



## Cambridge International AS & A Level

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**MARINE SCIENCE**

**9693/43**

Paper 4 A Level Data Handling and Investigative Skills

**May/June 2022**

MARK SCHEME

Maximum Mark: 75

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**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 2022 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

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This document consists of **13** 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 descriptors 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.

**Key Points**

- Refer to the *Instructions for Examiners (marking scripts on-screen) 2022* booklet for details of all procedures.
- As soon as you are able (usually about two days after the paper set date), please access the question paper and provisional mark scheme from the **RM support portal**. In conjunction with the provisional mark scheme, browse scripts in **RMA<sup>3</sup>** and feed any issues or comments to your **Team Leader**.
- The decisions of the **Principal Examiner** are final, and the final agreed mark scheme must be applied as intended by the Principal Examiner. If you are in any doubt about applying this mark scheme, consult your **Team Leader** by telephone or by email.
- Please report any serious problems during marking to your **Team Leader / Principal Examiner** (details in the confidential package).
- If you require technical support, please contact the **RM Helpdesk**. If you require administrative support relating to the examination process, please contact the **Cambridge International Examiner Helpdesk**. For all queries relating to payment, please contact **Cambridge Assessment Finance Division**. Up-to-date contact details for each of these can be found in the *Instructions for Examiners (marking scripts on-screen) 2022* booklet.
- The schedule of dates is very important. It is **essential** that you meet the **Batch 1** and **Batch 2** deadlines. If you experience problems, you must contact your Team Leader without delay.
- Mark strictly to the mark scheme. All marks awarded must relate directly to the mark scheme. However, always credit correct, relevant, science, even if it lies outside of the syllabus content. For answers not provided for in the mark scheme, give as far as possible equivalent marks for equivalent work. If in doubt, consult your Team Leader.
- Never transfer marks allocated for one question item to another.
- Where work has been crossed out, mark it when nothing else has been written.
- Do not penalise grammatical constructions/spelling of words that are not in the syllabus, so long as the meaning is clear.
- Credit should be given to all the candidate's correct responses, wherever they have been written (including blank pages, around diagrams, etc.).
- Additional materials may be attached and must be checked for candidates' responses. Show that you have checked blank pages for answers by placing an annotation on each blank page. Do not use crosses or ticks for this purpose, unless the points are credited as part of a response to a specific question. In this instance, please use the On Page Comment tool to clearly annotate which question part the marks relate to.
- If the candidate has left an answer blank, or has left a mark/comment that does not in any way relate to the question (for example 'my dog is black' or '----' or 'can't do' or '?') use the **NR** (No Response, #) option.
- Award 0 marks for any attempt which does not earn credit. This includes copying out all / part of the question or any working that does not earn any marks (whether crossed out or not).

- This mark scheme will use the following abbreviations:

;	separates marking points
/	separates alternatives within a marking point
()	contents of brackets are not required but should be implied / the contents set the context of the answer
R	reject
A	accept (answers that are correctly cued by the question or guidance you have received)
I	ignore (mark as if this material was not present)
AW	alternative wording (where responses vary more than usual, accept other ways of expressing the same idea)
AVP	alternative valid point (where a greater than usual variety of responses is expected)
ORA	or reverse argument
<u>underline</u>	actual word underlined must be used by the candidate (grammatical variants excepted)
MAX	indicates the maximum number of marks that can be awarded
+	statements on both sides of the + are needed for that mark
OR	separates two different routes to a mark point and only one should be awarded
ECF	error carried forward (credit an operation from a previous incorrect response)

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Question	Answer	Marks
1(a)(i)	linear axes that use at least one y axis scale half the grid ; all axes labelled ; plots correct ; points joined by straight lines ; key for both lines / labelled lines;	<b>5</b>
1(a)(ii)	<i>any 2 from:</i> seagrass cannot live in areas with high salinity / less seagrass grows in areas with high salinity / seagrass cannot live in areas of concentrated brine / <b>ORA</b> ;  high salinity / water near desalination plant, has a low <u>water potential</u> ; water is lost from seagrass cells (by osmosis) / cells lose turgidity / <b>AW</b> ; toxins are released from desalination plant / <b>AW</b> ;	<b>2</b>
1(b)	<i>any 3 from:</i> salmon body (cells) have higher water potential than seawater so lose water (by osmosis) ; salmon drink water ; excrete / release, salt / <b>AW</b> ; produce <u>concentrated</u> urine ; active pumping (of salt) into water ;	<b>3</b>

Question	Answer	Marks
2(a)	<i>any 4 from:</i> mercury passes along food chains / <b>AW</b> ; mercury <i>of</i> is not broken down / bioaccumulation / excreted ; biomagnification occurs (of mercury through the food chains / trophic levels) / mercury builds up ; fish from higher trophic levels / fish that eat other fish / predators, have higher levels of mercury / fish that consume dead organisms have high levels / <b>ORA</b> ; dead fish may have high concentrations which killed them / were predator species / <b>AW</b> ; plants obtain mercury from substrate / do not obtain mercury from other trophic levels / do not feed on other organisms ;	<b>4</b>
2(b)(i)	154 000 ( $\mu\text{g}$ ) ;;	<b>2</b>

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Question	Answer	Marks
2(b)(ii)	<i>any 2 from:</i> tuna are top predators / high trophic levels / at top of food chain <b>and</b> accumulate mercury / have high concentrations of mercury ; mercury could harm baby / is toxic / nervous system problems / <b>AW</b> ; mercury concentration in baby would be high (due to smaller size of baby) / what is safe for adult is not for baby ;	<b>2</b>

Question	Answer	Marks
3(a)(i)	$6\text{O}_2 + \text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$ ;	<b>2</b>
3(a)(ii)	coral / zooxanthellae would not photosynthesise / photosynthesis would not occur ; so no oxygen is released / oxygen levels are not affected (by photosynthesis) ;	<b>2</b>
3(a)(iii)	$10 - 8.5 (= 1.5)$ $8.5 - 10.0 = (1.5) / 15 = 0.1$ ; negative gradient (minus) $(-0.1)$ ; $\text{mg dm}^{-3} \text{ min}^{-1}$ ;	<b>3</b>
3(b)(i)	increase ; level off / decrease from, 7 / 8 / 9 (a.u.) ;	<b>2</b>
3(b)(ii)	<i>any 3 from:</i> maintains / steeper, diffusion / concentration gradient ; movement of tentacles (increasing surface area contact with oxygen in water) ; another factor begins to limit rate (at speed of 7) ; such as, surface area of tentacles, rate of oxygen use by coral / temperature / <b>AW</b> ;	<b>3</b>



Question	Answer	Marks
3(c)	<p><i>hypothesis:</i> increasing temperature increases speed that agar changes colour / increases rate of diffusion / reduces time taken for agar to change colour / <b>AW</b> ;</p> <p><b>plus any 11 from:</b></p> <p><i>variables:</i> independent variable: temperature ; at least five <u>stated</u> temperatures ; dependent variable: time taken for block to change colour / rate of diffusion ; record time taken for block to change colour with stop clock / timer ;</p> <p><i>controls:</i> <b>max 3 from:</b> cubes have same surface area / volume ; same concentration of acid / pH ; same volume of acid ; same concentration of alkali in block ; same concentration of agar ;</p> <p><i>method:</i> use of water bath / <b>AW</b> ; left for period of time to reach temperature ; cut agar with scalpel / knife and measure with ruler ;</p> <p><i>analysis</i> <b>max 3 from:</b> repeats, and means calculated / anomalies identified; rate calculated by inverse of time / <b>AW</b> ; graph of rate / time taken against temperature ; appropriate statistical test ;</p>	12

Question	Answer	Marks
3(c)	<p><i>safety:</i> <b>MAX 1 from:</b> safety with cutting away from the body / take care with scalpel ; correct safety precaution linked with acid, e.g. eye protection ; care with hot water baths ;</p> <p><i>ethics</i> <b>MAX 1 from:</b> do not let acid / indicator / alkali drain into natural water ; no living things involved / affected so few ethical issues ;</p>	

Question	Answer	Marks
4(a)(i)	<p><i>any 3 from:</i> forms <math>\text{H}_2\text{CO}_3</math> / carbonic acid ; (<math>\text{H}_2\text{CO}_3</math>) dissociates / <b>AW</b>, into <math>\text{H}^+</math> <b>and</b> <math>\text{HCO}_3^-</math> / hydrogen ions and hydrogen carbonate ions ; increased <math>\text{H}^+</math> causes an increase in acidity ; <math>\text{H}^+</math> reacts with <math>\text{CO}_3^-</math> ions / removes / reacts / combines with carbonate ions ;</p>	<b>3</b>
4(a)(ii)	<p><i>any 2 from:</i> fewer carbonate ions in water ; shells become thinner / weaker / lose mass / dissolve / less calcium carbonate / <b>AW</b> ; more susceptible to, predation, wave action / damage / <b>AW</b> ;</p>	<b>2</b>
4(b)	<p>as atmospheric carbon dioxide rises, pH falls / there is a negative correlation (between carbon dioxide and pH) / <b>AW</b> ;</p> <p><i>plus any 3 from:</i> fossil fuel use releases carbon dioxide ; ocean pH, has a lot of fluctuations / <b>AW</b> ; fluctuations in oceanic pH do not match the atmospheric <math>\text{CO}_2</math>; <b>carbon dioxide</b> may not be from human use ; data does not give any information on fossil fuels use / <b>AW</b> ; pH data only from 1988 ; other factors may be causing the <b>change in pH</b> / correlation does not mean causation ; data are only limited to Hawaii / other areas need to be checked / no statistical analysis ;</p>	<b>4</b>

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Question	Answer	Marks
4(c)(i)	<i>any 2 from:</i> as light intensity increase, pH increases / <b>AW</b> ; (photosynthesis) uses carbon dioxide / more carbon dioxide is taken up / <b>AW</b> ; less carbon dioxide <u>dissolved</u> in water reduces acidity / less H <sup>+</sup> present / less carbonic acid present ;	<b>2</b>
4(c)(ii)	<i>any 3 from:</i> increased light intensity reduces carbon dioxide concentration ; data are close to line of best fit / strong correlation ; at low light intensity there is less pH reduction / <b>AW</b> ; only shows summer months / cold water area / one area near Norway / <b>AW</b> ; no control experiment / <b>AW</b> ; in winter / with less light so would not work as well / <b>AW</b> ; other factors could affect photosynthesis (e.g. temperature / sediment in water) ; cannot grow kelp forests everywhere / kelp cannot survive in other areas ; kelp could become an invasive species and damage the environment ;	<b>3</b>
4(c)(iii)	three cells touching and double layer (in appropriate areas) for cell wall ; thin, continuous line with no shading ; size and proportions correct – minimum size, cell length longer than width and bottom of cell B is above bottom of cell A ;	<b>3</b>

Question	Answer	Marks
5(a)(i)	a species that has been introduced outside its natural past or present distribution and has become problematic / <b>AW</b> ;	<b>1</b>
5(b)(i)	<i>any 3 from:</i> between 2004 and 2006 / up to 2006, (slow population increase) as lionfish, adapt to area / have few to breed / take time to establish / <b>AW</b> ;  from 2004, increase as lionfish have abundant food / few predators / high breeding rate / outcompete other species / <b>AW</b> ; plenty of niches available for lionfish ; from 2007 / 2008 population stabilises / levels off / falls, due to competition / as food limiting / predators arrive / control methods / harvesting / <b>AW</b> ;	<b>3</b>

Question	Answer	Marks																		
5(b)(ii)	<p><i>any 2 from:</i>            wide variation in number of lionfish sightings in years between 2007 and 2010 ;            less / little variation in number of lionfish sightings in years 2004 / 2005 / 2006 ;            no overlap between 2006 and 2007 shows (significant) difference / <b>AW</b> ;            overlap between 2007 and 2010 shows no (significant) difference / <b>AW</b> ;</p>	<b>2</b>																		
5(c)	<p><i>any 3 from:</i>            decrease in (small) prey species as they are eaten / predated (by lionfish) ;            increase in (small) non-prey species due to less competition (from other fish) / more algae to eat ;            large competitors decrease as lionfish consume food / take territory / <b>AW</b> ;            large non-competitors show similar numbers so maintain niche / are unaffected / have enough food ;            algae increases, as small herbivores / small prey species, are, consumed / are fewer ;</p>	<b>3</b>																		
5(d)(i)	<table border="1"> <thead> <tr> <th>Reef area</th> <th>Number of damselfish (O)</th> <th>Expected number of damselfish (E)</th> <th>(O-E)</th> <th>(O-E)<sup>2</sup></th> <th><math>\frac{(O-E)^2}{E}</math></th> </tr> </thead> <tbody> <tr> <td>Lionfish removed</td> <td>420</td> <td>390</td> <td>30</td> <td>900</td> <td>2.308</td> </tr> <tr> <td>No lionfish removed</td> <td>360</td> <td>390</td> <td><b>-30</b></td> <td><b>900</b></td> <td><b>2.308 ;</b></td> </tr> </tbody> </table>	Reef area	Number of damselfish (O)	Expected number of damselfish (E)	(O-E)	(O-E) <sup>2</sup>	$\frac{(O-E)^2}{E}$	Lionfish removed	420	390	30	900	2.308	No lionfish removed	360	390	<b>-30</b>	<b>900</b>	<b>2.308 ;</b>	<b>1</b>
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5(d)(ii)	4.616 ;	<b>1</b>																		
5(d)(iii)	<p><i>any 3 from:</i>            the null hypothesis is rejected ;            there is a significant difference (in the number of damselfish) ;            the calculated value is greater than the critical value ;            correct reference to 3.841 / critical value for 0.05 and 1 degree of freedom ;            there is a probability of less than, 0.05 / 5%, that the difference is due to chance ;</p>	<b>3</b>																		

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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
5(d)(iv)	<i>any 2 from:</i> marine ecosystems are large ; species cross (national) national borders ; species are migratory / breed in different locations ; ocean currents move species / pollutants around the globe / <b>AW</b> ; trade of species occurs between countries / ref to trade restrictions ; some areas of ocean / High Seas have no national ownership ;	<b>2</b>