CAMBRIDGE
International Education

Cambridge International AS & A Level

MARINE SCIENCE **9693/41**

Paper 4 A Level Data-handling and Investigative skills **May/June 2024**

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 2024 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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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 descriptions 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.

- 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
Underline	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)

Question	Answer	Marks
1(a)	controls the cell / contains genes / contains chromosomes / contains DNA / stores DNA / synthesis DNA / **AW** ;	**1**
1(b)(i)	2.0 up to 2.1 (three marks) ;;; correct answer to wrong number of significant figures (two marks) ;; 82 000 up to 85 000 (mm) **OR** division by 40 000 **OR** 0.00205 / 0.002125 (one mark) ;	**3**
1(b)(ii)	lines are thin, clear, unbroken and no shading ; size takes up most of the space provided ; correct proportions of gaps between membrane groups ; correct detail ; *nuclear envelope drawn as two close lines, circle structure present and at least four lines for bottom right membranes*	**4**
1(c)(i)	*any **3** of:* 1 surface water alga has high(est) / best, growth with purple / **AW** ; 2 *Dunaliella* has high(est) / best, growth with blue / **AW** ; 3 both species grow least with yellow / **AW** ; 4 surface water alga has highest overall growth (with purple) (compared with *Dunaliella*) / **AW** ; 5 *Dunaliella* is higher than surface alga with blue / green / yellow / orange / **ORA** 6 wider range of growth for surface water alga / **ORA** / **AW** ; 7 comparison with manipulated data ;	**3**
1(c)(ii)	*any **3** of:* 1 *Dunaliella* grows more with green / yellow (compared with surface alga) / is better at absorbing (all) colours / **AW** ; 2 red light does not penetrate into deeper water / **AW** ; 3 surface alga has (mainly) chlorophyll (a) / primary pigment ; 4 chlorophyll absorbs red and blue / chlorophyll does not absorb green / yellow ; 5 *Dunaliella* has (more) accessory pigments ; 6 *Dunaliella* is adapted for deep water because has high growth with blue / increase with blue / **AW ;** 7 but there is no proof for presence of accessory pigments ; 8 surface alga can absorb some of all colours / may just have different proportions of pigments ;	**3**

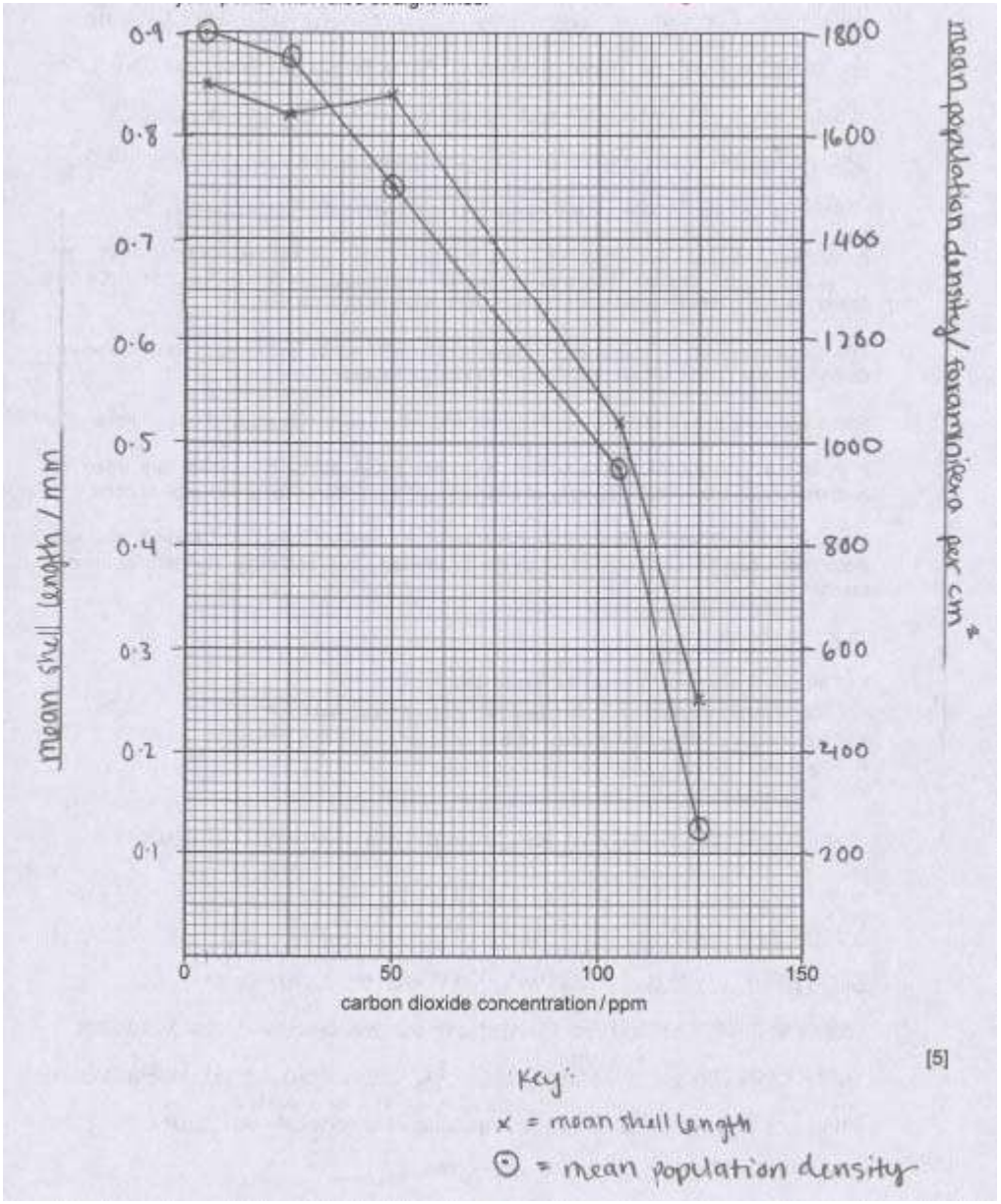
Question	Answer	Marks
2(a)(i)	*any **2** of:* 1 (uses) hydrogen sulfide ; 2 (and) carbon dioxide ; 3 (hydrogen sulfide is a) source of energy ;	**2**
2(a)(ii)	mutualistic relationship / mutualism ; *Riftia* obtains sugars / glucose from *Endoriftia* **and** *Endoriftia* gains minerals / carbon dioxide / shelter / protection / habitat from *Riftia* ;	**2**
2(b)	*any **3** of:* 1 more bacteria around vents / fewer bacteria around seabed / **AW** ; 2 methane / hydrogen provides energy ; 3 methane has a more / bigger, effect (than hydrogen) / **ORA** / **AW** ; 4 data manipulation to support answer ;	**3**
2(c)(i)	*any **2** of:* 1 there is a lot of variation (for the vents) because error bars are large (so less reliable) / **AW** ; 2 the error bars for the vents overlap so all vents have similar rates / **AW** ; 3 the error bar for deep sea bed does not overlap so is different (to vents) / **AW** ;	**2**
2(c)(ii)	*any **3** of:* 1 feeding is high(er) around vents (compared with deep seabed) / **ORA** / **AW** ; 2 protoctists obtain energy from the (chemosynthetic) bacteria / **AW** ; 3 (chemosynthetic) bacteria are producers / **AW** ; 4 but there may be other organisms that consume the bacteria / **AW** ; 5 conditions around the vents / seabed / **AW**, may differ from the laboratory ; 6 only one experiment / need more repeats / **AW** ;	**3**

Question	Answer	Marks
3(a)(i)	*any **3** of:* 1 eggs placed / larvae grown in indoor tanks / **AW** ; 2 sterile conditions / **AW** ; 3 (postlarvae) transferred to nurseries / nursery tanks ; 4 (post)larvae / juveniles, transferred into raceway ponds / outdoor pools / natural water / growout pools / **AW** ; 5 feed / algae provided / **AW** ; 6 **AVP** ;	**3**
3(a)(ii)	*any **2** of:* 1 availability of stock / **AW** ; 2 availability of clean water / water purification / remove wastes / **AW** ; 3 availability of feed / **AW** ; 4 efficiency of use of feed / use high quality feed / **AW** ; 5 availability of labour / **AW** ; 6 disease management / **AW** ; 7 availability of location / space / **AW** ; 8 (market) demand / **AW** ; 9 access to markets / transport / **AW** ; 10 return on investment / profit making / money to reinvest / **AW** ;	**2**
3(b)(i)	0.083 ;; (two marks) 2(.00) – 1.5(0) **or** 1.5 – 2 **or** 0.5 **or** ÷ 6 (for one mark only) mg dm^{-3} day^{-1} ;	**3**
3(b)(ii)	*any **3** of:* 1 with no mussels, there is a (steady) decrease ; 2 with four mussels there is a greater / steeper / **AW**, decrease ; 3 with eight mussels there is decrease up to 2 days and then an increase ; 4 correctly manipulated data ;	**3**

Question	Answer	Marks
3(c)(i)	*any **2** of:* 1 algae photosynthesise ; 2 photosynthesis / algae, <u>produce</u> / <u>release</u> oxygen ; 3 algae increase in population (as they absorb nitrate ions) ; 4 no / less, respiration (from mussels) (to remove oxygen) ;	**2**
3(c)(ii)	*any **4** of:* 1 <u>oxygen</u> decreases more with 8 mussels / **AW** ; 2 nitrate increases with 8 mussels / **AW** ; 3 <u>more / many</u> algae <u>consumed</u> / **AW**, with 8 mussels ; 4 less nitrate <u>removed / absorbed</u> by algae (with 8 mussels) ; 5 faeces / waste, decomposes / decays / **AW** ; 6 respiration (by mussels / bacteria) removes oxygen ; 7 less <u>photosynthesis</u> to release oxygen with 8 mussels ;	**4**

Question	Answer	Marks
4(a)	1 both y axes labelled with units ; 2 two linear y axes with suitable scales so that lines cover at least half grid ; 3 points correctly plotted ; 4 neat lines joining points with no extrapolation ; 5 key for both lines ;	**5**

carbon dioxide concentration/ppm	mean shell length/mm	mean population density /foraminifera per cm^3
10	0.85	1800
25	0.82	1750
50	0.84	1500
110	0.52	950
125	0.25	250

Question	Answer	Marks
4(a)	 [5]	

Question	Answer	Marks
4(b)	*any **3** of:* 1 carbon dioxide <u>dissolves</u> in water ; 2 forms, carbonic acid / H_2CO_3 / acidification occurs / pH drops / **AW** ; 3 (carbonic dissociates) into, bicarbonate (ions) / HCO_3^- (and H^+ ions) ; 4 (H^+) reacts with, CO_3^{2-} / carbonate ions ; 5 loss of calcium carbonate from shells / shells dissolve / weaker shells produced / poor shell growth / **AW** ;	**3**
4(c)	***Hypothesis (h):*** increase in temperature will reduce diversity / **AW** ; *any **10** of:* ***Independent variable (i)*** 1 independent variable identified as temperature / **AW** ; 2 at least five stated temperatures ; ***Dependent variable (d)*** 3 dependent variable identified as species <u>diversity</u> / **AW** ; 4 (count) number of different species / **AW** ; 5 (count) number of (individuals of) each species of foraminifera / **AW** ; ***Standardised variables (s)*** **max 3** 6 same <u>stated</u> time (more than one week) ; 7 same pH ; 8 same salinity / same calcium / mineral ions / **AW** ; 9 same number of foraminifera at start / same volume of starter culture / <u>initial</u> diversity / **AW** ; 10 same quantity of food / nutrients / **AW** ; 11 same volume of water / volume of tanks / **AW** ; 12 same carbon dioxide / oxygen ; 13 same size / mass / amount of coral / **AW** ;	**11**

Question	Answer	Marks
4(c)	***Method marks (m)*** ***max 2*** 14 method of changing temperature (e.g. water-bath) / **AW** ; 15 use of pipette / syringe / **AW** ; 16 count / identify foraminifera using, microscope / haemocytometer / **AW** ; 17 use of key to identify foraminifera / **AW** ; ***Analysis (a)*** ***max 2*** 18 use Simpson's index of diversity / **AW** ; 19 plot graph of diversity index against temperature ; 20 calculation of correlation coefficient / Spearman's rank ; 21 example of correct results table ; 22 repeats and calculate mean / median / standard deviation / standard error ; ***Ethical / Health and safety (e)*** 23 identification of any risk with method to minimise / statement that experiment is low risk / **AW** ; 24 treat foraminifera ethically by using acceptable range of temperatures / return foraminifera to sea / replace coral / **AW** ;	

Question	Answer	Marks
5(a)	*any **2** of:* 1 to protect, endangered species / species at risk of extinction ; 2 species live across national boundaries / species live in international waters / **AW** ; 3 species migrate ; 4 need to control import / export / trade (between countries) / **AW** ; 5 so same rules for all / as different countries may have different views / **AW** ;	**2**
5(b)(i)	6.7 / 6.67 / 6.666 recurring / 7% ;; (**two marks)** **one mark** for 10 **or** 6.6 ;	**2**
5(b)(ii)	*any **4** of:* 1 few(er) acclimatised salmon (compared with non-acclimatised), move upstream / go the wrong way / **AW** ; 2 more of both types of salmon go downstream (compared with moving upstream) / **AW** ; 3 acclimatised salmon move upstream earlier / do not stay in area long / **AW** ; 4 acclimatised salmon move downstream later / stay in area longer / **AW** ; 5 wider range of times for acclimatised salmon moving downstream / wider range of times non-acclimatised salmon moving upstream / **AW** ; 6 acclimatised salmon adapt to water conditions / food / currents / temperature / **AW** ; 7 **AVP** ;	**4**
5(c)(i)	25 , 625 , 41.7 ;	**1**
5(c)(ii)	51.3 ;	**1**
5(c)(iii)	*any **3** of:* 1 the null hypothesis is rejected ; 2 the calculated value is greater than the critical value ; 3 correct identification of critical value of 3.841 **or** 6.635 ; 4 there is a significant difference ;	**3**