Environmental systems and society (ESS)

Overall grade boundaries

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 13	14 - 26	27 - 39	40 - 51	52 - 63	64 - 75	76 - 100

Standard level practical work

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 14	15 - 19	20 - 24	25 - 29	30 - 34	35 - 42

The range and suitability of the work submitted

December 2014, all exams are finished and examiners all over the world are struggling to meet deadlines. Internal Assessment moderation is finished for the most part, except for niggling little details. Chile's southernmost tip is closest to Antarctica, and thus news about the icy continent has a regular place in our newspapers. It's not very encouraging news at times as expeditions mounted to research glaciers all point to important changes in the not so distant future. Getting students to understand how science works so that they can read these articles and sieve through all the conflicting information is crucial.

As always, new teachers should really take the time to read previous reports. The issues don't change significantly from session to session and students continue to struggle with many of the same problems year to year. Moderators provide good feedback and have access to previous year's feedback as well. While it is discouraging to see some schools making the same mistakes year after year, it is really rewarding to see programs improve as teachers implement suggested changes.

Candidate performance against each criterion

Planning (Pl)

Aspect 1 of this criterion continues to highlight the fact that the differences between independent and dependent variables are not always well understood and of more critically, this sets the ground for problems throughout the practical. Teachers really should work with students to clarify this concept and to ensure that students can identify, with precision, the variables that impact their design. When a student indicates, that in their practical on the impact of different soils on productivity, the independent variable is "loam, sand, potting soil" they reflect a lack of precision in their thinking and this should be clarified by the teacher.

Some schools use a chart in which students. list variables and how these are to be controlled. There is nothing wrong with this, and attempts at systematizing students' work can be very helpful. However, if the reasons for controlling the variables are not well stated, this should be penalized in Aspect 2 of Pl and not Aspect 1.

Many students need to devote more effort to describing how they choose their sampling sites, how was the location of the quadrat chosen? Why was a sample of earth taken here, and not there? Materials often need to be specified more carefully, a 0.25 m^2 quadrat may or may not be appropriate for the sampling which is to take place, and so not specifying the actual size may constitute a lack of control. If a student specifies a beaker to measure out small differences in a solution of acid which is to be used for watering plants, this is also a lack of control, a graduated cylinder should be used.

Practicals in which students use less than five treatments and less than five repetitions will normally be awarded a "partial" for Aspect 3. This has been stated in various previous reports. It is very frustrating to see students engaging in research in which one tomato seed is planted in five different pots which are to be watered with different pH solutions, and be awarded a "complete" for Aspect 3. The student is being misguided into thinking that this constitutes good design and this has a knock on effect in their thinking about the scientific endeavor.

Data Collection and Processing (DCP)

Student tables have improved in quality over the years and many schools are producing near professional quality data tables, complete with clear titles and excellent row and column headings. Students will normally lose marks if they place units in individual cells or neglect to include units in row and column headings. A good clear title is a necessary component of any data table. "Raw Data Table" is not an adequate title and will normally result in the loss of a mark in Aspect 1. A few schools had problems in that the work being moderated generated data tables that are too simple to adequately assess this skill. Other schools erred in providing students sample tables.

Aspect 2 often suffers from the lack of a sample calculation and from inappropriate or incorrect calculations. (The correctness should be spot-checked by teachers, incorrectly rounded averages, for example, should result in the loss of a mark.) Clearly teachers can at

times be overwhelmed with work, but it is really important to determine if the calculations make sense. For example if a student measures plant length every day and generates five measurements, averaging these data is meaningless. For example if on days one through five a seedling measured 5, 7, 8, 10, and 10 centimeters, averaging these five numbers generates a mean of 8cm and this is meaningless. This kind of mistake should receive zero marks for Aspect 2.

Aspect 3 continues to suffer from the graphing of unprocessed data which will normally result in a "not at all" being awarded. Other common mistakes were lines of best fit being drawn for non-continuous data or the use of line graphs for the same. More schools are encouraging students to calculate standard deviations, but these are often not used meaningfully. Perhaps the most serious example of this is a graph of the standard deviation for each mean as a stand-alone bar graph. Standard deviations, when calculated, can be used to add error bars to graphs and this should be explained, i.e. "error bars represent ± one standard deviation." This is important because it is by no means obvious. Additionally good graphs require good titles.

Discussion, Evaluation and Conclusion (DEC)

Many students lost marks in Aspect 1 of DEC for a retelling of the trends in the data to the exclusion of any other discussion. A lengthy data set may result in paragraph after paragraph of a descriptive narrative and this is not the same as a discussion. In this case a graph is worth a thousand words. This first aspect needs a brief analysis of data quality and the standard deviation can help in this. The discussion should be grounded in theory or the context of an issue. Some good questions for guiding the writing of this section are, "Why is my research interesting/important/meaningful?" or "How do my results compare to literature?" or "My data are trustworthy/not trustworthy because?"

Many schools have students providing thoughtful, considered evaluations. These include an analysis of the problems that are inherent in the method; for example random sampling that is unrepresentative, or inability to control temperature in a photosynthesis experiment or biomass in roots that wasn't considered in measuring GPP. It is frustrating to read evaluations that are completely attitudinal, in students that are graduating from secondary education. For example, "our group was pretty sloppy when measuring the samples of earth and this might have caused some errors in our data." Most teachers remark on this and dock marks as they should but too many award good marks for evaluations such as these. This type of analysis is wonderful for a reflective exercise on how students approach their work, but it is not what is expected in Aspect 2 of this criterion.

Many students would benefit from clear subheadings for this criterion to effectively separate their discussion from their conclusion. Conclusions should be brief, cite data directly and provide an explanation for what has been observed and relate to the research question. Too many students lose marks for not using their data explicitly in this section.

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Some teachers are using the comment and track changes features of word to provide students with feedback, and this is a growing trend. However, as printed copies **are** required, please make sure that moderators can read the comments. Being able to access teacher feedback to students is incredibly useful in the moderation process. Often times, teachers provide accurate comments and then neglect to make the necessary adjustments in their marking. For example when a teacher writes, "please include a good explanatory title for your data tables" it is surprising to the see the student awarded a "complete" for Aspect 1 of DCP.

Recommendations for the teaching of future candidates

A really good way to improve a practical program is for students to read work that has received high marks in all components. These are available from the online curriculum center (OCC), and provide students with a bench mark. In DCP, giving students a good data table which is annotated, showing the presence of a title, good column and row headings, attention to decimal place consistency, etc. can really help candidates. This gives them a model to check their own work. Many students would profit from a careful analysis of the types of graphing tools available to them and why these are or are not appropriate for certain types of data.

As has been stated before, students need access to open ended questions where they really have to think about how they will tackle the data gathering to ensure that they are doing good unbiased scientific research (as much as is possible within a high school setting). Exercises that are too prescriptive don't capture the essence of the scientific endeavor and do not challenge students sufficiently and not surprisingly often achieve poor marks.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 6	7 - 13	14 - 19	20 - 24	25 - 28	29 - 33	34 - 45

General comments

Paper 1 was wide ranging in its coverage of the syllabus. Out of the 734 candidates, marks ranged from 1 to 41 out of the maximum achievable of 45 marks. The mean for Nov 2014 was 20.00 compared to 22.59 for May 2014 and 22.45 for Nov 2013 sessions.

Overall G2 comments were highly positive. They confirmed that the level of difficulty was appropriate for an SL paper and there were no significant difference in difficulty compared to the Nov 2013 paper. Most G2 respondents considered the clarity and presentation of the paper to be good or better. The majority of respondents also agreed that questions were accessible to all candidates with learning support and irrespective of religion/belief system, gender or ethnicity.

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

- providing accurate definitions i.e. carrying capacity and pollution

- aspects that impact carrying capacity and therefore its measurement

- renewable natural capital

- calculating the annual rate of population increase

- construction of dichotomous key to classify organisms

- calculating Simpson's Diversity Index

- calculating the biomass of an ecosystem

- factors to consider when collecting data on succession

- nitrogen cycle

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

- solid domestic waste management

- calculation of proportions

- transfer and transformation processes

- reduction of water use

- differences between technocentric and ecocentric

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

1a i) & ii) The majority of candidates correctly identified a solid waste management strategy and associated advantage and disadvantage.

1b i) & ii) Most candidates correctly calculated the two percentages required and were able to draw the two missing bars from the bar chart but many did not label the x and y axis.

1c i) Often the definition for carrying capacity was incomplete with concepts of 'maximum number of a species' and/or 'sustainability' missing.

1c ii) Many candidates incorrectly focused on how population size varies rather than on aspects that determine resource use.

2a i) Few candidates answered correctly; a significant number stated 'non-renewable' instead of 'renewable' as the type of natural capital for ivory.

2 ii) A significant number of responses were too vague e.g. 'hunting' without link being made to reduction in population size.

2b) Most candidates attained some marks for this question and understood the knock on effects of removing elephants from a grassland system.

2c) The majority of candidates did not correctly calculated the annual rate of population increase using the data from the graph.

2d) Responses to this question were varied; common errors included a focus on strategies to further encourage population growth of elephants or on factors which contribute to a successful conservation area.

3a) Many candidates found it difficult to construct a suitable identification key, with a number of candidates making no or little attempt at this question.

3b) Many candidates struggled with this calculation with many not attempting the question, although a significant number of responses did also attain full marks. A common error included misinterpretation of the equation given.

3c i) Few definitions were complete, many were too vague and lacked reference to 'substances or energy produced by human activity'.

3c ii) Most candidates were able to describe at least one correct difference.

3c iii) The majority of responses correctly identified stream B but did not always give the reason for this in sufficient detail.

4a) The majority of candidates provided a clear definition of 'biome'. Common error was to omit 'collection of ecosystems'.

4b) Few candidates achieved full marks for this. Most answers were too vague with regards to how samples were collected and how the representative biomass data collected could then be extrapolated to the area. There were a significant number of blank responses or description of Lincoln Index given.

4c i) Few candidates were able to state two correct abiotic factors with most responses focusing on sampling techniques or stated 'stage of succession'.

4cii) Responses were very varied. A common error was to 'state' two factors rather than 'describe' factors that could affect succession.

5a) Responses were wide ranging achieving form 0 to 3 marks. A significant number of responses were left blank or only had drawn arrows without any labels.

5b) Although a number of candidates confused the two processes, many were able to clearly distinguish between the two and provide appropriate examples.

5c) A number of responses were too vague and 'stated' factors rather than 'describing' how they impacted on the nitrogen cycle.

6a) Most responses were too vague and did not give reasons why water may become limited in the future.

6b) Most candidates correctly answered this question. A common mistake was to focus on actions such as 'have showers instead of baths' without explaining how this could be encouraged by governments.

6c) Responses to this question varied widely. A common error was to only provide generic technocentic and ecocentric viewpoints without linking this directly to the dam.

Recommendations and guidance for the teaching of future candidates

Students should be encouraged to:

- Read the exam question carefully and ensure they address the specific command term and actual question being asked. For example, many students added arrows to the nitrogen cycle but did not name the processes (as required by the question); students did not label axis on the graph; students often gave responses that 'stated' rather than 'described' as requested.

- Attempt all components of the exam questions and not leave any blank responses.

- Ensure all aspects of the syllabus are covered and appreciate the inter-connections between each ESS topic.

- Practice past question papers and other questions that involve application of knowledge and understanding to different situations, including working with graphs (including using a ruler to draw straight lines) and mathematical calculations.

- In addition, students should ensure they are familiar with the key terms and concepts listed within the glossary of the ESS Guide.

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 7	8 - 14	15 - 23	24 - 31	32 - 40	41 - 48	49 - 65

General comments

12 schools completed the online G2 form; 9 in English and 3 in Spanish. This is a decline from previous years. All the schools found the paper had a suitable level of difficulty. 10 schools found the exam of a similar standard to last year, one indicated it was a little easier and one a little more difficult. All found the clarity of wording and the presentation satisfactory or good.

Few comments on the G2 forms indicated syllabus coverage issues; one mentioned that the paper "covered the breadth of the course". One comment found the photo used in Figure 6b was unclear, this was accepted by the team, but the general information in the image could still be seen. Mention was made of the font, and IB has changed the fonts for exam papers from May 2015. One comment mentioned the wording of the parts of the essays as being

ambiguous, 5b, or a restrictive question, 2c, the students did not find either of these questions difficult to answer.

The lack of comments, or G2 responses, can be viewed in a positive light and the assumption is made that the teachers and students found the exam paper accessible and the questions asked to be suitable.

In the essay section question 2 was the most popular, closely followed by question 4, then 3 and question 5 was the least popular.

The standardizing team considered how the candidates answered questions as the final markscheme was prepared. When students approached questions in a different way from the original exam writers expected interpretation then the markscheme is reviewed. Generally both the original interpretation and the post-exam interpretation are included, as long as the concepts are correct.

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

In Section A some candidates gave one sentence answers for two or three mark questions, usually meaning only one mark was awarded. The questions which required application of syllabus content, rather than information from the resource booklet directly, gave the most difficulty. A significant minority of candidates just quoted from the resource booklet, rather than answering the question asked.

The questions linking the case study to biodiversity, acid deposition and global warming proved to be harder for the candidates.

Students found it challenging to have to use the concepts in relation to the case study rather than to just define the term. This led to definitions being given in the boxes before the actual question was attempted.

In Section B some students are still trying to incorporate the three parts of the essay into a continuous prose. This can mean they focus mainly on one part only, not always the part with the most marks available. Very few candidates gave no response to parts of questions.

The essays often repeat points and use weak, vague examples to support the topics. Often the example used wandered off from the question asked. Here the student was just writing all the information they knew about the example or topic without referring back to the question. Application of concepts and examples to a specific question indicates the holistic aspects of the course are lacking.

Question 5c which combined parts of the syllabus, global warming and biomes, proved to be problematic for the candidates. They found the linkage hard to grasp and providing answers using contrasting value systems almost impossible, only the really strong candidates managed to be successful with this. This was the least popular essay done.

Evaluate and discuss are the command terms that are most often misunderstood. All the part Cs had discuss and only strong candidates gave the balancing/arguments and a conclusion. Assessment objective 4 stresses the need to make reasoned and balanced judgments using appropriate economic, historical, cultural, socio-political and scientific sources. Only the very best candidates were able to demonstrate this balance.

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

Most candidates completed the paper answering all the parts of section A and two essays in section B. The candidates seemed to generally have enough time to complete the paper. The resource booklet did not seem to cause problems with accessing information. They were able to extract the required details from the resource booklet when asked in specific questions. The calculations and graph reading was completed accurately by most candidates. Not many students required extra paper, indicating that the space provided was adequate.

The handwriting was generally clear this session, most students used a dark enough pen (it should be blue or black) and so the computer image was clear.

The drawing of diagrams in the essays was better than in previous sessions. The required diagram for 4b was well drawn and detailed enough with strong candidates.

The essays were asking for the use of case studies and application of environmental value systems. Generally the students had solid case studies and knew and could apply the value systems.

The concepts of development policies, energy transfer, endangered species and eutrophication policies were seen to be grasped by the candidates.

The use of examples was more prevalent this session, even when the question did not specially ask for an example. There is still a need for more detail to be given in the examples used.

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

Section A

Question 1

   a) i) Only a very small minority gave an incorrect answer here. Most candidates mentioned endemic species or the mangroves.

   ii) Again the majority found this question straightforward to answer. The production of oil/fossil fuels or palm oil were the main answers

iii) Weaker candidates gave more incorrect answers here, mentioning the endemic species or a physical aspect of the delta.

b) The majority of students gained marks for the narrow top and wide base features. However a significant number were too vague for the shape of the pyramid, often just repeating the previous points made. Weaker candidates left the last box blank.

c) The candidates generally had no problems with calculating the % of the population living on the delta, 14%. A range of answers were accepted.

d) i) Most candidates gave the correct answer, $750 from reading the graph. A few were outside the range of acceptable answers. Some weaker candidates did leave this question blank.

   ii) The positive correlation was identified easily by strong candidates. Weaker candidates usually described the graph rather than stating a relationship.

e) The candidates found this question difficult to answer. Most managed points from mentioning the climatic factors of the tropics and then some gained a second point from the conditions allowing many endemic species. However the "BOD – benefit of doubt" annotation was also used in many scripts.

f) This question was a clear discriminator question, which needed the candidates to apply their knowledge of the course to the case study. The strong candidates managed this well and the weaker candidates generally receive 1 or 0 points. It was unfortunate to note that many answers gave CO_2 as the gas causing acid deposition.

g) This question really challenged the candidates. Both strong and weaker candidates gave good and poor answers. Generally candidates failed to link a specific aspect of the delta and the people to global warming impacts. So the answers were too vague/general and often only on one point, repeated.

h) i) The candidates found this question straightforward as they could use the information directly from the resource booklet to answer. Finding three reasons was harder for weaker candidates.

i) Again the resource booklet provided a number of direct answers for this question. However the candidates did need to link these answers to the level of difficulty. Gaining full marks for this question was rare. Many candidates ended up repeating themselves.

j) Most candidates gained one mark for this question. Stating two clear suggestions for the message proved hard for weaker candidates.

Section B

Question 2

a) Generally the candidates showed that the concepts of positive and negative feedback

have been understood. Most made a reasonable to very good attempt at using examples to illustrate the feedbacks. Only a few candidates gave non-ecological examples. Weak answers showed glimpses of understanding and too vague was the annotation often used. Some candidates did confuse the two types of feedback.

b) Naming three development policies was not a problem for the majority of candidates. The stronger candidates gave detailed explanations of how these policies lead to population stabilization over time. Weaker candidates sometimes gave explanations but without the link back to the population stabilization.

c) The candidates struggled with the discussion aspect of the question. Most candidates took a stand for or against being vegetarian. However keeping to the question asked proved more difficult to do. Many candidates diverted to farming practices and how those impact the environment. Most of these environmental issues apply whether crops or livestock are being raised, so not addressing the question. Only the strongest candidates managed to balance the answer to mention the positives/negative of being a vegetarian and being a meat-eater. Simplistic conclusions about vegetarians or meat-eating being healthier for a person were common.

Question 3

a) The majority of candidates were able to distinguish one to two points between the pyramids. A few confused the pyramids or mentioned a pyramid of biomass rather than productivity. A significant number wrote that a pyramid of productivity is never inverted, which is untrue.

b) Many candidates started the answer with a detailed description of eutrophication, which did not gain marks. The candidates mainly managed to give three clear strategies, however the weakest part was explaining how these strategies reduce eutrophication. Often the candidates gave confusing or vague answers. The answers to this question often illustrated how the candidates see the content in the question and then write an answer about that. So not answering the question asked at all.

c) Many candidates gave very vague examples of food production systems, thus limiting the marks they could receive. The other area of concern with this question was candidates only writing about the environmental impacts of the two systems. The counter arguments and balancing factors were only really attempted by the strongest candidates.

Question 4

a) Most candidates gave a reasonable description of natural selection and isolation. This indicates good progress as natural selection questions in the past have been poorly answered. Gaining full marks for this question was generally the stronger candidates.

b) The candidates all made an attempt at the required diagram, indicating they read the question carefully. Most gained one mark, for the sun and heat; however a significant

majority did not include decomposers and so did not gain the second mark. This question was well answered and even very weak candidates wrote enough to gain a few points. Some answers were very eloquent and indicate the candidates have a strong grasp of energy transfer.

c)   Nearly all candidates named an appropriate endangered species, mostly animals but some plants. The answers all included both parts of the question, why endangered and why it should be conserved. The stronger answers made sure to include a range of reasons for each. Some weaker candidates gave generic answers about the species being important for the ecosystem, but no details. The conclusion mark was difficult for most candidates.

Question 5 Few candidates attempted this question.

a)   The candidates could clearly show the difference between fossil extinctions and historic ones using time. Most gained at least two marks here. Getting the other two marks was dependent on how much more they wrote. If they continued writing many gave examples for each extinction period or gave the reasons for the extinctions.

b)   The question was poorly answered by most candidates. Most did give a definition for a model but linking the strengths and weaknesses to predicting climate change was more difficult. A few candidates gained full marks but most did not as the answers were too vague, or repeated.

c)   The candidates really struggled with this question. Very few grasped the idea of naming an effect on the tundra and then stating how contrasting environmental value systems would respond. The most common response was to define the tundra but then ignore specific effects on the tundra and name generic effects. Candidates were stronger on how ecocentrics would respond than technocentrics. Many technocentric answers indicated a lack of understanding about the value system, with comments about destroying the environment being part of this value system.

Recommendations and guidance for the teaching of future candidates

The following is a summary of the advice for teaching future candidates:

•   Review the meanings of command terms so students know what is required in each question, especially for level 3 command terms.

•   Encourage students to make annotated diagrams large and clear if they are using them.

•   Make sure students pay attention to the "point value" for each question to gauge how many different and distinct statements they need to address to earn full marks. Encourage candidates to give clear, diverse and discreet marking points, rather than

a single vague, limited, and repetitive discourse.

- Encourage students to break up their answers into the relevant sub sections to make it easier for the examiner to identify which part of the question they are answering. The answers are not expected to be one long essay.

- Ensure sufficient time is dedicated to the teaching of the systems and values elements of the course. To enable the holistic nature of the course to be recognized and used in the answers.

- Reinforce the importance of learning key definitions and terminology.

- Clarify how expression of ideas marks are allocated and perhaps use them in your own marking so students get used to developing their answers, including examples and structuring their ideas.

- Candidates should be encouraged to write within the space provided within the exam paper.

- Please encourage students to print specific examples as these are often hard to interpret when the handwriting is bad.

- Detailed examples are needed for all areas of the syllabus. Local ecosystems should be used and then the inter-relationships can be explicitly noted.

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