MARINE SCIENCE

Paper 9693/11
AS Structured Questions

Key messages

Candidates should learn definitions of key terms within the subject specification so they can use them appropriately. They should be encouraged to use their scientific knowledge, choose their vocabulary with care and ensure their answers are in the correct context.

Candidates should be aware that any diagrams they draw should be neat and accurate. They should be encouraged to use a ruler to achieve this.

Some questions require observation and interpretation of graphs and illustrations. The answers given should describe what is actually visible and candidates should be able to interpret the trends or features shown, linked to their subject knowledge.

Candidates should be familiar with command words such as “compare” to ensure they answer the questions as they have been set.

General comments

Knowledge of food chains and webs was strong. Aspects of the syllabus which seemed less well understood included evaporation and condensation in **Question 2(a)(ii)**.

On many occasions candidates did not give sufficient detail in their answers to fully answer the question.

Comments on specific questions

Question 1

(a) Most candidates were able to calculate the answer correctly.

(b) Many candidates understood this relationship in the Atlantic Ocean, but some missed the idea that the percentage peaked at 40–59 m.

(c) There were many excellent answers to this question describing the effect of reduced light intensity on photosynthesis by the zooxanthellae which gained full credit.

(d) Many repeated the question stem only, when they needed to go further and explain how the width of the bands varied in response to changes in environmental conditions. Some candidates correctly explained how carbon dating could indicate the age of the coral and a few went on to mention fossil record comparisons and chemical analysis of the bands.

Question 2

(a) (i) Very few candidates gained full credit and answers were often too generalised. High winds were often quoted, which was insufficient. Candidates needed to describe that these winds would be rotating or spiralling. Many recognised that the cyclone would be formed in a low pressure area. Although many candidates knew the temperature should be at least 26.5 °C, they needed to indicate that this referred to ocean surface temperature.

(ii) Only the strongest candidates answered this question correctly. There was rarely any sequential coherence between the points made. Under each heading, many candidates made just one vague statement concerning the formation of a cyclone, which was often in the wrong context. Statements such as “hot water rising” did not receive credit, and there was very little understanding of latent heat energy powering the storm.

(iii) This was answered well and most candidates explained clearly that upwelling would bring cold water from the depths of the ocean to the surface, so reducing surface water temperature.

(b) (i) Most candidates gained full credit and quoted the correct figure and units from the graph.

(ii) Most candidates answered this question well, although some comments were not directly comparative, which was a requirement of the question.

Question 3

(a) Candidates were able to identify the correct levels, whether they quoted these as producer and secondary consumer or as Level 1 and Level 3.

(b) (i) Food pyramids were understood well. However, some candidates drew a triangular pyramid rather than the steps needed. Many of the drawings were untidy and use of a ruler would have been helpful.

(ii) This idea was not fully understood by many candidates. Many discussed the notion that there would not be enough food available and not enough energy to supply five levels. Many answers were too generalised and candidates needed to clarify the idea that energy was lost at each stage.

(iii) Most candidates identified ecotype B correctly, but some then went on to discuss that whales could obtain more food, when they needed to state more types of prey or food would be available.

(c) Candidates needed to understand the significance of the direction of arrows in a food web. Many described how silverfish would feed on the toothfish or the Adélie penguins. This consequently invalidated further comments made in their answer.

(d) Most candidates understood the idea of a keystone species, but some linked it to the food chain when reference to the food web was required.

(e) The most common correct response was a reference to calcium being passed along the food chain to the toothfish. Some discussed calcium being eaten or consumed by the producers, which was not accepted; they needed to state that the calcium is being absorbed, taken up or assimilated.

Question 4

(a) Many answers described properties or features of atolls that were not visible in **Figure 4.1**. Candidates needed to read the question carefully and then produce accurate observational features common to the two atolls.

(b) (i) This was generally not answered well and there were many vague statements describing fringe reef formation. For example, many candidates discussed the reef growing or developing with no reference to coral or coral polyps.

(ii) In this question responses were again too generalised. Many candidates discussed barrier reefs forming from fringing reefs without any real information relevant to the question. Some correctly quoted the idea that there would be a lagoon or body of water between the reef and the shore.

Question 5

(a) Many candidates obtained full credit by completing **Table 5.1**. The most common error was the description of the conservative plate boundary as a divergent plate. For example, some candidates discussed the plates rubbing together or colliding with each other rather than sliding past.

(b) (i) Most candidates named the geological feature correctly and only a few referred to **X** as a ridge.

(ii) The majority of candidates drew the arrows in the correct direction to show the movement of plates **A** and **B**.

(iii) There were many precise descriptions of this process and most candidates scored at least partial credit. A few gave vague answers, such as “the plates were sinking”, which were not linked to the notion of plate **A** being forced down. Some commented on plate **A** being heavier, when in fact reference to plate **A** being denser or plate **B** being less dense was needed. Very few answers mentioned that the subductive plate would melt.

Question 6

(a) The process of runoff was usually correctly named.

(b) The majority of candidates named a relevant nutrient, but sometimes a list of nutrients was given when only one was asked for in the question.

(c) Most candidates correctly stated that the algal bloom would block out light and therefore reduce photosynthesis. They then needed to explain that reduced photosynthesis would decrease oxygen concentration. Many candidates spent most of their answer referring to the effects of bacteria using up oxygen. This was not credited as it was in the question stem in **Figure 6.1**.

(d) Most candidates understood that increased rainfall would increase runoff, which would carry more nutrients to the ocean. A number of answers linked up the rainfall with clouds which would block sunlight, so reducing the rate of bloom development. This type of answer was not credited. A few correctly described how increased rainfall could dilute the ocean water which could lower the concentration of nutrients.

Question 7

(a) There were many excellent descriptions of the effects of wave action on organisms in a tidal pool. Some candidates referred to the waves eroding rocks in the pool to release nutrients, which was not accepted. In answers referring to the waves bringing water into the pools, this alone was not enough unless linked to the idea of protecting organisms from desiccation.

(b) This question was generally not well answered and often vague answers were given on the structure of the two shores. There needed to be comparison between the two shores and the conditions that formed them. The most common correct answer was that the wave action on the rocky shore was high compared with less action on the muddy shore.

(c) Only the strongest candidates answered this question correctly and there were many generalised answers. For example, many candidates concentrated on the fact that the ecosystem would have lots of niches so the species there could fill many of them. A few candidates correctly identified that there would be less competition. There was rarely any reference to the narrowing of food sources or that there would be less variation within the habitat.

Question 8

(a) (i) This question was answered well and most candidates knew the term thermocline.

(ii) In many cases candidates compared only two factors rather than three. The same point was sometimes made in two separate sentences, with no stated link between them. Many candidates only attempted to describe the changes in temperature, density and salinity with depth, whereas the question asked for a description of the relationships between temperature, density and salinity.

(b) Some candidates gave very good responses with a range of reasons for the variation in oxygen concentration. Some attempted to explain the difference in terms of producers or other biological reasons, but the explanations were often poor. Relatively few answers gave physical explanations linked to dissolution, wave action, or solubility linked to temperature. The most common correct answer involved more photosynthesis at the surface due to the availability of more light energy.

MARINE SCIENCE

Paper 9693/12
AS Structured Questions

Key messages

Candidates should be reminded to give only the number of responses asked for when this is clearly stated in questions, e.g. **Question 1(b)(ii)** asked for one use for each nutrient.

Where candidates need to explain relationships between two observations, they should avoid using the term '(x) Affects (y)' but should clearly state the effect one has on the other. For example, in **Question 6 (a)(ii)** some candidates stated that the Moon's gravitational pull Affects the tides, but they needed to explain that relationship to achieve full credit.

General comments

Generally candidates had read the questions carefully before planning and writing their answers. Many candidates were able to answer questions in a detailed manner, often providing relevant data where appropriate, e.g. suggesting an extreme temperature found at hydrothermal vents, or providing values for conditions required for coral growth.

Candidates were well prepared for this paper and took care in the presentation of their answers, and applied their scientific knowledge to new situations in a thoughtful manner.

Comments on specific questions

Question 1

(a) The majority of candidates were able to give two features of hydrothermal vents that made them extreme environments, and many of the strongest candidates also provided examples of the conditions, e.g. possible temperature, pH or pressure, found at hydrothermal vents.

(b) (i) Some candidates referred to the minerals as nutrients rather than correctly using the term "minerals", but many were able to express the idea of the water being heated by the magma to a high temperature. Some candidates stated the minerals "mixed with the water" or that minerals were "picked up" rather than using the scientific terminology required of dissolving or leaching into the water. A few candidates linked the temperature of the water to the ability to dissolve minerals more efficiently.

(ii) The majority of candidates were able to give accurate and concise answers. Some candidates however, provided more than one answer for each, sometimes contradicting themselves.

(c) Many candidates answered this very well, giving full details of how the hydrothermal vents are formed, and stronger candidates mentioned the minerals precipitating when they reached the cold water again. Some weaker candidates simply talked about magma escaping from a divergent boundary rather than demonstrating a full understanding of the process.

(d) (i) Many candidates gave a clear definition of mutualism, although some then did not use the example in the question. The strongest candidates were able to provide detailed answers, including named tubeworms e.g. *Tevnia* or *Riftia*, with some candidates using the terms "host" and "symbiont" correctly (although the latter is outside the requirements of the specification). Some candidates just mentioned the two organisms, without giving any details.

(ii) Many candidates again were able to give a concise and accurate meaning for succession. Candidates who were not so familiar with the term were able to say it was a change in something (often habitat) over time, and sometimes gave the impression that the *Tevnia* evolves into *Riftia*, rather than being replaced by *Riftia*.

Question 2

(a) Many candidates answered this very well. Small errors included not mentioning that the volcano was near to the surface or had emerged above sea level, or not mentioning corals or coral polyps at all in answers.

(b) Many candidates answered this question well and were able to give conditions for the growth of corals. However, candidates needed to provide some degree of detail, e.g. a suitable stated temperature, or a range of temperatures they could grow well in, rather than just “warm water”. Some answers to this question were too vague to be awarded credit.

(c) Most candidates were able to give at least one factor leading to reef erosion with many giving two. Although many candidates mentioned storm/hurricane/cyclone/typhoon, they needed to state that this caused (physical) damage to the coral, as not all storms will cause damage. A number of candidates also stated “temperature” without any implication of a change in temperature.

(d) The majority of candidates could provide one, and usually two ways to reconstruct a reef history However some candidates did not read the question carefully and provided answers about how to reconstruct a reef, e.g. seeding with new polyps, sinking an artificial reef.

Question 3

(a) Many candidates found this question challenging. Some candidates stated that the phytoplankton “created food energy” rather than light energy being converted or transferred to food energy.

(b) Whilst a significant number of candidates completed this question well, a number of candidates did not check their answers carefully enough.

(c) Many candidates correctly stated reasons for loss between the trophic levels, including not all being eaten, and heat loss from respiration, but some candidates discussed excretion from zooplankton rather than the herring, as an energy loss between zooplankton and herring.

(d) The majority of candidates carefully drew an accurate pyramid, using fully enclosed rectangular boxes for each level and often labelled them very comprehensively. The most common error was to draw a triangle, then to add the labels within that, but this did not adequately represent the information provided.

(e) Many candidates were able to explain the impacts on the food chain clearly, with some of the strongest candidates also mentioning that organisms such as the orca and salmon may also feed on other prey species so populations may not be as affected as the simple food chain may suggest. A few candidates made statements such as “the number of zooplankton would increase because there are less herring” without explaining why that would happen. Candidates should be encouraged to look carefully at the command words and to consider what is being asked for by those command words.

Question 4

(a) Many candidates correctly identified monsoon winds, with the most common error seen being trade winds or El Nino.

(b) Some candidates were able to answer very well, demonstrating a clear understanding of the causes and effects of differential heating of the water and land. However others showed little understanding of the process. Some candidates confused air rising due to change in density from heating, with evaporation, stating water evaporated from the land.

(c) Some candidates who had not been able to explain **(b)** were able to explain themselves clearly here, and some who had shown a clear understanding in **(b)** could not explain this part well.

Question 5

(a) These questions proved more challenging for many candidates, requiring some interpretation of observations and facts to form a cohesive answer. In general candidates were more able to state where on the shore the algae were found, but often found it difficult to give a reason for that distribution based on information about each algae species. Some candidates linked the position to more water/less water, but didn't make the link to the ability of the different species to withstand desiccation, or linked the length to their ability to reach light for photosynthesis.

(b) (i) The vast majority of candidates could state the relationship between temperature and oxygen concentration in sea water and fresh water.

(ii) Many candidates were able to state the increased temperature in the rock pool would decrease oxygen concentration, with some stating that increased temperature would affect the oxygen, without stating how it would be affected.

(c) Many candidates were able to clearly link the increase in salinity to evaporation removing water from the rock pool. The most common error was candidates not mentioning that it is only the water which evaporates.

Question 6

(a) (i) Whilst many candidates correctly gave "high tide", a significant number gave "spring tide" despite the fact that the diagram gave no indication of the location of the Sun.

(ii) Many candidates were able to explain this clearly, but some misunderstood the movement of the Moon around the Earth, and stated that high tides only occur at night, when the moon is in the sky. Candidates should be encouraged to look for the moon in the sky during cloudless days around the quarter moons to challenge these ideas, then to link to high tide times that day. Some candidates stated that the Moon has a gravitational effect on the water, but did not state what the effect was.

(b) This part proved more challenging for many candidates, with some stating that the Sun also has a gravitational effect, but not going on to say how it interacts with that of the Moon to create spring and neap tides.

(c) Some candidates could give three factors with accuracy but others were more vague, for example stating simply "pressure", rather than atmospheric or air pressure, and simply "wind", rather than wind direction or wind speed.

Question 7

(a) Many candidates gained at least partial credit for this question, but the definitions given sometimes did not clearly separate the idea of a parasite or predator/prey relationship. Candidates often stated that one organism lives off another organism, or feeds off another organism. However this could also refer to a predator/prey relationship. Candidates needed a clearer understanding of the difference between predator/prey relationships and parasite/host relationships.

(b) (i) Many candidates understood that the fish becomes more likely to be predated on by the bird. Only the strongest candidates were able to give a reason for this, but many were able to explain the benefit to the parasite.

(ii) A number of candidates were able to state that the parasite would not be able to complete its life-cycle, or that the parasite would lose its food source and need to transfer to a new host.

MARINE SCIENCE

Paper 9693/13
AS Structured Questions

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MARINE SCIENCE

Paper 9693/21
AS Data Handling and Free Response

Key messages

Candidates should read the questions carefully and consider what the question is about. They should select appropriate information to answer the questions and try to avoid including irrelevant or vague descriptions.

Candidates should manipulate data presented in tables or graphically, rather than quoting figures directly to support a trend in the data.

The quality of graph drawing was generally high. Candidates should be reminded that axes should be labelled correctly and that they should not use non-linear scales when working out the size of the graph axes. The graph must take up at least 50% of the graph paper provided. There is no need to shade individual bars within a chart unless asked to do so.

General comment

A very high standard of scientific knowledge and understanding was displayed by many candidates.

Most candidates attempted every question. Weaker candidates sometimes did not answer some questions or attempted a vague answer with very little scientific detail.

Overall candidates tended to answer better in ***Section B*** than in ***Section A***, showing that many candidates were able to apply their knowledge of principles and concepts in a logical, deductive manner.

Comments on specific questions

Section A

Question 1

(a) Almost every candidate identified the year in which there was a maximum catch as 1961. A few candidates misread the question and stated the peak catch rather than the peak year.

(b) The changes in catch were reasonably well described by the majority of candidates. Most stated that there would be an overall decrease, but fewer candidates recognised that the most rapid decline would be between 1983 and 1989. Many stated that it was a big drop, which did not imply a rate. Many candidates commented on the fluctuations, particularly after 1995, and some candidates attempted to manipulate figures although these were sometimes incorrect.

(c) The percentage change in catch from 1967 to 1991 was incorrectly calculated by many candidates, with a variety of figures given. There did not seem to be a consistent error but many candidates calculated the percentage difference rather than the percentage change. Stronger candidates provided a figure between 78.1 and 80.3% but often omitted to indicate that this would be a decrease.

(d) Many candidates understood that the population of tuna would increase if the catch decreased, while some candidates referred to overfishing causing a decrease. However, some simply stated that fishing would decrease the population number without further qualification. Very few candidates stated that the population would remain the same if the catch stabilised.

Question 2

(a) (i) Many candidates found this question challenging and only the strongest candidates gained full credit for describing a method divers could have used to collect reliable data. Some candidates mentioned taking repeats, finding an average, using a quadrat followed by the size of the quadrat that could be used and diving to the different depths. Many candidates stated that the number of species should be counted, rather than the number of colonies of each species. There was also the occasional references to controlled variables, such as sampling the same reef. A lot of candidates used the term "quadrant" for quadrat.

(ii) Many candidates gained full credit for the correct bar chart to illustrate the number of each coral species at a depth of four metres. However, a number of candidates took insufficient care with the graph, drawing freehand sometimes, and producing bars which were significantly different in their widths from top to bottom. Also, bars should not have touched each other in the bar chart. Finally, a number of candidates tried to plot all species at all depths and did not read the "at 4 m".

(iii) In general, most candidates were able to gain at least partial credit for describing the depth preferences for the six coral species. Many candidates referred to species **A** and **B**, and occasionally species **F**, preferring 2 m while species **C** and **D** preferred 12 m. Species **E** and **F** proved to be more problematic as some candidates did not appreciate that the numbers at each of the three depths were fairly similar, so some candidates attempted to suggest a preferred depth. A minority of candidates misread the question and simply described the number of coral species at 4 m.

(b) A number of candidates provided two correct statements regarding the extent to which the data supported the hypothesis, but frequently candidates failed to qualify their statements with reference to the particular species in the table.

Section B

Question 3

(a) Most candidates were able to score at least partial credit for this section, with a number of candidates gaining full credit. Many candidates gave correct definitions of mutualism as the relationship between two species where both benefit, and parasitism as the relationship between two species when one benefits while the other is harmed, frequently referring to the host as the organism being harmed. Many candidates also provided suitable marine examples of mutualism, such as corals and zooxanthellae, or chemosynthetic bacteria and tubeworms or clown fish and sea anemones. Most candidates were able to give advantages to both species, although they were sometimes a little vague. Examples of parasitism were less precise, with candidates simply stating, for instance, "a parasite and fish". Often, the disadvantage to the host was not mentioned, apart from the fact that it would hurt. However, stronger candidates gave tuna and nematodes, salmon and fish lice or blue whales and tapeworms, stating that the parasite would obtain its nutrition from the host, which would ultimately result in the death of the host, which is not generally in the interests of the parasite. A few candidates used incorrect examples of parasitism: sharks and tuna, parrotfish and corals and crown of thorns starfish and corals. Also, some candidates mixed up tubeworms with tapeworms. Relatively few candidates mentioned that both mutualism and parasitism are symbiotic relationships. A small number of candidates gave terrestrial examples, which were not credited.

(b) (i) Stronger candidates appreciated that productivity is defined as the rate of increase in biomass, but some candidates negated their answer by stating that energy would also be produced. Weaker candidates commented on the rate of reproduction or the level of activity taking place in a habitat or ecosystem.

(ii) The reasons why coral reefs have a high productivity were often poorly described. Few candidates achieved full credit. Many candidates commented on the high biodiversity of the habitat or the number of specialised niches. Stronger candidates appreciated that corals occupy shallow depths where there would be a high availability of light, although reference to high light penetration was rarely seen. Some stronger answers mentioned clarity of water or low turbidity. Most candidates mentioned producers although this was rarely linked to a high rate of photosynthesis. Some candidates also stated that the coral reef is a stable, or a non-extreme, environment. Many candidates mentioned availability of lots of nutrients, but rapid nutrient cycling was a rare answer. Few candidates mentioned a suitable temperature or a temperature range, more candidates used

the word “warm” which was not credited. However, a tiny minority of candidates linked temperature to its effect on enzyme activity.

Question 4

(a) (i) The significance of the alignment of the Sun and Moon on tidal range was well understood by the majority of candidates, but few gained full credit. Many candidates understood that a spring tide would result when the Moon, Earth and Sun were aligned at 180° while a neap tide would be due to a perpendicular arrangement of the three. These candidates often went on to state that spring tides have a large tidal range while neap tides have a small tidal range. Some candidates commented on the importance of gravitational pull of both the Sun and Moon in the production of these tidal ranges, but some candidates only mentioned the pull of the Moon. Some candidates referred to phases of the Moon without explaining alignments and these answers received no credit. References to the combined gravitational effect in spring tides or reduced effect in neap tides were often imprecisely described. Weaker candidates described the diurnal cycle, trying to explain why there are different tides within a day.

(ii) There was a wide range of suggestions for other factors which might influence the tidal range, including tsunamis, temperature, pH, salinity and currents, and many unqualified references to wind. Some candidates simply repeated their answer to **(i)**. Stronger candidates understood that the size of the body of water and the slope/shape of the coastline would have a significant effect, as well as wind speed/strength or offshore/onshore wind direction. Some candidates mentioned air or atmospheric pressure but other candidates stated pressure only, which was not specific enough to gain credit.

(b) Accounts of the effects of environmental factors on the formation of communities on a rocky shore were very varied with few candidates gaining full credit. Most candidates understood that wave action would be a significant effect and that organisms would have to be adapted to survive the harsh conditions such as being pounded by crashing waves or desiccation at low tide. Many candidates mentioned that organisms would cling/attach to the rocky substrate using for example, a muscular foot. While few candidates mentioned the slope or topography of the shore, there were a number of references to rock pools (tide pools) as being a safe place for organisms to shelter at low tide. Some candidates described how evaporation of the pool would increase salinity of the water. A large range of temperature, variations in gas concentration, type of substrate or aspect of the shore were all rare answers. Weaker candidates focussed on greater erosion and less sedimentation at rocky shores without explaining the factors causing it.

MARINE SCIENCE

Paper 9693/22
AS Data Handling and Free Response

Key messages

Candidates should ensure they read each question carefully, focusing on the particular command word(s) used, and should be familiar with the meaning of each, (such as “describe”, “suggest”, “explain”).

The number of marks available and the space provided for a question will help candidates to determine the level of detail required in their answer.

Candidates should be reminded to check their answers to ensure they have not missed out or misspelled a key term.

When responding to questions that are asking for patterns and trends in data, candidates must ensure they read the question carefully to correctly identify which part(s) of the data set they are to comment on.

If naming examples of ecosystems or organisms in their answers, candidates must ensure that these come from the marine environment.

General comments

The standard of knowledge and understanding seen were very impressive overall, with many students answering questions well, particularly in ***Section B***.

Candidates found some aspects of ***Section A*** more difficult, particularly **Questions 2(b)(i)** and **2(c)(ii)** where they had to use the patterns in the data to support their answer. Candidates must ensure that they study the data presented carefully to ensure they are specifically answering the question as it has been set.

Comments on specific questions

Section A

Question 1

(a) The majority of candidates correctly identified the first trophic level, and were able to explain that chemosynthesis produced organic molecules. Fewer related this process to making these molecules available to the rest of the food chain, or that the source of energy was chemical potential.

Candidates needed to avoid references to “making” or “creating” energy, unless in the context of making it available to other organisms.

(b) Most candidates plotted good, clear graphs with points joined with ruled straight lines. However, some candidates did not choose appropriate scales and did not sufficiently fill the area given. They should allow the plotted points to cover at least half of the grid provided. Others extrapolated the lines beyond the plotted points, particularly through zero which was not a plotted point.

(c) The majority of candidates were able to identify the overall trend in the data, but a number did not then distinguish between the more rapid rate of increase in the earlier years and slower rate of increase later. Some candidates incorrectly described the decrease in rate of increase as just a decrease.

Candidates needed to attempt to manipulate/process data to support their answer, rather than just quoting numbers.

Question 2

(a) Most candidates correctly identified the relationship as mutualism or symbiosis.

(b) (i) This question proved challenging for many candidates as a significant number did not focus on the specific part of the data that the question asked about and described the changes over the entire 10 year period, rather than just the position after 10 years. In particular this affected comments on algae, with many candidates focusing on the increase and subsequent decrease from year 1 to 10, rather than stating that there had been an overall increase. Similarly for coral cover, many candidates focussed on the initial rapid decline, followed by a levelling off, rather than simply stating the cover was significantly lower after 10 years.

(ii) Most candidates realised that an increase in algae would result in a decrease in penetration of light, but not all then related that to the ability of zooxanthellae to photosynthesise. Some candidates confused the algal population with zooxanthellae and suggested that the corals would be provided with more nutrients.

Few students suggested that an increase in algae might result in reduced space for corals to settle, or that feeding may become more difficult for the coral polyps.

(c) (i) Few candidates gained full credit for this question as many did not describe a controlled method for accurately counting the corals/calculating the coral cover, such as using a quadrat.

(ii) Although this question was answered well by many, a number of candidates did not distinguish between the coral reef community and the coral cover. As such they only commented on coral cover changes and ignored the algae cover and number of fish species, which are also part of the community.

(iii) Most candidates correctly stated that fish are herbivores and will eat/feed on algae.

Section B

Question 3

(a) This question was answered well by many candidates, showing a detailed knowledge of the particular conditions required for a tropical cyclone to form. Some answers were not specific enough however. For example some candidates did not quote a minimum sea surface temperature (26.5°C) or depth (50 m).

Many candidates were able to describe the roles of evaporation and condensation in causing moist air to rise, cool and condense, but fewer were able to communicate the effect of the latent heat released in perpetuating the cyclone.

(b) This question was also well answered by the majority of candidates, but there were references to some examples that were not from the marine environment.

In defining ecosystems, most candidates were able to make reference to both biotic and abiotic factors, but not all made the importance of the interaction between them clear. Very few candidates described the cycling of nutrients or the flow of energy through ecosystems.

Biodiversity was often correctly defined in terms of number of species in an ecosystem, but very few candidates made reference to the relative abundance of each species.

(c) Most candidates were able to describe how mangroves protect coastlines to some extent, with many good answers seen, but only a minority of candidates gave a comprehensive response. Answers needed to particularly focus on how the nature of mangroves helps to reduce erosion and encourage sedimentation. Mention of roots was not always qualified with their extensive nature. Protection from wave action was not always explained in terms of dissipation of energy.

Some candidates described the benefits to human coastal communities, or their acting as nurseries for young fish, which did not answer the question.

Question 4

(a) This question was answered well by many candidates who correctly described the replenishing of surface waters with nutrient rich water from depth, and the subsequent impact on productivity. Some candidates incorrectly implied that fish would benefit directly from consuming the extra nutrients, rather than linking this to an increase in their food source. Candidates should take care to name nutrients correctly, e.g. nitrates (not nitrogen) and calcium ions (not calcium).

(b) This was also very well answered by many candidates. Most candidates suggested advantages such as improved feeding, reduced risk of predation and increased chance of reproductive success. However, some candidates needed to elaborate on these suggestions, such as increased chance of fertilisation.

Fewer candidates suggested increases in hydrodynamic efficiency/decreased energy expenditure when swimming.

(c) Most candidates were able to describe the causes of El Niño to some extent, and many answers described this very well and in detail. However, some candidates were confused regarding the changing of the prevailing wind conditions. Some candidates were not able to describe wind direction correctly, for example showing a lack of understanding that an easterly wind is one that originates from the east and blows to the west.

Some candidates focused on areas outside the boundaries of the question, such as the impact on global climate/weather patterns.

MARINE SCIENCE

Paper 9693/23
AS Data Handling and Free Response

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MARINE SCIENCE

Paper 9693/03
A2 Structured Questions

Key messages

Candidates should be reminded to read the questions and all accompanying information carefully before starting their answers.

Some candidates had a tendency to use imprecise language e.g. “breathe” for respiration or just “pollution”, when specific examples were required.

General comments

There were a few very good performances from candidates, with fewer very weak candidates. Strong candidates showed a sound understanding of the syllabus and were able to process the information provided, while other candidates gave generalised answers that gained partial or no credit. Data analysis and manipulation of figures from graphs was often weak. **Question 3** on lobster fishing and **Question 6** on turtle conservation were generally well answered. By contrast, more demanding topics such as photosynthesis in algae in **Question 1**, osmoregulation in **Question 2** and selective breeding in **Question 7**, were less well understood.

Comments on specific questions

Question 1

(a) Stronger candidates were able to identify that giant kelp lives in shallow waters. Common incorrect answers were “intertidal”, “tidal” or “benthic”.

(b) Only the strongest candidates answered this question correctly. A common misconception was that red and brown algae did not contain chlorophyll a.

(c) Stronger candidates gained full credit and most candidates gained partial credit, usually for stating that different wavelength travel to different depths. Common misconceptions included that green algae absorb green light or that red algae absorb red light, or that green algae absorb blue light and brown algae absorb red light. Some candidates thought that the wavelength was the distance travelled, so red light reached a depth of 700 nm.

(d) Many candidates made vague comments, such as “they get the correct wavelength” or “obtain nutrients” without linking this to competition. Several candidates misread the question and gave answers in terms of the benefit of algae to other marine organisms e.g. as a food source or oxygen provider.

Question 2

(a) There were few correct responses with most candidates answering in terms of mud binding salt, not water, or referring to the addition of water by the incoming tide or from rivers.

(b) (i) The majority of candidates were able to gain credit for the idea of temperature being a controlled variable.

(ii) Most candidates could state that aeration provided oxygen, but this was rarely linked to respiration. Common answers included vague references to oxygen being required to “breathe” or to “survive”.

(iii) There were many correct descriptions with most candidates gaining credit. Imprecise language that suggested some form of regulation was not credited.

(c) (i) Full credit was rarely awarded and only stronger candidates mentioned osmosis. Most candidates made vague references to the internal salinity being different from the environment and had to be regulated "for the body to work correctly" or "if they don't they will die".

(ii) Only the strongest candidates answered this question correctly. Many candidates confused osmoregulation with ventilation, or tried to describe euryhaline fish. There were some very confused answers about salinity, salts and ions, but weaker candidates often gained partial credit for a correct reference to salts being removed in urine or by the gills. Few references were made to removing excess salts.

Question 3

(a) (i) Most candidates gained partial credit for stating that the lobsters would not be caught as they live in burrows or crevices. Few references were made to the net being damaged by benthic trawling over a rocky substrate. A significant number of candidates thought that benthic trawling only took place during the day and so would not catch nocturnal lobsters. Many answers only focused on the negative aspects of benthic trawling and could not be credited.

(ii) The majority of candidates gained full credit, but weaker candidates only made vague references to replenishing the population.

(b) A minority of candidates referred to migration to colder waters. Most incorrect answers stated the advantages of warm water e.g. "extended breeding season". Those that had read the information provided could correctly state that there was less predation by cod, so lobster numbers would increase. A few candidates thought that lobsters ate the cod.

(c) Most candidates answered this question correctly. A few incorrect responses referred to the stones making the trap look like a burrow, or stones forcing the lobster into the second compartment and the small exit being there to remove the lobster out of the trap.

(d) It was recognised that boats raced to areas where the lobster population was high, but this needed to be identified as rocky areas to gain credit.

(e) (i) The idea of colonisation or succession was well understood and was usually linked to coral growth.

(ii) Partial credit was gained by stating that the artificial reef increased lobster habitat. Very few candidates stated that the artificial reef should be placed in sandy areas. Most answered in terms of "fishermen knowing where to go" or that lobsters were "easier to catch".

Question 4

(a) Only stronger candidates gained full credit, but partial credit was common. Many candidates seemed to confuse tuna or grouper with salmon, suggesting rivers/gravel beds for larvae and juveniles.

(b) (i) Extensive aquaculture was usually linked to living in the sea, but often no further explanation was given. A few good answers referred to water currents removing waste products. More candidates gained partial credit for mentioning intensive aquaculture, which was usually linked to being fed by humans. There were some incorrect answers involved controlling sea temperatures, light and pH.

(ii) Only the strongest candidates gained full credit. The most common errors included stating that juvenile tuna were sold before reaching sexual maturity or failing to be clear if they were referring to depletion of wild tuna populations. A number of candidates considered only the point of view of the fish farmer and the economic impact of a lack of juveniles.

(iii) Most candidates gained partial credit, but many answers were incomplete or too vague for further credit e.g. "less wasted fish under cage" and "stops catching too many wild fish".

(iv) Those candidates who had read the information provided gained full credit. Those that did not, answered in terms of tuna being difficult to keep in captivity, not getting enough food or cannibalism.

(c) Only the strongest candidates gained full credit for this question. Partial credit was often awarded for the idea of less pressure on wild tuna stocks. There were very few references to having a constant supply to sell or to less bioaccumulation of mercury/toxins. Incorrect responses often included the idea of selective breeding, larger sizes, lack of disease and more worryingly, stating that tuna from aquaculture must be GM.

Question 5

(a) Most candidates gained partial credit for stating that the ice mass decreased. Those that worked out by how much, often disqualified their answer by adding "per year" after 2000 billion tonnes. Stronger candidates described the seasonal fluctuations correctly, while weaker candidates could only state that the ice mass changed or omitted the units in their calculation of decrease.

(b) (i) This question proved challenging for many candidates. Incorrect responses referred to the water around Greenland as being too warm or that the melting glaciers made the water too cold. There were few references to prey species moving north or to less oxygen linked to respiration.

(ii) Candidates tended to copy the information provided instead of identifying that there would be less catch/income from fishing or less tourism as cruise ships were unable to land their passengers ashore.

(iii) Many candidates gained at least partial credit but some gave answers that were not precise enough e.g. "more fish will be available" or "more nutrient rich rock will be available". A few candidates speculated that the nutrients would run into the sea and cause increased plant growth.

(c) Partial credit was gained by referring to darker surfaces absorbing more heat. Stronger candidates gained further credit by stating that this would increase global warming. Weaker candidates went on to explain about ice melting, sea levels rising and other effects of global warming, but none of these were creditworthy. A common misconception was that that global warming would decrease as the heat was trapped in ice.

Question 6

(a) The trend proved difficult to describe and many candidates just stated the number of nests in each year. Few were able to state that there was no clear trend or that there was a decrease after 2000.

(b) (i) This was generally well answered as most candidates knew that turtles were confused by artificial light and that humans could destroy nests by walking over them. Weaker candidates answered with reference to the ocean, ignoring the phrase "on beaches" in the question. References to coastal development and to egg collection were rare.

(ii) Answers were frequently too vague or incomplete to gain any credit e.g. "pollution kills turtles", "fishing", "boats" or "by-catch". However, stronger candidates gained full credit.

(c) (i) Many responses were too brief or too vague for any credit e.g. "to stop damage to the nest". Stronger candidates knew that marking and covering nests were there to raise awareness. Similarly for the second part, there were many vague answers about making sure that the young turtles were safe, but stronger candidates were able to say that the young turtles could be helped to the sea.

(ii) This question was generally well answered, with most candidates gaining full credit for stating that the number of nests had increased both on indicator beaches and in the whole of Florida. Stronger candidates also included a correct data manipulation. Very few candidates described how the data might not support the claim.

Question 7

(a) (i) Some candidates gave three clear definitions. Weaker candidates sometimes did not attempt this question or gave very confusing answers e.g. "genes are what you inherit" or that phenotype

"describes the physical appearance" without any reference to genes or genotype. Selective breeding was often confused with genetic engineering.

(ii) Few candidates gained full credit, but most gained partial credit for stating that disease resistance meant that fewer fish died. Common errors included "grow faster and sold faster" for increase growth rate and "more fish faster" for early age of sexual maturity.

(b) (i) Many stronger candidates gained full or partial credit for data manipulation from the graph. There were few references to data at day 5 or day 10. Some candidates went on to explain reasons for the change in survival rate despite being asked to describe the changes in percentage. A few candidates also included Group **C** in their answer.

(ii) Most candidates gained credit by stating that Group **A** was resistant to the disease. Common errors were failing to state which group was resistant, or just stating that it was the selectively bred fish.

(iii) Many candidates gained credit for this question, usually for stating that Group **C** was not exposed to IPN. Few references were made to natural resistance in Group **C**.

MARINE SCIENCE

Paper 9693/04
A2 Data-Handling and Free Response

Key messages

Candidates should be reminded to:

be familiar with the use of two separate *y*-axes on graphs

consider how to plan valid experiments that have all variables controlled and generate reliable data

understand that the command word "explain" requires more than just a description

apply their knowledge to new situations when answering data analysis questions.

General comments

The general standard of answers was very good. Excellent depth of knowledge and graph skills were shown by many candidates but some candidates found plotting data challenging. Many excellent answers were seen in questions that considered the environmental effects of desalination plants, agriculture and tourism. There was often a high standard of experimental planning, and a good depth of understanding of pollution and salmon aquaculture was seen. Candidates should ensure that they are familiar with all the command words listed in the syllabus.

Comments on specific questions

Section A

Question 1

(a) This question required candidates to plot a graph from two sets of data. Many candidates organised their graphs well. Most drew line graphs with two separate *y*-axes that used different scales. Very few candidates used non-linear scales and most picked sensible scales. Candidates are reminded that the use of sensible linear scales makes it less likely that they will make mistakes when plotting. In addition, most candidates were careful to add labels and units on axes. Other correct graphical representations were accepted. For example, some candidates drew bar charts and others drew two separate graphs with a shared *x*-axis. Common errors included having touching bars on bar charts, extrapolating lines to the origin, and not labelling the *x*-axis. Some candidates confused which data series to plot and tried to plot the quantity of chlorophyll against the oxygen concentration.

(b) (i) This question required candidates to use their graph and the data shown in **Table 1.1** to explain the relationship between the quantity of chlorophyll and oxygen concentration. Many candidates only described the trends and did not go on to explain that chlorophyll is important for photosynthesis. A number of candidates did not make the link between chlorophyll, photosynthesis and oxygen production. Some candidates thought that photosynthesis would use up oxygen.

(ii) This question required candidates to suggest factors that may affect the concentration of oxygen in the water. Most candidates were able to suggest one factor, which was usually temperature, but only stronger candidates went on to give a second. There was significant confusion over the actual effect that changing temperature and salinity would have, with many candidates suggesting that colder and lower salinity water carries less dissolved oxygen. Only a few candidates recognised that melting of the ice sheets would enable increased dissolution of oxygen from the atmosphere.

(c) Only the strongest candidates answered this question correctly. Many thought that the increased temperature would reduce productivity due to the denaturation of enzymes. Stronger candidates recognised that primary productivity could increase and that there would be increased flow of energy along food chains.

Question 2

(a) (i) Most candidates were able to gain at least partial credit, with many gaining full credit. Common mistakes included miscalculating the volume of the agar cube, and dividing the volume by the surface area.

(ii) A wide range of answers to this question were seen. Many excellent answers fully explained that as animal size increases, the surface area to volume ratio gets smaller, and then went on to relate this to the diffusion of oxygen. Some candidates gave vague answers that simply suggested that larger animals need more diffusion, and others did not refer to diffusion, instead giving vague references to gaseous exchange.

(b) This question required candidates to devise a valid experimental plan. When producing experimental plans, candidates should ensure that they select a reasonable range for the independent variable, control all other variables and ensure reliability by planning for repeats that enable means to be calculated. Many excellent plans were seen that gained full credit. Common mistakes included only suggesting two or three temperatures, not controlling variables, not suggesting suitable equipment such as stop watches and/or not carrying out repeats.

Section B

Question 3

(a) (i) Many candidates understood that the precautionary principle considers the risks, but only stronger candidates went on to explain that it is applied since there is insufficient evidence to appreciate the risks. Some gave vague references for the “need to take precautions”.

(ii) Many candidates demonstrated an excellent understanding of the genetic engineering of salmon and wrote detailed answers describing the insertion of growth promoting genes and promoter sequences. Some gave full descriptions of the technology including the roles of restriction and ligase enzymes. Others, however, gave only vague statements such as “salmon are genetically changed”. Most candidates understood that salmon have been genetically engineered for rapid growth, but only stronger candidates went on to explain that these salmon are able to grow all year round and so meet consumer demand.

(b) Most candidates were able to gain some credit for this question. The effects of aquaculture on the environment were clearly well understood by many candidates and some excellent answers were seen. Most candidates appreciated the potential consequences of escape of the fish and how this could affect food chains. The effect of fertiliser escape was also explained thoroughly by many candidates. Where candidates did not gain full credit, it was typically for exploring only one aspect rather than giving breadth to their answer.

Question 4

(a) (i) Most candidates understood that agriculture can lead to eutrophication, but many did not give an explanation and simply gave descriptions of fertiliser leaching or runoff from the fields. Where candidates answered well, they were able to give explanations that linked a factor with its effect. There was some confusion regarding the terms “fertiliser”, “herbicide” and “pesticide” with many thinking that fertilisers directly poison other organisms and herbicides causing eutrophication.

(ii) Many candidates found this question challenging and some did not recognise the significance of desalination plants, with some candidates suggesting that they were plant species that would affect food chains. Many thought that desalination plants would cause salinity to decrease by increasing the amount of fresh water in the sea. A common error was to give vague descriptions such as, “the desalination plants kill organisms”, or to not include explanations in their answer, such as, “desalination plants release toxins”. Candidates should read the definitions of each of the command words in the syllabus carefully and structure their answers appropriately.

(b) Most candidates were able to gain at least partial credit for this question and the majority understood the roles of ecotourist resorts. Some excellent, detailed answers were seen that often used examples of specific ecotourist resorts that candidates had studied. All content points from the mark scheme were seen frequently, and many candidates gave in excess of the seven available. Weaker candidates often did not consider many aspects of the question and focused their answer on one point.