May 2017 subject reports

Marine Science

Overall grade boundaries

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0-14	15-30	31-40	41-49	50-59	60-68	69-100

Standard level internal assessment

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0-3	4-6	7-10	11-13	14-16	17-19	20-24

The range and suitability of the work submitted

It was clear that students were being encouraged to explore a topic of interest. The wide range of topics reflected student-led inquiry, which was good to see. The student voice was evident in the wide variety of investigations undertaken. The bulk of the investigations were focused on traditional "wet labs" with few students using databases or alternate data sources such as simulations. More students explored options other than traditional “wet labs”, which Is encouraging as they are examining other ways in which the science process can create knowledge. However, they need to ensure that these alternatives still provide the student with the opportunity to ask a focused research question and choose appropriate mathematical processing methods to reach a conclusion about the patterns in the data. Students will find it difficult to meet the criteria of exploration, analysis and evaluation if they are simply reporting/restating other research with no input, i.e. processing of their own.

These types of investigation represent a new opportunity to investigate topics but do require appropriate experience, and guiding of the student to explore topics that allow the use of databases, or combinations of traditional labs and databases, or simulations, in a way that will allow them to address the criteria.

International Baccalaureate
Baccalauréat International
Bachillerato Internacional

All of the work submitted complied with the ethical guidelines for the treatment of animals. It was clear that the students were participating in a wide range of interesting Group 4 Projects and their reflections showed they were both enjoying and learning from the experience.

Candidate performance against each criterion

Personal Engagement: Most candidates included statements justifying the scientific interest of their investigation, and some statement of personal interest. Stronger students also indicated how and why they had adapted the procedure to test their question.

This criterion assesses evidence of:

- independent thinking or creativity;
- personal significance;
- personal input into the design.

Exploration: Most candidates gave some background information in order to set the context of the investigation. Descriptions of the procedure varied in specificity. There were variations in the depth of understanding of safety and ethical considerations. This criterion assesses evidence of:

- a clear and focused research question, including identification of the independent variables, identification of the dependent variable, and how it will be measured;
- background information provided to justify the research question, including the range selected for the independent variable, a description of controlled variables and their expected effect, as well as the means used to control or monitor their effect;
- methodology that is of sufficient detail that a reader could feasibly carry out the process to collect consistent data;
- methodology that is a fair test of the research question;
- methodology that leads to collection of **enough data given that the project is given 10 hours** of practical time for completion;
- attention to safety and ethical concerns such as safe handling of materials, ethical treatment of subjects, careful consumption and disposal of materials, the impacts of disturbance/sampling on natural systems.

Analysis: Most students neatly and clearly organized their raw data. The distinction in performance was usually at the processing level. For guidance on the mathematical expectations of a Marine Science student, please refer to page 23 of the subject guide. Students often neglected to consider the effects of variance in the data and uncertainty in the measures on their results. This criterion assesses evidence of:

- the collection and presentation of raw data, including appropriate relevant qualitative data;
- clear and appropriate data processing, with sample calculations provided;
- appropriate statistical analyses;
- data displayed for easy interpretation in graphs or tables;
- a clear, correct interpretation of the analyses, with an explanation of trends observable in data displays such as tables and graphs.

International Baccalaureate
Baccalauréat International
Bachillerato Internacional

Evaluation: Students usually stated a conclusion, based on their evidence, that referenced their research question. Stronger candidates also linked their observations and conclusions to the scientific context established by their background research. Students usually considered sources of experimental error, as opposed to simple carelessness on their part in the execution of technique. Many neglected to link the source of error to its possible effect and then suggest a solution for that specific effect, so their evaluation was too general. Many students failed to exploit the strengths of their data. This criterion assesses evidence of:

- A conclusion that addresses the ability of the data to answer the research question;
- A conclusion that is mathematically justified by the data and where appropriate, compared to the scientific literature for context;
- Assessment of the strengths and weaknesses of the data and the investigation;
- Suggestions for how to improve the investigation itself and how to extend the investigation.

Communication: In general, it was clear that students had been taught to use a format and they were adhering to the guidelines. They were usually consistent in the use of one citation style. This criterion assesses evidence of:

- clear communication that is sufficiently detailed, but not repetitive or filled with unnecessary detail;
- well-organized and properly titled graphs and tables that are combined where possible to allow for the best opportunity for comparing raw or processed data;
- the use of correct scientific conventions including reporting of the uncertainty of measurements and instruments used in measuring, scientific names, and units;
- appropriate use of citations and references (all investigations that use a modification of a standard protocol should provide a reference to a source of that basic protocol);

Recommendations for the teaching of future candidates

In future teaching it would be important for some students to be given a bit more direction in refining their topic as they had planned investigations that allowed them to collect little data, or had no real research question to test. It is no longer necessary for all students to work from a single generic prompt. This widens the scope of permissible topics of investigation by individual students. In general, the command terms included in the subject guide are an excellent tool to help students understand the requirements of the different levels of performance reflected for each aspect of the criteria. For example, clear and focused research questions that are well justified not only state the relationship to be tested, they define the range of variables to be tested and predict some aspect of the expected outcome, justified with reference to proposed mechanisms, theoretical models or previous observations. The command terms organized according to the cognitive level of assessment objective they represent are provided on pages 92-93 of the subject guide.

Personal Engagement: Students should be encouraged to ensure that their report addresses why they undertook the investigation and why this investigation is of scientific interest. When they are doing preliminary trials, or pilot studies to refine their methodology they should also

International Baccalaureate
Baccalauréat International
Bachillerato Internacional

include brief descriptions or outlines of the trials as these are evidence of personal commitment and engagement.

Exploration: Students need to spend time refining their research question. The greater the specificity/focus of the question, the better students performed in other aspects of the criterion. Students who included a photo or diagram of their investigation generally also did a better job of clearly describing the procedure. Students can be guided to elevate their addressing of safety and ethical considerations by applying the command terms to that aspect in the review of the draft, e.g. identify/outline as compared to describe/explain as compared to discuss/evaluate.

Analysis: Students need to report the range or SD when means are calculated. The t-test is only applicable when there are only two levels of the independent variable. As soon as multiple t-tests are carried out within an investigation, the P value of falsely rejecting the null increases for each comparison, so with more than two levels of the independent variable a different statistical tool must be used. Students need to choose carefully the best graph to display/discriminate among their data. Lines of best fit can often be determined/justified by the mathematical relationship predicted by the theory or model described in the background information.

Evaluation: Students need to discuss the effects of the sources of experimental error in terms of their effects on results or on the ability to have a 'fair' test'. They also need to be encouraged to reflect on the strengths of their investigation/data. This criterion also requires both realistic improvements and extensions to the investigations.

Communication: This criterion is where students were penalized for poor communication in the use and titling of graphs and tables, and in the reporting of uncertainties of the measures, such as limitations in the precision of the instruments, and for inconsistencies in the reporting of the precision of the measurements. Any standard citation style is acceptable but students need to consistently conform to one of the standard styles. Other subjects within the Diploma programme are also teaching students to use suitable styles and so it might be helpful to students if one of the styles they are already learning is adopted as the class style so that they can learn to use it consistently and effectively.

Additionally, teachers are permitted to comment on one draft of the investigation prior to final submission and it might be reasonable in some cases for the student to then refine their ideas at that point, and perhaps refine their lab. Care must be taken to ensure that the student is not given too much direction, but some feedback is appropriate to guide them in their learning. Information and advice about giving suitable feedback on a draft is available in the information for supervisors of the Extended Essay, located on the OCC. In marking the final IA submission of the student and preparing the documents for uploading, please remember to remove identifying information from the main document. The candidate number and student name should not appear in the uploaded document although they may be used to title the document for ease of organization at the school level. Instructions for uploading documents are available on the OCC for each session as the old session finishes.

International Baccalaureate® Baccalauréat International Bachillerato Internacional

Further comments

These instructions are included to provide teachers with an understanding of the moderation process. In understanding the role of examiners moderating the IA, and the instructions they receive you might better be able to help a moderator understand your application of the criteria to the student work uploaded as a sample by providing comments that facilitate moderation.

- Read the whole report first to gain a general impression before attempting to establish marks. Evidence for particular criteria may appear in several parts of the investigation.
- Use a best-fit approach. The aim is to find the aspect within a criterion that most accurately conveys the level attained by the candidate. This approach means that compensation can be made when a piece of work matches different descriptors of a criterion at different levels.
- The overall mark per criterion is not an arithmetic mean, and only whole numbers should be awarded. Fractions or decimals cannot be entered.
- Teachers have been advised to read the aspects for each criterion starting with the lowest, but examiners may moderate using the teacher's marks as a starting point (i.e. looking for evidence, going up or down or accepting marks awarded as necessary). Examiners may mark by initially giving careful consideration to the teacher's mark and comments and then looking to see if there is clear evidence to adjust the mark upwards or downwards. If it is felt that the teacher has made a sensible interpretation of the criterion in question then the teacher's mark should be supported.
- Mark positively. Look for what is present in an investigation rather than minor omissions. Instead of questioning whether they have included everything, ask "have they said enough to meet the descriptor level?"
- Where there are two marks available within a descriptor level the upper marks should be awarded if the investigation demonstrates the qualities described to a greater extent (the work may be closer to achieving marks in the level above). The lower descriptor level would apply if the candidate's work demonstrates the qualities described to a lesser extent (the work may be closer to achieving marks in the level below).
- Examiner are asked "Does your final moderated mark look fair?". On samples where they support the overall mark, nonetheless small disagreements with the teacher's mark within a criterion may be seen. Examiners allow these random uncertainties to cancel out. However, if the marking of a criterion is consistently harsh or lenient, they will consider moderating the mark up or down respectively.
- Be open-minded and try to reward independent thinkers and risk takers. A candidate may have produced work that fulfils a criterion in a way these guidelines have not foreseen. Let the work in front of you define the outcome.
- If there is no achievement against one of the four descriptors within a criterion (with the occasional exceptions of the safety, ethical, environmental aspects of the Exploration criterion, when there is clearly no relevant issue to address), the overall mark for the criterion will most likely be impacted but this should not be over penalized.
- "Double marking" considerations might happen, especially regarding investigations that generated limited data: there may possibly also be an impact on exploration, analysis and evaluation.
- You should not have to read appendices to see the data. In cases where a data-logger has been used, a sample of the raw data should be included in the report. Raw data

should be organized and appear in the main report, displayed clearly for the marker's interpretation.

- When considering the page limits on the report allow some flexibility to accommodate well-organized data tables, and graphs that are pertinent and aid in the understanding of the research.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0-11	12-22	23-27	28-31	32-36	37-40	41-65

The areas of the programme and examination which appeared difficult for the candidates

Candidates struggled most when asked to evaluate a data set and then apply the information to answer a question or explain a complex phenomenon. Interpreting a figure to describe a trend, as in question 1(e)ii, confused students. Candidates struggled when asked to use the data given to support their ideas. Synthesis of information was sometimes weak.

Students struggled when describing data or showing an understanding of how data is collected. This was apparent in the answers to questions 1(d)ii where a named technique or instrument to study the Mid-Atlantic Ridge had to be explained.

Candidates also struggled in section B when asked to "discuss" or "explain". Answers were often rich in detailed subject content but often did not address the question fully, e.g. by including elements such as "a range of arguments, factors or hypotheses", or by including "reasons or causes". Human impacts were often mentioned, but students did not seem prepared to grapple with complex issues or to deal with multiple points of view.

Comfort levels for biological (basic ecological principles, details of different habitats) and geological (e.g. describing ocean basins, plate tectonics, tsunamis) content seemed to be much higher than for syllabus areas that encompass chemical or physical knowledge (interactions between atmosphere and oceans, especially with respect to the water cycle, chemical and physical properties of water, or ocean acidification).

Connections between the atmosphere and the ocean did not seem to be well understood.

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

The areas of the programme and examination in which candidates appeared well prepared

Candidates showed strengths in communicating basic ecological principles. Basic analysis and evaluation of data e.g. interpreting a simple question from a figure or doing simple calculations was generally competent. Knowledge of ocean structures, dynamics of the earth's crust and processes such as tides showed some variation but in general candidates seemed to have the vocabulary related to these topics, although sometimes a deeper understanding was lacking.

Candidates generally showed an awareness of environmental issues although the level of sophistication and the grasp of the details varied a great deal. Climate change, ocean acidification, and issues related to pollution were mentioned often. Essay responses in section B often demonstrated a sense of the ethical implications of human activities.

The strengths and weaknesses of the candidates in the treatment of individual questions

Question 1

1(a). Basic figure interpretation—most candidates answered correctly. Most errors seemed to be due to misreading the scale of the figure or to interpolating incorrectly.

1(b). Most candidates were able to state 1 of 2 reasons that loss of sea ice in the Arctic was a concern but the majority of students were under the misconception that melting of free Arctic sea ice would contribute to sea level rise. Melting of continental ice sheets will contribute to sea level rise but the question was specific to sea ice.

1(c)i. Most candidates were able to identify correctly from the figure the subpopulation of polar bears that was increasing.

1(c)ii Most candidates were able to use their understanding of basic ecological principles to suggest a reason why the number of polar bears in some populations was stable or increasing.

1(d). Only the strongest answers received more than 1 out of 4 marks for this question. Candidates rarely used the all the data in this section to discuss the designation of polar bears as threated or vulnerable. It was telling that students who had correctly identified populations that were increasing still chose to base their answers on perceptions of population decline that were not supported by the data provided. This question was a good example of how important it is to continue to build skills to develop evidence-based arguments. Some students did try to grapple with a lack of data and the amount of variability in the data, but while they showed an awareness that the error bars were important they did not know quite what to do with them. Some candidates wanted to invoke the precautionary principle which does show a sense of the ethical implications of the question and they deserve kudos for attempting to navigate this extremely complex concept. (A side note: use of the precautionary principle in the EU differs substantially between parts of the world. A full exploration of this topic is more suitable for advanced study). However, in most cases the data presented was not used to support ideas. The weak answers may have been in part due to the small amount of space given for the answer, it may have affected the students' perception of what kind of response was expected. The number of one or two sentence answers suggests that they were taking their cues more from the size of the box than from the number of points allotted.

1(e). Most candidates answered this correctly.

1(e)ii. Stronger candidates were able to identify and distinguish between the trends in DDT and CHL. Many candidates gave a lot of specific detail but were not able to articulate the trends correctly. Others overgeneralized and did not note the differences.

1(f). Again, most candidates were able to suggest successfully a reason for the differences in PCB concentrations in the different sub-populations, showing a good understanding of basic ecological interactions. However, there were some misconceptions about how the size of a bear or size of a population would affect the concentration of pollutants. Distinctions were not being made between the total amount that might be present in an animal's tissue and the concentration or amount per unit of tissue.

1(g). Candidates struggled with this question. A strong understanding of the scientific process includes the ability to evaluate the support for an hypothesis. Data can be used to disprove or support, but not to prove. Candidates often considered the declining populations with the high PCB concentrations in isolation, without considering the conflicting data. Given that there are stable or increasing populations of bears with high PCB levels and that there is insufficient data for many of the populations, the hypothesis is not supported. A key element of the critical thinking required in the scientific process is to understand the difference in weight between a small amount of data that, taken all by itself, supports your hypothesis, and a small amount of data that does not.

2(a). Most candidates were able to demonstrate a basic understanding of why some earthquakes would generate a Tsunami, but answers rarely demonstrated a more sophisticated understanding of the forces involved in a megathrust earthquake or any of the other types of earthquakes that can generate a tsunami.

2(b). The DART system was very poorly understood. Students rarely distinguished between the sensors on the bottom of the sea floor for detecting differences in sea level and the buoys for communication at sea level. Common misconceptions included thinking that the buoys were the sensors, thinking that the buoys were seismometers, and that earthquakes were monitored instead of sea level changes, and thinking that the system predicted whether or not a tsunami would form.

3(a)i and ii Candidates were able to identify labelled features fairly well.

3(b). Candidates generally answered correctly that sea level was higher above the mid-ocean ridge. The question did not ask for an explanation but many students offered one anyway. Most of the explanations were not correct. Candidates were not penalized for these misconceptions, but many thought that displacement of the water was the reason for higher sea levels or that the sea level decreased because the rift valley was so deep and the water filled up the space. Students were clearly not understanding the effect of gravity on sea level and the scale of the structure.

International Baccalaureate® Baccalauréat International Bachillerato Internacional

3(c). Candidates generally were able to partially explain how the Mid-Atlantic Ridge was forming. The most common mistake was thinking that the plates were convergent instead of divergent. Some students were also not entirely clear about the role of magma in forming new crust in this area. Candidates rarely mentioned details about the density, or the differences in temperature. Weaker candidates showed a confusion about the differences between convergent, divergent and transform plates.

3(d)i. Candidates were often able to state a technique or a process used to study the Mid-Atlantic Ridge.

3(d)ii. Candidates were not always able to correctly explain what the process or technique tells us about the Ridge. They often stated a different technique or explained something else. If they listed 'satellite' in question 3(d)i it was clear that they often did not understand that the bathymetry was inferred from measurements of sea level from space. Other tools that were poorly understood included GPS and carbon dating.

4. This was the question in Section A that most frequently demonstrated gaps in content knowledge or ability to correctly apply knowledge to the interpretation of a figure.

4(a). Most candidates did not correctly interpret the 30-day time series of water levels as showing a mostly mixed semi-diurnal tide pattern. Most students incorrectly characterized it as semi-diurnal.

4(b). Many candidates were correctly able to annotate the portion of the figure that would represent a neap tide. The most common error was to include too large a range of dates. The other common error was to label the highest peaks and the lowest lows indicating confusion between neap and spring tides. Sometimes the labels on the figure would be incorrect but the explanation in 4(c) would be correct and vice versa. This suggests that patterns of words were being memorized without a conceptual understanding.

4(c). Candidates asked to explain the occurrence of spring and neap tides were often able to communicate the relative positions of the sun and the moon with the earth competently but the level of understanding with respect to the forces involved was not demonstrated at a high level. Some confusion was evident with the description of "lessening gravity" when what is meant is that the gravitational influence of the moon is moderated by the gravitational influence of the sun.

4(d). Candidates were asked to list four factors that affected the ranges of tides. There were issues with an understanding of the difference between cause and effect for some students. Many candidates referred to different aspects of tides or water movement in general but not to what was causing the differences. The language was often very vague in this section, or the same phenomenon would be described in different ways.

Part B Extended answer questions

The essays most commonly chosen were questions 5 and 6.

International Baccalaureate® Baccalauréat International Bachillerato Internacional

There were some weaknesses evident in examination technique. Candidates should be encouraged to answer each section with careful attention to the actual question asked. The phrase, ‘as explained above’ showed up in one script. The details that would have been relevant to one section were often included as irrelevant detail in another. Information was ‘dumped’ without enough attention to where it would have provided the most support. Several candidates chose to answer the three sections of an essay option as one long, running commentary. The examiner(s) did their best to pull apart the sections but it would have been in the candidate’s best interest to pay attention to the format by indicating question number and section *eg* “5(a)”.

5(a). Candidates were often able to outline the effects of depth on the transmission of light with respect to wavelength. Many candidates communicated a sense that the level of light penetration was fixed with respect to distance and did not show any understanding that it is quite variable. The effect of turbidity (sedimentation) was rarely mentioned.

5(b). In general, the explanation of the effects of light on productivity in the water column covered the existence of the photic zone and basic trophic interactions. However, differences between photosynthetic pigments were rarely mentioned and specific connections with the open ocean food web were not often noted. This question was often answered more as an outline than as an explanation. Some answers discussed trophic interactions inappropriate to the open ocean such as the relationship of coral to the surface. Candidate descriptions of open ocean food webs were sometimes inaccurate or too vague.

5(c). Hydrothermal vent productivity was well described as being based on the chemosynthetic activity of bacteria. Many candidates were aware of the symbiotic relationships between *Riftia* and bacteria. Responses became vague when it came to details of the source of the energy for chemosynthesis. The importance of the special chemistry involved, such as the dissolved minerals in the heated water (or H_2S) could have been emphasized more. Just saying that chemical-rich water from the vent is important was too vague; H_20, CO_2 and so on are all chemicals so actually all water is rich in chemicals: more precise use of relevant terminology would have been helpful. Some candidates were under the impression that the whole ecosystem was bathed in very hot water but actually, even though the water leaving the vent directly can be upwards of 300°C the mixing with the cooler sea water happens very quickly and within even a few centimetres the water is much cooler.

6(a). Candidates describing the interactive effects of oceans and atmospheric CO_2 were generally able to communicate that the ocean was a sink for CO_2 and that ocean acidification was taking place, but they were unclear about some of the details. Rarely did anyone mention that there was a relationship between temperature and gas solubility and that as the temperature of the water was increasing this decreased the ability of the ocean to act as a sink. The descriptions of the relationship between ocean acidification and CO_2 were weak. Decreasing pH does not necessarily mean that the liquid has become an acid. A basic or alkaline solution can have a lower pH and still be basic. An understanding was not demonstrated that the ocean is becoming more acidic/pH is dropping by tiny amounts, and that these tiny changes are enough to affect organisms more adapted to higher pH values. The relationships between downwelling and the ocean acting as a carbon sink were not discussed. Some students demonstrated an understanding of the carbon cycle in terms of primary producers taking up the CO_2 to make carbohydrates during photosynthesis. However, many candidates demonstrated misconceptions about how oxygen is generated during photosynthesis. Students referred to the generation of oxygen by organisms but communicated as if the oxygen was generated directly from the CO_2. Candidates shared a common misconception that the oxygen in the CO_2 molecule contributes to increase in oxygen during photosynthesis, but it is actually from the splitting of water. The details of photosynthesis are outside the scope of the syllabus but candidates were making inappropriate connections in this question.

6(b). The understanding of the relationship between CO_2 dissolving in water and the resulting effects on the calcium carbonate chemistry relevant to molluscs was very poor. Candidates often mentioned different parts of the carbonic acid/bicarbonate/carbonate buffer system, indicating that they had been exposed to the material, but the statements were often incorrect. Candidates sometimes understood that the pH of the ocean was dropping but often incorrectly characterized the ocean as ‘acid’. The corrosive nature of more acidic water was mentioned, but the change in the availability of the carbonate ions that can affect development and slows down or limits shell construction was poorly characterized.

6(c). Candidates were able to discuss threats to coral reef ecosystems fairly well. The threats were often communicated with good detail. The background knowledge of problems in this area was extensive. The section of the essay that spoke to how humans were responding to the threats described was usually weaker. Few candidates did a really good job of providing all the elements of a discussion, for example, by including multiple points of view or an acknowledgement of where points of tension or challenges in implementation might be present.

7(a). Few candidates chose question 7 but of those that did few could explain how evaporation, condensation and precipitation affect surface waters of oceans. They struggled with the basic energy relationships inherent in condensation and precipitation. Few were able to apply an understanding of the high specific heat of water in this context.

7(b). Most candidates could name two habitats although not all could name two relevant organisms. Some scripts described adaptations that were correct for the organism but not an adaptation for euryhaline habitats. There was some confusion about the kinds of adaptations that fish (particularly anadromous fish like salmon) have for dealing with changes in salinity.

7(c). Most candidates who attempted to describe a pycnocline showed a basic understanding that it related to density changes in the water, though not all understood the scale of change in context. Not all students made it clear that they understood that the pycnocline was the layer where the density changed very rapidly; some wrote about it as if it encompassed the entire water column wherever density was measured.

Recommendations and guidance for the teaching of future candidates

Candidates should

- Develop the skill of reading and interpreting questions properly. This should be practised throughout the course, so that the exam is a natural extension of classwork.

- Work to become critical thinkers who can write balanced arguments that give multiple perspectives and/or the advantages and limitations of ideas or data. It is useful to be able to evaluate different sources of data critically and weight them appropriately, and to learn to recognize the difference between what the data might be expected to suggest and what it actually suggests.
- Practise writing responses to questions that require synthesis of data
- Practise writing responses that are appropriate to the command terms.

Teachers should

- Expose candidates to a variety of graphs, flow charts and models for interpretation.
- Help students understand how to pull together sources of data, and how to construct an evidence-based argument.
- Challenge students to evaluate data that may be contrary to expectations.
- Have candidates practise writing long response questions and then have them look at an answer key/markscheme to see the level of detail required, and what is missing in their own work.
- Emphasize question-answering techniques e.g. avoiding contradiction and irrelevance, and, where possible, help candidates to create connections within their answers. Each candidate could then mark another classmate's answers, using a markscheme. This type of activity is bound to activate student critical thinking skills about the content they should be learning.
- Give clear expectations for calculations, including number of decimal points and use of units. Insist that students show workings when doing calculations. Guidance can be found in the Mathematical Requirements section of the new syllabus about what calculations and statistical tools candidates are expected to be able to use.

International Baccalaureate
Baccalauréat International
Bachillerato Internacional

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0-4	5-9	10-13	14-17	18-21	22-25	26-35

General comments

Generally, students seemed well prepared for the examination. Only one teacher responded with G2 comments, so it is difficult to comment on the acceptability of the exam as seen by teachers. Balance between Section A and Section B could be expected to discriminate between strong and weak students. However, this was not the case as most candidates earned a disproportionate number of their marks in one section or the other. Thus, they did not show balance. However, those candidates who did show balance between the two sections all scored in the above average categories.

The areas of the programme and examination which appeared difficult for the candidates

Candidates struggled with describing some of the ecological relationships in habitats that are more specialized e.g. salt marshes, eel-grass beds or sediment-covered shores.

Demonstrating an understanding of the some of the skills-based concepts was difficult for many candidates.

The areas of the programme and examination in which candidates appeared well prepared

Candidates seemed to have a good understanding of more standard ecological relationships like those between phytoplankton and fish.

Candidates seemed able to interpret simple figures and graphs.

The strengths and weaknesses of the candidates in the treatment of individual questions

Section A

Question 1

1(a) Not all candidates were familiar with the term celerity and used some unusual formulae for working out this quite simple calculation. The difficulty seemed to be in eliminating the unneeded dimensions given in the problem.

1(b) Many candidates were able to identify a wind factor that could increase wavelength. Fetch was seldom mentioned and duration was not mentioned. Credit was given for strength of wind or how hard wind blows as WTTE for wind speed.

1(c) Only the strongest answers contained an explanation of the dimensional changes for a wave entering shallow water. Many answers suggested that candidates did not have a firm grasp of the relevant physical concepts.

Question 2

2(a) Many candidates were able to identify the Gulf of Mexico from the map. Identifying the North Sea from the map seemed to be more challenging. Many students misidentified this body of water as the Bering Sea. Other mistakes that were made that were not so far off included the Norwegian sea and the Baltic Sea.

2(b) This question discriminated well, with the best answers scoring both marks, the average answers scoring 1 mark and the weakest answers scoring no marks. Since the question required an explanation, the skill with which candidates developed the answer was an indicator of stronger thinking/communication skills.

Question 3

3(a) Many candidates answered correctly. The most common error was an answer that was too vague. A species was requested and many students answered with a general term, snails. Weaker students did not find the variability across the years and instead identified the species with the highest density.

Questions 3(b) and (c) were designed to assess student understandings and the practical skills expected from topic 5.3. Sadly, only the strongest candidates recognized that the most significant interaction at a rocky shore is the impact of tides on tidal zonation, and that both density and distribution of organisms can be practically measured using quadrats and/or transects. Even if a rocky shore is not handy to the school, the use of visual simulations makes an understanding of this ecosystem accessible to all students. The interplay of abiotic factors with this ecosystem is an easy one to approach if candidates have experienced them on some level.

International Baccalaureate® Baccalauréat International Bachillerato Internacional

3(b) There was a great deal of variability in the candidates' ability to describe the skills involved in determining species density in a rocky shore. Not all students seemed to understand the concept of density and not all seemed to be familiar with tools or techniques such as a quadrat sample.

3(c) Many candidates confused abiotic with biotic. Other candidates named an abiotic factor but were not able to describe a design for an appropriate method for investigating its effect on the biodiversity of a rocky intertidal zone. Many of the designs were very impractical and those answers seemed to reflect a lack of field experience.

Section B

Most of the candidates chose option A; 17 chose option B and 2 chose option C. Eight candidates answered more than one option. This is not a wise choice as only one score can be used to determine the mark.

Option A

4(a) Many candidates were able to do the basic calculations necessary for this question.

4(b) Many candidates were able to apply an understanding of trophic relationships to interpret the data given and to suggest that satellite data could help conserve fish populations. However, few explained that satellites collect colour data, indicating chlorophyll levels that can be used to determine productivity, leading to estimates of fish populations.

4(c) Candidates varied in their ability to identify the phytoplankton micrographs. This may reflect their amount of lab experience with the organisms.

4(d) Many candidates seemed to be familiar with diatoms, but answers focused on anatomical structures instead of life cycle details.

5(a) This was a difficult question for candidates. Most candidates were able to identify the salt marsh and eelgrass as the autotrophs in the figure given. The most common error was to include the bacteria. While bacteria can be autotrophs in some ecosystems, in this example they are not. Detritus was sometimes given as a producer. Candidates should be reminded to make sure they are answering the question given and pay close attention to the data and/or figure they are using and not let prior knowledge or perceptions skew their answers. This is a key element of learning to think critically.

5(b) There was some confusion about the difference between detritus and detritivores. The fact that detritus includes both the decomposing matter and the decomposers makes this a complex description as well as a complex concept to teach. Many candidates earned at least one of these marks.

5(c) This was the most difficult question for candidates. Only the strongest candidates scored full marks. The weakest candidates scored no marks. Some candidates were not able to show much depth of understanding of how the 'health' of an ecosystem could be measured. Scripts did not mention indicator species or biodiversity very often. Optimally candidates would understand that many of the parameters that are used to measure the health of an ecosystem

International Baccalaureate
Baccalauréat International
Bachillerato Internacional

are only useful when combined with some sense of the baseline. Some ecosystems are going to be naturally less diverse than others. Diversity indices are not always sensitive to the presence or absence of keystone species or indicator species. So multiple factors need to be taken into account.

6. The elements of a discussion were not always present. Answers seldom indicated why humans do the action that causes the harm. Students were often able to name a human impact on sediment-covered shores but they did not seem to be drawing from very much in-depth content or conceptual understanding in their answers. Sediment-covered habitats have some issues that are unique and so it was not a question where it was easy to draw on knowledge from other contexts. Although ‘trampling’ was accepted as an answer, this action was difficult to develop as the literature does not support many of the claims made by candidates.

Option B

Although the best marks were earned on Option A, and only a few schools taught Option B, candidates who chose the option were fairly successful. With so few scores, statistical analysis is not very useful. However, question 7(b) and question 9 did discriminate well. The top candidates scored full marks, average scoring candidates received partial marks and weak candidates were unable to provide appropriate answers.

7(a) and (b) These questions required graphical interpretation. Most candidates were able to make a successful simple analysis of the graph, but fell short when applying energetics to the information in the graph.

7(c) Answers to this question were disappointing as candidates usually answered with anthropogenic causes of climate change rather than the other causes of climate variability as expected of Topic B.3. Thus they limited themselves to only one mark.

7(d)/8(a) Candidates appear not to have studied the advantages and limitations of modelling. Without a basic understanding of the relationship between models and the realities they represent, the topic of climate cannot be critically taught.

8(d) Since candidates could not define teleconnections, they were unable to apply the term to El Niño events.

9. Most candidates could name a specific coastal disaster with a generalized statement of its effects, however specific human responses were limited to the stronger answers and only the strongest answers suggested realistic mitigation.

Option C

Some of the data used in questions for this option could be used to teach core topics as well as Option C. For example the analysis of the core sample in questions 11(b) and (c) could be used to study tsunamis. An analysis of the drawing in question 10(a) could help students learn to analyse unknown equipment and what it measures (a common theme throughout the course).

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

Recommendations and guidance for the teaching of future candidates

Candidates should

- practise using content-appropriate terminology precisely. Activities such as developing flashcards for terms, making vocabulary lists and forming study partnerships can make this process more appealing.

- keep a list of the expected calculations, units, supportive diagrams and sample workings.

- organize understandings. For example:
    - phenomena have *causes, dimensions, modifiers* and *effects*;
    - wind-generated waves are caused when wind imparts energy from the atmosphere to water by friction;
    - the dimensions of wind (fetch, duration and speed), affect the dimensions of waves (height, length, celerity, period, etc.), which are further modified by depth of water, size of basin, shape of coastline and topography of basin floor.

- ask questions like: How was that measured? What makes that a valid method for measuring this dimension? How was that information verified? What evidence do we have? How does the model reflect reality? What is the best way to get that information?

- practise thinking critically about what a particular question is asking, and how to apply conceptual and content knowledge effectively.

Teachers should

- provide students with rich experiences of hands-on / interactive activities, evaluative discussions and of contexts for the material being studied.

- encourage candidates to think critically about what a question is asking. If this skill is practised during class conversations, then it will be automatic during examinations.

- provide students with opportunities to develop their practical skills in lab and field activities. Understandings of: measurements; equipment; the verification of data through the use of varied techniques; the use of calculations, and application of these in laboratory and field settings, are essential to success in the course.

- provide students with opportunities to practise writing answers to questions that have specific command terms. A useful activity is to take a question and have students develop the question through the command terms by objective, increasing the demands of the question in the process. For example:
    - *list the causes of waves (assessment objective 1);*
    - *describe causes of wind-generated waves OR outline causes of wind-generated waves (assessment objective 2);*
    - *explain causes of wind-generated waves (assessment objective 3);*

International Baccalaureate® Baccalauréat International Bachillerato Internacional

Hopefully, this activity will stimulate higher order thinking skills as found in the command terms (at the end of the course guide.) Another example would be:

- *state* the relationship found in the data *(assessment objective 1);*
- *outline* trends in the data *(assessment objective 2);*
- *evaluate* the data or *evaluate* the procedures used to obtain the data *(assessment objective 3);*

- since no school has access to all of the many ecosystems of the syllabus, teachers will need to be creative about developing simulations and data-based enquiries to provide their students with realistic experiences.

- give students feedback or have other students provide guided feedback on their skills development. Encourage individuals by acknowledging strengths!

International Baccalaureate® Baccalauréat International Bachillerato Internacional