# MARINE SCIENCE

**Paper 9693/01**
**AS Structured Questions**

## Key messages

Candidates should ensure they read questions carefully so that if, for example, they are asked to give three reasons in answer to a particular question, then that is what they do, rather than give a long list.

In questions involving a diagram or the drawing of a graph line, candidates should ensure their answers are clear by writing and drawing as neatly possible.

The space available for the answer and the number of marks allocated should be used by candidates as a guide to the amount of detail expected in the answer.

## General comments

Many candidates showed a strong knowledge of the syllabus and in particular **Questions 3**, **6**, **7** and **8** were answered well. Questions involving interpretation of data, such as **5(a)**, were generally answered well, and most understood the implication of the figures. Areas of the syllabus content which were less well understood included the detail of plate tectonics.

## Comments on specific questions

### *Section A*

### Question 1

**(a) (i)** Many candidates gave general answers for this question. Stronger answers included examples of producers and consumers.

**(ii)** Most candidates understood the role of chemosynthesis and photosynthesis in energy production.

**(b)** Nearly all candidates were able to give three accurate reasons why phytoplankton could not survive in this environment. Most knew the physical conditions which exist around a vent.

### Question 2

**(a)** Only the strongest candidates were able to show detailed knowledge of the theory of plate tectonics. Many candidates discussed Pangea and the idea of continental drift rather than the lithosphere being made of individual plates which lie on top of the mantle and may move independently by convection currents. Many knew the importance of plate boundaries and gave correct examples.

**(b)** The majority of candidates were able to gain partial credit in this question. Most understood that the hot magma emerged, but stronger candidates went on to explain the subsequent cooling and solidifying of the lava to form a new crust.

**(c)** Geological features at tectonic boundaries seems to be an area of this topic that was well understood, with most candidates obtaining at least two of the three available marks.

**Question 3**

**(a) (i)** Most candidates knew the term trophic level but few candidates included correct examples.

**(ii)** This section was clearly understood by candidates.

**(iii)** Candidates generally understand that a community involves species in a habitat. However, only the strongest candidates were able to clearly explain the fact that it is all of the organisms of all of the species interacting together

**(b) (i)** Although the shore type was correctly identified by most candidates, the other parts of the grid were not as well known. Many indicated that the rocky shore would be prone to significant amounts of erosion but few made reference to the idea of little or no sedimentation. Likewise, the community aspect of the rocky shore was only understood by stronger candidates and many of the organisms suggested were examples from different habitats. Rock pools would have been a suitable example of a rocky shore community.

**(ii)** Candidates gave many correct factors in answer to this question. Some, such as tides and desiccation, were described in detail.

**Question 4**

**(a) (i)** Many candidates drew the temperature line correctly and understood that the largest fall in temperature occurred within the thermocline layer.

**(ii)** Despite answering **(i)** correctly, many candidates then drew an inaccurate line, often just an arrow, pointing at the thermocline. The answer needed a horizontal line in the top third of the water column showing the thermocline layer.

**(b)** There were many good answers to this question and the concept was clearly understood.

**(c) (i)** Upwelling and waves were the two factors selected by most candidates. If wind or weather was suggested, candidates needed to emphasise that storms or high winds were necessary to cause mixing of the water layers.

**(ii)** There were many references to increased nutrients being available. Candidates then needed to explain how the phytoplankton would photosynthesise to increase productivity.

**Question 5**

**(a) (i)** Most candidates were able to interpret the data from Table 5.1 and gave the correct relationship.

**(ii)** The idea of biodiversity was clearly understood.

**(iii)** Most candidates were able to suggest at least one reason why Japan has a higher tourism value, although few mentioned factors such as climate or weather conditions. Some correctly identified that the Pacific is a much larger area with many islands, which could make it less accessible than Japan.

**(iv)** This was only answered well by the strongest candidates. Answers needed to show the link between reef biodiversity and how it might add value to the economy of the area, both now and in the future.

**(b)** Many candidates gave excellent descriptions of how reefs protected the coast and prevented erosion.

**Question 6**

**(a)** This was well explained by most candidates, usually with a correct example such as shark or tuna.

**(b) (i)** Some candidates stated that the butterfly fish was the factor causing damage to the coral, rather than the blast fishing. The idea of negative correlation was rarely given as an answer.

**(ii)** Many candidates gave a generalised or incorrect answer to **(i)** and were then unable to give relevant explanations of the relationship shown in Table 6.1. Candidates needed to link blast damage to fishing because this damage would cause loss of habitat and food sources.

**(iii)** This part of the question proved challenging for many candidates. Answers needed to suggest controls or collection of different data to confirm the hypothesis that blast fishing was the responsible factor. Ideas such as predation, disease, turbidity or comparing species numbers with another reef area were rarely suggested.

**Question 7**

**(a) (i)** This was generally answered very well.

**(ii)** Nearly all candidates knew that magnesium was used to make chlorophyll.

**(b)** Most candidates knew the nutrients and their uses.

**Question 8**

**(a) (b)** Excellent descriptions and examples were given and these terms were clearly understood by most candidates.

**(c)** This term was less well understood and many candidates described succession as just one species replacing another. Candidates needed to emphasise the idea of a change in species or communities over time. Most candidates were able to identify the vent community as an example of succession.

# MARINE SCIENCE

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

## Key message

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 round answers up or down correctly. Units should always be included with numerical answers where appropriate.

The quality of graphs drawn was generally high. Candidates should be reminded to use a ruler for the axes and for joining plotted points, rather than free-hand lines. Candidates would benefit from practice in converting tabulated data into suitable graphical forms and make sure they label axes accurately.

When answering extended questions, candidates should be reminded to use the correct scientific terminology and ensure it is spelt correctly.

## General comments

A high standard of scientific knowledge and understanding was displayed by many candidates. Most candidates attempted every question. Weaker candidates sometimes did not answer the question as it was set. In these cases, candidates should be reminded to read the stimulus material and each question carefully.

Overall, candidates performed equally well in ***Sections A*** and ***B*** with many candidates 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)** Nearly all candidates correctly stated that mussels occupied the second trophic level. Primary consumer was also an acceptable answer. Some candidates were confused about the position and gave the incorrect answer of primary trophic level.

**(b) (i)** A common error in this question was to include the energy transferred between eider ducks and gulls giving the incorrect figure of 3012.3 kJ per $m^2$ per year. Some candidates calculated the energy transferred correctly but then subtracted this figure from the mussel productivity. Candidates often missed that it was the energy transferred per year which was required, and gave the incorrect units of kJ per $m^2$.

**(ii)** Candidates had to use their answer to **(i)** to calculate the energy transferred as a percentage of productivity. Most candidates calculated the percentage with the most common error being inaccuracies in rounding their answers.

**(iii)** Only the most able candidates were able to answer this question fully. Most candidates were able to state that the mussel population would decrease. Fewer candidates were able to explain that the losses were greater than productivity. Very few answers manipulated the data to support their

answer. Weaker candidates described different methods of energy loss, which while true were not relevant to the question asked.

**Question 2**

**(a)** This question was answered particularly well with many candidates gaining full credit for fully detailed answers. Candidates clearly understood the link between increased concentration of atmospheric carbon dioxide with increased dissolution resulting in the formation of carbonic acid and the decrease in pH of seawater.

**(b) (i)** A few candidates gave a separate *y*-axis for site A and site B. This was accepted if the points were plotted correctly. Many candidates answered well, using suitable scales and plotting points with care and accuracy. A few candidates did not label the axis correctly, mostly forgetting to include the units on the *y*-axis. Some candidates tried to sketch a line of best fit rather than joining the plotted points as asked. A very small minority of candidates tried to plot the data for site A and site B against each other.

**(ii)** Candidates were generally able to compare the data with accuracy. Most candidates were able to describe the general trend shown by the data, with some able to manipulate the data to support their answers. If candidates are asked to describe or compare data, they should be encouraged to include data quotes and manipulation to support their answer.

**(iii)** In this question candidates needed to identify that the data both supports and refutes the hypothesis and to give details of the evidence from the data provided. Many of the candidates were able to do this, but some chose to only refer to one set of data so that it would fit the hypothesis. Stronger answers analysed what the data showed as a whole.

***Section B***

**Question 3**

**(a) (i)** The vast majority of candidates were able to define a habitat correctly.

**(ii)** Most candidates where able to provide a suitable definition of a species. A few candidates tried to explain how species were classified by grouping organisms with similar characteristics. Common errors were either to fail to specify that the offspring produced would be fertile or to state that species were a group of the same organism.

**(b)** For this question producers were not accepted as an example of prey. Most candidates were able to describe the cyclical changes. Fewer candidates explained that prey population and biomass are usually larger than prey. Credit could be gained directly from a labelled graphical diagram. However, very few candidates chose to do this.

**(c)** Some candidates made several excellent points to give a complete explanation of why coral reefs contain narrow ecological niches. Most candidates recognised that coral reefs contained high levels of biodiversity. Many candidates linked the idea that narrow niches reduce competition for resources. Weaker candidates confused the coral reef having a large range of food sources with an organism with a narrow niche feeding on a wide range of food sources. Few candidates chose to explain what a niche was or give an example of organisms with a narrow niche. This would have added to their explanations.

**Question 4**

**(a)** This question was answered particularly well with many candidates showing good understanding of the impacts of the alignment of the Earth, Moon and Sun on the tidal range. The most thorough answers explained the key terms. Credit was awarded for explaining the term ‘tidal range’. Most candidates gave clear explanations of the spring and neap tides, describing their causes and effects. A few weaker candidates misunderstood the question and described the causes of tides over a 24-hour period.

**(b)** Many good descriptions of the development of a cyclone were seen. There was some confusion over the order of events and some inaccuracies of the use of the terms evaporation, condensation and latent heat energy. Some candidates were not specific enough in their explanations, vaguely

referring to the movement of winds or loss of energy. Very few candidates referred to the depth of water at which cyclones begin to develop.

**(c)** Most candidates gave acceptable suggestions as to why lagoons had lower concentrations of dissolved oxygen. Many candidates suggested higher temperature or less wave action and gave an explanation of why this would decrease dissolved oxygen concentration. Fewer candidates suggested the lagoon had fewer producers. Some candidates tried to relate the dissolved oxygen concentration to rates of respiration rather than photosynthesis.

# MARINE SCIENCE

**Paper 9693/03**
**A2 Structured Questions**

## Key messages

- Candidates need to make sure that they read and process all the information provided before they start writing their answers.
- When asked to use information from a table or figure, this information must be included in answers.
- Candidates should use correct scientific terms and avoid vague words or phrases such as 'amount', 'pollution' or 'causes organism to die'.

## General comments

There were some very good answers showing a strong knowledge of the syllabus content and the ability to use this knowledge to interpret information provided. This was particularly evident in **Question 3** (**a**) on the life cycle of oysters, **Question 5** on aquaculture in giant clams and **Question 6** on problems caused by the release of methylmercury from dredging. **Question 2** proved challenging and knowledge on pumped and ram ventilation in fish was minimal.

## Comments on specific questions

### Question 1

**(a) (i)** Most candidates were able to give at least one reason why kelp and seagrass were found next to coastlines, with 'shallow water' and 'enough light for photosynthesis' common answers. Some candidates mentioned that there would be more nutrients, but this needed to be linked to run off from land. Few candidates mentioned the need for a substrate for attachment.

**(ii)** Most candidates could identify a region where both seagrass and kelp were found and a region where one was more common than the other. There were fewer references to regions where neither was found, or to where only one was found. Some candidates made vague references to the northern or southern hemisphere or to the tropics which were too general to be credited.

**(iii)** To gain full credit, candidates needed to avoid vague terms such as 'food source', 'shelter' and 'habitat' unqualified. Several candidates mentioned 'breeding grounds' when 'nursery areas' was required. References to coastal erosion were not credited as they did not relate to the marine ecosystem.

**(b)** Stronger candidates were able to study and compare the two food webs and could quote specific examples from them. These candidates had studied the food webs and had understood the effects of overfishing and hunting. There was a misconception by some candidates that the arrows represented the predator being eaten by the prey. Weaker answers stated that there were fewer predators and so more prey which was too vague to be credited.

**Question 2**

**(a) (i)** Most candidates were able to calculate the correct diffusion coefficient for oxygen in water. The most common error was not squaring the value for distance before dividing by time.

**(ii)** This question proved challenging. Common errors were forgetting to square 3000 before dividing by 3.6, or adding an extra 0 to the correct answer.

**(iii)** Only the strongest candidates gained full credit for this question but most candidates gained some credit, usually for the idea that the diffusion distance was too great or for a reference to diffusion time. Common errors were to state that there was a large surface area to volume ratio and that cells were too far away from each other.

**(b) (i)** This question proved challenging and only the strongest candidates demonstrated detailed knowledge of pumped ventilation. Most candidates stated that the mouth opened, but not that the operculum closed. There were few references to pressure or that the water was pulled into the mouth and forced out of the operculum. Most answers were too vague to gain any credit.

**(ii)** Most candidates stated that there was continuous movement of water across the gills, which was not enough to gain credit. Answers needed to be clear that the rate or speed of water movement over the gills had increased. Only the strongest answers mentioned maintaining a diffusion gradient.

**Question 3**

**(a) (i)** Most candidates were able to name each stage correctly.

**(ii)** Almost all candidates gave a reason why so many eggs were produced, usually referring to the increased chances of fertilisation. There were few references to eggs being eaten by predators or that eggs were affected by adverse pH or temperature.

**(iii)** Almost all candidates could state the purpose of the foot.

**(b)** Only the strongest candidates gained credit here. Common misconceptions were that adult shrimp were found in mangroves or in estuaries or that adult giant clam were found on the sea floor which was too general.

**(c) (i)** Burning fossil fuels was a very common correct answer for this question.

**(ii)** Most candidates referred to dissolution. However, there were many vague references to causing the pH to become acidic instead of stating the exact reason for the acidity.

**(iii)** Only the strongest candidates were able to state that shell formation was dependent on the availability of calcium in the water and the acid conditions reduced calcium availability. Some candidates gained partial credit for stating that pH adversely affects enzymes. Some misconceptions were that the change in pH also caused salinity changes or that there was an effect on osmoregulation.

**Question 4**

**(a)** This question was well answered. The use of sonar to locate and catch shoals of fish was common, as was mentioning factory ships with storage facilities, but this was not always linked to being able to stay at sea for longer. References to satellites or GPS had to be linked to FADs to gain credit.

**(b) (i)** Better candidates gained partial credit on this question but few gained full credit. References to fewer adult fish available to reproduce or references to recruitment were rare.

**(ii)** The calculation proved straight forward for nearly all candidates.

**(iii)** This question was challenging for most candidates**.** The strongest candidates understood that for the same effort, catch would now decrease as fewer fish were available to catch.

**Question 5**

**(a)** Most candidates could state the relationship between the two organisms, with the idea of clams providing a habitat for dinoflagellates, while these provided sugar for the clam.

**(b) (i)** Many answers to this question were vague and no credit could be awarded for answers such as 'impurities', 'chemicals' or 'toxins' or the idea of 'pollution'. Correct answers needed to highlight what a filter would remove from the water.

**(ii)** Most candidates gained partial credit here. Temperature was not credited as the system was a flow-through system.

**(c) (i)** The strongest candidates were able to state that young clams less than two years old were all male and so would not be able to breed as there were no female clams available.

**(ii)** This question proved challenging. Few candidates suggested that the injection of hormones into a mature clam could damage internal organs. For method 2, candidates needed to realise that the sex hormones were released onto adult clams so promoting gamete release in the tank containing adult clams. Answers stating that gametes would be damaged by crushing could not be credited. Most answers for method 3 only stated that the clam would die, whereas better candidates stated that they would die from dehydration.

**(d)** Most candidates answered this question well and were able to give valid reasons why reef **A** was more suitable than reefs **B** and **C**. The best answers fully explained the reason for the choice.

**Question 6**

**(a)** Stronger candidates read the information provided carefully and made the link between the port, with a high number of boats, and mercury which is produced from anti-fouling paint.

**(b) (i) (ii)** These parts of the question were well understood and most candidates gained full credit.

**(iii)** Many answers were not specific enough with some candidates stating that the tuna contained high concentrations instead of the highest concentrations of methylmercury.

**(c)** Most candidates answered this question well with full credit common. A common misconception was that zooplankton carried out photosynthesis even though zooplankton are shown to eat phytoplankton in the figure.

**(d)** Few candidates gained credit here as answers were too vague. Answers often mentioned dumping on land which was not enough as the waste is highly toxic.

**Question 7**

**(a) (i)** Most candidates gave part answers for this question. For example, by referring to oil pollution but not how to reduce this type of pollution or to carrying a small number of people but not why this was important.

**(ii)** Most candidates gained partial credit here, usually for referring to more employment opportunities and to bringing money into the local economy.

# MARINE SCIENCE

**Paper 9693/04**
**Data Handling and Free Response**

## Key Messages

Candidates should read questions carefully to ensure that they understand what is required before they start their answer.

They should identify command word such as 'explain' and 'suggest' in the question to ensure they answer the question as it has been set.

The number of marks available for each question will give a good indication of the length of answer required.

Candidates should be aware of the mathematical skills that are stated in the specification, such as an understanding of standard deviation, and should use these skills where necessary.

## General Comments

Some excellent answers were seen where candidates analysed data carefully to draw correct conclusions and wrote strong extended answers. Most candidates showed a good, detailed knowledge of the syllabus and generally performed well on the free-response questions. Many candidates found data analysis challenging and graphs were of a very variable standard.

## Comments on Specific Questions

***Section A***

**Question 1**

**(a) (i)** Most candidates recognised that the experiment carried out at 5 ºC was a control experiment. Some referred to it being a controlled variable and others suggested that it was to investigate photosynthesis in the water compared to the air. Some candidates did not fully appreciate that the seaweeds were exposed to different temperatures in air but thought that the experiment was entirely carried out in the air.

**(ii)** This question was demanding for many candidates. Only stronger candidates answered well. A common mistake was to either only describe or only explain the data rather than stating the patterns and then accounting for them. Most candidates were however able to relate the changing levels of oxygen with changing rates of photosynthesis. Very few candidates referred to the standard deviation and error bars. An understanding of the mathematical requirements of the specification and the synoptic experimental skills from Topic 1 of the syllabus were important here.

**(b) (i)** Graphical skills were mixed. A surprising number of candidates drew line graphs and several drew histograms rather than bar charts. Other common errors included inaccurate plotting, not labelling axes and not using any form of identification key. Candidates should appreciate that categoric data should be plotted using a bar chart.

**(ii)** Very few candidates suggested that exposure to –20 ºC would cause water to freeze and result in cell damage. Many candidates thought that the temperature would affect enzymes.

**(c)** Most candidates gained partial credit on this question with many gaining full credit. Most candidates correctly suggested that the algae were adapted to their habitats and many went further to explain this in terms of freeze resistance or susceptibility and its impact on photosynthesis. A few candidates misunderstood the question and suggested that the different penetration of different light wavelengths would cause the results.

**Question 2**

**(a) (i)** About half of the candidates correctly suggested a reason for only culturing male tilapia with most suggesting preventing breeding or larger size. Some candidates gave vague suggestions such as better meat quality.

**(ii)** Most candidates suggested a correct reason for the objections by consumers, typically the impact on human health. Few gave a reason for negative effects on both consumers and the environment, with only stronger candidates giving an answer for each aspect.

**(b)** Stronger candidates usually answered well and fully understood the concept of relative effects, often describing the bigger impact of methyltestosterone compared to temperature and the combined effects of both treatments. Many candidates simply gave descriptions of the effects without discussing the relative effects of methyltestosterone and temperature. Only a minority manipulated the data in their answer with many simply quoting figures from the table.

**(c)** Many candidates discussed the risks and benefits of genetically engineering the tilapia, with the majority who gained credit referring to the risk of escape of the fish and the reduced risk of chemicals. Weaker candidates often only gave one side of the argument and so could not gain full credit.

***Section B***

**Question 3**

**(a)** Most candidates showed an excellent understanding of the factors that affect salinity with many answers referring to at least one of evaporation, rivers and rain. Most also appreciated the effects of different salinity on osmosis in fish. There were some excellent descriptions of osmoregulation including the role of gill ion pumps, the drinking of seawater and the production of concentrated urine. Few candidates considered the effects of salinity on osmoconformer species. A few candidates were confused about the direction of water movement in osmosis, thinking that high salinity would increase water uptake.

**(b)** Similarly to **(a),** many candidates gave excellent accounts of the causes and effects of increased atmospheric carbon dioxide. Most were aware of the roles of burning fossil fuels and deforestation and went on to discuss how this would affect the marine environment. Increased ocean acidity and its links to coral bleaching, raised temperatures and altered phytoplankton productivity were frequently discussed. A few weaker candidates focused their answers on only one aspect. Stronger candidates answered fully on this free-response question rather than limiting themselves to one or two aspects.

**Question 4**

**(a)** Most candidates could correctly name at least two methods that can be employed to ensure sustainable fish exploitation. A few candidates did not gain full credit by restating the same method two or three times.

**(b)** Most candidates could appreciate the positive impact of the MPAs on preventing extinctions and preventing loss of biodiversity and the negative impacts on fishing industry employment and loss of development in the area. Some excellent, well considered answers were seen that gave a very balanced discussion of both the positive and negative effects.

**(c)** This question required candidates to use their knowledge of aquaculture and release of cultured fish to replenish fish stocks. Some candidates considered several factors such as suitability of

location, presence of predators and cost effectiveness. Weaker candidates found the question challenging and often simply gave accounts of aquaculture rather than relating this to the question regarding release of cultured fish.