



Cambridge International AS & A Level

MARINE SCIENCE

9693/41

Paper 4 A Level Data-handling and Investigative Skills

May/June 2022

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

This document consists of **16** 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 **RMA³** 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)	plastic that is less than 5 mm (in diameter) ;	1
1(a)(ii)	<p><i>any 4 from:</i></p> <ul style="list-style-type: none"> 1 microplastics bind to (organic), toxins / poisons ; 2 (microplastics) are <u>consumed</u> / <u>taken up</u>, by (marine) organisms ; 3 (microplastics / toxins) pass along food chains / AW ; 4 (microplastics / toxins) do not break down / (bio)accumulate ; 5 biomagnification occurs ; 6 humans consume high trophic level organisms / AW ; 	4
1(b)(i)	4 750 000 ; kg ;	2
1(b)(ii)	<p><i>any 2 from:</i></p> <ul style="list-style-type: none"> 1 higher population density around area / AW ; 2 less powerful currents to move plastic / AW ; 3 idea that Mediterranean is an enclosed water body ; 4 many large rivers (empty plastic into Sea) ; 5 there are countries with less waste disposal of plastic / fewer environmental, policies / laws / AW ; 	2
1(c)(i)	8.3 : 1.0 ;;	2
1(c)(ii)	<p><i>any 3 from:</i></p> <ul style="list-style-type: none"> 1 (more) plastic is degraded / broken down (into microplastics) / AW ; 2 (higher exposure to) UV light ; 3 (higher action of) wind ; 4 (higher action of) waves / turbulence; 5 warm(er) temperature ; 6 more direct release of (primary) microplastics ; 	3

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Question	Answer	Marks
2(a)(i)	<p><i>any 3 from:</i></p> <ul style="list-style-type: none"> 1 sea water has high(er) salinity / AW / ORA ; 2 sea water has lower water potential / ORA ; 3 water moves into sea water (from freshwater) ; 4 volume increases ; 	3
2(a)(ii)	<p><i>any 3 from:</i></p> <ul style="list-style-type: none"> 1 (osmotic power) is a <u>renewable</u> (energy source) ; 2 (idea of) less need for fossil fuel ; 3 (less) carbon (dioxide) (released) / (less) carbon emission / lower carbon footprint ; 4 less <u>greenhouse</u> effect ; 5 less reflection / trapping, of radiation (back to Earth) ; 	3
2(b)(i)	<p>an organism that can only survive in a narrow range of salinities / AW / ORA ; an organism that has <u>same</u> salinity as its surrounding water / AW ;</p>	2
2(b)(ii)	<p><i>any 3 from:</i></p> <ul style="list-style-type: none"> 1 salmon will gain water by osmosis ; 2 excrete / release, (excess) water through, <u>kidney / urine</u> ; 3 take salt (from water) into, blood / body / salmon ; 4 using <u>active</u> transport / <u>active</u> pumping ; 	3

Question	Answer	Marks																															
3(a)	<p>any 3 from:</p> <ol style="list-style-type: none"> 1 symbiosis / mutualism ; 2 both organisms benefit / help each other ; 3 <i>Endoriftia</i> provides, glucose / energy ; 4 <i>Riftia</i> provides carbon dioxide / place to live / habitat / minerals / protection / shelter / acts as a host / AW ; 	3																															
3(b)(i)	<p>any 2 from (mark in pairs):</p> <p>temperature ;</p> <p>affects enzymes / diffusion rate of carbon dioxide ;</p> <p>pH ;</p> <p>affects enzymes ;</p> <p>(initial concentration of) carbon dioxide ;</p> <p>is a raw material for chemosynthesis / AW ;</p> <p>same salinity of water ;</p> <p>affects osmosis (of cells) / chemical reactions / AW ;</p>	2																															
3(b)(ii)	<ol style="list-style-type: none"> 1 both axes labelled with units ; 2 complete linear scales that use at least half of grid ; 3 plots all correct ; 4 ruled lines that join points ; 5 key for all lines / all lines labelled ; <table border="1" data-bbox="349 967 1115 1305"> <thead> <tr> <th rowspan="2">time / minutes</th> <th colspan="3">mean mass of carbon dioxide taken up / mmol g⁻¹</th> </tr> <tr> <th>control experiment (no additional gas)</th> <th>with hydrogen sulfide gas</th> <th>with hydrogen gas</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>5</td> <td>7</td> <td>34</td> <td>18</td> </tr> <tr> <td>10</td> <td>10</td> <td>45</td> <td>20</td> </tr> <tr> <td>15</td> <td>12</td> <td>54</td> <td>22</td> </tr> <tr> <td>20</td> <td>15</td> <td>58</td> <td>23</td> </tr> <tr> <td>25</td> <td>21</td> <td>60</td> <td>32</td> </tr> </tbody> </table>	time / minutes	mean mass of carbon dioxide taken up / mmol g ⁻¹			control experiment (no additional gas)	with hydrogen sulfide gas	with hydrogen gas	0	0	0	0	5	7	34	18	10	10	45	20	15	12	54	22	20	15	58	23	25	21	60	32	5
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3(b)(iii)	<p>increased / faster, rate of carbon dioxide uptake / more carbon dioxide taken up ;</p> <p>levels off / slows down / reduces uptake after 5 minutes ;</p>	2																															

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Question	Answer	Marks
3(b)(iv)	<p><i>any 3 from:</i></p> <p>1 hydrogen sulfide and hydrogen both cause an increase in, (chemosynthesis / CO₂ uptake) ;</p> <p>2 hydrogen sulfide increases, (chemosynthesis / CO₂) uptake <u>most / more</u> ;</p> <p>3 hydrogen sulfide / hydrogen, provides energy ;</p> <p>4 (extra) <u>energy</u> increases rate of chemosynthesis / carbon fixation ;</p> <p>5 there is (enough) energy without, hydrogen sulfide / hydrogen, to perform some chemosynthesis / AW ;</p>	3

Question	Answer	Marks
4(a)	<p><i>any 2 from:</i></p> <p>there is no, intermediate different form / larva / AW ;</p> <p>no <u>metamorphosis</u> ;</p> <p>no form that, occupies different niche / lives in different area / has another habitat / AW ;</p>	2
4(b)	<p><i>any 3 from:</i></p> <p><i>(supported because)</i></p> <p>the <u>line</u> (of best fit) shows a <u>positive</u> correlation ;</p> <p>so as life expectancy increases, so does post-menopause length ;</p> <p><i>(not supported because)</i></p> <p>some / many / several of the points are far from the line of best fit / there are several anomalous values / outliers / points are very scattered ;</p> <p>no idea how large sample size was used ;</p>	3

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Question	Answer						Marks																					
4(c)(i)	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;">species</th> <th style="width: 15%;">maximum life expectancy</th> <th style="width: 15%;">rank maximum life expectancy</th> <th style="width: 15%;">maximum length of post menopause period</th> <th style="width: 15%;">rank maximum length of post menopause period</th> <th style="width: 10%;">D</th> <th style="width: 10%;">D²</th> </tr> </thead> <tbody> <tr> <td>fin whale</td> <td>98</td> <td>1</td> <td>2</td> <td>6.5</td> <td>(-)5.5</td> <td>30.25</td> </tr> <tr> <td colspan="6" style="text-align: right;">ΣD^2</td> <td>59.5 ;</td> </tr> </tbody> </table>						species	maximum life expectancy	rank maximum life expectancy	maximum length of post menopause period	rank maximum length of post menopause period	D	D ²	fin whale	98	1	2	6.5	(-) 5.5	30.25	ΣD^2						59.5 ;	1
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ΣD^2						59.5 ;																						
4(c)(ii)	there is no , correlation / relationship / association, between the life expectancy and length of (post-) menopause period ;						1																					
4(c)(iii)	0.5(04...);						1																					
4(c)(iv)	<p><i>any 3 from:</i></p> <p><i>If the calculated number is smaller than the critical value...</i></p> <ol style="list-style-type: none"> 1 there is no (significant) correlation / there is no (significant) association between life expectancy and (post) menopause length ; 2 the calculated value is not larger than the critical value ; 3 (identification) of 0.7(00) ; 4 so there is a probability of greater than, 0.05 / 5%, that the correlation / association is due to chance / AW ; 5 the null hypothesis is not rejected / null hypothesis is accepted ; <p><i>If calculated number is larger, then accept:</i></p> <ol style="list-style-type: none"> 1 there is a correlation ; 2 the calculated value is larger than the critical value ; 3 (identification) of 0.7(00) ; 4 so there is a probability of less than 0.05 / 5%, that the association is due to chance / AW ; 5 the null hypothesis is rejected ; 						3																					

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Question	Answer	Marks
4(d)	<p><i>any 2 from:</i></p> <p>1 (helping to) feed / protect calves / nurture / protect the group / lots of parental care needed / investment needed / AW ;</p> <p>2 increase <u>survival</u> of calves ;</p> <p>3 orcas have few calves / are k-selectors / AW ;</p> <p>4 (and need) calves stay with group for years / calves stay with mothers / group for a long time / AW ;</p>	2

Question	Answer	Marks
5(a)	<p>1 clear, complete outline of structure with four 'spikes' and the flagellum and at least same size as photo ;</p> <p>2 lines thin, continuous and no shading ;</p> <p>3 correct proportions and angles of body, spikes and flagellum ;</p>	3
5(b)(i)	71(.4...) (%) ;	1
5(b)(ii)	<p><i>any 1 from:</i></p> <p>1 algal blooms are most likely to happen when the concentration is greater than 1.5 (mmol dm⁻³) / AW ;</p> <p>2 correlation between urea concentration and chance of an algal bloom ;</p> <p>3 as urea concentration increases there are more (algal) blooms / AW ;</p>	1
5(b)(iii)	<p>1 high protein / feed, <u>causes</u> high urea concentrations / <u>releases_urea</u> / causes organisms to <u>release_urea</u> / AW ;</p> <p>2 there are <u>more</u> blooms when <u>urea</u> (concentration) is <u>higher</u> / <u>more</u> / ORA ;</p> <p><i>max 2 from:</i></p> <p>3 it is a correlation not causation ;</p> <p>4 other factors may cause the blooms ;</p> <p>5 urea may not be from the protein feed / or from other sources ;</p>	3

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Question	Answer	Marks
5(c)	<p><i>any 2 from:</i></p> <ul style="list-style-type: none"> 1 (availability of) stock ; 2 (availability of) <u>clean</u> water ; 3 (availability of) feed ; 4 efficiency of use of feed ; 5 (availability of) labour / people to work there / people to run it ; 6 disease management / AW ; 7 cleaning / filtering of <u>waste</u> water (so environment is not polluted) ; 8 (availability of) location ; 9 market demand / AW ; 10 access to market / ability to transport to markets ; 11 return on investment / profitability ; 	2

Question	Answer	Marks
6	<p>one mark for hypothesis <i>hypothesis (h):</i> 1 increase in ammonium nitrate increases rate of growth of algae / AW ;</p> <p><i>any 11 from other sections:</i> safety and ethical treatment (e) 2 wear, safety glasses / gloves, <u>with</u> reason ; 3 remove any animals / fish from tanks / do not release chemicals into open water / do not wash chemicals / algae down drain / do not release algae into open water / AW ;</p> <p><i>independent variable (i)</i> 4 <u>independent</u> variable: concentration of ammonium nitrate ; 5 at least 5 <u>stated</u> concentrations ; 6 <u>control</u> experiment with no ammonium nitrate ;</p> <p><i>dependent variable (d)</i> 7 <u>dependent</u> variable: <u>rate</u> of growth / <u>mass</u> of algae ; 8 measure, (dry) mass of algae / weigh algae / light penetration / height of algae in tank / surface area of algae / counting cell number / AW ; 9 leave algae for <u>stated</u> time (more than one day) ;</p> <p><i>controls (c)</i> max 3 controls from: 10 same, (starting) mass / species / type / age, of algae ; 11 light (intensity) ; 12 provide other minerals / keep other minerals constant ; 13 temperature ; 14 pH / salinity ; 15 volume of water / solution / volume of tanks ; 16 carbon dioxide ;</p>	12

Question	Answer	Marks
6	<p><i>method and techniques (m)</i> <i>max 3 from:</i> 17 (use of) pipettes / syringe / measuring cylinder (to measure volumes) ; 18 (use of) water-bath to maintain temperature / AW ; 19 (use of) balance to weigh algae ; 20 (use of) oven to dry algae ; 21 (use of) sodium hydrogen carbonate as source of carbon dioxide ;</p> <p><i>analysis (a)</i> <i>max 2 from:</i> 22 replicates / several repeats and calculate mean / identify anomalies / outliers / identify if errors had occurred ; 23 calculation of rate as (change of) mass over time / AW ; 24 correct statistical test ; 25 plot graph of rate of growth / mass, against concentration of ammonium nitrate / AW ;</p> <p><i>dependent variable (d)</i> 7 <u>dependent variable</u>: <u>rate</u> of growth / <u>mass</u> of algae ; 8 measure, (dry) mass of algae / weigh algae / light penetration / height of algae in tank / surface area of algae / counting cell number / AW ; 9 leave algae for <u>stated</u> time (more than one day) ;</p> <p><i>controls (c)</i> <i>max 3 controls from:</i> 10 same, (starting) mass / species / type / age, of algae ; 11 light (intensity) ; 12 provide other minerals / keep other minerals constant ; 13 temperature ; 14 pH / salinity ; 15 volume of water / solution / volume of tanks ; 16 carbon dioxide ;</p>	

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