MARINE SCIENCE

Paper 9693/01
AS Structured Questions

Key Messages

Where a question requires a short response, such as a letter or number, only one answer should be given.

Where it is necessary to change an answer, the original one should be crossed out clearly. It is unwise to attempt to write over an existing answer. Very often the result is an answer that cannot be read.

Candidates should try to frame their answers clearly and in an unambiguous manner. The use of bullet points is perfectly acceptable.

In questions requiring a numerical response, the units should always be given except where they are printed on the answer line.

General Comments

Some candidates had a reasonable grasp of some elements of the subject matter of the syllabus and were able to demonstrate their knowledge and understanding in the relevant questions. In this respect, topics such as symbiosis, parasitism and plate tectonics were generally well known.

However, a considerable number of candidates did not possess the required level of knowledge and understanding to achieve a good grade in the examination.

Comments on Specific Questions

Question 1

(a) (i) As indicated above, many candidates were able to state the type of the relationship between cod and nematodes as a parasitic one and were also able to describe it clearly.

(ii) The symbiotic relationship between coral and zooxanthellae was well known by many candidates.

(b) A large number of candidates were able to describe the effect of increasing temperature on the condition of the coral. This was usually in terms of the increase in coral death with the rise in temperature. Credit was available for candidates who illustrated their responses using the data in the table and many candidates did this.

(c) (i) The graph drawing question drew a variety of responses, many of which were an improvement on previous years. The biggest mistake was the drawing of unsuitable scales on both the x and y-axes, which made determining the accuracy of the plots rather difficult.

(ii) While most candidates appreciated that the density of the zooxanthellae decreased as the temperature increased from 30 °C to 32 °C, very few gave the necessary numerical value of the decrease.

Question 2

(a) This part of the question was quite well answered with many candidates gaining credit, usually by providing an appropriate reference to light energy and by discussing the roles of carbon dioxide and water in the process of photosynthesis.

(b) (i) Most candidates were able to deduce from the food web which of the two organisms was the predator and which was the prey.

(ii) Most candidates clearly understood the term trophic level and were able to name one organism at that level in the food web.

(iii) Often, candidates gained partial credit, and this for an understanding that some light is reflected by the water at the ocean surface. However, simply to say that light is reflected did not gain credit by itself. Similarly, the phrase “light is absorbed” lacked the detail required.

(iv) This part of the question was generally well answered and most candidates were able to state one way in which energy is lost as it passes along a food chain. The most frequent response was a correct reference to the loss of heat from respiration.

(c) (i) This mathematical question was very poorly done and only a minority calculated the correct answer.

(ii) Some candidates appreciated that an increase in the human population would lead to an increase in hunting and thus a fall in the sea lion population over the appropriate time period. Other candidates merely made the observation that the human population had increased without outlining a possible consequence of this increase. Some candidates reasoned, correctly, that the fall in the number of herring shown in the graph would result in less food for the sea lions with a subsequent fall in their population.

Question 3

(a) (i) The reefs A and C were correctly identified as a barrier reef and a fringing reef by most candidates.

(ii) Most candidates were able to order the three stages of atoll formation into the correct sequence.

(b) (i) The poor performance in this part of the question was largely a result of candidates not giving sufficient detail in their responses.

(ii) Many candidates either misread the graph or simply gave only one distance instead of two. Consequently, the question was very poorly answered.

Question 4

(a) While many candidates were able to name an organic compound in living organisms, a considerable number could not.

(b) (i) Rather than naming the form, i.e. carbon dioxide, in which carbon enters the ocean from the atmosphere many candidates named a process such as dissolution.

(ii) Only a surprisingly small number of candidates were able to name a human activity which adds carbon to the atmosphere.

(iii) The majority realised that process A shown in the diagram represented upwelling.

(iv) Only a very small minority of candidates appreciated that carbon could be released due to tectonic processes or dissolution of rocks or shells.

(v) This part of the question was very poorly answered and while many answers discussed the process of photosynthesis this was not related to the process of respiration balancing out the carbon taken in by photosynthesis. Rarely was there any reference to the processes of upwelling and death and decay. Numbers from the diagram were not used by candidates to illustrate their responses.

(vi) Some candidates did appreciate that an increase in the carbon added to the surface could lead to ocean acidification or the result of that on marine organisms such as corals.

Question 5

(a) Descriptions of the theory of plate tectonics were generally quite good with many candidates gaining credit. Most candidates could name the types of plate boundaries, were aware of plate movement and could refer appropriately to the asthenosphere.

Some candidates continue to refer to the Earth being made up of tectonic plates rather than the Earth's crust.

(b) Many candidates are now familiar with the evidence for the theory of plate tectonics and where wrong answers appear this is usually due to insufficient detail or use of vague language.

(c) (i) There were many good responses explaining the role of tectonic processes in the formation of underwater volcanoes. Explanations given included references to convergent plate boundaries, pressure build up, pressure release and the release of magma and hot gases.

(ii) The role of plate tectonics in the formation of underwater earthquakes was reasonably well known by many candidates and relevant points made included a reference to convergent plate boundaries, the locking together of the plates and the subsequent release of pressure leading to an earthquake.

Question 6

(a) This part of the question was very well answered and most candidates were able to outline the effects of evaporation and precipitation on the salinity of sea water.

(b) Generally, only the more able candidates were able to describe how salinity gradients form in water columns. Usually, references were made to the relationship between salinity and density with denser water being at the bottom of the column. References to the halocline were uncommon. Sometimes candidates attempted to involve changes of temperature.

(c) (i) A common mistake in this part of the question was for candidates to draw a line correctly from the y-axis increasing from left to the right but to have a start point from zero.

(ii) Only a minority of candidates were able to given a valid explanation for the shape of their line.

Question 7

(a) This part of the question was quite well answered by most candidates. The most common mistake was for candidates to describe how a hurricane is formed rather than describing the features of them.

(b) (i) Most candidates were able to deduce the relationship between hurricane category and central pressure.

(ii) Very few candidates made a reasonable suggestion as to the meaning of the term storm surge.

(c) Many candidates were able to suggest at least one way in which hurricanes can be beneficial. Most often this suggestion referred to water or nutrients being carried to farmland.

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Paper 9693/02

As Data-Handling and Free-Response

Key Messages

Candidates should:

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

General Comments

This paper includes questions requiring both data handling and answers written in continuous prose. The questions are intended to test candidates' knowledge and understanding of the syllabus content, and their ability to apply their knowledge in new and possibly unfamiliar contexts. In ***Section A***, questions may relate to Scientific Method (Syllabus ***Section 1***) and will expect candidates to be able to understand the relationship between hypothesis, experiment and theory in science and to recognise uncertainty in experimental results. Questions may also relate to practical activities, including the design of an investigation to test a hypothesis, with references to the control of variables.

Many candidates were well-prepared for this paper and coped well with the different skills being tested, including accurate recall of information and an ability to apply their knowledge and understanding of the subject content in a new situation. Almost all candidates attempted every part of the paper.

In ***Section B***, **Question 4** was generally well answered and the marks for this question were usually higher than they were for **Question 3**. Overall, candidates tended to score better in ***Section B*** than in ***Section A***, showing that many candidates were able to recall factual content of the syllabus more successfully than they were able to apply the principles and concepts in a logical, deductive manner.

Comments on Specific Questions

Section A

Question 1

(a) This question required candidates to use the data to compare the distribution and numbers of the two species of molluscs. Many candidates referred correctly to the relative abundance of the species, for example by stating that there are more rough periwinkles than edible periwinkles. There were also a number of correct references to the distribution of the two species in relation to their position on the shore, for example by indicating that rough periwinkles are found higher on the shore than edible periwinkles.

The key word in this question is *compare* and there was a tendency for candidates to give separate descriptions of the data without making clear comparative points. Comparisons can include both

similarities and differences, and it is advantageous for candidates to make a comment about one species, linked with a corresponding comment about the other species. To illustrate this point, comments such as “rough periwinkles are more abundant than edible periwinkles” or “edible periwinkles are found nearer to the low water mark than rough periwinkles, which are found higher on the shore” both make suitable comparative points. From the data, it can also be seen that rough periwinkles are more widely distributed than edible periwinkles and it is appropriate to note that neither species is found at 8, 14 or 30 metres from the low water mark.

(b) Candidates scored well for this part as the majority were able to suggest at least two suitable physical factors which could influence the distribution of these molluscs. Candidates were given credit for factors such as temperature, humidity, exposure time and slope. It is important to note that physical factors were expected; consequently, biotic factors, such as predation, and chemical factors, such as salinity, were not given credit.

(c) This part was intended to test candidates’ ability to explain how inherent variations and limitations in the measurement of experimental data lead to uncertainty in the results. Candidates were therefore expected to refer to the small sample size, lack of repeats and sampling only at 2 m intervals, suggesting that the results may not be representative. Relatively few candidates gained full credit for this part and there were a number of references to errors in counting, which were not given credit.

(d) Candidates were given guidance with an introductory explanation of the term population density and it was expected that candidates would describe the use of random sampling, using a quadrat, and how the mean population density could be calculated. Many of the answers to this part described systematic sampling, essentially using a transect, rather than random sampling which, in this case, is the appropriate method to determine population density. If candidates described systematic sampling, they could still gain credit for suitable references to repetition and to counting the numbers of periwinkles in each sample area. In questions of this sort, which involve ecological sampling, candidates are expected to have undertaken relevant practical activity which should include fieldwork.

Question 2

(a) The majority of candidates recognised that sea lice had a harmful effect on the salmon which, in this experiment, reduced their swimming endurance. Fewer candidates went further to support their answer with reference to, for example, sea lice obtaining nutrients from salmon.

(b) Candidates generally scored well on this part by suggesting two appropriate chemical properties of sea water, such as salinity, the concentration of dissolved oxygen, or pH. This question relates to syllabus topic 1(b) in which candidates are expected to be able to design experiments and control variables. It is important to be able to give relevant variables, in this case chemical, rather than physical variables. As examples, some candidates suggested temperature, or light intensity, which were not accepted.

(c) Many candidates found this part difficult and did not appreciate that by measuring the mean length of the salmon it removed a variable from the investigation. It can be seen from the data that the mean lengths of the salmon in each group are similar, differing by a maximum of 1.7 mm. The length of the salmon was another control variable, helping to ensure that the observed effect was due to the number of sea lice infecting the salmon and not to some other factor.

(d) Almost all candidates correctly indicated that the results support the hypothesis and supported their conclusion with reference to the relationship between the number of sea lice and the swimming endurance. In questions of this type, it is important for candidates to make their answer clear and unambiguous; an answer such as “yes” is, therefore, not suitable.

Section B

Question 3

(a) In general, candidates were able to describe temperature and salinity gradients with references to the changes in temperature and salinity in relation to depth. However, the explanations of how the gradients form, in terms of changes in density of sea water, were less often described accurately. Candidates sometimes included the terms *thermocline* and *halocline* in their answers, but these were given credit only if used in the correct context and accurately defined. To illustrate this, it is inaccurate to refer to a salinity gradient as a halocline rather than a zone of maximum change in salinity with depth. For high marks in this part, it was essential for candidates to describe *how* these gradients form, rather than simply giving a description of each one.

(b) This part was intended to test candidates' ability to apply their knowledge and understanding of syllabus topic 7. The majority of candidates were able to suggest what effect an increase in wave action and an increase in temperature would have on the concentration of dissolved oxygen, but the explanations of each effect were sometimes less successful. Many candidates correctly explained that an increase in wave action will increase the dissolution of atmospheric oxygen, but the effect of temperature on the solubility of oxygen in sea water was less well understood. Some of the incorrect suggestions here referred to the evaporation of oxygen, which does not occur.

(c) There were some good answers to this part, with appropriate references to the movement of cool air, saturated with water vapour, from the Indian Ocean and that this air rises and cools further resulting in condensation of water vapour and heavy rainfall. Some of the answers were not written in a logical sequence, although they included some relevant points. This question specifically related to the heavy rainfall during the months of June until September; several accounts were general descriptions of the different types of seasonal changes, rather than focusing on the question. This illustrates the importance of selecting relevant content in the answers. Irrelevant content is not penalised, but candidates may waste time writing material which does not gain any credit.

Question 4

(a) The majority of candidates scored well with this part, with many achieving maximum credit. This is a topic which therefore seemed to be familiar to candidates, who readily gained credit for references to the physical and chemical factors required for the growth of corals, including a suitable temperature, availability of light, clear water, and a substrate for attachment.

(b) The answers to this part were rather more variable, with some containing no relevant material. This question related to reconstruction of the history of coral reefs and candidates were expected to include references to taking samples from different depths and comparing the ages of these samples to provide evidence for the growth of the reef over time. There were some good descriptions of sampling and carbon dating, which gained partial credit. Some candidates seemed to be unsure that carbon-14 is taken up during the life of the coral and it is the carbon-14 that decays. A few answers gave irrelevant descriptions of the formation of artificial reefs. This illustrates the importance of reading the question carefully before attempting to write the answer.

(c) Most of the answers to this part were consistent with the answers to part (**a**) and consequently this part was usually answered well. Candidates were generally able to give at least two benefits of artificial reefs, often including both environmental benefits and economic benefits, such as an increase in tourism and recreational diving.

MARINE SCIENCE

Paper 9693/03
A2 Structured Questions

Key Messages

Candidates should ensure that they:

- read questions carefully so they answer the question asked
- know how to interpret graphs and process data from both graphs and tables
- know definitions and be able to quote them accurately.

General Comments

Candidates appeared to find this paper challenging as there were often parts of questions without any response. In some questions, answers were either too generalised and did not answer what was being asked or showed limited understanding of the topic. This was particularly evident in **Questions 2, 4** and **7**. Candidates' writing was often poor and difficult to read, particularly where answers had been crossed out and written over. If there is not enough space to write an alternative answer, it is better to write this somewhere else on the question paper and make a note as to where it is. Poor use of language also limited the answers made by some candidates, for example using "it" and "they" within the same sentence to refer to different processes or organisms, so the meaning of the sentence was unclear.

Comments on Specific Questions

Question 1

This question was about the effect of temperature on solubility of carbon dioxide in sea water.

(a) (i) (ii) Almost all candidates gave a correct answer to both these questions.

(iii) Very few candidates appeared to recognise that the gases each have a different solubility in water. A common answer, that was not credited, was that there was greater photosynthesis and respiration in the oceans than on land.

(b) (i) Almost all candidates gave a correct description of the effect of temperature on carbon dioxide solubility. Better answers quoted appropriate figures, the commonest being the values at 0 °C and 60 °C. Candidates should be reminded to always quote units when referring to data.

(ii) Better answers showed the expected curve below that of solubility of carbon dioxide in fresh water, with approximately the same shape. Poorer answers included parabolic curves with the greatest solubility at 30 °C, or the lowest solubility at 30 °C, horizontal lines at various carbon dioxide solubility values and curves above that of solubility of carbon dioxide in fresh water.

(c) (i) There were some correct definitions, although many candidates omitted to relate the rapid change in temperature to the depth of water. Relatively few candidates appeared to realise that this layer acts as a barrier between the upper surface water and the deep water below the thermocline. It is important that candidates understand this, as the depth of the thermocline affects many of the biological processes in the surface water.

(ii) Very few candidates were able to give a complete description. Better answers indicated that carbon dioxide concentration would increase with depth because the temperature decreases with depth, but this was rarely linked to the thermocline barrier.

(d) Most candidates realised that the North Atlantic Ocean would have more available carbon dioxide as it is colder. Better answer made a correct connection to a bigger population of primary producers. Poorer answers referred to primary productivity or to increased energy availability in the food web.

Question 2

This question was about osmoregulation and the strategies used by different marine organisms to survive in different marine environments. Answers to this question showed confusion about the causes of the osmotic differences between marine organisms and sea water. Candidates need to understand that the concentration of a solution is due to the relative proportion of solute and solvent (water), such that a concentrated solution has a high proportion of solute to water. They also need to understand a solution, such as body fluids, with a high proportion of water to solute, will tend to lose water to a solution with a low proportion of water to solute, such as sea water. This understanding was essential to answer most of this question.

(a) Most candidates were aware that osmosis is the way in which water moves from marine fish into sea water. Some answers showed confusion about the cause of the osmotic difference and the correct terminology to describe the osmotic gradient between the marine fish and sea water. For example, some answers started by referring to high water potential in fish and low water potential in the sea and then changed to concentration gradients, with the highest concentration in the marine fish. Candidates should be encouraged to use one convention throughout their answers and to avoid the terms hypotonic and hypertonic, which are commonly confused.

(b) Very few candidates gave correct answers. The most common answer for the marine boy fish was B, which is incorrect as this line shows changes in the body fluid composition with changes in salinity. Marine fish regulate their body fluids independently of the external salinity, so that C was the expected answer. The reasons were marked independently of the organism identified, so credit was given for knowing that mussels are osmoconformers and marine fish are osmoregulators.

(c) This question was also answered poorly, mainly because candidates were unable to relate the concentration of the body fluids of the fish to the concentration of sea water.

(i) (ii) Better answers showed an understanding that the total solute concentration of sea water (1020 mmol dm^{-3}) needed to be compared to the total solute concentration of the different fish. These candidates were able to deduce that the total solute concentration of the surface water shark (894 mmol dm^{-3}) had the smallest difference in concentration and was thus likely to lose least water and that the surface water bony fish (392 mmol dm^{-3}) had the greatest difference and was thus likely to lose most water. Candidates who did not understand the mechanism of osmosis commonly reversed these answers. A common incorrect answer for both **(i)** and **(ii)** was mid water bony fish.

(iii) Candidates who gave correct answers to **(i)** and **(ii)** gave a correct explanation, but very few quoted the relevant figures. Error carried forward was allowed for an explanation for candidates who did not identify the correct type of fish in **(i)** and **(ii)**, although in most cases these candidates did not appear to understand the relationship between sea water concentration and the fish body fluids. Vague and irrelevant answers such as “to prevent the loss of too much water “and “so they can survive at the water surface” were common.

(iv) Correct answers were rare. Candidates appeared to ignore the question which specifies the role of urea and trimethylamine in osmosis and described the function of urea in excretion instead.

Question 3

This question was about a specific type of shrimp and the habitat associated with the different stages of its life cycle. Candidates were expected to use their knowledge of marine habitats and the information given to answer the questions.

(a) (i) Surprisingly few candidates were able to work out that the breeding ground of the adult shrimps must be the place where the eggs are found. Candidates who got this far often omitted to give a reason. A common answer was estuaries because the food supply was plentiful.

(ii) Better answers showed an understanding that external fertilisation results in low levels of fertilisation as many gametes are lost. Poorer answers knew that the large numbers of eggs and sperm was related to external fertilisation, but did not explain why.

(iii) Some candidates were able to suggest one advantage, commonly the number of plankton available as food. Very few candidates mentioned the role of ocean currents in dispersal to new habitats or the relatively high oxygen content of surface water. A common incorrect answer was "there are fewer predators".

(iv) Most candidates gained credit by a correct reference to food supply. Better answers also linked food supply to the process of sedimentation and the feeding habits of young juvenile shrimps. Poorer answers copied the information about the preferred foods of older juvenile shrimps, but did not relate this to the biodiversity of mangroves or wetlands.

(b) (i) Better answers gained credit for a reference to loss of local fishing and sometimes loss of food sources. Poorer answers assumed that the local economy depended on shrimp farming, which would be lost.

(ii) Most candidates were aware that mangroves have a role in coastal protection against strong wave action caused by tropical storms. Answers that did not explain how this might affect the local ecosystem, for example loss of habitats, were not credited. Very general statements such as "destruction of the ecosystem" and "loss of biodiversity" were not sufficient to gain credit. Better answers also showed an understanding that shelter for juvenile fish would be lost with a consequent effect on fish populations.

Question 4

This question was about the various methods used to monitor and enforce fishing regulations. Most answers were limited as candidates did not appear to be able to distinguish the difference between methods used for monitoring and surveillance of fishing activity and the methods used to achieve sustainable fishing.

(a) (i) Most candidates answered in terms of sustainable fishing practices, such as limiting catch size, rather than the requirement to report some fishing activities, such as catch size, or the inspection of fishing activities, such as size of boat and the fishing gear used.

(ii) Candidates were able to give at least one example of fishing activity that is monitored, commonly the size of the catch or the size of the fish caught.

(iii) The answers of most candidates were too vague for credit. The question is about how surveillance systems are used, candidates usually named the type of system. Most candidates were aware of coastal patrol boats and helicopters but not how they are used. Similarly GPS and radar were often mentioned without any explanation of how they are used.

(iv) Better answers showed familiarity with GPS signals and vessel monitoring systems (VMS). Many candidates left this question blank.

(b) (i) A few candidates gave good descriptions of enforcement methods, such as fines, confiscation of boats and imprisonment, although these candidates did not always explain how these would help sustainability. Poorer answers were restricted to the use of fines for illegal fishing. Many candidates misinterpreted this question and explained how sustainable fishing practices, for example closed seasons and restrictions on fishing gear, help to maintain fish stocks.

(ii) Most candidates gained credit for describing an aspect of corrupt practices, such as collusion with port officials to report false information about catch size and fishing gear. Better answers also commented on the cost of patrol boats or aircraft and poor enforcement of regulations.

Question 5

This question was about the effect of chromosome number and genetic modification on the growth of salmon used for aquaculture.

(a) Most candidates gave a suitable definition of aquaculture.

(b) Better answers were able to give the origin of the growth promoting gene and the promoter gene. Only the best answers showed an understanding about how these genes function to increase the growth rate of salmon. Poorer answers showed confusion about the source of genes used and the linking of these genes together before insertion into salmon. Many candidates appear to believe that genes can be injected into adult salmon.

(c) (i) The majority of candidates gave a correct answer.

(ii) Almost all candidates used incorrect data for their calculation. The question asks for the difference in **maximum** mass; most candidates gave the difference in **mean** mass. Candidates should be familiar with range bars and standard deviation bars on graphs and know how to use this data.

(iii) Many candidates gave a correct answer. The most common error was to divide the mean mass of GM salmon by the mean mass of non-GM salmon, giving an answer of 3.9 instead of the expected 2.9.

(iv) Poorer answers tended to consider only one type of salmon.

(d) Candidates tended to refer to the faster growth of the salmon, which is not valid for non-GM salmon with extra chromosomes as they do not have the growth promoting genes. GM salmon have still to be approved for rearing on a commercial basis. Only a few candidates seemed to be aware that salmon with extra chromosomes are sterile and so cannot interbreed with wild populations.

Question 6

This question was about mercury pollution and the way in which mercury passes through food chains.

(a) (i) Most candidates gave a correct answer. The only common incorrect answer was metal production.

(ii) The most common answer was “runoff”, which was credited, although the answer would have been improved by giving the source of the mercury in the runoff. Only better answers gave two different ways by which mercury could enter the ocean.

(b) (i) Answers were often too vague for credit, for example eaten by plankton and absorbed by fish. The most common correct answer was swallowing water containing mercury.

(ii) Candidates appeared to find it difficult to explain the why mercury concentration increases at each trophic level. Some better answers gained credit as they showed an understanding that bioaccumulation occurs within a trophic level and biomagnification occurs between trophic levels. Poorer answers showed considerable confusion between bioaccumulation and biomagnification. Candidates need to understand that bioaccumulation occurs because mercury cannot be metabolised and is excreted very slowly, so it is sequestered in tissues. Over time, as more mercury enters, the concentration builds up within the organism until it exceeds that of the environment. Biomagnification occurs because at each trophic level an organism eats a large number of food animals or plants that contain sequestered mercury, so the concentration in each trophic level is magnified because of the quantity taken in with the food.

(iii) There were very few correct answers to this question. Most candidates described the effect on humans of eating food containing high levels of mercury. The expected answer was a consideration of how human food intake might be affected by high levels of mercury in some marine food sources.

Question 7

This question was based on a scenario where the loss of a major industry in a region has resulted in proposal to provide alternative employment. Candidates were expected to assess the pros and cons of these proposals from the point of view of specific stakeholders. Most answers were not related to the specified stakeholders and many candidates simply copied the information given.

(a) (i) Some better answers recognised that some fishing boats could be adapted providing employment for some of the fishermen. This was credited, although the stakeholder specified was the fishing boat owners, not the fishermen. Poorer answers simply said boats could be used for tourists.

For support business stakeholders, most answers were about the development of the market area improving the economy, which is not related directly to these stakeholders.

(ii) Most candidates gained credit for answers about the continued use of fishing boats without any need to modify them.

Answers related to support business owners were less common, only better answers showed an understanding that fishing boats would still need the same support if they were used by the aquaculture development.

(b) There were some good answers that commented on the seasonal nature of tourism and the need to attract tourists to a place that was unknown in the tourist industry. Answers about the relative costs were not credited. Some candidates answered a different question to that asked and explained why **proposal 2** was better than **proposal 1**.

MARINE SCIENCE

Paper 9693/04

A2 Data-Handling and Free-Response

Key Messages

Candidates have good graphical skills but should be careful when plotting points or bars to ensure accuracy. Many candidates have good factual knowledge of some areas of the specification, such as the effect of the oil industry on marine ecosystems, but need to extend this to all areas. Candidates need to read all parts of questions thoroughly and think carefully about data that is presented to them, spending time processing it before writing their answer.

General Comments

The standard was very variable. Some candidates demonstrated an excellent knowledge and understanding of the oil industry, conservation and the effect of surface area to volume ratio on gas exchange. Other candidates had a rather patchy understanding of most topics and answers contained insufficient detail.

Comments on Specific Questions

Section A

Question 1

(a) Almost every candidate was able to correctly calculate the percentage.

(b) Most candidates gained at least partial credit. A surprising number, however, did not attempt the graph and some candidates failed to label axes. Many candidates were not sufficiently accurate in plotting the bars / points and candidates should be reminded of the need for precision. Where candidates did attempt the graph, the majority used a linear y-axis.

(c) (i) The majority of candidates recognised that as the mesh size increased, the mean fish length also increased. A few thought the length decreased. Very few candidates looked at the spread of the data and recognised that the correlation was in fact very weak.

(ii) About half of the candidates recognized that the larger mesh size would allow smaller fish to escape. Many gave vague references to more bycatch escaping. Only a handful appreciated that the increased proportion of larger fish retained would make the mean length higher.

(d) Most candidates gained some credit on this question. Many clearly understood how the restrictions would enable the population to increase and good references to reproductive age and recruitment were seen. For the drawbacks, many cited the loss of employment although many gave well-reasoned answers referring to the loss of other species or dumping of small fish.

Question 2

(a) The majority of candidates identified the effect of increasing light on oxygen concentration. Only a handful spotted that up to a light intensity of 100 a.u., oxygen is being removed from the water. About half of the candidates gave a good reference to the levelling off or decrease of oxygen at approximately 420 a.u.

(b) Very few candidates were able to recognise that the three separate lines represented three different saline concentrations. Many thought that the x-axis was salinity. A handful of candidates recognised that the 3.6% and 4.0% saline concentrations gave the same trend. Very few were able to describe how 3.8% salinity gave both lower and higher changes depending on the light intensity.

(c) Most candidates found this question very demanding. Most gave vague references to coral survival and did not recognise that the coral contained zooxanthellae which would photosynthesise. Only stronger candidates made the link between the change in oxygen and the processes of respiration and photosynthesis. Candidates should be encouraged to think carefully about what the data is showing and carefully read the introduction to the question. The introduction stated that the investigation concerned metabolism and that the coral possessed zooxanthellae – this set the scene for the rest of the question.

Section B

Question 3

(a) Many highly competent answers were seen with a full appreciation of the effect of size on surface area to volume ratios. Many candidates understood the process of diffusion and the factors that affect it such as the diffusion distance. Some candidates thought that larger organisms would have a larger surface area to volume ratio. A few, weaker, candidates simply gave descriptions of gas exchange in different organisms and confused the processes of diffusion, osmosis and active transport.

(b) Many candidates found this question quite demanding. It required candidates to give a detailed understanding of the pump ventilation system of groupers and how the gill structure is designed to maximise diffusion. Only a few candidates gave a detailed description of the gill lamellae or understood the volume or pressure changes in the buccal cavity. Many candidates knew the terms buccal cavity and operculum but were unable to put them into the correct context. A few good answers were seen that gave details including features such as the counter current system and the role of the circulatory system in maximising the diffusion gradient. Candidates should try to ensure that their answers show depth rather than writing superficially with little technical terminology and explanation.

Question 4

(a) This question generated a range of answers. Some candidates did not fully understand the question and only focused upon what the conservationists should consider. Many did not read the information given to them. Many appreciated that the sturgeon is commercially important and that its loss would affect food chains. Some stronger candidates gave excellent explanations of how introducing the sturgeon into other lakes could affect both prey and competitors and how it could breed unchecked. In addition, many appreciated that the lakes would have to have sufficient food and that the abiotic factors (usually salinity and temperature) would have to be correct. A few candidates became side-tracked with answers concerning the cost of the operation.

(b) Most candidates gained some credit on this question and understood that oil spills can cause harm to ecosystems. Most candidates referred to the effects on birds and the toxic effects on organisms in general. Many gave excellent references to the lack of light penetration and resultant effect upon photosynthesis and food chains. Only a few considered the effect of burning the oil and then went on to discuss carbon dioxide release. There were several answers also seen that gave irrelevant answers about eutrophication, or other forms of pollution; candidates should try to ensure that they address the questions posed rather than writing everything they know about a topic area.