



# Cambridge International AS & A Level

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**MARINE SCIENCE**

**9693/41**

Paper 4 A Level Data-handling & Investigative Skills

**October/November 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 October/November 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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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.

**PUBLISHED****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.

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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
1(a)(i)	(large) (permanent) vacuole ; store sap / salts / water / sugars / nutrients / <b>AW</b> :	<b>2</b>
1(a)(ii)	length measured ; divide length by 30 000 ; convert to magnitude of units and unit, ( $\mu\text{m}$ or mm) ;	<b>3</b>
1(b)(i)	<i>any 3 of:</i> 1 no change / little change, in percentage water content at 35 (ppt), 37 (ppt) and 46 (ppt) ; 2 decrease at 54 (ppt) ; 3 ref to overlap of error bars ; 4 (at 54 ppt) decrease after four and at six weeks / continues to decrease over time ; 5 credit correct manipulated data ;	<b>3</b>
1(b)(ii)	<i>any 3 of:</i> 1 water moves out (of cells) ; 2 by osmosis ; 3 because water potential was higher inside / moves down a water potential gradient / <b>ORA</b> ; 4 concentration of, solute / salts / <b>AW</b> , in cells increases ; 5 so that water potential decreases (in cells) ; 6 more water is removed (at 54 ppt) over time ;	<b>3</b>

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Question	Answer	Marks
1(c)	<p><i>any 3 of:</i></p> <p>1 metal ions are taken up by producers / filter feeders / low trophic levels / <b>AW</b> ;</p> <p>2 metal ions are, not excreted / stored in tissues / bioaccumulation occurs / <b>AW</b> ;</p> <p>3 concentration of metal ions increases along the food chain / biomagnification occurs / <b>AW</b> ;</p> <p>4 death of producers / lower trophic level organisms results in less food / less energy in ecosystem / damage to food chains / <b>AW</b> ;</p> <p>5 ref to how metal ions damage organisms ;</p>	<b>3</b>

Question	Answer	Marks
2(a)	<p><math>C_6H_{12}O_6</math> ;</p> <p><math>6CO_2 + 6H_2O</math> ;</p>	<b>2</b>
2(b)	<p><math>525 \div 0.6 \div 2 = 437.5</math> ;</p> <p>440 ;</p>	<b>2</b>
2(c)(i)	<p>two separate linear y axes scales for oxygen and ventilation rate that use at least half the grid ;</p> <p>both y axes and x axis labelled and with units ;</p> <p>x axis has linear scale ;</p> <p>ruled straight lines with key ;</p> <p>plots ;;</p>	<b>6</b>

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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
2(c)(ii)	both oxygen consumption and ventilation rate increase then decrease ; both increase up to water current speed of 15 cm s <sup>-1</sup> / decrease after 20 cm s <sup>-1</sup> ;	<b>2</b>
2(c)(iii)	<p><i>any 4 of:</i></p> <ol style="list-style-type: none"> <li>1 pumped ventilation, uses, operculum / muscles / has open and closing mouth, to force water over gills and ram ventilation uses open mouth to allow water to flow over gills / <b>AW</b> ;</li> <li>2 swaps to ram ventilation after 15 cm s<sup>-1</sup> / from 20 cm s<sup>-1</sup> ;</li> <li>3 increased water speed causes more muscle contraction / <b>AW</b> ;</li> <li>4 (from 0 to 15 cm s<sup>-1</sup>) more oxygen for more respiration ;</li> <li>5 (pumped) ventilation rate increases to supply oxygen ;</li> <li>6 pumped ventilation is more energetically costly compared with ram ventilation / pumped ventilation uses more energy / ram ventilation is more efficient / <b>AW</b> ;</li> <li>7 below 15 cm s<sup>-1</sup> water speed is not fast enough to supply sufficient oxygen via ram ventilation / water speed needs to be at least 15 for ram ventilation ;</li> </ol>	<b>4</b>

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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
3(a)	<p><i>any 4 of:</i></p> <ul style="list-style-type: none"> <li>1 brood salmon are used to produce eggs and sperm / <b>AW</b> ;</li> <li>2 eggs / small fish / fry / alevins, kept in (indoor), hatcheries / tanks ;</li> <li>3 transfer to, cages / nets, in sea / outdoors / <b>AW</b> ;</li> <li>4 keep large and small fish apart / separate by age / <b>AW</b> ;</li> <li>5 add feed / add feed pellets / <b>AW</b> ;</li> <li>6 use of pesticides / antibiotics / vaccinations / <b>AW</b> ;</li> <li>7 prevent predator action / <b>AW</b> ;</li> <li>8 ocean currents supply oxygen / food / remove waste ;</li> </ul>	<b>4</b>
3(b)(i)	(82 / 100 × 53 =) 43 ;	<b>1</b>
3(b)(ii)	<p><i>any 2 of:</i></p> <ul style="list-style-type: none"> <li>1 salmon live for more than one year / <b>AW</b> ;</li> <li>2 more salmon escape each year / <b>AW</b> ;</li> <li>3 damage to the cages / bad weather disrupting the cages / cages get larger holes over time / <b>AW</b> ;</li> <li>4 number of wild salmon is decreasing / <b>AW</b> ;</li> <li>5 increased number of salmon farms / more stock kept / <b>AW</b> ;</li> <li>6 credit reason for decrease in number of wild salmon / <b>AW</b> ;</li> </ul>	<b>2</b>



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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
3(c)(i)	<p><i>any 1 of:</i></p> <ol style="list-style-type: none"> <li>1 salmon that have lived for several years outside the farm will have less dye in body / will have been eating more wild food / <b>AW</b> ;</li> <li>2 recently escaped salmon will have higher dye concentrations ;</li> <li>3 egg sizes vary (so concentration varies) / wild salmon fertilised salmon so dye reduced ;</li> <li>4 different amounts of dye were given to salmon when in the farm / some salmon ate more food when in the farm ;</li> </ol>	<b>1</b>
3(c)(ii)	<p><i>any 4 of:</i></p> <ol style="list-style-type: none"> <li>1 escaped salmon are able to breed / reproduce / <b>AW</b> ;</li> <li>2 but egg viability / hatching rate is lower than wild salmon / do not develop as well as wild salmon / <b>AW</b> ;</li> <li>3 escaped salmon breed for several years ;</li> <li>4 shown by the wide range of dye in eggs ;</li> <li>5 escaped salmon outcompeting wild salmon / consume more food / <b>AW</b> ;</li> <li>6 wild salmon may lose breeding sites / habitats / <b>AW</b> ;</li> <li>7 fewer wild salmon survive / proportion of wild salmon are decreasing / <b>AW</b> ;</li> <li>8 salmon may pass on disease to the wild salmon ;</li> <li>9 escaped salmon affect the gene pool / reduce genetic diversity / have weaker alleles / <b>AW</b> ;</li> </ol>	<b>4</b>

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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
3(c)(iii)	<p><i>any 2 of:</i></p> <ol style="list-style-type: none"> <li>1 a very small sample size has been used / not enough data / <b>AW</b> ;</li> <li>2 no mention of how many eggs, develop / produced (as it is a percentage) / redds may have different numbers of eggs / <b>AW</b> ;</li> <li>3 the wild salmon may breed in different areas (compared with escaped) / no clear information about locations / no information about size of habitat / no information about distances escaped salmon travel / <b>AW</b> ;</li> <li>4 the dye colour may be lost from eggs / salmon after several years very wide difference in dye concentration / dye is not passed on into adults from eggs / <b>AW</b> ;</li> <li>5 no data about disease or genetics of salmon ;</li> <li>6 no direct data to show how wild salmon populations have changed / correlation does not show causation / <b>AW</b> ;</li> </ol>	<b>2</b>
4(a)	<ol style="list-style-type: none"> <li>1 thin, unbroken clear lines in pencil ;</li> <li>2 correct proportions and takes up at least two-thirds of space ;</li> <li>3 six cells drawn, cell walls for all cells, nucleus in middle cell, double line for outer layer ;</li> <li>4 no shading and only draw what is inside circle ;</li> </ol>	<b>4</b>

Question	Answer						Marks
4(b)(i)	area of mangrove forest / km <sup>2</sup>	rank of area of forest (r <sub>1</sub> )	Simpson's index of diversity	rank of Simpson's index of diversity (r <sub>2</sub> )	D (r <sub>1</sub> -r <sub>2</sub> )	D <sup>2</sup>	<b>2</b>
	0.02	8	0.44	7	1	1	
	0.04	5.5	0.56	5	0.5	0.25	
	0.02	<b>8</b>	0.34	10	<b>-2</b>	<b>4</b>	
	0.11	1	0.82	1	0	0	
	0.02	<b>8</b>	0.38	8	<b>0</b>	<b>0 ;</b>	
	0.05	4	0.61	3	1	1	
	0.06	3	0.58	4	-1	1	
	0.09	2	0.75	2	0	0	
	0.01	10	0.35	9	1	1	
	0.04	5.5	0.54	6	-0.5	0.25	
						<b>Σ D<sup>2</sup> = 8.5 ;</b>	

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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
4(b)(ii)	0.948 ;;	<b>2</b>
4(b)(iii)	<p><i>any 3 of:</i></p> <p>null hypothesis is rejected ;</p> <p>calculated value is greater than the critical value ;</p> <p>critical value identified as 0.648 ;</p> <p>there is a (significant) positive correlation between size of mangrove forest area and species diversity / there is probability of less than 0.05 that the association is due to chance ;</p>	<b>3</b>
4(b)(iv)	<p><i>any 2 of:</i></p> <p>more producers / more productivity / more photosynthesis ;</p> <p>more energy enters ecosystem ;</p> <p>more (trophic) levels possible in food chains ;</p> <p>more niches ;</p> <p>more habitats / more (variety of) food sources / more nesting sites / more shelter from predators / <b>AW</b> ;</p>	<b>2</b>

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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
4(c)	<p><i>any 3 of:</i></p> <ol style="list-style-type: none"><li>1 few people are currently involved / <b>AW</b> ;</li><li>2 but local people, want / are willing to get involved / <b>AW</b> ;</li><li>3 need to pay people / compensate for time spent working / <b>AW</b> ;</li><li>4 education / training needed (as people do not already have skills) ;</li><li>5 train local people to teach other locals (peer education) / encourage social activities around planting / <b>AW</b> ;</li><li>6 local community involvement could be more successful than 'top down' government work / make local people stakeholders / <b>AW</b> ;</li></ol>	<b>3</b>

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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
5(a)(i)	reduced NADP / NADPH / NADPH <sub>2</sub> ; ATP ;	<b>2</b>
5(a)(ii)	<i>any 2 of:</i>  (species A) because it can absorb more light / green light, between 510 nm and 640 nm ;  red light / longer wavelength light, is not available in deeper water / <b>AW / ORA</b> ;  so (species A) has, accessory pigments / fucoxanthin, (as well as chlorophyll) (that absorbs in the 510 nm to 640 nm range);	<b>2</b>

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Question	Answer	Marks
5(b)	<p><i>hypothesis</i></p> <p>1 photosynthesis (rate) / (rate of) oxygen production, will decrease as weedkiller concentration increases / <b>AW</b> ;</p> <p><i>and any 10 of:</i></p> <p><i>independent variable</i></p> <p>2 identified as concentration of atrazine ;</p> <p>3 use of at least 5 different concentrations in range of up to 1% ;</p> <p><i>dependent variable</i></p> <p>4 identified as rate of photosynthesis / rate of oxygen production / <b>AW</b> ;</p> <p>5 ref to method of measuring dependent variable in set time ;</p> <p><i>standardised variables</i></p> <p><i>max 3</i></p> <p>6 same volume of water / same salinity of water ;</p> <p>7 constant temperature ;</p> <p>8 pH ;</p> <p>9 same size / volume / mass of plant ;</p> <p>10 light intensity / wavelength / lamp placed at set distance from plant / <b>AW</b> ;</p> <p>11 same volume / concentration of hydrogencarbonate solution / same carbon dioxide / <b>AW</b> ;</p>	11

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Question	Answer	Marks
5(b)	<p><i>method</i> <i>max 3</i></p> <p>12 method to make dilutions ;</p> <p>13 ref to placing shoot of plant cut end uppermost in boiling tube / beaker ;</p> <p>14 ref to using paperclip to weigh down plant / <b>AW</b> ;</p> <p>15 ref to using 0% or water to replace atrazine as a control experiment ;</p> <p>16 ref to using a heat shield between lamp and plant / use water bath ;</p> <p>17 use of pH buffer solutions ;</p> <p><i>analysis</i> <i>max 3</i></p> <p>18 ref to replicating experiment 3 times and calculating means / medians ;</p> <p>19 method for calculating the rate of photosynthesis ;</p> <p>20 plot graph of rate of photosynthesis against concentration ;</p> <p>21 ref to suitable named statistical test e.g. Spearman's rank ;</p> <p>22 correct example of results table with headings ;</p> <p><i>safety and ethics</i></p> <p>23 atrazine is toxic so, use eye protection / use gloves / wash spills / pH buffers are irritants so use eye protection / gloves ;</p> <p>24 do not wash down sink / AW, due to environmental impacts / do not take large amounts of plants from the wild / <b>AW</b> ;</p>	