CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

MAY/JUNE 2014

ENVIRONMENTAL SCIENCE

GENERAL COMMENTS

In Unit 1, overall performance was comparable with that of 2013. Ninety-five per cent of candidates achieved Grades I–V. In terms of module performance, candidates performed similarly on all three modules: Module 1 (Fundamental Ecological Principles); Module 2 (Human Population and the Environment) and Module 3 (Sustainable Use of Natural Resources).

In Unit 2, 97 per cent of candidates achieved Grades I–V compared with 94 per cent in 2013. Candidates performed best on Module 1 (Agriculture and the Environment) followed by Module 2 (Energy and the Environment) and then Module 3 (Pollution and the Environment).

DETAILED COMMENTS

UNIT 1

Paper 01 – Multiple Choice

Paper 01 consisted of 45 multiple-choice items, 15 from each module. Candidate performance on this paper was very good.

Paper 02 – Essay Questions

Overall, candidates' performance was similar for all three modules.

Module 1: Fundamental Ecological Principles

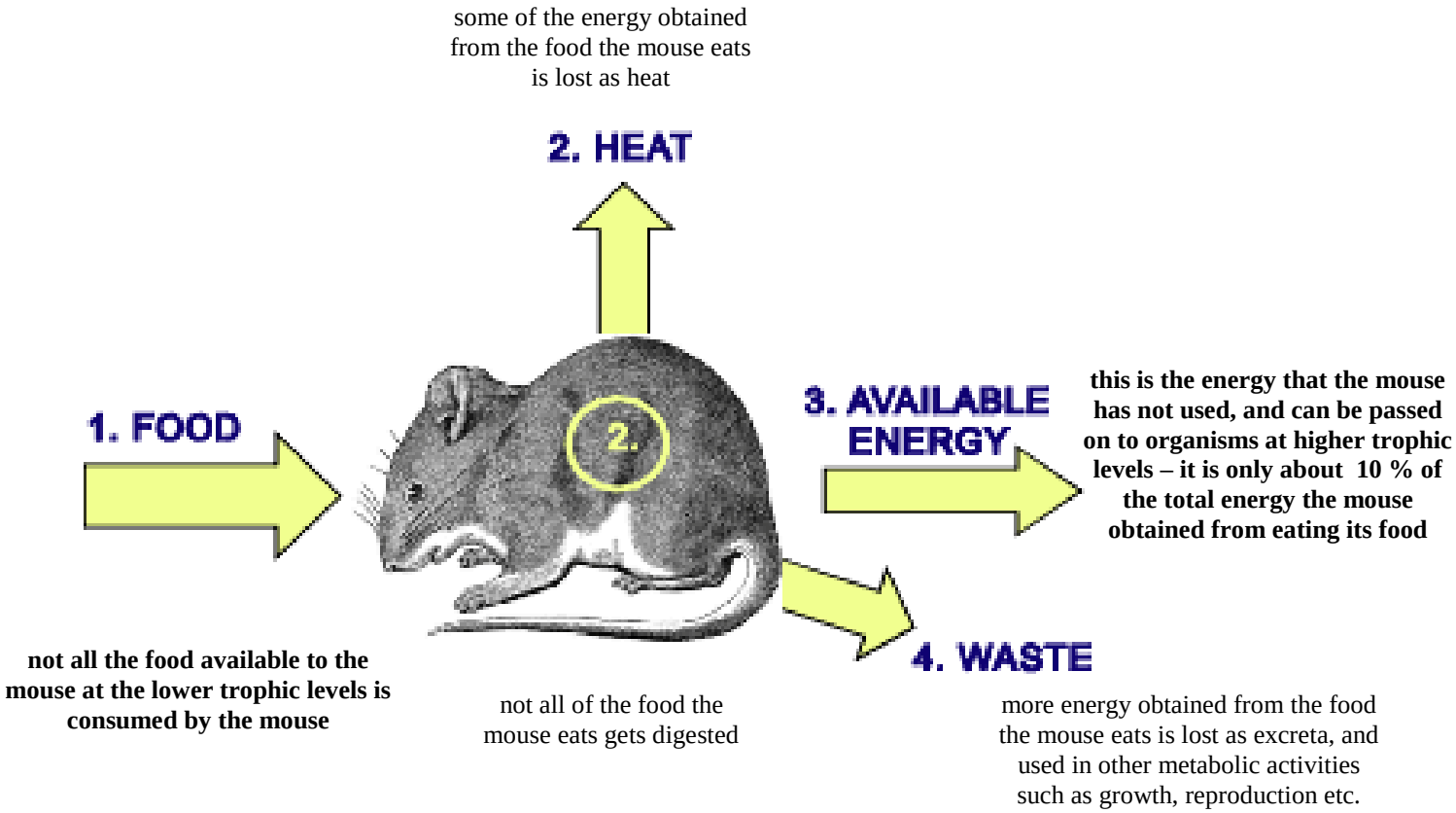
Question 1

This question was based on energy flow through ecosystems, the concept of carrying capacity, and the use of the capture-recapture technique.

In Part (a), candidates were presented with a diagram which depicted the trophic levels in a terrestrial ecosystem, and the amount of energy each level contained. The value for one of the trophic levels was not included in the diagram.

For Part (a) (i), candidates were required to calculate the amount of energy represented by the missing value. While the majority of candidates arrived at the correct value of 3,000 kilocalories, many ignored the instruction to calculate, and the fact that this part was worth two marks. As a result, many candidates lost the second mark available for the question. This is a clear example of where candidates should have taken cognisance of both the term used to introduce a question, and the amount of marks awarded for that question. These would have guided the candidate to produce both the required calculation and the answer for the maximum marks.

Part (a) (ii) required candidates to explain the pattern of energy flow through the trophic levels. This section was poorly done, and it is of great concern that this fundamental principle of ecosystem dynamics continues to pose a challenge to candidates. Candidates were required to identify the rationale behind the 'ten-percent rule'. The diagram below can be used by teachers to explain the pattern of energy flow in an ecosystem to their students.



Part (b) (i) required candidates to define the term *carrying capacity*. This part was poorly done.

Part (b) (ii) required candidates to explain why the concept of carrying capacity is important to maintaining the balance of an ecosystem. Again, this part was poorly done, and therefore this is a concept which needs to be highlighted to students in the future.

Part (c) required candidates to explain why phosphorous is a limiting factor in terrestrial ecosystems. This required candidates to identify features of the phosphorous cycle — its sedimentary nature, lack of a non-gaseous phase etc. — and relate these to the concept of limiting factors. However, this was not well explained by the majority of candidates, with many either choosing to discuss what was meant by a limiting factor, or why phosphorous affected terrestrial and aquatic ecosystems (heavy use in agriculture, runoff, eutrophication etc.).

Part (d) (i) required students to identify a suitable formula to calculate the estimated size of a population of deer using the capture-recapture method. This part presented problems since the logistics of the method were clearly unfamiliar to many candidates, and they were unable to offer a suitable formula. Many almost 'automatically' used the formula for species diversity – which has been widely examined over the years. A suitable formula is

$$N = \frac{MC}{R}$$

where

N = *estimate of total population size*
M = *total number of deer captured and marked on the first visit*
C = *total number of deer captured on the second visit*
R = *the number of deer captured on the first visit that were then recaptured in the second visit*

However, other suitable formulas were also credited.

Candidates' unfamiliarity with the capture-recapture method further persisted into Part (d) (ii) of the question. This part required candidates to identify assumptions of the capture-recapture method but many candidates offered limitations of the method instead. In science, all tests involve making assumptions which enable scientists to prove or disprove their hypotheses. Assumptions may be justified by past tests performed by other scientists, or are unknown, in which case the scientist can test independently to help establish their accuracy. The assumptions in the capture-recapture method are an example of the former.

Candidates' performance on this question was less than expected. Too many candidates were unable to suitably address Parts (a) and (d) of the question.

Candidates' responses to Part (a) (ii) illustrated that their understanding of the flow of energy in ecosystems is limited and their responses to Parts (c) and (d) indicated that their familiarity with the phosphorus cycle and capture-recapture method was limited.

Overall, performance on this question was less than satisfactory.

Recommendation

- Teachers are reminded that while the phosphorous and sulphur cycles are not as widely addressed in text books, they are on the CAPE Environmental Science syllabus, and students are expected to have a comprehensive knowledge of them.

Question 2

This question tested feeding relationships, species diversity, the concept of *natural selection*, and the effect of human activities on the ecosystem.

Part (a) required candidates to examine a graph of the predator-prey relationship, perform a calculation and derive trends.

In Part (a) (i), candidates were asked to explain the relationship between predator and prey as shown on the graph. This section was poorly done since most candidates explained the trend of the predator separate from that of the prey, and failed to illustrate the relationship between the two populations. In fact, the majority of candidates sought to give a descriptive account of the graph by detailing what occurred on every point on the graph, instead of giving an analytical overview of the trend.

In Part (a) (ii), candidates were expected to read off the correct values from the graph, and then calculate the change in size of the predator population between months 2 and 7. This part was adequately done.

Part (b) of the question required candidates to explain the importance of natural selection in the evolution of a species. This part was not well done, and it was clear that candidates could not distinguish between natural selection, adaptation and evolution. An example of a correct response is:

> *Natural selection acts on pre-existing genes, when selective pressures occur and favour advantageous genes in the population. This leads to the survival of the individuals in the population with these genes – the so called "survival of the fittest". Individuals with these favourable genes survive and reproduce successfully, and these genes are passed on to successive generations. Over time, it is the organisms with these favourable genes that survive and dominate in the population.*

Part (c) required candidates to explain ways in which human activities can disrupt the integrity of natural ecosystems. This part was widely known and well done by the majority of candidates.

Part (d) (i) required candidates to interpret a graph, identify and derive values, and undertake two calculations.

In Part (d) (i), candidates were required to calculate the total number of individuals in the two least collected species. This part was adequately done by the majority of candidates.

Part (d) (ii) tested candidates' ability to calculate species diversity by utilizing an appropriate formula. This part was widely known, and candidates were able to reproduce and correctly substitute the values into the formula.

Candidates' performance on this question was good.

Recommendation

- Teachers are asked to ensure that students are aware of the correct formulas for the full gamut of concepts in the CAPE Environmental Science syllabus, and understand how to derive data, perform calculations and interpret the results.

Module 2: People and the Environment

<u>Question 3</u>

This question tested the concept of the human development index (HDI), per capita freshwater consumption and the role of women in sustainable development. In Part (a), candidates were presented with a diagram of factors used in calculating the HDI for two countries – A and B.

Part (a) (i) required candidates to define the term *human development index* (HDI). Candidates performed poorly on this part; the majority could not adequately define the term.

Instead, they stated that it consisted of health, education and life expectancy factors. This was obviously based on a transcription of the factors presented in the table, and as a result did not adequately define the concept. A correct response is:

> *HDI is a composite statistic of life expectancy, education, and income indices used to rank countries into four tiers of human development – very high, high, medium and low. It implies whether a country is developed, still developing, or underdeveloped.*

In Part (a) (ii), candidates were required to make four deductions from the data presented in the table. While the majority of candidates attempted the question, most of the deductions were a description of the values in the table (for example, the life expectancy in country A is higher than that in B), rather than solid inferences based on the data (for example, Country A has a higher life expectancy than Country B, and is therefore likely to be a developed country, because there is better healthcare and other facilities). Some candidates chose to utilize inverse deductions to make up two deductions (for example, Country A has a higher life expectancy than Country B and Country B has a lower life expectancy than Country A. In these cases, only one deduction was credited, since the stimulus provided enough material to make four distinct deductions.

For Part (b), candidates were presented with the statement "Educating women is a critical approach that can be used by countries for achieving sustainable development" and asked to evaluate it. Many candidates chose to highlight the relationship between the education of women and fertility rates but failed to relate this to achieving the goal of sustainable development. Some candidates in their evaluation disagreed with the statement, and once the rationale was plausible, they were accredited accordingly.

In Part (c), candidates were presented with a graph illustrating the per capita freshwater consumption over a period for a country. For Part (c) (i), candidates were asked to define *per capita freshwater consumption*. Most candidates failed to provide an adequate definition.

For Part (c) (ii), candidates were asked to calculate the rate of per capita freshwater consumption for the period 2000 to 2003. Most candidates were able to read off the values and perform the necessary calculation.

Part (c) (iii) required candidates to offer a plausible reason for the trend shown in the graph. The majority of candidates were able to proffer a reason, but many were confusing freshwater *water* consumption with freshwater *fish* consumption. This probably goes back to the overall lack of understanding of the term *per capita freshwater consumption*.

When asked in Part (d) (iv) to describe two possible environmental impacts of the trend in consumption shown in the graph, many candidates were unable to do so. Many identified the effects on freshwater resources from other activities such as pollution which would make freshwater scarce, rather than the effects of increased *use* of freshwater on the freshwater resource.

Overall performance on this question was satisfactory.

Recommendation

- Students should be encouraged to define terms and concepts clearly.

Question 4

This question dealt with the demographic features of infant mortality and annual population growth rate.

Part (a) presented information in tabular form on the infant mortality rate of two countries — Country A and Country B. Candidates were asked in (a) (i) to define the term *infant mortality*. Most candidates were unable to do so.

Part (a) (ii) required candidates to utilize the data in the table to determine which country would have a faster growing population. Critical to answering this question was the reason which was proffered by the candidate since, depending on the application of their knowledge of demographic factors, a case could be made for either Country A or Country B.

- *Country A because it has a lower infant mortality rate – therefore infants have a higher chance of surviving to maturity and contribute to population growth*.

- *Country B because it has a higher infant mortality rate, therefore people will have more children in the hope that some survive to maturity. This is symptomatic of most developing countries*.

For Part (a) (iii), candidates were asked to identify and give reasons for which of the two countries, A or B was a developing country. This question was fairly well done, with the majority of candidates identifying B as most likely a developing country. Many candidates however, lost the second mark available for the question by not providing a reason for their answer. Again, it is underscored that when candidates fail to follow instructions, it is difficult for them to be rewarded for responses that are presented.

It was noted that in Parts (a) (ii) and (a) (iii), candidates were confusing the terms *developing* and *developed* country, thus completely misinterpreting the question.

Part (b) was based on demographic data presented for a country, from which candidates were asked to make certain calculations and deductions. One of the slots in the table was left blank. In Part (b) (i), candidates were required to define the term *annual population growth rate*. Most candidates were unable to do so. Part (b) (ii) required candidates to use the data provided in the table to calculate the annual population growth rate for the year 1990. This calculation would complete the table. The majority of candidates was able to satisfactorily perform this calculation.

Part (b) (iii) required candidates to calculate the doubling time for the country based on the statistics in 2010. Again, the majority of candidates was able to identify the correct formula for doubling time, and substitute the correct data to perform the calculation.

In Part (b) (iv), candidates were asked to state the trend in annual population growth rate, and describe an implication for the country. Most candidates were able to correctly identify the trend but failed to make the link of the implication of the trend.

In Part (c), candidates were asked to discuss two impacts of increasing population growth on a less developed country. The responses by candidates illustrated that many have a general idea of the impact of increasing population growth, but were unable to clearly identify these impacts before discussing the consequences. This would have affected a candidate's ability to score the maximum three marks which were available for each impact. A satisfactory answer is as follows:

> *Ecosystem degradation and species loss (**1**): as the population of a country increases, it may become difficult for countries to provide for increasing populations (**1**). This often leads to a greater need for resources, which may promote greater resource exploitation in an effort to meet the growing needs of the population – often resulting in ecosystem degradation and species loss (**1**).*

Recommendations

- The examining committee has observed a disturbing trend by some of the candidates in attempting this question. Some utilized information from Question 3 in their responses to the question, presumably because that question also featured a Country A and Country B. The committee recommends that students be advised that unless otherwise stated, information from one question is not to be used in another question. The conclusion of a question is clearly outlined by the statement.

- Students should be reminded of the need to include the correct units when required by the answers, for example, in this question, 87.5 or 88 years.

- The skill of deduction–induction is identified as a skill which needs to be improved on by students.

Module 3: Sustainable Use of Natural Resources

<u>Question 5</u>

This question addressed concepts underlying natural resource conservation, techniques used by the indigenous peoples of the Caribbean in natural resource conservation, and methods used in natural resource conservation – including land use planning and zoning, recycling and sustainable yield management.

Part (a) of the question required candidates to identify one ethical and two ecological reasons for natural resource conservation. Most candidates were able to identify ecological reasons but many had difficulty identifying an ethical reason. Examples of ethical reasons as identified in Syllabus Objective 3.9 include:

- sacredness
- right to exist
- spiritual values
- cultural values
- conserving for future generations (inter-generational equity)

In Part (b), candidates were asked to explain why 'slash-and-burn agriculture' as practised by the indigenous peoples of the Caribbean is considered a sustainable practice. This part of the question was not well answered, and two things were apparent to the examining committee. First, Syllabus Objective 3.12, which is concerned with the ways in which indigenous peoples have used and managed their natural resources, may not have been dealt with comprehensively by teachers and students in their preparation for the examination. Second, many of the candidates who attempted the question did so from the perspective of the Geography syllabus – which deals with why 'slash-and-burn agriculture' is not a sustainable practice in *contemporary* circumstances (for example, land tenure systems).

In Part (c) of this question, candidates were presented with a table outlining the annual mass of solid waste received by a landfill in the Caribbean country. Part (c) (i) required candidates to calculate the total mass of solid waste sent to the landfill from 1998 to 2000. It was observed that a large number of candidates had great difficulty with this simple calculation, which was of great concern to the examining committee. It is also to be noted that many candidates who successfully completed the calculation, omitted to place a unit at the end of their answers.

In Part (c) (ii), candidates were required to estimate the annual mass of solid waste that was sent to the landfill in the year 2005. Candidates' performance on this question was less than satisfactory. Many candidates had great difficulty with this simple calculation.

In Part (c) (iii), candidates were asked to state the trend highlighted in the table, and to explain how a recycling scheme might help the problem. The majority of candidates was able to identify that the general trend was that the amount of waste was increasing annually, but many failed to adequately explain how a recycling scheme could help the problem. This is an example of candidates failing to translate lower order cognitive skills (such as definitions, identifications, illustrations and inferences) into the higher order cognitive skills (compare and contrast, explanations and applications) which entail application and analysis.

Part (d) (i) required candidates to explain how natural resource conservation can be accomplished either by land use planning and zoning regulations or sustainable yield management. This part of the question was widely attempted by most candidates, but it was evident to the examining committee that Syllabus Objective 3.10 (v) — concerned with land use planning and zoning regulations, integrated development planning and integrated coastal zone management as measures and tools available for natural resource management and conservation — may not have been dealt with comprehensively by teachers or candidates in their preparation for the examination. This deficiency needs to be urgently addressed given the importance of these tools to many aspects of environmental and natural resource conservation and management.

Part (d) (ii) was unquestionably the best performing part of this question, with the majority of candidates successfully identifying three systems that governments could use to effectively achieve natural resource conservation in Caribbean countries. It is heartening that most of the measures and tools available for natural resource management and conservation under Syllabus Objective 3.10 are known to candidates.

Candidates' performance on this question was satisfactory.

Recommendations

- It should be noted that Syllabus Objective 3.12 is meant to address how agricultural, forestry and fishery practices as *traditionally* practised by the indigenous peoples of the Caribbean were sustainable ways in managing and using natural resources. This objective needs to be taught and stressed from this perspective, and it is suggested that the use of case studies would an excellent method of consolidating the objective.

- It should be noted that correct units are required for a complete answer, and for a candidate to earn the maximum marks available for the question.
  176,900 + 172,300 + 196,000 = 545,200 (1) **<u>tonnes</u>** (1)

- It may be concluded that students demonstrated limited skills at manipulating data and performing calculations. This is another area of skill development that should be focused on during classroom sessions. Candidates need to pay greater attention to their basic mathematical skills and on how to execute mathematical calculations using data from tables or graphs.

- Teachers need to ensure that they cover the full gamut of measures and tools identified under Syllabus Objective 3.10 in preparing students for the examination. The use of case studies would be an excellent method of consolidating this objective.

<u>Question 6</u>

This question addresses the categorization, management and location of natural resources in the Caribbean region.

Part (a) required candidates to outline why fertile soil could be described as both a 'renewable' and an 'exhaustible' resource. While most candidates had difficulty distinguishing between 'renewable' and 'exhaustible' resources, the majority could explain why fertile soil could be considered a renewable resource. These are two fundamental concepts of natural resource use, management and conservation, and need to be clearly understood by candidates:

> *A renewable resource is one which can be extracted and utilized, but if given enough time it can replenish itself, for example, trees. However, if the rate at which the renewable resource is consumed exceeds its renewal rate, renewal and sustainability will not be ensured.*
>
> *An exhaustible resource is one that can be used up, because its quantities are effectively fixed, and cannot be increased by the natural forces of the environment.*
>
> *Accordingly, fertile soil can be classed as renewable because its fertility will be replenished quickly through natural processes, but it can be exhausted if the soil fertility is used up faster than it is renewed.*

Part (b) also presented significant challenges to candidates. Candidates were required to state one 'consumptive' use and two 'non-consumptive' uses of natural resources. While the overall responses were an improvement on preceding years, there is still ample evidence that candidates were not completely familiar with the meaning of these terms. This could be seen by the examples posited by candidates. A correct response to this part is

> *A consumptive use of natural resource is one where the quantity and quality of the resource is depleted in its use. Examples include:*
>
> - *logging*
> - *fishing*
> - *quarrying*
> - *mining*
>
> *A non-consumptive use of a natural resource is one where the use of the resource does not deplete its quality or quantity. Examples include:*
>
> - *ecotourism activities such as whale-watching, canopy walkways and zip-lining;*
> - *bioprospecting and*
> - *research*

Part (c) of this question was based on a graph which compared the average net primary productivity of various types of aquatic and terrestrial ecosystems.

In Part (c) (i), candidates were asked to calculate the total net primary productivity that could be achieved from the tropical rainforest and savannah ecosystems. Most candidates were able to successfully perform this calculation, but many misread the calibration on the graph and lost one of the available marks.

In Part (c) (ii), candidates were required to identify the ecosystems with the highest and lowest average net primary productivity. Most candidates were able to provide the correct answer to this section. While the answer required an identification of the specific ecosystems with highest and lowest average net primary productivity, it was also noted by the examining committee that some candidates used the key to the graph, and calculated the total average net primary productivity of the aquatic and terrestrial ecosystems, and then ranked them. This was also accepted by the examining team.

Part (d) (i) was the most popular part of this question. It required candidates to identify three named natural resources present in a named Caribbean country. This question was not as well done as hoped for a variety of reasons:

- candidates used ecosystems from the graph in Part (c);
- candidates used ecosystems which did not match up with the named Caribbean country, for example, Barbados: gold, diamond and bauxite;
- candidates used non-Caribbean countries, for example, Brazil;
- candidates did not specify the Caribbean country, but listed the resources, for example, sea grass beds, coral reefs and mangroves;

All of these would have affected the ability of the candidates to score maximum marks. It was also apparent that both teachers and students needed a wider understanding of the occurrence and distribution of resources in the Caribbean region.

In Part (d) (ii), candidates were asked to discuss two reasons for the importance of each of the natural resources identified in Part (d) (i) above. This part was well attempted by candidates, but most failed to score the maximum available marks because they did not adhere to the requirement in the question that "...each reason may only be used once ...," and often repeated a reason that fell into one cluster under Specific Objective 3.6.

- livelihood (income generating activity);
- foreign exchange earner;
- food security;
- raw material for industrial processes;
- recreation;
- sacred and spiritual value;
- ecosystem value;
- intrinsic value;
- research and teaching;
- physical/structural functions.

Candidates' performance on this question was good.

Recommendations

- Candidates need to pay greater attention to their basic skills at manipulating data and executing calculations from tables or graphs.

- Teachers should provide concrete examples when teaching topics and may supplement text material with case studies so that students have support material, relevant examples, and facts.

- Candidates are reminded to read the instructions to questions carefully.

- The examining committee wishes to underscore to teachers and students that the term *beach* has a very specific meaning within the context of the CAPE Environmental Science syllabus. A beach is used to indicate a landform along the shoreline of an ocean, sea, lake, or river, usually consisting of loose particles, which are often composed of sand, gravel, pebbles, or shells. Colloquial uses of the term (which often include the sea or ocean) will not be accepted.

- Candidates need to be able to differentiate between the terms *coal* and *charcoal*:

    - Coal – a combustible black or brownish-black sedimentary rock categorized as a fossil fuel, and composed primarily of carbon. Coal is used as an energy resource for the production of electricity and/or heat, and also for industrial purposes, such as refining metals.

- Charcoal – a light black residue consisting of carbon, and any remaining ash, obtained by the burning of organic material (animal and vegetation substances) at elevated temperatures in the absence of oxygen (or any halogen). The resulting soft, brittle, lightweight, black, porous material resembles coal. Charcoal production at a sub-industrial level is one of the causes of deforestation of mangrove and other forest ecosystems in the Caribbean and other parts of the world.

Paper 031 – School-Based Assessment (SBA)

Once again there was some improvement in the overall presentation of SBAs for Unit 1. Teachers should be commended for their efforts in guiding students during their SBAs. Teachers are reminded that their guidance is crucial for a successful SBA product, and they should make every effort to ensure that projects conform to the guidelines set out in the syllabus, and contain content within the syllabus. Additionally, teachers are encouraged to network with other teachers doing CAPE Environmental Science within their territories and other territories doing the subject. This will help them to cross-fertilize ideas, share experiences and utilize the network as a resource-sharing and problem-solving mechanism.

There was evidence of some very thorough work on the part of students and also some evidence of effective teacher guidance. This may have contributed to the improvement in the overall standard of the SBAs. It is also heartening to note that there was a substantial number of students who submitted work of a very high standard. The overall quality and content can still be improved by choosing topics that lend themselves to more scientific and investigative activities. In addition, topics should be appropriate to Unit 1. In some cases, students presented projects on unsuitable areas. Although the project itself may be excellent, if the project aim and objectives do not relate to any Environmental Science module, the student's scores would be negatively impacted.

In general, the required criteria for this component were effectively applied. Literature review is still an area of concern in many of the pieces submitted. Too often the literature review is either irrelevant or inadequate. There is an immediate need for students to improve their writing and expression skills. This severely affects the quality of the report and at times is not reflective of the CAPE level.

Still a major concern was the way in which the titles of projects were written. Titles were frequently misleading or ambiguous and written in the form of an objective. The Purpose of the project was also not 'concise'. In addition, some projects did not have clearly stated variables and/or objectives of the research.

Writing and detailing the problem statement was difficult for most students. Too many of them wrote objectives instead of problem statements. Note that the objectives are the specific activities the student will be carrying out, while the problem statement describes the problem that the successful execution of the objectives will solve.

While there was some improvement in the literature review component, there were still many instances when the literature review was merely a listing of the literature without much discussion and relevance to the chosen topic. Students must also pay attention to the format used for citations. Teachers should encourage the utilization of the citation style used for

referencing in the *most recent edition* of the CAPE Environmental Science syllabus.

The Methodology frequently did not describe how the variables and parameters would be measured, observed and recorded. Also, very frequently, students used questionnaires that were not always appropriate and, where appropriate, consisted of questions that were not formulated to yield the information pertaining to the stated objectives.

Some of the SBAs submitted did not demonstrate adequate field investigation and did not demonstrate much creativity and skills in Presentation of Data; often the presentation was limited to a number of graphs of similar type, graphs that were inappropriate, and/or photographs without titles. Students are encouraged to use a variety of formats for presentation of data. Other tools such as sketches, maps and data trends should also be encouraged.

While analyses were fairly adequate in some instances and were based on the data presented, they could have benefited from more variation in techniques (other than percentages).

The Discussion of Findings in some instances lacked depth of interpretation, and very few showed validity and reliability. Often they were not based on actual findings of the particular research but on some generalized information on the topic, perhaps from research on a similar topic or from the literature.

The Conclusion in many instances simply revisited the Purpose and, similar to 'Discussion of Findings', was often based on generalized information on the topic but not the actual findings in the research. It would have been helpful at that point to recall some of the most significant findings.

In a few instances, recommendations were based solely on limitations of the activity. Limitations are not recommendations, and are more appropriately addressed in the methodology.

While the communication of information was generally good, there is still the need for greater improvement in this aspect. There are still too many instances where students demonstrate a very poor standard of writing and communication skills for the CAPE level. It would be helpful if students use the terminology associated with the study of Environmental Science in order to improve the overall quality of the SBAs. Less use of colloquial expressions and general improvement in grammar will also improve the quality of SBAs.

In several instances, the conventional format for references was not applied. Additionally, textbooks and websites were intermixed. In some cases for website references, only the search engine was mentioned. Students should reference website URLs in their entirety. References should be *numbered*, and follow the format which is utilized in the *most recent edition* of the CAPE Environmental Science syllabus.

In summary, some other areas of concern regarding SBAs in Unit 1 are:

- Inappropriate use of questionnaires: If questionnaires are chosen as the data collection method, it must be established that the method is appropriate for the type of study to be undertaken.
- Poorly formulated problem statements.

- In terms of the laboratory exercise, in some instances, the observations were inadequate for the type of study that was undertaken. In some instances, students simply recorded data rather than made recordings of observations.
- The lack of proper planning for and design of the activity.
- Presentation of data: There is still some amount of inappropriate use of graphs and when presented, the information on the graphs was not discussed at all.
- Use of photographs: Better use could be made of photographs. In some instances, photographs were not presented with captions. Oftentimes, the photographs did not relate to the objectives of the study.
- Some studies did not establish a relationship to the environment. This is very important since the subject area of study is environmental science and addresses impacts, issues and solutions relating to environmental relationships and actions and activities.
- Award of marks by teachers: In some instances, teachers were either too lenient or too severe. This was evident in some school submissions where the better students were marked in a lenient manner and the perceived poorer students were marked more severely.

Some areas in which SBAs for Unit 1 may be improved are:

- Each activity of the SBA must relate to at least one specific objective.
- Site visits should include experimental work and a field trip where students can observe a process. For example, a wastewater treatment plant is not a site visit.
- Site visits need to be more specific and parameters chosen for observation must be more amenable to measurement.
- Students must say what they will do at the site in addition to stating what is going on or taking place at the site they will visit.
- The final report for the journal must be informed by the laboratory exercises and the site visits.
- Please note that follow-up activities are intended to indicate what the student will do after each site visit and on the next site visit. It is not intended to be a section for data analysis and conclusions.
- Research titles should be more concise and focused.
- The purpose of the project should be clearly outlined and variables should be clearly defined.
- Greater attention should be paid to the relevance and appropriateness of the literature review. This is more than a list of references; it should summarize the current state of knowledge about the area under investigation. It should also put the current project in context.
- The Methods of Investigation section must provide specific information about how each variable/parameter will be measured. This can include a list of apparatus and essential steps for collection of the data.
- Careful observation should be taken during laboratory and site visits. Observations are not only the numbers, but can include things like weather conditions or specific colour change in a laboratory test. Often, observations of the surroundings at a site can help the student to explain the results they get from that site.
- Data presentation should be emphasized. Diagrams and illustrations need to be more appropriate and well integrated into the text to increase their effectiveness. They should be properly labelled, titled and scaled as appropriate. Diagrams, photographs,

line drawings and tables all must have captions to indicate what is being presented. A very useful technique is to present a summary table of data gathered in the field visits and laboratory exercises. In this way, the researcher can view the data set 'at a glance' and can perhaps glean patterns or essential points. A summary table can be useful in guiding the analysis, and the table itself can be used as an analytical technique.

- Data analysis requires the use of appropriate statistical tools to give improved results. If such tools are used, then this should be specified in the text, for example, the results are presented as the average +/- the standard deviation.
- Discussion of the project findings should represent the student's interpretation of their own results (not results found in a reference), as well as what explanation the student can give for an observation. For example, if the data indicates that there is more of a certain species of plant in one area, the discussion should suggest why that might be so. Research in the literature can also help students to find reasonable explanation for the things they observe in the laboratory or the field.
- Discussion of findings, conclusion and recommendations should be based only on what was presented in the literature review and the data that is collected, presented and analysed. No new material should be introduced at this stage.
- Conclusions must always be included in the project report. They must also be clear, based on the student's own findings, valid, and related to the purpose of the project. It is not simply a restatement of the project objectives.
- Recommendations must be based on the student's own findings and must be fully derived from findings. Recommendations and Limitations are two different things.
- Bibliographic references should be written using a consistent convention. There should be at least four up-to-date references. It is recommended that use be made of the style and format contained in the syllabus when writing bibliographic references.

Paper 032 – Alternative to the School-Based Assessment (SBA)

The number of candidates sitting the Paper 032 in 2014 was smaller than in 2013, but was still considerably higher than historical values. There continues to be minimal improvement in candidates' responses to questions in Paper 032. There is still need for greater improvement in the depth and breadth of coverage with respect to certain areas of the syllabus. Greater effort must be made by candidates to improve their ability to organize, apply and communicate information.

It must be recognized that Paper 032 is an alternate paper for the SBA and as such candidates are required to demonstrate satisfactory understanding and application of practical applications and solutions to environmental problems. This was not evident in most of the candidates' responses.

Overall, candidates did not demonstrate adequate practical abilities and so did not adequately address questions that dealt with practical applications.

Question 1

Candidates were presented with data of the changes in population size over time for a rare and endangered species which was protected by a management and conservation programme. The data was presented in a tabular format.

In Part (a), candidates were required to use the data in the table to construct an appropriate graph. The majority of candidates was able to construct the graph correctly, and most candidates recognized that a bar chart was the most appropriate graph to use. Most candidates therefore scored highly on this part of the question. However, many candidates did not state the scale that they used, nor did they give their graphs titles. A few candidates used overly complicated scales, which was quite unnecessary since the data was easy to manage.

This part was generally well done, with candidates losing marks on the details of the graph, such as title, label and scale of the graph. Candidates should be aware that when asked to plot a graph, marks are generally awarded for:

- an appropriate title
- correct labelling of horizontal axis and vertical axis
- correct labelling of graphs
- use of an appropriate scale on each axis
- plotting all points correctly, and utilizing the dot and circle to identify each point plotted
- drawing a smooth curve through all points.

Part (b) required candidates to utilize the information from the table to describe the trend shown in the data; they were required to include values in their answers. Few candidates did what was required. Many described the trend but failed to mention any values. Again, candidates must recognize that a trend is more than a simple description of the rise and fall in values, but is more of an overall assessment of the changes seen. In this case, candidates had both the tabular data and the graph to use as references, which should have simplified the process of identifying the trend.

In Part (c), candidates were asked to suggest five reasons for the observed trend. Most candidates were able to effectively describe five reasons but many also incorrectly stated that there is no predation in the protected area. Natural ecological activities are carried out in a reserve, including predation, which serves to benefit both the population of the predator and the prey. One of the better responses was as follows:

> *Sufficient resources encouraged the proliferation of the species population resulting in an increase in species population size until the amount of resources become insufficient to sustain the growing population, resulting in a decrease in population number.*

Part (d) required candidates to estimate the carrying capacity of the forest ecosystem. Most candidates got the correct response of 690.

Candidate performance on this question was good.

Question 2

This question was designed to test candidates' understanding and knowledge of the following topics within the module Human Population and the Environment:

- age-sex structure diagrams
- urbanization
- per capita consumption

Part (a) (i) required candidates to define the term *per capita waste generation*. Few candidates were able to satisfactorily provide a definition for this term, with most candidates giving incomplete or incorrect responses, and not understanding the meaning of the term *per capita*.

Part (a) (ii) required candidates to use the data on per capita waste generation presented to calculate the percentage difference in the per capita waste generated between Country A and Country B. This question highlighted some of the difficulties that candidates have with simple mathematical calculations. The answer was a straightforward calculation of the total waste produced, and the difference, which was to be given as a percentage as follows:

Country A = 150 kg of waste
Country B = 750 kg of waste
Total waste produced: 150 + 750 = 900 kg
Difference in waste: 750 - 150 = 600 kg
Percentage difference: 600/900 x100 = 66.7%

Some candidates calculated the percentage for Country A, then Country B, and subtracted the two, which was also acceptable. However, too many candidates were unsure of how to perform this simple calculation.

In Part (a) (iii), candidates were required to use the data in the table to determine which country is most likely to be a developed country. Most candidates were able to correctly identify Country B as the developed country as well as give the required three reasons to justify their answer.

Part (b) showed an age distribution pyramid for Country B for the year 2000. Candidates were required to calculate the percentage of the population in the pre-reproductive age group. Most candidates were able to identify the pre-reproductive age groups as 0–4, 5–9 and 10–14. However, it was apparent that many candidates did not have the requisite tools, especially rulers, to measure accurately from the graph. While the accuracy of the readings was low, most candidates demonstrated a sound knowledge of the process of calculating the response.

In Part (b) (ii), candidates were required to calculate the number of females in the pre-reproductive group. Once candidates had calculated the correct percentage in the previous question, they were able to complete the calculation and find out the number of females based on the total population given in the data. A major problem with many responses was the lack of units.

Part (c) (i) required candidates to identify the trend in population distribution, which was *urbanization*. Many candidates were unable to correctly identify this term as the trend. In the follow-up questions, Part (c) (ii) required candidates to state three features of this distribution, and Part (c) (iii) asked them to suggest four reasons for the trend. These parts of the question were very poorly done, with few candidates answering both (c) (ii) and (iii) correctly. Most discussed the problems of urbanization such as pollution and slums, rather than features which would have included *a move to increasing industrialization*, and *increased population living in the cities and towns*. Since candidates largely did not answer (c) (ii) correctly, they were also unable to effectively answer (c) (iii).

Many candidates had difficulty working with large numbers (millions, billions) and including appropriate units in their responses.

Candidate performance was less than satisfactory.

Question 3

Data was presented in graphical format outlining the impacts arising from the consumptive use of two natural resources in a country and the percentage contribution made by three countries to the total regional production of a specific natural resource.

Part (a) (i) required candidates to define the term *consumptive use of natural resources*. This was generally very poorly done as most candidates seemed not to know what this term meant and confused the term with non-renewable resources.

Part (a) (ii) required the use of information provided to make deductions. Again, the level of deduction was quite low, with most candidates simply quoting trends and figures from the graph, rather than applying that information to their real-life or wider knowledge. Some candidates did not seem to understand the graph itself, and thus made deductions which were totally incorrect. Most of the candidates were able in some way to make the requisite three deductions, albeit limited to the "mineral extraction caused less sedimentation than timber extraction" type of response. Only one or two candidates went beyond to make a substantial deduction about the impact of these activities on the environment. For example, one candidate wrote:

> *Mineral extraction is undoubtedly responsible for the destabilization of many habitats due to the high rate of discharge of chemicals into the environment...*

It must be pointed out that more than one candidate interpreted the phrase 'make deductions using the data' in a strictly mathematical sense, and actually subtracted values from each other, seemingly at random. It is clear that this would not have been the intention of the question, and candidates are reminded of the glossary of terms in the syllabus which explains clearly the meanings of the various terms used in question statements.

Part (a) (iii) required candidates to rank the impacts for timber harvesting in increasing order. Many candidates simply wrote the impacts without providing a system of numbering; others wrote the impacts in decreasing order, despite the words increasing being capitalized in the question.

Part (b) was generally quite poorly done by the majority of candidates. Most simply described the effects of the mechanism and were only able to answer very superficially. There was very little explanation of how the two suggestions given could actually be used for natural resource management. For example, most candidates mentioned fines, legislation and penalties for polluters but did not discuss the need for defining roles and responsibilities of the agencies in natural resource management, nor did they mention the establishment of a legal framework for regional and international cooperation on the issue. Similarly, education was mentioned by many candidates in the context only of teaching people about the environment, rather than discussing the role of education in changing behaviours or consumption patterns or in developing alternative resources.

Part (c) (i) required candidates to state two factors that could affect natural resource management in a country. These are clearly outlined in the syllabus as geographical, economic, political, demographic, and technological factors. Most candidates did not explicitly state them as given above but were able to give appropriate examples of the categories, for example, population growth (demographic) and accessibility (geographical).

Part (c) (ii) was less well done. Few candidates were able to effectively discuss how the factors named in (c) (ii) would influence the use of natural resources.

In Part (d) (i), most candidates were able to make four reasonable deductions based on the graph, and in Part (d) (ii), the reasons for these deductions were generally good and valid.

Candidate performance on this question was less than satisfactory.

Recommendations

Candidates must work harder to address the following areas of weakness identified:

- Mathematical ability: Too many candidates were unable to complete simple mathematical calculations.
- Definitions: This area needs to be focused on and covered more thoroughly.
- Making deductions: This is a higher level skill and needs to extend beyond simply reading values from the graphs presented.
- Use of tools: Too many candidates constructed graphs without using a ruler, and were unable to effectively read the data from the graphs provided.

Students are urged to engage in more field and laboratory practical based activities so that they would be in a better position to apply practical knowledge to the questions. Accordingly, liaisons with schools, colleges, centres of learning or universities which have the facilities or do the practical components, should be encouraged and fostered.

Candidates may benefit from greater emphasis on definitions and terminology and the use of appropriate terminology when answering questions.

Candidates should ensure that they provide appropriate units for all numerical responses.

Candidates need to pay greater attention to their basic mathematical skills and on how to execute mathematical calculations using data from tables or graphs.

UNIT 2

Paper 01 – Multiple-choice Questions

Paper 01 consisted of 45 multiple-choice items; 15 items from each module. Candidate performance on this paper was very good.

Paper 02 – Essay Questions

Module 1: Agriculture and the Environment

Question 1

Parts (a) (i) and (ii) were well done by most candidates; most were able to correctly identify three deductions from the data in the graph, and correctly do the calculation.

Parts (a) (iii) and (iv) were also generally well done; most candidates were able to suggest why organic farming and hydroponics are not popular farming techniques and to correctly identify two benefits of organic farming.

Part (b) was moderately done. This question required candidates to explain with two reasons why global warming should be of major concern to agriculture-based economies in the Caribbean. Most candidates could clearly describe the cause and effect of global warming but a significant number failed to connect this to how they affect Caribbean agriculture. The question required more than a description of global warming, and the additional focus on agriculture was often missed.

Part (c) was well done. Most candidates were able to state three reasons why farmers are increasing their use of technology in agriculture.

Candidate performance on this question was very good.

Recommendation

Candidates should present full working to all calculations, even if it appears simple and could be done 'mentally'.

Question 2

Parts (a) (i) and (ii) were generally well done by most candidates. The requirements were for candidates to use information presented in a table to make deductions on the kind of agriculture practised, and then to explain which farm would have a greater impact on the environment. Part (a) (i) posed no problem for the majority of candidates, although some did mix up the farms, misidentifying the commercial farm as subsistence. Part (a) (ii) was also quite well done with most candidates being able to identify which farm had a greater impact, and to explain why. In some cases where the responses required explanation, answers were not in enough depth.

Part (b) was generally not well answered by most candidates. It required an explanation of why the practice of sustainable agriculture would maintain ecological integrity. Many responses were incomplete; candidates gave very good descriptions of sustainable agriculture but failed to make the connections and explain why these practices would lead to ecological integrity. This is a common problem in questions where explanations are required.

Part (c) included a graph illustrating the effectiveness of various pest control methods; candidates had to study the graph and answer questions based on this stimulus material. Part (c) (i) required candidates to determine what percentage of pest was eliminated using the least popular method. Most were able to identify this from the graph, however, some misread the question and instead of providing the *percentage* of the least popular method (15 per cent), they identified which method it was (genetic control). This was a common mistake and was noted in other questions where a graph was used as stimulus material.

Part (c) (ii) was generally answered correctly but Part (c) (iii) was not done as well. This part of the question required the candidate to suggest two reasons why the method identified in Part (c) (ii) (genetic control) may have been the most effective. Many candidates described *features* of genetic control, but did not explain *why* these features would result in more effective pest control. This seems to be a common thread throughout questions that ask for explanations; candidates are to be reminded that an explanation must include a component answering the question *why?* If this is not found in the answer, then what the candidate has written is a description, not an explanation.

Candidate performance on this question was very good.

Recommendations

Candidates are reminded that questions worth more than one mark require more than a simple statement; they will need supporting information in order to get full marks.

Students should be encouraged to read questions carefully.

Module 2: Energy and the Environment

Question 3

Part (a) of this question tested candidates' knowledge of the energy conversions in a process; in this case the conversion of energy from the sun into that of a moving, gasoline-powered vehicle. The responses varied considerably in this question. Many could not identify what the different kinds of energy were, or how they changed from compartment to compartment.

Part (b) on the whole was poorly done. The question provided information about two different types of water heaters, and tested candidates' ability to extract information from a table, and use it to explain issues addressing energy conservation. In Part (b) (i), most candidates were able to correctly identify the natural gas heater as cheaper to operate. Part (b) (ii) was a calculation from data in the table; this caused some difficulty to a number of candidates. There appeared to be problems for candidates identifying what numeric data needed to be pulled from the table, and also what they should do with the data, once pulled.

Generally, Part (b) (iii) was not done well. It required candidates to compare the performance of the water heaters based on economic and energy conservation issues. Many candidates were able to identify the relevant information from the table for each water heater. However, too often the comparisons were very shallow – along the lines of "A is bigger than B" and "B is smaller than A". Given that the question was worth 6 marks, more was expected. The comparison should have gone beyond the simple and direct comparison of the two heaters, and should have given some supporting information, as is required in questions worth a significant number of marks. In addition, candidates should be aware that marks will not be awarded for responses that give "both sides of the coin". In other words, an answer that says "A is bigger than B" and "B is smaller than A" can only get half the marks allotted.

Part (c) was also not well done overall. It contained a graph, and required candidates to use the information to answer questions about petroleum prices.

Part (c) (i) asked candidates to describe the trend in the graph. Too many candidates took this to mean to *describe each and every point* in the graph. Candidates are reminded that a *trend* is an *overall picture*, not a detailed description. As such, in some cases, candidates spent a lot of time going over each bump and dip in the graph, providing a lot of unnecessary information, and wasting precious examination time.

Part (c) (ii) asked candidates to give reasons why technological limitations, geographical restrictions and reliability of supply would explain the trend observed in the graph. On the whole, this part of the question was not done well. There were two main problems. First, many candidates did not appear to understand these three terms — t*echnological limitations, geographical restrictions* and *reliability of supply* — as factors affecting energy prices. The second problem was that even the candidates who did know were not able to link the factors to the trend in the graph. The question clearly stated that the *trend in the graph* must be explained using these factors. There were very few superior answers where candidates were able to use the factors for this purpose.

Candidate performance on this question was less than satisfactory.

Recommendation

More emphasis should be placed on how to extract and use relevant information from tables.

<u>Question 4</u>

Part (a) was based on the conventional generation of electricity from natural gas combustion.

Part (a) (i) required candidates to identify some of the unit processes involved in the conventional generation of electricity while Part (a) (ii) required the discussion of one environmental impact likely to result from the conventional generation of electricity from fossil fuels. Part (a) (i) was generally not well done. Many candidates simply could not identify the unit processes even though this is a common process done in all Caribbean territories.

Part (a) (ii) was fairly well done by most candidates who were able to correctly identify a suitable impact and discuss it reasonably well. It was expected that candidates would provide answers relating to global warming, acid rain or photochemical smog, all of which are direct

consequences of the combustion of fossil fuels which is the main pollution mechanism of electricity production. However, a significant number of candidates seemed unaware of this, and discussed pollution due to the extraction of fossil fuels; although possible, this was a much less suitable answer to the question as stated.

Part (b) required candidates to extract information from a table and use it to answer questions about electricity consumption as well as to discuss the effect of economic cost and government policies on electricity generating demand.

Part (b) (i) was not well done; some candidates were able to rank the countries in the table in decreasing order of per capita electricity consumption. A significant number of candidates were not awarded the mark for this question due to uncertainty as to the order of the items presented in the response.

Part (b) (ii) was not well done. It required candidates to identify the country in the table that had the smallest total electricity consumption. In order to do this, candidates would have had to extract the per capita consumption as well as the population numbers, calculate the total electricity consumption from each country and then identify which country had the smallest value. Many candidates were able to do this correctly but a significant number did not recognize the difference between the per capita value and the total value of electricity consumption.

Part (b) (iii) was not well done by most candidates. Many candidates were able to correctly identify how economic cost would affect electricity generating demand but the effect of government policy was not so clearly identified. The other concern was that the depth of many responses was not enough to achieve the full three marks for each factor. The superior response to this question identified how the factor would affect electricity demand and also provided some supporting information or relevant example to give a well-rounded and complete answer to the question.

Candidate performance on this question was less than satisfactory.

Recommendations

Candidates must be reminded that when a question asks for information to be ranked in descending order, it is understood that the first item would be the largest, and the last item the smallest. If some other order is given in the response, then the candidate must show by an arrow or some other indicator which direction is descending.

Candidates should be reminded that in any question where calculations are required, all working must be shown if full marks are to be awarded.

It is suggested that teachers and students pay more attention to identifying what ‘government policies’ are, as well as how such policies are likely to affect energy use and demand.

Module 3: Pollution of the Environment

Question 5

Part (a) required candidates to match a list of pollutants correctly with their sources. Many candidates were able to do this, however there was a significant number who were not.

For Part (b), candidates were required to use information presented in a table to answer questions.

Part (b) (i) was fairly well done by most candidates. This question was worth three marks; many candidates did not achieve full marks because they did not fully explain the reason for the difference in the nitrate concentration in the ponds. Saying that one is higher and the other is lower is only a *description* of what is happening in the pond; for three marks, the candidate must also provide an *explanation*. This explanation should take into consideration what the factual data is (taken from the table) and then provide some overall conclusion as to why this would result in the observed differences.

Part (b) (ii) was generally well done. Most candidates were able to correctly identify and discuss the most likely impact of the pollution described in the table as eutrophication; marks were lost where candidates left out important details in the discussion of the problem.

Part (b) (iii) was also generally well done; most candidates were able to suggest reasonable measures that could have been taken to reduce the risk of eutrophication in the ponds.

Part (b) (iv) was also generally well done; most candidates were able to provide a reason why they thought their measure would be successful or not.

Part (c) required candidates to answer questions using information presented graphically. Responses to this question highlight the need for more preparation of candidates in the use of graphical information. Many candidates were unable to read the graph correctly, or they misread the question, and provided the wrong information.

Part (c) (i) was fairly well done. Many candidates were able to correctly identify the time taken for the first effects to be seen.

Part (c) (ii) was also fairly well done; for many candidates with incorrect responses in this question, the biggest problem was misreading. The question required candidates to identify *when* the turbidity was at its maximum. A significant number of responses indicated *what the maximum value was*. Candidates need to read questions more carefully to ensure that they answer what is asked.

Part (c) (iii) was poorly done. Candidates were asked to identify from the data presented in the graph if five hours was enough time for the turbidity to return to pre-rainfall levels. Many candidates answered yes, even though a cursory examination of the graph shows that at five hours, the turbidity levels are still significantly higher than they were before the rain started.

Candidate performance on this question was satisfactory.

Recommendations

During class presentations of the various types of pollution, care must be taken to associate the pollutant with the source.

Candidates are reminded to use the mark allocation as a guide for the level of depth expected in the response.

Candidates need to ensure that they have a ruler in the examination room so that they can correctly read data from a graph.

Teachers are encouraged to practice using graphical data in a variety of ways in the classroom.

Question 6

This question tested candidates' understanding in a variety of areas — pollutant fate and transport; pollution by various stages in the acquisition of fossil fuels; issues surrounding the greenhouse effect; and the Kyoto Protocol. Not many candidates attempted this question and those who did were generally unable to complete it. Overall, the question was very poorly done by the majority of candidates.

In Part (a), candidates were required to examine a diagram illustrating the fate and transport of pesticides in the environment, and identify which of the transport arrows were incorrect. This part was fairly well done, with many candidates able to identify the two incorrect arrows.

Part (b) of the question was generally well done; most candidates were able to correctly explain the effect of fossil fuel extraction, transportation or processing on the environment. There was some misunderstanding of some of the terminology – some candidates read "fossil fuel processing" as "fossil fuel combustion", even though the question clearly indicated that combustion was not to be considered. The idea of oil refining and associated pollution was not brought out by candidates who chose to discuss the environmental effect of fossil fuel processing.

Part (c) (i) required candidates to draw an annotated diagram to illustrate the movement of energy in the greenhouse effect; this was generally not well done. There were few superior responses that drew an appropriate diagram and gave correct annotations. From the responses given, there was some difficulty with question terminology; in this case, the idea of an annotated diagram was not well understood. Some candidates drew a diagram but then had all of the text in a paragraph afterwards. Annotation requires that the information be included on the diagram. Also, in their diagrams, a significant number of candidates incorrectly included the ozone layer as being an integral part of (and in some cases responsible for) the greenhouse effect. It is a recurring problem in the Environmental Science examination that candidates continue to mix up the problems of ozone depletion/CFC pollution with global warming/greenhouse effect. In addition, a large number of the incorrect responses were because candidates drew diagrams illustrating how greenhouse gases are formed, not how energy movement can cause the greenhouse effect.

Part (c) (ii) was poorly done. Many candidates could not identify what the Kyoto Protocol was. Those who had some idea often mixed up the Kyoto and Montreal Protocols, describing the Kyoto Protocol as the one that dealt with CFC management.

Part (c) (iii) was also poorly done. Many candidates could not give a reason why the Kyoto Protocol was not successful. The mix-up between the Montreal and Kyoto Protocols impacted candidates' ability to do this correctly.

Part (d) required candidates to use data presented graphically to answer questions. This question was generally not well done.

Part (d) (i) required candidates to determine the annual rate of increase of atmospheric CFC from 1979 to 1989. This question gave problems for a variety of reasons. First, many candidates had difficulty reading the graph properly. Of those who did get the appropriate values for the 1979 and 1989 levels, many did not calculate the rate correctly; most gave the *overall increase* instead of the *rate of increase*.

Part (d) (ii) was generally not done well; it required candidates to determine when the Montreal Protocol first had an effect on CFC levels. There was a wide variety of responses to this question, indicating that many candidates were not familiar enough with using graphical information to make conclusions.

Candidate performance on this question was less than satisfactory.

Recommendations

Candidates are reminded to review the glossary provided in the syllabus so that they are aware of what is required from a question.

Teachers should ensure a good grounding in how international agreements work in general, with specific information about individual protocols (in particular the two most well-known — the Montreal and Kyoto Protocols). In addition, more work on the factors that affect the success of these international agreements is needed.

Students should be reminded that they should have rulers with them in the examination room. Trying to read a graph without a ruler is almost a guarantee for an incorrect reading.

Candidates, teachers and students are reminded to place more emphasis on the higher order skills of data extraction and conclusion making when using graphical data.

Paper 031 – School-Based Assessment (SBA)

In general, the Unit 2 SBAs were fairly well done and most of the students were able to obtain a passable grade. However, the overall quality of the work presented indicated that there are areas which require much improvement. Additionally, there are indications that students are unclear about what is expected of them in certain sections of the SBAs. These areas, which will be mentioned below, should be clarified to enable students to improve the quality of work submitted as well as their grades.

In this regard, teachers should be mindful of the topics on which they choose to conduct SBAs. Some topics do not foster much scientific investigation therefore the scope of the work done will be limited and based merely on observation. In such instances, it is difficult to derive laboratory exercises that are relevant to the topic understudied resulting in sub-standard SBAs. Topics chosen must be appropriate and relevant to the course of study.

Journals

Objectives

The objectives in most cases were relevant to the topic chosen; however, many of these were too ambiguous. It is advised that students use more specific objectives that can be accomplished within the scope of their study.

Activities

Of the ten marks allocated for journals, four marks were given for activities. Students were unable to access the marks for activities because of three reasons: activities did not reflect the work done by the students at the sites; activities were not presented in a clear and logical manner; activities included observations and not the methods used to obtain data for the observation sections of the journals.

Observations

Observations were generally well done and were related to the objectives and activities. Students in some schools recorded numerical data without descriptive comments of their observations at the sites which adversely affected the quality of their observations.

Comments

Comments were usually attempted but did not include very in depth interpretations of the observations. Many of the comments were basically observations of the activities conducted at the sites. This is an area that requires great improvement. Students are required to give interpretations that explain what they observed at the sites and comments that are related to the activities conducted as well as the objectives of the site visits.

Follow-up Activities

The follow-up activities were generally well done but in some instances included recommendations instead of activities that were done as a result of tests or activities completed at the sites.

Laboratory Exercises

Students performed fairly well in the laboratory component of the SBAs, displaying their ability to conduct experiments and present their findings in the standard format. However, there were issues pertaining to the relevance of the laboratory exercises to the topic researched; exercises were often not linked to the topic. In several cases, the quality of work done was adversely affected by the topics chosen.

The major issues encountered with the laboratory exercises were in the areas of observation and analysis as discussed below.

Title and Aim

The titles and aims of the laboratory exercises were of a good quality in most instances; however, at times the aims were too vague and did not link the laboratory exercises to the project or site visits. For example, a title that just says Soil pH does not state which site the soil samples are taken from. A more appropriate title may be Soil pH of the School Garden.

A similar standard should be applied to the aim. Focus must be placed on whether the aim can be achieved by the method intended to carry out the investigation or the experiment. If not, the aim is unachievable and marks allotted for the design of the experiment will be lost.

Materials and Method

The aspect of the journals that dealt with materials and method was generally well done and was effective in achieving the aim of the laboratory exercises. In a few cases, the design of the laboratory exercises were inappropriate since the work done was not suited for the level of the examination. Occasionally, methods were not very descriptive and the work done could not be clearly understood.

Observations and Recording

Many students did not include written or descriptive observations in their laboratory exercises; they were preoccupied with recording numerical data. Students seemed to have ignored the need for observations. For example, if samples were collected to conduct a test on the humus content of a soil sample, a description of the samples collected and probably the site they were collected from is necessary to accompany the results of the test.

Recordings were generally well done. Most of the students' work included recordings but in many instances the data tables did not follow appropriate standards (units were missing or irrelevant for the parameters being measured) and also the titles of the tables were omitted.

Analysis and Interpretation

Invariably, analysis was excluded from laboratory reports; students were unable to use the data collected to produce graphs, charts and other statistical diagrams. Those students who were able to display this skill gained the marks allotted for that section.

Interpretation of the results also displayed students' weaknesses in explaining the results of their investigations and relating them to theories that govern the natural phenomenon being investigated. However, students who attempted a proper interpretation of the results were able to execute it effectively, reflecting proper guidance from their teachers. This is an area that requires more involvement and guidance from teachers, enabling students to do in-depth research instead of regurgitating the data obtained and observations made.

Final Report

The final report was fairly well done but there is room for much improvement. Firstly, it must be made clear that the final report is a summary of the work done in the laboratory exercises and site visits. The final report is not a separate project; whatever is presented in the final report must come directly from the laboratory exercises and site visits. Some students submitted SBAs where the final report was a different project. However, in most of the SBAs reviewed the correct procedure was followed.

Students generally showed understanding of what was required of them in the final report and the work displayed conscientious efforts by the students to present well-structured and detailed final reports.

Below is a summary of the final report and some of the challenges faced by the students.

Problem Statement

The problem statement is an area which needs to be improved; many of these were not specific and did not clearly express the real world problems to be addressed. In some cases, the problem statement was too expansive and not a concise description of the natural phenomenon being investigated.

Purpose of the Project

The purpose of the study was generally well done. Students were able to state the objectives of the journals and methods of the laboratory exercises. However, this section can be improved by including the variables and parameters to be tested. For example, if the students are doing water quality testing, it is necessary to state what parameters are included as a part of the investigation, for example, salinity, BOD, conductivity, turbidity.

Methods of Data Collection

Generally, students were able to express the methods used to collect their data in a proper and logical manner. However, in some cases the methods used to conduct the study were not appropriate for the design of the project and the heavy reliance on questionnaires persists. While questionnaires are effective investigative tools it is necessary to accompany them with other scientific methods to validate the information gained. For example, if students are researching pollution and questionnaires were conducted, it is important to test the quality of the water, air or soil for evidence of the pollutant(s).

Literature Review

This aspect of the final report was greatly misunderstood; students were not clear about how to complete a literature review. Much of the information provided was general information on the topic and not specific to the project being conducted. Teachers should give students examples of literature reviews or conduct exercises on how to do literature reviews as classroom exercises in order to improve their quality. Citations were often not used, and in the cases where they were used, they were not properly done.

Presentation and Analysis of Data

The presentation of data was generally well done except for a few cases where the statistical figures were not appropriate for the data presented. For example, pie charts were used when the data could have been better represented graphically.

Most students attempted an analysis which they could have improved by using a variety of sources. In most cases, students just presented the data from the site visits and laboratory exercises without further analysis. For example, if the turbidity of the water of more than one site was tested, that data could have been combined and presented on one graph as a form of comparison.

Discussion of Findings

Students showed the desire to discuss their findings but unfortunately their discussions were usually more like literature reviews; discussions were not based on the findings of the research, and reliability and validity factors were often absent. Students did not relate their results to the theory that governs the natural phenomenon they were investigating. Validating the findings of the research by linking them to the theory that governs the topic being investigated is another area of the research in which students need much more guidance from teachers.

Conclusion

The conclusions were generally well done except for some cases where they were not linked to the aim and objectives of the research.

Recommendations

The recommendations were mostly done properly except for a few cases where they needed to be more detailed and specific to the project. For example, if the suggestion is that laws must be implemented then students should state what laws should be implemented and what issues the laws are intended to address.

Bibliography

Students need to follow the prescribed format for bibliography and whichever format they chose (APA or AMA) must be consistent throughout the bibliography. Students generally did not show the ability to properly construct a bibliography.

In conclusion, the Unit 2 SBAs reflected some of the challenges students faced from previous years. It is apparent that teachers are unclear about some of the SBA requirements and as a result, they may have incorrectly guided students. This is evident because in many cases similar errors were visible in all the samples submitted by schools and not depicted in only one student's work.

In cases where students were properly guided, the SBAs were very well done and students were able to obtain very good grades.

Some areas in which SBAs for Unit 2 may be improved are:

- Each activity of the SBA must relate to at least one specific objective.
- Site visits need to be more specific and parameters chosen for observation must be more amenable to measurement. Site visits should result in students taking measurements of some kind. Site visits where students simply observe a process (for example, a recycling plant), is not suitable and will not allow them to have much to say in their reports. This will impact negatively on students' marks in the SBA.
- In addition to stating what is going on or taking place at the site they will visit, students must say what they will do at the site.
- The final report for the journal must be informed by the laboratory exercises and the site visits.
- Please note that follow-up activities are intended to indicate what the student will do after each site visit and on the next site visit. It is not intended to be a section for data analysis and conclusions.
- The project's problem statement should be clearly stated. Students should avoid using questions as a problem statement. The problem statement should be specific and concise, highlighting a problem. It is not necessary to include irrelevant information like aim, hypothesis or limitations.
- The purpose of the project should be clearly outlined and variables should be clearly defined in suitable objectives.
- Greater attention should be paid to the relevance and appropriateness of the literature review. This section should provide the background and context for the study. It should provide information about the general understanding of the subject area, and references/citations must be clearly stated. In many cases, references were missing. Students should avoid including lengthy lists of advantages and disadvantages or extensive history background as this is often not necessary and usually results in exceeding the word limit. It is recommended that teachers and students use the referencing system illustrated in the syllabus for guidance, or utilize a standard system, for example, Chicago or American Chemical Society (ACS).
- The laboratory and site visit information cannot be used verbatim as the Data Analysis and Discussion in the final report. Marks cannot be awarded twice for the same information. The information from the laboratories and site visits must be included in the final report, but there should be some additional, more holistic discussion, as the final report should ideally include data from most, if not all of the labs and site visits – the discussion cannot be the same as in each individual activity.
- The discussion of findings, conclusion and recommendations should be based only on what was presented in the literature review and the data that is collected, presented and analysed. No new material should be introduced at this stage. Students need to critically assess the information from both the results and literature review and make

appropriate and relevant inferences. This is where observations can be particularly helpful to explain anomalous results.

- Conclusions must be clear, based on findings, valid, and related to the purpose of the project. Students should avoid simply stating whether or not the project was successful. A highlight of the limitations should not be included in the Conclusions.
- Recommendations must be specific to the student's own study, based on their own findings, as well as be feasible and practical.
- Bibliographic references should be written using a consistent convention. There should be at least four up-to-date references. It is recommended that use be made of the style and format contained in the syllabus when writing bibliographic references.

Paper 032 – Alternative to School-Based Assessment (SBA)

In this paper, there is still room for improvement in the depth and breadth of coverage with respect to certain areas of the syllabus. Greater effort must be made by candidates to improve their ability to organize, apply and communicate information.

Question 1

Candidate performance on this question was generally not good. They were required to demonstrate understanding of organic and traditional farming techniques, as well as the environmental impacts of the same. In addition, the question required the planning and design of a simple experiment to determine which of these two farming techniques would have higher productivity.

In Part (a), candidates had to explain how organic farming would minimize the impact of farming on the environment. This part of the question was fairly well done; responses indicated that many candidates had an understanding of the operations of organic farming, although some candidates restricted their responses to organic fertilizers instead of discussing organic farming as a whole. Most candidates were able to explain the ways in which pollution was reduced due to the absence of agro-chemicals. Some also mentioned the improvements in soil structure due to the addition of organic fertilizers as part of the overall system of organic farming. Some responses were not detailed enough however, and therefore did not receive full marks.

Part (b) required candidates to plan and design an experiment to determine whether organic farming produces less yields than traditional farming. This was generally well done; most candidates were able to demonstrate the ability to plan and design an appropriate experiment and lay out the requisite steps clearly and logically.

In Part (c), candidates were required to list four features of sustainable agriculture. Few were able to list all four; most repeated the same points in different words. Some listed examples of activities which fit into the appropriate category. These features — social equity, ecological integrity, economic viability and adaptability — are listed in the syllabus.

Part (d) was poorly done by most candidates. They were required to state and discuss one threat to sustainable agriculture but few were able to do this effectively. Most were unable to identify the threats as listed in the syllabus and fewer were able to discuss how these would then affect sustainable agriculture. Many candidates wrote about pests and diseases, which

are not major threats. Few candidates were able to relate these threats to Farmer Smith's plan for organic farming.

Candidate performance on this question was less than satisfactory.

Recommendation

Candidates are reminded to use the mark allocation as an indication of the depth or extent of response that is required. A nine-mark question cannot get a one-sentence answer.

Question 2

This question tested candidates' ability to calculate energy use using data in a compound bar graph. In addition, the question required candidates to demonstrate their understanding of energy efficiency. They were also asked about the operation of a nuclear power plant and the reasons for concern with respect to the use of nuclear power. This question was not well done by the majority of candidates.

Performance on Part (a) (i) was very poor. Candidates were unable to give an adequate description of the general operation of a nuclear power plant. Some candidates focused only on the words 'power plant' and talked about the use of fossil fuels to generate electricity. Those who did mention nuclear power clearly did not know much about the process used in a nuclear power plant.

Part (a) (ii) was done slightly better although candidates did not answer in the depth required for six marks. Most candidates were aware of the concerns surrounding the use of nuclear energy but they did not go into sufficient detail in their responses. They mentioned issues such as the cost of operation, as well as concerns about radioactive waste disposal and the possibility of accidents leading to meltdowns and the potential harm to surrounding communities.

Part (b) focused mainly on calculations using the stimulus data provided. Candidates generally were able to respond correctly in this section. However, it must be stressed that calculations attracting more than one mark must show working or the steps that the candidate followed to arrive at the answer in order to gain full credit. Too many candidates simply wrote down the correct response in a three-mark question. Again, the use of units is crucial.

Parts (c) (i) and (ii) were the most poorly done sections of this question. Very few candidates were able to define the terms *kilowatt hour* and *power*. This is very distressing as these terms are fundamental to the discussion of many other topics and concepts in this module. Similarly, only one or two candidates were able to identify the number of joules in one gigajoule. Again, this is fundamental information which was lacking.

In Part (d), most candidates confused energy efficiency with energy conservation and so performed poorly. Very few candidates gained full credit for this question. Only a few mentioned measures such as making buildings more efficient by using natural sunlight, or effective building materials to keep the buildings cooler or warmer as needed. Other candidates incorrectly identified conservation measures such as turning off lights and electrical equipment when not in use, or carpooling.

Candidate performance on this question was less than satisfactory.

Recommendation

Candidates are encouraged to make better use of topical case studies in their preparation for examinations. Only a few candidates actually mentioned the Fukushima plant in Japan as an example.

Question 3

This question was generally well done by most candidates. It tested their ability to determine environmental receptors and the pathways of pollution from a landfill given a sketch map as stimulus; construct a bar chart using data on solid waste; describe environmental impacts from a poorly managed landfill; and demonstrate their understanding of the mitigation measures against pollution from landfills.

Part (a) (i) was poorly done by most candidates; it was clear that many did not fully grasp the idea of an environmental receptor.

Part (a) (ii) was well done on the whole; many candidates were able to identify suitable pathways for pollution to move through the environment. Candidates should note that suitable pathways would have included *overland flow from the landfill as well as through the air*, in addition to *travelling through the groundwater and into the well from the groundwater*.

Part (b) was well done; most candidates were able to construct a suitable bar chart to show the data, although few explicitly stated the scale of the graph. Units are also important, and some candidates did not recognize that the units for the y-axis should have been in thousands of tonnes. Candidates mainly lost marks on the details of the graph, such as title, label and scale. Candidates should be aware that, when asked to plot a graph, marks are generally awarded for:

- an appropriate title
- correct labelling of horizontal axis and vertical axis
- correct labelling of graph
- use of an appropriate scale on each axis
- plotting all points correctly.

Part (c) was fairly well done. Many candidates were able to identify some environmental impacts but were unable to discuss their responses in the detail required. Most responses were limited to a simple identification of the impacts. This suggests that candidates ran out of time and were unable to expand on their responses.

Part (d) (i) was fairly well done. Candidates were required to identify three measures to mitigate landfill pollution and most were able to do so. However, too many spoke of relocating landfills to remote locations, which is not particularly feasible in a Caribbean context. Better responses from candidates focused on waste minimization and recycling as important measures. In comparison, Part (d) (ii) was not well done. Very few candidates were able to give correct responses to the ways of ensuring that the measures identified in (i) are effective in the Caribbean. This suggests a lack of preparation for the practical

application of theory in the Caribbean. Candidates could have mentioned *the need for strong institutional services, strong and impartial enforcement, the provision of trained personnel,* and *acceptance by the public* as responses to this question.

Candidate performance on this question was satisfactory.

Recommendation

More case study material should be studied by candidates in preparation for the examination.