CAMBRIDGE
International Education

Cambridge International AS & A Level

MARINE SCIENCE **9693/41**

Paper 4 A Level Data-handling and Investigative Skills **May/June 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 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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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
	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
	benefit of doubt was considered, but the response was decided to not be sufficiently close for benefit of doubt to be applied

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Annotation	Meaning
PAG	point already given
POT	power of ten error
R	incorrect point or mark not awarded
RE	rounding error
SEEN	point has been noted, but no credit has been given or blank page seen
TV	response is too vague or there is insufficient detail in response
1, 1, a	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

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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 excepted)
( )	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)	rough endoplasmic reticulum / RER / rough ER ;	**1**
1(a)(ii)	*any **2** from:* 1 translation / joining of amino acids / **AW** ; 2 protein synthesis / polypeptide synthesis ; 3 (proteins) leave in <u>vesicles</u> / sends (proteins) to <u>Golgi</u> / **AW** ; 4 **AVP** ;	**2**
1(b)(i)	1 outline: unbroken lines and no shading ; *must be the area in the circle on the diagram* 2 size: most of the space provided ; *minimum 70 mm high x 70 mm wide* 3 proportion: cristae are correct lengths and spacing ; • *lengths of cristae in proportion (two bottom left crista needs to be longer than top)* • *horizontal spaces and space between upper and lower cristae in proportion* • *glycogen granule in scale* 4 detail: at least 7 cristae **and** the glycogen granule **and** outer membrane ;	**4**

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Question	Answer	Marks
1(b)(ii)	1700 OR 1800 = 3 marks An answer between 1700 and 1800 that is not to two significant figures = **2 marks** One mark for: ÷ 65 000 in working **OR** mm measurement × 1 000 000 in working **OR** cm measurement × 10 000 000 in working	**3**
1(b)(iii)	*any **4** from:* 1 more mitochondria present in red muscle cells / higher (mean percentage) in red muscle / **ORA** ; 2 5.4(%) more mitochondria in red muscle / 5.4(%) less in white muscle / 3.3 × more mitochondria in red muscle ; 3 mitochondria are used for <u>aerobic respiration</u> ; 4 more <u>ATP</u> / <u>energy</u> needed for long distance swimming / for swimming for long times **/ ORA** ; 5 for (more) <u>muscle contraction</u> ; 6 red muscle (does mainly) aerobic respiration / white muscle (does mainly) anaerobic respiration / **AW** ;	**4**

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Question	Answer	Marks
2(a)	mutualism / symbiosis ; *Riftia* gains energy / ATP / glucose / sugars / carbohydrates / **AW** ; *Endoriftia* gains minerals / carbon dioxide / a host / habitat / protection / **AW** ;	**3**
2(b)(i)	(375 / 50 =) 7.5 ; m^2 ;	**2**
2(b)(ii)	*any **2** from:* 1 bone contains energy (in molecules) / biomass / nutrients / **named** organic molecule / **AW** ; 2 bone decomposes ; 3 (decomposer) microbes / bacteria (colonise bone) / **AW** ; 4 *idea that* more energy to pass on through food chains / **AW** ;	**2**

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Question	Answer	Marks
2(b)(iii)	*any **4** from:* 1 more organisms / higher density of organisms with methane (for all substrates) / **AW** ; 2 calcium carbonate has, highest / very high, increase in number of organisms / **AW** ; 3 more diversity with methane for calcium carbonate / bone (but not wood) / **AW** ; 4 methane provides energy / **AW** ; 5 chemosynthetic bacteria make glucose / chemosynthesis makes glucose / **AW** ; 6 more **energy** for, food chains / food webs / **AW** ; 7 can sustain more trophic levels (with methane present) / **AW** ; 8 calcium carbonate / carbonate (increases colonisation) as it helps shell / skeleton growth / **AW** ;	**4**

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Question	Answer	Marks
2(b)(iv)	*any **1** from*: conclusion supported as • large increase / significant increase / **AW**, for calcium carbonate / **ORA** ; • all three substrates have an increase in density / colonisers / **AW** / **ORA** ; • both areas are same depth (control idea) / **AW** ; • *idea that* seven years is a long time so reliable / long enough, to see an effect / 7 years is enough time for colonisation / **AW** ; ***PLUS** any **1** from:* *conclusion not supported as:* • no statistical test / standard deviation / **AW** ; • only small increase in population / **AW**, for bone ; • number of different species / diversity, falls for bone / **AW** ; • no idea of the types of organisms / species ; • other factors could have affected results / unsure of other events that may have occurred / **AW** ; • correlation not causation ; • substrate areas are not the same size / area / **AW** ; • lack of replicates / low sample size / only two areas sampled / only one trial / lack of replication / **AW** ;	**2**

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Question	Answer	Marks
3(a)	*any **3** from:* 1 larvae can move to other areas / larvae allow distribution to other areas / **AW** ; 2 reduced competition / **AW** ; 3 (reduced competition for) food / nutrients / **AW** ; 4 *idea that* larvae and adults occupy different niches / **AW** ; 5 increased genetic diversity (if oysters spread to other areas) / **AW** ; 6 reduces spread of disease (as population density is lower) ;	**3**
3(b)(i)	180 = 2 marks 36 (%) = 1 mark **OR** 320 survived = 1 mark	**2**
3(b)(ii)	(optimum temperature) = 27 (°C) optimum pH = 8(.0) ;	**1**
3(c)(i)	1. linear y axes for both temperature and pH, labelled with units, and horizontal axis as month ; 2. all three scales enable plots to cover at least half grid ; 3. plots correct +/- ½ square for temperature ; 4. plots correct +/- ½ square for pH ; 5. points joined with straight lines and key ;	**5**

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Question	Answer	Marks
3(c)(ii)	*any **4** from:* 1 in April, conditions enable survival / there are optimal conditions / oysters can breed / conditions are ideal for breeding / **AW** ; 2 August has a temperature of 30 °C and pH of 7(.0) / April has a temperature of 27 °C and pH of 7.9 / **AW** ; 3 in August, conditions reduce larvae settling / kill larvae / few larvae survive / will not settle in August / too acidic for survival / **AW** ; 4 there is only one successful breeding season (per year) / **AW** ; 5 *idea that* few oyster larvae become adults / it takes time to produce adults (so effects are only seen in 2011) / **AW** ; 6 few other months have ideal conditions for larvae / **AW** ; 7 overfishing / pollution / **AW**, may be causing the fall ;	**4**
3(d)	*any **3** from:* 1 release of carbon dioxide / **AW** ; 2 causes (enhanced) greenhouse effect / increased temperature / global warming / **AW** ; 3 acidification of water / **AW** ; 4 (acid) reduces oyster shell formation / erodes shells / dissolves shells / **AW** ; 5 larvae do not survive / larvae cannot settle / fewer adult oysters to breed (in future) / **AW** ;	**3**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(a)(i)</td><td>
<table>
<tr><th>species</th><th>activity level (10 = highly active)</th><th>rank activity level</th><th>gill surface area / $cm^2\ g^{-1}$</th><th>rank gill surface area</th><th>D</th><th>D^2</th></tr>
<tr><td>butterfish</td><td>5</td><td>7</td><td>461</td><td>6</td><td>1</td><td>1</td></tr>
<tr><td>fluke</td><td>2</td><td>11</td><td>247</td><td>11</td><td>0</td><td>0</td></tr>
<tr><td>mackerel</td><td>9</td><td>2</td><td>1040</td><td>2</td><td>0</td><td>0</td></tr>
<tr><td>menhaden</td><td>10</td><td>1</td><td>1241</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>mullet</td><td>8</td><td>3</td><td>1010</td><td>3</td><td>0</td><td>0</td></tr>
<tr><td>puffer</td><td>4</td><td>9.5</td><td>423</td><td>9</td><td>0.5</td><td>0.25</td></tr>
<tr><td>scup</td><td>6</td><td>5</td><td>498</td><td>4</td><td>1</td><td>1</td></tr>
<tr><td>sea Robin</td><td>5</td><td>7</td><td>432</td><td>8</td><td>–1</td><td>1</td></tr>
<tr><td>sea Trout</td><td>5</td><td>7</td><td>275</td><td>10</td><td>–3</td><td>9</td></tr>
<tr><td>sheepshead</td><td>7</td><td>4</td><td>467</td><td>5</td><td>–1</td><td>1</td></tr>
<tr><td>tautog</td><td>4</td><td>9.5</td><td>450</td><td>7</td><td>2.5</td><td>6.25 ;</td></tr>
<tr><td>toadfish</td><td>1</td><td>12</td><td>151</td><td>12</td><td>0</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>19.5 ;</td></tr>
</table>
</td><td>2</td></tr>
<tr><td>4(a)(ii)</td><td>0.93(1818181818181818….) (2 marks) ;;

one mark for 1716 OR ($12^3 – 12$) OR $12(12^2 – 1)$ OR 12(144 – 1) OR 12(143) OR (1728 – 12) OR 0.068(….) in working</td><td>2</td></tr>
</table>

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Question	Answer	Marks
4(a)(iii)	*any **3** from:* 1 the calculated value is greater than the critical value ; 2 of 0.587 ; 3 so the null hypothesis is rejected ; 4 there is a significant positive correlation ; 5 probability of less than 0.05, that the correlation is due to chance ; **NOTE:** If no calculated value, then only mp2 awarded for recognition of 0.587	**3**
4(b)	*any **3** from:* 1 more active fish require a larger (gill) surface area / **ORA** / **AW** ; 2 for fast diffusion of oxygen (into blood) / **AW** ; 3 for fast diffusion of carbon dioxide (out) / **AW** ; 4 (more) (aerobic) respiration ; 5 produce ATP / release energy, for muscle contraction ;	**3**

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Question	Answer	Marks
5(a)	*any **2** from:* 1 method / net (volume) sizes / **AW** ; 2 season / time of year / breeding season / **AW** ; 3 location / area / breeding grounds / MPAs / **AW** ; 4 fishing intensity / fishing effort / boat days / boat sizes / **AW** ; 5 setting quotas / size of catch / / **AW** ; 6 fish size / set minimum sizes (that can be kept) / mesh size on net / age of fish / **AW** ; 7 licensing / **AW** ;	**2**
5(b)	*any **1** from:* • lack of food / starvation / malnutrition / lack of protein / **AW** ; • poverty / lack of income / **AW** ; • unemployment / lack of jobs / lack of work / **AW** ; • loss of services (in the area) / loss of tourism / **AW** ; • unable to care for families / **AW** ; • loss of culture / traditions / **AW** ; • conflict with government / authorities / **AW** ; • increased crime / more at risk of prosecutions / risk of fines / **AW** ; • **AVP** ;	**1**

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Question	Answer	Marks
5(c)	*any **4** from:* (*at least **1** from*) *supported because* 1 increase in (overall) biomass / increase in (biomass of), herbivores / secondary consumers / **AW** ; 2 <u>significant increase</u> in herbivores as error bars do not overlap / **AW** ; 3 more food for, secondary consumers / carnivores / higher trophic levels (due to more herbivores) / more energy for, secondary consumers / carnivores / higher trophic levels / **AW** ; 4 reliable / valid, as large sample size used / many areas used / **AW** ; (*at least **1** from*) *not supported because* 5 high trophic level fish is only a small increase / **AW** ; 6 error bars for high trophic level fish / secondary consumers / (overall) biomass, overlap so <u>no significant difference</u> / **AW** ; 7 large error bars suggests, wide variation / range (in biomass) / **AW** ; 8 only a short period of time (so not reliable) / no information about time of year / **AW** ; 9 no reference to, types of species / numbers of individual species / populations / **AW** ;	**4**

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Question	Answer	Marks
6(a)	*any **2** from:* 1 toxic / **AW** ; 2 transferred through food chains / concentration increases along food chains / **AW** ; 3 bioaccumulation occurs / do not break down / are not excreted / **AW** ; 4 **AVP** ;	**2**
6(b)	*any **1** from:* *hypothesis (h)* • increasing concentration of bromosphaerol reduces growth of barnacles / **AW** *any **10** from:* *independent variable (i):* • independent variable / IV, is concentration of bromosphaerol ; • make up at least five different concentrations (must have units or percentage at least once) ; *dependent variable (d):* • dependent variable / DV, is number of barnacles / mass of barnacles / area covered / **AW** ; • method of, measuring area of barnacles / measuring mass of barnacles / counting barnacles / **AW** ;	**11**

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Question	Answer	Marks
6(b)	*standardised variables (c):* **(MAX 3)** • same salinity / salt concentration / same or stated ppt ; • same pH ; • same temperature / suitable stated temperature ; • same material for substrate / same sized substrate / same type of substrate / **AW** ; • same volume of solution / water / **AW** ; • same species of barnacle / number of barnacle (larvae) added / **AW** ; • same food / mass of food / **AW** ; • same oxygen (concentration) / same carbon dioxide (concentration) ; • same light intensity / colour / wavelength / distance of lamp / **AW** ; • same length of time / stated time period / **AW** ; *method details (m):* **(MAX 2)** • use of serial / proportional dilutions ; • use of pipettes / syringe / measuring cylinder (to measure volume) / thermometer to measure temperature / **AW** ; • correct method for maintain temperature, e.g. water bath / heat lamp / aquarium heater / **AW** ; • use of pH buffer (to maintain pH) ; • use of oxygenation / **AW** ;	

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Question	Answer	Marks
6(b)	*safety and ethics (e)* • suitable safety measure and reason, e.g. gloves / eye protection / **AW**, as bromosphaerol is an irritant / harmful / **AW** ; • suitable ethical measure, e.g. avoid extreme temperature or pH or salinity / dispose of solutions carefully / do not tip solutions down sink / into environment / **AW** ; *analysis (a):* **(MAX 3)** • suitable graph described ; • replicates / repeat at least twice and calculate, means / medians / standard deviations ; • use of standard error to compare means / use of Spearman's rank to see if correlation (between concentration and barnacle number) / **AW** ; • suitable example of table ;	

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