



## Cambridge International AS & A Level

---

**MARINE SCIENCE**

**9693/43**

Paper 4 A Level Data-handling and Investigative skills

**May/June 2023**

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 2023 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 **17** 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	<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.

**PUBLISHED**

This mark scheme will use the following abbreviations:

<b>;</b>	separates marking points
<b>/</b>	separates alternatives within a marking point
<b>()</b>	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)

**PUBLISHED**

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
1(a)	A: phospholipid ; B: (carrier / integral / channel / intrinsic) protein ;	<b>2</b>
1(b)(i)	correct reading from graph (16) ; calculation of gradient ( $16 / 20 = 0.8$ ) ; correct units ( $\mu\text{g min}^{-1}$ ) ;	<b>3</b>
1(b)(ii)	both have same (increase) up to 15 (minutes) / both are same rate up to 15 mins ; <i>AND 1 of:</i> with cyanide, the uptake levels off / no more taken up / <b>ORA</b> ; without cyanide the maximum rate is, higher / <b>ORA</b> ;	<b>2</b>
1(b)(iii)	<i>any 4 of:</i> 1 (facilitated) diffusion occurs ; 2 because potassium enters the cells when cyanide is present / when no respiration / when no ATP released ; 3 (facilitated diffusion occurs when) concentration of potassium is higher outside the cells compared to inside the cells (over the first 15 mins) / <b>AW</b> ; 4 active transport (also) occurs ; 5 because adding cyanide causes uptake to stop / stops when no respiration / <b>AW</b> ; 6 and active transport requires, energy / ATP / <b>AW</b> ; 7 active transport moves against the gradient ;	<b>4</b>

**PUBLISHED**

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
2(a)(i)	one mark for correct division of 516 / 111 ; one mark for correct sig. figs. of 4.649 ;	<b>2</b>
2(a)(ii)	<i>any 3 of:</i> rod and line takes fewer fish / purse seine fishing takes more fish ; catch per unit effort is lower for rod and line so this method is less efficient / takes less catch per trip / <b>AW / ORA</b> ; rod and line may catch fewer non-target species / less bycatch / <b>ORA</b> ; lower catch per unit effort over time may indicate that the stocks of fish caught by rod and line are lower in those areas / <b>AW / ORA</b> ; purse seine causes overfishing / takes more than MSY / depletes stocks / <b>ORA</b> ; <b>AVP</b> ;	<b>3</b>
2(b)(i)	there is no <u>difference</u> in the mean length of fish caught by rod and line and the mean length of the fish caught by purse seine / <b>AW</b> ;	<b>1</b>
2(b)(ii)	0.49 ;	<b>1</b>
2(b)(iii)	74.02 (cm) to 75.98 (cm) ;	<b>1</b>



**PUBLISHED**

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
2(b)(iv)	<p><i>any 3 of:</i></p> <ol style="list-style-type: none"> <li>1 the null hypothesis is rejected ;</li> <li>2 there is a probability of &lt;0.05 that the difference in mean length is due to chance / <b>AW</b> ;</li> <li>3 there is a (significant) difference in the mean lengths of the fish caught by rod-and-line and purse seine ;</li> <li>4 as the confidence limits do not overlap ;</li> <li>5 mean length caught by rod and line is greater than by purse seine ;</li> <li>6 the range of sizes is greater / more variation for purse seine (as higher standard error) ;</li> </ol>	<b>3</b>
2(b)(v)	<p><i>any 3 of:</i></p> <p>purse seine will lead to a fall in stocks / populations / overfishing / <b>ORA</b> ;</p> <p>more juvenile / immature, fish are caught/more fish are caught before they are mature / the mean length of fish is lower / smaller fish are caught / <b>ORA</b> ;</p> <p>less reproduction / fewer fish reproduce / fish caught before they can reproduce / less recruitment / <b>ORA</b> ;</p> <p>a wider variety of fish are caught by purse seine / more bycatch / more small fish species / bait fish / <b>ORA</b> ;</p> <p>affects food chains and food webs / loss of biodiversity / <b>AW</b> ;</p>	<b>3</b>

**PUBLISHED**

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
2(c)	<p><i>any 3 of:</i></p> <p>restricting seasons / times of year / <b>AW</b> ;</p> <p>restricting <u>mesh sizes</u> / bigger minimum mesh size ;</p> <p>catch quotas / restrict <u>net sizes</u> / catch up to MSY / licences / <b>AW</b> ;</p> <p>restricting areas / marine reserves / marine protected area / <b>AW</b> ;</p> <p>restricting size of fish / increase minimum fish length / <b>AW</b> ;</p> <p>use of licences / permits / <b>AW</b> ;</p> <p>restrict number of boats / fishing effort / hours at sea / fishing intensity / boat size / fleet size / <b>AW</b> ;</p>	<b>3</b>

**PUBLISHED**

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
3(a)	<p><i>any 4 of:</i></p> <ol style="list-style-type: none"> <li>1 fertiliser contains nitrates / phosphates / <b>AW</b> ;</li> <li>2 algal blooms / eutrophication / <b>AW</b> ;</li> <li>3 reducing light intensity / increased turbidity / <b>AW</b> ;</li> <li>4 less photosynthesis (by zooxanthellae / phytoplankton / algae) ;</li> <li>5 less glucose for coral / equivalent ;</li> <li>6 death / decomposition, of algae / <b>AW</b> ;</li> <li>7 reduced oxygen / hypoxia, (due to bacterial respiration) ;</li> <li>8 less (coral) respiration ;</li> </ol>	<b>4</b>
3 (b)(i)	<p>two linear y-axis scales using more than half grid ;</p> <p>plots correct ;</p> <p>all axes labelled ;</p> <p>points joined with ruled, straight lines with no extrapolation / bars neat and even spaces between ;</p> <p>lines or bars labelled / <b>AW</b> ;</p>	<b>5</b>

**PUBLISHED**

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
3(b)(ii)	<p><i>any 3 of:</i></p> <ol style="list-style-type: none"> <li>1. (increased coral growth) increases <u>primary</u> productivity of reef / more energy fixed / more carbon fixed ;</li> <li>2. increased, number of species / species richness ;</li> <li>3. more food for (consumer) organisms ;</li> <li>4. more niches available / habitats / shelter / <b>AW</b> ;</li> <li>5. more food chains / <b>AW</b> ;</li> <li>6. more nursery sites / <b>AW</b> ;</li> <li>7. (and) increased balanced number of species / <b>AW</b> ;</li> </ol>	<b>3</b>
3(b)(iii)	<p><i>any 2 of:</i></p> <p><i>idea of</i> correlation does not mean causation / <b>AW</b> ;</p> <p>has not been compared with an area of reef not in MPA / there is no control area / area may still have pollution (from other sources) ;</p> <p>regrowth (of coral) could be due to other factors / <b>AW</b> ;</p>	<b>2</b>

**PUBLISHED**

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
4(a)	able to live in / tolerate a range of salinities / can live in fresh and sea water / <b>AW</b> ;	<b>1</b>
4(b)(i)	correct length conversion to $\mu\text{m}$ from mm or cm (100 000) ; correct division of 100 000 by 14 000 (7.14...);	<b>2</b>
4(b)(ii)	outline drawn with thin, clear, unbroken lines ; proportions of length and width okay ; <i>at least 1 / 3 of space, not drawn over text of question and fourth crista between half and three quarters length of other cristae ;</i> correct detail ; <i>four cristae and membrane as two lines</i> no shading ; <i>at least three cristae and membrane must be drawn</i>	<b>4</b>
4(c)(i)	fish are different masses / different sizes / to make a valid comparison / <b>AW</b> ;	<b>1</b>
4(c)(ii)	decrease then increase / <b>AW</b> ; correct quantitative manipulation of data ;	<b>2</b>

**PUBLISHED**

Question	Answer	Marks
4(c)(iii)	<p><i>any 4 of:</i></p> <ol style="list-style-type: none"> <li>1 increased oxygen consumption due to increased (aerobic) respiration / ATP production / <b>AW</b> ;</li> <li>2 <u>increased</u> (density of) ionocytes when need to transport more, salt / ions / <b>ORA</b> ;</li> <li>3 ions pumped out in high salinity / 35 / ions pumped in, in low salinity / 0 / no need to osmoregulate at 11 / <b>ORA</b> / <b>AW</b> ;</li> <li>4 ref to <u>active transport</u> of ions ;</li> <li>5 high(er) salinity water has lower oxygen concentration ;</li> <li>6 increasing salinity increases gill SA ;</li> <li>7 (so) increasing gill area will compensate for lower oxygen concentration / increased gill surface area to increase diffusion of oxygen / <b>AW</b> ;</li> </ol>	<b>4</b>

**PUBLISHED**

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
5(a)	<p><i>any 2 of:</i></p> <p><i>idea of additional stages / larval stage ;</i></p> <p><i>for distribution / live in different habitats ;</i></p> <p><i>to consume different food source / not compete with adults / <b>AW</b> ;</i></p>	<b>2</b>
5(b)(i)	<p><i>any 3 of:</i></p> <p>1 more two-month-old / older microplastic (with algal growth) are consumed (by all copepod groups) ;</p> <p>2 largest increase for male copepods (between new and old) / smallest increase for larvae / <b>AW</b> ;</p> <p>3 adults consume more than larvae / larvae consume the least / <b>ORA</b> ;</p> <p>4 correct manipulation of data ;</p> <p>5 more new microplastics are consumed by the females / least new microplastic consumed by larvae ;</p>	<b>3</b>
5(b)(ii)	<p><i>any 3 of:</i></p> <p>1 food breaks down / decomposes, to release mineral ions / named mineral ion ;</p> <p>2 algae grow due to high mineral ion concentration / <b>AW</b> ;</p> <p>3 (large amounts of) algae will <u>attach</u> to the microplastics / <b>AW</b> ;</p> <p>4 microplastics <u>absorb</u> toxins ;</p> <p>5 copepods eat (large amounts of) microplastic (when covered with algae) / <b>AW</b> ;</p> <p>6 salmon will consume copepods that contain microplastics / toxins will accumulate in salmon / bioaccumulation / biomagnification / <b>AW</b> ;</p>	<b>3</b>

**PUBLISHED**

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
5(b)(iii)	<p><i>clear statement of hypothesis:</i> increasing temperature will increase rate of / reduce time taken for, breakdown / <b>AW</b> ;</p> <p><b>AND any 10 of:</b></p> <p><i>independent variable</i></p> <p>1 independent variable identified as temperature ;</p> <p>2 using a range of at least five temperatures, stated or range given ;</p> <p><i>dependent variable</i></p> <p>3 dependent variable identified as measuring loss of / change in, mass / length / area, of plastic ;</p> <p>4 description of how to measure change over a stated time ;</p> <p><i>standardised variables</i></p> <p><b>MAX 4 of:</b></p> <p>5 same size / type of plastic / same mass / area, of plastic ;</p> <p>6 same light intensity / UV / <b>AW</b> ;</p> <p>7 same movement of water / <b>AW</b> ;</p> <p>8 same volume of water / <b>AW</b> ;</p> <p>9 same salinity / <b>AW</b> ;</p> <p>10 same acidity / carbon dioxide / other correct variable / <b>AW</b> ;</p>	<b>11</b>



**PUBLISHED**

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
5(b)(iii)	<p><i>Safety and ethics</i></p> <p>11 safe / ethical disposal of plastic ;</p> <p>12 eye protection with pH buffers / salinity / care with heating apparatus / statement of low-risk experiment ;</p> <p><i>Analysis</i> <b>MAX 3 of:</b></p> <p>13 repeat at least three times and calculate means / medians / averages ;</p> <p>14 plot graph of rate / change in mass / <b>AW</b> vs. temperature ;</p> <p>15 correct named statistical test (e.g. Spearman’s rank) / standard deviation / error bars ;</p> <p>16 calculate rate as change / time taken ;</p> <p>17 results table with headings ;</p>	