MARINE SCIENCE

Paper 9693/01
AS Structured Questions

Key messages

Candidates should be reminded to use the correct scientific vocabulary when describing and explaining phenomena. Understanding the meaning of key terms outlined in the syllabus gains credit independently but can also provide an aide to answering longer prose type questions.

General comments

A high standard of scientific knowledge and understanding was displayed by many candidates. Many candidates gave clear, articulate and accurate responses and attempted every question.

It is important for candidates to read all the stimulus material carefully and to complete all the instructions in the question. Some candidates could not access the full marks available or gave responses that were not relevant, due to not reading the question thoroughly or providing an answer which did not match the question set.

The mark allocation for each question part can be used as a guide by candidates to identify the number of points they need to make in responses. Good exam practice would be to refer to the mark allocation and include at least this many relevant points in responses.

Comments on specific questions

Question 1

(a) (i) Most candidates were able to construct a correct food chain from the food web that was given. Very occasionally weaker candidates omitted arrowheads on the arrows of their food chain.

(ii) There was some confusion about whether the food web contained three or four trophic levels. However, most candidates could correctly identify the number of trophic levels present in the given food web.

(b) (i) Candidates needed to apply their knowledge to what the question asked for. Although calcium is used for the production and maintenance of bone tissue, krill are crustaceans and so do not contain bone. The strongest answers referred to the shell of the krill.

(ii) There were some vague responses relating to krill weakening or their population decline, without a detailed explanation of why this would happen. Stronger responses related nitrogen to amino acids or protein synthesis and subsequent growth of krill.

(c) (i) Most candidates correctly calculated the efficiency of energy transfer between the two trophic levels. Occasionally some candidates calculated the percentage difference between the energy contained within the two trophic levels.

(ii) A number of candidates identified that trophic level two may be larger than trophic level one and related this to differences in biomass. Only the strongest candidates were able to explain why the biomass of trophic level two could be larger than the biomass of trophic level one. Candidates who explained this generally suggested the idea of the reading or estimate being taken at a singular point in time rather than referring to the rate of reproduction rate or rate of productivity of the phytoplankton.

Question 2

(a) (i) Some candidates were not specific enough in their responses to gain full credit. There were several simple responses referring to a predator–prey relationship with no further detail.

(ii) Candidates should take care to read the question carefully. Some candidates tried to answer this question without referring to the niches of each species. The strongest responses identified that the two species had different niches and manipulated the data provided to provide evidence for their statements.

(b) This question was answered correctly by the vast majority of candidates, with the idea that the parasite would use some of the energy, thus decreasing the efficiency of energy transfer.

Question 3

(a) (i) Candidates could generally identify the conditions present at a hydrothermal vent. Very occasionally there were some vague responses referring to extreme temperature or extreme pressure. Candidates needed to be specific in their responses and state high temperature and high pressure.

(ii) The majority of candidates could explain the reason for the low biodiversity at hydrothermal vents.

(b) Many responses lacked the detail necessary to gain full credit. Candidates should be reminded to read the question carefully and to complete all the instructions given. There were some candidates who did not refer to any named species. A common misconception was that tube worms were the pioneer species in a hydrothermal vent.

(c) (i) Many candidates could identify the source of energy, but many misinterpreted the question and gave the name of the chemosynthesis process.

(ii) The definition of productivity was well known.

(iii) Candidates generally identified that an increase in minerals would result in an increase in chemosynthesis. Fewer were able to relate this to productivity in terms of biomass or carbohydrates produced.

Question 4

(a) A common misconception was that the weathering, erosion and deposition all happened at the same area and time to form a sandy shore, rather than the weathering taking place at an alternative location. It is important that candidates make use of scientific terminology correctly in questions of this type and know the difference between terms such as sedimentation, deposition, and erosion. There was some confusion between the wave action that causes the original breaking down of rock and the low wave energy that results in deposition.

(b) Most candidates explained why there were a lack of producers on a sandy shore, with most referring to the lack of stable substrate for attachment.

(c) Some candidates struggled to identify two adaptations. There were many detailed explanations of why adaptations were necessary, but this needed to be linked to a specific adaptation. The most common adaptation identified was the ability to burrow.

Question 5

(a) The majority of candidates correctly calculated the percentage of dissolved substances at location B.

(b) There were several good suggestions for the differences between the salinities at the two locations. Many candidates described possible differences in temperature, evaporation, and rainfall.

(c) Candidates found this question more challenging. Many tried unsuccessfully to link pH with salinity. Stronger candidates suggested reasons relating to ocean acidification due to dissolution of carbon dioxide.

Question 6

(a)(i) Most candidates correctly identified the direction of movement of the two plates.

(ii) The majority of candidates identified the location of the youngest rock on the figure.

(iii) The majority of candidates identified the name of the plate boundary.

(iv) Many candidates were not detailed enough in their explanations to gain full credit. Most candidates identified that magma rises and solidifies. Only the strongest candidates provided a more detailed explanation relating the movement of the plates to differences in temperature of the magma and resultant convention currents.

(v) Most candidates were able to state one piece of evidence such as magnetic stripes. Fewer candidates were able to provide further descriptions of the alternating polarity either side of the mid-ocean ridge.

(b)(i) There were some very detailed responses, describing how earthquakes are formed. Most candidates used correct scientific terminology to describe this phenomenon.

(ii) The correct answer of trench was often seen. Inaccurate responses of mid-ocean ridge and volcanoes were also seen.

Question 7

(a) Most candidates identified the correct number of years. Incorrect responses of 14 years and 1 year and 2 months were occasionally seen.

(b) Most candidates were able to correctly identify the largest band.

(c) Most candidates provided detailed and accurate suggestions for the reasons for faster coral growth.

(d) Candidates were usually able to provide several suggestions of environmental conditions that could lead to stress periods in the coral.

(e) Carbon dating was the most common answer given by candidates.

Question 8

(a) There were many excellent responses to this question. The majority of candidates recognised that this question required both a description and an explanation to gain full credit. Occasionally there were inaccuracies in descriptions, with some references to currents travelling left to right or right to left rather than anti-clockwise and clockwise. Explanations were generally accurate and explained in terms of the Coriolis effect.

(b) Most candidates gave two factors that caused mixing.

(c) Most candidates correctly identified upwelling as the process.

MARINE SCIENCE

Paper 9693/02
AS Data-Handling and Free-Response

Key messages

Candidates need to be familiar with the different keywords and have an understanding of how they need to answer different types of questions. Some candidates could have used more scientific vocabulary in their answers, avoiding long descriptions of a word. Weaker candidates needed to try to be more specific in their answers, so instead of saying “water temperature affects density” they should have stated that “increasing water temperature reduces density”.

Candidates should be encouraged to show their workings for any mathematical questions worth more than one mark as credit is awarded for their mathematical method.

Candidates also need to ensure they carefully read and consider all the information and data provided in a question rather than going directly to a question to try to answer it.

General comments

Most candidates managed to attempt all questions and made comments that were relevant to the questions. There were some excellent answers to questions, showing stronger candidates had a good understanding of the syllabus and could link these ideas in unfamiliar situations. Some candidates were also able to evaluate results of investigations and to critique a method.

Comments on specific questions

Section A

Question 1

(a) Candidates needed to consider the data carefully along with the diagrams provided to ensure they understood what was happening. Stronger candidates took the time to understand what the data was telling them. Some candidates annotated the diagrams to help their understanding.

(i) Candidates needed to understand how the salinity within an estuary changes due to the change in tidal height. Many candidates recognised that species **C** was the most tolerant as it had an even distribution throughout the length of the estuary studied, but some candidates suggested **B**, as they noted a tick in the high column, and they interpreted widest range as high. Of those who correctly identified **C**, not all could explain that the percentages were quite close in all three regions of the estuary.

(ii) Candidates needed to understand which area of the estuary was exposed for the most time, which most candidates worked out and gave a good explanation for.

(iii) Some candidates only considered species found in the medium intertidal zone or the lower zone, and so gave several responses.

(b) (i) Some candidates stated that taking samples from more than one estuary would improve accuracy of data rather than reliability. Candidates should be familiar with, and understand, the differences between reliability and accuracy of data, and be able to apply this to unfamiliar situations. Some candidates gave answers such as “it improves accuracy and reliability” and so contradicted themselves. Some candidates also stated, “to get an average”, which at this level was not

sufficient. Candidates are expected to know the difference between mean, median and mode, and should have been able to state, "to calculate the mean of the data".

(ii) Some weaker candidates stated "sedimentation" without qualification, such as type or amount of substrate.

Question 2

(a) (i) Many candidates calculated the mean correctly, but some candidates added 12 and 8, then divided by 2, showing a lack of understanding of the data. Again, candidates needed to take their time to understand what the information and data provided was telling them to allow them to answer correctly. Some candidates who produced numbers higher than 4, could have gone back to the data when they realised the scale of the graph for **(ii)** did not go above 4. Instead many of them who had made an error, divided their answer by 10 so it would fit on the scale provided, or just drew the bars at random heights.

(ii) Only stronger candidates completed this well, with neat lines of an appropriate height and width constructed.

(b) Candidates needed to show their workings for full credit. Candidates needed to read data from the graph for each bar presented on island M, then use those figures to calculate the percentage difference. Some weaker candidates chose to calculate the difference between the number of fish sampled (6 and 8) or used the number of fish as the denominator for their calculation. Some candidates read the data correctly but did not calculate the difference between the numbers before completing the calculation.

(c) This was an evaluation question based on the data presented. Some candidates gave vague answers, e.g., "some islands hardly vary, and other islands vary a lot" without stating which islands they were referring to. Simply stating "it does support it" or "it does not support it" was insufficient for credit. Candidates were expected to be able to identify which data points/sets, support or do not support the theory. Stronger candidates clearly stated that Island I did not support the theory, and usually stated that the other islands did support the theory. Few candidates considered the quality of the data in terms of the number of samples, the number of fish tested in each area, or other variables that may have influenced the parasite loading. Some candidates tried to explain the results rather than evaluate them.

(d) Stronger candidates could usually give one or two of the variables. Other candidates made suggestions such as "the weather" or "climate conditions" without being specific.

Section B

Question 3

(a) The majority of candidates gained partial credit for mentioning winds, and many made a start on the effects of temperature. Stronger candidates stated a factor, and then went on to discuss how that caused a surface or deep water current to form, often answering well. Some candidates just listed factors, and therefore limited the credit available to them. It is important for candidates to understand what is meant by different keywords in questions. Candidates were required to state a factor and then discuss how that factor can create surface or deep water currents, linking these together.

(b) Most candidates scored at least partial credit here. Weaker candidates often did not give the level of detail required or tried to describe what occurs but did not use much scientific language. The question asked about cycling within the marine environment, but some candidates started with how calcium reaches the ocean in the first place which was outside of the scope of the question. Many candidates gave very good descriptions of how calcium is used within organisms and released in faecal waste or when the organism dies.

Question 4

(a) The majority of candidates answered this question well, with the main error being describing the coral as a habitat for the zooxanthellae. Most candidates stated that it was a mutualistic relationship, with both organisms benefitting from the relationship.

(b) Candidates found this question more challenging. They often did not relate the abiotic factors that allow coral polyps to thrive, to the photosynthesis occurring in the zooxanthellae that created biomass, and that this biomass is rapidly turned over through consumption by organisms in higher trophic levels. When candidates mentioned photosynthesis, they did not state that it would be occurring rapidly, or that more photosynthesis would occur under these conditions, just that it would occur. Some candidates stated there were high levels of nutrients in the water which would make the water clarity lower, rather than understanding the nutrients are locked up in the organisms. Some candidates were too imprecise, e.g., stating “high temperatures” rather than warm waters, or stating a water temperature range the polyps live in. Warm temperature alone was insufficient for credit as they needed to state if it is the air or water temperatures, as air temperatures can fluctuate quite rapidly. Many candidates talked about high levels of biodiversity rather than productivity.

(c) Most candidates made some relevant comments regarding shoaling in fish, with weaker candidates often just stating what the advantages were rather than expanding their answers to show they understood why these were advantageous for an individual fish. Stronger candidates also used scientific vocabulary to good effect here, talking about hydrodynamic efficiency, drag or reproductive and feeding strategies.

MARINE SCIENCE

Paper 9693/03
A2 Structured Questions

Key messages

- Candidates must read and process all the information provided in the question before starting their answers.
- Candidates should note that if there are two command words, then both parts need to be addressed to gain full credit.
- Candidates should note the mark allocation for each question and make sure that they match their answers to the number of marks awarded.

General comments

There were some very good responses to questions, demonstrating a good knowledge of the syllabus content and examination technique. Candidates generally performed well on **Questions 1**, **3** and parts of **Question 5**. **Question 2** on ventilation in fish proved challenging for some candidates. Similarly, questions on Section 15 of the syllabus, **Question 5(b)** and **6(b)**, were also very challenging, even for some stronger candidates.

Comments on specific questions

Question 1

(a) (i) Most candidates correctly identified open water as the habitat for *Sargassum* in the Sargasso Sea. The most common incorrect answer was “surface waters”, while “intertidal areas” was also given.

(ii) To gain credit, answers needed to mention circulating currents as the reason for keeping *Sargassum* within the Sargasso Sea. Just stating “currents” was not enough to gain credit.

(iii) Some answers were not precise enough, for example, “oxygen is produced by photosynthesis”. Incorrect answers restated factors provided in the question, e.g., “energy” or “food source”. Few references were made to the role of decomposition as a source of nutrients.

(b) (i) Paired answers were required to answer this question. Detail was often lacking for the explanation part of the answer, for example stating that a higher light intensity at the equator would increase the rate of photosynthesis or productivity. For the last marking point, candidates needed to be more specific about the role of the extra nutrients from upwelling or brought via the Amazon River. Just stating that the “extra nutrients could be used for growth” was not enough. They needed to state that the extra nitrogen would be used for growth or to make protein.

(ii) A few candidates misread the question and gave answers in terms of tourism or disturbance by humans. Stronger candidates were able to provide two correct answers.

Question 2

(a) The strongest candidates were able to describe ram ventilation and gained full credit. Most answers either lacked the detail required or included irrelevant information. Examples included “water enters mouth and goes out over the gills” and references to counter-current mechanism or to diffusion gradients or rates.

(b) Knowledge of this topic was not always secure. Stronger candidates gained full credit, but weaker candidates often produced confusing or incorrect answers e.g., “carbon dioxide is released”, or gave answers adding references to gas exchange.

(c) Only stronger candidates answered this well with many giving answers that were too vague, e.g., “water is pumped through the gills”.

Question 3

(a) (i) Almost all candidates answered this correctly.

(ii) Many candidates answered this correctly and referred to the idea of mass gamete release at the same time due to tuna gathering, in the same place. Just stating that “more gametes would be released” or that “tuna move in shoals” was not sufficient.

(iii) This was a two-part answer as the command words were state and explain. Some candidates only provided one part of the answer. Examples included “the mother provides milk for her calf” or that the calf is “protected from predators”.

(b) (i) Candidates were required to read and process all the information provided to answer this question. Weaker candidates made no reference to this information at all or did not say why the population had not recovered. Incorrect answers included “whales attract attention be emitting sounds”, or that “boats cause sound pollution” or references to overfishing.

(ii) Most candidates gained at least partial credit, usually for stating that whales would collide with ships or that fishing reduced whale prey.

(c) This question was well answered, with many candidates gaining full credit. The most common correct answers included “fewer collisions as boats were travelling at less speed”, “reduced fishing would increase the food supply for whales” and “loss of income for local fishermen”. A few answers were too vague for credit to be awarded, e.g., “whales would be safer from vessels”. There was misunderstanding by some candidates who referred to whaling and whale numbers.

(d) Incorrect answers stated that satellites provide “real time” data instead of stating that they provided continuous data, or that satellites provided “faster data” rather than more accurate data.

(e) A common misconception was that the sonar station could monitor the whales and track their migration, so increasing whaling. Correct answers referred to the sonar station disrupting whale communication.

(f) Many answers did not provide enough information for credit to be awarded. Examples included “to allow more whales to be born” or “to allow the whale population to increase”. A reason was required in each case.

Question 4

(a) This question was generally answered well. Incorrect answers included “prey population” and “habitat” which was not enough by itself.

(b) (i) Stronger candidates were able to provide a correct description of sustainable fishing. Weaker candidates made incorrect references to by-catch or to supply and demand.

(ii) Most candidates could state that the catch had increased, but few went on to say that the population of yellowfin tuna could not recover.

(iii) Most candidates gained full credit for this question.

(c) (i) To gain full credit, answers had to make it clear that tuna were found in the pelagic zone, not close to the sea floor, so would therefore not be caught by benthic trawling.

(ii) This question required candidates to carefully study the information in the figure and table before attempting to answer the question. A few weaker candidates did not match the correct fishing

method with the correct fish, so could not gain credit. Credit was usually awarded for identifying longline as the most common method used to catch albacore tuna, while purse seine fishing was a common method used to catch yellowfin tuna. Only stronger candidates then went on to link these methods with sustainability and stock numbers. There were very few references to the destructive nature of gillnets and their effects on yellowfin tuna stocks.

(d) Only stronger candidates gained credit, usually for stating that conservation of one organism could affect food chains/webs. Candidates needed to be clear that organisms were interdependent on each other in a particular habitat. No references were made to the recycling of nutrients for successive generations.

Question 5

(a) (i) The majority of candidates provided one of the three alternative answers.

(ii) Fewer candidates gained credit for this question. A common incorrect answer was that “seabass are cultivated in the sea”.

(iii) All candidates were able to state that the top of the cage was netted to prevent fish escape or to prevent birds from eating the fish.

(iv) This question had two command words, and often candidates correctly stated that there was a greater chance of disease spreading but did not provide a reason why. Few references were made to the build up of toxic waste or to the fact that some fish might not have enough food.

(v) Stronger candidates knew that oxygen was required for respiration. “So that the seabass do not suffocate” was not enough to gain credit.

(vi) There were some excellent answers to this question where candidates demonstrated their knowledge of what happens to fish waste under sea cages. Other candidates gave incorrect answers which referred to surface phytoplankton or to algal blooms.

(b) (i) Processing the information provided in this question was vital to achieve credit and only the strongest candidates did this well. Weaker answers referred to accuracy or cost, or to the speed of results, none of which could be credited.

(ii) Only stronger candidates answered this correctly. Credit was awarded for the idea that computer predictions might not be as accurate as counting actual specimens, or that the eDNA might have come from elsewhere.

Question 6

(a) (i) Most candidates were able to gain partial credit, usually for stating that there would be an increase in biodiversity. However, some candidates copied the information provided in the question. Examples included, that oysters were “filter feeders and improved water quality” or that oysters “provided a habitat for other species”. To gain credit for the habitat, it needed to be clear that the oyster sanctuary was providing a permanent habitat for other species. Few references were made to increased oyster breeding or to a greater chance of oyster larvae spreading to other areas.

(ii) Many candidates gained at least partial credit, usually for reference to increased breeding by aquaculture and subsequent transfer of spat to the sanctuary. Others correctly stated that aquaculture could relieve the pressure on harvesting wild oysters.

(iii) Very few candidates gained full credit here, but the idea of local involvement and programme acceptance was often known.

(b) (i) Candidates who understood the process of selective breeding answered this well. Common errors were not stating that parents with the disease resistant gene were bred together, and not repeating this process for several generations.

(ii) Stronger candidates could define the term gene, but weaker candidates were not specific enough or gave incorrect answers. Examples included that the “DNA was a protein”, “a length of DNA that codes for a trait or characteristic” or “a gene is a strand of DNA”.

(iii) Weaker candidates had difficulty expressing their answers, so were unable to gain credit.

(iv) This was a very challenging question, but the strongest candidates gained at least some credit, usually for the idea that there would be less genetic diversity.

MARINE SCIENCE

Paper 9693/04
A2 Data-Handling and Free-Response

Key messages

Candidates should:
- be clear on the meaning of all the command words used
- show all working for mathematical calculations
- fully understand how to plan valid, precise investigations
- be confident in the use of scientific vocabulary
- ensure that the depth of answers is of A Level standard.

General comments

The standard of responses was high in many cases. Many candidates demonstrated excellent factual knowledge and understanding and were able to manipulate and interpret data effectively. Experimental planning skills were excellent, and candidates used scientific terminology confidently and accurately. It was very clear that many candidates had spent a great deal of time preparing carefully for the examination. A few candidates found data handling challenging and tended to underestimate the depth needed for a full response.

Comments on specific questions

Section A

Question 1

(a) This question tested experimental skills in the context of a practical investigating photosynthesis. Candidates were required to identify and explain one variable that should be controlled. Most candidates were able to identify one correct variable and many went on to give a correct explanation. Common variables included carbon dioxide concentration and temperature. A few candidates gave the same variables that were listed in the question (e.g. mass of algae). Candidates should be careful to read questions carefully.

(b) Many excellent graphs were seen that had fully labelled axes, keys and sensible scales that made full use of the grid. A small number of candidates did not use linear scales, or plotted bar charts. Candidates should take care when plotting graphs to select a sensible scale that makes plotting the points easy.

(c) Most candidates were able to gain at least partial credit, and many went on to gain full credit. Stronger answers referred to the different absorption spectra of the two algae, the role of accessory pigments and the different penetration depths of light wavelengths and colours. Some candidates correctly suggested the names of accessory pigments that would be present. A few candidates gave answers that just described the differences in the absorption spectra. The command word for this question was “explain” so answers needed to give reasons for the observations.

Question 2

(a) (i) This question required candidates to look at data on the effect of TBT on the development of two species of mollusc larvae. Candidates needed to use the graph to identify the percentage of larvae that were abnormal and use this figure to calculate the exact number. Most candidates gained at least partial credit for correctly identifying the percentage of abnormal larvae and many went on to

use this to calculate the number of affected larvae. A few candidates used the wrong line on the graph for their calculation.

(ii) This question required candidates to compare the effects of TBT on the two species of larvae. Most candidates were able to gain at least partial credit. Where candidates did not gain credit, it was usually for misreading numbers from the graph. Care should be taken to give accurate values.

(b) This question assessed experimental planning and many candidates understood how to plan a valid experiment. Candidates should always aim to state the independent variable, how they would change it and give at least five values that they would choose. Methods for measuring the dependent variable should be given and a description of how replicates will be carried out, including the calculation of means. Standardised variables and methods for their controls should also be included.

Section B

Question 3

(a) (i) Many candidates gained at least partial credit for this question concerning how size and shape affects the need for gaseous exchange organs. Many recognised that smaller organisms generally have a larger surface area to volume ratio and how the body surface can be used as an exchange surface. Some candidates made correct references to how different organs such as gills increase surface areas. Weaker answers often suggested that larger organisms have a higher surface area to volume ratio and did not relate the shape of organisms to the need for organs such as gills.

(ii) Many candidates found this question challenging. The question required candidates to look at diagrams of the circulatory systems of a dolphin and a fish and relate these to metabolic demands. Stronger answers explained that a double circulatory system would deliver oxygenated blood to muscles faster than a single circulatory system and so enable more rapid respiration. Weaker answers were often very confused with some candidates suggesting that the heart and circulatory system is involved in ram and pump ventilation and that dolphins have gills.

(b) This question required candidates to describe the life cycle of oysters and many excellent answers were seen. A detailed answer was given by many candidates. Most candidates were able to describe the different larval stages and their locations and explained how settling and metamorphosis occurs. Impressive use of terminology was seen with many answers making references to veligers, pediveligers, metamorphosis and spats. A few candidates confused the sequences of the larval stages.

Question 4

(a) Stronger candidates listed several negative and positive impacts of restrictions. Many candidates were able to explain that in the short term, fishers would lose income due to restrictions and that there could be effects on fish prices. Many also went on to state that in the long term, sustainable employment could occur and that coastal areas may develop other industries. Weaker answers tended to focus on only one or two aspects and often focused on ecological impacts rather than sociological ones.

(b) This question required candidates to describe the benefits of energy conservation methods used in ecotourist resorts on conservation. Stronger answers explored the topic fully, giving a range of benefits, such as the use of solar power in reducing carbon emissions and ocean acidification. Weaker answers tended to focus on only one or two aspects and often gave general ecotourism methods rather than focusing on energy conservation.

(c) Many excellent, detailed answers were seen for this question. Candidates were asked to explain the negative consequences of dredging on the marine environment. Most candidates were able to gain at least partial credit, with many going on to gain full credit. Common correct answers included the destruction of habitats, the release of heavy metals ions from sediments and their consequences, and the consequences of silt release. There was an impressive depth of knowledge shown in answers. For example, several candidates mentioned the effects of silt on turbidity, and then went on to fully explain the consequences of this on photosynthesis, productivity, gill damage, and oxygen depletion. Weaker answers tended to focus on only one issue and did not include fully explain consequences of silt release.