MARINE SCIENCE

Paper 9693/01
AS Structured Questions

Key messages

- Candidates should ensure that they read each question carefully and that they are familiar with command words such as 'compare'. They should also understand the differences between words such as 'explain', 'outline', 'describe' and 'suggest'.
- Some questions required careful observation of graphs and illustrations. Candidates should ensure that answers produced describe what is actually shown and then link this to relevant topic knowledge.
- Candidates should be encouraged to practice drawing conclusions from evidence which may be given in the form of data, illustrations or graphs.

General comments

Many candidates performed well and gave satisfactory answers throughout this paper. Aspects of the syllabus content which were less well understood included hydrothermal vent formation in **Question 6(b)(i)** and the influence of temperature on water movement in **Question 5(c)**.

Comments on specific questions

Question 1

(a) (i) Most candidates correctly identified the months but some candidates listed more than two.

(ii) Many candidates described and repeated the data given in **Fig. 1.2**. They needed to compare the mean cyclone numbers making or not making landfall in the various months shown. This could include noting that the smallest difference occurred in March, while the greatest difference occurred in August. The use of figures from **Fig. 1.2** was acceptable, but they needed to be explained in a comparative way.

(iii) Most candidates correctly identified that the seas were warmer in July and August and many quoted that a temperature of at least 26.5°C would increase the number of cyclones.

(b) (i) This question was answered well and most candidates gave accurate examples of the harmful effects.

(ii) The beneficial effects were equally well known.

(c) Some candidates understood that there would be less water or lower evaporation over land to sustain the cyclone. However, very few understood that this would result in less energy for the cyclone. Some realised that the cyclone could meet resistance from buildings, mountains or trees, which would reduce cyclone speed.

Question 2

(a) Most candidates correctly identified biomass production by a producer as a part of this definition. For full credit reference to the rate or amount/unit time was required.

(b) (i) The trend was correctly identified by most candidates. The increase from August to October was missed by those who just read off the first part of the graph.

(ii) This was well understood by most candidates and there were many accurate answers explaining the increase in phytoplankton numbers. However, some candidates needed to emphasise that increased photosynthesis would result in more growth or reproduction.

(iii) Most candidates recognised that the nutrient level was falling. To gain full credit, they then needed to explain that it was because more nutrients were being absorbed to increase the numbers of phytoplankton.

(iv) Full credit was awarded to candidates who clearly indicated that the line peaked between mid-March and May. However some answers lacked accuracy and neatness, with the lines drawn being imprecise and went beyond the June period.

(v) This topic was clearly understood by the majority of candidates. There were many detailed explanations of the **Fig. 2.1** data and many candidates also accurately described the concept of time lag between the two populations.

Question 3

(a) (i) Nearly all the candidates correctly identified structure **A**.

(ii) Many candidates knew the names of the structures involved in atoll formation. However they often arranged them in the wrong order when describing the processes in stages **2** to **4** because they confused fringing and barrier reefs. Many candidates also incorrectly stated that it was the sea rising that accounted for the gradual disappearance of the volcano. Most candidates identified that a lagoon was formed during this process.

(b) Most candidates were able to identify at least one factor that would lead to leaf erosion. Answers needed to include examples with the factor chosen, e.g. anchoring or dredging by fishermen could cause reef erosion.

(c) (i) Most candidates correctly interpreted the relationship in the figure.

(ii) Nearly all candidates identified the age of the material and showed how they arrived at this figure by clearly marking the graph in the figure.

(iii) Many candidates worked this out correctly. Those that only used the *x* axis incorrectly quoted the answer as 25 000 years.

(iv) Most candidates appreciated that the C^{14} left was too small for accurate measurement. Some misinterpreted the graph and incorrectly indicated that there was no C^{14} left, or that the level was at zero.

Question 4

(a) (i) Most candidates gained at least partial credit on this question and many clearly understood the distinction between predator and prey. Some candidates listed zooplankton as a predator, when **Fig. 4.1** indicates that they only feed on phytoplankton.

It should be noted that due to the terms ‘primary consumer’ and ‘secondary consumer’ not being specified in the Learning Outcomes of the 9693 Specification, the two columns headed with these terms were not taken into consideration for the awarding of credit.

(ii) This was answered well and most candidates chose two appropriate organisms at the third trophic level.

(b) There were many excellent responses describing the advantages of shoaling. Candidates clearly understood this concept and many gave four correct answers to gain full credit.

(c) (i) Many generalised answers were given to explain parasitism. While candidates clearly understood the term they needed to emphasise the benefits to the parasite of living in or on a host and the harm this would cause. Some candidates used examples to help explain the term.

(ii) Nearly all candidates read the figure correctly from the graph.

(iii) This was answered well and the majority of candidates understood the relationship between fish age and larval length.

Question 5

(a) Knowledge of biological nutrient use was well understood and most candidates gained full credit here.

(b) This part of the question proved challenging for many candidates. Many understood run-off but then gave generalised answers with no detail. The answer required examples of named ions or nutrients which, having reached the surface waters of the sea, could have an effect on acidity and salinity. Some candidates correctly stated that the run-off of fresh water alone would cause the salinity to decrease.

(c) Many candidates misunderstood the focus of this question and just described the details of nutrient upwelling. Answers needed to explain how temperature changes would affect water density and hence the direction of water movement. For example, this could include a decrease in surface water temperature which would increase water density, causing this cold water to sink. However many candidates correctly indicated that the water from below would replace these surface waters.

Question 6

(a) There were many accurate descriptions of the evidence supporting this theory and the majority of candidates gained full credit. Some candidates only gave one-word answers when the space given on the question paper indicated that more was expected. Some candidates discussed the distribution of fossil fuels, which was not accepted and some mentioned greater volcanic or seismic activity which needed to be linked to plate boundaries.

(b) (i) Most candidates understood that water seepage into cracks in the sea bed at divergent plate boundaries was then heated up by the magma. However only a minority described the process of minerals dissolving into the water before it erupts back up to the sea, where they precipitate out and solidify to form the vent chimney.

(ii) Most candidates showed an understanding that this was an extreme environment with high temperatures and pressures restricting plant growth. Candidates needed to emphasise that there was no light for photosynthesis at these vents.

(iii) There were many excellent answers describing chemosynthesis and many candidates gave a full chemical equation of the process. Chemical energy was not always referred to but nearly all candidates understood the role played by the vent bacteria.

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

Key messages

- Candidates should manipulate data presented in tables or graphically, rather than quoting figures directly, to support descriptions of the data. When calculating a percentage, for example, they should not quote the answer to more decimal places than given in the original data and should take care to round answers correctly. Units should always be included with numerical answers, where appropriate.
- When drawing graphs, candidates should be reminded to use a ruler for the axes and for joining plotted points, rather than free-hand lines. It is important to remember to include units when labelling axes labels.
- Candidates should be reminded to read the stimulus material and the question carefully and to ensure that they answer the question completely.

General comments

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

Candidates generally showed good use of English, expressing their ideas in continuous prose. When answering extended questions, candidates should be reminded to use the correct scientific terminology.

Overall, candidates answered equally well in ***Sections A*** and ***B***. and were able to recall factual content of the syllabus as well as applying their knowledge of principles and concepts in a logical, deductive manner.

Comments on specific questions

Section A

Question 1

(a) Most candidates were able to correctly calculate the total number of organisms. Fewer candidates were able to correctly calculate the second column value of **n(n–1)**. There were a number of candidates who made simple transcription errors.

(b) Credit was given to candidates who used their incorrect values from **(a)** correctly. A common error was to round incorrectly. Frequently seen incorrect values for the diversity index were 5.5 and 5. Some candidates used the incorrect formula resulting in a calculation of $(79 \times 78) \div (1106 \times 1105)$.

(c) The vast majority of candidates recognised that shore **B** had a greater diversity index and so higher biodiversity than shore **A**. There was some confusion between the number of organisms and the number of species. Weaker candidates were not clear about what they were referring to and had not read the stimulus material carefully enough, particularly table headings to gather the information required to answer the question accurately. In this case the number of species were the same but each shore had a different number of organisms of each species.

(d) This question was only answered well by the strongest candidates. Candidates often gave two abiotic factors. Few candidates gave answers relating to the methodology of the investigation. The most common correct answers related to the sampling area.

Question 2

(a) Some excellent graphs were drawn. Very occasionally candidates forgot to include the units on the axes labels.

(b) Almost all candidates were able to interpret the data and recognised that as temperature increases the concentration of dissolved oxygen decreases. Fewer candidates gained full credit however. A number of candidates simply quoted the data with no manipulation. However, stronger candidates correctly calculated that concentration of dissolved oxygen decreased by 5.9 mg per dm^3 between 0 – 40°C. Other correct data manipulation was also credited.

(c) (i) Candidates were generally able to give the correct answer of decreases here.

(ii) This question proved more challenging than **(i)** but the stronger candidates were able to give the correct answer of increases.

(d) The idea of there being more producers or more photosynthesis providing oxygen was well understood. Fewer candidates gave the answer of wave action providing more dissolved oxygen. A common error was to try and relate the difference in dissolved oxygen content to salinity or temperature.

Section B

Question 3

(a) (i) The definition of community was generally well understood. For full credit however, both ideas of the same habitat and at the same time were required. Again, there was some confusion of the meaning of the term “species”. A number of candidates stated that a community consists of only organisms of the same species, which was incorrect.

(ii) Candidates generally understood the idea of rate of biomass production, but it was often not clearly expressed. Candidates sometimes referred to biomass production with no reference to rate or referred to biomass without the idea of production. Alternative ways to express rate such as amount per unit time were accepted.

(b) In this question, many candidates recognised that sand is unstable and prone to erosion. A common error was to refer to the conditions such as wave action, salinity and tides. However, these are not exclusive to sandy shores and references to these were generally not creditworthy. The best responses referred to the lack of substrate for attachment, which results in fewer producers coupled with more exposure to predators and only burrowing organisms being able to survive on sandy shores. Stronger candidates were detailed in their responses and had clearly referred to difficulties associated with attachment.

(c) Many candidates gave very detailed answers about how coral reefs would increase biodiversity and tourism. However, this was not what the question asked for. Many candidates referred to a reduction in wave action/energy and erosion. A common source of error was to refer to preventing or stopping erosion. This was inaccurate as coral reefs cannot stop wave action and erosion but they can reduce the effects. Stronger candidates were detailed in their responses. Responses of “providing anchorage” was not enough for credit. Candidates needed to have the idea that coral reefs provide **safe** anchorages.

Question 4

(a) Most candidates gave good suggestions for the differences in salinity between a lagoon and an estuary. However, occasionally candidates only referred to the conditions in one of the environments. Candidates were frequently able to relate the high temperatures to evaporation and an increasing concentration of salts in a lagoon. References to the conditions in an estuary were less well understood with many candidates not being detailed enough in their responses to gain full

credit. Candidates often referred to the river meeting the sea with no reference to freshwater or the dilution of the sea water, decreasing the salt concentration.

(b) The Coriolis effect was only well understood by the very strongest candidates. Few candidates were able to recall the causes or the results of the Coriolis effect. Some candidates had the right idea about the deflection of currents, but were often unable to express it clearly or succinctly. The idea of deflection was preferable to the idea of currents simply changing direction. Some candidates referred to the different directions of spin in the northern and southern hemispheres which was acceptable.

(c) There was some confusion between density and temperature. A number of candidates thought that an increase in temperature led to an increase in density. Most candidates tried to explain upwelling and generally answered reasonably well. Fewer candidates offered explanations on how currents were formed.

(d) Although there were some strong answers to this question, some candidates perhaps, did not read the question carefully enough and did not provide named examples in their responses as required. However, most candidates generally answered well and gave clear responses.

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Paper 9693/03
A2 Structured Questions

Key messages

- Candidates need to use precise language in their answers to ensure they are clear. In this series some answers were not precise enough in terms of vocabulary, e.g. “amount” for number or mass or volume and “nutrients” for food.
- Candidates should be reminded to read and process information in the question carefully before attempting their answers.

General comments

There were some very good answers from strong candidates who showed a sound knowledge of the syllabus content and used their knowledge to interpret information provided in the question. Many candidates answered well on factually based questions such as **1(a)** and **5(a)(i)** and **(c)**. Aspects of the syllabus which appeared to be less well understood include osmoregulation and genetic engineering.

Comments on specific questions

Question 1

(a) (i) Credit was gained for identifying the intertidal region or rocky shore as areas where the three types of algae are found. The most common incorrect answers were “lagoon”, “coral reefs” and “shallow water”.

(ii) Most candidates described or provided an equation for photosynthesis. To gain credit, carbon had to be fixed or biomass produced. Many answers referred to food being provided for food chains/webs, but to gain credit, the idea of energy being transferred along the food chain was required.

(iii) Most candidates could correctly state that light decreases with depth and that this would result in a reduction in photosynthesis. Good responses also gave correct references to different wavelengths. There were many references to a decrease in temperature with depth, but this needed to be linked to the effect on photosynthetic enzymes to gain credit.

(b) (i) Stronger candidates were able to name the nitrogen-containing waste products produced by fish and released into the water. Few answers referred to bacteria breaking down these waste products into nitrogen-containing nutrients that the kelp could use.

(ii) Most candidates could state that the nitrogen-containing compounds could be used to make amino acids or proteins.

(iii) Most candidates gained full credit for a correct reference to photosynthesis as the reason why the concentration of each gas changed.

(c) This topic was well understood, with most candidates gaining full credit. The most common omission was to state “shelter” but not from what. Weaker candidates used the term “nutrients” instead of food.

Question 2

(a) (i) Most candidates gained at least partial credit. References to internal fertilisation were less common.

(ii) Full credit was common, but some candidates referred to the length of young, or length of time to reach sexual maturity.

(b) Candidates were expected to refer to the length of time each species took to reach sexual maturity. References to size at birth, or that the adults were a similar size, were rare.

Question 3

(a) (i) Stronger candidates could give a correct definition. Weaker candidates referred to regulating the internal concentration to match the external concentration.

(ii) Most candidates gained credit. Those that did not produced a stepped line or a horizontal line.

(iii) Fewer candidates gained credit for this graph. The most common error was to reproduce the first graph.

(iv) Only stronger candidates gained full credit. The most common error was to state that as the external concentration decreased, so did mussel mass. References to osmosis were rare. Weaker candidates made references to sodium or chloride ions instead of referring to water.

(b) (i) Strong candidates were able to process the correct information from the table and quote correct figures with units. Again, weaker candidates made incorrect references to sodium and chloride ions.

(ii) Candidates needed to identify that sea water has a higher concentration of chloride ions than skipjack tuna in this question. There were many incorrect references to water instead of chloride ions.

(iii) Few candidates identified the difference in total concentration between the eel blood and fresh water. There were many incorrect references to sodium and chloride ions and many answers just repeated the information in the question.

Question 4

(a) Stronger candidates gave a correct definition for the idea that harvesting should not exceed recruitment. Weaker candidates gave vague answers or repeated the question.

(b) Full credit was rare, mainly because answers referred either to methods used to ensure that fish stocks are fished on a sustainable basis or to enforcement methods.

(c) Most candidates gained full credit, usually for the idea that if juveniles were caught, they would be unable to reach maturity and reproduce to maintain fish stocks. References to sustainability of fish stocks were rare.

(d) In order to gain full credit, candidates needed to process all the information provided. Weaker candidates made little reference to this information and consequently gained no credit for answers such as “the water warms and the fish die” or the idea that El Niño brought more nutrients for the fish, so numbers increased.

(e) (i) Many candidates were able to identify that both insects and soya have a high level of protein and omega-3.

(ii) The majority of candidates gained full credit for stating that protein was required for growth.

(iii) Only stronger candidates answered this question correctly. Most answers just repeated the information provided without stating the advantage e.g. insects were fed on waste food. However to gain credit, answers needed to say that this was readily available.

Question 5

(a) (i) To gain credit, answers needed to state that the wind blows surface waters away. There were few references to the difference in temperature between surface waters and deeper water.

(ii) A common misconception was that the extra nutrients were used by fish, so numbers increased. There were few references to the nutrients being used by phytoplankton for growth. However stronger candidates correctly stated the effect of increased phytoplankton numbers on food chains/webs.

(b) (i) Most answers stated the effect of surface algal blooms on light availability for bottom dwelling producers, which could not be credited. There were very few references to nutrients running out, causing death of surface algae.

(ii) Most candidates gained partial credit for the idea that benthic animals died from lack of oxygen. Few answers stated the corresponding effect of food chains/webs. Many answers just copied the question.

(c) Most candidates could name an agricultural pollutant, with “pesticide” the most common answer.

Question 6

(a) Stronger candidates gained full credit, while most candidates gained partial credit, usually for naming the stage in life cycle rather than for naming the habitat for smoult.

(b) (i) Many candidates merely copied the information provided, rather than explaining how the proposed mine might affect the salmon. A number of answers were vague and incomplete e.g. “mine waste might kill salmon”, or “explosives kill salmon”.

(ii) Stronger candidates gave a correct definition of a stakeholder. Weaker candidates gave answers such as “someone who has an interest in the sea”.

(iii) To gain credit, candidates were required to use the information provided. Answers such as “the government” or “jewellers” as examples of stakeholders could not be credited.

Question 7

(a) Most candidates gained full or partial credit, usually for “biotechnology” and “selective breeding”. Genetic engineering was a common error for gene.

(b) (i) While stronger candidates answered this well, it was often not attempted by weaker candidates.

(ii) Many candidates could correctly state the role of the promoter.

(c) Most candidates gained partial credit, with many gaining full credit. Answers stating that the GM salmon could breed with the wild salmon were common, but to gain credit, the idea of gene transfer was required.

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

Key messages

Candidates should be reminded to:

- include key scientific terminology when answering all questions, particularly ***Section B***.
- analyse data carefully and be familiar with terms such as independent and dependent variables.
- apply their knowledge of the scientific method to data analysis questions.
- consider mathematical skills that are listed in the syllabus, such as a knowledge of standard deviation.
- be careful to answer the question posed rather than writing their entire knowledge of a topic.

General comments

The general standard of answers was very high, with some outstanding responses showing great depth and detail of knowledge. Generally, answers to free-response questions (***Section B***) were stronger than data handling questions (***Section A***). It is important that candidates have a full understanding of the scientific method and should be familiar with experimental planning and analysis. Despite some candidates finding data handling challenging, there were many excellent answers that demonstrated impressive analysis and understanding of the scientific method.

Comments on specific questions

Section A

Question 1

(a) (i) This question was challenging for many candidates who were not clear on the difference between independent, dependent and control variables. Some candidates thought that the growth of the salmon was an independent variable whilst others gave variables that should have been controlled.

(ii) As in **(a)(i)**, there was some confusion about which variables were controlled and which were independent variables. Many candidates gave correct, relevant variables such as temperature, oxygen, or tank volume. Candidates needed to give variables that were relevant to the context of the investigation and not simply write down a list of any variables. Some candidates gave more than the two factors asked for. Candidates should be advised to answer the question as set and some needed to restrict their answers here.

(b) (i) This question was well answered with the majority of candidates being able to correctly extract information from the graph and then calculate the difference. A few candidates went on to try to calculate a further percentage, not appreciating that the graph was showing mean percentage increase.

(ii) The stronger candidates were able to answer this question correctly. Candidates needed to understand the idea of limiting factors and apply this to an unfamiliar context. Many candidates listed other factors such as oxygen or accumulation of toxins but did not recognise that if a factor is

limiting, increasing it will result in an increase of rate. Stronger candidates understood the idea of limiting factors and gave well explained answers.

(c) Most candidates gained at least partial credit for this question, but only stronger candidates gained full credit. Weaker candidates tended to give general answers about why increasing food would increase the mass of the salmon and did not refer to the data. Stronger answers explained how the rate of respiration would increase with temperature and this would place higher demands on feeding to replace the nutrients used up. Only a few candidates referred to the effect of the temperature increase on the growth of the salmon when they were given no food.

(d) As with **1(c)**, many candidates tried to answer the question without referring to the data and gave general answers referring to salmon needing to migrate or breeding less. Stronger answers considered how the respiration rate of the salmon would lead to an increased demand for food, and that if food was limiting, salmon growth would decline causing a fall in population.

Question 2

(a) (i) Many candidates found this question demanding and a range of answers were seen. A common mistake was not to consider that both the sites surveyed had a control area and the MPA, giving an overall answer of 200.

(ii) Many candidates understood that a control area was needed for a comparison. Only the stronger candidates were able to explain that the conditions in the control areas would be similar to the MPAs and so the comparison would be valid.

(b) Most candidates were able to identify that the number of lobsters in the MPAs were higher than the control areas, and that the increase in **site B** was higher than **A**. However many did not consider the changes to lobster numbers over time and only a few candidates noticed that the control areas in **B** had increased, which suggested that lobsters were spilling over from the MPA. Only stronger candidates considered the significance of the overlapping standard deviations.

Section B

Question 3

(a) (i) Most candidates had a good understanding of the role of gas exchange surfaces. A few candidates thought that larger animals would have a larger surface area to volume ratio and many did not consider the need for a transport system. Generally the role of diffusion in gas exchange was well understood.

(ii) Most candidates were able to gain at least partial credit for this question. The majority of candidates were able to explain the roles of ram and pump ventilation and understood why ram ventilation can be energetically more efficient when swimming at speed. Stronger candidates made excellent references to the role of gill lamellae in increasing surface areas, the need for the maintenance of the diffusion gradients and the purpose of the counter-current flow. Many candidates had an excellent understanding of this topic and were able to use accurate, detailed vocabulary.

(b) Stronger candidates often gave excellent, detailed answers that fully explained the roles of accessory pigments and the different depths that light colours can penetrate to in water. Only a small number of candidates referred to the idea of a competitive advantage for algae that have the accessory pigments. Some weaker candidates referred to the different light intensities at depths rather than considering the colours of light and often discussed turbidity.

Question 4

(a) This question was well answered and most candidates were able to gain some credit. The majority of candidates explored the question fully, considered both advantages and disadvantages, and also considered both the mangroves and artificial reefs. Candidates tended to consider the advantages more than the disadvantages and only stronger candidates considered the possibility of aspects such as mangroves negatively affecting the economy or becoming invasive. There was often an excellent understanding of the methods used to rehabilitate species.

(b) Most candidates were able to correctly explain the effects of increased acidity on coral and gave full explanations of coral bleaching. Many candidates were also able to explain the consequences of increased carbon dioxide on global temperatures and subsequent effects on changes in salinity, habitats and sea levels. Some candidates only considered one aspect of increasing carbon dioxide and so restricted their answers. Stronger answers explored all areas of the topic taking advantage of the prompt in the question to discuss the methods.