

Cambridge International AS & A Level

MARINE SCIENCE**9693/11**

Paper 1 AS Level Theory

May/June 2026**MARK SCHEME**Maximum Mark: 75

Published

This mark scheme contains the instructions and marking guidance that our examiners used to mark candidate responses for this component.

Before they start marking, examiners complete a standardisation process. They review a range of candidate responses and discuss the mark scheme in detail to agree which answers can and cannot be accepted. Examiners award marks where it is clear that candidate responses have met the requirements of the mark scheme. These requirements may vary between different components or different versions of the same component, depending on the exact requirements of the question and the candidate responses seen during the standardisation process.

Sometimes, our mark schemes may allow marks to be awarded to responses which contain elements that are factually incorrect or for content not covered by the syllabus. We do this in response to the demands of a specific question to support candidates and make sure that our assessments are fair. However, these allowances should not be used as a guide for teaching and learning.

We cannot discuss the mark scheme with schools, and we recommend that schools read the mark scheme together with the assessment material and the Principal Examiner Report for Teachers.

This document consists of **26** printed pages.

General marking principles

All examiners must apply these marking principles when marking candidate responses.

1	Examiners must award marks for each response in line with: - the specific content defined in the mark scheme - the specific skills defined in the mark scheme or in the level descriptions - the standard of response required as exemplified by the standardisation scripts.
2	Examiners must award whole marks (not half marks, or other fractions).
3	Examiners must award marks positively . This means that: - marks are not deducted for errors or omissions - marks are awarded for correct/valid answers as defined in the mark scheme and also for other valid answers which go beyond the scope of the syllabus and mark scheme referring to your team leader as appropriate - the quality of spelling, punctuation and grammar are judged only when the mark scheme indicates that these features are specifically assessed in the question. However, the meaning of all responses must be unambiguous.
4	Examiners must consistently apply the requirements of the mark scheme and any rules for what to do when candidates have not followed instructions correctly.
5	Examiners must use the full range of marks defined in the mark scheme, unless limited by the quality of the candidate responses seen.
6	Examiners must award marks according to the mark scheme and must not award marks with grade thresholds or grade descriptions 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	<u>'List rule' guidance</u> For questions that require <i>n</i> responses (e.g. State two reasons ...): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked <i>ignore</i> in the mark scheme should not count towards <i>n</i>. • Incorrect responses should not be awarded credit but will still count towards <i>n</i>. • 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 <i>n</i> 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.

Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

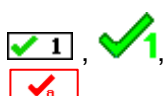
We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

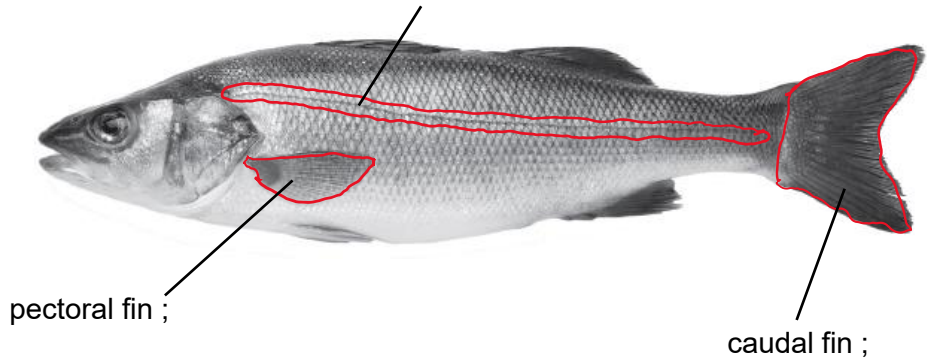
Annotation	Meaning
	correct point or mark awarded
	incorrect point or mark not awarded
	information missing or insufficient for credit
	allow or accept
	incorrect or insufficient point ignored while marking the rest of the response
	contradiction in response, mark not awarded
	benefit of the doubt given
	error carried forward applied
	maximum mark reached
	point already given

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Annotation	Meaning
	power of ten error
	incorrect point or mark not awarded
	rounding error
	point has been noted, but no credit has been given or blank page seen
	response is too vague or there is insufficient detail in response
	marking point 1 or marking point a is awarded. Used to mark against a particular marking point from an extended answer MS
	used to highlight parts of an answer / incorrect idea / irrelevant to question
	used to highlight parts of an extended response / incorrect idea / irrelevant to question
	key point attempted / working towards marking point / incomplete answer / response seen but not credited / blank page seen
ruler	allows lengths to be measured
multi-line overlay	overlays graphs

Mark Scheme abbreviations

;	separates marking points
/	alternative responses for the same marking point
R	reject the response
A	accept the response
I	ignore the response
ECF	error carried forward
AVP	any valid point / alternative valid point
ORA	or reverse argument
AW	alternative wording
underline	actual word given must be used by candidate (grammatical variants excepted)
()	the word / phrase in brackets is not required but sets the context
MAX	indicates the maximum number of marks that can be given
+	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

Question	Answer	Marks	Guidance
1(a)	structures correctly labelled:  lateral line ; pectoral fin ; caudal fin ;	3	1 quality of line (i.e. straight, thick, arrowheads etc.) Label lines must touch structure within the boundaries shown for the pectoral and caudal fin. Lateral line must be touched with accuracy.

Question	Answer	Marks	Guidance
1(b)	<i>any 4 of:</i> anchovy populations are (very) large ; (so) food for <u>many</u>, secondary consumers / different species ; (so anchovy populations) control / reduce, algal / phytoplankton / producer, population / number / abundance ; Peruvian anchoveta / sea bass, move, nutrients/energy, along the food chain ; sea bass, control / reduce, primary consumer population or sea bass, control / reduce, Peruvian anchoveta population ; sea bass are prey / food, for tertiary consumers ; AVP ;	4	Max 3 if ONLY discuss anchovy or only discuss sea bass I larger population than sea bass I food for humans A '(anchovy) keep population of in check' '(anchovy) regulates population of..' A '(anchovy) keep populations of ...in balance / in equilibrium / stable A (anchovy) maintains the population of... I (anchovy) keep population of ...in place I (anchovy) prevent algal bloom I amount I anchovy eat plants / are herbivores / seabass are predators / eat anchovy I anchovy population would increase if sea bass decreases A named examples of nutrients A Peruvian anchoveta reduce turbidity (because they feed on phytoplankton) A Peruvian anchoveta /sea bass, move nutrients back into the ocean OR release, urine / faeces / release nutrients, when decomposed OR move nutrients through the ocean (new location)

Question	Answer		Marks	Guidance
1(c)	conditions	occurs during El Niño	2	MAX 1 mark if 3 ticks No marks if 4 or more ticks I crosses if ticks used as well. If only crosses they MUST be in the 3 middle boxes for 2 marks BOD (if correct 2 left blanks) Crosses used instead of ticks = 0 marks. e.g. 3 ticked, 2 correct 1 wrong = 1 mark 1 correct 2 wrong = 0 mark
	weaker winds blow from the west	✓ ;		
	stronger currents move water from south to north			
	colder water			
	more upwelling			
	reduced plankton populations	✓ ;		

Question	Answer	Marks	Guidance
2(a)(i)	protons + neutrons ; 11 protons + 12 neutrons ;	2	R mp1 if suggestion of electrons in the nucleus I ref to electrons in shells outside the nucleus I photons

Question	Answer	Marks	Guidance
2(a)(ii)	sodium (atom) has 1 electron in outer shell / has 1 valence electron / configuration of 2.8.1 ; (therefore) loses 1 electron ; (electron is) negatively charged (therefore positive ion is formed) ;	3	Allow e ⁻ throughout A sodium ion will have a full, outer / second shell, for MP1 only A electron, taken / given to R shared A sodium loses its valence electron =2 marks R sodium loses ion A (have lost an electron) so it has 1 more proton than electron A it loses 1 e ⁻ for 2 marks R gains a proton
2(b)	solute and solvent ;	1	This order only A solvant
2(c)(i)	(area of the ocean) where salinity changes ; change (in salinity), is <u>large</u> over a (small) depth / steep (vertical) <u>gradient</u> ;	2	A area with a (large) salinity gradient A change in sodium chloride concentration A (region where) salinity increases / salinity decreases I fluctuates A sudden / drastic / dramatic / rapid / fast, for large or steep Must have ref to depth for second MP, can be a point in depth I Area where high salinity and low salinity meet in the ocean I change in density A large increase in salinity with small change in depth = 2 marks A layer in water with a steep vertical salinity gradient = 2 marks

Question	Answer	Marks	Guidance
2(c)(ii)	higher salinity causes higher density / ORA ; less dense (sea) water floats (on more dense (sea) water) or more dense (sea) water sinks (beneath less dense (sea) water) ; (if) there is no / little mixing (between depths / densities a halocline forms) ;	3	I denser water particles/ molecules I freshwater less dense than sea water A freshwater floats on salt water A saltier water sinks I salt sinks (must be salt water)

Question	Answer	Marks	Guidance
3(a)(i)	(propagule) germinates attached to, tree / parent OR seed germinates away from the tree / parent, OR its viviparous/shows viviparity OR roots start to grow while attached to the tree/parent ;	1	A (young plant / propagule) begins to grow attached to, tree / parent A dispersed after germination I develop
3(a)(ii)	salt, exclusion / filtration, by roots / roots filter out salt ;	1	A removal of salt through leaves A reverse osmosis by root A ultrafiltration by root (unqualified) I sacrificial leaf (where salts are deposited) I idea of roots expelling / removing salt R salt exclusion by leaves

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Question	Answer	Marks	Guidance
3(b)	<i>any 3 of:</i> (red mangrove have) prop. roots ; (roots) decrease (speed of) water movement / absorb or reduce, wave energy / wave height ; (therefore cause) sedimentation / prevents erosion ; AVP ;	3	A stilt roots A long + branched roots / cage-like roots I large / big roots / pneumatophores I barrier to waves or protects from wave energy or reduces waves / calm water A reduces, wave action / water current A (that) trap sediment / mud, with their roots A (sedimentation / stabilisation) allows further colonisation / succession
3(c)	<i>any 2 of:</i> for timber / lumber ; (wood) for fuel ; to be able to build on the, area / land ;	2	A wood for building material A to burn for heat / cooking A (named) infrastructure, e.g. shrimp farms / aquaculture / agriculture / hotels / houses etc. replace with tourist beaches / coastal development / urbanisation / create new waterways I oil pollution / pollution

Question	Answer	Marks	Guidance
4(c)	<i>any 2 of:</i> geological matching of rock formations / structures (on different plates / continents) ; distribution of, <u>same / similar</u> fossils (on different plates / continents) ; jigsaw fit of continents / al (coastlines) ; AVP ;	2	I same rocks A mountain ranges join up OR glacial scarring matches OR named mountain ranges e.g. Appalachians and Caledonian, A distribution of similar (living) organisms (on different plates) A fossil distribution of a species I puzzle I coal found in Antarctica A earthquakes / volcanoes, occur around plate boundaries I earthquakes and volcanoes unqualified

Question	Answer	Marks	Guidance
5(a)	<i>Acanthaster</i> ;	1	I italics and capitalisation R Acanthaster planci

Question	Answer	Marks	Guidance
5(b)(i)	$= (-)2.875(\%)$;;	2	A for 1 mark $\frac{(-)345000}{12000000} \times 100$ or $\frac{11655000 - 12000000}{12000000} \times 100$ or A $(-)2.9$ or $(-)2.88(\%)$ R 3 No marks for $(-)\underline{2.96}$ $(-)0.02875 / 0.0288 / 0.029$
5(b)(ii)	<i>any 1 of:</i> time (consuming) ; (scientists) could not, find / reach, COTS ; lack of poison ; may need special equipment (for injection) / scientists need special training OR may not be enough scientists with those skills ; poison may not be completely effective / some COTS <u>are</u> resistant / too small a dose given ;	1	A too much area to cover I immunity

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Question	Answer	Marks	Guidance
5(c)(i)	more, invertebrates / molluscs / crustaceans, are predators as life stage increases / progresses ;	1	A as COTS, age / get older / develop I as COTS grow I COTS are preyed on the most (by invertebrates) I positive relationship/ correlation
5(c)(ii)	population (of COTS) increases/ repopulate ; (because there are) fewer fish to, predate / eat, COTS OR less predation of, COTS / larvae / sperm + eggs, by fish ORA ; more larvae survive to reach adulthood ORA ; adults COTS <u>more likely to</u> reproduce ;	4	I positive correlation A fish mostly eat larvae I references to invertebrate species effect A <u>greater chance/ probability of</u> reproducing

Question	Answer	Marks	Guidance
6(a)	<i>any 6 of:</i> (a) organic + physical + chemical ; (b) chemical (weathering) when, chemicals react with rock / change the minerals in the rock / change in chemical composition of the rock / sediment ; (c) example of chemical weathering ; (d) physical (weathering) when (physical), processes/forces, cause a rock to break apart; (e) example of physical weathering ; (f) organic (weathering) when plants / animals / biological <u>factors</u>, cause rocks to break down ; (g) example of organic weathering ;	6	See page 25 for acceptable examples for each A substrate / reef for rock throughout MPs are independent as long as they do not mismatch their answers e.g. state chemical weathering is when waves crash against the shore breaking bits off. I chemicals break down the rock I water dissolving components or parts of rock A ocean acidification qualified A mechanical (weathering) I sediment A idea of force e.g. waves crashing, wave action A physical weathering is waves crashing on a shore breaking the rocks = 2 marks I currents e.g. water in cracks freezes and, expands / thaws, OR temperature changes of rocks cause rocks to expand and contract I human physical e.g. boat props A biological (weathering) I sediment e.g. plant roots break rocks / expanding cracks A animals eating coral (skeleton) A parrot fish eating the coral (polyps) I animals eating the rock I other named species of animal eating the coral

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Question	Answer	Marks	Guidance
6(a)			Biological weathering can be physical or chemical, so if they give 2 examples of biological, one that is physical and one that is chemical, allow both examples. e.g. bacteria releasing enzymes which break down the rock AND tree roots growing through the rock.

Question	Answer	Marks	Guidance
6(b)	any 9 of: (a) erosion is the movement of rock ; (b) varies with shape / size / density, of substrate ; (c) small sediment / substrate etc., is carried further OR larger substrate moved a shorter distance ; (d) rate of erosion varies with rate of, deposition / sedimentation ; (e) (erosion is caused) by moving water ; (f) large or fast waves / strong current / high or spring tides, increases erosion OR faster water moves greater volume of substrate OR faster water moves bigger/ denser rocks ORA ; (g) rate of erosion varies depending on, (physical) shelter / exposure (to harsher weather conditions) / shape, of coastline ; (h) (biological) shelter example ; (i) (human controlled) reduced by presence of groynes / seawalls / gabions / breakwater/ artificial reefs / sea defences / man made structures ; (j) (rate of erosion) varies depending on named weather conditions ;	9	A sediment / stones / gravel / sand / particles of substrate, for rock throughout 'Material' penalise once, then allow ECF R breakdown linked to erosion For size accept large, greater mass or weight or pebbles and sand compared A correct comparison of two substrates e.g. rocky (low erosion) and sandy / muddy shores (high erosion). Must be related to water A waves, currents, tides, rivers, tsunami e.g. headlands may be more exposed to high energy waves /larger fetch, so more erosion e.g. (coral) reefs / sea grass beds / salt marshes /mangroves / roots, reduces (erosion) A heavy rainfall / storms / wind / hurricanes I tsunami I temperature I rainfall unqualified

Question	Answer	Marks	Guidance
6(b)	(k) stated example of the effect of different weather conditions on erosion ; (l) (rate of erosion is affected by) rate of weathering ; (m) slope (angle) of shore affects (rate of) erosion ; 1 erosion caused by (idea of) moving ice / glacial erosion / transported in icebergs ; 2 description e.g. glaciers carry rocks OR glaciers break off forming icebergs which melt and deposit the rocks in ocean ; 3 climate change / global warming / warmer temperatures, changes / increases, rate of glacial erosion OR global warming affects named weather condition OR global warming affects distribution of marine plants or organisms or habitats, ; 4 AVP ;		e.g. higher wind speed transports <u>more</u> <u>small</u>, pieces / particles of rock, OR increased rainfall moves <u>more</u>, <u>larger</u> sediments R large sediment moved (for wind) I rock unqualified e.g. more weathering can lead to more erosion ORA A steeper angle of the slope increases rate ORA I sea ice / description of sea ice formation causing erosion A static ice can reduce wind erosion Must be an example, not just 'global warming affects erosion', e.g. global warming may increase storms / wind speeds increasing erosion small animals / birds, <u>move</u> sediments / cause erosion biofilms cover substrate reducing erosion

Question	Answer	Marks	Guidance
7	<i>any 7 of:</i> (a) Increased / high rate of photosynthesis will (usually) increase <u>biomass</u> / <u>population of secondary consumers</u> OR A ; (b) photosynthesis, uses / traps / absorbs, light (energy) ; (c) to produce, glucose ; (d) (glucose) used to make, starch / cellulose / biological molecules / biomass ; (e) (for) plants / algae / producers, to grow / reproduce / increase population ; (f) (plant biomass) is digested by consumers ; (g) to produce (new / different), biological molecules / biomass, in consumers ; (h) biomass / energy, passes along food chain / trophic levels ; (i) only approx. 10% of biomass is transferred between trophic levels / 90 % lost ; (j) (biomass/energy) lost in inedible parts, parts not digested / are egested, not all organisms on a trophic level are eaten / not all parts are eaten / (carbon dioxide) lost in respiration / lost to heat, waste, movement ; (k) AVP ;	7	Max 6 if no mention of biomass I solar / Sun , A sunlight R creates / makes energy A high light intensity increases rate of photosynthesis I photosynthesis makes food A create glucose A (used for) primary productivity A reproduction = new biomass A (more photosynthesis makes) more producers A reproduction for biomass A named examples e.g. amino acids to make new proteins A passed down the food chain A energy for biomass A urea lost in urine If the rate of photosynthesis in producers is lower than the rate of respiration using the products of photosynthesis there will be no energy / biomass to pass up the food chain.

Question	Answer	Marks	Guidance
8	<i>any 8 of:</i> (a) (tidal range) changes/varies, due to the effect of the Sun and Moon ; (b) Moon and Sun exert <u>gravitational pull / force / effect</u> (on water) ; (c) Moon and Sun in line with Earth ORA ; (d) so (total) gravitational pull (on water) is strongest / additive (in one direction) ORA ; (e) (causing) higher / highest / spring, tidal range / larger or higher ocean bulge ORA ; (tidal range) also affected by (f) coastal geomorphology ; (g) such as funnel effect ; (h) low air pressure increases tidal <u>height</u> ORA ; (i) onshore wind increases tidal <u>height</u> ORA ; (j) increase in (onshore) wind speed increases tidal <u>height</u> ORA ; (k) larger water body causes higher <u>range</u> (generally) ORA ; (l) change in the shape of the seabed (after tectonic activity) ; (m) AVP ;	8	I ref to diurnal / semidiurnal tides A on a diagram showing both spring and neap tide A <u>syzygy</u> (for spring tide) / quadrature (neap) A in alignment for in a straight line ORA's for neap: Moon and Sun at right angles to Earth ; so gravitational pull is in different directions/ reduces overall gravitational pull on the water ; causes neap tides / lower / lowest tides / smaller ocean bulge ; MP's c d and e MUST all relate to the same type of tide. A shape of the coastline A narrow opening channel causes higher <u>range</u> ORA ; A (high air pressure) causes surge for increased tidal height (for MP h,i,j) A hurricanes/ cyclones /tropical storms /typhoons have low air pressure and high wind speed so greater tidal height for MPi and MPj A El Nino/ prevailing winds push water away from shore for MPj

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Question	Answer	Marks	Guidance
8			e.g. equinox spring tides have a greater range as the Sun is directly above the equator / Moon is closer to the Earth in perigee so tidal range is greater

Additional info for Q6(a).**Physical (Mechanical) Weathering**

Physical weathering involves the breakdown of rocks without changing their chemical composition. It is driven by environmental factors such as temperature fluctuations, pressure changes, and mechanical forces. Common types include:

- **Frost Wedging (Freeze-Thaw Weathering):** Water enters cracks in rocks, freezes, expands / melts and gradually breaks the rock apart.
- **Thermal Stress Weathering:** Rocks expand when heated and contract when cooled. (Repeated cycles cause cracking).
- **Pressure Release / Exfoliation:** Overlying rock layers erode, reducing pressure on underlying rocks, causing them to expand and fracture in sheets, forming features like granite domes.
- **Salt Crystallisation:** Salty water seeps into rock pores, and as salt crystals grow, they exert pressure that fragments the rock.
- **Abrasion:** Rocks are worn down by, friction / abrasion / rubbing, with other rocks, wind carrying, sediments / sand, water or ice carrying stones / rocks.

Chemical Weathering

Chemical e.g. carbon dioxide reacting with water to produce a (weak) acid that reacts with rock **or** oxygen reacting with iron in rocks to form iron oxide / rust, I water dissolving components or parts of rock (not calcium carbonate)

Chemical weathering **alters the mineral composition of rocks** through chemical reactions, often involving water, oxygen, carbon dioxide, and acids:

- **Hydrolysis:** Minerals react with water, forming new minerals.
- **Oxidation:** Oxygen reacts with minerals, especially iron, forming oxides, weakening the rock.
- **Carbonation:** Carbon dioxide dissolves to form carbonic acid, which reacts with rocks (like limestone).

Biological Weathering

Biological weathering involves **living organisms contributing to rock breakdown**, and it can be both physical and chemical:

- **Root Wedging:** Plant roots grow into cracks, prying rocks apart.
- **Microbial Activity:** Microbes produce acids that chemically alter minerals / rocks.
- **Animal Activity:** Burrowing animals / insects, can fragment rocks.

PUBLISHED**Appendix – additional guidance for marking responses from candidates who have used braille papers**

The table below lists modifications made on the braille paper only where a different approach to marking is required.

Question	Modification	Marks	Marking guidance
1(a)	Label lines added to the figure. Candidate needs to identify label lines X, Y and Z.	3	X – pectoral fin ; Y – caudal fin ; Z – lateral line ;
1(c)	No table provided. Candidates provided with the conditions as a list (i) to (v) and need to identify the conditions either by stating or by naming the condition	2	Weaker winds blow from the west ; Reduced plankton populations ; OR (i) and (v) ;;