CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION MAY/JUNE 2005

ENVIRONMENTAL SCIENCE

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GENERAL COMMENTS

UNIT I

In Unit I, candidates performed best on Paper 03 but exhibited about the same level of performance on Paper 01 and Paper 02. However, there were still too many candidates achieving less than 50 per cent of the marks available and obtaining unacceptable grades on Paper 03.

While there have been improvements, only a few candidates in their responses demonstrated a high level of knowledge and comprehension as well as organisation and application. The majority of candidates had difficulty distinguishing between and responding to terms such as 'discuss', 'describe' and 'assess'.

There were a number of test items in Paper 01 and Paper 02 on which many candidates performed poorly. Some candidates showed some knowledge but the depth required to answer these questions satisfactorily was lacking.

Candidates performed best in Module 1, followed by Module 2 and Module 3.

Generally, candidates' performance was satisfactory. There is still the need for overall improvement in the depth and breadth of coverage with respect to certain areas of the syllabus. Greater effort must also be made to improve candidates' ability to organise and apply knowledge.

DETAILEDCOMMENTS

UNIT 1

Candidates performed satisfactorily on this paper. Candidates' performance was good on Questions 3, 6, 8, 10 and 11. Overall, candidates performed better in Module 3 than in Module 1 or Module 2. The best performance was on Question 10 and the worst was in Question 5. Overall, candidates struggled with questions that required the application of knowledge.

Module 1: Fundamental Ecological Principles

Question 1

In Part (a) of this question, candidates were required to define specific ecological terms.

In Part (b) candidates were required to define the term 'ecotone' and tested candidates' understanding of the characteristics of ecotones.

While most candidates were able to define 'ecotone', many found it difficult to state the characteristics of ecotones.

Note:

An ecotone

- is a transient zone containing plant and animal species from adjacent ecological regions
- supports many species not found in bordering ecosystems
- contains a greater number of species than surrounding areas

Question 2

This question focused on the concept of competition in ecosystems and also required candidates to be able to determine which of the types of competition was more intense.

Most candidates were able to identify correctly the two types of competition that occur in ecosystems as 'interspecific' and 'intraspecific' competition. However, a few candidates could not identify which was more intense or give reasons why intraspecific competition was the more intense.

Question 3

Part (a) required candidates to use their knowledge of ecological succession to identify the type that was represented in Figure 1. In Part (b), candidates were required to identify pioneer and climax communities from Figure 1.

Most candidates were able to state the type of ecological succession and identify pioneer and climax communities from the information provided.

In Part (c) candidates were expected to describe the role of the pioneer community in ecological succession. Many candidates had difficulty describing this role. Candidates need to recognise that in ecological succession the role of the pioneer community involves the following:

- the pioneer community is the first community to become established in a once barren environment and gradually change their environment;
- lichens capture windblown dirt particles promoting further soil development;
- dead lichens crumble and become part of the soil along with remains of insects and fungi;
- over time, enough soil develops for mosses to take root;

These new conditions allow for a new intermediate community to form.

Question 4

This item tested required knowledge of environmental resistance and how environmental resistance impacted on the rate of population growth.

Candidates had difficulty in stating the meaning of environmental resistance and outlining how environmental resistance may result in a decrease in the rate of growth of a population.

Candidates demonstrated lack of knowledge when attempting Part (b)(ii).

Note:

- Species have reproductive rates that allow them to produce large numbers very quickly given unlimited resources and no limiting factors.
- This maximum reproductive rate is the biotic potential.
- Environmental resistance reduces biotic potential.
- As population size increases, environmental resistance which may manifest itself as lack of adequate food resources decreases the rate of growth of the population.
- As the population approaches the carrying capacity, growth rates approaches zero.

Module 2: People and the Environment

Question 5

This question focused on the candidates' ability to:

Calculate the percentage growth rate of the population.
Calculate the doubling time of the population.
Predict changes in population size .

This question was done poorly by candidates. The responses suggest that candidates did not fully understand how to calculate percentage growth of a population and the doubling time of a population. Consequently the majority of candidates were unable to determine the year when the population size would have been approximately 5,000,000.

Note:

Increase in population size = (births – deaths) + (immigrants – emigrants)

$$Increase = \left(\frac{29}{1000} - \frac{4}{1000}\right) + \left(\frac{2}{1000} - \frac{5}{1000}\right) = \frac{(25 - 3)}{1000} = \frac{22}{1000} = 0.022$$

$$\%\ Increase \text{ in population} = 0.022 \times 100 = 2.2\%$$

$$Doubling\ time = \frac{70}{\%\ \text{increase}} = \frac{70}{2.2} = 31.8 \text{ years}$$

At 5,000,000 the population will be twice the size of what it was in 1990. Hence at the current rate of growth, this would take about 32 yrs.

The year in which the population will be 4,800,000 (approximately 5,000,000) will be 1990 + 32 = 2022

Question 6

This question examined candidates' knowledge of how abiotic factors affect the location of human populations.

Candidates performed well on this question with a mean score of 58 per cent.

Candidates were able to state biotic factors that affect the location of human populations and also outline ways in which each factor affected the location of populations.

Question 7

In Part (a) candidates were required to define 'per capita waste production'.

Part (b) required candidates to suggest three reasons for the difference in the per capita waste production for North America and the Caribbean.

Candidates' performance on this question was below expectation. Most candidates had difficulty in defining 'per capita waste production' and also stating reasons for the difference in 'per capita waste production' for North America and the Caribbean.

Note:

'Per capita waste production' refers to the quantity of waste produced in a country that is attributable to each member of the population.

Question 8

This question examined candidates' understanding of population parameters for developed and developing countries. Part (a) required candidates to complete a Table summarising parameters of various types of country.

In Part (b), candidates were required to outline the relationship between the three population parameters, 'doubling time', 'infant mortality' rate and 'per capita GDP (US$)' for a developing country.

Candidates' performance on this question was good with 56 per cent of candidates scoring over 50 per cent of the total marks available. However, while candidates had good knowledge of the individual population parameters presented, many had difficulty in outlining the relationship between the three population parameters.

Module 3: Sustainable Use of Natural Resources

Question 9

This question focused on types of coastal ecosystems and the relationship between these ecosystems.

In Part (a), candidates were required to identify three types of coastal ecosystems. Candidates performed satisfactorily on this part of the question as most were able to identify the three major coastal ecosystems – coral reefs, mangroves and sea grass beds.

In Part (b), candidates were required to describe one relationship between these three ecosystems. Candidates found this part of the question more challenging than Part (a). Most candidates failed to describe a relationship and so performed poorly on this question.

Question 10

This question examined candidates' understanding of the importance of natural resources in providing employment and foreign exchange. Candidates performed best on this question. Candidates were able to identify a natural resource and establish how the resource provides employment and foreign exchange.

Question 11

This question focused on trends in the use of natural resources and the ways in which these trends impact on the environment.

Overall candidates performed satisfactorily on this question. While most candidates were able to state the trend in timber use over the period shown in the figure, many had difficulty outlining how the stated trend would impact on the environment. Consequently, many candidates were unable to state four steps that could be taken to mitigate the environmental impacts.

Question 12

Part (a) required candidates to define the term 'Protected Areas'.

Part (b) tested candidates' ability to identify two categories of Protected Areas under the International Union for the Conservation of Nature (IUCN) Classification System.

In Part (c), candidates were required to state two reasons why each category chosen should be protected.

Most candidates were unable to define correctly the term 'Protected Area' and seemed unfamiliar with the IUCN categories of Protected Areas. As a result, it was difficult for the majority of candidates to give reasons why the different categories should be protected.

Candidates need to recognise that a Protected Area is "an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources, and managed through legal or other effective means".

UNIT 1

PAPER 02

Candidates performed best in Module 1 where 78 per cent of candidates attempting each of Questions 1, 2 and 3 scored at least 50 per cent of the total marks available. The best performance was on Question 7 where the mean score was 61 per cent of the available marks while the weakest performance was in Question 9, where the mean score was 38 per cent of the available marks.

Module 1: Fundamental Ecological Principles

Question 1

In Part (a), candidates were expected to distinguish between 'carbon sinks' and 'carbon sources'. While most candidates were able to define the two terms correctly, they were unable to state distinguishing features and cite correct examples.

In Parts (b) and Part (c), candidates were required to demonstrate their knowledge of the carbon and phosphorous cycles. Part (b) required candidates to use annotated diagrams to outline the carbon and phosphorous cycles while Part (c) required candidates to identify the major difference and the consequence of this difference between these two cycles.

While most candidates had no difficulty with the carbon cycle many found outlining the phosphorous cycle quite challenging. Candidates also had difficulty identifying the major difference between the carbon and phosphorous cycles and outlining the major consequence of the difference between the two cycles.

Note:

The phosphorous cycle has no atmospheric phase. With no atmospheric phase, phosphorous is transported in aqueous form. Inorganic phosphorous is taken in by producer organisms, incorporated into organic molecules and passed on to consumers. It is returned to the environment by decomposition. This replenishment is very slow. Any phosphorous that is deposited on the ocean bed is usually lost to the cycle.

The performance on this question by most candidates was satisfactory.

Question 2

Parts (a), (b) and (c) of this question tested candidates' understanding of food webs, the roles of organisms at the respective trophic levels and how energy become incorporated in the marine ecosystem outlined in Figure 1. Part (d) assessed candidates understanding of how the community would be altered if the population of a member of a trophic level died out.

In Part (a), most candidates were able to group the organisms in their respective trophic levels and also explain in Part (b) how energy becomes incorporated in the given ecosystem.

Part (c) was not done well by all candidates as many were unable to suggest reasons why only a small percentage of the energy incorporated into the ecosystem was available to the barracuda.

Note:

Energy transfer between trophic levels is inefficient and only ten per cent of the energy is transferred. Not all primary producers (algae) are eaten. Not all that is consumed is digested. At each level, energy is utilised by organisms to maintain their function while some is lost as heat. Some of the organisms at each trophic level may die before they are eaten by predators. As a result as trophic levels are ascended the available energy is reduced significantly.

In Part (d) most candidates were able to identify the effect on the community if the population of sea urchins died out.

Overall performance for this question by candidates was satisfactory.

Question 3

Part (a) of this question required candidates to use specific examples to describe TWO impacts of humans on ecosystems.

Part (b) required candidates to outline FOUR reasons why it is important for humans to maintain the integrity of ecosystems.

Some candidates did not approach this question by considering that it was the natural ecosystem that was being addressed. As a result these candidates failed to recognise that humans can impact both the biotic and abiotic components of the ecosystem.

Note:

Humans cause imbalance in ecosystems by altering abiotic and biotic factors of ecosystems. Pollution disrupts abiotic conditions by altering chemical balance and changing physical conditions. Humans and the pollution caused by them can have direct impacts on biotic communities.

Module 2: People and the Environment

Question 4

Part (a) of this question required candidates to use the information provided by the "Age structure diagram for Country X in Figure 2" to calculate the percentage of population in a specific age group (0 – 19 years).

Most candidates did not understand how to perform this calculation and so the response to this part of the question was poor.

Note:

Percentage of population in 0 – 19 years range
Total number of males = (1.0 + 1.0 + 0.9 + 0.9) x 100,000
Total number of females = (1.2 + 1.1 + 1.0 + 0.9) x 100,000
Total population = 3,800,000 + 4,200, 000 = 8,000,000

$$\textit{Percentage}\ \text{of population in the 0 - 19 age group} = \frac{8{,}000{,}000 \times 100}{16{,}000{,}000} = 50\%$$

In Parts (b) and (c), candidates were required to describe how the growth rate of the population will be determined by the age group ranging from 0 – 19 years and also to outline the impact on the environment that this population could have if it grew at the rate expected. A few of the candidates were able to outline the relationship between increasing population growth and environmental impact. Overall, candidates performed better on these two parts of the question.

Part (d) required candidates to use the age structure diagram in Figure 2 to state characteristics of the population. Most candidates were unable to state characteristics of the population that could have been inferred from the age structure diagram.

While candidates gained marks in Parts (a) and (b) their responses were far too general. Overall candidates did not appear to grasp the concept of an age structure diagram, how to calculate demographic parameters and how to make inferences from age structure diagrams.

Question 5

Part (a) of this question tested candidates understanding of the terms 'total fertility rate' and 'life expectancy'. Part (b) tested candidates' ability to use selected demographic statistics to outline relationship between total fertility rate and the life expectancy for the Ethiopian population. In Part (c) candidates were required to suggest TWO reasons for the low percentage of Ethiopian women using contraceptives. In Part (d), candidates were required to suggest an approach aimed at decreasing the fertility rate of Ethiopian women.

Most candidates did not define 'total fertility rate' as the average number of children a woman would have throughout her childbearing years (usually considered to be between 15 to 49 years). Few candidates defined 'life expectancy' as the average number of years a newborn is expected to live.

Part (b) was done unsatisfactorily as most candidates failed to grasp the relationship between total fertility rate and life expectancy. Consequently the responses offered by candidates did not address clearly the relationship between the two demographic factors.

Question 6

Parts (a) and (b) of this question examined candidates understanding of the characteristics of poverty and the international indices used to rank the development status of countries.

Part (c) tested candidates understanding of the impact of population growth on poverty and how poverty can hinder the ability of a country to achieve sustainable development.

The majority of candidates recognised poverty as the lack of sufficient resources to meet one's basic need for food, clothing and shelter. Most candidates were able to list characteristics of persons living in poverty.

Candidates had difficulty identifying and defining international indices used to rank the development status of countries.

Candidates are expected to be conversant with the definitions of basic indices such as GDP, GNP, HDI and GDI.

Candidates experienced difficulty justifying whether population growth in a country will lead to an increase in poverty levels. Most candidates simple indicated that an increase in population size will increase poverty levels. Few candidates' demonstrated knowledge of the concept of sustainable development, therefore, many candidates were unable to make the link between increasing poverty levels and the ability of a country to achieve sustainable development.

Module 3: Sustainable use of Natural Resources

Question *7*

Candidates' ability to evaluate the factors affecting natural resource use was tested in this item. The question required candidates to refer to the graphs in Figure 3 and Figure 4 which showed the variation in the quantity of fish caught and the number of boats engaged in fishing over a period of time.
In Part (a) candidates were expected to describe the trends indicated in the figures. In Part (b), candidates were required to determine and justify their response as to whether the problems experienced by the fishing industry could have been prevented. Parts (c) and (d) required candidates to identify approaches to address current problems in the fishing industry and to assess the effectiveness of TWO of the approaches identified.

Candidates' performance on Parts (a) and (c) were satisfactory. However their performance on Part (d) was poor. While candidates were able to identify and outline approaches to deal with current problems being experienced in the fishing industry they experienced great difficulty in assessing the effectiveness of these approaches.

Candidates should note that in assessing effectiveness the following can be considered:

- Availability of the regulatory tools
- Ability and extent of implementation of regulatory tools and approaches
- Monitoring capacity
- Feedback mechanisms
- Appropriate legislation
- Enforcement capability
- Response processes

Question 8

This item focused on the functions of mangrove ecosystems, the impacts on these ecosystems in the Caribbean resulting from developmental activities and the methods available for conserving mangrove ecosystems in the Caribbean.

Candidates performed well on Part (c) of this question. However, candidates had difficulty in describing the functions of mangroves in Part (a) and discussing impacts on mangroves in Part (b). Most candidates described impacts on the economy of the country rather than impacts on mangroves, indicating that they concentrated on the role that mangroves played in the economy of Caribbean countries rather than the function of mangroves in the ecosystem.

Question 9

In this question, candidates were required to discuss how various factors affected the exploitation of a specific mineral resource.

Most candidates approached this question by considering environmental impacts that would arise if exploitation of this mineral resource is undertaken. Candidates failed to recognise that the question required them to address factors affecting natural resource use.

Note:

Factors affecting natural resource use include:

- Technology
  Appropriateness of the technology
  Availability of the technology
  Environmental soundness
  Affordability

- Demographic
  Level of environmental awareness of population
  Level of affluence
  Consumption patterns
  Population growth and distribution
  Effects on resource consumed by population

- Geographic
  Spatial distribution of resource
  Accessibility
  Quantity of the resource
  Quality of the resource
  Location
  Effects on habitats and biodiversity

- Political
  Government policies
  Legislation and enforcement
  Sustainable development policies
  Environmental policies
  Private investment and privatisation policies
  Nationalisation policies

- Economic
  Role of foreign investment in national development
  Export of resource as primary product

Export of resource as value added product

- Environmental
  Habitat destruction, loss and degradation
  Species loss and displacement
  Pollution
  Soil erosion

PAPER 03B

Candidates were required to answer all questions. Too few candidates demonstrated the expected level of knowledge and comprehension as well as the ability to apply and organise this knowledge.

Question 1

Candidates performed well in this question. Candidates were able to use the information provided in Table 1 to plot an appropriate graph showing the variation in the size of the population of parakeets. Candidates were also able to describe the variation of the parakeet population and suggest a plausible explanation for the variation. Most candidates were able to use their graph to estimate the carrying capacity of the ecosystem for the parakeets.

Question 2

Performance on this question was fair. While candidates were able to identify the possible impact of the stated actions of the developer on the parakeet population many had difficulty in evaluating the possible impact as was required in the question.

Question 3

The majority of candidates found this question challenging. Many candidates failed to present a logical design of a monitoring plan. Candidates simply concentrated on identifying some activities that they felt were necessary but did not provide a sequence in which these activities were to be undertaken.

Candidates could have followed a sequence that allowed for the following:

- Identification of the specific location within the map area
- Recording of the initial number of nests, chicks and sightings
- Recording of prevailing conditions at data collection points and times
- Identification of measures to be introduced to allow for monitoring and data recording

DETAILED COMMENTS

UNIT 2

In general, candidates performed well in Module 1 of both Papers 01 and 02. However, as had been the case in the previous years, candidates did not perform as well in Modules 2 and 3. There were some areas where it was apparent that candidates lacked the requisite knowledge, while in other areas the problem was one of applying knowledge.

PAPER 1

Module 1: Sustainable Agriculture

Question 1

This question required candidates to list three distinct types of agricultural systems in the Caribbean. The majority of candidates correctly listed the three types of agricultural systems and stated two characteristics of each.

The syllabus describes agricultural systems as commercial, subsistence and peasant farming. Candidates should note that monocropping, however, is a characteristic of commercial agriculture system.

The characteristics of peasant and subsistence agriculture should be noted as well.

In subsistence farming, small areas of land are utilized, mechanisation is lacking and there is minimal use of agro-chemicals to maintain yields. The majority of the produce is consumed by the farmers and the excess sold.

In peasant farming, small areas are cleared to plant crops, generally by burning. There is constant movement from place to place over a period of years, agro-chemicals are not used and all that is produced is consumed by the farmer.

Question 2

In this question, candidates were required to outline the socio-environmental consequences of the agricultural practices of deforestation and use of artificial fertilizers. Generally, this question was well done. Most candidates identified two positive and two negative consequences of each practice.

A few candidates misinterpreted parts of this question. For example, a candidate identified the following as positive consequences of deforestation:

- Serves as wind barriers in the time of hurricane

Both statements are positive environmental contribution of forest but are incorrect responses to the question.

Two positive consequences of deforestation are that land becomes available to produce food crops and there are economic benefits from the sale of lumber.

It should also be emphasized to candidates that salinisation is a process associated with long term irrigation and not the use of inorganic fertilizer.

Question 3

The focus of this question was on hydroponics as a sustainable agricultural practice. The majority of candidates had a basic understanding of the process of hydroponics. However, many candidates neglected to mention the need for an inert medium in which the plants are grown.

Hydroponics is the science of growing plants without the use of soil, using an inert medium, to which is added a nutrient solution containing all the essential elements needed by the plant for its normal growth and development.

In Part (b), many candidates could state at least one reason why hydroponics can be considered to be a sustainable agricultural practice. Some reasons are presented below.

- Soil borne pest, diseases and weeds are eliminated, thus decreasing the use of pesticides and the environmental consequences of their use.
- More plants can be grown in a limited space, decreasing the need to clear more forest areas causing habitat destruction.
- Since fertilizers will be reused, the quantity of fertilizers entering water bodies and the possibility of eutrophication will be decreased.

Question 4

This question focused on of the impact of agriculture on the lifestyle of Caribbean people. This question was poorly done by the majority of candidates. Generally candidates responded by stating the contribution of agriculture in Caribbean societies but did not extend their responses to show how these contributions impacted on the lifestyles of Caribbean people. An example of the expected response is provided below.

In the Caribbean, many rural communities are agricultural in nature. The lifestyle of the people is centred around agricultural activities such as planting crop and tending fields and livestock. Daily activities are related to crop cycles which include activities such as field preparation, planting, weeding and reaping. For instance, in order to complete field activities children might be prevented from attending school, as they often have to contribute by working on the farms.

Module 2: Sustainable Energy Use

Question 5

In Part (a), the majority of candidates correctly defined the term 'energy'. In Part (b), candidates were required to identify a form of 'energy' and outline a social and economic dependence of Caribbean countries. This section was well done by the majority of candidates. Some candidates however named a source rather than a form of energy. While heat, electricity and light are forms of energy fossil fuels and the sun are sources of energy.

Question 6

This question examined candidates' understanding of renewable energy sources and their applicability in the Caribbean. In Part (a), the majority of candidates correctly explained the term renewable energy source. In Part (b), the majority of candidates also correctly identified a renewable energy source suitable for their country as well as provided an appropriate reason for their choice.

In Part (c) candidates were required to suggest two reasons for the source they identified not being used more effectively in their country. Some candidates suggested appropriate reasons such as those listed below in relation to solar energy.

- The start-up capital to implement this technology is quite high especially for the equipment needed.
- There is still a great reliance on traditional non-renewable energy sources.

It was apparent that the majority of candidates had the requisite knowledge, but some had difficulty in applying this knowledge in Part (c).

Question 7

In this question, candidates were presented with the statement "It is suggested that the cost to society of using fossil fuels is more than the money paid to purchase the fuel and generate energy" and asked to justify the position they adopted.

It was expected that candidates would agree with the statement and justify their position by discussing the socio-environmental impact of the extraction, transportation and use of fossil fuels to generate energy. Candidates could adopt either allowance for either position provided the justification was valid. Only a few candidates responded appropriately. An example of the appropriate response is given below:

Combustion of fossil fuels results in the emission of air pollutants such as particulates. Small particles can be inhaled into the respiratory system, aggravating respiratory illnesses. Long term exposure may cause increased incidence of chronic conditions such as bronchitis. There is a cost to society of treating such illnesses. There is also a cost to society in terms of the number of hours lost, as a result of persons being absent from work as a result of such illnesses.

Question 8

Part (a) of this question examined candidate's knowledge of the features of a photovoltaic cell circuit. While many candidates identified the incoming solar radiation and the connecting wire in the diagram (A and C), the majority of candidates did not identify B, the thin wafer of crystalline silicon.

In Part (b), candidates were required to state three advantages and three disadvantages of a photovoltaic cell as a source of energy. Some candidates' discussed the advantages and disadvantages of solar energy, some aspects of which were not true for a photovoltaic cell.

Module 3: Pollution of the Environment

Question 9

This question examined candidates' understanding of pollution and how population growth and economic development contributed to increased environmental pollution. The majority of candidates performed well on this question. However some candidates did not score maximum marks in Part (b) because their response was incomplete because the link between the increase in environmental pollution and, for instance, economic development was not clearly outlined. An expected approach is outlined below.

Economic development will result in increased industrialization. New industries will develop such as those processing and manufacturing chemicals. Processing and manufacturing chemicals may produce by-products or waste which are harmful. If these by products are not disposed of appropriately, this will lead to increase environmental pollution.

Question 10

The focus of this question was on sound as a pollutant. The majority of candidates identified at least one the required two characteristics of sound that makes it a pollutant.

Sound becomes a pollutant when it is very loud, disagreeable or results in physiological or psychological harm.

In Part (b), candidates were required to list four impacts of sound pollution on human beings. This section was well done by the majority of candidates.

Question 11

In Part (a), candidates demonstrated a good knowledge of the different types of parameters that can be measured to determine the water quality of a river.

In Part (b) candidates found it difficult to explain the significance of a BOD value of 5 mg/L measured for the river.

BOD is a measure of the amount of oxygen consumed by decomposing organic matter. Based on the BOD measurement, the organic matter contained in 1 litre of river water, consumes 5 mg of oxygen when it decomposes. This provides a measure of the amount of organic matter present in the river water. Organic matter is considered a pollutant because it promotes eutrophication. This value is relatively high for river water.

Parts (c) and (d) requiring candidates to state two sources of water pollutants that cause high BOD and one environmental impact of high BOD, was generally well done.

Question 12

This question focused on the Montreal Protocol and its impact on the problem of ozone depletion. It was apparent that many candidates had no knowledge of the Montreal Protocol, while some had incomplete knowledge.

The Montreal Protocol is an agreement signed in 1987 by a number of countries to significantly reduce CFC production by 50 per cent by 1998.

In Part (b), many candidates had difficulty stating two reasons why there was no immediate change in the problem the Protocol addressed.

Acceptable reasons are:

- There are no natural processes occurring in the stratosphere that return ozone depleting substances to the troposphere. Substances that have collected in this region will remain until completely broken down.
- Ozone depleting substances such as CFC's are very stable. They will continue to deplete stratospheric ozone for many years.

Paper 02

Module 1: Sustainable Agriculture

Question 1

Part (a) of this question examined candidates' understanding of the environmental impacts associated with agricultural practices in the Caribbean. Part (b) tested candidates' understanding of the importance of agricultural sustainability and Part (c) tested candidates' knowledge of environmentally sustainable practices.

The majority of candidates identified an environmental problem associated with agricultural practices. While, some candidates did not outline adequately, theenvironmental problem identified, others mentioned a number of environmental problems, without adequately outlining one, as part of the question required.

Many candidates had difficulty explaining the importance of agricultural sustainability in Part (b). While some candidates demonstrated an understanding of the concept of sustainability, they were unable to use this understanding to explain the importance of agricultural sustainability.

Many Caribbean countries obtain a significant portion of their revenue from the export of agricultural products. The economic viability of their economies depends on their ability to increase output and decrease cost so as to maximise returns. Environmental problems resulting from agricultural practices threaten the ability of Caribbean countries to maintain or increase revenue from agricultural exports.

Many candidates were able to identify two environmentally sustainable practices in Part (c), however, their description of the practice and explanation of its sustainability were incomplete in some cases.

In general, this question was well done.

Question 2

This question examined candidates' understanding of technological applications in agriculture and the associated environmental impacts. In Part (a) candidates were required to describe three technological applications. Very few candidates responded with a description. The majority of candidates identified the technological applications and explained the benefits of the application.

Pesticides are chemical compounds that protect crops from disease and pest. Pesticides may be provided in a liquid form for ease of application. They may be applied using a device that allows the manual spraying of the crops.

Question 3

In Part (a) of this question, candidates were required to distinguish between biological and chemical pest control and in Part (b) to discuss one advantage and one disadvantage of chemical pest control. Both sections were well done by candidates.

In Part (c), candidates were asked to explain the concept of Integrated Pest Management and why they would recommend its adoption by their country. Candidates demonstrated adequate knowledge of Integrated Pest Management but some did not apply their knowledge to answer the second part of the question appropriately. An example of the expected approach is provided below.

My country is a small island with many indigenous organisms. The use of pesticides in agriculture puts these organisms at risk because of the toxic and persistent nature of such chemicals. In Integrated Pest Management the use of pesticides is minimised. There is a decreased risk to these organisms. Integrated Pest Management, therefore, supports the conservation of wildlife.

Module 2: Sustainable Energy Use

Question 4

In Part (a) of this question, candidates were required to state three inferences drawn from the graph which showed the change in energy demanded and generated between 1990 to 2000. Some candidates' responses were a statement of

the observed trend, which was considered inadequate. Examples of the expected responses given below.

Between 1990 and 1993, energy generated exceeded energy demand and during 1993, energy generated satisfied energy demand.

Since around the end of 1993, energy demand has exceeded energy generated. Since 1990, the rate of increase in demand has been greater than the rate of increase in generating capacity.

Part (b) of this question was generally poorly done. Only a few candidates were able to discuss two constraints that non-oil producing countries face in satisfying the increasing demand for energy of their population. There were, however, some encouraging responses that indicated application of relevant knowledge from difference sections of the Module.

Some of the constraints which could have been discussed include:

- Cost of purchasing and transporting additional fossil fuel to satisfy the increasing demand
- Cost of constructing additional facilities and purchasing machinery such as turbines
- Cost and affordability of energy to consumers (this is a valid point because if the energy is delivered to the customer at a price beyond their reach the company may not be able to generate revenue to sustain its operation)
- Cost associated with implementing alternative energy sources

In Part (c)(i), while many candidates had a basic knowledge of cogeneration, their explanation of the process for the most part was incomplete. In Part (c)(ii), only a few candidates adequately justified their position regarding the suitability of cogeneration to satisfy the increasing energy demand. In questions of this nature, candidates are allowed to take either position, provided their position is justified.

Cogeneration allows the utilization of energy that would normally be wasted. This may improve the efficiency of energy generation by up to 80 per cent. This allows more energy to become available to satisfy the increasing demand without purchasing additional fuel. This additional energy is available only as heat and may be used to provide a supply of hot water for industries and hospitals. If the demand is for more electricity, the extent to which this may be used to satisfy this additional demand is limited.

Question 5

In Part (a) of this question, candidates were required to distinguish between nuclear fusion and nuclear fission. Many candidates had knowledge of the basic difference between a nuclear fission and fusion. However, many candidates in their responses stated that the process was atomic rather that nuclear. An example of an incorrect response is given below.

Nuclear fission is the splitting of an atom into two, while the combining of two atoms into one occurs in nuclear fusion.

It should be emphasised to candidates that fission and fusion are processes that occur to the nucleus of atoms.

In nuclear fission the nucleus of a large atom such as U-235 is split into smaller nuclei as a result of collision with a neutron. In the fusion process, however the opposite occurs, as two smaller nuclei such as hydrogen are combined to produce a larger nucleus.

In Part (b), only a few candidates correctly wrote the equation for the nuclear fission process occurring in nuclear reactors. Candidates were expected to write a proper nuclear equation for the fission process. Some candidates responded with a diagrammatic representation of the process that was not acceptable. The percentage of candidates that were able to explain how a nuclear power generated electrical energy was disappointing. In the majority of cases, candidates' explanations were incomplete A satisfactory response is given below.

- In the nuclear reactor the fission process occurs in a chain reaction producing a large amount of heat energy. The reactor is cooled by passing a coolant such as water or liquid sodium through the reactor's core. The heat is used to boil water (using a heat exchange mechanism) which forms steam. The pressurised steam is used to turn a turbine generating electricity, which is transmitted to the national grid.

In Part (d), many candidates identified at least two valid issues that could be of concern to a Caribbean country considering using nuclear fission to generate electricity. However, many candidates 'stated' rather than 'discussed' the issues in their responses.

Question 6

In Part (a) of this question, candidates were required to distinguish between energy conservation and energy efficiency. The majority of candidates demonstrated an understanding of the concept of energy conservation, but had more difficulty explaining the concept of energy efficiency.

While energy conservation is the moderation or elimination of wasteful or unnecessary energy consuming activities, energy efficiency is the utilisation of technology to accomplish a particular task with less energy.

In Part (b), candidates were required to explain the concept of energy-efficient buildings. It was apparent that some candidates who attempted this question lacked the depth of knowledge to respond adequately. An explanation of the concept of energy-efficient buildings is as follows;

Energy-efficient buildings are (homes, commercial or industrial buildings) that are designed with cost-effective, energy-efficient measures. The objective is to decrease energy consumption to a minimum and reduce cost for cooling, heating and lighting.

In Part (b), candidates were more able to state four ways of applying the concept of energy-efficient building with respect to lighting than with regards to maintaining a comfortable temperature.

Methods of maintaining comfortable indoor temperatures include:

- Use of light coloured finishes for walls and roofing to reflect thermal energy from sunlight
- Shading of roofs, walls and windows with eaves, awnings and carports
- Decreasing glare and heat gain from sunlight using blinds and shutters
- Designing and landscaping of outdoor surfaces to reduce air temperatures and minimise glare. For example, this can be achieved by minimizing paved areas and maximising grassed and planted areas.

Module 3: Pollution of the Environment

Question 7

This question examined candidates' understanding of the type, nature and sources of air pollutants. In Part (a), candidates were required to identify air pollutants, other than volatile organic compounds, that may possibly be emitted from the stack shown in the diagram. Many candidates correctly identified two other air pollutants and in Part (b), most candidates correctly stated four environmental receptors of one of the pollutants they identified.

In Part (c), candidates were required to outline the impact of one pollutant on one of the environmental receptors they identified. Many candidates responded adequately to this question. A response that was awarded maximum marks is presented below.

"Sulphur dioxide is a yellowish and highly corrosive gas. When present in the atmosphere it is oxidized to sulphur trioxide which reacts with water vapour or water droplets in the atmosphere to form sulphuric acid. This is a major component of acid rain. When acid rain falls on plants, it causes those which cannot tolerate acidic conditions to die. It may cause a reduction of growth in others and the rotting of roots in other cases. The root may be unable to uptake the required nutrients from the soil resulting in the reduction of growth."

Many candidates performed poorly on Part (d) of this question. Very few candidates exhibited knowledge of the

operations of scrubbers and electrostatic precipitators in reducing the emissions of air pollutants. An example of the expected response is presented below.

Electrostatic precipitators efficiently remove particulates from stack emissions. Particulates pass through an electric field that charges the particles. The charged particles then attach themselves to the oppositely charged walls of the device. When the electric current is switched off, the particles fall to the bottom of the device and is removed.

Question 8

In Part (a), candidates were required to explain the term 'hazardous waste' and identify an example and source of this type of waste in the Caribbean. Many candidates explained the harmful nature of this type of waste, but some did not make clear that it may be solid, liquid or gaseous material. Too many candidates lost marks because of using the term 'hazardous' to explain the biological impact of hazardous waste. Generally, candidates were able to indicate an example of hazardous waste as well as identify the source in the Caribbean.

Few candidates appropriately defined the three categories of hazardous waste in terms of their impact on human beings. The majority of candidates responded by defining general categories of solid waste. An appropriate response is presented below.

- Carcinogenic wastes contain chemical or physical agents that cause cancer to develop in human beings.
- Mutagenic wastes causes damage to the genetic material of living cells in human beings, resulting in mutations.
- Terratogenic wastes are chemical, ionising agents or viruses that cause birth defects.

In Part (c), candidates were asked to outline four considerations when planning for the disposal of hazardous waste. Few candidates responded adequately in applying their knowledge of waste disposal methods. Some of the considerations are listed below.

- Appropriate methods of collecting and storing the waste before disposal
- Safe methods of transporting the waste to the disposal site
- Location of disposal sites with respect to ecosystems, water resources and communities
- Geological activeness of disposal site
- Security of disposal site
- Cost associated with constructing and maintaining the disposal site

In Part (d), very few candidates adequately described a disposal method for hazardous waste considered appropriate to the Caribbean.

The most appropriate method for disposing hazardous waste in the Caribbean is a sanitary land fill. A large hole is excavated and lined with several layers of compacted clay and plastic liners. This prevents leaking of hazardous substances into surface water and groundwater. Liquid that percolates through the hazardous waste is collected and treated to remove contaminants. Only solid chemicals that have been treated to detoxify them as much as possible are accepted for disposal. These chemicals are placed in sealed barrels before being stored in the landfill. This method is most appropriate because it decreases the risk of contamination of underground water resources which are an important source of water for many Caribbean countries.

There are other acceptable methods such as incineration. However, candidates would need to recognise environmental problems associated with this method. With incineration, there is the problem of toxic emissions as well as the disposal of toxic ash from the process.

Question 9

In Part (a), candidates had to define the term 'pathogen' and provide an example. This section was well done by the majority of candidates.

In Part (b), candidates were required to identify an agricultural source of pathogens and outline its environmental pathway from the source to water bodies. This section was also well done by the majority of candidates.

In Part (c), candidates were required to outline a wastewater treatment process that removes pathogens and nutrients. The appropriate response should have been an outline of a tertiary wastewater treatment process. Few candidates exhibited partial knowledge of waste water treatment processes, and as a result, the majority of responses was inadequate.

In Part (d), many candidates demonstrated knowledge of the purpose of effluent discharge regulations.

Effluent discharge regulations are laws that regulate the amount and composition of waste water discharged into the environment. It protects water quality by establishing penalties for non compliance with the regulation.

UNIT 2

PAPER 03B

Generally, candidates' performance was satisfactory. There is still the need for overall improvement in the depth and breadth of coverage with respect to certain areas of the syllabus. Greater effort must also be made to improve candidates' ability to organise and apply knowledge.

Question 1

Candidates performed well in this question. Candidates were able to use the information provided in Table 1 to plot an appropriate graph showing the variation in BOD along the river from Sites A to G, describe the trend in the variation of BOD with sampling sites, as well as suggest appropriate reasons for the variation identified.

Question 2

This question focused on water quality parameters and activities associated with a water quality monitoring programme of a river. Performance on this question was poor. While candidates were able to identify the three different water quality parameters, they were unable to explain the procedure for conducting a BOD test. Candidates also did not explain adequately the importance of the additional water quality parameters for which testing was suggested.

Question 3

This question required candidates to design a water quality programme and to comment on the use of algae to monitor pollution in the river. Candidates did not outline adequately the steps expected in a water quality programme. Similarly, candidates did not explain the significance of using the algae as an indicator or stated the advantages and disadvantages associated with its use. Candidates appeared to lack the depth of knowledge required to perform well in this question.

THE INTERNAL ASSESSMENT

While most of the Internal Assessments were of a satisfactory standard, there were still some very poor pieces. In general, most teachers demonstrated that they understood the assessment criteria and so were able to apply these criteria effectively. However, a few teachers were very lenient with the marks awarded.

A few of the Internal Assessment pieces submitted did not conform to the requirements of the respective Unit. The criteria outlined in the Syllabus must be used as this will allow candidates to submit pieces that meet all the required criteria.

Candidates are reminded that each activity of the Internal Assessment should relate to at least ONE specific objective. Teachers are encouraged to ensure that this aspect of the syllabus is applied.

In many instances candidates did not conform to the word limit criteria for the project assignment for Unit 1 and also the written paper for Unit 2.

It was evident from the pieces submitted for both Units that there was a heavy and at times excessive reliance on secondary data. Candidates are encouraged to pay attention to data collection and to collect primary data. This allows for more effective data presentation and analysis. This was one of the weaker areas of assessment in both Units.

Candidates are encouraged to write bibliographic references using a consistent convention. In addition, candidates need to ensure that there are at least four references and that these references are up to date.

Candidates and teachers are reminded that to conform to the format that is provided by the syllabus for a particular type of assessment. In a few instances, the format provided for the journal was not used by candidates.

Teachers are reminded

(i) to distribute the total marks for the Internal Assessment for Unit I across the three Modules as indicated on the moderation sheet provided by CXC

(ii) that fractional scores are not to be awarded

(iii) that the specified internal assessment forms are to be used and submitted to CXC.

DETAILED COMMENTS

UNIT 1

Candidates were required to complete a single project that would span the three modules in the Unit. Some candidates did some very good pieces. These had components of each of the three Modules of the syllabus. However, there were some projects which did not conform to the recommended format specified in the syllabus and presented little or no evidence of field investigation and collection of primary data.

As indicated in previous years, some ways in which projects in Unit 1 may be improved are:

- Candidates should be more concise and focussed on the formulation of research topics (many of the titles while understood were not concise);
- The topic chosen should be relevant to at least one specific objectives in the Unit;
- Data collected should be described clearly;
- Diagrams and illustrations should be appropriate, well-integrated to increase their effectiveness;
- Candidates should strive to undertake appropriate analysis at all times and these should be as comprehensive as possible.
- Discussion of findings, conclusion and recommendations should be based only on what was presented in the literature review and the data that are collected, presented and analysed. New material should not be introduced in the discussions.

Candidates are reminded that conclusions must be clear, based on findings, valid and related to the purpose of the project. In addition, recommendations must be based on findings and must be fully derived from findings.

UNIT 2

For Unit 2, each candidate was required to complete three pieces: a written paper, a journal and laboratory report. (This requirement will change for 2006, see p.31). The overall quality of the submissions for this Unit was good.

In general, the journals, written paper and laboratory reports showed evidence of fieldwork and individual student

involvement. The literature review was satisfactory, however, improvement is needed in the referencing of textual material.

It was apparent in some cases that there was difficulty in identify appropriate tasks for the laboratory exercises.

Candidates continued to show weakness in analysing and interpreting results.

A few candidates failed to submit the required minimum number of pieces for the laboratory report and the journal entries.

Teachers are reminded to submit mark schemes used for the laboratory exercises

LABORATORY EXERCISES

In general, most candidates submitted an adequate number of laboratory exercises with satisfactory coverage of the criteria to be assessed. In a few instances, the spread of the laboratory exercises was narrow but most were satisfactory.

While most candidates demonstrated adequate coverage of the skills assessed, there is still room for improvement in analysis and interpretation.

WRITTEN PAPER

Overall, candidates did well on this component and teachers' application of the mark scheme for this component was good.

Some candidates needed to devote more attention to the planning and design of the research paper. This will direct the types of data to be collected while at the same time determine the type of analysis that will be used. Effective planning and design will also allow for effective interpretation and discussion since the scope and purpose of the written paper would have been identified.
One shortcoming throughout was that many candidates failed to link the discussion and conclusion to the purpose of the written paper. In some instances, candidates failed to state the purpose of the written paper which resulted in a piece that was unfocused.

JOURNAL

Significant improvement was noted in the quality of journal entries. Most candidates followed the criteria outlined and were able to make adequate and in a few instances comprehensive observations. The analysis and interpretation of the observations were in the most part adequate and almost all of the submissions contained an adequate number of entries. It was evident that teachers and candidates concentrated on quality and an adequate number of entries.

It cannot be overemphasised that an introduction to the journal is useful for indicating the scope and purpose of the journal entries to the reader. It will also help to focus the candidate and ensure that appropriate observations and interpretative comments are made.

The syllabus advises that journal entries should be based on either field visits to **one** site where changes over time are observed **OR** on visits to different sites to compare and contrast similar processes or occurrences. Although this was evident in most of the candidates' submissions, a few cases showed that this requirement was either not clearly understood or simply not followed. In these cases, candidates visited different sites but compared and contrasted different processes and occurrences. This was ineffective as there was no basis for comparisons.

***NB**
Please note change in requirements for Unit 2 in AMENDMENT TO THE SYLLABUS IN ENVIRONMENTAL SCIENCE (Effective for Examinations from May/June 2006)