# MARINE SCIENCE

**Paper 9693/01**
**As Structured Questions**

## Key Messages

Candidates should be fully conversant with the command words used in the questions and detail their answers accordingly. For example, a question asking for a description or an explanation requires a fuller and longer response than a question asking for a simple statement.

Candidates should attempt to keep their responses both concise and precise. Sometimes the use of bullet points is appropriate and can help to achieve this aim.

Time – candidates should allow sufficient time for each question in order to give a fully detailed response.

In quantitative questions, the phrase "show your working" is used and it is important that this instruction is followed as marks are often available for this.

Where units are not given on the answer line then these must be stated as part of the answer.

## General comments

Many candidates demonstrated a good knowledge and understanding of topics such as symbiosis and parasitism, upwellings, tropical cyclones and the cycling of calcium in the marine environment.

Many of the questions requiring higher order skills such as interpretation and application of knowledge to novel situations or scenarios were less well answered.

With respect to graph drawing, some candidates showed some improvement but the graph plotting skills displayed by many candidates still fell below the standard expected at this level.

## Comments on specific questions

### Question 1

**(a) (i)** Most candidates were able to interpret the graph showing the distribution of warm water corals and conclude that most were located between the latitudes 30 °N and 30 °S. Use of the word latitude was not expected in the answer. In this question, less detailed answers such as "close to the equator" were allowed.

**(ii)** The reasons given for the distribution of warm water corals were either quite precise or vague. A response such as "the water temperature is ideal for coral growth"' or similar was required: a response such as "corals need warm water" was considered inadequate.

**(b) (i)** Many candidates appreciated that the reason that corals need clear water was related to the amount of light reaching them and, often, a reference to photosynthesis was given.
Fewer candidates referred to zooxanthellae in the coral tissues.

**(ii)** A large majority of the candidates appreciated that a rocky substrate was needed for the attachment of coral.

**(c) (i)** Most candidates were able to read the graph correctly, describing the change in coral cover as a decrease of 13 %.

**(ii)** The reasons given for this decrease varied considerably; candidates need to ensure sufficient detail is provided. For example, a response of "pollution" requires elaboration, with the type of pollution that would affect coral being described.

**Question 2**

**(a) (i)** Most candidates were able to give a satisfactory definition of a trophic level and to give an example from the food web.

**(ii)** Many candidates appreciated that the arrows represent a transfer of energy from one organism to another but much fewer realised that they also represent a transfer of biomass. Many candidates tried to express an answer in terms of which organism eats another but usually these answers were very unclear.

**(iii)** This was general well answered and most candidates appreciated that the fish and squid can eat each other. Many fewer candidates went on to refer to the idea that this depended on the stage in the life cycle, the size or species of fish and squid.

**(iv)** Overall, this part of the question was not very well answered. Most candidates gained partial credit for drawing a stepped pyramid and correctly naming the organisms in the pyramid. Very few candidates drew their diagram to the correct scale with respect to the estimated numbers at each level. There were also a number of sloped pyramids drawn which are not acceptable at this level. Also of note in this question was the number of freehand diagrams: a ruler should have been used for the answer to this question.

**(b) (i)** This part of the question was very well answered and it was pleasing to note how many candidates were able to give an accurate description of upwelling. The only issue with the responses was that some candidates give their answers in such a way as to imply that it is only nutrients rising into the surface waters rather than water containing nutrients.

**(ii)** In this question many candidates did not appreciate the link between the increased nutrient provision, the effect of this on the producers and the subsequent increase in productivity.

**Question 3**

**(a) (i)** Most candidates were aware that symbiosis involves a relationship between two organisms and were able to state an example. Very few candidates expressed the fact that this relationship was between organisms of different species.

**(ii)** The same comments relating to parasitism apply here as those relating to symbiosis expressed above.

**(b)** It was pleasing to note how many candidates were aware that tube worms such as *Tevnia* have a symbiotic relationship with chemosynthetic bacteria which provide their food. They were generally able to give detailed responses worthy of full credit. Some candidates had some problems in expressing their answers and gave the impression that the *Tevnia* were carrying out chemosynthesis.

**Question 4**

**(a)** Many candidates gained half or more of the available credit in this section of the question. Most were aware of the need for low pressure and warm water with the correct water temperature often being quoted. Less frequent were references to evaporation and condensation and the release of heat energy.

**(b) (i)** This was well answered and most candidates were able to calculate the difference in the maximum and minimum air pressure. Most candidates also gave the units which were needed in order to gain credit.

**(ii)** As mentioned in the general comments, there has been an improvement in the standard of graph seen. There still remain a large number where the actual plotting of points is poor. Plots are best drawn with a sharp pencil as a neat and small 'x'. Similarly, lines should be drawn with a ruler and

a sharp pencil where a straight line is called for. Curved lines should also be drawn with a sharp pencil and should be a single line not a double one as is often seen.

**(iii)** Few candidates gave the relationship correctly and usually gave only half of it. Answers such as "it increases with distance" or "decreases with distance" were common. Candidates often did not appreciate that the relationship involved both of these points, i.e. it increases then decreases as the distance from the centre of the cyclone increases. The reverse expression of the relationship was also acceptable. Some candidates did gain credit for the appreciation that there was a change at 40 km.

**Question 5**

**(a) (i)** While the term thermocline was generally well known, many other names were quoted for the part of the water column shown on the graph.

**(ii)** Many candidates were able to draw a correctly shaped line on the graph within the range 10 °C and 0 °C and falling to the left between the line already on the graph and the y-axis. Some drew incorrect lines showing both an increase and decrease in temperature as depth increased.

**(b) (i)** A large number of candidates labelled the graph correctly showing the greatest density at the bottom of the water column. However, the reason given for this was usually incorrect and often related to salinity rather than temperature.

**(ii)** Many candidates appreciated that factors such as precipitation, reduced evaporation and influx of fresh water would decrease the salinity of sea water.

**(c)** This proved to be a somewhat difficult question for many candidates. While there was some appreciation that the oxygen concentration is increased by the process of photosynthesis, a lot of candidates merely hinted at this. Answers such as "oxygen is increased because there are a lot of plants" were not sufficiently detailed enough to merit credit. A similar type of response was given in respect of the effect of respiration
**O**ther candidates were aware that the solubility of oxygen decreases with increasing temperature and thus there would be a lower concentration at the surface compared with lower depths. Quite a few candidates put forward, quite correctly, the idea that oxygen concentration was increased by the action of turbulence caused by winds or wave action.

**Question 6**

**(a)** This question elicited a wide range of responses and most candidates gained at least partial credit from the wide range of acceptable answers, and there were a decent number of very good answers. The most common points made were references to a rocky shore being more stable than a sandy shore and a rocky shore providing a suitable surface for attachment of organisms. Many candidates also correctly made the point that sandy shores often only provide a suitable habitat for organisms which burrow or live under the surface.
Some candidates aimed their responses purely on the rocky shore and failed to make any comparative statements about the sandy shore.

**(b) (i)** The type of responses seen nearly always followed the same pattern. Candidates generally gave one or two correct suggestions as to how the root systems of mangroves either reduce wave energy or reduce water flow or trap sediments. These suggestions could then be related to the structure of the root system of a mangrove for further credit.

**(ii)** Many candidates gained full or partial credit and were able to state two or three suggestions for the fall in the area of mangrove forest. These were, most often, references to deforestation or physical destruction by storms or other similar natural phenomena. Other candidates gave rather vague suggestions with little reference to examples. As an illustration of this, references to "pollution" were not considered creditworthy unless supported by an appropriate example.

**Question 7**

**(a) (i)** Many candidates were able to describe the relationship between the concentration of carbon dioxide in the atmosphere and in sea water as both increasing. Fewer candidates were able to suggest an explanation for the relationship although there were many excellent responses. These usually stated clearly and precisely that carbon dioxide in the air dissolves in sea water and carbon dioxide from sea water enters the air. Few referred to an equilibrium between the sea and the atmosphere. Some candidates gave details of the source of the carbon dioxide which in the context of this question was irrelevant.

**(ii)** As in the previous question, most candidates were able to see the relationship shown in the graph and to express it quite precisely. Candidates did not, on the whole, give a valid explanation for the relationship, although the formation of carbonic acid or bicarbonate ions was known by many.

**(b)** Most scored at least half of the available credit for this section of the question with some giving excellent answers. The idea of erosion and the movement of calcium containing particles into the sea/ocean were described by most. The concept of calcium being taken up by marine organisms and passing through a food chain and the subsequent death and decay of the organisms was less well known. Some candidate's responses were simply a narrative of rocks containing calcium falling into the sea and sinking to the sea bed to forms sediments.

# MARINE SCIENCE

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

## Key Messages

Candidates should:

- read the questions carefully, consider the 'command words' used and note the mark allocation
- select appropriate information to answer the questions and try to avoid including irrelevant details
- manipulate data in tables, rather than quoting figures directly, when describing results
- try to write free response answers in a logical and coherent sequence
- use appropriate examples from the marine environment
- use scientific terms and vocabulary
- include units with numerical answers.

## General Comments

This paper is intended to test candidates' ability to interpret data, possibly in an unfamiliar context, using their knowledge and understanding of the subject content, and to write extended answers in continuous prose. The range of responses to this paper was very wide, from those candidates with a detailed knowledge of the content and an ability to apply their knowledge, to those with little knowledge of some of the basic factual content of the syllabus. In general, candidates coped better with **Questions 2** and **4** than with **Questions 1** and **3**. In **Question 2** part **(c)**, for example, there were a number of answers giving detailed experimental plans and some detailed descriptions of hydrothermal vents in **Question 4**. Questions requiring interpretation or manipulation of data were often answered less successfully.

Questions in ***Section A*** mainly focus on application of knowledge (Assessment Objective B) and candidates are expected to be use principles and concepts within the syllabus and apply them in a logical, deductive manner. Questions in ***Section B*** mainly focus on knowledge with understanding (Assessment Objective A) and require candidates to be able to recall and understand the learning objectives within the syllabus. Some candidates had a better ability to recall factual information from the syllabus than to apply their knowledge in an unfamiliar context. Skills in this latter area can be practised, for example the interpretation of data and the application of the mathematical requirements of the syllabus.

## Comments on Specific Questions

### *Section A*

### Question 1

This question proved to be difficult for many candidates and the answers were often expressed using inaccurate vocabulary. A number of candidates did not read the instruction for part **(b)(ii)** carefully, resulting in incorrect calculations.

**(a)** The majority of candidates gained both marks for this part, for references to the production of organic substances using light energy, or through photosynthesis. There were also a number of acceptable descriptions of chemosynthesis. Key concepts in this explanation are the use of photosynthesis, light energy or a reference to autotrophic nutrition and the production of organic substances, or a named example such as glucose or carbohydrates. One common error was the suggestion that producers 'create energy' which is clearly incorrect.

**(b) (i)** Most candidates carried out this simple subtraction correctly, although a number did not give the correct units with their answer, or quoted only part of the units, for example, kJ. It is essential that appropriate units are included in numerical questions of this type.

**(ii)** This part proved to be more challenging for candidates and it appeared that a number did not read the question carefully as they did not use the answer to **(b)(i)** in their calculation. It was quite common, therefore, to see the productivity of the herbivores expressed as a percentage of the productivity of the producers. Candidates who made an error with the subtraction in **(b)(i)** were given credit if they used this figure for their calculation in **(b)(ii)**.

**(c)** Candidates generally found it difficult to give three accurate reasons to account for the difference between the productivity of the herbivores and the productivity of the producers. Candidates who answered this well were able to give appropriate reasons for the energy losses between the producers and the herbivores, including references to heat loss as a result of respiration, not all of the producer being eaten by the herbivore, and not all of the producer being digested and the subsequent energy loss in faeces. A number of the answers were inaccurate references to the relative numbers of producers and herbivores, pyramids of numbers and 'the 10% rule' but without any further qualifications. Clear, scientific explanations were expected here and it is not accurate, for example, to refer to 'energy lost as waste'. Candidates are expected to be able to account for the efficiency of energy transfer between trophic levels, but may have found it difficult to apply their knowledge and understanding within the context of this question.

**(d)** Many candidates gained partial credit for suggesting that the difference between productivity of producers in an estuary and in the open ocean is due to the availability of nutrients. Relatively fewer candidates went on to explain that this is due to run-off and nutrients being brought into an estuary by rivers. There were a number of suggestions relating to differences in light intensity, salinity or depth, but it is unlikely that these would cause the difference in primary production between these two habitats.

**Question 2**

**(a) (i)** The majority of candidates appreciated that the cultures were illuminated to provide light for photosynthesis, but a number suggested that illumination provides warmth for the cultures or that this enables the experimenter to inspect the cultures.

**(a) (ii)** This part tested Topic 4, learning outcome (f) and candidates were expected to give a specific biological use of each of these nutrients. However, the reasons given for including magnesium and phosphorus in the culture solution were often rather vague, such as suggesting that the concentrations would be the same as those found in the natural habitat, or simply that both are required for growth of the algae. Careful expression of the answer is important here, because it is insufficiently accurate to state, for example, that 'they are required for chlorophyll and DNA' without specifying which nutrient is required for which purpose.

**(b)** Previous reports have commented on the importance of looking carefully at data and giving accurate, quantitative descriptions, rather than generalisations. This part proved to be difficult for many candidates who were unable to translate the data into an accurate description of the effect of temperature on the growth of the alga. Relatively few included references to both the temperatures and the numbers of cells. Some descriptions stated, incorrectly, that the number of cells at 18 °C is lower than the number at 14 °C. Although many candidates identified 26 °C as the optimum, a number quoted a wide range. Candidates were also given credit for a manipulated, quantitative description, such as giving the change in the number of cells over a specified temperature range, but comparatively few included this in their answer.

**(c)** This part was usually answered more successfully than part **(b)** and many candidates correctly applied the information provided in the question to describe a laboratory-based investigation into the effect of salinity on the growth of *Isochrysis*. Most of the answers included a reference to using a range of different salinities, although very few suggested how this could be achieved by using different concentrations of sodium chloride solution. Many answers also included references to the initial number of cells added to each culture and stated two variables, such as illumination and temperature, which would be controlled. There were also many references to a suitable time period for the experiment, usually 10 days. This question also expected candidates to include a reference to the collection of quantitative results and a simple statement such as 'results would be

noted' would be better expressed with reference to counting the cells, to measure growth at each of the salinities.

Some accounts were essentially repeats of the original investigation into the effect of temperature, rather than salinity, on the growth of the alga. Nevertheless, candidates were usually able to gain partial credit for these answers.

***Section B***

**Question 3**

**(a) (i)** The explanations of the term *succession* were very variable as candidates often found it difficult to express their ideas using accurate vocabulary. Consequently, it was not always clear whether candidates were describing succession or zonation, or other changes in population size as a result of competition between two species. There were some good explanations in terms of changes in community structure over a period of time which gained full credit. Weaker answers sometimes referred to changes in the habitat or in the environment, or made vague references to different organisms being present at different times. Descriptions of both primary and secondary succession were accepted.

**(a) (ii)** This part proved to be more familiar to candidates, many of whom gained full credit for descriptions of succession at a hydrothermal vent. These answers often included detailed descriptions of the hydrothermal vent community, with appropriate references to chemosynthetic bacteria, tubeworms and succession illustrated by *Tevnia* and *Riftia*. There were also some answers which described predator-prey relationships, food webs or food chains. Candidates were also given credit for other examples of succession in the marine environment, such as colonisation of a sunken ship or whale-fall.

**(b)** A wide range of responses was seen to this part and there were some excellent, detailed accounts covering several different aspects of shoaling and their advantages. A number of accounts tended to concentrate on one aspect only, such as predator avoidance or foraging efficiency. This question asked candidates to explain why shoaling may be an advantage to herrings; unqualified references to shoaling, without an explanation of the consequent advantages were often insufficient to gain credit. To illustrate this point, a reference to 'hydrodynamic efficiency' on its own, is insufficient. This would be better expressed as 'shoaling increases hydrodynamic efficiency and therefore saves energy'. There were many references to reproduction, but again the advantages of shoaling in this context were often not well explained. However, there were some good descriptions in which candidates clearly described the presence of both male and female fish of the same species within a shoal and the consequent increased chances of fertilisation.

**Question 4**

**(a)** The majority of candidates were able to cite at least one piece of evidence to support the theory of plate tectonics, the most common of which was a reference to the fit between coastlines of Africa and South America. References to the distribution of fossils on different continents were also frequent and many candidates also referred to the magnetic stripes on the ocean floor. Some candidates included descriptions of seismic activity associated with plate boundaries, or commented on the age of the crustal plates. Some of the answers to this part explained what the term *plate tectonics* means, but without including evidence. The most frequent examples of evidence were references to the fit of coastlines, distribution of fossils and magnetic stripes on the sea floor; many candidates included all three in their answer and gained full credit.

**(b)** The answers to this part were more variable than those to part **(a)**. Convergent and divergent plate boundaries were often confused, although many candidates appreciated that ocean trenches are associated with subduction and ocean ridges are associated with the upward movement and subsequent solidification of magma. The formation of tsunamis was less well understood than the previous features; many answers described the destructive effects of a tsunami, rather than how tectonic processes give rise to their formation. Candidates were often unsure which type of tectonic movement is responsible, although there were many acceptable references to underwater earthquakes and to the subsequent displacement of a large volume of water.

**(c)** Hydrothermal vents seem to be familiar to the majority of candidates and there were many good descriptions of the physical and chemical factors associated with these features. A number of candidates gained full credit for this part, for references to no light, high temperature and high pressure, low pH and the presence of hydrogen sulfide, or minerals such as iron and zinc. Some of the answers digressed into descriptions of the communities and food chains associated with hydrothermal vents, often essentially repeating information given in **Question 3**, part **(a)(ii)**. This illustrates the importance of reading the question carefully and selecting relevant information for the answer.

# MARINE SCIENCE

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

## Key Messages

- Read questions carefully and answer only what is being asked.
- Use correct terminology for measurements and names of organisms.
- Show the main steps of calculations clearly and use appropriate units for answers.

## General Comments

There were some good answers showing a sound knowledge and understanding of the syllabus. To access high marks, candidates need to use precise language and avoid generalised vague statements, for example, in **Question 1 (c)(ii)** definitions of thermoclines were too generalised and in **Question 3 (e)** single word answers without explanation were common. In questions using data, candidates can usually select the correct data to use, but often lack the mathematical skills to process it as expected. For example, in **Question 5 (a)** many candidates could not calculate a percentage increase or work out a proportion and in **Question 4 (b)** the change in correlation between the two types of fish was often missed.

## Comments on Specific Questions

### Question 1

This question was about the effect of temperature on the number and distribution of phytoplankton.

**(a) (i)** Very few candidates gained credit. The correct response was the surface of the open ocean.

**(ii)** The majority of candidates gave a correct answer, either dinoflagellates or cyanobacteria. The question asked for a type of phytoplankton, so specific examples were not credited.

**(b)** Most candidates knew that phytoplankton form the basis of marine food webs. More in-depth answers were able to relate changes in productivity to food availability within the food web and the consequential effect on human food supply. Less creditworthy answers gave a general account of energy flow in marine food chains.

**(c) (i)** Most candidates gave a correct response. Candidates should ensure the relationship between the two variables is described, rather than looking at each curve individually.

**(ii)** Many candidates had clearly learned a definition of a thermocline but often presented it too vaguely for credit. For example, stating that a thermocline is an area, rather than a layer and that the temperature changed with depth, rather than decreased rapidly as depth increases. Maximum credit was available for a well annotated diagram. Answers needed to go beyond stating that warm water floats on the surface.

**(iii)** Candidates need to improve their understanding of the effect a thermocline has on the movement of water between the upper and lower layers of the ocean: a thermocline is a barrier that prevents mixing between nutrient-rich deep water and nutrient-poor surface waters. The deeper the thermocline, the less mixing occurs so the surface waters are nutrient limited. The majority of answers did not consider nutrient supply. Some candidates used the information in Fig. 1.1 to reach incorrect conclusions. Those who stated that a shallower thermocline would make the water colder concluded that there would be more phytoplankton. Others stated that the water would be warmer and so there would be less plankton. There were also candidates who ignored the thermocline entirely and answered in terms of light penetration and photosynthesis.

**Question 2**

This question was testing the understanding of adaptations by fish to low oxygen concentration.

**(a) (i)** Almost all candidates were able describe at least one way in which oxygen enters water. The most common was photosynthesis. Other creditworthy answers referred to physical aeration by wave action or to diffusion from the atmosphere. Dissolution from the atmosphere was an acceptable answer.

**(ii)** Most candidates gave examples of habitats were oxygen concentration was low but did not always refer to a community. Credit was given for these answers. The most common were benthic communities and hydrothermal vents. Credit was not given for just naming a type of organism, such as tube worms, as different species of these animals live in a wide variety of habitats.

**(b)** Candidates were expected to relate their answers to the features specified in the question. Overall, the most detailed answers were for explanations of the use of slow movement, the least detailed those concerning increased ventilation mechanisms.

Most candidates knew that movement requires energy provided by respiration and so gained credit for answers that referred to a lower energy demand requiring less respiration and thus less oxygen. Very few candidates stated that the energy was required by muscle. Most candidates were able to state in some way that a large surface area would increase oxygen uptake by gills, but only better answers related this to the greater surface available f or diffusion. Very few candidates showed an understanding of the purpose of a ventilation system, so answers were often very vague references to 'getting more oxygen'. More detailed answers gained credit for knowing that the flow rate through the gills would increase, but rarely linked this to a diffusion gradient and increased rate of diffusion into the blood.

**(c)** Candidates were familiar with the process of ram ventilation and there were some good responses. Candidates must give detailed answers to these questions: whilst the majority stated that the mouth is open all the time, few linked this to the constant or fast swimming that occurs during ram ventilation. A few candidates confused ram ventilation and pumped ventilation.

**Question 3**

This question was testing knowledge of breeding in whales.

**(a)** Most of the answers were disadvantages of internal development rather than internal fertilisation. Candidates should be aware that transfer of sperm between two individuals presents problems in finding and attracting a mature animal of the opposite sex and having a means of inserting sperm so it does not get lost to the environment.

**(b) (i) (ii)** Most candidates gave correct answers.

**(c)** The most common correct answers were in the context of the maternal energy input that is required to produce milk.

**(d)** Almost all candidates gained some credit for this question. The most usual answers were related to protection from predators and 'teaching' the young whales survival skills.

**(e)** Some candidates gave clearly stated reasons, but the majority tended to be incomplete. For example, a popular answer was 'pollution', which was not acceptable unless it was linked a specific aspect of human activity such as oil exploration or dumping of toxic chemicals.

**Question 4**

This question was testing understanding of the natural dynamics of fish populations and the impact of fisheries protection legislation on commercial fishing.

**(a) (i)** The term recruitment was not well understood, in the main. There were many answers that talked about 'adding 'fish, which was not credited as this can imply human intervention, as in aquaculture, or that newly hatched fish are part of the main population.

**(ii)** The low level of understanding of recruitment also influenced the type of answers given to this question. Candidates were expected to answer in terms of natural fish population dynamics, but the majority answered in terms of fishing practices. Some candidates realised that fish mortality and breeding success were the major influences on recruitment Candidates need to understand that in the life cycle of most fish, the eggs hatch into larvae that are not part of the main fish population and, in the context of this question, must survive three years in different habitats before they can join this population. This then leads to the consideration of factors that influence the survival of fish larvae.

**(b) (i)** The best answers were able to describe the relationship between mature fish and three year old fish three years later. Recognition in changes in a relationship should be described in questions such as this: candidates could not gain full credit where they did not refer to the maximum point of the curve and note the change in correlation. Some answers stated that numbers of mature fish and 3 year fish increased and decreased together, suggesting that these candidates had misinterpreted the graph in Fig.4.1.

**(ii)** Responses to this question also suggest understanding of population dynamics is an area centres can target. As already noted, from their knowledge of fish breeding candidates were expected to know that the young fish that develop from the eggs laid by the adults join the main population 3 years later as recruits. The presence of more young fish increases competition with mature fish until the resources become limiting, so that fewer young fish than mature fish can survive. Many answers were about overfishing, removing too many mature fish so that no more young fish are produced: this is not shown by Fig. 4.1.

**(c)** This question was well answered with many candidates gaining maximum credit. Some candidates did not read the question carefully and quoted data from before 1980.

**Question 5**

This question was about the increase in fish production by aquaculture and the main requirements for successful aquaculture.

**(a) (i)** Many candidates did not appear to know how to calculate a percentage increase. Common errors were to divide 78 by 31, or to multiply 78 by 31. Candidates should be encouraged to practice this type of calculation.

**(ii)** Most candidates extracted the correct figures from Fig.5.1 but did not appear to be familiar with the necessary calculation. The most common errors were to divide 78 by 2 instead of 3, or to multiply 78 by 2. Almost all candidates gave a correct unit.

**(b)** Many candidates did not appear to have read this question carefully enough. They were expected, in each case, to select a method that would be suitable for an intensive system **and** sustainable. The majority of candidates selected options suited to intensive systems without considering sustainability, so their reasons did not gain credit, even if a correct option was selected. For example for '*supply of clean water,* many candidates chose method 3 which is suited to intensive systems, but method 2 is better if sustainability is taken into account as costs are lower and a natural resource is being utilised. For *'availability of food'* most candidates correctly identified method 2 and gave reasons related to reducing waste or making food pellets. Although these reasons are valid, they do not address the sustainability of the wild fish being used as human food.

**(c)** Most candidates were able to identify economic consideration, usually for market demand or return on investment. Less considered answers often referred to set up costs, but without any consideration of profit. Other candidates appeared to misinterpret the question and described loss of income or loss of jobs by fishermen.

**Question 6**

This question tested understanding of the effects of marine pollution caused by human activities.

**(a) (i)** Most candidates knew that human wastes contain bacteria or viruses that are pathogens and that these could be passed back into the human population by eating infected seafood. The way in which this happens was often misunderstood, for example statements like the fish become diseased or marine organisms become infected were common. Only a few answers explained that some fish and filter feeders like oysters feed on human waste and ingest the pathogens. Accumulation of these pathogens in the fish results in contamination by large populations of the pathogen causing food poisoning if eaten. To gain maximum credit candidates needed to specify the types of animal eaten by humans that could become contaminated. The majority made vague references to 'marine organisms'. Some candidates misinterpreted the question and wrote about algal blooms or toxic wastes.

**(ii)** There were some good answers that explained how algal blooms prevented light penetration and detailed the subsequent effects on plants and animals living below the surface. Other answers required more detail: for example, 'reduces oxygen' was a common answer but this needed to be related to fewer algae photosynthesising below the surface or to decomposition by bacteria. Many candidates also wrote 'red tides' or 'dead zones' without any further explanation.

**(b) (i)** Candidates should ensure answers are focused and not merely long, but vague, discussions of the topic concerned.
Some confusion existed about how the refuse could cause death in affected animals. For example, common answers included 'refuse in the digestive system causes marine mammals to choke to death', 'turtles swallow plastic bags so they can not breathe' and 'refuse cannot be digested'. Candidates were expected to use information from the passage to explain how these could be dangerous. Credit was given for other well described examples such as cigarette butts swelling in the stomach of fish, mammal or turtles so the animals are unable to feed and die of starvation. Some candidates did not appear to have read the question and gave an answer more suited to part **(b)(ii)**.

**(ii)** This section was well answered with many candidates gaining maximum credit. The most popular answers were about fishing line, nets or rope entangling turtles, mammals or divers so they could not reach the surface to get air and thus died of suffocation.

**Question 7**

This question expected candidates to evaluate proposals for the development of an area for ecotourism.

**(a)** Few candidates were able to give a clear definite of ecotourism. Common answers were 'ecotourism is to conserve the environment' or 'ecotourism is to look at the environment without having any impact'.

**(b) (i)** To gain credit, candidates needed to choose three of the proposals in the question **and** explain their choice. Most candidates were able to choose suitable proposals, but rarely explained why these were examples of responsible practice. The most common choices were solar cells, collecting rainwater and river water for washing and parking vehicles at the nearby village. Acceptable reasons for solar cells were given by only a few candidates, for example, solar cells use a renewable energy source or there are no carbon emissions. The majority answered in terms of not building a power station or not having any wires. Reasons given for parking away from the development were usually 'less pollution' which needed to be further qualified by the type of pollution and the potential effect on biota or environment.

**(ii)** Many candidates ignored the information that only **some** of the trees were to be cut down and answered in terms of deforestation, which was not credited. Very few considered the impact of self-catering or camping on litter and food waste. Most answers focused on the use of river water and draining waste water into the sea. More considered answers suggested that the use of river water might reduce the water supply to the surrounding area and that waste water could cause pollution from detergents or cleaning materials.

**(c)** Many answers to this question gained maximum credit. The most popular answers were about increased chance of employment and improvement in the local economy.

# MARINE SCIENCE

**Paper 9693/04**

**A2 Data-Handling and Free Response**

## Key Messages

- Many, but not all, candidates have a detailed factual knowledge of all areas of the specification.
- Most candidates can plot graphs but precision and care are important when plotting graphs and reviewing data.
- The section on mathematical requirements in the specification should be considered carefully.
- At A2 there is an assumption that candidates will be familiar with the AS course of study.

## General Comments

Many candidates demonstrated a strong grasp of the topics covered by the specification in line with what is expected at A-level. Many candidates were able to write detailed, well organised answers to all questions and clearly have an excellent understanding of all areas of the course. Some candidates are underestimating the level of detail and precision that is required in their answers. A significant number of candidates were unable to carry out simple numerical calculations, and graphical skills were often poor and imprecise. Candidates should also consider that correct usage of scientific terminology will gain far more credit than vague statements.

## Comments on Specific Questions

***Section A***

**Question 1**

**(a)** Most candidates were able to correctly describe the reduced time to hatching with increasing temperatures although few noticed or stated that at 33 °C no eggs were able to develop.

**(b) (i)** Many candidates plotted excellent graphs that were fully labelled and carefully plotted, and joined the points up with straight lines. A large number of candidates failed to join up points with straight lines, as requested in the question, and many inverted the axes. Many candidates also failed to place correct labels and units on the axes. A small minority drew bar charts. Many candidates used scales that generated graphs that were far too small and lacked detail – candidates should use truncated axes where appropriate.

**(ii)** Most candidates were able to use their graphs to correctly predict three values. There was a great deal of imprecision with the use of the graphs however – candidates should be encouraged to be rigorous when using data.

**(c) (i)** About half of the candidates were able to gain at least some credit. Most were able to recognise that time spent on the beaches by female turtles would lead to increased mortality. Fewer gave a cause of the mortality or compared it to the improved survival of the males. A large number of candidates referred to the hatchlings and incorrectly assumed that the female hatchlings would have a higher mortality rate.

**(ii)** This question gave a good range of responses with most candidates gaining credit. Most were able to recognise that the increased temperature would increase the number of female turtles and / or cause no hatching if the temperature exceeded 33 °C. Many candidates recognised the effect on hatching at high temperatures but failed to state the temperature. Few candidates appreciated that the earlier hatching of turtles would be a problem for feeding off seasonal food sources and few gave any manipulated data to support their answer.

**Question 2**

**(a) (i)** This question was found to be surprisingly difficult for a significant number of candidates. Many measured in cm rather than the mm that was requested in the question, and many gave numbers that were far out of tolerance.

**(ii)** A sizeable number of candidates were able to gain credit for this question. Many, however, were unable to use the formula correctly and often failed to give units. Many candidates multiplied by 10 rather than dividing giving a very unrealistic answer – candidates should consider their answers carefully to see if they are in the correct magnitude.

**(b)** Most candidates were able to recognise that the highest growth rate was in year one and that this may be due to either nutritional factors or age dependent factors.

**(c)** Only the more considered candidates gained significant credit for this question. Many candidates assumed that the question referred to fish farming and how the farmers could alter feeding rates. Others assumed that removal of the otoliths could be done without killing the fish. Of those who did gain credit, most referred to the age and reproductive maturity of fish and the migration patterns. Few considered the ability to track illegal fishing of underage fish.

***Section B***

**Question 3**

**(a) (i)** Most candidates gained at least partial credit here. Most appreciated the tolerance of a wide range of salinities and the majority gave salmon as a typical euryhaline fish. Less able candidates often mixed this up with osmoconformers or with osmoregulation in general.

**(ii)** Again, a decent proportion of candidates gained at least some credit here. A wide range of species were suggested. Again, there was confusion for some candidates, in this case with osmoregulators such as tuna.

**(b)** There were many excellent answers to this question that demonstrated a full understanding of marine fish osmoregulation. Stronger candidates fully appreciated the osmotic problems associated with high salinity and how fish overcome these. Other candidates often failed to appreciate that marine fish need to osmoregulate and just gave vague statements about water balance. The term osmosis was used only by a minority of candidates – candidates should aim to use full scientific vocabulary in their answers.

**(c)** Many candidates seemed to have forgotten this topic or confused it with oyster life cycles. Where candidates had knowledge of the topic, full, detailed answers including terms such as trochophore and pediveliger larvae were common. Candidates with less knowledge of the life cycle often gained some credit for appreciating that fertilisation is external or that the larvae settle onto a substrate.

**Question 4**

**(a)** This question was found to be very difficult by many candidates. Only stronger candidates understood the differential penetration of water by different wavelengths of light and / or the different absorbencies of the pigments. Many thought that red light would penetrate the furthest and also thought that the green algae would absorb green light. A surprisingly large number did not realise that the light absorbance links to photosynthesis and very few recognised the effect of ecological competition between the algae and the energetic costs of having extra pigments. Where candidates understood the topic, they often gave very detailed answers with full usage of scientific vocabulary.

**(b)** The majority of candidates were able to gain some credit here. Most understood that fish escape would be a problem and then often went on to qualify this with effects on food chains or breeding with wild salmon. A consideration of the benefits of the GM salmon was found to be more challenging and many misinterpreted this as the benefits of fish farming in general – candidates should spend time carefully reading what the question is asking for before rushing a “pre-prepared” answer onto the paper that may not be fully relevant. Few appreciated that there would be less

food wastage and that this would reduce eutrophication; where credit was gained it was typically for the idea of larger fish or getting fish to market size faster.