



## Cambridge International AS & A Level

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**MARINE SCIENCE**

**9693/41**

Paper 4 A Level Data-handling and Investigative skills

**May/June 2023**

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 2023 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 **14** 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**

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|---|--|
| 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 | <p><u>'List rule' guidance</u></p> <p>For questions that require <i>n</i> responses (e.g. State <b>two</b> reasons ...):</p> <ul style="list-style-type: none"><li>• The response should be read as continuous prose, even when numbered answer spaces are provided.</li><li>• Any response marked <i>ignore</i> in the mark scheme should not count towards <i>n</i>.</li><li>• Incorrect responses should not be awarded credit but will still count towards <i>n</i>.</li><li>• Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should <b>not</b> 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.</li><li>• Non-contradictory responses after the first <i>n</i> responses may be ignored even if they include incorrect science.</li></ul> |

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

Question	Answer	Marks
1(a)(i)	A: Golgi, (body / apparatus) ; B: <u>rough</u> endoplasmic reticulum / <u>RER</u> ;	<b>2</b>
1(a)(ii)	10 (mm) ;  10 / 5000 = 0.002 ;  correct unit ; <b>ONLY AWARD UNIT MARK IF ANSWER IS CORRECT</b> (e.g. 2 μm, 0.002 mm)	<b>3</b>
1(b)(i)	increase and decrease; (increase up to) 25 (ppt) / from 30 (ppt);	<b>2</b>
1(b)(ii)	<i>any 3 of:</i> 1 (correct because) the highest / fastest rate of growth is at 25 (ppt) / <b>AW</b> ; 2 carried out with ten / many leaves so reliable ; (incorrect because) 3 no significant difference between 20 / 30 (ppt) and 25 ) ppt) ; 4 (because) standard deviations overlap (between 20 / 30 (ppt) and 25 (ppt)) / <b>AW</b> ; 5 optimum may be between 20 (ppt) and 30 (ppt) ; 6 no measurements taken between 20 (ppt) and 25 (ppt) / 25 (ppt) and 30 (ppt) ;	<b>3</b>
1(b)(iii)	<i>any 4 of:</i> 1 reduced photosynthesis ; 2 (because) desalination plants release high salinity water / brine / concentrated brine / increase salinity / return salt to sea / <b>AW</b> ; 3 growth is reduced / lower growth, at high salinities / concentrations / above 25 (ppt) / <b>AW</b> ; 4 osmotic effects harm the seagrass / osmosis will occur / <b>AW</b> ; 5 water leaves cells / plant / seagrass ; 6 cells / plant / seagrass, no longer supported / cells plasmolyse / cells are not turgid / <b>AW</b> ; 7 desalination plants stir up sediment / increase turbidity ; 8 <b>AVP</b> ;	<b>4</b>

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Question	Answer	Marks
2(a)(i)	clear labelling of stroma ;	<b>1</b>
2(a)(ii)	<ol style="list-style-type: none"> <li>1 thin, unbroken, clear lines that do not overlap ;</li> <li>2 correct proportions and takes up at least two-thirds of space ; <i>(gap between outer membrane and thylakoids of similar size to width of thylakoids + intergrana and grana in same direction, no large spaces between thylakoids)</i></li> <li>3 correct detail ; <i>(membrane on outside with two continuous lines, two intergrana on left + start of third intergranum on left + grana drawn on right)</i></li> <li>4 no shading and only draw what is inside circle + no additional structures ; <i>(needs to have membrane, grana and intergrana)</i></li> </ol>	<b>4</b>
2(b)(i)	correct mean (178.25) ; correct number of significant figures (178) ;	<b>2</b>
2(b)(ii)	<i>any 1 of:</i> <ol style="list-style-type: none"> <li>1 to show that chloroplasts do not change the colour of DCPIP without light / <b>AW</b> ;</li> <li>2 to show that light is needed (to change colour of DCPIP) / to show what would happen (to DCPIP) without light ;</li> <li>3 to show that DCPIP does not change colour without light ;</li> </ol>	<b>1</b>
2(b)(iii)	<i>any 1 of:</i> <ol style="list-style-type: none"> <li>1 to show that light does not change the colour of DCPIP / <b>AW</b> ;</li> <li>2 to compare the final colours (of other tubes) with ;</li> <li>3 to show that chloroplasts / chlorophyll (and light) are needed (to change the colour) ;</li> </ol>	<b>1</b>
2(b)(iv)	<i>any 4 of:</i> <ol style="list-style-type: none"> <li>1 fastest rate of decolourisation with red and blue light / blue light / slowest rate with green / <b>AW</b> / <b>ORA</b> ;</li> <li>2 red / blue, light absorbed ;</li> <li>3 green is reflected / not absorbed ;</li> <li>4 (by) chlorophyll / primary pigments / (chloroplasts) contain chlorophyll ;</li> <li>5 electrons (from chlorophyll) are released ;</li> <li>6 electrons decolourised / reduced DCPIP ;</li> </ol>	<b>4</b>



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Question	Answer	Marks
2(b)(v)	<p>any 3 of:</p> <ol style="list-style-type: none"> <li>1 xanthophyll / fucoxanthin / carotene / chlorophyll <u>B</u> / phycobilin / phycocyanin / <b>AW</b> ;</li> <li>2 red / yellow / orange light is absorbed by surface water / does not penetrate far (in water) / <b>AW</b> ;</li> <li>3 blue / green light available (in deeper water) / blue / green reaches deeper water / penetrates into deeper water ;</li> <li>4 (accessory pigments) absorb other wavelengths of light / absorb blue / green / <b>AW</b> ;</li> <li>5 so (algae) can produce glucose / starch / compete (with other algae) ;</li> </ol>	<b>3</b>

Question	Answer	Marks
3(a)	<p>any 3 of:</p> <ol style="list-style-type: none"> <li>1 symbiosis / mutualism ;</li> <li>2 <i>Endoriftia</i> live within trophosome / live inside (body of) <i>Riftia</i> ;</li> <li>3 <i>Endoriftia</i> uses (energy from) hydrogen sulfide (to fix carbon) / performs chemosynthesis ;</li> <li>4 <i>Endoriftia</i> provide glucose / carbohydrate (for <i>Riftia</i>) / <b>AW</b> ;</li> <li>5 <i>Riftia</i> provides minerals / substrate / source of carbon dioxide ;</li> </ol>	<b>3</b>
3(b)(i)	<p>Scale: linear scale for y-axis for mass of carbon dioxide that uses at least half of axis ;            Label: label for y axis ;            Plots: bars plotted accurately ;            Bars: gaps between the hydrogen sulfide concentrations and neat bars ;            Key: key and x axis labelled ;</p>	<b>5</b>
3(b)(ii)	<p>any 4 of:</p> <ol style="list-style-type: none"> <li>1 increasing hydrogen sulfide (concentration) increases rate (of carbon dioxide uptake) / rate of chemosynthesis / <b>AW</b> ;</li> <li>2 increasing hydrogen sulfide (concentration) has no effect between 65 and 250 when at low pressure / (only) increases rate between 65 and 250 when at high pressure / <b>AW</b> ;</li> <li>3 (increasing) pressure does not affect rate at 35 / 65 / rate is same at both pressures at 35 / 65 / increasing pressure increases rate at 250 / <b>AW</b> ;</li> <li>4 carbon dioxide / hydrogen sulphide is used for chemosynthesis ;</li> <li>5 credit manipulated data for carbon dioxide uptake ;</li> <li>6 rate is limited by hydrogen sulfide between 35 and 65 / rate is limited by pressure between 65 and 250 ;</li> </ol>	<b>4</b>

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Question	Answer	Marks
4(a)	<p><i>any 4 of:</i></p> <ol style="list-style-type: none"> <li>1 smolt placed into cages (from stocks) ;</li> <li>2 feed on (high) protein pellets / feed <u>regularly</u> / <b>AW</b> ;</li> <li>3 keep fish of different ages / sizes in separate cages / <b>AW</b> ;</li> <li>4 place in open water / estuary / coastal water ;</li> <li>5 <u>water currents</u> remove waste / deliver food / nutrients / oxygen ;</li> <li>6 <u>monitoring</u> of abiotic factors / named factor ;</li> <li>7 add pesticides / antibiotics / vaccines / include cleaner fish / keep stocking density low / <b>AW</b> ;</li> <li>8 prevent predators getting in / <b>AW</b> ;</li> <li>9 harvest / reach maturity after one / two years ;</li> </ol>	<b>4</b>
4(b)(i)	32 (kg) ;	<b>1</b>
4(b)(ii)	<p><i>any 3 of:</i></p> <ol style="list-style-type: none"> <li>1 (salmon aquaculture) releases less phosphate / releases less carbon dioxide / causes less land loss / <b>ORA</b> ;</li> <li>2 (less phosphate) so less eutrophication / fewer algal blooms / <b>ORA</b> ;</li> <li>3 less oxygen loss / <b>AW</b> / <b>ORA</b> ;</li> <li>4 (less carbon dioxide), so less global warming / less (enhanced) greenhouse effect / less acidification / <b>AW</b> / <b>ORA</b> ;</li> <li>5 less loss of, biodiversity / habitats, due to less land loss / <b>ORA</b> ;</li> <li>6 shrimp aquaculture has less biotic depletion so fewer wild organisms are lost / less loss of biodiversity (in oceans) / <b>ORA</b> ;</li> </ol>	<b>3</b>
4(b)(iii)	<p><i>any 4 of:</i></p> <ol style="list-style-type: none"> <li>1 seaweed / mussels, remove phosphate (from salmon) / <b>AW</b> ;</li> <li>2 less eutrophication / algal blooms / <b>AW</b> ;</li> <li>3 seaweed removes carbon dioxide / reduces carbon dioxide ;</li> <li>4 (carbon dioxide) produced by respiration / decay / decomposition ;</li> <li>5 seaweed will, increase / release oxygen, (from photosynthesis) ;</li> <li>6 from photosynthesis ;</li> <li>7 (seaweed / mussels) has little (extra) biotic depletion / <b>AW</b> ;</li> <li>8 (seaweed / mussels) has little extra land loss / land loss is insignificant / <b>AW</b> ;</li> <li>9 seaweed can provide a habitat for other organisms / increase biodiversity ;</li> </ol>	<b>4</b>

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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
5(a)	<i>any 2 of:</i> 1 plastic broken into pieces of less than <u>5mm</u> ; 2 due to action of UV (radiation) ; 3 due to wave (action) ; 4 due to high temperature ; 5 due to wind (action) ;	<b>2</b>

Question	Answer						Marks
5(b)(i)	human population density / people per km <sup>2</sup>	r <sub>1</sub> , rank of human population density	number of microplastic particles per 250 cm <sup>3</sup> sand	r <sub>2</sub> , rank of number of microplastic particles	D (r <sub>1</sub> – r <sub>2</sub> )	D <sup>2</sup>	<b>2</b>
	0	1	5	1	0	0	
	5	2	7	3	–1	1	
	10	3.5	19	6	–2.5	6.25	
	15	5	6	2	3	9	
	155	11	85	11	0	0	
	75	8.5	75	9.5	–1	1	
	65	7	25	7	0	0	
	75	<b>8.5</b>	65	8	<b>0.5</b>	<b>0.25 ;</b>	
	10	3.5	11	4.5	–1	1	
	20	6	11	4.5	1.5	2.25	
	120	10	75	9.5	0.5	0.25	
	175	12	115	12	0	0	
					$\Sigma D^2 =$	<b>21 ;</b>	
5(b)(ii)	0.93 ;						<b>1</b>

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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
5(b)(iii)	<p><i>any 3 of:</i>            the null hypothesis is rejected ;            the calculated value is greater than the critical value ;</p> <p>critical value is 0.587 ;</p> <p>there is a significant positive correlation / there is a significant association between human population and microplastic density ;</p>	<b>3</b>
5(c)	<p><i>any 2 of:</i>            (area with high human populations have) high densities of microplastic / <b>AW</b> ;            microplastics absorb toxins / <b>AW</b> ;            mussels, take in / eat, microplastics ;</p> <p>humans get toxins from eating mussels / humans get microplastics from eating mussels / <b>AW</b> ;</p>	<b>2</b>

Question	Answer	Marks
6	<p><i>(hypothesis)</i> clear statement of hypothesis ;</p> <p><i>and any 10 of:</i> <i>(independent variable)</i> 1 independent variable identified as <u>pH</u> ; 2 use at least five different pHs ;</p> <p><i>(dependent variable)</i> 3 dependent variable identified as number of larvae that settle / <b>AW</b> ; 4 counting number that settle in a <u>set time</u> ;</p> <p><i>(standardised variables and methods)</i> <b>(max 4)</b> 5 same <u>volume</u> of tank / water ; 6 same salinity / stated salinity / <b>AW</b> ; 7 maintain temperature / monitor temperature / <b>AW</b> ; 8 same species of oyster / larvae / age of larvae / number of larvae / <b>AW</b> ; 9 same mass of food / type of food / <b>AW</b> ; 10 maintain oxygen by bubbling air through ; 11 same substrate type / same area / volume of substrate / <b>AW</b> ; 12 use of random sampling method to count larvae ; 13 same light intensity by placing under lamp / in same area of light / <b>AW</b> ;</p> <p><i>(safety and ethics)</i> 14 wear eye protection / gloves ± when handling solutions / buffers / acids / larvae / <b>AW</b> ; 15 no extreme pH / temperature used / allow larvae to acclimatise / return oysters to wild / do not release chemicals into sea / do not take larvae from wild stocks / <b>AW</b> ;</p> <p><i>(analysis)</i> <b>(max 3)</b> 16 at least two replicates <b>and</b> finding means / medians ; 17 graph of number settled against pH ; 18 correct statistical test (e.g. chi squared / t-test / standard error, depending on comparison) / use of standard deviations / error bars ; 19 results table with headings drawn and independent variable in left column ;</p>	11