MARINE SCIENCE

Paper 9693/01
AS Structured Questions

Key Messages

Candidates should be guided by the number of marks allocated to each question and the amount of space available for the answer.

It is helpful for candidates to read through their answer to make sure that they have made their meaning clear. Centres should encourage this practice.

Candidates should ensure that they read the questions carefully and thoroughly so that they answer the question that has been asked. They should be familiar with the command words used in the examination paper.

In questions involving a calculation, the working should be shown. There is usually a mark for the working even if the answer is incorrect.

Candidates should also be encouraged to quote units in a numerical answer.

General Comments

Many candidates, scored more highly on some factually based questions than others. In this respect it was pleasing to note the many good answers to **Question 6**. Knowledge of plate tectonic theory, formation of mid-ocean ridges and hydrothermal vents was much better answered than in previous years' examinations.

Those questions involving a mathematical calculation, **Questions 2 (a)** and **5 (b)(i)** were also generally well answered. Answers to such questions must show the units if these are not given on the answer line. In most instances there will be a mark for showing the correct units. For this reason, some candidates did not gain credit for **5 (b)(i)** even though the calculation was correct.

Also, the working must always be shown as a mark is usually available for this.

Aspects of the syllabus content which appeared to be less well understood included pyramids of energy, **2 (d)**, atmospheric dissolution of gases, **7 (a)**, and salinity gradients, **7 (b)(iii)**.

Comments on Specific Questions

Question 1

(a) This section of the question was well answered and most candidates were able to make the correct link between the ecological term and its meaning. The structure of the question helped candidates to show their knowledge of this section of the syllabus.

(b) (i) While many candidates knew that producers, in an ecological sense, manufacture their own food few indicated the process used i.e. photosynthesis or chemosynthesis. Good explanations of the term 'primary consumer' were common.

(ii) This part of the question was very well answered and nearly all candidates were knowledgeable about trophic levels and could name an organism from the food web.

(iii) There were many excellent and well reasoned suggestions and many candidates gained full credit. Generally, the correct answers given followed the idea that a fall in the population of prawns would

leave less food for the blennies who would consume more barnacles leading to a fall in their population. There were a number of other valid arguments, most commonly, an increase in zooplankton numbers giving more food for the barnacles with a consequent rise in their population.

Some candidates correctly reasoned that the barnacle population would not change due to a combined effect of the two scenarios given.

(iv) This part of the question was not so well answered. There were few references to 'disease' or 'competition for food' as limiting factors.

Question 2

(a) There were accurate calculations in this part of the question.

(b) The calculation of the percentage of the Sun's energy used by the producers was quite well done.

Most problems arose as to the position of the decimal point and consequently answers such as 0.1 and 0.01 were not uncommon. This question was a good example of a calculation where a command to 'show your working' was given but which many candidates chose to ignore. As indicated in the general comments a mark can be gained for showing the correct working even if the final answer is incorrect. Centres should encourage this practice.

(c) Correct suggestions as to why most of the Sun's energy is not used by the producers usually centred on the fact that much of the light energy does not penetrate far enough down into the sea water or that some of the energy is reflected from the ocean surface. There were few references to incorrect wavelength or not being absorbed by the chlorophyll.

(d) The majority of candidates were able to gain partial credit for drawing either a straight or stepped pyramid and for labelling it correctly. There were very few candidates who draw to scale on the graph paper provided. Centres should emphasise to candidates that using a scaled diagram when drawing ecological pyramids is essential.

(e) There were many excellent explanations as to how energy is supplied to organisms at hydrothermal vents. Most candidates were aware of chemosynthetic bacteria and their use of dissolved minerals to release energy in the form of organic material. There were also quite frequent references to symbiotic relationships at hydrothermal vents.

Overall, most candidates had a good knowledge of this section of the syllabus.

Question 3

(a) The biological uses of nitrogen, magnesium and phosphorus were well known. Occasionally, there was some confusion between the uses of magnesium and phosphorus.

(b) (i) Some candidates did not fully appreciate that the arrow labelled **B** in the diagram represented a movement i.e. sinking to the sea bed of dead organisms of detritus. Often candidates wrongly assumed it represented death.

Numerous candidates appreciated that the arrow labelled **A** represented uptake or absorption of nutrients into organisms in the food chain.

(ii) There were many clear, accurate and precise descriptions of upwelling referring to rising of nutrient rich deep sea water to the ocean surface caused by wave action, currents or wind. The mistake seen most often was to state simply that upwelling was a movement of nutrients.

Centres should impress on their candidates that it is the movement of the sea water carrying the nutrients which is the essence of the process.

(iii) Most candidates were able to identify the two processes but the descriptions of human involvement were often imprecise.

Question 4

(a) This section of the question was quite well answered with most candidates completing at least two of the three spaces correctly. On occasions 'harbour' was given rather than 'anchorage'

(b) The essence of the answer required candidates to realise that silt in the water reduces the amount of light that the zooanthallae within the coral tissues can obtain for photosynthesis. Many candidates appreciated that the silt would reduce the light but did not expand their response to explain about the photosynthetic zooanthallae. Often answers simply indicated that the corals need light. Candidates should try to give as detailed a response as possible.

(c) (i) In this section of the question almost all candidates realised that the asbestos, wiring and paint were removed as they were toxic or harmful to marine life. The two marks available needed two points to be made. The amount of space was also an indication of the length of the expected response. Further valid points included the fact that some of the contaminants could dissolve in the water and that they could enter the food chain.

(ii) Most candidates appreciated that the creation of the artificial reef would attract tourists and their spending would give a boost to the economy.

Question 5

(a) (i) The most common answers included references to 'tropical' or 'subtropical climates', 'shallow water', 'low oxygen levels in the water', 'intertidal' or 'estuarine zones' and references to 'salinity'. Vague responses, such as 'warm climates' or 'watery conditions', were not credited.

(ii) The most frequent error made by candidates was to indicate that <u>both</u> structures **A** and **B** functioned to support the plants. Rarely was structure **B** known to be able to absorb oxygen. For structure **A** many candidates correctly indicated that these roots carried out a supporting function. However, answers such as 'they are very sturdy' or 'they allow the plant to stay strong' were too vague and imprecise.

(b) (i) As indicated in the general comments most candidates read the graph correctly and gave the correct figure but either did not give the units or gave them incorrectly. Rather than 1000 ha, units were given simply as 'ha'.

(ii) Almost all candidates read the graph correctly and gave 'Asia' as their answer.

(iii) Reasons for the decrease in mangrove cover most often centred on the ideas of 'removal for timber', 'deforestation', and 'removed for tourist developments'. Some less than adequate responses such a 'increase in the human population' were seen quite frequently.

Candidates should think carefully whether their response answers the question precisely enough.

Question 6

(a) As indicated in the general comments, candidate's knowledge and understanding of plate tectonic theory was considerably better than in previous years and it was pleasing to see so many good answers referring to 'the earth's crust being composed of plates', references to the 'plates moving' references to the 'asthenosphere' and references to 'plate boundaries' among other valid points.

(b) Most candidates correctly ticked two of the boxes; usually 'distribution of fossils' and 'the fit between continental coastlines'. On occasion, the 'process of isostasy' was thought, incorrectly, to provide evidence for the theory of plate tectonics

(c) (i) The marking points most often referred to and credited in this question were a reference to a divergent plate boundary, the upward movement of magma and the formation of new crust. Some candidates correctly described a mid-ocean ridge as an underwater mountain range and made the point that the rising magma cools and solidifies. There was some confusion with the formation of ocean trenches.

(ii) There were many excellent answers to this part of the question namely: references to 'divergent plate boundaries', 'sea water entering cracks in the sea floor', 'water being heated by the magma', 'water carrying minerals being forced up and cooling' and 'the minerals precipitating out to build up the vent'.

Where candidates did seem to go wrong most often was confusing how hydrothermal vents formed with the formation of mid-ocean trenches or volcanoes and thinking that, somehow, the convergence of tectonic plates played a major role.

Some candidates were under the impression that the vent was formed by magma rising from below the ocean floor and cooling to build up the vent.

Question 7

(a) Most candidates did name a gas that could dissolve in sea water. This was usually oxygen or carbon dioxide. Many fewer candidates made any reference to relevant compounds that could be formed. However, many candidates did appreciate that dissolution of carbon dioxide would lower the pH and make the sea water more acidic.

(b) (i) Most candidates appreciated that the salinity would fall but the explanation given was often a repetition of the information shown in the diagram i.e. the salinity would fall because of more rain or because little water evaporated. What was required was a realisation that the high rainfall would dilute the water.

(ii) Once again the change in water level was shown correctly i.e. a decrease and a number of candidates linked this to the fact that cold and dense water sinks.

(iii) This part of the question was poorly answered and there many rather poorly drawn diagrams. Centres should encourage their candidates to convey ideas in clear, accurate diagrams which are neatly drawn. Candidates were required to draw a diagram showing how a salinity gradient forms in a water column. Most often candidates did show differing salinities at the top and bottom of the water column and some also indicated the halocline. Rarely was there any further description of the formation of the salinity gradient.

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Paper 9693/02
AS Data-Handling and Free Response

Key message

Candidates should:

- read the questions carefully, consider the 'command words' used and note the mark allocation;
- select appropriate information to answer the questions and avoid including irrelevant details;
- use scientific terms and vocabulary;
- refer to the mathematical requirement of the syllabus.

General comments

This paper, including questions requiring data handling and free-responses, tested candidates' ability to apply their knowledge to new and possibly unfamiliar situations. In ***Section A***, questions relate to Scientific Method, and candidates were expected to be able to understand the relationship between hypothesis, experiment and theory in science and to recognise uncertainty in experimental results. Questions were also related to practical activities.

There was a general improvement in candidates' responses to this paper compared with the previous examination. Candidates seemed to be more familiar with the subject content and many were able to express their answers concisely, using appropriate scientific vocabulary.

Comments on specific questions

Section A

Question 1

The majority of candidates managed well with parts **(a)** and **(b)**; part **(c)** proved to be more discriminating and relatively few candidates scored full credit for this part. Parts **(b)** and **(c)** required candidates to interpret graphical information and the questions related, in part, to the mathematical requirements of the syllabus.

(a) This part relates to Subject Content 7, learning outcome **(c)**, in which candidates were expected to recognise the definition of the term *thermocline*. Some candidates were unfamiliar with this term and there was misunderstanding between a temperature gradient and gradients in other factors, such as density and salinity.

(b) (i) The majority of candidates read the temperature correctly from the graph, giving an answer of 8 °C.

(ii) The answers to this part were more variable. Although many candidates correctly quoted a value of 500 m, it appeared that a number of candidates used either the incorrect axis, or attempted to read the value using the temperature curve, rather than the curve for dissolved oxygen.

(c) The majority of candidates correctly described the decrease in the concentration of dissolved oxygen as the depth increases from 0 m to 100 m. There were a number of answers that included descriptions of the change over the whole range of depth, or described the change only, without offering an explanation. Fewer candidates attempted to explain the change in the concentration of dissolved oxygen. Those that did generally referred to either a decrease in the rate of photosynthesis, or indicated that oxygen is used in respiration. Candidates were also given credit for references to the dissolution of atmospheric oxygen as an explanation for the high concentration near the surface.

Question 2

This question required candidates to interpret experimental data relating to an ecological study of the numbers of selected invertebrates in an estuary. This question was related to scientific method, variations and limitations in the measurement of experimental data and uncertainty in the results.

(a) In this part, candidates were expected to refer to an estuary as an area in which a river meets the sea, and in which dilution of sea water occurs. Many candidates gained partial credit, usually for reference to dilution of sea water, variable salinity, or to the presence of brackish water, but relatively few included both parts in their answer.

(b) This part proved to be accessible to the majority of candidates who correctly calculated the mean number for each of the two species.

(c) The majority of candidates gained minimal credit in this part for stating only that the results support the hypothesis because the numbers of *Hydrobia* exceed the numbers of *Nereis*. Some candidates went on to comment correctly on the uncertainly of these results, with references to the sample areas in which the reverse is true. Candidates were also given credit for recognising the fact that this hypothesis is based on 10 samples, and that it may not be representative of the estuary as a whole.

(d) A wide range of acceptable environmental factors gave candidates an opportunity to score well for this part and many gained partial credit for suggesting factors such as temperature, dissolved oxygen, availability of food and the nature of the substrate. Factors such as 'weather' and 'human activities' were not given credit.

(e) (i) Many candidates gained partial credit for a reference to the inverse relationship between the numbers of the two species. In questions of this sort, descriptive answers should be supported with a quantitative description. As an example, some candidates correctly stated that as the numbers of *Corophium* increased from 11–20 to 21–30, the mean number of *Hydrobia* halved. Those candidates were awarded full credit.

(ii) This part proved to be discriminating. Candidates were expected to suggest that the reason for the relationship between the numbers of these two species was competition for a resource, such as food or space. The introduction to **(e)** informed candidates that *Corophium* feeds on plankton and it was therefore inaccurate to suggest a predator-prey relationship.

Section B

Question 3

(a) There were a number of good answers to this question, with appropriate references to the gravitational effects of the Sun and Moon in relation to the tidal range. There were also answers which described how tides are formed, but without adequately addressing the question about tidal range. Answers should describe how changes in the alignment of the Sun and Moon affect the tidal range, with references to spring tides and neap tides. Some answers included statements such 'when the Sun and the Moon are in a straight line' or 'when the Sun and Moon form an angle of 90°', without also referring to the Earth.

A number of answers suggested that spring tides are high tides and neap tides are low tides, which is inaccurate. It is better to refer to the tidal range and to indicate that spring tides have a greater tidal range than neap tides.

(b) The majority of candidates appreciated the effect of these factors on the tidal range. Incorrect answers referred to the likely effect of these on currents, waves or tides in general, without reference to the tidal range.

(c) This part specifically related to Subject Content 7, learning outcome **(f)**. It was essential for candidates to explain how wind and the shape of the sea bed produce ocean currents and upwelling. The answers to this part were very variable, but the best responses showed detailed and accurate content. Some of the answers digressed into accounts of upwelling and changes in ocean currents, often with details of El Niño and the Coriolis Effect.

Question 4

(a) The majority of candidates scored well for this part, usually by citing coral reefs, sandy shores or slopes and hydrothermal vents. Credit was also given for other appropriate examples of these marine environments.

(b) There were a number of good answers to this part, with references to the physical conditions in both an extreme environment and in an unstable environment. The answers often included an explanation of the term *biodiversity* and gave suitable examples of organisms adapted to these conditions. Some of the answers did not distinguish between extreme and unstable environments, but nevertheless gained credit for relevant details in the appropriate context.

In general, candidates were more familiar with the conditions associated with hydrothermal vents, than those associated with an unstable environment. Many of the answers included references to the high temperature, low pH, low oxygen availability and high pressure as reasons for the low biodiversity. An expression such as 'extreme temperature' is ambiguous because this could refer to either an exceptionally low or exceptionally high temperature. A number of candidates suggested that organisms have to be 'able to adapt' to the environmental conditions. It would be more accurate to state that organisms are adapted to the conditions and, in these environments relatively few species are adapted to withstand the conditions.

(c) There were some good quality answers to this part and a wide-ranging mark scheme made it possible for many candidates to access high credit. The majority of answers tended to focus on coral reefs. Some did not refer to the open sea and gave reasons for the narrow ecological niches of the reef only.

Good answers included an explanation of the term niche, references to the high biodiversity of a coral reef and the consequences of high biodiversity, in terms of interspecific competition and the effects of narrow niches. Many of these answers also included a reference to a specialised niche, often illustrated with reference to coral-eating fish, or a specific example. These answers also included references to the lower biodiversity of the open sea, reduced competition, exploitation of a wider range of food sources and general niches, often illustrated with reference to a suitable oceanic species such as tuna.

References to the 'role' of an organism within an ecosystem are acceptable. However, words such as 'job' or 'duty' are inappropriate.

Some answers described the environmental conditions required for the growth of coral reefs and included details of the symbiotic relationship between corals and zooxanthellae, which was not relevant to this question.

MARINE SCIENCE

Paper 9693/03
A2 Structured Questions

Key messages

Candidates need to be able to apply their knowledge and understanding of the syllabus to different situations. There are no specified examples of ecosystems in this syllabus, so candidates should expect to use their knowledge in different contexts. For example, candidates should know the different methods used in fisheries protection and then be able to select examples appropriate to answer a specific question. Candidates also need to be able to use data provided in questions to support their answers. This may include calculations, recognising patterns in data, either presented as a graph or in a table and drawing conclusions.

General comments

Overall, answers often lacked specific detail. There was tendency to answer too generally. Questions that required knowledge or direct use of data were answered better than those that required some explanation. For instance, most candidates were able to extract information from Fig. 1.1, but could not apply their knowledge to explain the adaptations of the cells in Fig. 2.1. **Question 3**, which was almost entirely knowledge based was well answered. However, in **Questions 4(c)**, **5(b)**, **6(c)** and **7(b)**, candidates were often unable to apply their knowledge to a specific example.

Comments on specific questions

Question 1

This question was about the effects of carbon dioxide concentration on sea water and marine productivity.

(a) (i) Most candidates knew that carbon dioxide dissolves in sea water making it acidic. Better answers referred to the reduction in pH of the water.

(ii) Answers to this section were often ambiguous. Although candidates knew that acid was likely to cause damage to calcium carbonate structures, very few could explain why. Only better answers referred to the solubility of calcium salts in acid

(iii) Many candidates gave correct answers, mostly related to the loss of external structures.

(b) (i) There were some good answers to this question. Almost all candidates referred to the high productivity zone south of Australia and South America. Better answers also recognised the greater productivity of coastal areas and the southern hemisphere. Weaker answers tended to quote figures without any descriptions.

(ii) Most candidates answered in relation to coastal areas having a higher nutrient content. Better candidates linked this either to run off from land, or to currents bringing more nutrients into the area.

Question 2

This question was about osmoregulation in marine fish, in particular the chloride content of the blood.

(a) Most answers to this question were too general and described how, rather than why, marine bony fish regulate their water and ion content. Better answers showed an understanding that these fish have a problem of constant water loss by osmosis. Very few candidates explained why the composition of body fluids should be kept as constant as possible.

(b) Candidates were expected to use their knowledge of how chloride ions are regulated and the information in the question to interpret the structure of the cells involved in the transport of these ions. A few candidates were able to link the release of energy by mitochondria to the active transport of chloride ions. Candidates who made this connection lost credit by referring to chloride uptake rather than chloride excretion. Most candidates identified the large surface area, but often related this to chloride or oxygen uptake.

(c) (i) Almost all candidates gave a correct answer.

(ii) Most candidates were able to identify at least one variable. The most common were the temperature of the water, food supply, age and the number of fish. Candidates should be encouraged to use precise terms for quantities, for example volume rather than amount of water and mass rather than amount of fish.

(d) Answers to this section were poor. Many candidates did not appear to know what is meant by a hypothesis and tended to describe the results.

Question 3

This question was about the life cycles of tuna, a marine fish, and salmon, a euryhaline fish.

(a) Most candidates were able to give a basic outline of the life cycle of salmon. Better answers were able to give some information about the larval stages, although very few referred to smoulting and the physiological changes that occur at this stage. Weaker answers mostly referred to spawning in fresh water, followed by the death of the adults.

(b) Most candidates were able to make at least two comparisons between the life cycle of tuna and salmon, commonly spawning, free floating eggs and planktonic larvae.

(c) Many candidates gave very ambiguous answers about weather conditions during spawning or the availability of food for the larvae. Better answers recognised that the eggs and larvae have much higher risk of predation. Very few candidates referred to the potential for overfishing during spawning.

Question 4

This question was about the use of technology for fishing and how sustainable fishing practices might be achieved.

(a) Most candidates gained at least half credit, commonly for the idea that catch would be increased.

(b) (i) There were a wide range of definitions given in answer to this question. Those that related the catch size to the time spent fishing gained credit. Weaker answers tended to relate the catch size to an aspect of the effort, for example the number of boats, or in some cases to cost of fishing.

(ii) Almost all candidates recognised that the use of Potential Fishing Zones increased the catch. Better answers worked out that this was double for each of the zones.

(iii) Most candidates recognised the potential danger of overfishing in these zones, but very few explained why this might be the case.

(c) Candidates were expected to consider, for each of the fishery control measures, how it is managed and the implications for the fish stocks. Many were able to describe some of the measures, but often did not explain their effect.

For restrictions on fishing time, candidates referred either, to closed seasons during spawning, or to limitations on the number hours fishing. Very few candidates explained the effect on fish stocks or recruitment.

For restrictions on fishing method, most candidates described bottom trawling or gill nets. Better answers explained why these methods were damaging to fish stocks, most commonly in relation to bycatch or juvenile fish. Relatively few candidates mentioned mesh size or drift nets.

For restrictions on fishing intensity most candidates described quotas. Better answers also referred to the number of boats allowed to fish or to compulsory line fishing instead of nets and how these changes affected the fish stocks.

Question 5

This question was about the impact of aquaculture on the marine environment and the possible effect of the development of sea-based aquaculture on a local community.

(a) (i) Candidates recognised that the proposed aquaculture development was semi-intensive. A variety of answers were acceptable, the most common were temperature control and oxygen supply. Weaker answers referred to food supply from the sea, suggesting that these candidates had not read all the information in the question.

(ii) This question expected candidates to consider the potential hazard of a non-native fish to the local marine environment. Better answers considered the possibility of predation by the local fish or by the non-native fish. Competition between the two species for the same resources was also a common answer. Weaker answers referred to the non-native fish being invasive, but did not explain what this meant.

(b) Few candidates gained more than partial credit as they assumed that the fish would escape and then interbreed with the local population or would out-compete the local populations. Many repeated the answer they gave for **(a)(ii)**. Better answers used the information about the use of chemicals to control algae and mollusc to suggest how this might spread into the water and cause an imbalance in food chains or be directly toxic to local fish. A few candidates also mentioned the spread of disease organisms and parasites. Very few candidates mentioned one of the main problems of this type of aquaculture, caused by excess food and excreta from the farmed fish being decomposed in the benthic zone, resulting in anaerobic conditions.

(c) Candidates could usually suggest an advantage to the community. The most common were increased employment or the improvement in the local economy from a new business.

Relatively few candidates were able to suggest a disadvantage to the community. Almost all answers assumed that the community was a fishing community and gave disadvantages that were the consequences of loss of the local fish.

Question 6

This question was about oil pollution, the danger to sea birds of oil pollution and how oil pollution at sea is managed.

(a) Most candidates were able to use the information in the question to work out that the feeding method of sea birds results in oiling of the feathers as the birds must dive through a surface layer of oil. There were some good answers to this question that described the effects of oiling on sea birds. Weaker answers showed some misconceptions about the effects of oil on the feathers, for example making the birds too heavy to fly and causing the birds to stick to the oil.

(b) (i) Better answers showed an understanding that the oil from illegal ship cleaning is a continuous low level input that is not managed, so oil is always present and thus likely to be a greater hazard than an accidental spill.

(ii) Almost all candidates gained partial credit for the idea that many birds die at a distance from the shore and are eaten or decomposed. Only better answers considered that the birds may be eaten on the shore before counting or be on a shore that is not sampled.

(c) (i) Candidates often assumed that the existence of oil rigs or an oil pipeline in this area would automatically cause more oil pollution. These were not acceptable answers as oil rigs are rarely a source of low level pollution and the pipelines are mainly on land. Better answers linked the existence of oil production to more shipping or the presence of many ports and thus more ship cleaning.

(ii) Common acceptable answers included reference to increased fines or more ship inspections.

(d) (i) Very few candidates were able to give a clear definition of biotechnology. The most common error was to state that technology was used to change a biological process.

(ii) Good answers explained that the metabolism of the bacteria could be changed by using a gene from another species that increased the rate of oil digestion. Weaker answers stated that the size or rate of reproduction of the bacteria would be changed.

Question 7

This question was about marine conservation and some of issues about development in a hostile and fragile ecosystem.

(a) Many definitions were incomplete and addressed only one aspect of conservation, for example 'to protect the species that live there' or, 'to protect the environment'. Candidates were also expected to describe how this is achieved by regulations or laws, such as preventing fishing or preventing development in specific habitats.

(b) (i) Most candidates gained credit for a comment about improving the economy of Greenland. Better answers also considered the world demand for a limited resource and improvements in technology and regulations so that drilling would have limited environmental damage. Answers that referred to oil platforms becoming artificial reefs or ecotourism were not acceptable. The safety of workers in a hostile environment was not considered.

(ii) Most answers to this question were about pollution from oil spills, but were rarely related to the specific habitat. Many candidates appeared to believe that the Arctic is an unexplored region and gave reasons more suited to the Amazonian rainforest, for example, rare plants that could provide cures for disease. A few better answers showed an understanding that the Arctic is a very fragile environment, some of which is already under threat from other human activities. Others realised that as the environment is so cold and remote, any oil spill would not disperse easily as the oil would not break down and clean-up operations would also be expensive and difficult to manage. A few candidates also considered the impact of pollution from humans, such as waste disposal. The hazards to oil workers in these extreme conditions, was not addressed.

MARINE SCIENCE

Paper 9693/04

A3 Data-Handling and Free Response

Key message

Candidates should always:

- read the questions carefully, consider the 'command words' used and note the mark allocation;
- select appropriate information to answer the questions;
- use scientific terms and vocabulary;
- refer to the mathematical requirement of the syllabus.

The results this year show the importance of preparing well for the examination, reading the questions carefully and giving answers of sufficient depth.

General comments

The overall standard this year was higher than previous years and there was strong evidence that candidates are preparing far better for the examination. Far more candidates wrote answers that were more detailed, had better use of scientific terminology and had a much more scientific basis. There were still a few candidates that underestimated the level of depth needed at A-level but, pleasingly, they were in the minority. Virtually every candidate answered every question and all seemed to fully understand what was required by the examination.

Comments on specific questions

Section A

Question 1

(a) The majority of candidates were able to plot the points accurately, although many lost marks by failing to add labels to axes and, in particular units. Only a few were able to draw a line or curve of best fit, with a significant number joining up points or drawing lines that were not of best fit.

(b) The majority of candidates were able to use their graphs correctly to identify the mean rate of respiration.

(c) Candidates generally found this question more demanding with many giving vague answers concerning fair tests. Strong candidates recognised the potential effect of feeding on respiration rate and oxygen demand.

(d) Many candidates were able to identify two controlled factors from the experimental method, although a significant number thought that temperature was controlled when in fact it was the independent variable.

(e) This section discriminated well and some excellent explanations were seen. Many candidates were able to make the link between increased temperature and increased respiration and oxygen uptake and used the information correctly. They were also able to link this to the problems associated with reduced phytoplankton productivity. Weaker candidates often failed to score more than one mark – usually for reduced pilchard populations and often confused this question with a food chain effect.

Question 2

(a) Most candidates were able to gain at least one mark here with many gaining maximum credit. Candidates clearly understood better this year the use of the command word "describe" and gave accurate, full descriptions with numerical references.

(b) Most candidates were able to identify the point at which the fish mass fails to increase. Many of these went on to explain that the fish will not grow any more if kept in the tank for longer. Only stronger candidates went on to describe the feeding costs over this period of no growth.

(c) (i) It was pleasing to see that candidates understood the instruction "compare" with many, excellent, detailed comparisons seen. Only a few gave a numerical calculation in their comparison but most were able to refer to the increased masses, faster growth and the fish reaching their maximum mass earlier.

(ii) This question discriminated well with only the strongest candidates gaining credit. Only a few were able to appreciate the idea of the extra cost of keeping the fish on a high protein diet. Even less were able to use the graph to identify that a high protein diet meant that the fish could be harvested earlier due to more rapid growth, but that this was only feasible when fish price was high, or protein feed cost was low.

Section B

Question 3

(a) This question drew a broad range of answers and candidates seemed to be very confused about the how surface area:volume ratios change with overall body size and shape. Many only considered surface area; others thought that the surface area:volume ratio increases with size. Very few gave examples of different structures that affect surface area:volume ratio. There were however, some excellent answers with full understanding of how both size and shape affect the ratio and excellent specific examples of structures such as gill lamellae.

(b) There were many excellent answers with full descriptions and comparisons seen here. Many candidates clearly have an excellent understanding of diffusion gradients, respiration rates, oxygen demands and how gas exchange is achieved in a range of species. There were also however, many other answers that gave very vague details that did not gain credit beyond specifying that diffusion is important or that groupers have gills. Many diverged into essays concerning the importance of zooaxanthellae in coral, or the life of a grouper.

(c) Only stronger candidates gained full credit here. Some excellent answers were seen that exhibited a full understanding of the two types of ventilation, how they function and how they relate to the energetics of the fish, swimming speed and muscle contraction. Many candidates, unfortunately, had little knowledge of both methods and there was often confusion as to which method involved swimming with an open mouth. Some major misconceptions were seen such as the active pumping of oxygen across the gill lamellae into the blood.

Question 4

(a) This question was well answered - the majority of candidates have a good knowledge and understanding of the process of bioaccumulation. Most were able to give a specific example (usually mercury) although there were a few candidates who thought the question was about the loss of producers and the resultant effect on food chains. Many excellent answers gave specific examples of species affected and gave concise, clear accounts of increasing concentrations, the lack of breakdown and the reasons for the effect on top consumers.

(b) The majority of candidates were able to gain some credit for this question, having some understanding of desalination; only stronger candidates gave answers that had sufficient depth and detail to gain maximum marks. Many had an excellent understanding of the harmful effects of the desalination plants and gave answers that explained the damage due to brine release, costs and the need for high power levels. Weaker candidates often understood that the desalination plants are often environmentally damaging but failed to give specific reasons for the damage – often simply citing "pollution, damage, harmful" rather than giving the full details. Only a few candidates gave positive effects of the plants on the local economy.

(c) Most candidates were able to gain some credit here and it is apparent that the majority of candidates have some knowledge of artificial reefs. The majority of responses referred to the habitat creation but only stronger candidates went on to discuss biodiversity or protection of endangered species. Most answers gave correct references to oil/toxin releases but only a few referred to the physical damage of reefs, caused by the wreck. Only stronger candidates considered the effect of attracting other species into the area and creating an ecological imbalance.