2}$ square for mean daily income ;</p> <p>5 points joined with straight lines (with no extrapolation) ;</p> <p>6 key for both sets of data ;</p>	6

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Question	Answer	Marks
3(b)(ii)	<p><i>any 4 of:</i></p> <p>1 initially / until 2004, CPUE AND income fell / CPUE AND income are lower until 2010 / AW ;</p> <p>2 so, few fish may be present / more fishing trips made / few fish are caught / fishing methods may be less efficient (compared with purse seine fishing) / AW ;</p> <p>3 (in the long term / over whole period), CPUE AND income increase / AW ;</p> <p>4 fish populations increase / more fish present / fewer trips needed / more efficient fishing / AW ;</p> <p>5 (initially), less money in <u>local economy</u> / less employment / AW ;</p> <p>OR</p> <p>(over long term), more money is brought into <u>the local economy</u> / more employment / more jobs / AW ;</p> <p>6 (initially) less food / less protein / less able to feed families / AW ;</p> <p>OR</p> <p>(over long term), more food for people / more protein in diet / AW ;</p> <p>7 (initially) increases sociological problems, e.g. more crime / more illegal fishing / loss of housing / low standard of living / AW ;</p> <p>OR</p> <p>(over long term), improved sociological issues, e.g. less crime / better housing / better infrastructure / AW ;</p> <p>8 (ban means) fishing industry is sustainable / will last for future generations / AW ;</p>	4

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Question	Answer	Marks
3(b)(iii)	<i>any 1 of:</i> sea patrols / coastguard checks ; satellite tracking ; inspection of, catch / log books / fishing gear ; onboard (human) observers ; electronic monitoring systems e.g.: CCTV / geotags ;	1

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Question	Answer	Marks
4(a)	thin, unbroken, clear lines with no shading, no stippling and no overhanging lines ; correct proportions of spirals + aperture ; <i>(aperture is approximately half width of shell and height shell is in proportion)</i> minimum of five spirals and aperture shown ; at least size of original image ;	4
4(b)(i)	any 2 of: carbon dioxide <u>dissolves</u> in water ; forms carbonic acid / H_2CO_3 ; produces / dissociates into, H^+ (ions) and HCO_3^- (ions) ;	2
4(b)(ii)	any 2 of: acid / H^+ , reacts with carbonate ions / AW ; less calcium carbonate deposited in shells / AW ; shells dissolve / poor shell growth / AW ;	2

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Question	Answer	Marks
4(c)	<p><i>hypothesis</i></p> <p>1 higher temperature <u>increases</u> loss of mass of shells / AW ;</p> <p>plus any 10 of:</p> <p><i>independent variable</i></p> <p>2 temperature ;</p> <p>3 at least five temperatures ;</p> <p><i>dependent variable</i></p> <p>4 mass / weight, of shell ;</p> <p>5 measured before and after ;</p> <p><i>control variables (max 3)</i></p> <p>1 same age / number / species of mollusc shell or mollusc species / shape of shell / AW ;</p> <p>2 same pH (if stated pH, must be lower than 7) ;</p> <p>3 same volumes of water ;</p> <p>4 same volume of buffer solution ;</p> <p>5 same carbon dioxide concentration / AW ;</p> <p>6 same salinity ;</p> <p>7 same time / stated time ;</p>	11

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Question	Answer	Marks
4(c)	<p><i>method (max 3)</i></p> <p>8 use of water bath / method of maintaining temperature of water ;</p> <p>9 using balance to measure mass ;</p> <p>10 control pH by adding buffer ;</p> <p>11 reference to drying shells before (re-)weighing ;</p> <p>12 reference to placing shell in water as a control / AW ;</p> <p><i>analysis (max 3)</i></p> <p>13 replicate the experiment 3 times <u>and</u> calculate mean / median / standard deviation / AW ;</p> <p>14 plot a graph of change in mass against temperature / AW ;</p> <p>15 calculate percentage change in mass / AW ;</p> <p>16 calculate rate of loss by dividing change in mass by time / AW ;</p> <p>17 use of a suitable named statistical test ;</p> <p>18 example of correct results table ;</p> <p><i>safety and ethics</i></p> <p>19 identification of any risk with method to minimise / AW ;</p> <p>20 do not take shells from wild molluscs as this could damage ecosystem / dispose of chemicals correctly / AW ;</p>	

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Question	Answer	Marks
5(a)	can live in a range of salinities / can tolerate a wide range of salinity / AW ;	1
5(b)(i)	0.18 ;	1
5(b)(ii)	3.44 to 4.16 ;	1
5(b)(iii)	<p>there is a <u>significant</u>, decrease / difference, in oxygen when in 47 ppt ;</p> <p>there is not a <u>significant</u>, decrease / difference, in oxygen when in 15 ppt ;</p> <p>because the ranges for 47 ppt do not overlap with 35 ppt / because the ranges when in 15 ppt the ranges do overlap with 35 ppt ;</p>	3
5(b)(iv)	<p><i>any 3 of:</i></p> <p>1 water potential of, body fluids / AW, is higher than solution ;</p> <p>2 so water loss occurs / AW ;</p> <p>3 <u>osmoregulation</u> occurs ;</p> <p>4 active transport of salt / ions / AW ;</p> <p>5 (more) respiration (using oxygen) ;</p> <p>6 correct reference to ATP use ;</p>	3