

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2007**

ENVIRONMENTAL SCIENCE

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ENVIRONMENTAL SCIENCE**CARIBBEAN ADVANCED PROFICIENCY EXAMINATION****MAY/JUNE 2007****INTRODUCTION**

Environmental Science is a two-unit subject with each unit consisting of three Modules: Unit 1 – Fundamental Ecological Principles, People and The Environment, and Sustainable Use Of Natural Resources; Unit II – Sustainable Agriculture, Sustainable Energy Use, and Pollution of the Environment. Both Units are examined by three papers. Paper 01 and 02 are external examinations, while Paper 03 is the Internal Assessment and is examined internally by the teacher and moderated by CXC.

Paper 01 consists of 12 compulsory, short-response questions with four questions based on the contents of each Module. Each Module contributes 30 marks to the total 90 marks for the paper. This paper contributes 30 per cent to the Unit.

Paper 02 consists of nine questions, three based on each Module. Candidates were required to answer two questions from each Module. Each question contributes 20 marks to the total 120 marks for the paper. This paper contributes 40 per cent to the Unit.

Paper 03, the Internal Assessment, contributes 90 marks or 30 percent to the total assessment. Unit 1 is examined by a single project while Unit 2 is examined by a journal comprising site visits and laboratory exercises.

GENERAL COMMENTS**UNIT I**

The performance of candidates was less than satisfactory in most cases. Only a few candidates demonstrated the breadth of knowledge necessary to perform well. There were many candidates whose responses were inadequate especially where they were required to distinguish between terms, explain interactions and inter-relationships, and infer relationships. In some cases, candidates were unable to define terms correctly. Greater attention to basic principles is required.

DETAILED COMMENTS**UNIT 1****PAPER 01**

Candidates performed best in Module 3 followed by Module 2 and then Module 1. The best performance was on Question 8 and the worst on Question 2.

Module 1: Fundamental Ecological Principles**Question 1**

In Part (a) of this question, candidates were required to distinguish between ‘the lithosphere’ and ‘the hydrosphere’. In Part (b), candidates were required to define and state THREE features of an ecotone. Candidates’ performance in this question was unsatisfactory. Most candidates had difficulty distinguishing between ‘the lithosphere’ and ‘the hydrosphere’. Most candidates also had difficulty in defining ecotone and stating its features. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Note: An ecotone is a zone of transition between adjacent ecological systems, having a set of characteristics uniquely defined by space and time-scales and by the strength of the interactions between them.

Ecotone has the following features:

- *Supports many species not found in either of the bordering ecosystems.*
- *Contains a mix of species and many unique species.*
- *Contains plants and animals from adjacent regions.*
- *Supports species that are adapted to the conditions in the ecotone.*

Question 2

This question tested candidates' understanding of the processes occurring in the nitrogen cycle and how human activities may affect the nitrogen cycle.

Candidates' performance in this question was below expectation. In Part (a) of this question, most candidates were able to identify the processes correctly but, in Part (b), most candidates had difficulty in outlining ONE way in which human activities may affect the nitrogen cycle. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 3

In Part (a) of this question, candidates were required to distinguish between 'intraspecific competition' and 'interspecific competition'. Candidates were also expected to state which of the types of competition was more intense and state why competition is important in an ecosystem.

This question was well done by the majority of candidates.

Question 4

This question tested the candidates' knowledge of the variation in the population size of organisms inhabiting a given area over a given period of time, and of estimating the carrying capacity from a given graph. Candidates were asked to define the term 'carrying capacity' and to use an appropriate example to explain how population size is regulated at the carrying capacity.

While it was obvious that many candidates had some knowledge of carrying capacity most candidates were unable to use an appropriate example to explain how population size is regulated at the carrying capacity. In general, candidates were able to estimate the carrying capacity from the graph.

Module 2: People and the Environment

Question 5

This question was designed to test the candidates' ability to

- (i) define the term 'birth rate' in Part (a)
- (ii) calculate the growth rate for a population in Part (b)
- (iii) use the calculated growth rate to determine whether the country was a developed or developing one.

Overall this question was done satisfactorily by candidates although many candidates had difficulty calculating the growth rate for the population. For Part (c), the responses suggest that candidates understood the difference between growth rates that are typical of developed and developing countries.

Question 6

Part (a) of this question tested candidates' knowledge of human population size and human population density of developed and developing countries. In Part (b), candidates were expected to identify two abiotic factors which impacted on human population density. In Part (c), candidates were expected to explain how any abiotic factor impact on human population density.

Candidates' performance in this question was unsatisfactory. Most candidates had difficulty in applying their knowledge to explain how abiotic factors impact on humans and less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 7

In this question, candidates were presented with a graph that showed annual fresh water consumption. Candidates were required to state the meaning of 'per capita fresh water consumption'; in Part (b), candidates were expected to suggest a reason for the trend in the per capita freshwater consumption shown in the graph, and to describe one possible environmental impact that may result from the trend in fresh water consumption indicated in the graph in Part (c).

In Part (a), candidates had difficulty in stating the meaning of 'per capita fresh water consumption'. Parts (b) and (c) of this question were done satisfactorily.

Note: Per capita fresh water consumption is the average amount of fresh water consumed annually by each member of the population.

Question 8

This question examined candidates' understanding of the distribution of populations in cities, towns and rural areas of a Caribbean country. In Part (c), candidates were required to outline ONE environmental problem associated with a particular population distribution that was illustrated.

Candidates performed best on this question. Candidates who correctly suggested appropriate reasons for the population distribution satisfactorily outlined an environmental problem associated with the given population distribution.

Module 3: Sustainable Use of Natural Resources

Question 9

In Part (a), many candidates had difficulty explaining 'bioprospecting'. In Part (b), most candidates provided satisfactory answers and reasons to support their choice. Most candidates did well in Part (c) and correctly stated environmental impacts associated with the extraction and use of hydrocarbons.

Question 10

In Part (a) of this question, candidates were required to distinguish between 'consumptive use' and 'non-consumptive use' of natural resources. Part (b) required candidates to describe TWO environmental impacts resulting from the consumptive use of natural resources.

Candidates performed satisfactorily on this question.

Question 11

In this item candidates were provided with a map of Jamaica showing protected areas. Candidates' understanding of the concepts of 'species depletion' and 'species extinction' was assessed.

Candidates performed very well on this item and were able to successfully distinguish between 'species depletion' and 'species extinction' while at the same time identifying their causes.

Question 12

This item examined candidates' knowledge of the method of cultivation practised by indigenous people and why the method is considered to be sustainable.

Candidates' performance on this item was below expectation. Candidates were able to identify the method of cultivation but were unable to describe the method of cultivation. Most candidates were unable to explain why the method of cultivation practised by indigenous people is considered sustainable.

Note:

The method of cultivation is 'slash and burn' and is considered sustainable because

- *the damage to the forest is negligible*
- *restoration of the forest ecosystem is possible after the plot is abandoned and vegetation regrowth takes place*
- *soil fertility is restored and the plot becomes useful again for cultivation*
- *burning provides ash which fertilises the soil, thus eliminating the need for artificial fertiliser input.*

UNIT 1**PAPER 02**

Overall, candidates performed satisfactorily on this paper and the performance was best in Module 3 followed by Module 1 then Module 2. Few candidates exhibited the required depth and breadth of knowledge and applied this knowledge well.

Module I: Fundamental Ecological PrinciplesQuestion 1

This question required candidates to examine the given diagram on feeding relationships in an ecosystem and to

- (a) name two groups of organisms represented in the feeding relationship
- (b) explain how the role of EACH group of organisms named is important to the functioning of the ecosystem
- (c) explain how human activity may disrupt the feeding relationship.

Most candidates were unable to name correctly two groups represented in the feeding relationship and therefore found it difficult to explain the role of each group in the functioning of the ecosystem. Most candidates were also unable to grasp the way in which human activity may disrupt feeding relationships.

Question 2

Part (a) of this question tested candidates' understanding of the terms 'ecological succession' and 'a climax community'.

Part (b) required candidates to outline THREE differences between 'primary ecological succession' and 'secondary ecological succession'.

Part (c) required candidates to calculate species diversity using the information presented. Candidates were also required to use the given information to rank the streams in decreasing order of species diversity and relate species diversity to stability.

Many candidates performed satisfactorily on Part (a) and Part (b). In Part (c), many candidates were able to calculate the species diversity but were unable to relate the species diversity to ecosystem stability.

Question 3

This question required candidates to study Figure 2 which showed a typical growth curve with different stages represented. They were required to

- (a) name any one of the growth stages
- (b) outline the features of each growth stage
- (c) explain how environmental resistance influenced the shape of the curve in Figure 2
- (d) suggest an environmental condition in the ecosystem that would cause the growth along the stated intervals.

Candidates exhibited satisfactory performance in Parts (a), (b) and (d) of this question. Part (c) proved challenging to most candidates and was not well done. Candidates experienced difficulties in explaining how environmental resistance influenced the shape of the curve.

Module 2: People and the EnvironmentQuestion 4

Part (a) of this question required candidates to calculate the doubling time for the population. Part (b) required candidates to use the result from Part (a) to evaluate whether both countries needed to implement population control measures. Part (c) tested candidates' understanding of factors that affected population growth.

Most candidates did not understand how to calculate doubling time and so failed to correctly evaluate the need for the implementation of population control measures. Candidates performed much better on Part (c) of this question; however, their responses were far too general.

Note acceptable responses:

- (a) Population increase = 8 205 000 - 8 056 000

$$\% \text{ annual growth rate } r = \frac{149\ 000}{8\ 056\ 000} \times 100 = 1.85$$

$$\text{doubling time} = \frac{70}{r} = \frac{70}{1.85} = 37.8 \text{ years}$$

- (b) *Country A's population will double in 140 years while Country B's population will double in 38 years. Country B's population is growing rapidly in comparison to Country A and even when compared with the world's time of 49 years. The per capita GNP provides an indication of the resources available to each member of a population. The relatively high per capita GNP of Country A of US\$7 500 is more likely to provide for any increase in its population. In contrast the low per capita GNP of Country B of US\$300 suggests low standards of living which will likely worsen with the rapid increase in population. Country B will need to implement measures to control its population growth.*
- (c) (i) • *Access to family planning programmes*
- *Social and economic status of women*
 - *Level of education*
 - *Culture*
 - *Access to proper health care*
- (ii) • *Family Planning Programmes: These provide education and clinical services that help couples to choose how many children to have and when to have them, provide access to contraceptive methods at an affordable price, promote and encourage the use of contraceptives and hence help to control population growth rates.*
- *Social and Economic Status of Women: When women have access to education and paying jobs and live in societies in which their individual rights are not suppressed, they tend to have fewer and healthier children.
By promoting the rights of women and the opportunity to become educated and to earn income, the government can help to slow population growth.*
 - *Culture: This refers to the values and norms of a society. A couple is expected to have the number of children that are determined by the traditions of their society. In many cultures, high fertility rates are traditional and encourage high population growth rates.*
 - *Education Level: In developing countries, educational opportunities especially for women, have had a significant impact on their fertility rates. Education increases the probability that women will know how to improve the health of their families and control their fertility, decreasing infant and child mortality. It also increases women's option with regards to careers and ways of achieving status other than by having babies.*

Question 5

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 - 49 years).

Part (b) was poorly done as most candidates did not appear to understand the relationship between total fertility rate and life expectancy. As a result, the responses offered by candidates did not address clearly the relationship between these two demographic factors. An acceptable comparison is outlined below.

In Country Y for every 1 000 live births, 108 infants die. For Caribbean countries, the average is 40 infant deaths for every 1 000 live births. The infant mortality of this country is therefore about 2.5 times that of Caribbean countries. Throughout her lifetime, a woman in the Caribbean is expected to have about 3 children. In Country Y, however, a woman is expected to have about 6 children. Women in Country Y are expected to have about twice the number of children than those in the Caribbean.

Part (c) was poorly done. The majority of candidates were unable to explain how infant mortality rate and fertility rate impact on the rate of growth of a population. An acceptable explanation is provided below.

When infant mortality rate is high the probability of children surviving to adulthood is low. Women, therefore, tend to have many children to compensate because in such societies children contribute to the family, for example, through their labour and wages. A high infant mortality rate encourages a high fertility rate. A high infant mortality rate encourages population growth.

Part (d) was poorly done. Most candidates experienced difficulties describing the relationship between the rate of growth of the population and the rate of deforestation. An example of an acceptable description is provided below.

A population requires resources to survive. People require land for erecting structures and materials for building and growing crops. Land and materials become available by clearing forest areas. As population size increases the demand for land space increases which in turn increases the rate of deforestation. The infant mortality rate and fertility rate of the country suggest a rapidly growing population which will exert increasing demands on its forestry resources, increasing rate of deforestation.

Question 6

In Part (a), most candidates were able to define poverty and justify the relationship outlined in the diagram showing a cycle of poverty. In Part (b), candidates experienced difficulties in evaluating the statement that was given and in many instances candidates failed to present reasons to support the position taken.

Module 3: Sustainable use of Natural Resources

Question 7

Candidates' knowledge and understanding of natural resources and their importance was tested.

The majority of candidates were able to explain the importance of water as a natural resource in a named country and also to explain why water is considered a 'natural resource'. Part (c) focused on management of water resources and was well done. Candidates were able to explain how the various measures were important.

Question 8

This question concentrated on environmental impacts associated with the use of land resources and the measures that could be recommended to address specific impacts.

Candidates were able to identify environmental impacts associated with the use of land resources in a named Caribbean country. However candidates had some difficulty in describing the environmental impacts as required in Part (b). Most candidates were able to describe the recommended measures for addressing the environmental impacts identified.

Overall, candidates' performance on this question was satisfactory.

Question 9

This question assessed candidates' knowledge and understanding of factors that may impact the exploitation of a natural resource which, in this case, was identified as limestone.

Candidates were required to explain how each factor identified could impact on the exploitation of the resource, and in Part (b) to outline FOUR environmental impacts that may result from the exploitation of the limestone resource in Part (c).

Candidates exhibited satisfactory performance on this question. Candidates who scored satisfactorily on this question were able to explain in a clear and concise manner how each of the factors that they identified could impact on the exploitation of the limestone resource. Also candidates were able to clearly outline four environmental impacts that may result from the exploitation of the limestone resource.

UNIT 1

THE INTERNAL ASSESSMENT

In general, the required criteria for this component were applied effectively.

There was heavy reliance on secondary data and too little evidence of primary data collection. Candidates should be encouraged to undertake projects that will require the collection and collation of primary data. This would enable better and more effective data presentation and analysis, one of the weaker areas of assessment.

The recommended format for each component should be used in order to facilitate the moderation process. In cases where the recommended format is not used, the teacher must submit the mark scheme used so as to ensure that the candidates' work is adequately assessed. The correct moderation forms should be used and the instructions given at the bottom of the Moderation Sheet for distributing scores to the three Modules should be observed.

DETAILED COMMENTS

Improvement was noted in the quality of the assignments submitted. However, literature review is still a major problem in many of the pieces submitted. Too often the literature review is either absent, irrelevant or inadequate.

Although some candidates were able to communicate the information in a fairly logical manner with few grammatical errors, there were still too many submissions with several grammatical errors. This reduced the overall quality of the final report.

Some areas in which projects in Unit 1 may be improved are:

- Each activity of the Internal Assessment should relate to at least ONE specific objective.
- Research topics should be more concise and focused. (Many of the titles although understood were not concise).
- Data collected should be described clearly.
- Diagrams and illustrations should be appropriate and well integrated in the text to increase their effectiveness.
- Appropriate analysis should be undertaken 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 on the data that is collected, presented and analysed. **No new material should be introduced in the discussions.**

- Greater attention should be paid to the literature review. This is still one of the weak areas in project reports submitted for moderation.
- 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.
- Bibliographic references should be written using a consistent convention. In addition, there should be at least four up-to-date references.

UNIT 1

PAPER 03B

Generally there is the need for overall improvement in the depth and breadth of coverage with respect to certain areas of the syllabus. Candidates' ability to organise and apply knowledge needs to be improved.

Question 1

In Part (a), candidates were expected to use the information provided to explain how the productivity in ecosystem is achieved.

In Part (b), Candidates were tested on their understanding of the following concepts:

- (i) Pyramid of biomass
- (ii) Procedure for determining the biomass of organisms
- (iii) Factors that influence 'Gross Primary Productivity'
- (iv) Trends in Pyramid of Biomass

Candidates performed poorly on this question. Candidates neither demonstrated an understanding of the procedure for determining the biomass of organisms nor an understanding of the factors that influenced Gross Primary Productivity. Most candidates appeared to lack the depth of knowledge required to perform well on this question.

Question 2

This question was designed to test candidates' understanding of the sequence of events that may have resulted in the events of fish kills observed by residents of Community B.

Overall, candidates performed well on Part (a) and Part (b), however most candidates had difficulty with Part (d). Candidates did not outline adequately the impact on the ecological balance of the aquatic community neither did they explain adequately the reason why only a small percentage of energy was incorporated into the tissues of the secondary consumer.

Question 3

Candidates' performance in Part (a) of this question was satisfactory. Most candidates demonstrated an understanding of the role of EIAs in impact mitigation.

Candidates performed poorly on Part (b) of this question. Most candidates did not demonstrate knowledge of sampling techniques for mobile populations.

In Part (c), while candidates demonstrated satisfactory knowledge of measures that can be implemented to prevent negative impacts on aquatic resources, some found difficulty in justifying each measure. Most candidates appeared to lack the depth of knowledge required.

GENERAL COMMENTS

UNIT 2

Only a small percentage of candidates exhibited a comprehensive knowledge of the content of the Unit. Candidates seem to lack content depth, especially in Modules 2 and 3. Too many candidates continue to struggle with questions requiring the use of higher order cognitive skills. It is recommended that in preparing for the examination, greater emphasis be placed on the type of questions in Paper 02.

DETAILED COMMENTS

UNIT 2

PAPER 01

Generally, the performance of candidates was less than satisfactory. Only a few candidates demonstrated the breadth of knowledge necessary to perform well. Candidates' responses in Questions 4, 5 and 12 suggested a lack of knowledge. In too many cases, candidates were unable to define terms correctly. Greater attention to basic principles is required.

Module 1: Sustainable Agriculture

Question 1

This question tested candidates' ability to compare and contrast agricultural systems in the Caribbean. Candidates were required to state THREE reasons why mariculture is not considered subsistence agriculture. To respond appropriately candidates needed to contrast the features of mariculture and subsistence agriculture. Only a minority of candidates responded appropriately. Other candidates offered incomplete responses stating only features of mariculture without highlighting how they differ from subsistence agriculture. Some examples of the expected responses are provided below.

- *Mariculture relies on the impounding of water in selected areas and the production of fish takes place within these confines. Subsistence agriculture may not be confined to a single area over a long-term period.*
- *To be productive and to produce enough to be economically viable, mariculture operations will utilize relatively large areas (of the sea or coastal environment). Subsistence farming utilizes small areas of land.*
- *In mariculture, the principal objective is to produce for sale and income generation. In subsistence farming systems, the principal objective is to produce for satisfying the farmer's household needs.*
- *In subsistence agriculture, the initial yield is high but decreases as productivity of the environment decreases. In mariculture, high yields are maintained through the inputs of food, fertilizers and management to reduce loss due to disease and predation.*

Question 2

This question assessed candidates understanding of technological applications in agriculture. In Part (a) (i), candidates were asked to distinguish between animal breeding and genetic engineering. In Part (a) (ii), candidates were asked to state one similarity between both techniques. The majority of candidates performed well on this question. However, there were some responses that suggested a total lack of knowledge of the techniques of animal breeding and genetic engineering.

In Part (b), candidates were asked to state two ways that genetic engineering impacts positively and negatively on food supply. Many candidates stated positive and negative impacts of genetic engineering without identifying how they affected food supply. Therefore they could not earn the maximum mark available. An example of a candidate's response that is considered complete is provided below.

Genetic engineering creates organisms that can survive or inhabit harsh environments that they might not have been able to do otherwise, thereby raising available food supplies.

Question 3

Part (a) of this question tested candidates understanding of the characteristics of the major agricultural practices in the region. Most candidates were able to outline two factors that influence the cultivation of sugar cane in the Caribbean.

Part (b) tested candidates' knowledge of the environmental issues relating to air and water pollution in the production of sugar cane. This was done satisfactorily.

Question 4

This question examined candidates understanding of the features of sustainable agriculture. Candidates were asked to explain how the practice of sustainable agriculture benefits Caribbean countries. Only the most able candidates responded appropriately to this question as the majority found this question difficult. The following are some features of sustainable agriculture.

Sustainable agriculture promotes social equity by ensuring that resources and power are distributed so that basic needs of all members of the society are met. This includes the right to use land, obtain adequate capital and technical assistance as well as the availability of markets for produce. Social equity or justice is important because social unrest can threaten the entire social system and agricultural system.

Ecological soundness requires the maintenance of the quality of natural resources. Soil is managed and the health of crops, animals and people is maintained through biological processes. Thus vitality of the entire agro-system is enhanced while preserving the environment of Caribbean countries.

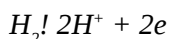
Module 2: Sustainable Energy Use

Question 5

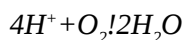
Candidates were tested on the operation and characteristics of a fuel cell as a source of electrical energy. In Part 5 (a), the majority of candidates correctly identified the chemicals, A and B, as hydrogen and oxygen. In Part (b), many candidates did not completely describe the operations of the fuel cell. Many candidates had a general understanding of the cell's operation, but their responses lacked information about the chemical reaction that occurs in the cell.

Note:

In the fuel cell, hydrogen diffuses to the anode which acts as a catalyst where it dissociates into protons and electrons.



The protons are conducted through the potassium hydroxide electrolyte to the cathode catalyst where they combine with oxygen to form water.



The electrons can only reach the cathode by travelling through an external circuit creating a current that can be utilized.

In Part (c), many candidates were able to state two advantages of fuel cells as sources of energy.

Question 6

This question tested candidates' comprehension of the limiting factors in the supply and use of energy and the environmental impact associated with energy use. In Part (a), the majority of candidates were able to state at least one reason correctly for the difference in per capita energy consumption between developed and developing countries as indicated by the graph. Many candidates however struggled to suggest a second correct reason.

Many candidates experienced difficulty in Part (b) in providing a reason to support the following statement:

The use of energy by developed countries will cause a greater environmental impact than the use of energy in developing countries.

The majority of candidates failed to show the relationship between greater per capita energy use by developed countries and greater environmental impact.

Note:

The main energy source in developed societies is fossil fuels such as coal, oil, and to a lesser extent natural gas. These are non-renewable resources and the increasing greater per capita use by developed societies will drive the demand for fossil fuel. This will encourage increased exploration and extraction of fossil fuels in even sensitive ecological areas such as the Arctic regions. This will result in increased incidences of habitat destruction associated with the extraction process.

Question 7

This question examined candidates understanding of methods for energy conservation and improving efficiency in relation to energy efficient buildings. In Part (i), only a minority of candidates correctly stated three ways of increasing the energy efficiency of a building through design modification of its ventilation system. This was also the case in Part (ii) where candidates were asked to state three ways of increasing the energy efficiency of the building with respect to lighting.

Question 8

This question tested candidates' ability to describe the characteristics of a windmill as a source of energy and to outline the environmental impact associated with its use. In Part (a), most candidates correctly identified the rotor blade and the turbine of the windmill. Many of the explanations regarding the production of energy for domestic distribution were incomplete. In general, candidates failed to identify the form of energy associated with wind and to explain how electricity is produced in the windmill.

The kinetic energy of the wind causes the blades of the windmill to rotate. The rotating blades turn a gear mechanism to which a turbine is attached. In the turbine, a coil is caused to rotate in a magnet field (or magnets are rotated in a coil). As the turbine is rotated, electricity is generated which can be transmitted through distribution lines.

In Part (c), the majority of candidates' correctly identified two advantages and two disadvantages associated with the use of the windmill as a source of energy.

Module 3: Pollution of the Environment

Question 9

This question examined candidates' comprehension of the environmental receptors and the various pathways of pollution in the ecosystem and biosphere. This question was generally well done by the majority of candidates. Most candidates correctly outlined at least two pathways of the chemical from the fields to the coastal waters. Candidates are however expected to use the correct terms, such as leaching, to describe the physical processes occurring.

Question 10

This question examined candidates understanding of methods of monitoring air pollution and the threat that air pollution poses. In Part (a), the majority of candidates experienced difficulty outlining the principle of operation of one type of air quality monitoring device. It was apparent from the responses that the majority of candidates had limited knowledge regarding the operation of such devices.

In Part (b), most candidates correctly identified two air pollutants that are of concern in cities. Similarly, most candidates correctly described the impact of one air pollutant on human health.

Question 11

This question examined candidates' knowledge of the type of pollution and the measures available to mitigate their impact in relation to solid waste disposal. The majority of candidates correctly described two environmental impacts related to the disposal of solid waste in the Caribbean in Part (a).

Generally, Part (b) of this question was also well done as many candidates described reduction, reuse or recycling as approaches for decreasing the volume of solid waste produced. Some candidates incorrectly described incineration which is a method of disposing of solid waste but will not decrease the amount of solid waste produced.

Question 12

This question examined candidates' knowledge of noise pollution and the reasons for monitoring noise pollution. In Part (a), many definitions of noise pollution were incomplete.

A complete definition is as follows:

Noise pollution is any unwanted disturbing or harmful sound that impairs or interferes with hearing, causes stress, hampers concentration and work efficiency or causes accidents.

Similarly, in Part (b), the majority of candidates' explanation for noise pollution being monitored was incomplete.

Noise pollution poses serious threats to the health of human beings, for example hearing damage, elevated blood pressure and muscle contraction may occur. Monitoring of the level of noise pollution provides valuable information so that the level of risk to health may be determined, appropriate mitigative measures may be adopted and breaches of noise regulations may be enforced.

PAPER 02

Generally, candidates' performance was unsatisfactory. Candidates continue to struggle with the contents of the Unit especially that of Module 2, Sustainable Energy Use and Module 3, Pollution of the Environment. Candidates' performance on Questions 1, 5 and 7 was exceptionally poor. In general, the majority of candidates' have not demonstrated the higher order cognitive skills that are required to perform well on this paper.

Module 1: Sustainable Agriculture

Question 1

This question assessed candidates understanding of the characteristics and the potential of the non-traditional agriculture system of mariculture to contribute to Caribbean economies.

In Part (a), only a few candidates correctly listed four features of mariculture. Some candidates' responses suggested a complete lack of knowledge of the subject.

In Part (b), the majority of the candidates struggled to evaluate properly the statement below.

“Mariculture has a tremendous potential to contribute to the economies of Caribbean countries”.

In evaluating the statement, candidates were expected to have organised their responses in the following manner:

- (i) Introductory statement outlining their position
- (ii) Discussion of the positive and negative contributions to the economies of the Caribbean
- (iii) Conclusive statement based on the preceding discussion

In general, candidates struggled to discuss the contributions of mariculture to the Caribbean. It appeared that many candidates were not prepared to respond appropriately to this question. Some contributions of mariculture are outlined below.

Alternative source of protein: Commercial fishing has resulted in overfishing and depletion of natural fish stocks. This has increased costs related to the provision of fish protein or alternative sources of proteins. Mariculture could provide or produce significant quantities of additional protein (food) for the growing Caribbean population, decreasing the need to import such products.

Lower cost per unit yield: Mariculture requires little input of food and energy at lower costs when compared to commercial fishing. Mariculture could produce high yields of fish protein at low cost and can be sustainable. Excess production could be sold to generate revenue for the country.

There is the potential for accumulation of organic matter on the sea bed which can lead to increased populations of marine worms and bacteria. Breakdown of the organic matter releases noxious gases which can kill or affect marine life. This has the potential to negatively affect wild fish populations in marine fisheries resulting in decreased yields.

Question 2

Part (a) of this question tested candidates' knowledge of sustainable agricultural practices. The majority of candidates correctly identified and described two sustainable agricultural practices in Parts (a) (i) and (a) (ii). However, some candidates experienced difficulties in stating the advantages and disadvantages of the sustainable agricultural system they identified.

In Part (b), candidates' understanding of the characteristics and technological application relating to commercial agricultural systems were tested. Candidates were asked to explain why such systems require high inputs of inorganic fertilisers. The focus of this question was on the need for **high inputs** of inorganic fertilisers in commercial agricultural systems. However, some candidates' responses focused on the advantages of inorganic fertilisers, such as, the ease of its application. The expected response is as follows:

Commercial agriculture is usually based on the intensive cultivation of a single crop. This often results in the withdrawal of particular mineral nutrients in large amounts. The soil will quickly be depleted of nutrients and lose its fertility, causing yields to decrease. To improve and maintain yields, the mineral nutrients are continually replaced by using large quantities of inorganic fertilisers.

In Part (c), candidates' understanding of the environmental issues associated with the use of **large amounts** of inorganic fertiliser in commercial agricultural systems was assessed. Generally, most candidates outlined the promotion of the eutrophication of water bodies as an environmental impact.

This question was the most popular and had the best performance in the Module and on the Paper.

Question 3

Part (a) of this question tested candidates' ability to interpret graphical data. Candidates were awarded marks for including in their description of the graphical trend, accurate quantitative statements of the changes in rice production during the period 1970 to 1995, as shown by the graph. Many candidates did not score high marks because their responses were too general. Some candidates' responses suggested that they did not understand the label on the y-axis, as they ignored the 10^4 tons. An example of the expected response is given below.

From 1972 – 1975, rice production with normal pesticide use increased significantly from about 10×10^4 tons to about 24×10^4 tons. This was followed by a slight decrease in production from 1975-1980 to about 18×10^4 tons. Production increased steadily from then to about 56×10^4 tons in 1988. From 1988 to 1992, production declined sharply to about 17×10^4 tons.

Parts (b) and (c) assessed candidates' understanding of alternative methods of controlling agricultural pests. In Part (b), some of the methods identified were not appropriate for rice farming. For instance, crop rotation would not be an acceptable method as it would require the rice farmers to cultivate other crops. Feasible alternative methods include biological pest control and genetic engineering.

In Part (c), many candidates gave incomplete explanations of the advantage and disadvantage of the methods they had described in (b). This question was the second most popular in the Module yielding the second best performance by candidates within the Module as well as on the Paper.

Module 2: Sustainable Energy Use

Question 4

This question assessed candidates' understanding of the characteristics and energy conversion processes of tidal and ocean thermal power plants. In Part (a), the majority of candidates correctly distinguished between 'renewable' and 'non-renewable' energy sources. In Part (b), many candidates struggled to describe the basic principle of operation of the tidal and ocean thermal power plants. Candidates' responses suggested that they had limited knowledge of the energy conversion processes in these plants. In many cases, the candidates' responses were a description of the diagram given. Candidates must be made aware that in describing any energy conversion process the different forms of energy existing at each stage of the process must be identified.

In Part (c) of this question, candidates were required to assess the feasibility of any of the systems to satisfy the energy needs of their country. As a guide, candidates were asked to include at least two advantages and two disadvantages in their assessment. The lack of knowledge of the operations of these plants was evident in the responses of candidates. Although a few candidates responded well, the majority were poor, lacking reference to the specific advantages and disadvantages of these energy conversion systems. For example:

The advantages of ocean thermal conversion system are that: the energy source is limitless at suitable sites; no costly energy storage and backup system is needed; the power plant is floating and hence occupies no land area; nutrient brought up when water is pumped from the ocean bottom might nourish schools of fish and other organisms.

The disadvantages are: the pumping of massive quantities of cold water to the surface in a tropical area might alter the properties of the water (temperature, salinity, turbidity, dissolved gases) which will negatively impact on organisms; it is believed that large scale extraction of energy by this method may never be economically competitive with other alternatives such as wind and solar energy; the fact that these plants are floating in coastal waters make them prone to damage by hurricanes or other weather systems.

This question was as popular as Question 5. The performance of candidates on this question was on the Module and yielded the second best performance by candidates on the Module and the fourth best performance on the Paper.

Question 5

This question tested candidates' knowledge of the conventional generation of electricity and the environmental impacts associated with this process specifically in relation to coastal areas. In Part (a), the majority of candidates correctly provided two reasons for the coastal location of

conventional power plants in the Caribbean. The two main reasons given were the ease of transportation by sea of oil imports and the availability of an abundant source of cooling water for the plant during operations. Some candidates responded by explaining why the plants were not located in the interior regions of their country. These responses were not credited any marks as they were deemed not to be answering the question asked.

The majority of responses to Part (b) were poor. The responses focused on the general impacts associated with the use of fossil fuel rather than the specific impacts associated with the operation of the power plant. The specific impacts on coastal environments include thermal pollution and oil spills when off-loading oil shipments.

Note:

Sea water used to cool turbines is returned warmer than it was originally. The increase in temperature of the water body results in less oxygen dissolving which forces organisms to migrate or die. Increased temperature also affects organisms' digestion rates. Typically, organisms require more food to maintain body weight in high-temperature environments. Such organisms have a shorter life span and smaller populations. Higher temperature also affects reproductive and respiratory rates. In the Caribbean, the temperature of the water is normally at the upper limit of the organisms' range of tolerance and any increase in temperature may cause migration or death.

The responses to Part (c) were also inadequate. Only a minority of candidates adequately explained how cogeneration could be used to decrease the environmental impact of these plants on the coastal environment as well as increase the efficiency of operation.

As a result of its operation a conventional power plant produces waste heat in the form of steam. This heat is disposed of in coastal waters. With cogeneration the waste heat can be utilised for useful activities such as heating buildings. As a result no heat is released in coastal waters thus preventing the occurrence of thermal pollution. Power plants convert only a small percentage of fuel consumed to electrical energy. Typically they achieve efficiencies of about 33 percent. The waste heat may be used as a source of energy to generate electricity or operate machinery. A greater percentage of the energy produced by the plant is used in increasing the overall efficiency of operation. Cogeneration may increase operating efficiency up to about 54 percent.

This question was as popular as Question 4 in the Module. Candidates' performance on the question ranked third in the Module and seventh in the Paper.

Question 6

This question tested candidates' knowledge of the environmental impacts associated with the use of petrol as an energy source for motor vehicles and the approaches that exist to mitigate these impacts. In Part (a) of this question, the majority of candidates satisfactorily described the environmental impacts of petrol use in motor vehicles. In Part (b), many candidates did not focus on approaches that Caribbean countries could adopt in order to specifically mitigate the environmental impacts directly related to the use of motor vehicles but generally on the use of petrol. Some measures that Caribbean countries could take include improving their road network, improving public transportation systems and enacting legislations that promote fuel efficiency.

Note:

At certain speeds, motor vehicles operate most efficiently. When roads are congested and traffic is at a standstill or moving slowly, the efficiency of operation is low. Road networks should be improved to allow rapid transit between point of origin and destination. This will decrease travel time, amount of fuel consumed and total emissions.

Only a minority of candidates appropriately evaluated the statement given in Part(c). Many candidates agreed that "cars powered by electricity will be the solution to the problems resulting from the use of petrol as the energy source in motor vehicles". Many failed to realise that only under certain conditions would the statement be true.

Note:

An engine that runs on electricity is much cleaner than gasoline since there are no emissions. The electricity for the operation of the vehicle may be sourced from a conventional power plant. If this is the case emission will still occur during the process of generating the electricity. The electricity may be sourced from renewable energy sources, such as, solar and hydropower. Under such circumstances, there will be no emission associated with the operations of this vehicle. Under such circumstances, the problem of emissions will be solved.

This was the most popular question in the Module. The performance of candidates on this question was the best on the Module and third best on the Paper.

Module 3: Pollution of the Environment

Question 7

This question tested candidates' ability to interpret graphical data, analyse the impact of pollution and to describe the pathways of pollution in the biosphere. Part (a) was well done with the majority of candidates identifying at least one hazardous chemical found in the soil. Similarly, many candidates' adequately described the trend shown by the graph. Candidates who did not include points read from the graph were not awarded full marks.

Many candidates experienced difficulties with Part (c) in explaining why the trend identified in the graph posed a significant threat to humans and other organisms. While some candidates had three appropriate reasons, their explanations generally were inadequate. The majority of candidates' struggled to offer one correct reason. The correct response to the question is provided below.

The nature of hazardous chemicals makes them a serious health threat to organisms. Some hazardous chemicals are carcinogenic. Such chemicals cause or promote the growth of malignant tumours in organisms. Hazardous chemicals have been linked to leukaemia and cancers of the brain and testicles. Some chemicals are teratogens and cause damage to genes. Prolonged exposure to these chemicals causes birth defects while the embryo is developing. Birth defects include stunted limbs. Many hazardous chemicals become stored in the fatty tissue of organisms. The concentration of the chemical increases in the body tissues as more of the substance is assimilated through the process of bioaccumulation. Non-degradable fat soluble chemicals also increase in concentration in organisms at successive trophic levels of food chain or web. This process called biomagnification increases the risks of cancers developing. This may affect the reproductive processes of the organism resulting in the birth of malformed offspring.

The majority of candidates gave incomplete answers to Part (d). It was obvious that candidates' either lacked the knowledge required or did not understand the question. The question required candidates to explain how human activities in surrounding countries could contribute to the increasing concentration of hazardous chemicals in the soil. The focus of this question was on the transfer and deposition of pollutants by atmospheric processes as outlined below.

Note:

As clean air in the troposphere moves across the earth surface, it collects the products of human activities. Chemicals from industrial processes in neighbouring countries may be emitted into the atmosphere. These pollutants mix with the air in the atmosphere and are then transported by wind currents. If the pollutants are persistent (long lived), then they can be transported great distances before returning to earth as solid particles, droplets or chemicals dissolved in precipitation. Since Caribbean countries are close together transfer of pollutants by atmospheric deposition is easy. The

increasing concentration of hazardous chemicals in the soil may be due to human activities in other countries which cause such chemicals to enter the atmosphere. These activities include increased use of incinerators to dispose of hazardous waste. Human activities increase the concentration of hazardous chemicals in the atmosphere and the probability that these forms of pollution will occur.

This question was the least popular in the Module. Candidates' performance on this question was the poorest both in the Module and in the Paper.

Question 8

This question tested candidates' ability to analyse data and their understanding of the sources and the environmental impact of water pollution. In Part (a), only a few candidates adequately explained the meaning of the term 'water quality standard'. In Part (b), there were many candidates who correctly compared the data in the table for each parameter with the given standard to determine the suitability of the river for the purpose of recreation and as a source of drinking water. It was encouraging to see that some candidates calculated the average concentration of the parameter in the river which was then used as the basis for comparison with the standard value.

In Part (c), most candidates were able to suggest one reason for the presence of nitrates in the water, but struggled to provide a second reason. The answer to this question is based on the environmental pathway of nitrates as outlined below.

Non-point sources of nitrate include agricultural fields from which inorganic fertilizers may leach by running water and enter the river directly, or flow into natural or man-made gullies which empty into rivers. Nitrates could dissolve in surface precipitation and percolate down into underground aquifer which empty into rivers.

Organic matter (such as leaves and tree limbs) may enter the river. As organic matter decays, it releases its chemical constituents which include nitrates. The river could be receiving sewage from point and non-point sources which include gullies or outfall pipes. This may contain oils, soaps and detergents which are sources of nitrates.

In Part (d), many candidates described the occurrence of eutrophication as one of the environmental impacts of nitrates on the river ecosystem. Related to the development of eutrophic conditions in the river is the decreasing concentration of dissolved oxygen which limits the ability of aquatic organisms to survive. Only a few candidates recognised the resultant decrease in biodiversity, the other environmental impact on the river.

The presence of nitrates in the river causes the enrichment of the water body. This supports the rapid growth of algae and cyanobacteria. The water becomes cloudy and green and its quality decreases.

Decomposition occurs when the vast quantity of algae and cyanobacteria dies. This process uses up dissolved oxygen in the water body resulting in a decrease in the available oxygen content of the river. Eutrophication reduces sunlight penetration which reduces the photosynthetic activities of bottom-dwelling aquatic plants.

Organisms need the oxygen dissolved in the water to survive. If the oxygen concentration is low, organisms are forced to migrate to other areas. This changes the composition and diversity of the organisms inhabiting the river. Extremely low levels of oxygen result in large-scale death of aquatic organisms.

This question was the most popular and had the best performance in this Module and the fifth best performance in the paper.

Question 9

This question tested candidates' understanding of the atmospheric process causing global warming and the proposed measures to slow it. Parts (a) and (b) were generally well done. Most candidates correctly identified the troposphere and stratosphere in the diagram and listed two gases having a predominant role in global warming. In Part (c), only a few candidates gave a complete description of the 'green house' process responsible for increased global temperatures. Some candidates' responses suggest that there is confusion between the processes of global warming and ozone depletion. A complete description of the process of global warming is provided below.

Solar energy penetrates the atmosphere and warms the earth's surface. Incoming radiation enters the atmosphere as short-wave infrared radiation. The earth's surface absorbs this heat which is radiated in the form of long-wave infrared radiation to the troposphere with some escaping into space. The greenhouse gases in layer B absorb some infrared wavelengths and re-radiate a portion of them to the earth. Atmospheric levels of certain green house gases such as, CO₂, have risen substantially in recent decades. The increased concentration of these gases is causing more heat to be trapped near the earth's surface in layer B resulting in increased retention of heat radiation. This has caused an overall rise in global temperatures called Global warming.

In Part (d), many candidates experienced difficulties assessing the measures to slow global warming. In general, candidates explained the proposed measures without making a judgement as to the effectiveness of each measure. Here also, the confusion between global warming and ozone depletion was evident, as some candidates' discussed the Montreal protocol as a measure to slow global warming. Candidates should understand that the Kyoto protocol is an international treaty designed to limit greenhouse gas emissions, which can only be achieved by implementing measures such as these outlined below.

Shifting to renewable energy will reduce the emissions of CO₂ and other pollutants. Current renewable technology satisfies a small percentage of our energy needs but have the potential to contribute more. Some of these technologies are expensive and perhaps not affordable by developing countries.

Increasing the efficiency of motor vehicles and appliances will result in a decrease in the consumption of fossil fuels. In turn, this will cause a decrease in the output of carbon dioxide and slow global warming. This is the quickest, cheapest and most effective way of reducing emissions of CO₂ and other pollutants.

This was the second most popular and the second best performing question in the Module. Overall this was the sixth best performing question in the paper.

UNIT 2

THE INTERNAL ASSESSMENT

For Unit 2, please note that the Internal Assessment requirements have been amended and this is available in the **Amendment to the Syllabus in Environmental Science Effective for Examinations from May/June 2006, on the CXC website (www.cxc.org)**.

The overall quality of the submissions for this Unit was good. Many of the students included an introduction to the journal which was very useful in indicating the scope and purpose of the entries to the reader. In addition, this also helped to focus the candidate in making appropriate observations and interpretative comments.

It was apparent in some cases that there was some difficulty in finding appropriate tasks for the laboratory exercises. Candidates again showed weakness in analysing and interpreting results.

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

For the moderation process, it is important that teachers submit mark schemes used for laboratory exercises. These were missing in too many instances.

LABORATORY EXERCISES

Significant improvement was noted in the overall quality and relevance of laboratory exercises. In general, most candidates submitted an adequate number of laboratory exercises with satisfactory coverage of the criteria to be moderated. Only in a few instances were the spread of the laboratory exercises too narrow and the laboratory exercises chosen too simple for the level of examination.

While the work of most candidates demonstrated adequate coverage of the skills to be assessed there is still room for improvement in the areas of manipulation and measurement and to a lesser extent in analysis and interpretation.

For Unit 2, it is important to note that laboratory exercises should relate to each or any of the series of site visits.

JOURNAL

Improvement was noted in the overall quality of journal entries. This year, more candidates were able to link journal entries and laboratory exercises to specific objectives and also to conduct appropriate, complementary and supporting activities. The area of greatest improvement was reflected in candidates providing the required number of journal and laboratory entries.

The main area of weakness identified was that of interpretative comments. This may be improved if candidates have developed the “habit of keen observation, relevant and precise reporting, concise recording and the ability for critical thinking, problem solving and decision making”. Other areas of weakness were linked to the fact that site visits were not always appropriate and in some instances objectives were not always tied to any specific objectives in the Syllabus.

It cannot be over-emphasised that the syllabus requires journal entries to 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’. In a few of the submissions, candidates visited different sites and so could not make valid comparisons having examined different processes and occurrences.

UNIT 2

PAPER 03B

Generally, candidates’ performance was unsatisfactory. 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

This question was designed to test candidates’ ability to:

- (i) Graphically represent tabulated data
- (ii) Analyse graphical data
- (iii) Outline methods of monitoring water pollution

Candidates' earned the majority of their marks in Parts (a), (b) and (c). In Part (a), however, the scale used by some candidates for the y-axis was inappropriate. Candidates should scale their graph so that it occupies more than 75 percent of the graph paper. In general, candidates adequately described the trend in nitrate concentration based on their graph in Part (b). Candidates, however, had some difficulty in Part (c), where they were required to state four conclusions regarding the impact of the development on the water quality of Dragoon Bay. This inability to make inferences based on graphical and tabulated data is a weakness that candidates' continue to display in these examinations.

In Part (d), only a few candidates gave a complete description of the laboratory process to test marine water for faecal coliform.

Question 2

This question was designed to test candidates' ability to

- (i) explain the importance of water quality monitoring
- (ii) explain the significance of water quality parameters
- (iii) design a water quality monitoring plan.

This question was done unsatisfactorily. Candidates had difficulty in explaining the importance of monitoring water quality. Candidates did not outline adequately the steps expected in a water quality programme or the significance of monitoring the concentration of nitrates, BOD and faecal coliform. Most candidates appeared to lack the depth of knowledge required to perform well on this question.

Question 3

This question was designed to test candidate's knowledge of Environmental Impact Assessments (EIA) and their ability to interpret the map that accompanied the question. The majority of candidates knew what an EIA was, but could not outline four steps of the process. In Part (c), only a few candidates compared the maps of Dragoon Bay in 1990 and 1992, and correctly explained the features that had a possible negative environmental impact on the water quality of the Bay. This question was poorly done by many candidates. An example of the expected response to Part (c) is provided below.

Sewage treatment capacity: The number of residential units has increased from 300 to 1300 without any increase in the capacity of the sewage treatment plant. Sewage plants are built to process a certain volume of sewage. When the capacity is not exceeded the residence or retention time of the sewage is enough to allow settling and bacterial action to remove most organic solids. This reduces the BOD of the effluent that is discharged to marine waters. When the plant is overloaded the sewage is not retained long enough to substantially reduce the organic load. The discharged effluent contains a high concentration of organic matter, which will increase the BOD of the water.