MARINE SCIENCE

Paper 9693/01
AS Structured Questions

Key messages

- Candidates should ensure that they read each question carefully so that their answers are entirely relevant.
- They should be familiar with the differences between command words, such as explain, describe, suggest and phrases such as 'with reference to'.
- In questions involving a calculation, the working should always be shown. Credit may be given for correct working even if the final answer is incorrect.

General comments

Many candidates answered well on factually based questions such as **2(b)**. Knowledge of food chains and webs was good. Those questions involving interpretation of a graph, such as **1(a)(i)**, **1(b)**, **3** and **4(b)(i)** and **(ii)**, were generally well answered. Answers to more demanding questions, such as **6(b)(ii)**, need to contain more explanation and application of knowledge.

Aspects of the syllabus content which appeared less well understood included reef erosion, atmospheric dissolution and nutrient cycles.

Comments on specific questions

Section A

Question 1

(a) (i) Many candidates worked out a correct figure which included the units. However, some added up the totals for each year on the scale and then divided by 6, which was incorrect.

(ii) While many candidates understood the relationship between predator and prey, few realised the question required discussion of the trends shown on the graph.

(b) (i) Most candidates understood the trends on the graph and answered well. A reference to the years involved in either the decrease or increase, or a calculation derived from the data on the graph, was required for credit.

(ii) Most candidates correctly identified over-fishing as the problem, but many mentioned human predation rather than natural predation as a reason for the decline in cod mass.

Question 2

a (i) This question emphasised that *two* physical properties were required, and is an example of the need to read the question carefully, as many gave a long description or a list of more than two physical properties.

(ii) There were many excellent answers to this part of the question and the topics were well understood. However some candidates thought that the vent was formed by magma rising from the sea bed and then cooling to build up a vent.

(b) (i) Very few candidates correctly mentioned hydrogen sulphide. Many candidates just quoted the examples shown.

(ii) Generally, this was well known, but many candidates only gave one of the two named bacteria required.

(iii) This was very well answered and candidates clearly understand food chains.

(iv) Most candidates gained some credit in this question and chemosynthesis was clearly understood. However, explanations of what happens to the products of this process were less clear and should have involved the named organisms in the figure.

Question 3

(a) (i) Many answers described the shape of the line without any explanation. Reference to producers, photosynthesis and light were required. Some candidates correctly identified that air mixing with the waves at the surface would capture oxygen.

(ii) Whilst there were some strong answers to this question, often only the line change was described, with no reference to the changing conditions at these depths, such as no light, therefore no photosynthesis.

(b) (i) This was very well answered, with bones, DNA and ATP being the most common answers.

(ii) This was well understood, with most candidates gaining partial credit. A common misconception was that phosphorous sinks to the sea bed directly, rather than it being part of a dead organism which sinks (or part thereof).

Question 4

(a) (i) This question asked for an explanation of the effects of hurricanes, such as strong winds or waves and how they would damage the coral. Many candidates used the question stem (reef erosion) and then used the term ‘destroy’, which was not accepted.

(ii) Coral bleaching was well understood but few candidates described accurately the effect of this on the coral.

(iii) There were many references to turbidity and the likely reduction in light penetration. To gain full credit, these then needed to be linked to zooxanthellae.

(b) (i) This was answered very well and was expressed correctly in a variety of ways.

(ii) There were many strong answers to this question. Some candidates ignored their reasoning in **b(i)** and went on to discuss the involvement of carbon dioxide in photosynthesis and organic food production.

Question 5

(a) Most candidates knew that the currents would have a specific direction, but the idea of continuous water movement and its location was often missed.

(b) There were many good answers to this question, with most giving at least two of wind, temperature, and Coriolis effect.

(c) There were many clear and precise descriptions of the role of wind in upwelling. The most common error was to simply state that upwelling was a movement of nutrients. Candidates needed to know that it is the movement of sea water carrying the nutrients from the sea bed, which is the essence of the process. They also needed to describe the correct sequence of events following the action of wind pushing surface waters away from the coast to gain full credit.

Question 6

(a) (i) There were many strong descriptions of the role of photosynthesis. To gain full credit, a reference to light, rather than just sun, was required.

(ii) There were some excellent answers to this question. Common errors were to describe the sun as level 1 or to use the terms producer and consumer rather than the examples given in the figure.

(b) (i) Most candidates calculated this correctly. Candidates must be encouraged to show their working.

(ii) The reasons for energy loss in the food chain were well understood and many chose heat/respiration/excretion/parts not eaten as their answers. The strongest answers also then explained the differences in energy transfer values (TLTE) linked to these losses.

Question 7

(a) There were many good answers to this question based around harvesting by humans. Stronger candidates then went on to explain how this would affect the recycling of nutrients.

(b) (i) Many repeated the question stem as their answer and focussed on the use of the word 'harm'. The answer required detail of the effect of chemicals on the organisms, for example, toxicity. Bioaccumulation was rarely stated.

(ii) Most candidates understood this topic and gave some good examples of the benefits of runoff.

Question 8

(a) (i) The most common answers were the damage by anchors or named examples of fishing techniques which would damage the coral. The description of the effect on the balance of the food chains or web needed to be precise, with clear examples of the organisms involved. There were many answers which were very general and did not provide sufficient detail.

(ii) Many candidates correctly identified the reef as a breakwater or barrier, but the explanation of its effect was often too vague and generalised, for example 'would cause flooding or erosion'.

(b) This part of the question proved challenging and many candidates just re-stated the percentage values from the figure. Answers needed an accurate extrapolation of the percentages for each risk category. Many candidates used and quoted the totals. For example, critical risk in 2030 was often listed as 100%. To gain full credit, a comparison of the figures between 2011 and 2030 and a simple subtraction of two figures for a given risk factor (read correctly from the bar graph) was required.

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Paper 9693/02
Data Handling and Free Response

Key messages

Candidates should read the questions carefully and consider the 'command words' used for each, distinguishing carefully, for example, between 'describe' and 'explain'. They should select appropriate information to answer the questions and try to avoid including irrelevant details.

Candidates should manipulate data presented in tables or graphically, rather than quoting figures directly, to support descriptions of the data. When calculating a mean, for example, they should not quote the answer to more decimal places than given in the original data and round answers up (or down) correctly. Units should always be included with numerical answers, where appropriate.

Candidates should try to write free-response answers in a logical, coherent sequence, using scientific terms and vocabulary.

The quality of many graphs would be improved if a ruler was used for the axes and for drawing the bars, rather than free-hand lines. Candidates would probably benefit from practice in converting tabulated data into suitable graphical forms.

General comments

A very wide range of responses was seen to this paper. There were some very strong answers but also candidates who attempted only a few of the questions.

In ***Section B***, **Question 4** was generally answered better than **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 their knowledge of principles and concepts in a logical, deductive manner.

Comments on specific questions

Section A

Question 1

(a) It is important to note that parts of some questions on this paper will relate to the mathematical requirements included in the syllabus and candidates are, therefore, expected to be able to calculate arithmetic means. The majority of candidates answered this part correctly, giving a value of 0.32. There were some instances of incorrect rounding, or answers that gave the total of the values, rather than the mean.

(b) The majority of candidates recognised that the rate of nitrogen fixation is much higher in the locations with significant numbers of bacteria present, although fewer made the link between bacteria and the process of nitrogen fixation. Some candidates correctly supported their comparison with a numerical reference, for example by stating that "the mean rate of nitrogen fixation in areas with bacteria present is 54 times higher than that shown in Table 1.1."

(c) This part proved to be more challenging for many candidates than the first two parts of this question and there were a number of answers which essentially repeated information from part (**b**), or attempted to explain an increase in productivity of consumers, rather than specifically the producers. To answer this part successfully, candidates needed to assimilate information included

in the stem of the question and relate this to their knowledge and understanding of syllabus topics 3 and 4.

(d) The majority of candidates gained at least partial credit, usually for reference to runoff, or eutrophication, as processes which affect the availability of nitrogen in marine ecosystems. References to harvesting, decomposition and upwelling, although acceptable answers, were seen less frequently.

Question 2

(a) (i) There were some good answers to this part, with appropriate descriptions of the use of a quadrat and random sampling, to estimate the population of cockles on a coastal location. These better answers usually included a suggested size of quadrat, such as $0.25\,m^2$, and references to repetition and calculation of the mean population. A number of candidates also correctly suggested how they would estimate the total number of cockles present by taking into consideration the area of the location itself. Some of the weaker answers included few, if any, quantitative references or made vague suggestions about finding the 'amount' on cockles. The word 'amount', is inappropriate in this context, because this could refer to either mass or number. Similarly, there were a number of suggestions that the number of cockles should be estimated and then multiplied by the 'length of the coast'. A few candidates gave no practical details, but based their estimate on the assumption that were 1000 cockles per square metre.

(ii) The majority of candidates gained credit for this part, usually for a reference to burrowing affording protection from predators. Some answers stated simply 'protection' which was too vague to be awarded credit.

(b) (i) Most candidates calculated the percentages correctly and rounded their answers suitably. For example, the percentage of cockles that burrowed in group B was accepted as 62.2 or as 62 to the nearest whole number.

(ii) The standard of graph plotting was very variable. Candidates were given credit for using a suitable linear scale, with two bars, not touching and of equal width; labelling both axes suitably; and for plotting the data accurately. Candidates were given credit, where possible, if they calculated incorrect values in the previous part and then plotted these values. A number of candidates attempted to plot all the data in Table 2.1, rather than just the two calculated percentages as required.

(iii) The majority of candidates were able to give an acceptable hypothesis, based on the results of this investigation. This was usually to the effect that cockles that had been collected from beneath the surface were more likely to burrow than those collected from the surface. It was clear that some candidates did not read the question carefully and expressed their answers in terms of cockles that "were placed under the surface of the sediment." Some candidates suggested that cockles in group B burrowed faster than those in group A, which was also given credit.

Section B

Question 3

(a) (i) The answers to this part were rather variable and although many candidates found it difficult to explain the term *succession*, the majority of candidates were able to give a suitable example, usually with reference to succession in the hydrothermal vent community. Other examples of succession in the marine environment, such as succession on a whale carcase, or the colonisation of an artificial reef, were also given credit. However, some of the explanations clearly confused succession with predator-prey relationships, energy transfer, food chains, trophic levels, or evolutionary changes. Candidates were required to indicate that the changes in community structure occur over a period of time, to distinguish succession from zonation.

(ii) In general, the term *niche* was better understood by candidates than the term *succession* and this part was usually answered more successfully. Credit was given for indicating that niche is a description of the role of an organism in an ecosystem; inaccurate terms such as the 'job' or 'purpose' of an organism were not accepted. Candidates gave a range of acceptable examples, such as tuna occupying a generalised niche or butterfly fish having a specialised niche. Other examples, which included both the organism and it role in an ecosystem, were also given credit.

(b) Here, candidates were expected to discuss how environmental factors influence the ecological communities on a rocky shore. It was anticipated that candidates would identify factors associated with rocky shores, such as exposure due to tides, wave action and the nature of the substrate and relate these to their influence on the rocky shore communities. There was a tendency for candidates to describe the features of a rocky shore, without linking the factors to their effect. Some of the answers also attempted to explain why rocky shores have a relatively high biodiversity, without really addressing the question itself. Some credit was given for identifying appropriate factors, but for full credit, it was expected that each factor would be clearly linked to its effect on the living organisms in the rocky shore community.

(c) This part was usually answered quite well with many candidates gaining credit for a reference to the unstable nature of a sandy shore, a comment on the physical properties, such as sand being subject to erosion or drying out quickly, and a reference to burrowing organisms being adapted to life on a sandy shore.

Question 4

(a) The majority of candidates referred to temperature changes but many gave a general description of gradual changes in temperature in relation to depth, without identifying the thermocline as a discontinuity layer in which the greatest change in temperature occurs, or a boundary between warm water above and cold water below. Some of the weaker answers confused thermoclines with changes in other parameters, such as salinity or dissolved oxygen.

(b) (i) Most candidates were able to explain the effects of evaporation and precipitation on salinity. It was clear that the majority of candidates recognised that evaporation results in the loss of water only, although some referred incorrectly to the loss of salt with the water vapour.

(ii) Although some candidates described the possible dilution effect of estuaries flowing into sea water near coasts, there were a number of answers referring to other processes such as evaporation and wave action as possible factors to account for the difference in salinity.

(c) In this question candidates were required to recall accurately specific information relating to salinity gradients and subsequent mixing of the layers. Responses ranged from those that included an accurate explanation of the effect of changes in salinity on the density of sea water, to those that digressed into general accounts of the properties of sea water including changes in dissolved oxygen and temperature. Some other accounts included a description of salinity gradients in estuaries, which was not relevant to this question. Some candidates who were unable to explain the formation of salinity gradients were often able to gain some credit for references to ocean currents or upwelling as reasons for mixing.

The term *halocline* was included in many answers, but sometimes in an inaccurate context such as a statement to the effect that “salinity increases as depth increases, this is known as the halocline”. Candidates were expected to indicate that this is the region of the greatest change in salinity, rather than the overall change in salinity in relation to depth.

Some candidates clearly did not appreciate the relationship between salinity and density, using inaccurate scientific knowledge and confusing density with weight, for example, by stating that “salt water is heavier than fresh water”. Occasionally, references were seen to the salt itself sinking. A simple practical demonstration, using fresh water and sea water with a dye added may help candidates to appreciate the effect of density on the stratification of water.

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Paper 9693/03
A2 Structured Questions

Key messages

Candidates should ensure that they:
- read and consider the question carefully before attempting to answer,
- know how to interpret graphs and process data from both graphs and tables,
- make use of the information provided in questions where given,
- take care when calculating percentage change.

General comments

There were some good answers from strong candidates who showed a sound knowledge of the syllabus content and used their knowledge to interpret information provided in questions. Weaker candidates gave answers that were too generalised to gain credit. Topics such as fishing practices were generally well known. By contrast, there were many candidates whose knowledge of more demanding topics, such as osmosis and genetic engineering, was minimal.

Comments on specific questions

Section A

Question 1

(a) Only strong candidates gave a correct definition of an osmoconformer as organisms whose concentration of body fluid/blood was equilibrated with the external concentration. Common incorrect answers were ‘keep the salinity the same as the outside’ or ‘change their salinity to be the same as outside’.

(b) (i) Most candidates gave a correct answer, with the most common answer being ‘estuary’. Common incorrect answers included ‘coastline’, ‘open ocean’ and ‘hydrothermal vents’.

(ii) ‘Osmoregulation’ was the most common incorrect answer and described the overall process and not what was causing the mass change, which was ‘osmosis’.

(iii) Most candidates found this question challenging as it required some data processing to gain full credit. Strong candidates were able to identify that organism A gained more mass than organism B, while weaker candidates stated that ‘organism B’s mass decreased’ instead of identifying a decrease and an increase in mass. Units were often missing or were incorrectly stated as ppt.

(c) (i) This question proved challenging for most candidates. Many answers just described the data and did not process it, or did not mention salinity or time. Other candidates gave a definition of an osmoconformer and an osmoregulator or referred to ‘growth’ instead of ‘mass’. A common error was to relate little change in mass of B to salinity instead of time.

(ii) The very strongest candidates realised that 40 ppt was a high salinity, and linked this to the concentration in the organism and to the fact that there is a diffusion gradient that causes the chloride to enter. Many candidates referred to balancing the salt concentration, but rarely related this to an excess of ions. Some tried to explain this in terms of osmoregulation in bony fish and drinking sea water, but in most cases related this to water replacement and not the removal of excess chloride.

Question 2

(a) (i) Most candidates gained partial credit for 'colder temperatures' and strong candidates could link this to 'decreased enzyme activity' and 'slower growth'. There was a misconception by many candidates that the salmon had to swim further from the north to get to the sea.

(ii) Most candidates gained credit for 'smoult migrating from freshwater to seawater'. Strong candidates were able to state how smoult adapt to salinity changes. Very general answers, that did not gain credit, included 'it increases in size' or 'the diet changes' or quoting time spent as smoult. There was a misconception that smoult become euryhaline.

(b) The strongest candidates could state the purpose of the promoter gene. Many answers just stated that the 'growth gene was activated', but not that it was activated all the time. Weaker anwers stated that the promoter gene controlled sexual maturity, or enabled more offspring production.

(c) (i) Only the best answers gained full credit for this question. Some candidates completed the calculation, but often forgot to round up their answer, or include a recurrent symbol. Candidates needed to identify the correct figures of 3800 and 1300 and divide the difference by 600. Often candidates forgot to divide by 600, so gave incorrect answers of 2500 (g per day). A small number of candidates did not attempt this question.

(c) (ii) Strong candidates used the information from the graph and information in the question to suggest the economic benefits of GM salmon. However a number of candidates ignored the word 'economic' and described benefits such as maintaining wild fish stocks or focussed on lower costs being passed on to the customer, or job creation for farming GM salmon. Many candidates identified correct benefits, but often gave part answers e.g. that the fish 'required less feed' but then did not link this to 'cheaper to produce'.

(d) (i) There were some very good answers to this question. It was not possible to credit some answers as it was not clear that all the salmon were female and sterile. Common weaker answers referred to sea cages or escaped GM salmon outcompeting or breeding with the wild population.

(ii) This question proved challenging for many candidates. For full credit, candidates needed a clear statement that the customers would not buy the GM salmon. Several candidates made reference to unknown effects on people, but not unknown long term effects. Many candidates answered in terms of supermarkets as organic food suppliers or fear of supermarkets being sued if the GM salmon caused allergies or bad effects. There were misconceptions that the GM salmon was full of hormones and antibiotics or diseased and foreign DNA causing allergies.

Question 3

(a) (i) Most candidates gave a suitable example of a type of phytoplankton, usually 'diatom' or 'dinoflagellates'. The most common incorrect answer was 'zooxanthellae'.

(ii) Many candidates could complete the equation for photosynthesis. Common errors included 'sunlight' in the first box and 'water' in the second or stating 'ATP' or 'magnesium' instead of 'sunlight' and 'carbon dioxide' instead of 'water'.

(b) (i) Only the strongest candidates could identify storms, stronger currents/wind as a reason for the greater depth of mixing in November. Common incorrect answers were 'colder' and 'upwelling'.

(ii) Most candidates gained full credit, with 'increased temperature' and 'increased light' the most common answers. Weaker answers gave vague references to 'change in temperature' or 'change in light' or gave incorrect answers such as 'rainfall' or 'monsoon'.

(c) (i) Almost all candidates were able to identify that numbers decreased in March and increased in June. Some candidates included 'extra' information on depth of mixing and critical depth, which was not required as the question only asked them to state the changes in phytoplankton numbers.

(ii) This question proved challenging for many candidates. Candidates needed to refer to phytoplankton numbers, depth of mixing and critical depth. A number of weaker answers inlcuded just the information in the question or gave vague statements such as the depth of mixing 'passing' the critical depth or made no reference to the graph. Very few references were made to the rate of photosynthesis being greater than the rate of respiration and if 'enough nutrients' were mentioned at all, they were linked to 'more growth' instead of to 'more reproduction'.

Question 4

(a) (i)(ii) This topic was well known and almost all candidates gained full credit.

(iii) The most common correct answer was 'using different hooks', with 'using bird scarers' and 'fishing at a greater depth' rarely seen. A very common incorrect answer was 'using specific bait'.

(b) Strong candidates gained full credit and most candidates could describe at least one environmental benefit. For the first benefit, candidates needed to state that the sea bed was damaged and not just 'benthic habitat damaged'. 'Less by-catch' was a common incorrect answer.

(c) This topic was generally well known, with most candidates gaining at least partial credit. A few candidates did not answer in terms of fish stocks recovery and gave incorrect answers involving turtle excluder devices and ways to avoid by-catch.

(d) (i) Most candidates correctly named a processed product from the factory e.g. 'fertiliser' or 'fish food'. Weaker candidates either quoted 'bait' or 'chum', which did not gain credit.

(ii) All candidates were able to gain some credit for this question, usually for two advantages, 'more job opportunities' and/or 'improved economy'. There were few references to better transport links or to the idea of bringing more people into town. Fewer marks were gained for stating the disadvantages as most answers incorrectly included references to pollution of the environment or the sea.

Question 5

(a) (i) Most candidates recognised a correct trend. Many then quoted correct figures from the table, but gained no credit as these were not processed figures. Some candidates quoted figures for each year instead of from 2010 to 2013 as the question asked.

(ii) Only the strongest candidates asnwered this question well. Common incorrect answers were $0.27/0.485 \times 100 = (-)56\%$ and $0.48 - 0.27 \times 100 = (-)22\%$. Better candidates remembered to divide their answer by 0.485, but often forgot to add a negative sign before the correct answer of –44%.

(b) (i) There were many correct answers, but several candidates did not mention EMS or gave answers involving stocking density, so did not gain credit.

(ii) To gain credit, candidates were required to use the information provided in their answers. Strong candidates could identify two sources of EMS free shrimp, while other candidates gained some credit for 'low stocking density'. Common incorrect answers involved buying fewer shrimp or suggesting ways of reducing the disease in existing stock.

(iii) This questions was challenging but there were some good answers. There were a number of answers with vague wording e.g. 'the disease' or 'the infection is passed on'. There was a misconception that EMS could pass from infected adults to their offspring or that there was bioaccumulation of EMS at each stage in the food chain.

(iv) Better candidates asnwers included the idea that after 30 days the shrimp would be EMS free. There were a few references to 'easier to see the dead/diseased shrimp' but not to 'removing them'. Low stocking density was a common incorrect answer.

Question 6

(a)(b) This question was not well understood and many candidates gave incorrect answers on the effects of pollution, involving eutrophication and algal blooms. There was little or no reference made to the information provided.

(c) Strong candidates gained credit for 'using shore-side treatment facilities only' or 'for treating all waste water'. Most answers were very vague e.g. 'treat or recycle the water'.

(d) Most candidates answered this question well.

Question 7

(a) (i) Most candidates gained some credit for 'protection and preservation of species or habitats'. Very few mentioned human activity to manage/restore habitats for full credit.

(ii) Only stronger candidates mentioned 'preventing extinction' or 'preserving fish stocks'. There were very few references to source of food, oxygen or medicinal use. Weaker answers just referred to 'protecting the environment' or ensuring that 'resources don't run out'.

(b) This question proved challenging. There was some misinterpretation of the question in weaker answers in terms of links between organisations involved in conservation and government funding.

MARINE SCIENCE

Paper 9693/04
A2 Data-Handling and Free Response

Key messages

Candidates should be reminded to:

- use scientific language which is precise in their answers
- ensure that they analyse the data carefully
- use calculations in their answers where appropriate.

General comments

The overall standard of answers was good. Some excellent answers were seen where candidates had been able to analyse data effectively and apply their own theoretical knowledge. It appeared that many candidates found the physiology aspects demanding. The experimental planning exercise in **Question 1** was carried out well by most candidates and a good understanding of the scientific method was evident. Graph plotting was generally good, although the majority were unable to use a line of best fit. Some very detailed answers were given to explain the effects of shipwrecks on the ocean environment and this is a topic area that many candidates feel familiar with. Many candidates had only a rudimentary knowledge of aquaculture and were unable to describe the sustainable aquaculture of grouper in any detail. The physiology of gas exchange is still an area that many candidates find difficult and this was apparent in **Question 2** which was challenging for many candidates.

Comments on specific questions

Section A

Question 1

(a) The majority of candidates were able to able to gain partial credit for recognising that both temperature and light intensity caused a reduction in the number of zooxanthellae. However, only the stronger candidates went on to give more detail and either describe the larger effect of increased temperature compared to light intensity, or carry out a calculation to state the decrease in zooxanthellae. It is good practice to use a calculation in data analysis questions rather than simply quoting figures.

(b) The majority of candidates gained some credit for this question. Most candidates showed a good understanding of how to carry out a valid experiment. Many were able to suggest control variables such as light intensity and temperature, and gave methods for maintaining these variables. Most candidates were able to state that the corals would be placed into tanks with different salinities and many suggested ranges of salinities to use. A few struggled to state the dependent variable, counting the zooxanthellae with a microscope, with some stating that the level of bleaching could be measured. Only the strongest candidates stated that the experiment would need repeating and means would be taken. Weaker answers did not provide enough detail in the method to carry out the experiment and often language was not precise enough.

(c) This question proved challenging for many candidates. Many gave very vague answers suggesting that animals would lose their homes or that the food would be lost. A number of descriptions of El Niño were seen.

Question 2

(a) Many candidates found this question very demanding and only stronger candidates answered well. Few candidates referred to the loss of surface area and then often did not link it to less oxygen uptake. There was some confusion in the use of the term respiration with many candidates referring to it when they were describing ventilation. Only stronger candidates were able to explain the effect of the lack of oxygen on respiration rate. A significant number thought that the gills supplied food and nutrients.

(b) (i) The majority of candidates were able to gain partial credit and showed good graphical skills Although not always essential, it is generally good practice to place the independent variable on the *x*-axis and maximal use should be made of the graph area so that the plots cover at least half of the area. Labels should be clear and units included.

(ii) Many candidates found this question very demanding. Candidates were required to use their knowledge to determine that a line of best fit was required and draw this on the graph. Many joined the dots and a large number did not use the graph at all but tried to predict the next point by calculation.

(c) Most candidates gave the observation that the oxygen concentration decreased in warmer water. However fewer candidates went into more detail and so gained full credit. Very few used the term diffusion and candidates should remember that it is good practice to use specific terms where appropriate.

Section B

Question 3

(a) Most candidates stated that extensive methods often take place in natural waters, whilst intensive methods often take place in tanks. Stronger candidates were able to give a second point, usually stating a controlled factor such as temperature or feeding. It is good practice to suggest specific factors. For example, rather than simply stating ‘controlling factors’ it is better to state ‘controlling factors such as temperature and oxygen concentration’.

(b) This question proved challenging and it appeared that many candidates had not studied the aquaculture topic in sufficient depth. However, there were some excellent answers that gave full detail and explained the different conditions that the larvae, juveniles and adults were kept in. Stronger candidates also made references to the idea of sustainability using examples such as the plant protein food and reduced use of antibiotics. Some weaker candidates incorrectly discussed the conservation or overfishing of grouper.

(c) Most candidates gave answers mentioning coastal destruction and pollution or competition for land. The strongest answers referred to the competition for employment or the effect on biodiversity in the area. Unfortunately, some candidates misunderstood the question and discussed the effect of shrimp fishing or looking at the effect of tourism on the wild shrimp fishing industry.

Question 4

(a) Weaker candidates tended to gain partial credit for ideas such as ‘damage to the sea bed’, ‘release of toxins’ and ‘the formation of artificial reefs’. Stronger candidates often gained full credit as they produced answers that explained the similarities in wrecks of the two ship types and also differences. A few candidates became side-tracked and wrote essays about tourism and wreck diving. Some weaker candidates also restricted their answer to only one of the two types of ship.

(b) The majority of candidates were very familiar with the passage of mercury through food chains and the idea of bioaccumulation. Nearly all candidates were able to explain that the mercury increased with trophic level and that it came from eating members of the previous trophic levels. A few candidates thought that the fish directly ate mercury or absorbed it through their skin and some wrote essays about energy transfer. Unfortunately, many candidates did not go on to explain the effect on the foetus and so did not fully answer the question.