



CARIBBEAN EXAMINATIONS COUNCIL

CAPE[®]

Environmental Science

**SYLLABUS
SPECIMEN PAPER
MARK SCHEME
SUBJECT REPORTS**

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Environmental Science

Environmental Science is an interdisciplinary branch of science that deals with the interactions among physical, chemical, and biological components of the environment. The subject employs qualitative and quantitative approaches to the study of environmental systems. The CAPE Environmental Science Syllabus provides opportunities for students to acquire knowledge and skills to identify, prevent and solve problems and prepares them for careers in diverse fields related to environmental management and to sustainable development of the Caribbean Region. The aims of the syllabus include development of an understanding of the interdisciplinary and holistic nature of the environment and the interactions between people and the environment.

The subject is organised in two Units. A Unit comprises three Modules.

UNIT 1: Ecology, Human Population and Natural Resources

- Module 1 – Fundamental Ecological Principles
- Module 2 – Human Population and the Environment
- Module 3 – Sustainable Use of Natural Resources

UNIT 2: Agriculture, Energy and Environmental Pollution

- Module 1 – Agriculture and the Environment
- Module 2 – Energy and the Environment
- Module 3 – Pollution of the Environment



CARIBBEAN EXAMINATIONS COUNCIL

**Caribbean Advanced Proficiency Examinations
CAPE[®]**

**ENVIRONMENTAL SCIENCE
SYLLABUS**

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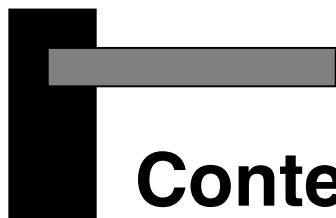
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Please note that the syllabus has been revised and amendments are indicated by italics.

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Please check the website www.cxc.org for updates on CXC's syllabuses.



Introduction

The Caribbean Advanced Proficiency Examinations (CAPE) are designed to provide certification of the academic, vocational and technical achievement of students in the Caribbean who, having completed a minimum of five years of secondary education, wish to further their studies. The examinations address the skills and knowledge acquired by students under a flexible and articulated system where subjects are organised in 1-Unit or 2-Unit courses with each Unit containing three Modules. Subjects examined under CAPE may be studied concurrently or singly.

The Caribbean Examinations Council offers three types of certification. The first is the award of a certificate showing each CAPE Unit completed. The second is the CAPE diploma, awarded to candidates who have satisfactorily completed at least six Units, including Caribbean Studies. The third is the CAPE Associate Degree, awarded for the satisfactory completion of a prescribed cluster of seven CAPE Units including Caribbean Studies and Communication Studies. For the CAPE diploma and the CAPE Associate Degree, candidates must complete the cluster of required Units within a maximum period of five years.

Recognized educational institutions presenting candidates for a CAPE Associate Degree in one of the nine categories must, on registering these candidates at the start of the qualifying year, have them confirm in the required form, the Associate Degree they wish to be awarded. Candidates will not be awarded any possible alternatives for which they did not apply.



Environmental Science

◆ RATIONALE

Science plays a major role in the evolution of knowledge by empowering us with the skills required for creative and independent problem-solving. It arouses our natural curiosity, encourages our ability to enquire, to pose questions, and to conduct research required to obtain answers. This approach leads to the construction of hypotheses, theories and laws that help us to explain natural phenomena, to understand human activities in relation to natural phenomena, and through this to meet the challenge of survival and progress in a diverse and changing world.

The environment and natural resource base of the Caribbean are critical for the welfare of Caribbean people. Natural resource and environmental management and conservation are pre-requisites for sustainable development in the region. Achieving sustainable development requires an appreciation of the value of natural resources and the environment, and the development of the knowledge base and skills required for effective management. A firm grounding in these skills, knowledge and attitudes is provided through a study of Environmental Science.

Environmental Science is an interdisciplinary subject which draws on the content of several disciplines to offer a balanced scientific and holistic perspective of environmental issues. It provides knowledge, skills and attitudes to identify, prevent and solve environmental problems and thereby prepares students for ultimate careers in diverse fields of relevance to environmental management and to sustainable development of the Caribbean Region.

This CAPE syllabus in Environmental Science presents a coherent course of study which provides a specific knowledge base of the environment and which facilitates the development of related skills and attitudes. The syllabus takes into account the requirements for tertiary education at regional and international institutions. It is intended for a wide range of students, including traditional sixth form students, part-time, mature and private students.

This syllabus will contribute to the development of the Ideal Caribbean Person as articulated by the CARICOM Heads of Government in the following areas: respect for human life and awareness of the importance of living in harmony with the environment; multiple literacies; independent and critical thinking and the innovative application of science and technology to problem solving. Based on the UNESCO Pillars of Learning, this course of study will also contribute to a person who will learn how to do, learn to live together and learn to transform themselves and society.

◆ AIMS

The syllabus aims to:

1. stimulate interest in the environment;
2. develop an understanding of the interdisciplinary and holistic nature of the environment;
3. develop knowledge and understanding of environmental issues and principles and the ability to apply these to environmental management, particularly in a Caribbean context;
4. develop the ability to identify critical research questions and formulate hypothesis or guiding statements.
5. develop the ability to collect, collate, analyze and interpret environmental data;
6. develop the ability to communicate environmental information and ideas logically and concisely in a variety of forms;
7. provide an understanding of interactions between people and the environment;
8. *increase an awareness of the importance of living in harmony with the environment;*
9. recognize and evaluate the socio-economic, political and ethical issues in Environmental Science;
10. foster positive attitudes, values and commitment to identifying, solving and preventing environmental problems;
11. develop an understanding of how natural resources and the environment affect quality of life and the quest for sustainable development in the Caribbean.

◆ SKILLS AND ABILITIES TO BE ASSESSED

The skills and abilities which students are expected to develop on completion of the syllabus have been grouped under three main headings:

- (i) Knowledge and Comprehension;
- (ii) Application of Knowledge;
- (iii) Practical *Abilities*.

Knowledge and Comprehension

The examination will test candidates' skills and abilities to:

- (i) Define terms and explain concepts;
- (ii) describe processes;
- (iii) state principles and properties;
- (iv) explain interactions and inter-relationships.

Application of Knowledge

The examination will test candidates' skills and abilities to:

- (i) analyze and discuss different environmental situations;
- (ii) evaluate and justify options (for the use of resources);
- (iii) compare and contrast alternative solutions to environmental problems;
- (iv) select techniques and methodologies appropriate to different environmental situations;
- (v) suggest possible solutions to specific environmental problems;
- (vi) draw inferences from environmental data.

Practical Abilities

The examination will test candidates' skills and abilities to:

- (i) *select techniques, designs, methodologies and instruments appropriate to different environmental situations;*
- (ii) use instruments to measure environmental parameters;
- (iii) collect and collate data;
- (iv) analyze, interpret and present data;
- (v) *use quantitative techniques appropriately;*
- (vi) *develop appropriate solutions to specific environmental problems.*

◆ PRE-REQUISITES OF THE SYLLABUS

Any person with a good grasp of the contents of the Caribbean Secondary Education Certificate (CSEC) Integrated Science or Physics or Chemistry or Biology or Geography or Agricultural Science syllabuses, or the equivalent, should be able to pursue the course of study defined by the syllabus. However, successful participation in the course of study will also depend on the possession of good verbal and written communication skills.

◆ STRUCTURE OF THE SYLLABUS

The subject is organised in two Units. Each Unit contains a body of knowledge and skills drawn from several disciplines that impact on the environment. Unit 1 addresses Ecology, Human Population and Natural Resource Use, while Unit 2 deals with Agriculture, Energy, and Environmental Pollution.

A Unit comprises three Modules, each requiring 50 hours. The total time for each Unit, is therefore, expected to be 150 hours. Each Unit can independently offer students a comprehensive programme of study with appropriate balance between depth and coverage to provide a basis for further study in this field.

UNIT 1: Ecology, Human Population and Natural Resources

- Module 1 - Fundamental Ecological Principles
- Module 2 - Human Population and the Environment
- Module 3 - Sustainable Use of Natural Resources

UNIT 2: Agriculture, Energy and Environmental Pollution

- Module 1 - Agriculture *and the Environment*
- Module 2 - Energy *and the Environment*
- Module 3 - Pollution of the Environment

In this syllabus, the specific objectives which are denoted by an asterisk (*) are particularly suitable for practical exercises. However, the project need not be limited to these objectives.

◆ UNIT 1: ECOLOGY, HUMAN POPULATION AND NATURAL RESOURCES

MODULE 1: FUNDAMENTAL ECOLOGICAL PRINCIPLES

GENERAL OBJECTIVES

On completion of this Module, students should:

1. understand the basic ecological concepts;
2. understand the processes that govern the interactions of organisms with the biotic and abiotic components of their environment;
3. understand the relationship between people and the environment;
4. acquire knowledge and develop practical and analytical skills.

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

- | | |
|---|---|
| <ol style="list-style-type: none">1. differentiate between key ecological terms and concepts;2. explain the relationship between living organisms and their environment; | <p>Ecology: species, population, community, ecosystem, biosphere, atmosphere, hydrosphere, lithosphere, habitat, niche, biome, ecotone.</p> <ol style="list-style-type: none">(i) The biotic and abiotic environments.(ii) Tolerance ranges and limiting factors.(iii) Ecological niches:<ol style="list-style-type: none">(a) fundamental niche;(b) realised niche. |
|---|---|

UNIT 1

MODULE 1: FUNDAMENTAL ECOLOGICAL PRINCIPLES (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES
Students should be able to:	
3. outline the importance of biogeochemical cycles;	(i) Carbon Cycle. (ii) Nitrogen Cycle. (iii) Phosphorus Cycle. (iv) Water Cycle. Include basic chemical equations and formula for biogeochemical cycles.
4. Explain the significance of <i>biogeochemical cycles</i> to organisms;	
5. explain how energy <i>and nutrients</i> flows within ecosystems;	(i) Productivity of producers and ecosystems. (ii) Food chains and webs. (iii) Trophic levels. (iv) Ecological pyramids.
6. discuss types of interactions between organisms in communities;	(i) Competition. (ii) Predator-prey. (iii) Symbiosis: (a) parasitism; (b) commensalism; (c) mutualism.
7. explain how ecosystems are self-sustaining;	Ecological succession and climax communities.
8. explain the process of natural selection and adaptation to the environment;	Natural selection, evolution and adaptation.

UNIT 1

MODULE 1: FUNDAMENTAL ECOLOGICAL PRINCIPLES (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES
Students should be able to:	
9. determine population size using appropriate sampling methods;	Population sampling methods for moving and non-moving organisms (for example, quadrats, transects, capture, mark, release, recapture).
10. calculate species diversity;	$D = \frac{\sum n(n-1)}{N(N-1)}$ <p>Where D – species Diversity N – total number of organism of all species n - total number of organism of a particular species</p>
11. analyse the relationship between species diversity and ecosystem stability;	(i) Diversity within species. (ii) Diversity between species. (iii) Community and ecosystem stability.
12. identify factors affecting population growth in a natural ecosystem;	(i) Biotic potential. (ii) Exponential population growth. (iii) Environmental resistance.
13. explain the concept of carrying capacity;	
14. evaluate human interactions within natural ecosystems;	(i) Human beings as part of the natural ecosystems. (ii) Benefits of natural ecosystems. (iii) Anthropogenic impact on ecosystems and <i>biodiversity</i> and the need to maintain its integrity.
15. investigate at least two ecosystems in a territory;*	Consider both terrestrial and aquatic (freshwater and marine) ecosystems.

UNIT 1

MODULE 1: FUNDAMENTAL ECOLOGICAL PRINCIPLES (cont'd)

16. measure and discuss environmental parameters in a given habitat;*
17. *apply scientific method to experimental design and analysis;* See suggested teaching-learning activities.
18. Present and interpret data using appropriate charts, table, graphs.

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Module, teachers are advised to engage students in the teaching and learning activities listed below.

1. *Define environmental science*
2. *Formulate hypothesis, develop guiding statements and generate and interpret data.*
3. *Discuss current environmental issues and highlight the importance of adopting an inter-disciplinary approach.*
4. Sample an ecosystem to determine population density and distribution.
5. *Conduct study visits, to identify species diversity.*
6. Investigate environmental parameters in a *natural aquatic environment*.
7. Create models of existing ecosystems in a specific location.
8. Create food webs and analyse possible disruption of feeding relationships.
9. Study the source(s) and distribution of a country's freshwater supply and its level of dependence on natural water cycles.
10. Visit to an ecosystem to identify and quantify human use of its components.

UNIT 1

MODULE 1: FUNDAMENTAL ECOLOGICAL PRINCIPLES (cont'd)

RESOURCES

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- Jackson, et al. *Global Issues 1999-2000*, Guilford, CT: Duskin Publishing Group Inc., 1998.
- Jordan, C. *Conservation*, New York: John Wiley and Sons, 1995.
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- Nebel, B. and Wright, R. *Environmental Science: The Way the World Works*, New Jersey: Prentice Hall, 1997.
- The Cropper Foundation (TCF), 2009. *Sustainable Development. Terms and concept: A reference for teachers and student*. Port-of-Spain, Trinidad
- Biodiversity of the Caribbean. A learning Resource prepared for Eastern Caribbean States*, Canada: EKOS Communications Inc. 2009.

Websites:

www.redlist.org/info/captions

www.biomeso.net

bioplan@undp.org

UNIT 1

MODULE 2: HUMAN POPULATION AND THE ENVIRONMENT

GENERAL OBJECTIVES

On completion of this Module, students should:

1. understand the historical and geographical trends in human population growth and consumption patterns;
2. understand the socio-environmental impacts related to population growth;
3. understand the factors that affect the growth rate of human populations;
4. appreciate the need for sustainable development;
5. acquire knowledge and develop practical and analytical skills.

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

- | | |
|---|---|
| 1. assess the relationship between people and the environment; | (i) Adaptation of people to the environment (including but not limited to how people adapt to the environment, crops they grow, culture, clothes, shelter). |
| | (ii) Abiotic and biotic factors that affect the distribution of population and their activities. |
| | (iii) Dependence of people on ecological systems and processes. |
| 2. explain the demographic characteristics of human population; | (i) Age and sex structure. |
| | (ii) Fertility rates. |
| | (iii) Mortality rates. |
| | (iv) Life span and life expectancy. |
| | (v) Immigration. |
| | (vi) Emigration. |
| | (vii) Doubling time. |

UNIT 1

MODULE 2: HUMAN POPULATION AND THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

- | | | |
|----|--|--|
| 3. | describe historical trends in human population size; | Compare historical and current trends in human population growth. |
| 4. | describe the current geographical distribution of human population growth; | Current geographical distribution of human population growth:

(i) in developing nations;

(ii) in developed nations. |
| 5. | interpret demographic tables, graphs and charts; | (i) Age and sex structure.

(ii) Fertility rate, mortality rate, birth rate, |
| 6. | calculate changes in demographic characteristics; | (i) Population size and growth rate.
Fertility rate; mortality rate; migration rate, birth rate.

(ii) Percentage increase in population

(iii) Doubling time = $\frac{70}{\% \text{ annual growth}}$. |
| 7. | assess the factors affecting population growth rate; | (i) Culture.

(ii) Religion.

(iii) Level and cost of education.

(iv) Social and economic status of women.

(v) Availability of pension schemes.

(vi) Level of affluence.

(vii) Economic development. |

UNIT 1

MODULE 2: HUMAN POPULATION AND THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

8. assess the effectiveness of population control methods and measures;

Population Control Measures:

- (i) Direct - Family Planning measures and methods, government policies
- (ii) Indirect - Natural disasters (floods, earthquakes, volcanoes, hurricanes).

9. *assess the relationship between population growth and poverty;*

(i) The Indices of poverty:

- (a) access to education;
- (b) access to health care;
- (c) access to basic needs such as food, housing, water.

(ii) Per capita, Gross Domestic Product and Gross National Product (GDP and GNP), Human Development Index (HDI), Gender Development Index (GDI).

(iii) Environmental impacts of population growth (for example, *deforestation in Haiti*. Include social, biological, economic, physical considerations).

10. describe current geographical variation in human consumption patterns;

(i) Consumption patterns as quantified by statistics on:

- (a) per capita water consumption;
- (b) per capita food consumption;
- (c) per capita fuel consumption;
- (d) per capita greenhouse gas emissions;
- (e) per capita waste production.

UNIT 1

MODULE 2: HUMAN POPULATION AND THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

- | | | |
|-----|--|--|
| 11. | explain the principal ways in which people impact negatively on the environment; | (ii) Current trends in per capita consumption particularly influenced by lifestyles in developed and developing countries. |
| 12. | | Environmental impacts of over consumption in developed and developing countries. |
| 13. | | (i) Overexploitation.
(ii) Habitat destruction.
(iii) Pollution.
(iv) Introduction of exotic species. |
| 14. | | (i) Change in lifestyles.
(ii) The use of substitutes.
(iii) Application of environmentally friendly technology.
(iv) Efficient use of natural resources, for example, recycling. Refer to Module 3, Specific Objective 10. |
| 15. | | (i) Causes of urbanisation.
(ii) Environmental impacts of urbanisation (including but not limited to sanitation, water supply, traffic congestion, housing, pollution, health care). |
| 16. | | (i) Concept of sustainable development.
(ii) Goals of sustainable development. |

UNIT 1

MODULE 2: HUMAN POPULATION AND THE ENVIRONMENT (cont'd)

- (iii) Population growth and changing consumption patterns as constraints to sustainable development in a finite world.
- (iv) Strategic Imperative for Sustainable Development #4 “Ensuring a Sustainable Level of Population” (Our Common Future, Brundtland Report, 1987).

Suggested Teaching and Learning Activities

To facilitate students’ attainment of the objectives of this Module, teachers are advised to engage students in the teaching and learning activities listed below.

1. Study a local population based on census statistics; generate population age structure, for all individuals and separately by sex.
2. Calculate crude birth rates, age-specific birth rates, total fertility rates, crude death rates, age-specific death rates, infant mortality rates, percentage annual increase in population size, and doubling times for populations.
3. Interpret World Population Data Sheets, as produced, for example, by the Population Reference Bureau Inc.
4. Arrange a debate on high population growth or high consumerism as principal causes of global environmental problems, using, for example, reports from the 1992 Rio Conference.
5. Conduct case studies of population size management and of related changes in consumption patterns.
6. Organise a debate on the definitions of development and sustainable development, and on the question of what constitutes an acceptable standard of living.
7. Discuss the main issues addressed by:
 - (i) the 1972 Stockholm Conference;
 - (ii) the 1980 International Union for the Conservation of Nature (IUCN) World Conservation Strategy;
 - (iii) the 1987 Brundtland Report (*Our Common Future*);

UNIT 1

MODULE 2: HUMAN POPULATION AND THE ENVIRONMENT (cont'd)

- (iv) the 1992 United Nations Conference on Environment and Development (The Rio Conference);
- (v) the 1994 United Nations Conference on Small Island Developing States;
- (vi) the 2002 World Summit on Sustainable Development *Johannesburg*.

RESOURCES

- Chiras, D. *Environmental Science. Action for a Sustainable Future*, United States of America: The Benjamin/Cummings Publishing Company, Inc. 1994.
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UNIT 1

MODULE 3: SUSTAINABLE USE OF NATURAL RESOURCES

GENERAL OBJECTIVES

On completion of this Module, students should:

1. be aware of the major 'natural resources' in the Caribbean;
2. understand the factors affecting natural resource use and the environmental impacts of their use;
3. be aware of measures and tools available for sustainable use and conservation of natural resources;
4. understand the value of natural resources;
5. understand the concept of ecological sustainability and implications for natural resource use;
6. acquire knowledge and develop practical and analytical skills.

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

- | | | |
|----|---|--|
| 1. | explain the term natural resources; | <i>Temporal Dimensions and limitations placed by technology.</i> |
| 2. | differentiate between renewable and non-renewable natural resources; exhaustible and inexhaustible resources; | (i) <i>Types and examples of natural resources: renewable and non-renewable.</i>

(ii) <i>Types and examples of exhaustible and inexhaustible resources.</i> |
| 3. | differentiate between the consumptive and non-consumptive use of natural resources; | (i) <i>Consumptive use (logging, fishing, quarrying).</i>

(ii) <i>Non-consumptive use - bioprospecting, ecotourism, research.</i> |

UNIT 1

MODULE 3: SUSTAINABLE USE OF NATURAL RESOURCES (cont'd)

SPECIFIC OBJECTIVES	EXPLANATORY NOTES
Students should be able to:	
4. identify the major categories of natural resources in Caribbean countries;	<ul style="list-style-type: none">(i) Biodiversity:<ul style="list-style-type: none">(a) species(b) genetic(c) Ecosystems: forest; coral reefs; wetlands; seagrass beds; mangroves; freshwater <i>and marine</i> ecosystems.(ii) Water as a resource, for example, waterfalls, lakes, streams, groundwater.(iii) Minerals and hydrocarbons: bauxite; gold; sand and gravel; oil; natural gas.(iv) Soil, landscape and seascape, (beaches, cliffs, mountains).
5. identify the location and distribution of natural resources in the Caribbean;	
6. assess the importance of natural resources in the Caribbean;	<ul style="list-style-type: none">(i) <i>Livelihood (Income generating activity).</i>(ii) <i>Foreign exchange earner.</i>(iii) <i>Food security.</i>(iv) <i>Raw material for industrial processes.</i>(v) <i>Recreation.</i>(vi) <i>Sacred and spiritual value.</i>(vii) <i>Ecosystem value.</i>(viii) <i>Intrinsic value.</i>(ix) <i>Research and teaching.</i>

UNIT 1

MODULE 3: SUSTAINABLE USE OF NATURAL RESOURCES (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

7. evaluate factors affecting natural resource use in the Caribbean;

- (i) Political - government policies on natural resource use:

(a) economic development policies;

(b) environmental and natural resources policies.

- (ii) *Economic: role of foreign investment; export of natural resources as primary products; sectoral activities - tourism, agriculture, mining, manufacturing, national debt.*

Refer to Specific Objective 10, Explanatory Note (iv).

8. access the environmental impact of natural resource use including tourism;

- (i) Biodiversity:

(a) species depletion and extinction;

(b) habitat disruption and destruction;

(c) disruption of ecosystem processes.

UNIT 1

MODULE 3: SUSTAINABLE USE OF NATURAL RESOURCES (cont'd)

SPECIFIC OBJECTIVES

Students should be able to:

EXPLANATORY NOTES

- (ii) *Water as a resource:*
 - (a) *Pollution and depletion of surface and groundwater, degradation of water, depletion of aquifers.
Human health risks (water borne disease)*
 - (b) watershed destruction.
- (iii) *Minerals and hydrocarbons:*
 - (a) physical conversion of vegetation and land;
 - (b) transformation of landscape
 - (c) dust and noise pollution;
 - (d) pollution from the discharge of process chemicals;
 - (e) sedimentation and siltation;
 - (f) *beach loss and change in river course;*
 - (g) oil spills;
 - (h) *human health risks;*
 - (i) *social dynamics (displacement of communities and introduction of new settlements).*

UNIT 1

MODULE 3: SUSTAINABLE USE OF NATURAL RESOURCES (cont'd)

SPECIFIC OBJECTIVES

Students should be able to:

9. justify the need for natural resource conservation;

(v) *Soil, landscape and seascape:*

(e) transformation of natural landscape to built environment;

(f) *soil degradation, erosion and sedimentation; soil productivity*

(g) *beach erosion*

(h) *degradation and destruction of coral reefs, seagrass beds and mangroves*

EXPLANATORY NOTES

(iv) *Soil, landscape and seascape:*

(a) transformation of natural landscape to built environment;

(b) *soil degradation, erosion and sedimentation; soil productivity*

(c) *beach erosion*

(d) *degradation and destruction of coral reefs, seagrass beds and mangroves*

(i) *The broad concept of natural resource conservation including: management; rehabilitation; restoration; preservation; conservation (in-situ and ex-situ).*

(ii) *Reasons for resource conservation:*

(a) ecological: depletion or degradation of natural resources and the threat to sustainable development; conservation of components of life support systems; conservation of endangered and threatened species;

(b) ethical: sacredness; right to exist;

(c) aesthetical value.

UNIT 1

MODULE 3: SUSTAINABLE USE OF NATURAL RESOURCES (cont'd)

10. describe measures and tools available for natural resource management and conservation;
- (i) Rates and techniques for exploitation of renewable resources; Sustainable Yield Management.
 - (ii) Use of substitutes for non-renewable resources; use of appropriate technology. Refer to Module 2, Specific Objective 12.
 - (iii) Reduction and minimisation of waste - recycling of solid, liquid and gaseous wastes.
 - (iv) Use of economic instruments: user fees; taxes; penalties; incentives; economic valuation of natural resources; environmental accounting and greening of national budgets.
 - (v) *Land Use Planning and Zoning Regulation; Integrated Development Planning and Integrated Coastal Zone Management.*
 - (vi) *Environmental Impact Assessments (A brief introduction to EIA as a Planning and decision making tool to natural resource management and conservation).*

UNIT 1

MODULE 3: SUSTAINABLE USE OF NATURAL RESOURCES (cont'd)

- (vii) Protected Area Systems (International Union for the Conservation of Nature (IUCN) Classification):
 - a. role;
 - b. ecotourism
- (viii) *Community Based Natural Resource Management (participation, monitoring and evaluation).*
- (ix) *Environmental legislation, policies and plans (Sustainable Development Plans, Natural Environmental Action Plans (NEAP), Forest Management Plans, Integrated Coastal Zone Management Plans; Enforcement and implementation.*
- (x) *Education, public awareness, advocacy and training. (Agenda 21, Chapter 36).*
- (xi) International environmental and conservation agreements.
 - (a) *United Nations Framework Convention on Climate Change (UNFCCC and Kyoto Protocol);*
 - (b) *United Nations Convention on Biological Diversity (UNCBD);*
 - (c) *United Nations Convention to Combat Desertification (UNCCD);*

UNIT 1

MODULE 3: SUSTAINABLE USE OF NATURAL RESOURCES (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

- | | | | |
|-----|-----|---|--|
| | (d) | <i>Specifically Protected Areas and Wildlife (SPA/W);</i> | |
| | (e) | <i>Ramsar Convention;</i> | |
| | (f) | <i>Marine Pollution (MARPOL).</i> | |
| 11. | | analyse the effectiveness of measures implemented for natural resource management and conservation; | Refer to SO 10 |
| 12. | | describe ways in which Indigenous People have used and managed their natural resources. | (i) Agriculture: rotation of fields during slash/burn activities, use of organic fertilizers, intercropping;
(ii) Use of forest: timber and non-timber forest products (NTFPS);
(iii) Fishing: traditional fishing methods
(iv) <i>Case studies from Belize, Dominica, Guyana, St. Vincent and the Grenadines and Suriname.</i> |

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Module, teachers are advised to engage students in the teaching and learning activities listed below.

1. *Case studies of Community Based Natural Resources Management, for example, forest, wetlands.*
2. *Research on indigenous people and natural resources.*
3. *Field exercises: species identification; visit to industry; visits and assessment of community based natural resource management initiatives, visit to indigenous communities.*

UNIT 1

MODULE 3: SUSTAINABLE USE OF NATURAL RESOURCES (cont'd)

4. *Discuss the main issues relating to the natural obligation under UNFCCC, UNCCD and the UNCBD.*
5. *Visits to or lectures by representatives of natural resource agencies.*
6. *View videos and slides of natural resource management activities and protected areas.*

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UNIT 1

MODULE 3: SUSTAINABLE USE OF NATURAL RESOURCES (cont'd)

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www.earthwatch.org

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www.panda.org

UNIT 2: AGRICULTURE, ENERGY AND ENVIRONMENTAL POLLUTION

MODULE 1: AGRICULTURE AND THE ENVIRONMENT

GENERAL OBJECTIVES

On completion of this Module, student should:

1. *understand the concepts, types and role of agriculture in the Caribbean;*
2. *understand the environmental impacts of and threats to agricultural systems in the Caribbean;*
3. *have knowledge of environmentally sustainable practices in agricultural systems; in the Caribbean;*
4. acquire knowledge, and develop practical and analytical skills.

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

- | | |
|--|---|
| 1. <i>compare and contrast agricultural systems in the Caribbean;*</i> | (i) <i>Definition of agriculture.</i> |
| | (ii) <i>Characteristics of Agricultural systems with respect to commercial and small scale farming including subsistence.</i> |
| | (a) scale of operation; |
| | (b) inputs: agro-chemicals, labour, machinery and equipment, energy, financing; |
| | (c) productivity of systems: yield per unit input, for example, tonnes per hectare; |
| | (d) <i>mariculture;</i> <i>genetic engineering;</i> |
| | (e) <i>aquaculture.</i> |

UNIT 2

MODULE 1: AGRICULTURE AND THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

- | | | |
|----|---|--|
| 2. | explain the roles of agriculture in the region; | (i) Food Security (production of food and non-food materials). |
| | | (ii) <i>Production of materials for agro-processing industries.</i> |
| | | (iii) <i>Economic:</i> |
| | | (a) <i>livelihood (income generating activities);</i> |
| | | (b) foreign exchange earnings; |
| | | (c) contribution to Gross Domestic Product. |
| 3. | <i>assess the impact of agriculture on the environment;</i> | (i) <i>Technological:</i> |
| | | (a) increased productivity; |
| | | (b) increased varieties; |
| | | (c) improved resistance to pest infestation; |
| | | (ii) <i>Environmental:</i> |
| | | (a) health risks; |
| | | (b) threats to sustainable livelihood of communities; |
| | | (c) <i>land take (need for vast amounts of lands for agriculture);</i> |
| | | (d) <i>pollution from inappropriate use of agro-chemicals (pesticides; fertilisers); antibiotics and hormones in aquaculture and mariculture; eutrophication</i> |

UNIT 2

MODULE 1: AGRICULTURE AND THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

- | | | |
|----|-------|---|
| | (e) | habitat destruction; loss of biodiversity; |
| | (f) | soil degradation: erosion; acidification; salinisation; water-logging; soil compaction, monoculture leading to reduction in soil fertility; |
| | (g) | <i>waste production: waste disposal and management; solid and liquid wastes;</i> |
| | (h) | water degradation: sedimentation; changes in water discharge to coastal zone surface and ground water pollution; |
| | (i) | land degradation: inappropriate use of land types; hillside farming, slash and burn agriculture; |
| | (j) | reduced water availability for irrigation, mariculture and aquaculture; |
| | (k) | <i>Climate change due to methane production.</i> |
| 4. | | <i>explain the features of sustainable agriculture;</i> |
| | (i) | Ecological integrity. |
| | (ii) | Economic viability. |
| | (iii) | Social equity. |
| | (iv) | Adaptability. |
| 5. | | <i>discuss threats to sustainable agriculture;</i> |
| | (i) | <i>Natural disasters: flood, hurricane, volcano.</i> |

UNIT 2

MODULE 1: AGRICULTURE AND THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

- | | |
|--|--|
| 6. <i>evaluate environmentally sustainable practices in agricultural systems;*</i> | <ul style="list-style-type: none">(ii) <i>Climate change: temperature rise, sea level rise. Change in precipitation patterns.</i>(iii) <i>External shocks: global markets, price fluctuations.</i>(iv) <i>Certification to meet international standards.</i>(v) <i>Importation of cheap agricultural products.</i> |
| 7. <i>present and interpret data using appropriate charts, tables and graphs.</i> | <ul style="list-style-type: none">(i) Contour farming.(ii) Terracing.(iii) Crop rotation.(iv) Conservation Tillage.(v) Agro-forestry.(vi) Pest control (biological and genetic) and Integrated pest management.(vii) Organic farming.(viii) Hydroponics.(ix) Post-harvest management: waste utilisation and waste minimisation.(x) <i>Genetic engineering.</i>(xi) <i>Plant and animal breeding.</i> |

UNIT 2

MODULE 1: AGRICULTURE AND THE ENVIRONMENT

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Module, teachers are advised to engage students in the teaching and learning activities listed below.

1. *Conduct* field visits to agrochemical factories, agriculture, aquaculture and mariculture farms to observe and analyse their operations.
2. Provide the opportunities for students to identify agro-chemicals used in territory and analyse their composition.
3. Invite guest lecturers to discuss issues in agriculture.
4. Allow students to create models illustrating soil erosion.
5. Allow students to conduct fertiliser experiments on plants.
6. Conduct brain-storming sessions to explore entrepreneurial opportunities for use of un-used production (for example, fruit under trees; non-meat parts of livestock).
7. Collect and document information on land use in a country, to assess how prime agricultural land is being used.
8. Allow students to conduct investigations on waste production and management in an agricultural entity.
9. *Conduct investigation on water quality at agriculture operations.*
10. Give students assignments in which they compare soil types and fertility in different agricultural systems.
11. Conduct field trips to compare productivity of different farms.

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- Miller, G. Tyler *Living in the Environment, Principles, Connections and Solutions, California*: Wadsworth Publishing Company, 1994.
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www.ecs.co.sz/env_articles

UNIT 2

MODULE 2: ENERGY AND THE ENVIRONMENT

GENERAL OBJECTIVES

On completion of this Module, students should:

1. understand the nature of energy and its use;
2. understand the socio-economic and environmental impacts of provision and the use of energy.
3. appreciate the advantages of using renewable energy sources;
4. acquire knowledge and develop practical and analytical skills in the areas covered.

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

- | | |
|--|---|
| 1. describe the nature, form and conversion of energy; | (i) Definition: energy, kinetic energy, potential energy, power. |
| | (ii) Units of measurement: Joule, MJ, TJ, GJ, Watt, MW, KWh. |
| | (iii) Types of energy: solar, heat, light, electrical, nuclear, chemical. |
| | (iv) Examples of energy and conversion, efficiency of conversion. |
| | (v) Renewable and non-renewable sources of energy. |
| 2. explain the importance of energy to society; | (i) Use of energy within societies. |
| | (ii) Socio-economic dependency on energy use. |

UNIT 2

MODULE 2: ENERGY AND THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

3. describe the characteristics of various energy sources;*

Primary Energy Sources

- A. Non-renewable
- (i) Fossil fuels: location of reserves, extraction, transportation processing and uses.
 - (ii) Nuclear Power: nuclear fission and nuclear fusion; use of nuclear fission, nuclear power plant (basic structure and operation).
 - (iii) Nuclear fuel cycle
- B. Renewable
- (i) Solar energy: harnessing and use:
 - (a) active (photothermal);
 - (b) passive (solar cookers, solar furnaces);
 - (c) photovoltaic cells.
 - (ii) Indirect solar power: principal features and methods of harnessing:
 - (a) wind energy;
 - (b) hydroelectric energy;
 - (c) biofuels: biomass fuel, biogas.
 - (iii) Geothermal energy.
 - (iv) Wave, tidal and ocean thermal energy.

UNIT 2

MODULE 2: ENERGY AND THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

Secondary Energy Source

Fuel cells: structure and process, Proton exchange fuel cell.

- | | |
|---|--|
| | (i) Technological limitations |
| | (ii) Geographical restrictions. |
| | (iii) Reliability of supply. |
| | (iv) Economic (cost of production), political (energy policy of country) and social. |
| 5. describe the conventional generation and distribution of electricity;* | (i) Conventional generation. |
| | (ii) Transmission. |
| 6. evaluate the use of renewable energy;* | |
| 7. discuss factors affecting electricity generating capacity and demand; | (i) Generation rates. |
| | (ii) Demand patterns. |
| | (iii) Energy storage. |
| | (iv) Stock piling capability for fossil fuels. |
| | (v) Diversity of energy sources. |
| | (vi) Economic cost. |
| | (vii) Government policies. |

8. *discuss various methods of energy conservation and improving efficiency;*
- (i) Definition: energy conservation, energy efficiency.
 - (ii) *Approaches to energy conservation (including but not limited to transportation energy conservation, domestic energy conservation, industrial energy conservation).*
- Improving energy efficiency:
- (i) Energy efficient buildings.
 - (ii) Co-generation.
 - (iii) Combined cycles.
 - (iv) *Use of alternative energy sources (for example, biofuels).*
 - (v) *Use of renewable energy (for example, wind, solar, water).*
 - (vi) *Technological (for example, types of lighting, appliances and machines).*
- Sustainable lifestyle (practices that reduce the demand on natural resources).*
9. *outline the impact of various forms of energy in the environment;*
- (i) Environmental:
 - (a) global warming;
 - (b) pollution impact;
 - (c) habitat destruction.
 - (ii) Socio-economic:
 - (a) health issues;
 - (b) dislocation of communities.

UNIT 2

MODULE 2: ENERGY AND THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

- | | | | |
|-----|---|-------|----------------|
| 10. | explain the total cost of energy use. | (i) | Political. |
| | | (ii) | Economic. |
| | | (iii) | Social. |
| | | (iv) | Environmental. |
| | | (v) | Technological. |
| 11. | interpret data using appropriate charts, tables and graphs. | | |

UNIT 2

MODULE 2: ENERGY AND THE ENVIRONMENT (cont'd)

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this module, teachers are advised to engage students in the teaching and learning activities listed below.

1. Conduct field visits to renewable energy facilities, for example, wind farms, solar water heater manufacturers and photovoltaic (PV) installations.
2. Conduct research on renewable energy systems used in the country and the extent of their market penetration.
3. Invite guest lecturers to discuss renewable energy.
4. Use contour maps to evaluate loss of area in the country if global warming leads to sea level rise.
5. Construct a simple device to measure energy use.
6. Construct a simple renewable energy device, for example, a solar water heater, a solar crop dryer, a PV powered device, and a simple solar cooker.
7. Allow students to investigate diversity and percentage contribution to total annual generation capacity in your country.
8. Conduct investigations on energy use in home and school and recommend methods of improving energy use and conservation.
9. Assign students to conduct an assessment of energy efficiency in buildings with respect to the features that characterise an energy efficient building.
10. Construct a model to depict an energy efficient building.
11. Assign students to conduct an investigation on the energy use of various sectors.
12. Collect documentation on policies that govern energy use, transportation and extraction, and promote energy conservation and efficiency.

UNIT 2

MODULE 2: ENERGY AND THE ENVIRONMENT (cont'd)

RESOURCES

- Arms, K. *Environmental Science*, Philadelphia: Saunders College Publishing (Harcourt Brace Publisher), 1994.
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UNIT 2

MODULE 3: POLLUTION OF THE ENVIRONMENT

GENERAL OBJECTIVES

On completion of this Module, students should:

1. be aware of the major types and sources of pollution;
2. understand the environmental impacts of pollution;
3. understand the methods available for monitoring, analyzing and mitigating pollution and its environmental impacts;
4. acquire knowledge and develop practical and analytical skills in the areas covered.

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

- | | |
|---|--|
| 1. describe the general sources and nature of pollutants; | (i) Definition of pollution and pollutant. |
| | (ii) Local examples of pollutants and incidences of pollution. |
| | (iii) Nature of pollutants: persistence, mobility, synergistic effects, toxicity. |
| | (iv) <i>Movement through the environment.</i> |
| 2. identify environmental receptors of specific pollutants;* | <i>Environmental receptors (micro-organisms, plants, animals, humans).</i> |
| 3. describe the various pathways of pollution in the ecosystem and the biosphere; | <i>Environmental pathways (biotic and abiotic), feeding relationships, bioaccumulation and biomagnification.</i> |

UNIT 2

MODULE 3: POLLUTION OF THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

- | | | |
|----|--|--|
| 4. | outline the <i>underlying</i> causes of pollution; | (i) <i>Resource extraction, transportation, processing and use.</i>

- <i>inappropriate technology, industrialisation;</i> |
| | | (ii) <i>Population growth: behavioural pattern, lifestyle, consumption pattern.</i>

- <i>lack of environmental consciousness;</i> |
| 5. | outline the <i>underlying</i> causes of pollution; | (iii) <i>Institutional Framework:</i>

(a) <i>Environmental standards, policies, legislation (Absence and limited implementation).</i>

(b) <i>Limited economic instruments (lack of incentives – tax rebates, limited implementation of pollution principles.</i> |
| | | (iv) <i>Lack of environmental ethics.</i> |
| 6. | <i>discuss</i> the major sources, impact and mitigation of pollution.* | A. Atmospheric Pollution

(i) The Atmosphere.

(a) structure and composition;

(b) physical processes <i>and features</i> related to the movement of pollutants (<i>wind, air</i> effects of topography on the movement of pollutants). |

UNIT 2

MODULE 3: POLLUTION OF THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES

Students should be able to:

EXPLANATORY NOTES

- (ii) Primary Air Pollutants:
 - (a) types: carbon monoxide; nitrogen oxides; sulphur oxides; suspended particulate matter; volatile organic compounds (*include formulae of pollutant*);
 - (b) sources;
 - (c) environmental pathways and receptors;
 - (d) environmental impacts (*for example, public health, Carbon Monoxide (CO) poisoning, acid rain*).
- (iii) Secondary Air Pollutants
 - (a) types: photochemical smog and acid rain;
 - (b) mechanism of formation and characteristics including equations;
 - (c) environmental pathways and receptors;
 - (d) environmental impacts (*for example, acidification of soil and water, damage to buildings*).

UNIT 2

MODULE 3: POLLUTION OF THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES

Students should be able to:

EXPLANATORY NOTES

- (iv) Global Impacts of Atmospheric Pollutants

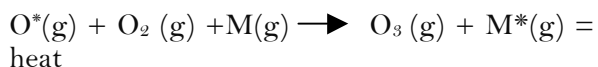
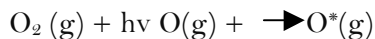
Global Warming:

- (a) greenhouse effect and earth's heat balance;
- (b) sources of greenhouse gases: anthropogenic and natural;
- (c) *greenhouse effect and global warming;*
- (d) impacts of global warming (*for example, sea level rise, increased temperatures, increased intensities of weather phenomena;*

Ozone Depletion:

- (a) Ozone depleting substances and sources: natural and anthropogenic substances;
- (b) chemical equation of formation and destruction *of ozone;*

- Formation of Ozone



UNIT 2

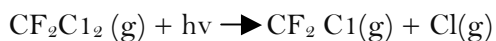
MODULE 3: POLLUTION OF THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES

Students should be able to:

EXPLANATORY NOTES

- Destruction of Ozone



or



Noise pollution:

- (a) sources: industrial; commercial;
 - (b) social; cultural; transportation;
 - (c) intensity measurement and monitoring;
 - (d) *health risks (for example, damage to ear drum, public health, stress).*
- (v) General Mitigative Measures and Monitoring:
- (a) air quality monitoring methods;
 - (b) solutions (*technological, education, public awareness, legislation and policy incentive, emission control and reduction methods*);

UNIT 2

MODULE 3: POLLUTION OF THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES

Students should be able to:

EXPLANATORY NOTES

B. Water Pollution

- (i) Properties of water:
 - (a) physical: colour, taste, odour, appearance, turbidity;
 - (b) chemical: pH, dissolved oxygen (DO) content, salinity.

Water pollutants and their sources: (sediment, heat, nutrients and biodegradable organic matter, pathogens, sewage and toxic chemicals). Sources (agriculture, municipal and domestic, industrial, atmospheric).

- (ii) Point and non-point sources.
- (iii) Factors affecting concentration of pollutants:
 - (a) volume of emission;
 - (b) volume of receiving water;
 - (c) residence time;
 - (d) rate of degradation and removal of pollutants.
- (iv) Environmental pathways and receptors.
- (v) Environmental impacts:
 - (a) eutrophication;
 - (b) deoxygenation;

UNIT 2

MODULE 3: POLLUTION OF THE ENVIRONMENT (cont'd)

- (c) coral reef destruction;
 - (d) fish kills;
 - (e) public health issues.
- (vi) *General mitigative measures and monitoring.*
- (a) solutions

SPECIFIC OBJECTIVES

Students should be able to:

EXPLANATORY NOTES

- (i) *technological (treatment of drinking water, treatment of sewage and industrial effluent);*
 - (ii) *education and public awareness;*
 - (iii) *legislation and policy, for example, effluent discharge regulations.*
- (b) *water quality monitoring methods (water quality parameters - nitrates, phosphates, Biological Oxygen Demand (BOD); Chemical Oxygen Demand (COD); Total Suspended Solids (TSS); faecal coliforms. An understanding of the protocol for testing each parameter is required);*

UNIT 2

MODULE 3: POLLUTION OF THE ENVIRONMENT (cont'd)

C. Land Pollution

- (i) Sources: industrial; agricultural; municipal; domestic.
- (ii) Causes of land pollution:
 - (a) atmospheric fallout;
 - (b) waste disposal (*domestic, industrial, open dumps, sanitary landfills*);
 - (c) dumping of mineral extraction spoils;
 - (d) agricultural processes (see Unit 2 Module 1);
 - (e) oil spills.
- (iii) Environmental pathways and receptors.
- (iv) Environmental impacts (*for example, reduced aesthetic quality, lowering of land value, health implications, change in land use*).

SPECIFIC OBJECTIVES

Students should be able to:

6. analyse the *environmental* impacts of pollution from specific sources;*
7. assess *the effectiveness of* measures to mitigate environmental impacts of pollution;
8. *discuss* the importance of international conventions and agreements regarding pollution control;

EXPLANATORY NOTES

- (v) General mitigative measures and monitoring
 - (a) Waste minimisation (reduction, recycling, reuse, rethink).
 - (b) Environmental Impact Assessments. (*Refer to Unit 1, Module 3, Specific Objective 10.*)
 - (c) Legislation, incentives and penalties.
 - (d) *Public awareness and* participation.
 - (e) *Public awareness and education.*
 - (f) *Clean up of pollution (bioremediation and phytoremediation).*
 - (g) *Incineration.*
 - (a) *(h) Research and development (research on status of environmental components and development of policy).*
- (i) Sources (*medical and industrial waste*).
- (ii) Toxic effects (carcinogenic, mutagenic, tetragenic *effects*).
- (iii) Improper disposal methods.
 - (i) *United Nations Convention on Climate Change (UNFCCC) and Kyoto Protocol.*
 - (ii) Montreal Protocol.

UNIT 2

MODULE 3: POLLUTION OF THE ENVIRONMENT (cont'd)

SPECIFIC OBJECTIVES

EXPLANATORY NOTES

Students should be able to:

- (iii) International Convention for the Prevention of Marine Pollution (MARPOL).
- (iv) Cartagena Convention.
- (v) Basel Convention.
- (vi) *United Nations Convention on Law of the Sea UNCLOS*.

9. interpret data using appropriate charts, tables and graphs.

Suggested Teaching and Learning Activities

To facilitate students' attainment of the objectives of this Module, teachers are advised to engage students in the teaching and learning activities listed below.

1. Assign students to investigate and categorise local pollution problems.
2. Assign students to monitor individual waste production on a weekly basis.
3. Conduct research to compare emission from leaded, unleaded and diesel fuels.
4. Assign experimental work to investigate lead content of vegetation near highways.
5. Conduct field studies on the collection and disposal of garbage.
6. Collect information on industries and their potential to produce pollution.
7. Conduct research to analyse the effectiveness of local legislation to reduce greenhouse gases.
8. Conduct field studies on industries or factories and analysis of their processes with respect to developing waste reduction strategies.

Assign students to investigate respiration ailments in a community.

UNIT 2

MODULE 3: POLLUTION OF THE ENVIRONMENT (cont'd)

9. Assign students to analyse air and water quality in urban areas.
10. Review relevant literature to establish size and location of ozone hole.
11. Assign students to carry out water quality measurements: and faecal coliform: BOD, COD, TSS, pH.
12. Conduct an investigation on the categories and sources of pollutants in water bodies.
13. Conduct experiments to identify the relationship between DO and temperature.
14. Collect information on the level of sewage treatment at selected treatment plants.
15. Conduct soil sampling exercise for pollutants and their concentration levels (urban, agricultural and industrial areas).
16. Assign students to conduct home audit for sources and categories of pollutants.
17. Conduct investigations on the extent of recycling activities in the country, identification of waste that could be recycled.
18. Conduct brain-storming session on business opportunities based on use of waste as a resource.
19. Assign students to measure noise levels.
20. Assign students to develop strategic plans on climate change.
21. Encourage students to garner information on national policies on pollution control.
22. Assign students to collect data on environmental impact assessments and make recommendations.
23. Encourage *students to view An Inconvenient Truth and read ITTC Report, Stern Report.*

UNIT 2

MODULE 3: POLLUTION OF THE ENVIRONMENT (cont'd)

RESOURCES

- Arms, K. *Environmental Science*, Philadelphia: Saunders College Publishing (Harcourt Brace Publisher), 1994.
- Chiras, D. *Environmental Science. Action for a Sustainable Future*, United States of America: The Benjamin/Cummings Publishing Company Inc., 1994
- Clarke, R. *Marine Pollution*, Toronto: Oxford University Press Inc., 1997.
- Cunningham, W. and Saigo, B. *Environmental Science, A global concern*, McGraw Hill.
- Enger, E. and Smith, B. *Environmental Science, A Study of Inter-relationships*, New York: McGraw Hill, 2002.
- Farmer, A. *Managing Environmental Pollution, London: Routledge, 1997.*
- Goodbody, I. and Thomas-Hope, E. *Natural Resource Management for Sustainable Development of the Caribbean*, Canoe Press, University of the West Indies, Mona, 2002.
- Ehrlich, P. and Ehrlich, A. *The Population Explosion*, New York: Simon and Schuster, 1990.
- Jordan, C. *Conservation*, New York: John Wiley and Sons, 1995.
- Miller, G. *Replenish the Earth*, California: Wadsworth Publications, 1996.
- Nebel, B. and Wright, R. *Environmental Science: The Way the World Works*, New Jersey: Prentice Hall, 1997.
- Reeve, R. *Environmental Analysis*, New York: John Wiley and Sons, 1999.
- Viessman, W. Jr., and Hammer, M. *Water Supply and Pollution Control*, California: Addison Wesley, 1998.

Website:

www.mhhe.com/environmentalscience

<http://www.basel.int/convention/about.html>

<http://ozone.unep.org/publications/exemplary-projects>

www.occ.gov.uk/activities/stern

www.imo.org/safety/mainframe

◆ OUTLINE OF ASSESSMENT

Each Unit will be assessed separately. The scheme of assessment for each Unit will be the same. A candidate's performance on each Unit will be reported as an overall grade and a grade on each Module of the Unit. The assessment will comprise two components, external and internal.

EXTERNAL ASSESSMENT (70%)

At the end of the academic year in which a Unit of the syllabus is taken, the student is expected to sit two written papers for a total of 4 hrs.

Paper 01 (1 hour 30 minutes) The paper *comprises forty-five compulsory, multiple-choice items, fifteen based on each Module.* (30%)

Paper 02 (2 hours 30 minutes) The paper *comprises six compulsory questions, two based on each Module.* (40%)

INTERNAL ASSESSMENT (30%)

The Internal Assessment in respect of each Unit will contribute 30% to the total assessment of a candidate's performance on that Unit.

(i) **Paper 03A**

The assessment for each *Unit* will be in the form of a journal. *The journal will comprise reports on site visits and laboratory exercises. The journal should focus on at least one specific objective from any of the three Modules in the Unit and incorporate the relevant practical skills.*

(ii) **Paper 03B**

This is an alternate to Paper 03A and is intended for private candidates.

MODERATION OF INTERNAL ASSESSMENT

Each year an Internal Assessment Record Sheet will be sent to schools submitting students for the examinations.

All Internal Assessment Record Sheets and sample of assignments must be submitted to CXC by May 31 of the year of the examination. A sample of assignments will be requested for moderation purposes by CXC. These samples will be re-assessed by CXC Examiners who moderate the Internal Assessment. Teachers' marks may be adjusted as a result of moderation. The Examiners' comments will be sent to schools.

Copies of the students' assignment that are not submitted must be retained by the school until three months after publication by CXC of the examination results.

ASSESSMENT DETAILS

External Assessment by Written Papers (70% of Total Assessment)

Paper 01 (1 hour 30 minutes – 30% of Total Assessment)

1. **Composition of the Paper**

The paper *comprises forty-five multiple-choice items, fifteen items based on each Module.*

2. **Syllabus Coverage**

(i) *Knowledge of the entire syllabus is required*

(ii) *The intention of this paper is to test candidates' knowledge across the breadth of the syllabus.*

3. **Question Type**

Questions may be based on diagrams, data, graph, *photographs* or prose.

4. **Mark Allocation**

(i) *One mark will be assigned for each item.*

(ii) *The maximum mark available for this paper is forty-five and will be weighted to ninety.*

(iii) *This paper contributes 30% towards the final assessment.*

(iv) *The marks will be awarded for Knowledge and Comprehension, Application of Knowledge and Practical Abilities.*

5. **Use of Calculators**

Candidates will be allowed to use a non-programmable calculator in the examinations. Each candidate is responsible for providing his/her own calculator and to ensure that it functions throughout the examinations.

6. **Use of Geometrical Instruments**

Candidates are allowed to use geometrical instruments in the examinations. Each candidate is responsible for providing his or her own instruments.

Paper 02 (2 hours 30 minutes – 70% of Total Assessment)

1. Composition of Paper

The paper is arranged into three sections. Each section represents one of the three Modules of the Unit. Each section contains *two compulsory questions*.

2. Syllabus Coverage

- (i) *Comprehensive knowledge of the entire syllabus is required.*
- (ii) *Each question may focus on a single theme or develop a single theme or several unconnected themes.*

3. Question Type

Questions are of a free-response form and may be based on diagrams, data, graph, *photographs* or prose. *Responses* are to be written in the *separate* booklet provided.

4. Mark Allocation

- (i) Each question is worth 20 marks and the number allocated to each sub-question will appear on the examination paper.
- (ii) *The maximum mark for this paper is 120.*
- (iii) *This paper contributes 40% towards the final assessment.*
- (iv) *The marks will be awarded for Knowledge and Comprehension, Application of Knowledge and Practical Abilities.*

5. Use of Calculators

Candidates will be allowed to use a non-programmable calculator in the examinations. Each candidate is responsible for providing his/her own calculator and to ensure that it functions throughout the examinations.

6. Use of Geometrical Instruments

Candidates are allowed to use geometrical instruments in the examinations. Each candidate is responsible for providing his or her own instruments.

INTERNAL ASSESSMENT

Internal Assessment is an integral part of student assessment in the course covered by this syllabus. It is intended to assist students in acquiring certain knowledge, skills, and attitudes that are associated with the subject. The activity for the Internal Assessment is linked to the syllabus and should form part of the learning activities to enable the student to achieve the objectives of the syllabus.

During the course of study for the subject, students obtain marks for the competence they develop and demonstrate in undertaking their Internal Assessment assignments. These marks contribute to the final marks and grades that are awarded to students for their performance in the examination.

During the course of study for the subject, students obtain marks for the competence they develop and demonstrate in undertaking their Internal Assessment assignments. These marks contribute to the final marks and grades that are awarded to students for their performance in the examination.

The guidelines provided in this syllabus for selecting appropriate tasks are intended to assist teachers and students in selecting assignments that are valid for the purpose of Internal Assessment. The guidelines provided for the assessment of these assignments are intended to assist teachers in awarding marks that are reliable estimates of the achievement of students in the Internal Assessment component of the course. In order to ensure that the scores awarded by teachers are not out of line with the CXC standards, the Council undertakes the moderation of a sample of the Internal Assessment assignments marked by each teacher.

The Internal Assessment component is compulsory. The assignment is assessed by the teacher, using Internal Assessment Criteria provided below.

The following are the skills that will be assessed:

- (i) the selection of techniques, designs, methodologies and instruments appropriate to different environmental situations;
- (ii) the collection and collation of data;
- (iii) the analysis, interpretation and presentation of such data;
- (iv) *the use of appropriate quantitative techniques;*
- (v) the development of appropriate models as possible solutions to specific environmental problems.

The Internal Assessment should relate to at least ONE specific objective in the Unit.

CRITERIA FOR THE INTERNAL ASSESSMENT

The following are the guidelines for assessing the journal.

1. The journal is internally assessed by the teacher and externally moderated by CXC.
2. Each candidate will be required to complete a journal in which he/she will be expected to demonstrate the practical skills listed on Page 53.

THE JOURNAL

The reports for a series of site-visits and laboratory exercises associated with the site-visits are recorded in the journal.

The journal will comprise:

- (a) an entry for each site visit
- (b) a report for the journal
- (c) a final report on the set of site-visits

Each student is expected to conduct and write a final report on a **minimum** of four (4) site visits and four (4) laboratory exercises.

- (i) Site visits should be based either on visits to **one** site where changes over a period of time are observed **OR** on a series of visits to different sites to compare and contrast similar processes or occurrences.
- (ii) Laboratory exercises should relate to each or any of the series of site-visits.
- (iii) The entries for the site-visits and the reports for the laboratory exercises **MUST** inform the final report for the journal. The final report must not exceed 1500 words.

Teachers are expected to work closely with students by providing feedback on all aspects of the project.

Students should be encouraged to develop the habit of keen observation, relevant and precise reporting, concise recording and the ability for critical thinking, problem-solving and decision-making.

Each student is required to keep a record (journal) for the reports on the laboratory exercises and a final report for entries on the site-visits.

It is recommended that the assessment criteria be available to candidates at all times.

(A) Site-Visit

The entry for each site-visit should be recorded using the format below:

(i)	Entry Number	
(ii)	Date	
(iii)	Site (Location)	
(iv)	Objective(s)	1 mark
(v)	Activities	4 marks
(vi)	Observations	2 marks
(vii)	Comments	2 marks
(viii)	Follow-up Activities	1 mark
		10 Marks

The teacher is required to assess each site-visit for a maximum of 10 marks. The total from a maximum of 40 marks should be scaled to 10 marks. No fractional marks should be awarded.

(B) Laboratory Exercise

The areas that will be assessed in the report for each **laboratory exercise** are:

(a)	Planning and Designing;	4 marks
(b)	Observation and Recording;	5 marks
(c)	Manipulation and Measurement;	2 marks
(d)	Analysis and Interpretation;	6 marks
(e)	Reporting and Presentation.	3 marks
	Total	20 marks <i>(Scaled to 10 marks)</i>

The teacher is required to mark and award a score out of a maximum of 20 marks for each laboratory report and then scale to 10 marks. **No fractional marks should be awarded.**

These entries for the site-visits and the laboratory reports should inform the final report for the journal.

Laboratory exercises should be reported using the format below:

- | | | | |
|----|-------|-----|-----|
| i) | Title | ii) | Aim |
|----|-------|-----|-----|

- iii) Materials
- iv) Procedure
- v) Data Collection/Results
- vi) Discussion and Conclusions

(C) Final Report for Journal

The areas that will be assessed in the final report for the journal are summarised in the table below.

Final Report for Journal		Marks
1.	Clarity of the statement of the real world problem being studied (project description)	2
2.	Definition of the scope of the project (purpose of project)	3
3.	Adequacy of information/data gathered and the appropriateness of the design chosen for investigating the problem	3
4.	Appropriateness of the literature review	5
5.	Presentation of data/Analysis of data	6
6.	Discussion of findings	8
7.	Conclusion	3
8.	Recommendations	4
9.	Communication of information	4
10.	Bibliography	2
Total		40

**ASSESSING THE JOURNAL REPORT
DESCRIPTORS FOR JOURNAL REPORT**

1.	Problem Statement	2	
	<ul style="list-style-type: none"> • <i>Problem</i> clearly stated • <i>Problem</i> clearly stated and concise 		1 2
2.	Purpose of Project	3	
	<ul style="list-style-type: none"> • Purpose stated • Purpose stated and some variables identified • Purpose stated and all variables identified 		1 2 3
3.	Methods of Data Collection	3	
	<ul style="list-style-type: none"> • Data collection design described • Design clear, appropriate, carried out with few flaws • Design clear, appropriate, carried out without flaws 		1 2 3
4.	Literature Review	5	
	<ul style="list-style-type: none"> • Literature review attempted • Literature review appropriate • Literature review appropriate and comprehensive 		1-2 3-4 5
5.	Presentation of Data	2	
	<ul style="list-style-type: none"> • Used graphs, tables, figures and statistical symbols adequately • Used graphs, tables, figures and statistical symbols creatively 		1 2
6.	Analysis of Data	4	
	<ul style="list-style-type: none"> • Some analysis attempted • Analysis adequately done • Analysis used 2 or more approaches • Analysis used a variety of approaches or exceeded requirements of the course 		1 2 3 4
7.	Discussion of Findings	8	
	<ul style="list-style-type: none"> • Some findings stated • All findings stated • Some findings stated and supported by data • All findings stated and supported by data • Some findings stated, supported by data and their interpretability addressed • All findings stated, supported by data and their interpretability addressed • Reliability or validity, and usefulness of some findings addressed • Reliability or validity, and usefulness of all findings addressed 		1 2 3 4 5 6 7 8

8.	Conclusion	3	
	<ul style="list-style-type: none"> • Conclusion clear and based on finding(s) 1 • Conclusion clear, based on finding(s) and valid 2 • Conclusion clear, based on finding(s), valid and related to purpose(s) of project 3 		
9.	Recommendations	4	
	<ul style="list-style-type: none"> • Few recommendations based on findings 2 • Most recommendations based on findings 3 • Recommendations fully derived from findings 4 		
10.	Communication of Information	4	
	<ul style="list-style-type: none"> • Information communicated in a fairly logical manner with several grammatical errors 1 • Information communicated in a logical manner with some grammatical errors 2 • Information communicated in a logical manner with few grammatical errors 3 • Information communicated in a logical manner with no grammatical errors 4 		
11.	Bibliography	2	
	<ul style="list-style-type: none"> • Number of references is less than 4 1 • Number of references <i>is</i> greater than 4, written using a consistent convention 2 		

Total **40 marks**

The overall assessment of each student is based on the entries for the four site-visits (40 marks), four laboratory exercises (40 marks) and the final report for the journal (40 marks).

A total of 90 marks summarised in the table below:

Component	Raw Marks	Total Marks
4 site-visits	4 x 10 = 40 Scaled to 10	10
4 laboratory exercises	4 x 10 = 40	40
Final report	40	40
Total		90

GENERAL GUIDELINES FOR TEACHERS

- The teacher is required to mark the journal and final marks must be recorded out

of 90.

2. The school must retain all journals for at least three months after publication of the results since journals may be requested by CXC for moderation purposes.
3. The specific objectives highlighted by an asterisk are suitable for Internal Assessment, but the assignments need not assess only these objectives;
4. The reliability of the marks awarded is a significant factor in the Internal Assessment, and has far reaching implications for the candidate's final grade. Teachers are asked to note the following:
 - (i) the marks awarded to the journal must be carefully transferred to the CXC Internal Assessment forms;
 - (ii) the teacher must allocate one-third of the total score for the Internal Assessment to each Module. **Fractional marks should not be awarded.** In cases where the mark is not divisible by three, then the allocation is as follows:
 - (a) When the remainder is 1 mark, the mark is allocated to Module 3;
 - (b) When the remainder is 2, then a mark is allocated to Module 3 and the other mark to Module 2.

For example, 35 marks are allocated as follows:

$$35 / 3 = 11 \text{ remainder } 2 \text{ so } 11 \text{ marks to Module 1 and } 12 \text{ marks to each of Modules 2 and 3.}$$
 - (iii) the standard of marking should be consistent.
5. Candidates who do not fulfil the requirements of the Internal Assessment will be considered absent from the whole examination.

◆ REGULATIONS FOR PRIVATE CANDIDATES

Candidates who are registered privately will be required to sit Paper 01, Paper 02 and Paper 03B. Detailed information on Papers 01 and 02 is given on pages 49 - 51 of this syllabus.

Paper 03B (Alternate to Internal School Based-Assessment) 30%-

This paper will be of two (2) hours duration and will consist of THREE questions as follows:

- (i) a practical question;
- (ii) a question based on data collection;
- (iii) a planning and design exercise.

This paper will constitute 30% of the overall assessment of the candidates performance on the Unit.

◆ REGULATIONS FOR RESIT CANDIDATES

Resit candidates must complete Papers 01 and 02 and Paper 03 of the examination for the year for which they re-register. Resit candidates may elect not to repeat the Internal Assessment component, provided they re-write the examination no later than two years following their first attempt.

Candidates may opt to complete an Internal Assessment (IA) for each Unit written or may opt to re-use another IA score which satisfies any of the conditions listed below.

- (i) *A candidate who re-writes the examination in the same Unit within two years may re-use the moderated IA score earned in the previous sitting within the preceding two years.*
- (ii) *Candidates re-using IA scores in this way must register as “Resit candidates” and provide the previous candidate number.*

All resit candidates may enter through schools, recognized educational institutions, or the Local Registrar’s Office.

◆ ASSESSMENT GRID

The Assessment Grid for each Unit contains marks assigned to papers and to Modules and the percentage contributions of each paper to the total score.

Papers	Module 1	Module 2	Module 3	Total	(%)
Paper 01	<i>15 (raw)</i> 30 (<i>wtd</i>)	<i>15 (raw)</i> 30 (<i>wtd</i>)	<i>15 (raw)</i> 30 (<i>wtd</i>)	<i>45 (raw)</i> 90 (<i>wtd</i>)	(30)
Paper 02	40	40	40	120	(40)
Paper 03A/03B	30	30	30	90	(30)
TOTAL	100	100	100	300	(100)

◆ GLOSSARY

<u>WORD</u>	<u>DEFINITION/MEANING</u>	<u>NOTES</u>
analyse	examine in detail	
annotate	add a brief note to a label	Simple phrase or a few words only.
apply	use knowledge/principles to solve problems	Make inferences/conclusions.
assess	present reasons for the importance of particular structures, relationships or processes	Compare the advantages and disadvantages or the merits and demerits of a particular structure, relationship or process.
calculate	arrive at the solution to a numerical problem	Steps should be shown; units must be included.
classify	divide into groups according to observable characteristics	
comment	state opinion or view with supporting reasons	
compare	state similarities and differences	An explanation of the significance of each similarity and difference stated may be required for comparisons which are other than structural.
construct	use a specific format to make and/or draw a graph, histogram, pie chart or other representation using data or material provided or drawn from practical investigations, build (for example, a model), draw scale diagram	Such representations should normally bear a title, appropriate headings and legend.
deduce	make a logical connection between two or more pieces of information; use data to arrive at a conclusion	
define	state concisely the meaning of a word or term	This should include the defining equation/formula where relevant.
demonstrate	show; direct attention to...	

<u>WORD</u>	<u>DEFINITION/MEANING</u>	<u>NOTES</u>
derive	to deduce, determine or extract from data by a set of logical steps some relationship, formula or result	This relationship etc. may be general or specific.
describe	provide detailed factual information of the appearance or arrangement of a specific structure or a sequence of a specific process	Description may be in words, drawings or diagrams or any appropriate combination. Drawings or diagrams should be annotated to show appropriate detail where necessary.
determine	find the value of a physical quantity	
design	plan and present with appropriate practical detail	Where hypotheses are stated or when tests are to be conducted, possible outcomes should be clearly stated and/or the way in which data will be analyzed and presented.
develop	expand or elaborate an idea or argument with supporting reasons	
diagram	simplified representation showing the relationship between components.	
differentiate/ distinguish (between/ among)	state or explain briefly those differences between or among items which can be used to define the items or place them into separate categories.	
discuss	present reasoned argument; consider points both for and against; explain the relative merits of a case	
draw	make a line representation from specimens or apparatus which shows an accurate relation between the parts	In the case of drawings from specimens, the magnification must always be stated.
estimate	make an approximate quantitative judgement	
evaluate	weigh evidence and make judgements based on given criteria	The use of logical supporting reasons for a particular point of view is more important than the view held; usually both sides of an argument should be considered.

<u>WORD</u>	<u>DEFINITION/MEANING</u>	<u>NOTES</u>
explain	give reasons based on recall; account for	
find	locate a feature or obtain as from a graph	
formulate	devise a hypothesis	
identify	name or point out specific components or features	
illustrate	show clearly by using appropriate examples or diagrams, sketches	
interpret	explain the meaning of	
justify	explain the correctness of	
investigate	use simple systematic procedures to observe, record data and draw logical conclusions	
label	add names to identify structures or parts indicated by pointers	
list	itemize without detail	
measure	take accurate quantitative readings using appropriate instruments	
name	give only the name of	No additional information is required.
note	write down observations	
observe	pay attention to details which characterize a specimen, reaction or change taking place; to examine and note scientifically	Observations may involve all the senses and/or extensions of them but would normally exclude the sense of taste.
outline	give basic steps only	
plan	prepare to conduct an investigation	
predict	use information provided to arrive at a likely conclusion or suggest a possible outcome	

<u>WORD</u>	<u>DEFINITION/MEANING</u>	<u>NOTES</u>
record	write an accurate description of the full range of observations made during a given procedure	This includes the values for any variable being investigated; where appropriate, recorded data may be depicted in graphs, histograms or tables.
relate	show connections between; explain how one set of facts or data depend on others or are determined by them	
sketch	make a simple freehand diagram showing relevant proportions and any important details	
state	provide factual information in concise terms outlining explanations	
suggest	offer an explanation deduced from information provided or previous knowledge. (... a hypothesis; provide a generalisation which offers a likely explanation for a set of data or observations.)	No correct or incorrect solution is presumed but suggestions must be acceptable within the limits of scientific knowledge.
test	to find out, following set procedures	

Western Zone Office
03 May 2010

CARIBBEAN EXAMINATIONS COUNCIL

Caribbean Advanced Proficiency Examination CAPE®



Environmental Science

Specimen Papers and Mark Schemes/Keys

Specimen Papers:

- Unit 1, Paper 01
Unit 1, Paper 02
Unit 1, Paper 03/2
- Unit 2, Paper 01
Unit 2, Paper 02
Unit 2, Paper 03/2

Mark Schemes and Keys:

- Unit 1, Paper 01
Unit 1, Paper 02
Unit 1, Paper 03/2
- Unit 2, Paper 01
Unit 2, Paper 02
Unit 2, Paper 03/2



TEST CODE **02120010/SPEC/2010**

C A R I B B E A N E X A M I N A T I O N S C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

ENVIRONMENTAL SCIENCE

UNIT 1

SPECIMEN PAPER

Paper 01

90 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This test consists of 45 items. You will have 90 minutes to answer them.
2. In addition to this test booklet, you should have an answer sheet.
3. Do not be concerned that the answer sheet provides spaces for more answers than there are items in this test.
4. Each item in this test has four suggested answers lettered (A), (B), (C), (D). Read each item you are about to answer and decide which choice is best.
5. On your answer sheet, find the number which corresponds to your item and shade the space having the same letter as the answer you have chosen. Look at the sample item below.

Sample Item

The interaction of plants and animals with components such as air and water describes

Sample Answer

- (A) a biome
- (B) a biosphere
- (C) an ecosystem
- (D) an ecological niche



The best answer to this item is “an ecosystem”, so answer space (C) has been shaded.

6. If you want to change your answer, erase it completely before you fill in your new choice.
7. When you are told to begin, turn the page and work as quickly and as carefully as you can. If you cannot answer an item, omit it and go on to the next one. You may return to the omitted item later. Your score will be the total number of correct answers.
8. You may use a silent electronic calculator.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

Item 1 refers to the following food chain.

Grass → grasshopper → frog → snake

1. The original source of energy for the food chain is the
- (A) frog
 - (B) grass
 - (C) sunlight
 - (D) grasshopper

2. Which of the following are characteristics of a biome?

- I. Climate barriers determine its boundaries.
- II. It encompasses interacting ecosystems.
- III. It is the next level of ecological organisation above the ecosystem.
- IV. It is usually confined to a relatively small geographical area.

- (A) I and III only
- (B) I and IV only
- (C) I, II and III only
- (D) II, III and IV only

3. The relationship between algae and the coral polyp is an example of

- (A) mutualism
- (B) parasitism
- (C) competition
- (D) commensalism

4. Which of the following factors will cause a decline in the population of organisms?

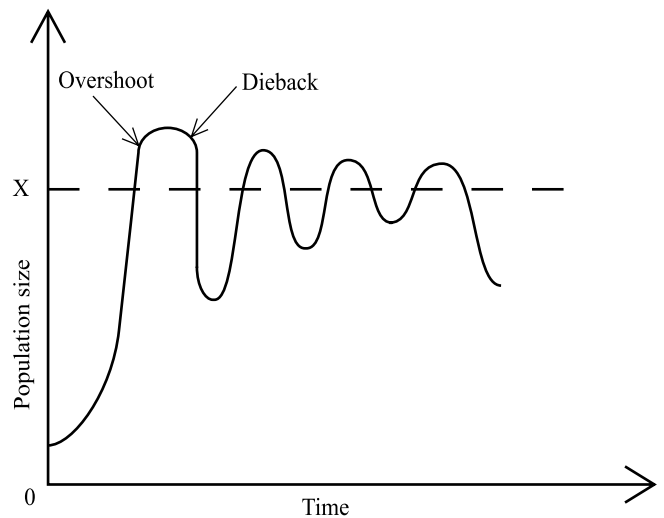
- I. Adverse climate conditions
- II. Food shortage and disease
- III. Predation and competition
- IV. Suitable habitat

- (A) I and III only
- (B) III and IV only
- (C) I, II and III only
- (D) I, II and IV only

5. An ecotone is BEST described as the boundary between

- (A) two types of communities
- (B) two types of ecological niches
- (C) plant and animal communities
- (D) two types of ecological communities

Item 6 refers to the graph of population size vs time below.



6. The broken line at X in the graph above represents the

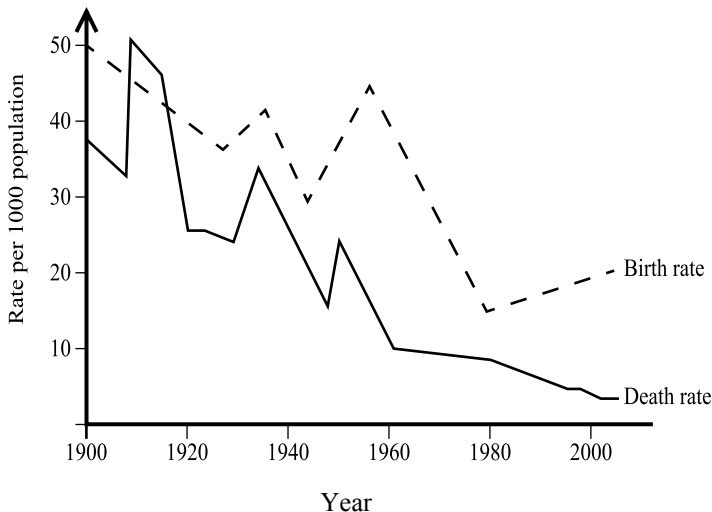
- (A) biotic potential
- (B) carrying capacity
- (C) environmental resistance
- (D) maximum population size

7. Succession is one of the most important ecological processes. Which of the following are sites where primary succession may occur?

- I. At the edge of retreating glaciers
- II. Sand dunes along sandy shores
- III. The lava flows of volcanoes
- IV. Abandoned pastures

- (A) I and IV only
- (B) II and III only
- (C) I, II and III only
- (D) I, II and IV only

Item 8 refers to the graph below which shows birth and death rates for the period 1900 – 2000 for a Caribbean country.



8. In which year was the LOWEST population growth rate recorded?

- (A) 1910
- (B) 1960
- (C) 1980
- (D) 2000

9. Which pair of organisms BEST illustrates the feeding relationship referred to as 'parasitism'?

- (A) Rat → Owl
- (B) Cow → Tick
- (C) Tick → Egret
- (D) Cow → Egret

10. Which of the following is TRUE about predator-prey relationships?

- I. Predators help to keep prey populations in check.
- II. Predators may help to drive natural selection in the prey populations.
- III. Prey populations do not influence natural selection in predators.
- IV. Predator-prey relationships are examples of commensalism.

- (A) I and II only
- (B) I and III only
- (C) I and IV only
- (D) I, II and IV only

11. Which of the following types of islands would have the LOWEST biodiversity?

- (A) Volcanic
- (B) Small isolated
- (C) Large continental
- (D) Small continental

12. Traditionally, woodpecker (A) was found in relatively large numbers in a particular ecosystem. However, since the addition of a new species, woodpecker (B), its population has greatly decreased. This example can be used to illustrate

- (A) genetic drift
- (B) a realised niche
- (C) a fundamental niche
- (D) the competitive exclusion principle

GO ON TO THE NEXT PAGE

Items 13 – 14 refer to the table below which shows the total number of various species within a marine community that has a total number of 100 individuals

Species	Total number of organisms
Cod	22
Haddock	28
Capelin	40
Shark	3
Harpseal	7

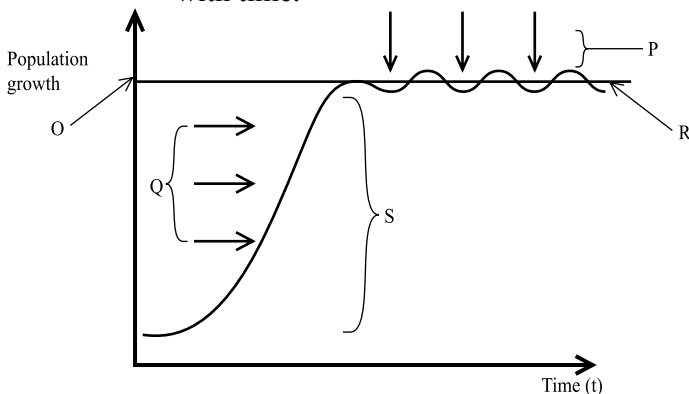
13. Using the formula $D = \frac{N(N-1)}{\sum n(n-1)}$, the species diversity (D) is

- (A) 2.50
- (B) 3.28
- (C) 3.50
- (D) 4.50

14. What percentage of the marine community is made up of haddock and shark?

- (A) 25%
- (B) 28%
- (C) 31%
- (D) 35%

Item 15 refers to the graph below which shows the variation of population growth with time.



15. The region labelled P on the graph indicates

- (A) biotic resistance
- (B) carrying capacity
- (C) environmental potential
- (D) environmental resistance

Item 16 refers to the following indices of the human population:

- I. Fertility rate
- II. Immigration rate
- III. Transition rate
- IV. Mortality rate

16. Which of the above are demographic indices of the human population?

- (A) I and II only
- (B) I and III only
- (C) I, II and III only
- (D) I, II and IV only

Item 17 refers to the following variables:

- I. Life expectancy
- II. Fertility
- III. Educational attainment
- IV. Real GDP per capita

17. Which of the variables above are used to determine the Human Development Index (HDI)?

- (A) I, II and IV only
- (B) I, III and IV only
- (C) II, III and IV only
- (D) I, II, III and IV

18. Which of the following indices of poverty is based on longevity, education and income for both men and women?

- (A) Gross National Product (GNP)
- (B) Gross Domestic Product (GDP)
- (C) Human Development Index (HDI)
- (D) Gender Development Index (GDI)

19. The difference between birth rate and death rate is called

- (A) the fertility rate
- (B) doubling time
- (C) the life expectancy
- (D) population growth

GO ON TO THE NEXT PAGE

20. When the death rate of a country is higher than the birth rate, the population size
- (A) decreases
 - (B) increases slowly
 - (C) increases rapidly
 - (D) remains the same
21. The MOST successful method of controlling a country's population size is
- (A) birth control
 - (B) natural disasters
 - (C) financial incentives
 - (D) government quotas on children produced

Items 22 - 23 refer to the following table of population growth rates for Jamaica and Trinidad and Tobago in 2009.

Country	Population (million.)	Annual Growth Rate (%)
Jamaica	2.7	1.2
Trinidad and Tobago	1.3	0.3

22. The estimated population of Trinidad and Tobago for the year 2010 is
- (A) 3 900
 - (B) 390 000
 - (C) 1 303 900
 - (D) 1 363 900
23. The estimated doubling time for Jamaica is
- (A) 45 years
 - (B) 58 years
 - (C) 69 years
 - (D) 72 years

24. A country is MOST likely to be densely populated in which of the following areas?
- I. Flat, lowland plains
 - II. Predominantly subsistence farming areas
 - III. Regions with intensive farming
 - IV. Deep humus-filled land
- (A) I and II only
 - (B) I and III only
 - (C) I, II and IV only
 - (D) II, III and IV only

Item 25 refers to the demographic statistics provided below.

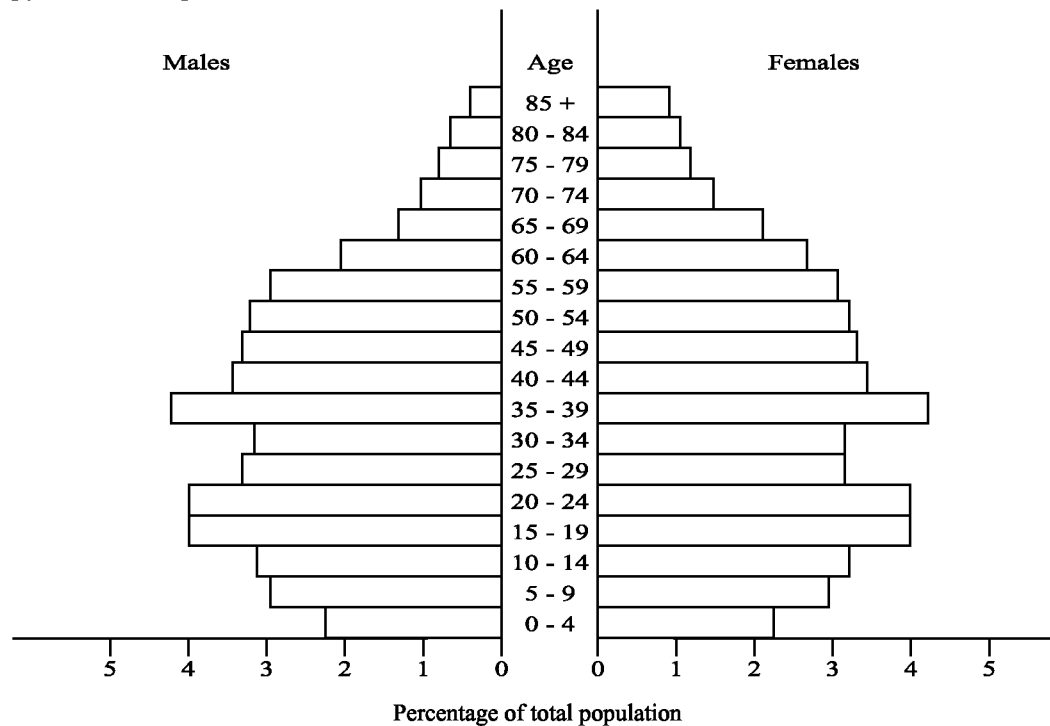
Demographic Statistics for Country X

Population in 2007: 5 273 196
Population growth for 2008: 2.4%
Population growth for 2009: 2.5%

25. Using the information above, calculate the population of Country X in 2009.
- (A) 5 399 753
 - (B) 5 405 026
 - (C) 5 531 583
 - (D) 5 534 746

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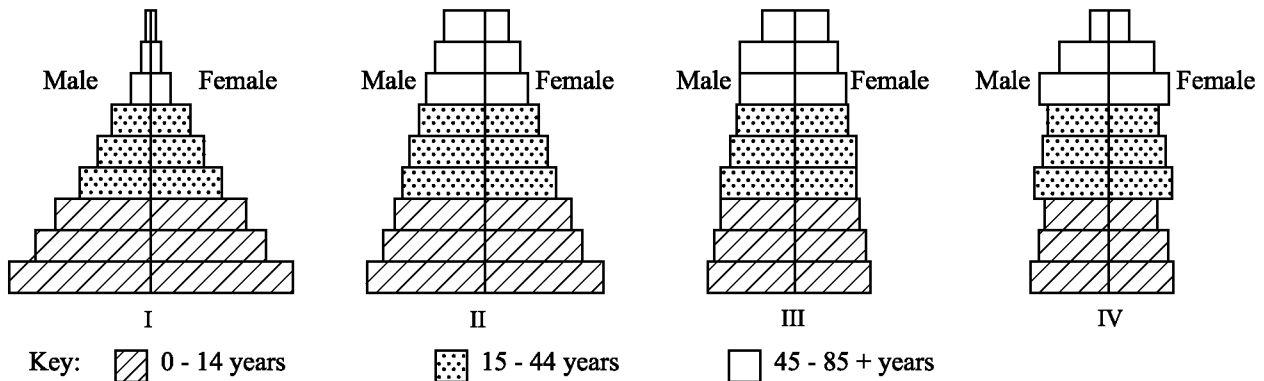
Item 26 refers to the following population pyramid of Japan in 2002.



26. Which of the following statements BEST describes the information shown in the population pyramid?
- (A) There is a high birth rate and a high death rate.
 - (B) More males live to an older age than females.
 - (C) Fertility is high as women are having more children.
 - (D) There is a low death rate and a falling birth rate.

27. The use of substitutes may help to reduce the environmental impacts of overexploitation by
- (A) reducing pollution
 - (B) reducing the demand for a particular resource
 - (C) increasing revenue from the sale of substitutes
 - (D) reducing the cost of exploitation of a particular resource

Items 28 □ 29 refers to the diagrams I - IV below which represent the age structure of four different countries.



28. Which diagram shows a population with a constant growth rate?

- (A) I
- (B) II
- (C) III
- (D) IV

29. Which diagram represents a population with the LEAST number of its people in the post-reproductive group?

- (A) I
- (B) II
- (C) III
- (D) IV

Item 30 refers to the table below which shows the immigration and emigration statistics for four countries.

Country	Immigration per 1000	Emigration per 1000
I	25	18
II	40	30
III	10	20
IV	20	5

30. Which of the above countries has a negative net migration?

- (A) I and III only
- (B) I, II and IV only
- (C) I, III and IV only
- (D) II, III and IV only

31. The MAJOR natural resource found in Trinidad is

- (A) oil
- (B) gold
- (C) bauxite
- (D) iron ore

32. Which of the following BEST describes the importance of an Environmental Impact Assessment (EIA)?

- (A) It is a legal requirement.
- (B) It provides the costing for a proposed project.
- (C) It must be done for the government's projects only.
- (D) It examines the environmental feasibility of a project.

33. Which of the following can be described as a renewable resource?
- (A) Asphalt
 - (B) Beaches
 - (C) Minerals
 - (D) Mangrove forests

34. The international convention, commonly known as the Kyoto Protocol is
- (A) CITIES
 - (B) UNCBD
 - (C) UNFCCC
 - (D) MARPOL

Items 35 – 36 refer to the following territories:

- (A) Jamaica
 - (B) Barbados
 - (C) Guyana
 - (D) Trinidad and Tobago
35. Which of the of the countries above possesses large reserves of limestone as a natural resource?
36. Which of the countries above possesses large expanses of virgin forests?
37. Mangroves are considered ecologically important because
- (A) they add aesthetic value
 - (B) they provide employment
 - (C) the roots perform important functions
 - (D) they are used for recreational purposes

Items 38 – 39 refer to the following terms:

- (A) Quarrying
- (B) Animal husbandry
- (C) Ecotourism
- (D) Agriculture

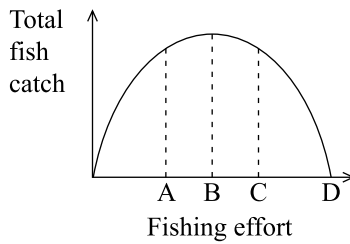
38. Which of the above activities may result in heavy metal contamination of water?
39. Which activity would result in the water being polluted by faecal coliform?
40. Which of the following is the BEST reason for the conservation of rainforests?
- (A) They have aesthetic value.
 - (B) They provide employment.
 - (C) They are a source of fuel wood.
 - (D) They are a habitat for many organisms.

41. Fires have destroyed many forested areas around the Caribbean. In some cases, pine trees are planted to replace the natural forest since pine trees grow faster and are more fire resistant than many native trees.

Which term BEST describes this approach to resource management?

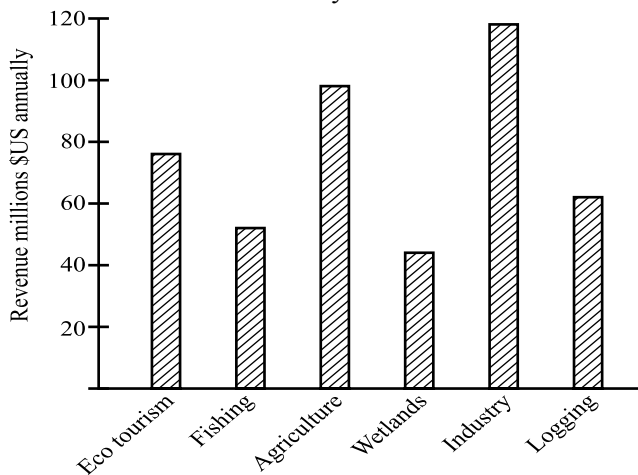
- (A) Restoration
- (B) Preservation
- (C) Rehabilitation
- (D) In-situ conservation

Item 42 refers to the graph below which shows how total fish catch varies with fishing effort.



42. Which point on the x -axis indicates the level of effort which will produce the OPTIMUM sustainable yield?

Items 43 – 44 refer to the graph below which shows the annual income distribution for a Caribbean country.



43. What is the total income of this Caribbean country?
- (A) 45 million
 (B) 46 million
 (C) 450 million
 (D) 460 million
44. What is the percentage income from non-consumptive use of natural resources?
- (A) 9.8
 (B) 16.9
 (C) 26.7
 (D) 38.7

Item 45 refers to the table below which shows per capita meat consumption for selected countries.

Country	Beef (kg)	Pork (kg)	Poultry (kg)	Mutton (kg)
India	1	0.4	1	1
China	4	30	6	2
Italy	26	33	19	2
United States	45	31	46	1

45. Using the data in the table above, determine which of the following statements is true?
- (A) The most populated countries consume the most meat.
 (B) The least populated countries consume the most meat.
 (C) More economically developed countries consume the most meat.
 (D) Less economically developed countries consume the most meat.

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.



TEST CODE **02120020/SPEC/2010**

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

ENVIRONMENTAL SCIENCE

UNIT 1: ECOLOGY, HUMAN POPULATION AND NATURAL RESOURCES

SPECIMEN PAPER

PAPER 02

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

1. Do NOT open this examination paper until instructed to do so.
2. This paper consists of SIX questions, TWO from each Module.
3. Answer ALL questions.
4. Write your answers in the answer booklet provided.
5. You may use a silent, non-programmable, scientific calculator.

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02120020/SPEC/ 2010

MODULE 1

Answer BOTH Questions.

1. Table 1 presents the species abundance of three species, X, Y, and Z, in two ecosystems, A and B.

TABLE 1: SPECIES ABUNDANCE IN TWO ECOSYSTEMS

Ecosystem	Species Abundance		
	X	Y	Z
A	9	4	2
B	11	11	12

- (a) Define EACH of the following:
- (i) Ecosystem
 - (ii) Ecosystem stability **(4 marks)**
- (b) Using the information in Table 1, calculate the species diversity for ecosystem A and ecosystem B. **(3 marks)**
- (c) Explain the relationship between species diversity and ecosystem stability. **(8 marks)**
- (d)(i) Species X, Y and Z are non-moving organisms. Describe a **named** method which is appropriate for sampling these organisms. **(4 marks)**
- (d)(ii) State ONE limitation of the method described in (d)(i). **(1 mark)**

Total 20 marks

2(a) Figure 1 illustrates the cycling of matter through an ecosystem.

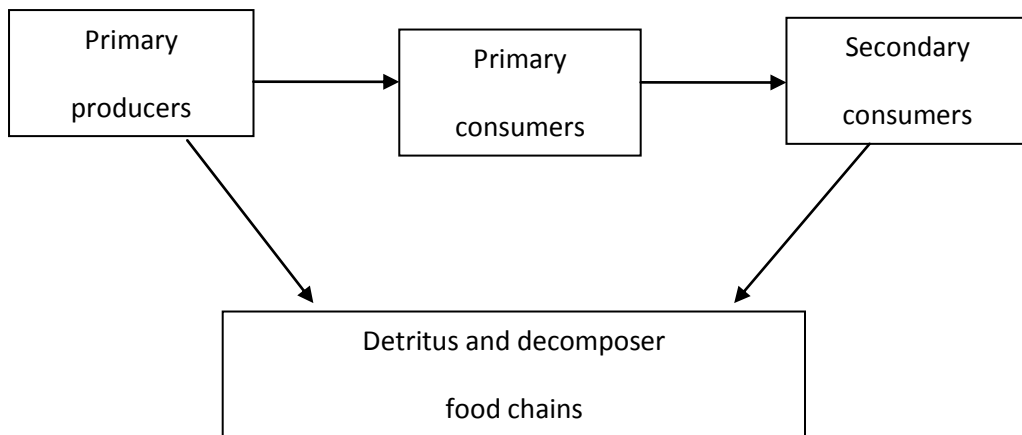


Figure 1. Cycling of matter through an ecosystem

- (i) Name ONE decomposer. **(1 mark)**
- (ii) Outline the importance of the decomposer in the cycling of matter illustrated in Figure 1. **(2 marks)**
- (b) Describe TWO ways in which human activities can disrupt the integrity of natural ecosystems. **(8 marks)**
- (c) With reference to any **named** ecosystem, construct a food web to show the feeding relationships between the organisms. **(4 marks)**
- (d) The table below shows the number of organisms in a community.

Organism	Number
Mango trees	5
Caterpillars	60
Small birds	10
Hawks	5

Use the information in the table to construct a pyramid of numbers. **(5 marks)**

Total 20 marks

MODULE 2

Answer BOTH questions.

3. Table 2 presents data on world population size in 1990 and the estimated size for 2020.

TABLE 2: WORLD POPULATION SIZE

	More Developed Countries (millions)	Less Developed Countries (millions)
Population in 1990	1247	4486
Estimated Population in 2020	1375	6548

- (a) Calculate the estimated percentage growth in world population attributable to Less Developed Countries between 1990 and 2020. **(5 marks)**
- (b) Explain why this estimated growth in the population of Less Developed Countries should be a cause for concern. **(4 marks)**
- (c) State **THREE** environmental impacts that could be associated with the percentage growth estimated in 3(a). **(3 marks)**
- (d) Select any **TWO** environmental impacts you stated in (c) above and suggest **TWO** measures that may be taken to mitigate **EACH** impact. **(8 marks)**

Total 20 marks

- 4(a) Explain how culture influences the rate of growth of a population. **(2 marks)**
- (b) Table 3 shows the Human Development Index (HDI) of two countries for 2007.

TABLE 3: HUMAN DEVELOPMENT INDEX

Country	HDI
A	0.89
B	0.38

State THREE deductions that may be made regarding the relative achievements of BOTH countries based on their HDI presented in Table 3. **(6 marks)**

- (c) Table 4 shows the total fertility rates for high and low income level countries.

TABLE 4: FERTILITY RATES

Year	High Income	Low Income
1965	5.8	7.5
1990	3.6	5.1
2000	2.1	4.6

- (i) Define the term 'fertility rate'. **(1 mark)**
- (ii) Draw a graph to illustrate the information provided in the table. **(5 marks)**
- (ii) State THREE conclusions (inferences) that can be made from the graph drawn in (c)(ii) above. **(6 marks)**

Total 20 marks

MODULE 3

Answer BOTH questions.

- 5(a) With reference to suitable examples, distinguish between ‘consumptive use’ and ‘non-consumptive use’ of natural resources. **(3 marks)**
- (b) The graph below shows the changes in the quantities of two natural resources, A and B, over a ten-year period.

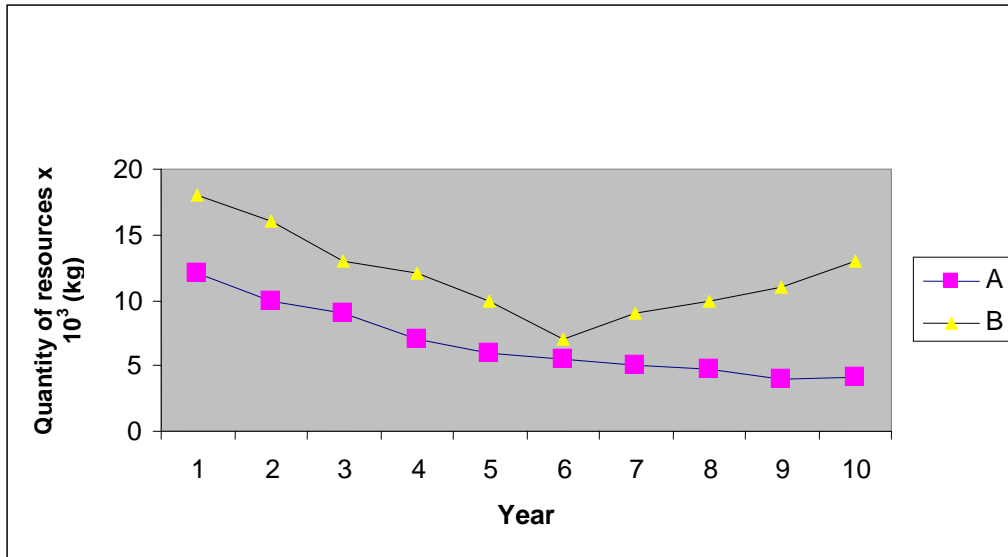


Figure 2. Quantities of two natural resources A, and B, over a ten-year period

- (i) Using actual values from the graph, describe the trend in the quantity of resource B over the ten-year period. **(5 marks)**
- (ii) From the graph drawn, identify the resource which is non-renewable and the resource which is renewable. **(2 marks)**
- (iii) Justify your answer in b (ii). **(7 marks)**
- (c) Suggest THREE ways by which the non-renewable resource can be conserved. **(3 marks)**

Total 20 marks

- 6(a) State THREE functions of coral reef ecosystems in the Caribbean. **(3 marks)**
- (b) Explain how ANY THREE human activities impact on coral reef ecosystems in the Caribbean. **(6 marks)**
- (c) The table below gives the percentage coral reef cover and the percentage fishable resources for the south coast of an island between 1995 and 2005.

TABLE 5: PERCENTAGE CORAL REEF COVER AND PERCENTAGE FISHABLE RESOURCES

Yr	% Coral Reef Cover	% Fishable Resource
1995	50	70
1996	46	71
1997	41	68
1998	33	71
1999	25	64
2000	19	59
2001	12	47
2002	8	41
2003	15	32
2004	21	30
2005	27	38

- (i) Plot a graph to show the information in the table. **(5 marks)**
- (ii) Use the graph to determine the time lag between reef degradation and the collapse of the fishable resources and give ONE reason for the time lag. **(2 marks)**
- (iii) Suggest TWO reasons for improvement in fishable resources associated with the recovery in coral reef ecosystems. **(4 marks)**

Total 20 marks

END OF TEST



TEST CODE **02120032/SPEC/2010**

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

ENVIRONMENTAL SCIENCE

UNIT 1: ECOLOGY, HUMAN POPULATION AND NATURAL RESOURCES

SPECIMEN PAPER

PAPER 03/2

2 hours

INSTRUCTIONS TO CANDIDATES

1. This paper consists of THREE questions.
2. Answer ALL questions.
3. Write your answers in the answer booklet provided.
4. Graph paper is provided.
5. You may use a silent, non-programmable, scientific calculator

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02120032/SPEC/ 2010

Answer ALL questions.

Read the paragraph below and answer the questions that follow.

A forest concession was granted to a timber company to harvest timber for a period of thirty years. The concession was granted on the condition that the species of a tree lizard endemic to the area was protected. The university in the country was asked by the company to monitor the lizard population for the duration of the operation of the concession. The university was also required to make recommendations for the conservation and protection of the lizard population.

Table 1 presents the results of monitoring the lizard population for the last ten years of the concession.

TABLE 1: LIZARD POPULATION OVER TEN-YEAR PERIOD

Year	Lizard Population
1996	170
1997	130
1998	120
1999	115
2000	110
2001	130
2002	147
2003	169
2004	180
2005	200

1. The mark-release-recapture method was used to collect the data presented in Table 1.
- Why is this method suitable for the lizard population? **(3 marks)**
 - Outline the mark-release-recapture method for collecting the data presented in Table 1. **(7 marks)**
 - State TWO assumptions that must be made when using the mark-release-recapture method to estimate population size. **(4 marks)**
 - Describe FOUR steps of a monitoring plan to track the lizard population. State ONE objective for EACH step described. **(8 marks)**
 - Use the information in Table 1 to plot an appropriate graph showing the variation in the lizard population during the period 1996 – 2005. **(8 marks)**

Total 30 marks

2. Figure 1 shows the age structure diagram for a country. The fertility rate of the country is at replacement level and its population size is 56.6 million.

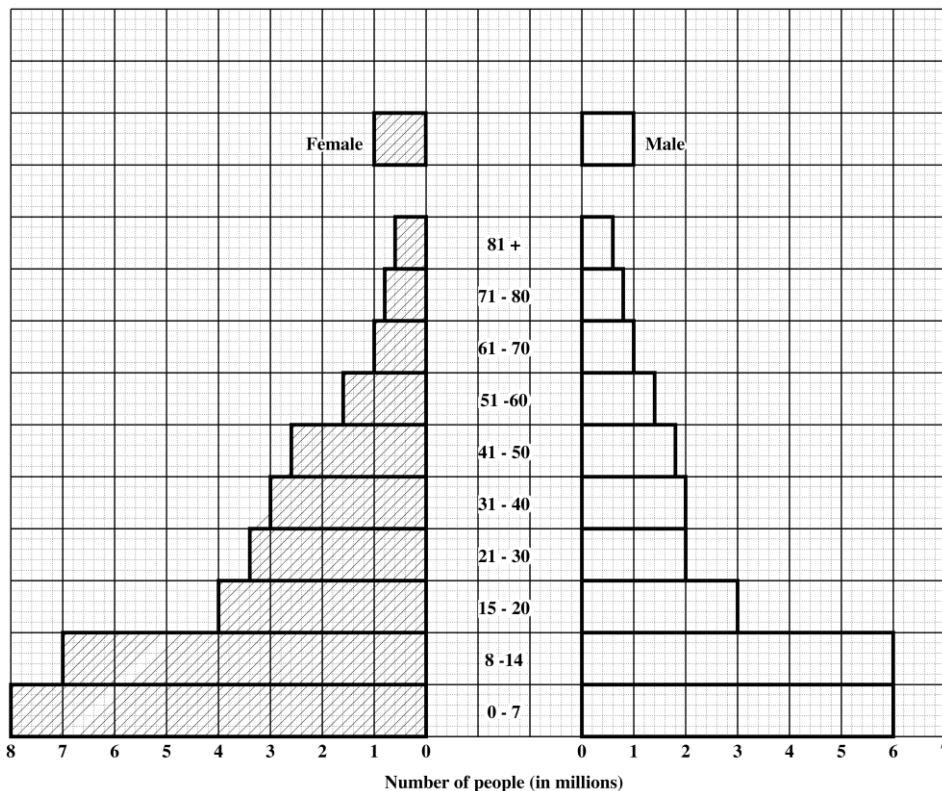


Figure 1. Age structure diagram

- (a) State what is meant by the terms
- (i) fertility rate
 - (ii) replacement fertility rate. **(4 marks)**
- (b) Use the diagram to calculate
- (i) the number of people in the 41 – 60 age group **(5 marks)**
 - (ii) the percentage of the population in the pre-reproductive years. **(7 marks)**
- (c) (i) How is the population of the country expected to change over the next ten years? **(1 mark)**
- (ii) Justify your answer in (c) (i). **(4 marks)**
- (d) Explain how EACH of the following factors may affect fertility rates:
- (i) Educational opportunities
 - (ii) Social and economic status of women
 - (iii) Family planning services **(9 marks)**

Total 30 marks

- 3 Figure 2 shows the effect of increased harvesting effort (number of fishing boats) on the daily fish catch.

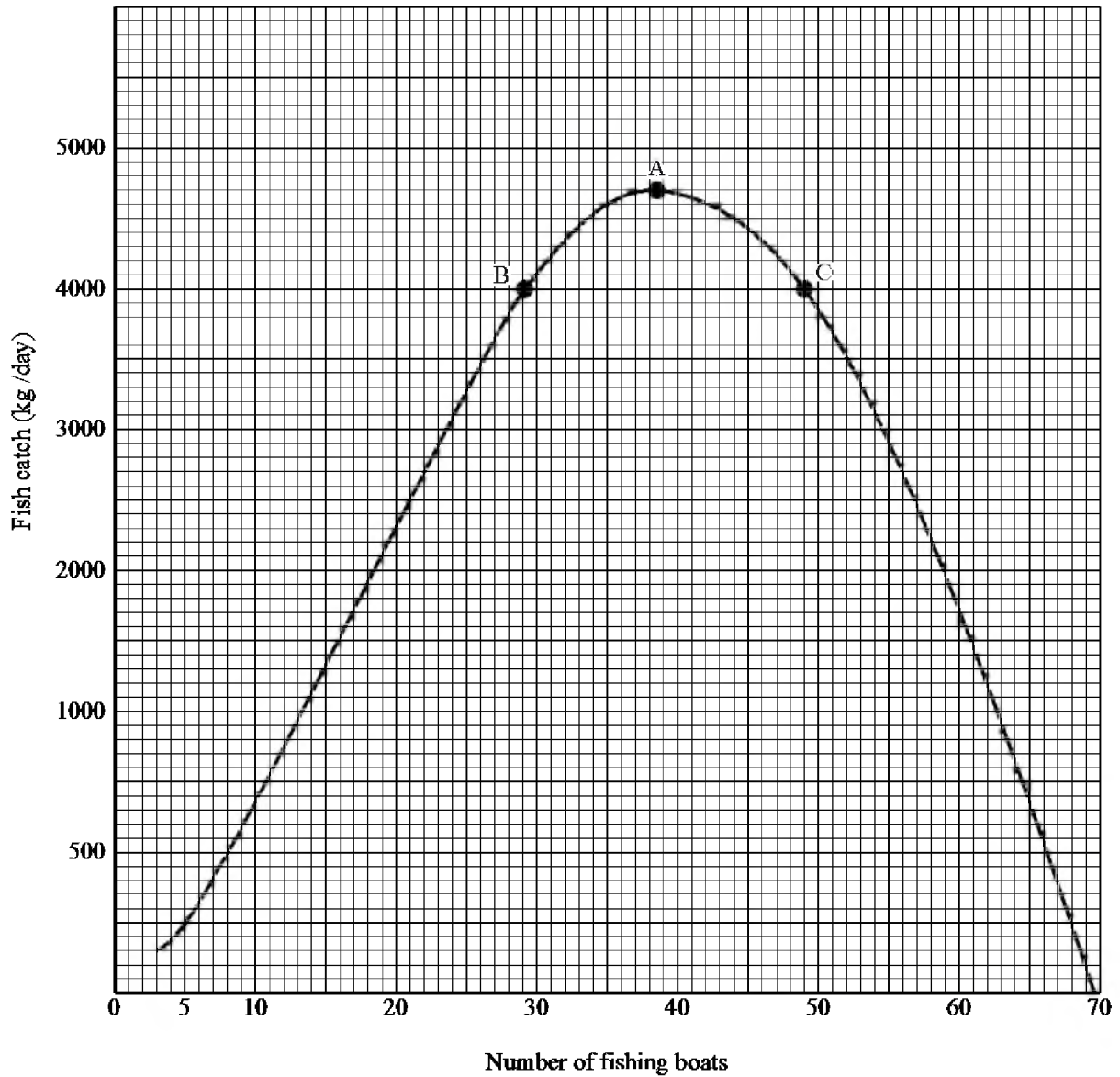


Figure 2: Effect of increased harvesting effort on the daily fish catch

- (a) (i) Describe the trend observed in Figure 2. **(8 marks)**
- (ii) Using the graph, determine what fishing effort will produce a daily catch of 3500 kg of fish. **(2 marks)**
- (b) (i) What is meant by the term 'maximum sustainable yield (MSY)' in relation to the harvesting of the fishing stock? **(2 marks)**
- (ii) At which of the three points, A, B or C, shown on Figure 2 should harvesting take place to achieve the maximum sustainable yield? **(1 mark)**
- (iii) Give THREE reasons why it is best to harvest the fishing resource at the MSY. **(6 marks)**
- (c) Explain the effect of EACH of the following on the harvesting of the fishing resource in Figure 2:
- (i) Population growth
- (ii) Level of environmental awareness **(6 marks)**
- (d) (i) Recommend ONE conservation measure that may be used to improve the status of the fishing resource. **(1 mark)**
- (ii) Give TWO reasons for the recommendation provided in (d)(i). **(4 marks)**

Total 30 marks

END OF TEST



TEST CODE **02220010/SPEC/2010**

C A R I B B E A N E X A M I N A T I O N S C O U N C I L

ADVANCED PROFICIENCY EXAMINATION

ENVIRONMENTAL SCIENCE

UNIT 2

SPECIMEN PAPER

Paper 01

90 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

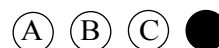
1. This test consists of 45 items. You will have 90 minutes to answer them.
2. In addition to this test booklet, you should have an answer sheet.
3. Do not be concerned that the answer sheet provides spaces for more answers than there are items in this test.
4. Each item in this test has four suggested answers lettered (A), (B), (C), (D). Read each item you are about to answer and decide which choice is best.
5. On your answer sheet, find the number which corresponds to your item and shade the space having the same letter as the answer you have chosen. Look at the sample item below.

Sample Item

Suspended particles in water cause

- (A) acidity
- (B) alkalinity
- (C) salinity
- (D) turbidity

Sample Answer



The best answer to this item is “turbidity”, so answer space (D) has been shaded.

6. If you want to change your answer, erase it completely before you fill in your new choice.
7. When you are told to begin, turn the page and work as quickly and as carefully as you can. If you cannot answer an item, omit it and go on to the next one. You may return to the omitted item later. Your score will be the total number of correct answers.
8. You may use a silent electronic calculator.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

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1. Which of the following may cause soil degradation?
- I. Leaching
 - II. Strip farming
 - III. Water logging
 - IV. Mono-culture farming
- (A) I and II only
(B) I, II and III only
(C) I, III and IV only
(D) I, II, III and IV
2. Which of the following BEST describes subsistence farming?
- (A) Large scale for profit
(B) Providing just enough for the farmer's own family
(C) Involving large amounts of inputs for example, fertilisers
(D) Involving few people and large amounts of land
3. Which of the following are effects of the continuous use of fertilisers?
- I. Few organisms in the soil
 - II. Reduced soil humus content
 - III. Poor crumb structure of soil
 - IV. Decreased soil mineral content
- (A) I and II only
(B) I and III only
(C) I, II and III only
(D) I, II, III and IV
4. Which method of increasing soil fertility has the GREATEST environmental impact?
- (A) Adding cow manure to the soil
(B) Ploughing a cover crop into the soil
(C) Planting pigeon peas between rows of other crops
(D) Adding inorganic fertiliser to the soil
5. The farming of ocean fish is BEST described as
- (A) apiculture
 - (B) aeroponics
 - (C) mariculture
 - (D) hydroponics
6. Which of the following are environmentally sustainable agricultural practices?
- I. Agro-forestry
 - II. Contour farming
 - III. Integrated pest management
 - IV. Mono-culture farming
- (A) I and III only
(B) I, II and III only
(C) I, II and IV only
(D) I, II, III and IV
7. Agriculture plays an important role in the economies of various countries. Which of the following are the MOST important economic roles played by agriculture?
- I. Provides form of food security
 - II. Contributes to Gross Domestic Product (GDP)
 - III. Provides opportunity for scientific research
 - IV. Attracts foreign exchange
- (A) I, II and III only
(B) I, II and IV only
(C) I, III and IV only
(D) II, III and IV only

GO ON TO THE NEXT PAGE

8. Which of the following are DISADVANTAGES of aquaculture?

- I. Large output of polluted water
- II. High yield in small volume of water
- III. Large inputs of land, feed and water needed
- IV. Dense population vulnerable to disease

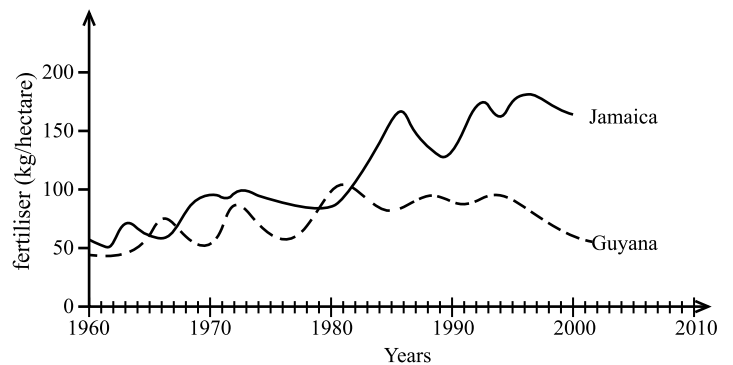
- (A) I and II only
- (B) I, II and III only
- (C) I, III and IV only
- (D) I, II, III and IV

9. Which of the following may be used in a programme of integrated pest management?

- I. Introduction of a non-native ladybird which eats the pest
- II. Occasional spraying of broad-spectrum pesticides
- III. Planting of non-crop plants between crops
- IV. Use of genetically engineered crops to resist disease

- (A) I, II and III only
- (B) I, II and IV only
- (C) I, III and IV only
- (D) II, III and IV only

Items 10 - 12 refer to the graph below which shows fertiliser consumption for Guyana and Jamaica for the period 1960 - 2010.



10. For the year 1970, the difference in fertiliser consumption between Jamaica and Guyana is approximately

- (A) 30 kg/hectare
- (B) 50 kg/hectare
- (C) 70 kg/hectare
- (D) 100 kg/hectare

11. Which of the following statements is correct?

- (A) For the period 1990 - 2000, fertiliser consumption is higher for Jamaica than for Guyana.
- (B) For the period 1990-2000, fertiliser consumption for both countries is directly proportionate.
- (C) For the period 1990-2000, fertiliser consumption for both countries is the same.
- (D) For the period 1990-2000, fertiliser consumption is higher for Guyana than for Jamaica.

12. Which of the following processes may be linked to the sharp increase in fertiliser consumption for Jamaica in the 1980s?

- (A) Salinisation
- (B) Soil erosion
- (C) Water logging
- (D) Eutrophication

GO ON TO THE NEXT PAGE

13. Winkler's Test is commonly used when determining the effect of
- (A) salinisation
 - (B) fertiliser run-off
 - (C) soil degradation
 - (D) heavy metal contamination

14. In the 1960s the 'Green Revolution' involved the widespread application of increased mechanisation, pesticide and fertiliser use, a general increase in farm size and widespread use of high-yield crop varieties.

Which of the following are likely to be consequences of the 'Green Revolution'?

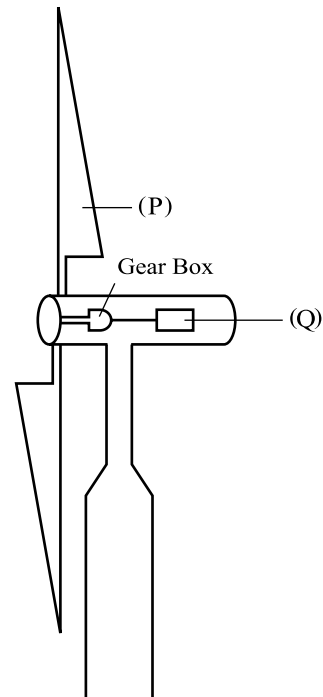
- I. An increase in food production
 - II. A long-term decrease in pest activity
 - III. A long-term decrease in soil quality
 - IV. An increase in agricultural biodiversity
- (A) I and II only
 - (B) I and III only
 - (C) II and IV only
 - (D) III and IV only

15. Which of the following is a likely disadvantage of the use of genetic engineering in agriculture?
- (A) Increased dependence on agrochemicals
 - (B) Increased need for mechanisation on farms
 - (C) Unanticipated ecological effects on natural ecosystems
 - (D) More time is needed for the production of results

16. Which of the following is an example of a renewable energy source?
- (A) Coal
 - (B) Fossil fuel
 - (C) Nuclear energy
 - (D) Geothermal energy

17. The energy that matter has because of its mass and velocity is
- (A) kinetic
 - (B) nuclear
 - (C) potential
 - (D) chemical

Item 18 refers to the diagram of a wind turbine below.

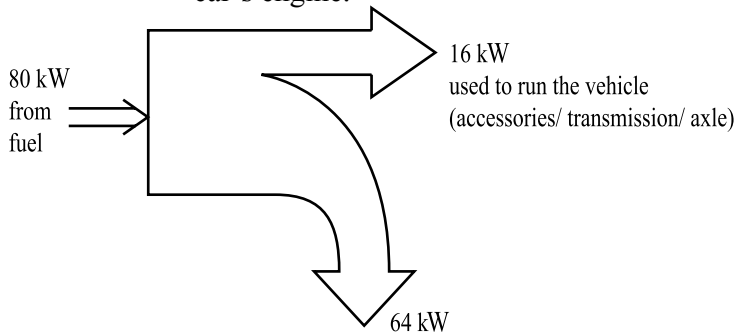


18. The part labelled P is the
- (A) generator
 - (B) drive shaft
 - (C) rotor blade
 - (D) electrical cable

19. Which of the following actions can increase the energy efficiency of a building?
- I. Aligning building to maximise air flow
 - II. Using central air conditioning
 - III. Having large glass windows
 - IV. Using light coloured paints on the wall
- (A) I and III only
(B) III and IV only
(C) I, III and IV only
(D) I, II, III and IV
20. Which of the following are potential environmental impacts of wind energy?
- I. Bird kills
 - II. Noise pollution
 - III. Water pollution
 - IV. Loss of biodiversity
- (A) I, II and III only
(B) I, II and IV only
(C) I, III and IV only
(D) I, II, III and IV
21. In the Caribbean, many islands rely on the importation of fossil fuels to generate electricity for domestic and industrial use. The cost attached to this importation of fuel can be classified as
- (A) social
(B) regional
(C) political
(D) economic
22. Which of the following energy conversions shows the conversion of energy in the production of electricity from crude oil?
- (A) Chemical → mechanical → heat → electrical
(B) Chemical → heat → mechanical → electrical
(C) Heat → chemical → mechanical → electrical
(D) Mechanical → light → heat → electrical
23. Which of the following may be done in the home to help conserve energy?
- I. Turn off the light when not in the room.
 - II. Unplug cell phone chargers and other devices when not in use.
 - III. Leave on the tap while brushing your teeth.
 - IV. Do not turn off the computer because it uses more energy on start up.
- (A) I and II only
(B) I and III only
(C) II and IV only
(D) III and IV only
24. Which of the following may be adopted to promote the use of hybrid vehicles (a vehicle which uses alternative energy sources) in the Caribbean?
- I. Charge no import duty on hybrid vehicles
 - II. Increase taxes on fuel for traditional vehicles
 - III. Increase taxes on gas and diesel engine vehicles
 - IV. Upgrade and increase the existing fuel stations to accommodate hybrid vehicles
- (A) I and IV only
(B) I, II and IV only
(C) I, III and IV only
(D) I, II, III and IV

GO ON TO THE NEXT PAGE

Items 25 - 26 refer to the diagram below which shows the energy conversion in a car's engine.



25. The energy efficiency of the engine is

- (A) 20%
- (B) 50%
- (C) 70%
- (D) 100%

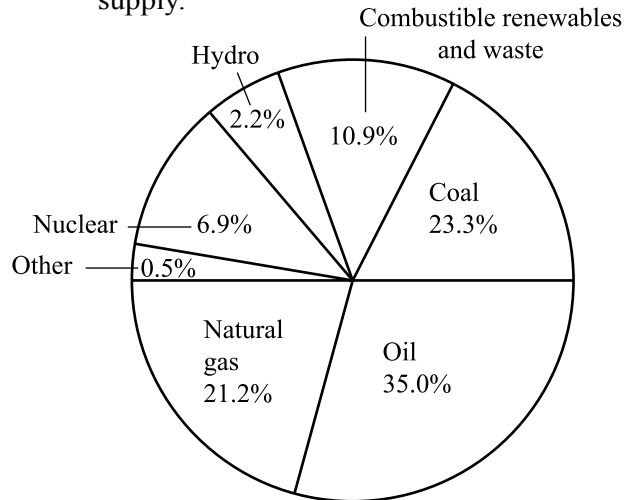
26. The remaining 64 kW is

- (A) used for braking
- (B) lost as heat energy
- (C) used for water cooling
- (D) re-circulated into the engine

27. Water stored in a dam is an example of

- (A) solar energy
- (B) water energy
- (C) kinetic energy
- (D) potential energy

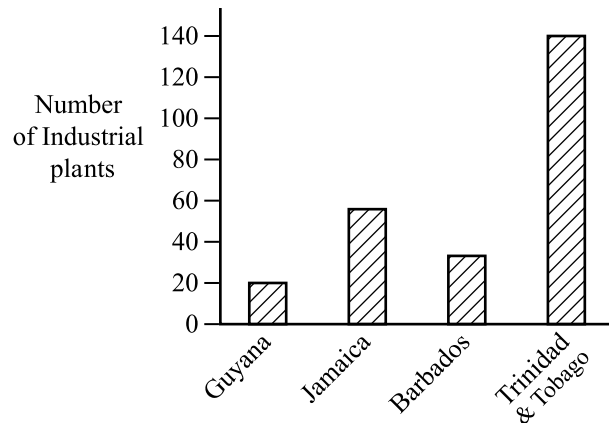
Item 28 refers to the following pie chart which represents global primary energy supply.



28. The total percentage of global energy supplied by fossil fuels is

- (A) 21.2%
- (B) 35.0%
- (C) 69.2%
- (D) 79.5%

Item 29 refers to the graph below which shows the number of Industrial plants in five Caribbean countries.

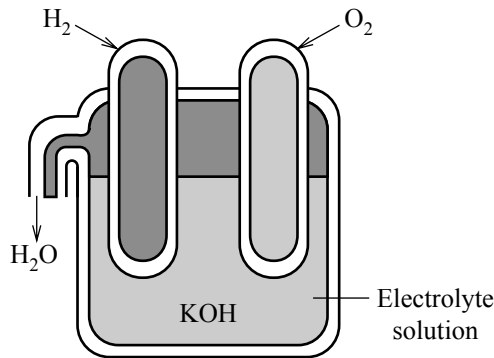


29. Based on the graph, which Caribbean country will have the GREATEST demand for electricity?

- (A) Guyana
- (B) Jamaica
- (C) Barbados
- (D) Trinidad & Tobago

GO ON TO THE NEXT PAGE

Item 30 refers to the diagram below.



30. The diagram shows the essential features of

- (A) a fuel cell
- (B) an electric motor
- (C) a nuclear fusion reactor
- (D) a nuclear fission reactor

31. The BEST example of a point source of water pollution is

- (A) storm water
- (B) factory effluent
- (C) acid precipitation
- (D) agricultural run-off

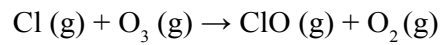
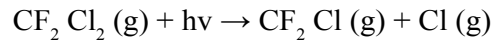
32. Ozone, O₃, is

- (A) a primary air pollutant in the troposphere
- (B) a secondary air pollutant in the troposphere
- (C) a primary air pollutant in the stratosphere
- (D) a secondary air pollutant in the stratosphere

33. Which international agreement was designed to protect the ozone layer?

- (A) Kyoto Protocol
- (B) Montreal Protocol
- (C) Basel Convention
- (D) Cartagena Convention

Item 34 refers to the equations below.



34. The equations above BEST describe the

- (A) greenhouse effect
- (B) process of oxidation
- (C) process of carbonation
- (D) destruction of the ozone layer

35. On which of the following does the toxicity of a substance depend?

- I. The amount of the substance the person has ingested, inhaled or absorbed through the skin
- II. How frequently the person is exposed to the substance
- III. The genetic make-up of an individual
- IV. The percentage of individuals in the population who are affected by the chemical substance

- (A) I and III only
- (B) I, II and III only
- (C) I, II and IV only
- (D) I, III and IV only

36. A synergistic interaction

- (A) either decreases or multiplies the harmful effect of a toxin
- (B) is an immediate or rapid harmful reaction to an exposure
- (C) reduces the harmful effect of a toxin
- (D) multiplies the harmful effect of a toxin

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37. Which of the following activities may result in an increase in pollution?

- I. Individual
- II. Recreational
- III. Festival
- IV. Tourism

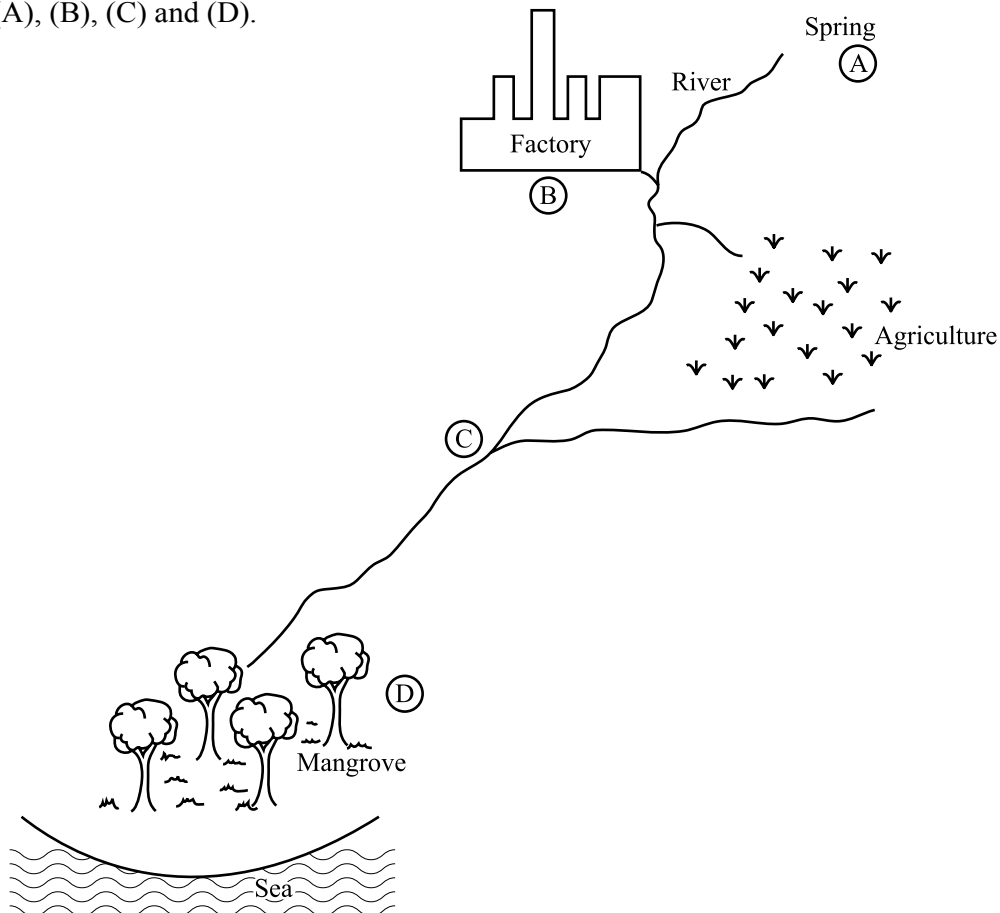
- (A) I and II only
- (B) II and III only
- (C) I, II and III only
- (D) I, II, III and IV

38. Which of the following should be considered when disposing hazardous waste?

- I. Security of disposal site
- II. Methods of transporting the waste to disposal site
- III. Weight of the hazardous waste
- IV. Geological activity

- (A) I, II and III only
- (B) I, II and IV only
- (C) II, III and IV only
- (D) I, II, III and IV

Items 39 - 40 refer to the diagram below showing a section of a village with locations labelled (A), (B), (C) and (D).



39. Which location on the diagram is the BEST location for a water treatment plant that produces potable water?

40. At which location on the diagram will the nitrates be in the HIGHEST concentration?

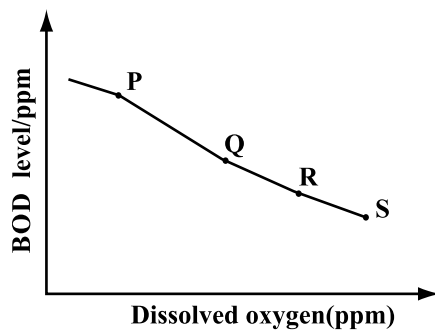
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41. Mr James, a farmer, uses the river which runs through his property for irrigation. He suspects the water is being contaminated by raw sewage.

Which parameter will he have to monitor to determine if his suspicions are justified?

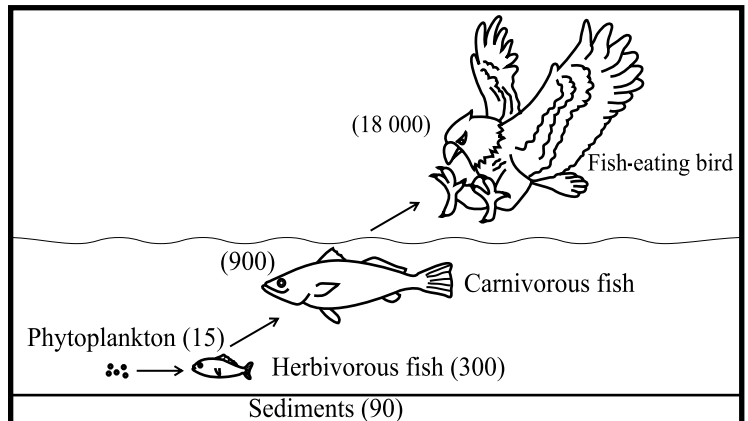
- (A) Turbidity
- (B) Total nitrates
- (C) Faecal coliform
- (D) Total suspended solids

Items 42 - 43 refer to the graph below which shows the relationship between biochemical oxygen demand and dissolved oxygen concentrations in a river. P to S represents values for BOD and DO from samples at four different points along the river.



42. Which sample was MOST LIKELY taken from the active decomposition zone?
- (A) P
 - (B) Q
 - (C) R
 - (D) S
43. Which sample was MOST LIKELY taken from a point in the river closest to the pollution source?
- (A) P
 - (B) Q
 - (C) R
 - (D) S

Items 44 - 45 refer to the diagram below which shows an aquatic food chain with the mercury concentrations at each level.



44. The process shown in the diagram is
- (A) bioremediation
 - (B) biomagnification
 - (C) bioaccumulation
 - (D) phytoremediation
45. The concentration factor for the mercury pollutant in the food chain is
- (A) 15
 - (B) 325
 - (C) 1 200
 - (D) 12 000

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.



® TEST CODE **02220020/SPEC/2010**

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

ENVIRONMENTAL SCIENCE

UNIT 2: AGRICULTURE, ENERGY AND ENVIRONMENTAL POLLUTION

SPECIMEN PAPER

PAPER 02

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

1. Do NOT open this examination paper until instructed to do so.
2. This paper consists of SIX questions, TWO from each Module.
3. Answer ALL questions.
4. Write your answers in the answer booklet provided.
5. You may use a silent, non-programmable, scientific calculator.

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02220020/ SPEC/ 2010

MODULE 1

Answer BOTH questions.

1. Figure 1 shows the agricultural yield from a farm when inorganic fertilisers and organic fertilisers are used.

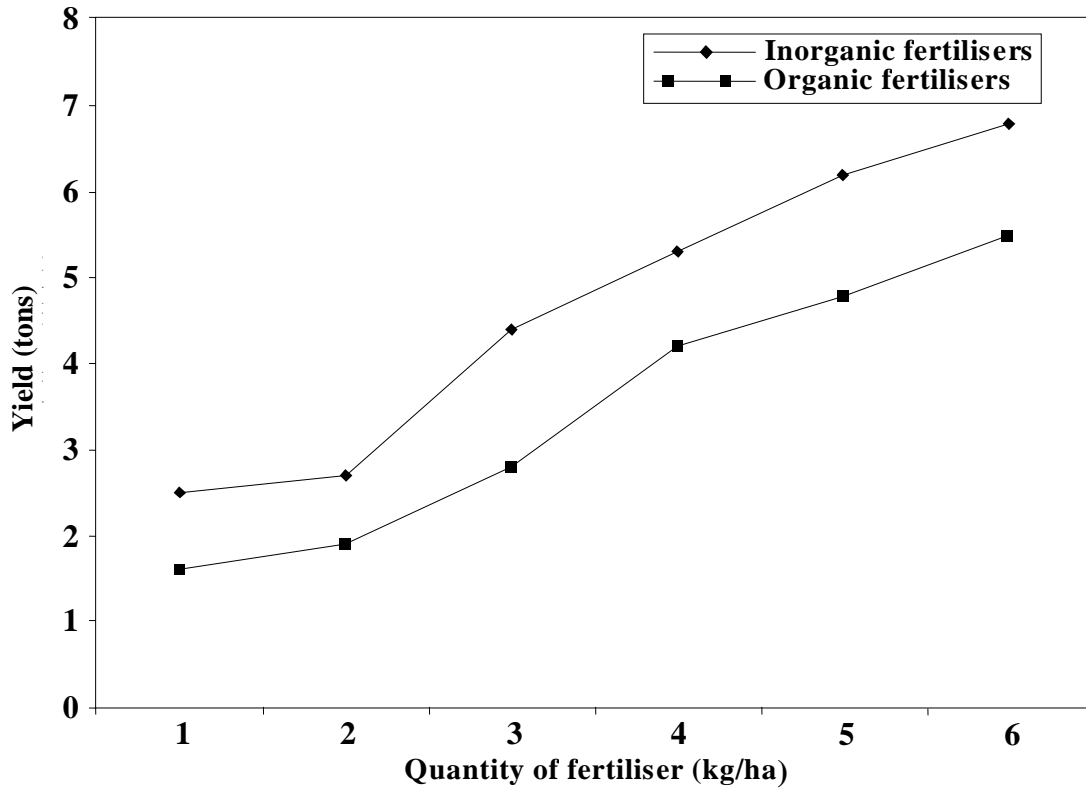


Figure 1. Yield and type of fertiliser used

- (a) With reference to Figure 1, state FIVE deductions that can be made about the agricultural yield from the farm. **(5 marks)**
- (b) Distinguish between ‘organic fertilisers’ and ‘inorganic fertilisers’. **(3 marks)**
- (c) Discuss why, in spite of the trend shown in Figure 1, farmers are still being encouraged to increase their use of organic fertilisers over inorganic fertilisers.

Include SIX points in your response. **(12 marks)**

Total 20 marks

2. Hillside farming has been a common occurrence for years in Toco Village. Recently residents of the village have observed increased cases of soil erosion and degradation of the water quality. Farmers have been planting the same crops for years and have complained of decreased yields and increased pest infestation.

- (a) Residents in Toco Village were told by the agricultural extension officer that their farming practices were responsible for the increased cases of soil erosion and water quality degradation.

Explain why the officer said this to the residents. **(6 marks)**

- (b) Farmers in Toco Village were advised to practise crop rotation in an effort to improve yields and reduce the problems caused by pest infestation.

Justify the advice given. **(6 marks)**

- (c) (i) Name ONE soil conservation method that is appropriate for the farmers in Toco Village. **(1 mark)**

(ii) BRIEFLY describe the method named in (c)(i) above. **(2 marks)**

- (d) The turbidity of the river in Toco Village was monitored from 1990 – 2000. The table below provides the information collected.

TABLE 1: RESULTS OF WATER QUALITY MONITORING

Year	Turbidity
1990	5.5
1992	9.0
1994	27.2
1996	29.2
1998	16.4
2000	10.2

- (i) Plot a graph to illustrate the information provided in the table. **(4 marks)**
- (ii) The farmers implemented the soil conservation method identified in (c)(i) during this period. In what year was this method implemented? **(1 mark)**

Total 20 marks

MODULE 2

Answer BOTH questions.

3. (a) Outline the process by which fossil fuels are formed. **(2 marks)**

(b) Figure 2 shows the annual consumption of fossil fuels by developing countries in 1990, 2000, 2003.

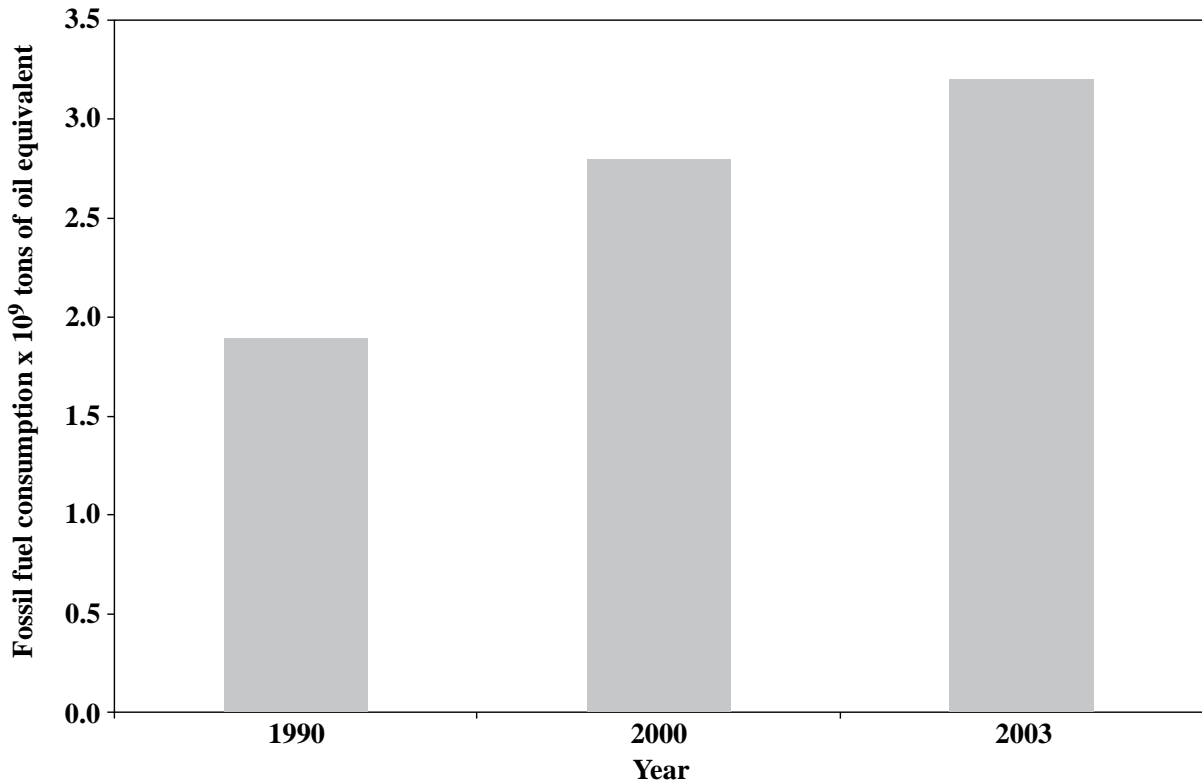


Figure 2. Annual consumption of fossils fuels by developing countries

- (i) Compare the annual consumption of fossil fuels over the three years. **(5 marks)**
- (ii) Describe ONE **environmental** and ONE **social** impact on developing countries as a result of the consumption pattern indicated in Figure 2. **(8 marks)**
- (c) (i) Define the term 'demand management' in relation to energy use. **(1 mark)**
- (ii) Explain how 'demand management' can help to mitigate the impacts of fossil fuel consumption. **(4 marks)**

Total 20 marks

4.(a) Figure 3 below shows a hydroelectric power plant.

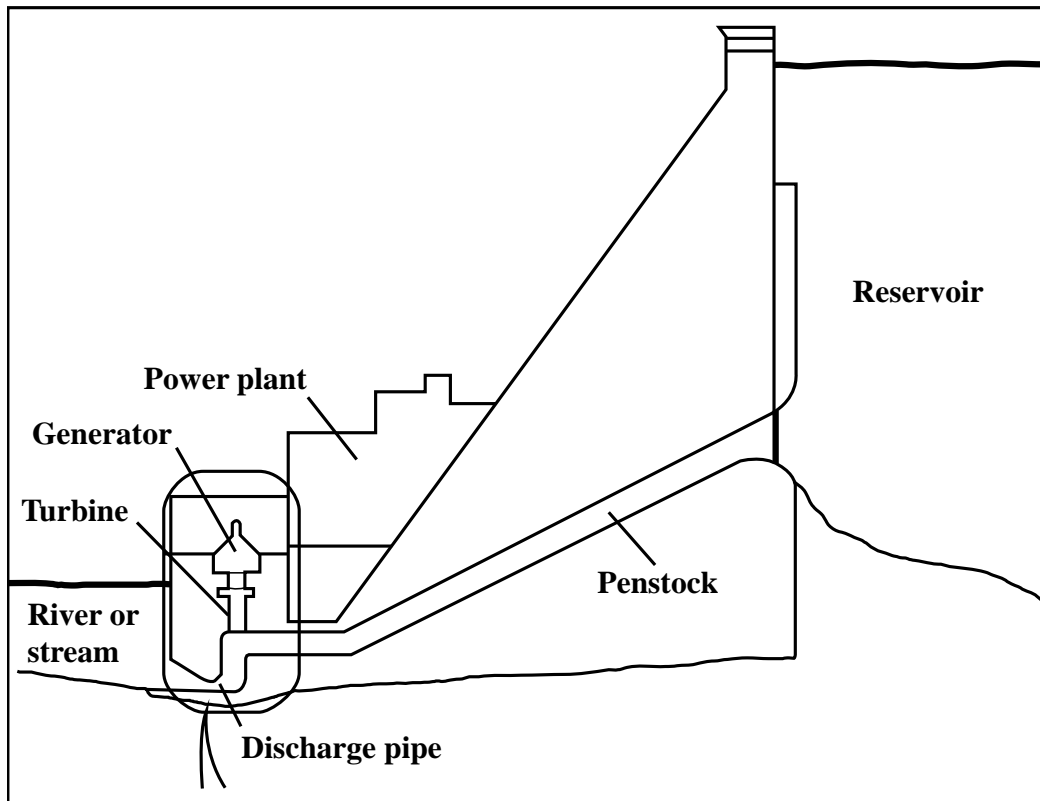


Figure 3. Hydroelectric power plant

- (a) Describe the energy conversion process occurring in the hydroelectric power plant, making clear in your description the meaning of the terms 'potential energy' and 'kinetic energy'. **(4 marks)**
- (b) State TWO advantages and ONE disadvantage of hydroelectric power generation. **(3 marks)**
- (c) Assess the suitability of (i) hydroelectricity AND (ii) solar energy to adequately meet the energy needs of developing countries. **(8 marks)**

(d) The data below represent the percentage use of various types of energy in the world.

Type of Energy	Percentage Use
Biomass	11.0
Coal	22.0
Geothermal, solar, wind	2.5
Hydropower	4.5
Natural gas	21.0
Nuclear	6.0
Oil	33.0

(i) Plot a bar graph to illustrate the data in the table. **(4 marks)**

(ii) What percentage of commercial energy used in the world is renewable? **(1 mark)**

Total 20 marks

MODULE 3

Answer BOTH questions.

5. Table 2 presents results from a monitoring programme to determine levels of the pesticide dieldrin present in an aquatic ecosystem. The pesticide concentration was measured in each organism that formed a part of a complete food chain.

TABLE 2: CONCENTRATION OF DIELDRIN IN AQUATIC ECOSYSTEM

Category of Organism	Organism	Dieldrin Concentration (ppm)
Producers	Algae, aquatic plant	0.05
Primary consumers	Small fish	0.3 – 1.2
Secondary consumers	Large fish	1.4 – 2.6
Tertiary consumers	Large bird	4.0 – 6.0

Concentration of dieldrin in water = 0.0002 ppm

- (a) State FIVE inferences that may be drawn from the data presented in Table 2. **(5 marks)**
- (b) Outline ONE environmental pathway of the pesticide. **(3 marks)**
- (c) Account for the difference in dieldrin concentration in the organisms presented in Table 2. **(6 marks)**
- (d) Describe TWO characteristics of pesticides that account for their environmental impact. **(6 marks)**

Total 20 marks

6. Figure 4 shows the solid waste composition for a Caribbean country in 1998 and 2007.

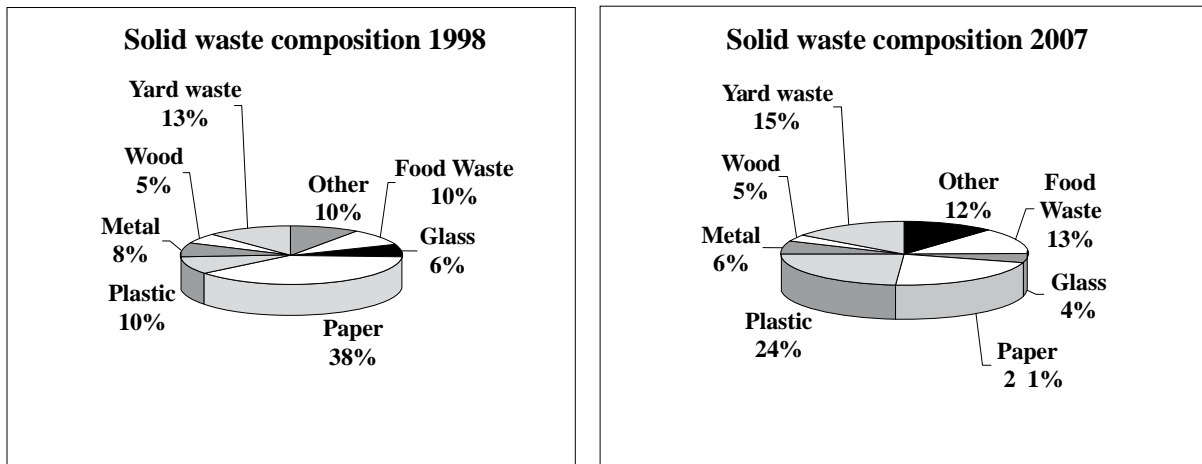


Figure 4. Solid waste composition for a Caribbean country, 1998 and 2007

- (a) (i) State TWO major changes in the composition of solid waste between 1998 and 2007. **(2 marks)**
- (ii) Explain the environmental significance of ONE of the changes in (i) above. **(2 marks)**
- (iii) Which solid waste is the same in both years? **(1 mark)**
- (b) Outline TWO reasons for the change in the composition of solid waste between 1998 and 2007. **(4 marks)**
- (c) (i) What is meant by the term 'recycling'? **(2 marks)**
- (ii) Name ONE type of waste that can be recycled. **(1 mark)**
- (d) Caribbean countries are proposing recycling programmes for minimising the volume of solid waste which they produce. Discuss FOUR advantages and FOUR disadvantages of these programmes. **(8 marks)**

Total 20 marks

END OF TEST



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CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

ENVIRONMENTAL SCIENCE

UNIT 2: AGRICULTURE, ENERGY AND ENVIRONMENTAL POLLUTION

SPECIMEN PAPER

PAPER 03/2

2 hours

INSTRUCTIONS TO CANDIDATES

1. This paper consists of THREE questions.
2. Answer ALL questions.
3. Write your answers in the answer booklet provided.
4. Graph paper is provided.
5. You may use a silent, non-programmable, scientific calculator.

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02220032/ SPEC/2010

Answer ALL questions.

Read the paragraph below and answer the questions that follow.

Tropic Farm has been in operation since 1970 producing bananas for the export market. Tropic Farm is located in the same region as the rural community of Maka Bush. Residents of this community depend on water from the Rio Minho River for domestic use. In 1995, Tropic Farm increased its production of bananas for the export market. Residents of Maka Bush claim that since 1995, the quality of the water in the Rio Minho has deteriorated.

Table 1 presents production data from Tropic Farm for the years 1993 to 2007 while Figure 1 shows average annual nitrate concentration in the Rio Minho River from 1992 to 2007.

TABLE 1: ANNUAL PRODUCTION OF BANANAS

Year	Banana Production
1993	1400
1994	1450
1995	1500
1996	2200
1997	2500
1998	2800
1999	3000
2000	3200
2001	3100
2002	3600
2003	3700
2004	3900
2005	4100
2006	4200
2007	4000

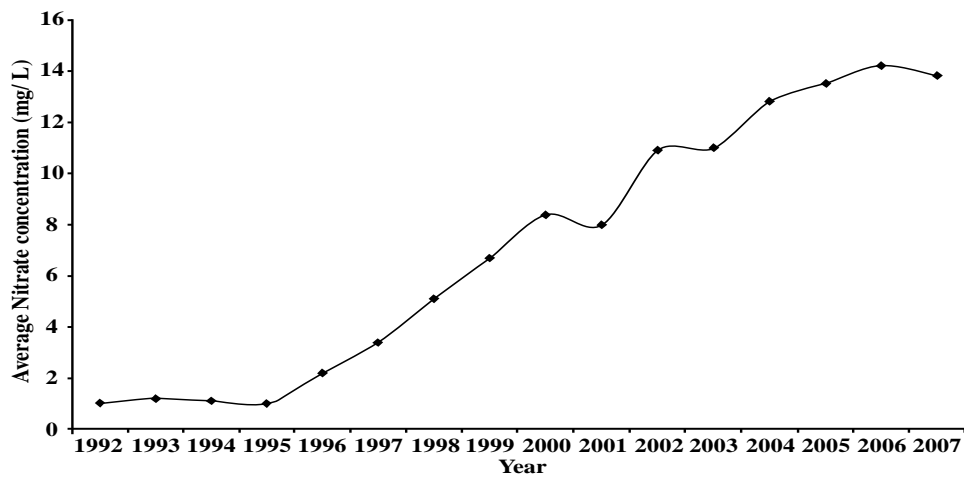


Figure 1. Nitrate concentration in the Rio Minho River

1. (a) Use the information in Table 1 to plot an appropriate graph showing the annual production of bananas by Tropic Farm from 1993 to 2007. **(12 marks)**
- (b) Describe the trend in the
 - (i) banana production between 1993 and 2007 **(4 marks)**
 - (ii) nitrate concentration from 1992 to 2007 **(4 marks)**
- (c) Calculate the rate of increase of the nitrate concentration from 1995 to 2000. **(3 marks)**
- (d) What evidence is there from the graph in Figure 1 to support the claim that the water quality of the Rio Minho has deteriorated? **(4 marks)**
- (e) Outline ONE possible environmental pathway of nitrates from the farm to the river. **(3 marks)**

Total 30 marks

2. (a) As part of its development drive, the national government has decided to invest in a hydroelectric power project on the Rio Minho River.
- (i) Hydroelectric energy can be classed as a type of indirect solar energy. State TWO other energy sources that can also be placed in the same class. **(2 marks)**
 - (ii) Describe how a hydroelectric power plant works. **(4 marks)**
- (b) The residents of Maka Bush have received letters informing them of the planned development and clearly outlining the advantages of hydroelectric power to the nation.
- (i) Provide FOUR advantages of hydroelectric power. **(4 marks)**
 - (ii) However, the residents of Maka Bush are very concerned about the possible negative impacts of this planned development, and take their concerns to the capital. Suggest FOUR concerns that the people in Maka Bush may have. **(4 marks)**
- (c) Having heard the concerns of the Maka Bush and other residents from the area, the national government provides some data on hydropower in the Caribbean to encourage the residents to get on board with the project. This data is provided in Table 2 below.

TABLE 2. GENERATION OF ELECTRICITY BY HYDROPOWER IN THE CARIBBEAN IN 2007

Country	Hydropower Generation,(billion kWh)	
	1997	2007
Antigua and Barbuda	0.00	0.00
The Bahamas	0.00	0.00
Barbados	0.00	0.00
Belize	0.07	0.18
Dominica	0.02	0.03
Grenada	0.00	0.00
Guyana	0.00	0.00
Jamaica	0.16	0.16
ST. Kitts/Nevis	0.00	0.00
St. Lucia	0.00	0.00
St. Vincent and The Grenadines	0.02	0.02
Suriname	1.30	0.90
Trinidad and Tobago	0.00	0.00

- (i) Plot a bar graph to illustrate the data in Table 2, using ONLY the data for the countries with actual hydropower generation capability. **(10 marks)**

- (ii) Describe the trend in electricity generation by hydropower in the Caribbean. **(3 marks)**
- (iii) What percentage of the electricity generated by hydropower was produced by Belize and St. Vincent and The Grenadines in 2007? **(3 marks)**

3. (a) Outline **THREE** reasons why it is necessary to monitor the water quality of water bodies. **(3 marks)**
- (b) (i) Identify **THREE** parameters, **excluding nitrates**, that should be measured in a programme to monitor the water quality of the Rio Minho River. **(3 marks)**
- (ii) Justify your choice of parameters to be measured in 3 (b)(i) above. **(6 marks)**
- (c) Outline the procedure to test for **THREE** of these water quality parameters. **(12 marks)**
- (d) (i) State **THREE** changes which may occur in a river ecosystem that has a high concentration of nitrates. **(3 marks)**
- (ii) Give **ONE** reason for **EACH** change stated in (d)(i). **(3 marks)**

Total 30 marks

END OF TEST

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

ENVIRONMENTAL SCIENCE – UNIT 1

SPECIMEN PAPER 2010

Item No.	Key	Cognitive Level	Syllabus Objective
1	C	KC	Module 1.5
2	C	KC	Module 1.1
3	A	KC	Module 1.6
4	C	KC	Module 1.12
5	D	KC	Module 1.1
6	B	KC	Module 1.13
7	C	AK	Module 1.7
8	A	AK	Module 1.12
9	B	AK	Module 1.6
10	A	AK	Module 1.6
11	B	AK	Module 1.11
12	D	AK	Module 1.2
13	C	PA	Module 1.10
14	C	PA	Module 1.10
15	D	PA	Module 1.12
16	D	KC	Module 2.2
17	B	KC	Module 2.9
18	C	KC	Module 2.9
19	D	KC	Module 2.6
20	A	KC	Module 2.6
21	A	KC	Module 2.8
22	C	PA	Module 2.6
23	B	PA	Module 2.6

Item No.	Key	Cognitive Level	Syllabus Objective
24	C	AK	Module 2.1
25	D	AK	Module 2.6
26	D	AK	Module 2.5
27	B	AK	Module 2.12
28	C	AK	Module 2.5
29	A	AK	Module 2.5
30	B	PA	Module 2.6
31	A	KC	Module 3.4
32	D	KC	Module 3.10
33	B	KC	Module 3.2
34	C	KC	Module 3.10
35	B	KC	Module 3.5
36	C	KC	Module 3.5
37	C	AK	Module 3.6
38	A	AK	Module 3.8
39	B	AK	Module 3.8
40	D	AK	Module 3.9
41	C	AK	Module 3.9
42	B	AK	Module 3.10
43	C	PA	Module 3.4
44	B	PA	Module 3.4
45	C	PA	Module 3.10

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CARIBBEAN EXAMINATIONS COUNCIL
HEADQUARTERS

ADVANCED PROFICIENCY EXAMINATION

ENVIRONMENTAL SCIENCE

SPECIMEN PAPER

UNIT 1 - PAPER 02

MARK SCHEME

Environmental Science

Specimen Paper

Paper 02 - Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
1 (a) (i)	1.1	All of the <u>interacting organisms</u> in an area together with the <u>physical environment</u> .		2		
1(a) (ii)	1.11	The ability of biological communities to remain <u>stable</u> and <u>constant</u> over time.		2		
1 (b)	1.10	$D = \frac{N(N-1)}{\sum n(n-1)}$ Species diversity A = 2.4 Species diversity B = 3.09	1 mark formula, 1 mark for calculation and 1 mark for answer		3	
1 (c)	1.10;1.11	Ecosystem stability is dependent on species diversity; ecosystem stability increase as species diversity increases.	1 mark for each point		2	
		<ul style="list-style-type: none"> Ecosystems are interconnected by feeding relationships, (1 mark) the higher the species diversity the more complex and interconnected the eco system (1mark)as a result it is more resistant to changes and can recover easily from disruptions (1 mark). Sometimes diverse communities contain keystone species, (1mark) and when these are removed associated species are also eliminated (1 mark) disrupting the ecosystem stability, in these cases species diversity makes the ecosystem less stable (1mark). 			3	

Environmental Science

Specimen Paper

Paper 02 - Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
1 (d) (i)	1.9	<p>QUADRAT</p> <ul style="list-style-type: none"> • A random numbers table is used to select coordinates • The quadrat is placed on the ground in several locations at the site. • The number of the species under investigation within the quadrat is recorded. • A mathematical equation is used to calculate the percentage frequency or species diversity. <p>OR</p> <p>LINE TRANSECT</p> <ul style="list-style-type: none"> • The sampling area is demarcated • The rope is marked and numbered at 0.5m or 1m intervals along its length. • The rope is laid across the area of study. • The species touching the line along the length of the transect is recorded. 	<p>1 mark</p> <p>Any THREE Points one mark each</p> <p>1 mark</p> <p>Any THREE Points one mark each</p>			4
1 (d) (ii)	1.9	<p>Difficulty accessing area under study due to the terrain.</p>				1
				4	11	5

Environmental Science

Specimen Paper

Paper 02 - Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
2 (a) (i)	1.5	Earthworms, mushrooms, molds, bacteria.	Any ONE 1 mark	1		
2 (a) (ii)	1.5	Decomposers break down organic matter, (1mark) releasing nutrients back into the soil (1 mark).		2		
2(b)	1.14	<ul style="list-style-type: none"> Improper disposal of non-biodegradable products: This practice can harm organisms and even kill some of them thus reducing potential food sources for others; it decreases ecological integrity and aesthetics and it can affect the rate of population increase. Pollution associated with agricultural and industrial activities: The pollutant bioaccumulate and biomagnify throughout food chains and food webs; these pollutants can harm organisms and can even kill some of them thus disrupting the ecosystem balance; the pollution can result in eutrophication. Removal of recyclable organic material from the ecosystem: This practice reduces source of food for detrital organisms; it reduces the amount of nutrients available for nutrient cycles; it disrupts ecosystems processes, biogeochemical cycles and feeding relationships. 	<p>1 mark for the way and 3 marks for describing how it disrupts the ecosystem</p> <p>ANY TWO WAYS</p>		8	

Environmental Science
Specimen Paper
Paper 02 - Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
2 (c)	1.5	Named ecosystem. Food web showing interactions at two different trophic levels. Construction of food web.	1 mark 2 marks 1 mark		4	
2 (d)	1.5	PYRAMID <div style="text-align: center;"> <div style="border: 1px solid black; width: 80px; height: 30px; margin: 0 auto; text-align: center; padding: 5px;">HAWKS</div> <div style="border: 1px solid black; width: 120px; height: 30px; margin: 0 auto; text-align: center; padding: 5px;">SMALL BIRDS</div> <div style="border: 1px solid black; width: 270px; height: 30px; margin: 0 auto; text-align: center; padding: 5px;">CATERPILLARS</div> <div style="border: 1px solid black; width: 120px; height: 30px; margin: 0 auto; text-align: center; padding: 5px;">MANGO TREE</div> </div>	Appropriate scale 1 mark Correct placement of each organism 1 mark each			5
				3	12	5

Environmental Science

Specimen Paper

Paper 02 - Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
3 (a)	2.6	<p>Total population increase = total population (2020) – total population (1990) .</p> <p>Population increase = (6548 +1375) M – (4486 + 1247) M = 2190.</p> <p>Increase in population of less developed countries (6548 - 4486) M 2062.</p> <p>% growth in world population due to less developed countries.</p> $\frac{2062}{2190} = 94\%$	<p>1 mark</p> <p>2 marks</p> <p>1 mark</p> <p>1 mark</p>			5
(b)	2.7	<ul style="list-style-type: none"> • In many of these countries the standard of living is much lower than in the developed countries • A greater percentage of the population is at or below the poverty level as the country is unable to provide the basic needs for the population • The economic level of many of these countries will be unable to support the increased population size • Population growth in these countries will drive more people into poverty and increase the pressure on the environment 	<p>1 mark</p> <p>1 mark</p> <p>1 mark</p> <p>1 mark</p>		4	

Environmental Science

Specimen Paper

Paper 02 - Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
3 (c)	2.17	<ul style="list-style-type: none"> • Increased pollution • Premature depletion of resources • More land use 	1 mark each	3		
3 (d)	2.12	<ul style="list-style-type: none"> • Increase production of food to keep pace with population growth • The use of technology to produce more food • Introduction of government policies to support family planning. • Government incentives for pollution reduction • Lifestyle changes • The use of substitutes 	Any FOUR points 2 marks each		8	
				3	12	5

Environmental Science

Specimen Paper

Paper 02 - Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
4 (a)	2.7	The number of children a couple is expected to have may be determined by the culture of the society because some cultures promote high fertility rates and this in turn leads to high population growth rates. In these societies child labour contributes to the family's income.	Full explanation 2 marks; partial explanation 1 mark	2		
4 (b)	2.9	<ul style="list-style-type: none"> • The life expectancy of an infant born in country A is higher than that of an infant born in Country B • The population of Country A is more educated than the population of Country B • The GDP per capita in Country A is higher than in Country B • There is a higher standard of living in Country A than in Country B 	2 marks for each deduction which shows comparison 1 mark if comparison is not indicated		6	
4 (c) (i)	2.5	<ul style="list-style-type: none"> • The average number of children born to each woman during her reproductive years. 		1		

Environmental Science

Specimen Paper

Paper 02 - Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
4 (c) (ii)	2.5	Graph: Axis - 1 mark Plotting of points - 2 marks Title - 1 mark				5
4 (c) (iii)		<ul style="list-style-type: none"> • The fertility rates for both low and high income level countries decreased during the period 1965 - 1990. • The fertility rates for both low and high income level countries decreased during the period 1990 - 2000. • The fertility rates for both low and high income level countries decreased during the period 1965 - 2000. • The fertility rates for low income countries decreased less than that for high income countries over the period 1965 - 2000. 	2 marks for each conclusion		6	
				3	12	5

Environmental Science

Specimen Paper

Paper 02 - Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
5 (a)	3.3	<p>Consumptive use of natural resources refers to use of natural resources in which these resources are utilized and removed from other natural environments (e.g. catching fish for food).</p> <p>Non-consumptive use of natural resources does not require that the resources be removed from their natural habitat (e.g. use of forest resources for ecotourism).</p>	<p>(1 mark) for consumptive use;</p> <p>(1 mark) for non-consumptive use and</p> <p>(1 mark) for any correct example.</p>	3		
5 (b) (i)	3.2	<p>The quantity of resource B <u>declined</u> from a start of 18×10^3 - kg up to <u>Year 6</u> when the amount was 7×10^3 - kg, this was followed by an increase from <u>Year 7 to Year 10</u> when the amount was 13×10^3 - kg.</p>				5
(ii)	3.2	<p>A is non-renewable</p> <p>B is renewable</p>	1 mark each		2	
(iii)	3.2	<p>Justification - Non-renewable resources which exist in fixed quantities and once used cannot be replaced.</p> <p>The quantity of resource A decreased during exploitation but after exploitation ceased the quantity of the resource remained the same after the eighth year.</p> <p>Renewable resources are those that can be replaced or replenished through natural processes.</p> <p>Resource B replenished itself after exploitation.</p>	<p>2 marks</p> <p>2 marks</p> <p>2 marks</p> <p>1 mark</p>		7	

Environmental Science

Specimen Paper

Paper 02 - Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
5 (c)	3.10	Conservation of resources: (i) use of substitutes (ii) use of appropriate technology (iii) reduction of use (iv) use of economic instruments.	Any THREE 1 mark each		3	
				3	12	5

Environmental Science

Specimen Paper
Paper 02 - Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
6 (a)	3.6	<ol style="list-style-type: none"> 1. Provide coastal and beach protection 2. Provide nursery and feeding areas for fisheries. 3. Support recreation and tourist activities. 4. Support food fishery. 	Any THREE 1 mark each.	3		
6 (b)	3.7	<ol style="list-style-type: none"> 1. clearance of coastal vegetation and inland forests results in loss of vegetation cover soil erosion, an increase in the amount of sediment entering waterways and the corals become stressed and eventually die. 2. Discharge of sewage into coastal water this contains bacteria which proliferate and kill the coral. 3. Coral harvesting results in the removal of the coral as well as damage to the coral reef structure. 	<p>TWO marks for each activity fully explained.</p> <p>1 mark for partial explanation.</p>	6		
6 (c) (i)	3.7	<p>Graph:</p> <p>Axis - (1 mark) Plotting of points - (3 marks) Title - (1 mark)</p>				5
6 (c) (ii)	3.8	<p>Lag time: 3 yrs Reason: Rate of replenishment (migration of reproduction)</p>			1 1	

Environmental Science

Specimen Paper
Paper 02 - Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
6 (c) (iii)	3.8	<ol style="list-style-type: none">1. The improvement in coral reef ecosystem is manifested by increased coral cover, improved habitat, greater diversity and therefore an increase in fishable resources on the reef.2. Greater diversity leads to improved food resources for the fish.3. Increased coral cover will offer more protection to fish resources from predators leading to an increase in fishable resources.	Any TWO 2 marks		4	
				3	12	5

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ENVIRONMENTAL SCIENCE

SPECIMEN PAPER

Unit 1 - Paper 03/2

MARK SCHEME

Environmental Science

Specimen Paper
Unit 1 Paper 03/2
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
1 (a)	1.10	Lizards are moving organisms (1) and it is difficult to count directly the number of organisms within a given area (1); they may not all be visible (1)		3		
1 (b)	1.10	Outline of the mark-release-recapture method: - A sample of the population is captured. (1) - Each individual in the sample is marked in a non-harmful way (1) and then released back into the general population (1) - after an appropriate length of time organisms are recaptured and (1) - the number of marked organisms recaptured is noted (1) - An estimate of the population is obtained by calculation using the following equation. (1) $\frac{\text{no. of population}}{\text{no. in first sample}} = \frac{\text{no. in recaptured sample}}{\text{no. already mixed in recaptured sample (1)}}$				7

Environmental Science

Specimen Paper
Unit 1 Paper 03/2
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
1 (c)	1.10	<p>Two assumptions that must be made when using the mark-release-recapture method to estimate population size:</p> <ul style="list-style-type: none"> • An appropriate time-scale for the population of marked and unmarked lizards to mingle. • Marking does not affect or harm the species' chance of survival and reproduction. • Each individual in the population has an equal chance or probability of being caught. 	Any two assumptions 2 marks each		4	
1 (d)	1.19	<p>Monitoring plan to keep track of the population</p> <p><u>Plan a visit to the site</u></p> <ul style="list-style-type: none"> - to observe the situation - to evaluate and determine the next steps - to have discussion with the workers, managers and concession holder. - To choose sampling sites and determine requirements for sampling and monitoring. 	<p>Any four steps 1 mark each</p> <p>One objective per step 1 mark each</p>			8

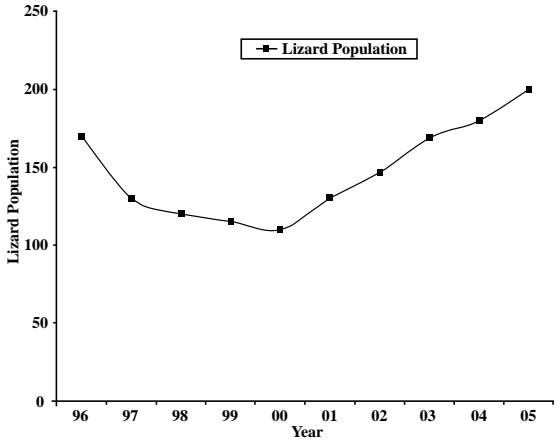
Environmental Science

Specimen Paper
Unit 1 Paper 03/2
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
1 (d) Cont'd		<p><u>Review previous data collected</u></p> <ul style="list-style-type: none">- to get information on specific site peculiarities- to familiarize oneself with previous limitations <p><u>Plan number and time of visits</u></p> <ul style="list-style-type: none">- to undertake sampling- to trap, mark and release animals- to recapture and check numbers of lizards- to observe if there are any new threats to the population and to make recommendations for dealing with these threats <p><u>Analyze population data</u></p> <ul style="list-style-type: none">- to calculate estimates of lizard population at each sampling time- to establish database so that information can be added to it and regular updates of the data to be made <p><u>Disseminate information</u></p> <ul style="list-style-type: none">- on status of monitoring and population data and other species information to assist others to be informed and participate in conservation efforts.				

Environmental Science

Specimen Paper
Unit 1 Paper 03/2
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks																							
				KC	AK	PS																					
1 (e)	1.22	 <p>The graph shows the Lizard Population over a ten-year period from 1996 to 2005. The vertical axis represents the population count, ranging from 0 to 250 in increments of 50. The horizontal axis represents the year, from '96 to '05. The population starts at approximately 170 in 1996, decreases to about 130 in 1997, 120 in 1998, 115 in 1999, and reaches its lowest point of about 110 in 2000. From 2000, the population begins to rise, reaching approximately 130 in 2001, 150 in 2002, 170 in 2003, 180 in 2004, and finally 200 in 2005.</p> <table border="1"><thead><tr><th>Year</th><th>Lizard Population</th></tr></thead><tbody><tr><td>96</td><td>170</td></tr><tr><td>97</td><td>130</td></tr><tr><td>98</td><td>120</td></tr><tr><td>99</td><td>115</td></tr><tr><td>00</td><td>110</td></tr><tr><td>01</td><td>130</td></tr><tr><td>02</td><td>150</td></tr><tr><td>03</td><td>170</td></tr><tr><td>04</td><td>180</td></tr><tr><td>05</td><td>200</td></tr></tbody></table>	Year	Lizard Population	96	170	97	130	98	120	99	115	00	110	01	130	02	150	03	170	04	180	05	200			
Year	Lizard Population																										
96	170																										
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98	120																										
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02	150																										
03	170																										
04	180																										
05	200																										

Environmental Science

Specimen Paper
Unit 1 Paper 03/2
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
		Title of Graph - 1 mark Labelling of axes - 2 marks Appropriate scales - 2 marks Plotting of points correctly - 5 marks Smooth curve - 2 marks <u>Plotting of graphs</u> 9 or more accurate points - 5 marks 7 - 8 " " - 4 " 5 - 6 " " - 3 " 3 - 4 " " - 2 " 1 - 2 " " - 1 " 0 " " - 0 "				8
				3	4	23

Environmental Science

Specimen Paper
Unit 1 Paper 03/2
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	
2 (a) (i)	2.2	The number of children a couple must have to replace themselves.	Incomplete definition	2		
(ii)	2.2	The average number of children born to each woman during her reproductive lifetime.	1 mark only	2		
(b) (i)	2.5	$28+18+14+19=79$	1 mark for answer and 4 marks for extracting information from chart			5
(b) (ii)	2.5	Pre-reproductive years 0 - 14 $8+7+6+6=27$	1 mark 4 marks for extracting date; 1 mark for answer			7
		Percentage = $27 \div 56.6 = 47.7$	1 mark			
(c) (i)	2.5	The population is expected to increase over the next ten years.				1

Environmental Science

Specimen Paper
Unit 1 Paper 03/2
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
(c) (ii)	2.5	<ul style="list-style-type: none"> The largest percentage of the population is in the pre-reproductive age group. When these children mature they will become the parents of the next generation. This group of parents will be larger than the previous group. Even if the fertility rate remains at replacement level the population will still continue to grow. 	1 mark for each justification			4
(d) (i)	2.7;2.8	<p>Educational opportunities</p> <ul style="list-style-type: none"> Women with higher educational backgrounds <u>marry later</u> (1), delaying the birth of their first <u>child reducing their childbearing years</u> (1). Educated women control their fertility <u>by using contraceptives</u> (1). <p>Social and economic status</p> <ul style="list-style-type: none"> In some societies women are <u>not exposed to education</u> (1) and other ways of uplifting their social status, evidence shows that <u>this lack of social status</u> (1) results in high fertility rates. In contrast women with <u>social status have the education</u> and means to <u>control their fertility rates</u> (1). <p>Family Planning Services</p> <ul style="list-style-type: none"> <u>Provides information on reproductive physiology</u> (1) and <u>contraceptives</u> (1) This information allows women <u>to control fertility rate</u> (1) by the use of fertility pills. 	<p>(3 marks)</p> <p>1 mark for each underlined point</p> <p>(3 marks)</p> <p>1 mark for each underlined point</p> <p>(3 marks)</p> <p>1 mark for each underlined point</p>		9	
				4	9	17

Environmental Science

Specimen Paper
Unit 1 Paper 03/2
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
3 (a) (i)	3.4	<ul style="list-style-type: none"> As the fishing effort increases the daily fish catch increases. The increasing trend continues up to a fishing effort of 35 boats after which as fishing effort increases daily catch decreases. The decreasing trend continues and reaches 0 when fishing effort is equal to 70 boats. The maximum daily catch is 4500 kg of fish with 35 boats operating. 	<p>2 marks for each point fully described.</p> <p>Partial description 1 mark.</p>			8
3 (a) (ii)	3.4	Fishing effort-25 boats.				2
(b) (i)	3.10	MSY- The largest amount of a resource that can be harvested without causing a decline in the stock of the natural resource.		2		
(b) (ii)	3.10	Point B				1
(b) (iii)	3.10	<ul style="list-style-type: none"> Harvesting at B will allow the stock to be sustained since it will be easy for it to recover. The minimum viable threshold will not be exceeded and the population will sustain its biomass. There will be enough members left to reproduce, replenish and sustain the population. 	<p>2 marks for each reason fully explained.</p> <p>1 mark for partial explanation.</p>		6	

Environmental Science

Specimen Paper
Unit 1 Paper 03/2
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
3 (c) (i)	3.7	<p>Population growth (3 marks)</p> <ul style="list-style-type: none"> Increased population growth means more people potentially demanding more fish resource. As demand increases greater fishing effort will be expended to harvest more fish. If the resource is not carefully managed this could lead to resource over-harvesting and resource decline. 				
(c) (ii)	3.7	<p>Level of environmental awareness (3 marks)</p> <ul style="list-style-type: none"> People become more aware of the issues and the negative impacts of humans on natural resources. They become more inclined to practice resource harvesting and management techniques. This leads to more sustainable fishing efforts and better managed fish stocks. 			6	
(d) (i)	3.10	Develop protected areas			1	
(d) (ii)	3.10	<ul style="list-style-type: none"> Protected areas will allow some areas to be managed for conservation. It allows for the maintenance and rehabilitation of habitats. It restricts and manages threats to the resource. Activity close to the protected area is limited. Protected areas provide safe breeding and feeding areas. 	2 marks each for any two reasons fully stated		4	
				2	17	11

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

ENVIRONMENTAL SCIENCE – UNIT 2

SPECIMEN PAPER 2010

Item No.	Key	Cognitive Level	Syllabus Objective
1	C	KC	Module 1.3
2	B	KC	Module 1.1
3	C	KC	Module 1.3
4	D	AK	Module 1.3
5	C	AK	Module 1.1
6	B	KC	Module 1.3
7	B	AK	Module 1.2
8	C	KC	Module 1.1
9	A	AK	Module 1.6
10	B	PA	Module 1.3
11	A	PA	Module 1.3
12	A	AK	Module 1.3
13	B	PA	Module 1.3
14	B	AK	Module 1.3
15	C	AK	Module 1.6
16	D	KC	Module 2.3
17	A	KC	Module 2.1
18	C	KC	Module 2.3
19	C	KC	Module 2.8
20	B	KC	Module 2.9
21	D	KC	Module 2.10
22	B	AK	Module 2.1
23	A	AK	Module 2.8

Item No.	Key	Cognitive Level	Syllabus Objective
24	D	AK	Module 2.8
25	A	PA	Module 2.5
26	B	AK	Module 2.1
27	D	AK	Module 2.1
28	D	PA	Module 2.3
29	D	PA	Module 2.7
30	A	AK	Module 2.3
31	B	KC	Module 3.5
32	B	KC	Module 3.5
33	B	KC	Module 3.8
34	D	KC	Module 3.5
35	B	KC	Module 3.1
36	D	KC	Module 3.1
37	D	AK	Module 3.4
38	B	AK	Module 3.5
39	A	AK	Module 3.5
40	C	AK	Module 3.5
41	C	PA	Module 3.5
42	D	PA	Module 3.5
43	A	PA	Module 3.5
44	B	AK	Module 3.3
45	C	AK	Module 3.3

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ENVIRONMENTAL SCIENCE

SPECIMEN PAPER

Unit 2 - Paper 02

MARK SCHEME

Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
1 (a)		<p><u>Deductions</u></p> <ul style="list-style-type: none"> - In both instances yield increased as the amount of fertilisers increased. - The yield is consistently one ton greater when inorganic fertiliser is used as against organic fertiliser. - The yield is consistently one ton less when organic fertiliser is used as against inorganic fertiliser. - The rate of increase in yield is greater when organic fertilisers are used. - The rate of increase in yield is less when inorganic fertilisers are used. - It is more efficient in the long run to use organic fertilisers. 	Any FIVE deductions 1 mark each			5
(b)		<ul style="list-style-type: none"> - Inorganic or 'commercial' fertilisers are manufactured, with the main ingredients being nitrate, phosphates and potassium. - Organic fertilisers include materials such as animal manure, green manure and compost that are applied to cropland as a source of plant nutrients. - Organic fertilisers are naturally occurring plant and animal materials that release nutrients slowly as they decompose - Organic fertilisers are complex and have variable compositions - Inorganic fertilisers are manufactured with specific components and concentrations 	Any THREE points 1 mark each	3		

Environmental Science
Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
1 (c)	1.3	<ul style="list-style-type: none"> - Inorganic or commercial fertilisers are manufactured with the main ingredients being nitrate, phosphates and potassium. - Inorganic fertilisers are expensive and farmers will therefore need to expend large amounts of money to acquire them in sufficient quantities. - Organic fertilisers are cheaper since they include materials that are usually considered waste materials on farms. They are also more readily available. - Inorganic fertilisers are soluble and immediately available to the plants but they are highly mobile and the nutrients are quickly leached out of the soil. Therefore farms will require regular inputs which increase costs. - Organic fertilisers are slow acting and long lasting since they release nutrients only upon decomposition. - Organic fertilisers are more environmentally friendly and are less of a pollution threat than are inorganic fertilisers. Inorganic fertilisers easily can contaminate ground water and surface waters leading to eutrophication of surface waters. - Organic fertilisers improve the soil structure by adding humus which increases the waterholding capacity as well as the soil microflora which are good for plant growth. - While the use of inorganic fertilisers may result in higher production in the short term, for long term sustainability, in terms of cost and environmental problems, it is better to use organic fertilisers. 	<p>Any SIX points fully discussed 2 marks each</p> <p>Partial discussion 1 mark each.</p>		12	
				3	12	5

Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
2 (a)		<ul style="list-style-type: none"> - Farmers often clear the vegetation from hillsides before farming. - This exposes the soil to erosion since the vegetation cover is removed and the roots are no longer in place to hold the soil particles together. - Water runs downhill, and the faster it runs the greater is the loss of soil. - As water runoff increases downhill, more soil will be washed downhill. - This soil gets into the river and other water systems. - Sedimentation levels increase erosion. - When agrochemicals are used by farmers, these are easily leached into the waterways. 	Any SIX points 1 mark each.		6	
(b)		<ul style="list-style-type: none"> - When the same crop is grown continuously, pests for that crop tend to accumulate to destructive levels because they have an abundance of food source and favorable conditions. - Rotating the crops will prevent an accumulation of pests for any one specific crop, thereby reducing the likelihood of pest infestation and pest damage. - Different crops have different and specific nutrient requirements. Growing one crop continuously can deplete the soil of nutrients that are specifically required by that crop. - The depletion of nutrients can result in decreased yields since over time, limited amounts of these nutrients would be available. However, when practised, it keeps the soil covered with vegetation. 	<p>Any THREE points fully discussed 2 marks each</p> <p>Partial discussion 1 mark each.</p>		6	

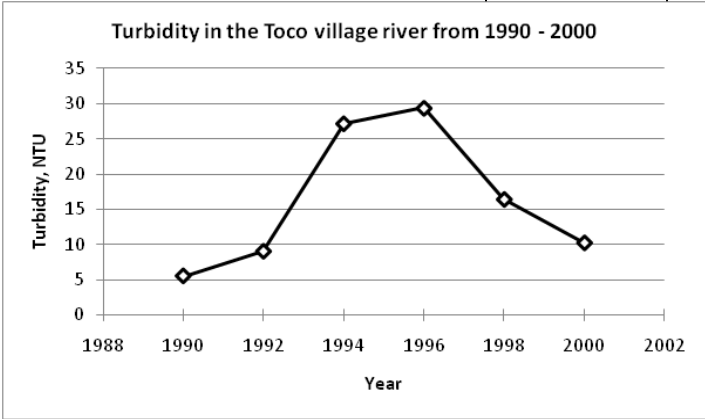
Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
2 (c) (i)		Contour ploughing, terracing, strip farming	Any ONE 1 mark	1		
(ii)		<p>Contour ploughing</p> <p>Ploughing and planting is done in rows across rather than up and down the sloped contour of the land. Each row planted along the contour of the land acts as a small dam to help hold soil and slow the runoff of the water.</p> <p>Terracing</p> <p>Each slope is converted into a series of broad, nearly level terraces that run across the contour of the land.</p> <p>Strip farming</p> <p>This is the planting of different kinds of crops in alternating strips along the contours of the land.</p>	<p>Complete description 2 marks</p> <p>Partial description 1 mark.</p>	2		

Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
2 (d) (i)	1.3;1.7	 <p>Turbidity in the Toco village river from 1990 - 2000</p> <p>Suitable scale: x-axis: 1 cm represents 1 year; y-axis: 1 cm represents 2.5 NTU.</p>			4	
2 (d) (ii)	1.7	1997			1	
				3	12	5

Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
3 (a)	2.3	<ul style="list-style-type: none"> - Fossils fuels are formed from decayed plants and animals that have been converted to crude oil, coal, natural gas, or heavy oils by exposure to heat and pressure in the earth's crust over hundred of millions of years. 		2		
(b) (i)	2.11	<ul style="list-style-type: none"> - For the years 1990 and 2000, annual fossil fuel consumption increased by 0.9×10^9 tons of oil equivalent from 1.9×10^9 tons of oil equivalent to 2.8×10^9 tons of oil equivalent. (1 mark) - This represents an average annual increase of 0.98 for the period 1990 to 2000. (1 mark) - For the years 2000 and 2003 the total increase was 0.4×10^9 tons of oil equivalent representing an average increase of 0.1×10^9 tons of oil equivalent. (1 mark) - The average annual fossil fuel consumption for the period 2000 to 2003 is 25% greater than that for 1900 to 2000). (1 mark) - For the years 1990 to 2003 the total increase was 1.3×10^9 tons of oil equivalent. (1 mark) 	EACH point 1 mark			5

Specimen Paper
Unit 2 Paper 02

Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
3 (b) (ii)		<p>Environmental impact</p> <ul style="list-style-type: none"> • Acid rain <ul style="list-style-type: none"> - Combustion of fossils fuels generates sulphur, nitrogen and carbon oxides - These dissolve in precipitation and return to earth as sulphuric, carbonic and nitric acids. - These acids negatively impact natural ecosystems such as forest. - Built areas such as monuments and sculptures made of marble are particularly vulnerable. • Global warming <ul style="list-style-type: none"> - Emissions of carbon dioxide from the combustion of fossil fuels are said to be the cause of the increased concentration of carbon dioxide in the troposphere. - This has led to an increased retention in solar energy in the atmosphere resulting in an increase in global temperatures called global warming. - Global warming has the potential to cause sea level to rise inundating coastal areas of many countries. - Other potential impacts of global warming include increase in the frequency and strengths of hurricanes, floods, droughts. 	<p>Any ONE environmental impact identified 1 mark</p> <p>Complete description of identified environmental impact 3 marks</p> <p>Partial description 1 - 2 marks</p>		4	

Environmental Science
Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
3 (b) (ii) Cont'd		<ul style="list-style-type: none"> • Habitat destruction - Harvesting, processing and distributing fossil fuels can also create environmental problems - Coal mining methods, particularly strip mining and mountaintop removal, have been responsible for largescale habitat destruction. - Offshore drilling can create a hazard for aquatic organisms. - Oil spills on the ocean are responsible for the deaths of aquatic organisms and damage to miles of beaches. - Fossils fuels also contain radioactive material mainly uranium and thorium that are released into the atmosphere during burning. <p>Social impact</p> <ul style="list-style-type: none"> • Air Pollution - Years of exposure to air pollution can break down the body's natural defenses causing or contributing to respiratory diseases such as lung cancer, asthma, chronic bronchitis and emphysema. - Elderly people, infants, pregnant women, and people with heart disease, (1) asthma or other respiratory diseases are especially vulnerable to air pollution. - Air pollution costs countries billions of dollars in health care costs and lost work productivity annually. - There are also many premature deaths each year as a result of pollution-related lung diseases. 	<p>Identification of social impact 1 mark</p> <p>Complete description of social impact 3 marks</p> <p>Partial description 1 - 2 marks</p>		4	
3 (c) (i)	2.7	<ul style="list-style-type: none"> - Demand management refers to actions taken to influence the quantity or patterns of use of energy consumed by end users. 		1		

Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
3 (c) (ii)	2.7	<ul style="list-style-type: none"> • Operators generally use the least expensive generating capacity at first to satisfy demand, and then use additional capacity from more expensive or inefficient plants as demand increases. • If demand significantly exceeds generating capacity, the additional demand may be satisfied by building additional plants. • Alternately management activities may be used to dampen demand in such a way that the current generating capacity can satisfy demand. • Consumers could be encouraged to modify their usage pattern so that domestic demand does not coincide with industrial demand. • Consumers could also be encouraged to use more efficient appliances such as flurorescent light bulbs decreasing overall demand. • Effective demand management can prevent the building of additional power plants and the habitat destruction and emission associated with power plants 	Any FOUR points 1 mark each		4	
				3	12	5

Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
4 (a)	2.1	<ul style="list-style-type: none"> The water has potential energy due to the difference in height of the water level at the intake pipe and the position of the turbine. As the water flows down the intake pipe, its potential energy is converted to kinetic energy resulting in an increase in the speed of water. As the water flows through the turbine it causes a coil to rotate in a magnetic field and the kinetic energy of the water is converted to the rotational energy of the coil. The rotating coil generates a potential difference across the coil. 			4	
(b)	2.3	<ul style="list-style-type: none"> Thus the kinetic energy of the flowing water is converted into electrical energy which is a form of potential energy. <p>Advantages</p> <ul style="list-style-type: none"> Hydropower generation has a moderate to high net yield and fairly low operating and maintenance cost. Hydropower plants rarely need to be shut down and do not emit carbon dioxide or other air pollutants such as nitrogen dioxides. They have life spans of 2 - 10 times those of coal or nuclear plants. In large systems dams are built across the natural flow of rivers. Large dams however can help in flood control and supply a regulated flow of irrigation water to areas below the dam. 	Any TWO advantages 1 mark each	2		

Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
4 (b) cont'd		<p>Disadvantages</p> <p>Large dams cause water to backup flooding large areas of land destroying plant and animal habitat.</p> <p>Dams destroy farmlands and displace people.</p> <p>Increased evaporation of water from the reservoir leads to serious water loss and increased salinity of the remaining water.</p> <p>If the dam breaks people and property downstream may be endangered. Over time the reservoir traps nutrient-rich silt preventing it from enriching agricultural lands downstream.</p>	<p>Any ONE disadvantage 1 mark each</p>	1		
4 (c)		<p>Hydroelectricity</p> <ul style="list-style-type: none"> The energy potential of hydroelectricity depends on the size and volume flow of water bodies. If large river systems exist in a developing country there is the potential for substantial contribution of hydroelectricity to the energy needs of the country. This would require damming the river which is costly. For countries with large rivers because of the environmental damage and the high cost only small plants will likely be developed to supply local needs. 	<p>TWO marks for each complete explanation</p> <p>Partial explanation 1 mark</p>		4	

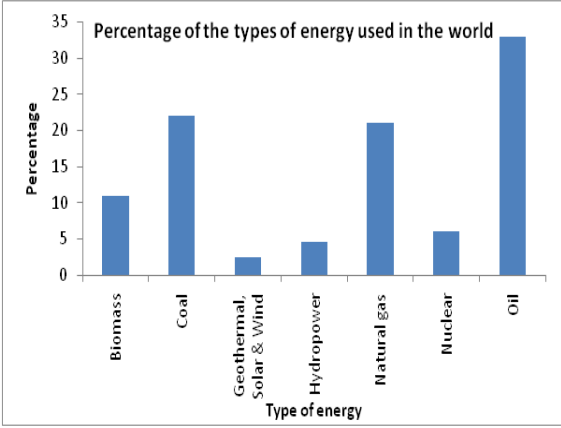
Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
4 (c) Cont'd		<ul style="list-style-type: none"> Many developing countries have small rivers which are able to generate small amounts of electricity. However, seasonal changes in volume flow make these small-scale systems unreliable. Hydropower therefore appears to have limited scope to supply the energy needs of these countries. Solar Energy <p>Solar energy is widely dispersed over the earth's entire surface which makes it available to all developing countries. Its intensity varies with latitude so that countries closer to the equator receive a greater intensity of solar energy. Its intensity also varies with season, cloud cover and time of day. The technology to utilize solar energy is well developed.</p> <p>One problem of using solar energy to generate electricity is that a back-up system must be available to generate electricity at nights, and on cloudy days when solar power output is low.</p> <p>The current technology used to trap the sun's energy is efficient but technological developments will improve efficiency of collection making it more cost effective.</p> <p>The initial cost of converting to solar energy is high, however, the long-term energy savings of solar power compensate for the high start-up cost.</p>	<p>Any TWO complete explanations 2 marks each</p> <p>Partial explanations 1 mark</p>		4	

Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				K C	A K	P S
4 (d)	2.3; 2.11	 <p>Suitable scale: y-axis: 1 cm represents 2.5%. No scale required for x-axis.</p>	Axis 1 Title 1 Bars 2			4
(d) (ii)		18%				1
				3	12	5

Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
5 (a)		<ul style="list-style-type: none"> All organisms have dieldrin concentration greater than that of the water. The dieldrin concentration at each trophic level varies with organism. Dieldrin concentration increases as the trophic levels increase. Tertiary organisms have a minimum concentration 20 000 times greater than in the water. 	1 mark for each inference			5
(b)		<ul style="list-style-type: none"> Bioaccumulation and biomagnification are taking place. <p>Environmental pathways:</p> <ul style="list-style-type: none"> Pesticide in air settles in soil and on crops. Erosion and leaching of soil cause pesticide to move into fresh water bodies such as rivers. The pesticide is transferred to aquifers which flow to water bodies such as river and oceans. <p>OR</p> <ul style="list-style-type: none"> Pesticide in air dissolves in rain (precipitation). This falls on soil and into water bodies As water (precipitation) percolates through soil, it may dissolve out pesticide. 	Any ONE pathway 3 marks	3		

Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
5 (c)	3.3	<ul style="list-style-type: none"> The build-up of pesticide in an organism's body is due to a process known as bioaccumulation. Concentration of pesticide in producers will be higher than that in the water due to bioaccumulation. The primary consumer will ingest tissue with a greater concentration of pesticide Similarly secondary consumers will ingest tissue with an even higher concentration of pesticide. Hence the concentration of pesticide increased in organisms moving from lower to higher trophic level. This increase in concentration as the pesticide passes through successive levels of the food chain is known as biological magnification. 	1 mark for EACH point		6	
5 (d)	3.3	<p style="text-align: center;">Characteristics</p> <p>Persistence: this refers to the stability of the pesticide.</p> <ul style="list-style-type: none"> Some pesticides are extremely stable and take many years to be broken down into less toxic forms. This allows their toxicity to increase in the environment and they are therefore able to affect a large range of organisms. 	Any TWO characteristics described 3 marks each (1 mark for characteristics and 2 marks for description)		6	

Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
5 (d) cont'd		<p>Mobility</p> <ul style="list-style-type: none"> • Pesticides do not stay where there are applied but tend to move through the soil, water and air sometimes over large distances. • The more mobile a pesticide the greater the potential geographical impact. <p>Synergistic Effect</p> <ul style="list-style-type: none"> • The effects of many pesticides are increased by interaction with other chemicals • Synergism increases the toxicity of the chemical 				
				3	12	5

Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
6 (a) (i)	3.5; 3.9	<ul style="list-style-type: none"> The percentage of plastics increases from 10% in 1998 to 24% in 2008. (1) The percentage of paper decreases from 38% in 1998 to 22% in 2008(1) 	ONE mark for each change			2
(ii)	3.1	<ul style="list-style-type: none"> Paper is biodegradable and in the environment it will be broken down completely by organisms. <p>OR</p> <ul style="list-style-type: none"> Plastics are not biogradable and will continue to pollute the environment for an extended period. 				2
(iii)	3.9	Wood				1
(b)	3.1	<ul style="list-style-type: none"> There has been an increase in consumption of raw materials and energy and in the manufacture, transport, sale and use of a wide variety of goods. More products such as toys, electrical and sporting goods are being made from plastics. Many are not designed to last very long and cannot be repaired. This results in a constant demand for the product since a replacement is often cheaper than repairing. Many industries rely on built-in obsolescence to maintain sales. 	<p>Any TWO reasons fully explained 2 marks each</p> <p>Partial explanation 1 mark</p>		4	

Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
6 (b) Cont'd		<ul style="list-style-type: none"> Increase in the amount of packaging used, the development of refrigeration and of rapid transport networks have allowed products to be sent around the world which requires considerable packaging. Huge amounts of packaging, a large percentage of which is plastic, are used to make goods more attractive to the consumer. There has been an enormous rise in demand for convenience products, particularly for disposable consumer goods such as supermarket ready-made meals, disposable razors disposable baby diapers and pens, which are usually made from plastics. 				
(c) (i)	3.5	<ul style="list-style-type: none"> Recycling is defined as the collection and separation of materials from the waste stream and their subsequent reuse or processing to produce a marketable or resaleable product. (1) 		2		
(ii)	3.5	Aluminium cans, plastic bottles	Any ONE 1 mark	1		
6 (d)	3.5	<p>Advantages</p> <ul style="list-style-type: none"> Recycling some material such as paper, aluminium and drink cans help to conserve non-renewable resources by reducing demand. This also reduces reliance on raw materials from a single country or a group of countries. 	Any FOUR advantages 1 mark each		4	

Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
6 (d)		<ul style="list-style-type: none"> Reduction in demand through recycling will reduce production of goods and the associated energy consumption and emission of greenhouse gases. Recycling results in a reduction of pollution from extraction industries, producing processes and waste disposal. Recycling may result in reduced waste disposal costs, and the need for additional land-fill space Discarded paper, glass, metal, foam and plastic packing produce are a major cause of litter and require expenditure for collection and cleaning. By encouraging the use of recyclable containers to reduce packaging this problem will decline. <p>Disadvantages</p> <ul style="list-style-type: none"> The production of recycled materials is not determined by demand but by production of waste. This causes economic problems since the supply of recycled products cannot respond directly to changes in demand. Recycling may require sponsorship, which is not always readily available, to be able to operate. 	Any FOUR disadvantages 1 mark each		4	

Environmental Science

Specimen Paper
Unit 2 Paper 02
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
6 (d) Cont'd		<ul style="list-style-type: none"> • Some material recovery may not be environmentally beneficial since energy and resources consumption may be greater than that required to produce new material. • Space must be available to store material to be recycled which may be limited in both urban and domestic environment. • Recycling of some materials may be detrimental to the environment. (Examples, paper, some older glass recycling plants, improper recycling of vehicle batteries). • Recycled products have to compete with virgin raw material already established in the market. 				
				3	12	5

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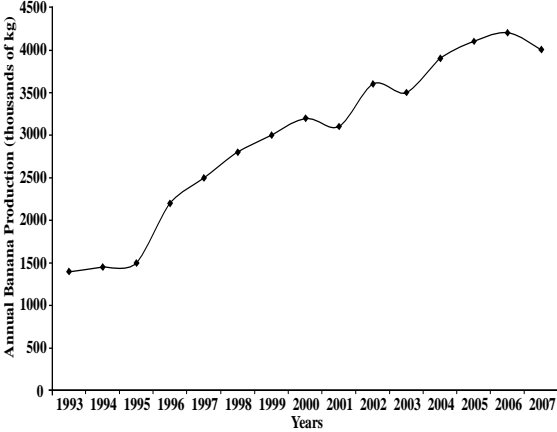
SPECIMEN PAPER

Unit 2 – Paper 03/2

MARK SCHEME

Environmental Science

Specimen Paper
Unit 2 Paper 03/2
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
1 (a)		 <p>Annual Banana Production (thousands of kg)</p> <p>Years</p>	<p>Title of graph (1 mark)</p> <p>Labelling of axes (2 marks)</p> <p>Appropriate scales on each axes (2 marks)</p> <p>Plotting of points (5 marks)</p> <p>Smooth curve (2 marks)</p>			12

Environmental Science

**Specimen Paper
Unit 2 Paper 03/2
Mark Scheme**

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
1 (b (i))		<ul style="list-style-type: none"> Banana production was fairly constant between 1993 and 1995. Banana production increased each year from 1995 to 2007. In 1995 Tropic farm produced 1 500 000 kg of bananas. This is an increase of 4 500 000 kg. This represents a doubling of production over the 12-year period. 	ONE mark for each point		4	
1 (b (ii))		<ul style="list-style-type: none"> Between 1992 and 1995 the nitrate concentration was relatively constant at about 1 mg/L. Between 1995 and 2007 the nitrate concentrate increased annually. In 2001 and 2003 there were some decreases in concentration to the previous years (2000 and 2002). The annual concentration in 2007 was 15 mg/L. This is an increase of 14 mg /L when compared to the annual concentration in 1995. Or an overall 1400% increase in the concentration of nitrates during the period. 	ONE mark for each point		4	

Environmental Science

**Specimen Paper
Unit 2 Paper 03/2
Mark Scheme**

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
1 (c)		Extraction of data (1) from graph. Calculate $\frac{7 \text{ mg/L} (1)}{5 \text{ yrs}} = 1.4 \text{ mg/L} (1)$ year				3
1 (d)		<ul style="list-style-type: none"> Between 1992 and 1995 the nitrate concentration remained fairly constant at about 1 mg/L. This suggests that the normal or ambient nitrate concentration of the river before 1995 is about 1 mg/L based on the available data. Since 1995 the annual nitrate concentration has increased annually above the ambient value. Concentration of nitrates in water bodies such as river is usually low. Since the nitrate concentration exceeds its ambient value and is higher than expected, the quality of the water between 1995 and 2007 is less than it was between 1993 and 1995. 	ONE mark for each point		4	

**Environmental Science
Specimen Paper
Unit 2 Paper 03/2
Mark Scheme**

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
1 (e)		<ul style="list-style-type: none">• Nitrates are soluble in water.• During periods of heavy rainfall, nitrates may be washed out of the soil on the farm.• The nitrogen-rich water flows into gullies or along natural storm water channels. <p>These water channels empty directly into the river or into streams leading to the river.</p>	Any THREE points 1 mark each	3		
				3	12	15

Environmental Science

**Specimen Paper
Unit 2 Paper 03/2
Mark Scheme**

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
2 (a) (i)	2.3	Wind energy; biofuels.		2		
(ii)	2.3	A dam is built across a river to create a large reservoir (1). A small amount of the water is allowed to flow through large pipes (1) and this turns a turbine (1) that is used to generate electricity (1).			4	
(b) (i)	2.3	High efficiency (1); low cost electricity (1); renewable energy source (1); low levels of pollution associated with operations (1) long life span (1); can provide flood control below dam (1); provides irrigation water (1); reservoir useful for fishing and recreation (1).	Any FOUR 1 mark each		4	
(ii)	2.3	High construction costs (1); High environmental impact from flooding to create the reservoir (1); danger of collapse (1); uproots people from reservoir area (1); decreases in fish harvest below dam (1); decreases flow of silt to land below dam (1).	Any FOUR 1 mark each		4	

Environmental Science

Specimen Paper
Unit 2 Paper 03/2
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks														
				KC	AK	PS												
2 (c) (i)	2.11	<p style="text-align: center;">Electricity generation by hydropower in the Caribbean in 2007</p> <table border="1"> <caption>Data from the bar chart</caption> <thead> <tr> <th>Year</th> <th>Electricity Generation (billion kWh)</th> </tr> </thead> <tbody> <tr> <td>Belize</td> <td>0.18</td> </tr> <tr> <td>Dominica</td> <td>0.05</td> </tr> <tr> <td>Jamaica</td> <td>0.15</td> </tr> <tr> <td>St. Vincent</td> <td>0.05</td> </tr> <tr> <td>Suriname</td> <td>0.9</td> </tr> </tbody> </table> <p style="text-align: center;">Year</p> <p>Graph drawn as illustrated above</p>	Year	Electricity Generation (billion kWh)	Belize	0.18	Dominica	0.05	Jamaica	0.15	St. Vincent	0.05	Suriname	0.9	<p>Title (1); axes (2); Scale (1); For EACH year all bars correct (6)</p>			10
Year	Electricity Generation (billion kWh)																	
Belize	0.18																	
Dominica	0.05																	
Jamaica	0.15																	
St. Vincent	0.05																	
Suriname	0.9																	

Environmental Science

Specimen Paper
Unit 2 Paper 03/2
Mark Scheme

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
2 (c) (ii)	2.11	<p><u>Trend</u></p> <ul style="list-style-type: none"> Suriname produced a significant amount of electricity using hydropower. Small island such as Antigua, Barbados, Grenada and St. Lucia did not use hydropower for electricity generation. St. Vincent and Grenada used hydropower to generate a small amount of electricity. Jamaica and Belize used hydropower to generate a moderate amount of electricity. 	Any THREE points 1 mark each			3
(iii)	2.11	<p>Belize & St. Vincent $0.18 + 0.02 = 0.20$ billion kWh (1)</p> <p>Total for Caribbean = $0.18 + 0.03 + 0.16 + 0.02 + 0.9 = 1.29$ billion kWh (1)</p> <p>% for Belize & St. Vincent = $0.2/1.29 * 100 = 15.5\%$ (1)</p>				3
				2	12	16

Environmental Science

**Specimen Paper
Unit 2 Paper 03/2
Mark Scheme**

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
3 (a)	3.5	(i) identify changes in water quality over time (ii) Identify specific existing or emerging water quality problems (iii) Gather information to design specific pollution prevention or remediation programmes (iv) Respond to emergencies such as chemical spills (v) Determine whether programme goals such as compliance with pollution regulations or implementation of effective control actions are being met.	Any THREE 1 mark each	3		
(b) (i)	3.5	Parameters: Phosphates, ammonium/ammonia chemical oxygen demand; total suspended solids; biochemical oxygen demand; dissolved oxygen; coliform (total/faecal)	Any THREE 1 mark each			3
(ii)	3.5	Phosphates <ul style="list-style-type: none"> • Phosphorous in small quantities, is essential for plant growth and metabolic reactions in animals and plants. • It is the nutrient in shortest supply in most fresh waters, with even small amounts causing significant plant growth and having a large effect on the aquatic ecosystem. 				

Environmental Science

**Specimen Paper
Unit 2 Paper 03/2
Mark Scheme**

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
		<p>Biochemical Oxygen Demand (BOD)</p> <ul style="list-style-type: none"> - This is a measure of the biodegradable organic content of waste. Biological oxygen demand means the amount of dissolved oxygen used for respiration during the aerobic metabolism of an energy source (e.g. organic matter) by bacteria or microorganisms. <p>Chemical Oxygen Demand (COD)</p> <ul style="list-style-type: none"> - This is a measure of the total organic content of waste, both degradable and refractory. - Chemical oxygen demand means the amount of oxygen required for maximum oxidation of the organic matter in a sample of the waste. This has implications for the availability of nutrients to aquatic organisms. <p>Total Suspended Solids (TSS)</p> <ul style="list-style-type: none"> - This means all solids that are suspended in a sample of waste but are not dissolved. - Total suspended solids are identified as the portion of a waste sample that does not pass through a glass fiber filter (i.e. non-filterable). 	<p>TWO marks for each parameter</p>		6	

Environmental Science

**Specimen Paper
Unit 2 Paper 03/2
Mark Scheme**

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
3 (b) Cont'd		<p>- This has implications for the colour and turbidity of the water which may affect photosynthesis of aquatic plants and ultimately reduce the productivity of the aquatic ecosystem.</p>				
(c)	3.5	<p>Phosphates</p> <p>A sample of water is filtered to remove suspended particulate matter (1). A test solution containing molybdate ions is added that forms a complex with phosphate (1). On addition of ascorbic acid, an intense blue colour occurs (1). The level of phosphate can be measured by comparing the colour obtained in the water sample with a range of colours obtained from known phosphate concentrations (1). OR The level of phosphate can be measured by using a spectrophotometer (1).</p> <p>Biochemical oxygen demand (BOD)</p> <p>A sample of water is collected and the initial concentration of oxygen in the mixture is measured by gas-sensing electrode OR by a Winkler titration (1). The bottles are placed in an incubator at 20°C for 5 days (1). After 5 days, the concentration of oxygen in the mixture is again measured (1). The BOD is calculated from the difference between these two measurements (1).</p>	FOUR marks for each parameter			12

Environmental Science

**Specimen Paper
Unit 2 Paper 03/2
Mark Scheme**

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
3 (c) Cont'd		<p>Chemical oxygen demand (COD)</p> <p>A sample of water is collected and mixed with a strongly acid solution of potassium dichromate (1). The mixture is heated under reflux conditions for 2 hours (1) OR the mixture is heated in a tightly closed glass container for 2 hours (1). After heating, the orange colour of the potassium dichromate will change to different shades of green depending on the level of COD present (1). The COD level can be measured by comparing the colour obtained in the water sample with a range of colours obtained from known COD concentrations (1). OR The COD level can be measured by using a spectrophotometer (1).</p>			6	

Environmental Science

**Specimen Paper
Unit 2 Paper 03/2
Mark Scheme**

Question	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
3 (c) Cont'd		<p>Total suspended solids (TSS)</p> <p>A glass fiber filter with pore size 0.45 µm is dried and weighed (1). A known volume of the water sample is passed through the filter under vacuum (1). The filter is dried in an oven at 105°C and reweighed (1). The TSS is calculated from the difference between the two masses, expressed per litre of water (1).</p>			6	
3 (d)(i)	3.6	<p>Change: increased growth of aquatic vegetation.</p> <p>Reason: increased nutrient availability.</p>				
3 (d) (ii)		<p>Change: decreased diversity of organisms in the river.</p> <p>Reason: death due to lack of oxygen.</p> <p>Change: decreased number of organisms.</p> <p>Reason: death due to entrophic conditions.</p> <p>Change: foul odor develops.</p> <p>Reason: death and decay of organism</p>	<p>1 mark for EACH change</p> <p>1 mark for EACH reason</p>		6	
				3	12	15

CARIBBEAN EXAMINATIONS COUNCIL

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

MAY/JUNE 2004

ENVIRONMENTAL SCIENCE

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CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

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INTRODUCTION

Environmental Science is a two-unit subject with each Unit consisting of three Modules. Unit 1 consists of Fundamental Ecological Principles, People and The Environment, and Sustainable Use of Natural Resources while Unit 2 consists of Sustainable Agriculture, Sustainable Energy Use, and Pollution of the Environment. For each Unit, the examination consists of three papers and a total of 300 marks. Papers 01 and 02 are examined externally by CXC, while Paper 03 is examined internally by the teacher and moderated by CXC.

Paper 01 consists of twelve short-answer questions, with four questions based on the contents in each Module. This is a compulsory paper with each Module contributing 30 marks, a total of 90 marks or 30 per cent of the total assessment.

Paper 02 consists of nine extended-response questions, three in each Module. Candidates are required to answer two questions in each Module. Each Module contributes 40 marks, a total of 120 marks for this paper or 40 per cent of the total assessment.

Paper 03, the school-based assessment, contributes 90 marks or 30 per cent of the total assessment. Unit 1 is assessed by a single project, and Unit 2 by a research paper, a journal, a laboratory exercise and a project. While the journal, research paper and laboratory exercise each focuses on a specific Module, the project is expected to encompass the three Modules.

GENERAL COMMENTS

UNIT 1 & UNIT 2

Candidates' performance in Unit 1 was better than in Unit 2. The mean score for Unit 1 was 148 with a standard deviation of 29, and for Unit 2, 132 with a standard deviation of 34. For each Unit, the performance of candidates was best on Paper 03, followed by Paper 02 and then Paper 01. It is expected that the candidates perform best on Paper 03 because this assessment is school based, and given the proper

guidance, candidates should perform significantly better on this paper than the others that are assessed under examination conditions. As in previous years, there are still too many candidates scoring less than 50 per cent of the marks available and obtaining low grades on this paper. The mean score for Paper 03 was 69 per cent and 63 per cent for Unit 1 and Unit 2 respectively.

The mean score for Paper 01 was 39 per cent and 40 per cent in Unit 1 and Unit 2 respectively. The unsatisfactory performances on Paper 01 in both units suggest a lack of comprehensive coverage of each syllabus. The mean score for Paper 02 was 42 and 38 per cent for Unit 1 and Unit 2 respectively. Some candidates demonstrated the required level of knowledge and comprehension, as well as the ability to apply and organise this knowledge in their responses to the questions on Paper 02. Unfortunately, too many candidates failed to demonstrate the higher order skills that this paper required. There were many candidates whose responses were inadequate, especially where they were required to explain importance and significance, interactions and interrelationships, or to justify or assess statements. Several candidates struggled to respond satisfactorily to questions that required application of knowledge. A greater emphasis should be placed on test items of this nature in preparing candidates to write these examinations. Candidates must be made aware of the meaning of the various instructional terms that they are likely to encounter in the examinations. A list of these terms is presented in the syllabus.

In responding to questions related to graphs or tables, many candidates only described general trends without supporting their statements with numerical information extracted from the table or graph. Candidates must be made aware that in such situations they are expected to present numerical information to support the statements that they make.

DETAILED COMMENTS

UNIT 1

The mean score in Modules 1, 2 and 3 were 45 per cent, 47 per cent, and 56 per cent respectively. Candidates performed significantly better on Module 3 than on the other two Modules. Candidates performed unsatisfactorily in Questions 5, 7 and 10 in Paper 01 and Questions 2, 3 and 5 in Paper 02. Some candidates showed some knowledge but the depth required to answer these questions satisfactorily was lacking. This suggests that some areas of the syllabus were not being covered to the depth that was required.

Paper 01

Module1: Fundamental Ecological Principles

Question 1

Parts (a), (b) and (c) of this question tested candidates' understanding of food webs, and the roles of producers and consumers in the functioning of a food web. Part (d) tested candidates' understanding of the distribution of biomass at different trophic levels and why a trophic level can only support a particular biomass.

Overall, candidates performed well on this question.

In Part (a), most candidates were able to identify a secondary consumer and the possible impacts on the ecosystem if the population of water beetles died out. This implied that the idea of feeding in a food web was well known by candidates. Part (c) was done well by candidates. However, Part (d) posed some difficulties for most candidates, as they could not explain satisfactorily why higher trophic levels cannot support a large biomass.

NOTE: Energy transfer between trophic levels is inefficient and only 10 per cent of the energy is transferred. At each level, energy is utilised by organisms to maintain their functions while some is lost as heat. Consequently, as the trophic levels increase, the available energy is reduced significantly. There would not be enough food resource or energy available to support organisms (the piranhas) at the higher trophic level. In addition, much of the preceding trophic level standing biomass is not consumed while that which is consumed is not all converted to biomass.

Question 2

Part (a) of this question assessed the candidates' understanding of natural selection and its role in the survival of species. Part (b) required candidates to identify how a resident species will react to new selective pressures. Candidates were also expected to state the conditions for each proposed alternative.

In Part (a), while most candidates recognized that natural selection eventually leads to survival of the fittest, not many of them were able to explain how this occurred. Candidates failed to explain that natural selection acts on pre-existing genetic diversity and that selective pressures favour advantageous genes. It is these individuals with favourable genetic traits that will survive and have more offsprings surviving into the next generation.

Very few candidates were able to identify correctly and outline adaptation, migration and extinction as alternatives that a resident species have when facing new selective pressures. Candidates lost marks because they stated rather than outlined the alternatives. In addition, candidates did not identify or state the conditions under which each alternative was likely to occur.

Question 3

This question assessed the candidates understanding of limiting factors and the effects of factors shifting from their optimum value to beyond the limit of tolerance.

Part (a) of this question posed a problem as candidates failed to recognize that the question asked for 'pH ranges'. Instead, candidates gave a specific pH value rather than a range.

Part (b) was generally well done. Candidates understood the concept of limiting factors and were able to state reasons why factors affecting the survival of a species are called 'limiting factors'.

In Part (c), not many candidates recognized that there is increased vulnerability to other stress factors through synergistic effects.

Question 4

This question tested the candidates understanding of species diversity and its relationship to ecosystem stability in Part (a). In Part (b), candidates were required to state one feature that was common to an agricultural farm and a natural ecosystem. This question was done fairly well.

In Part (a), candidates were able to state the meaning of the term 'species diversity' and also rank the fields in terms of stability. However, the majority of candidates had difficulty stating reasons to support their ranking. They did not understand that as the diversity of an ecosystem increases, its stability tends to increase because alternative links between different species exist. Thus, several species may also be able to carry out the same function.

Part (b) was done fairly well.

Module 2: People and the Environment

Question 5

This question was designed to test candidates' ability to:

- (i) Calculate average annual growth rate
- (ii) Calculate doubling time
- (iii) Predict changes in population size

The responses suggest that candidates did not fully understand how to calculate average annual growth rate and doubling time. Candidates were also unaware of how to calculate and predict changes in population size.

Question 6

In Part (a), candidates were required to describe how the world population has grown since 1800 to the present and to account for this growth in Part (b).

While some candidates were good at giving the reasons for growth of the world population, they had difficulty describing the trends to show how the world population grew since 1800 to the present.

NOTE: World population was about 800 million around 1750.

Between 1800 and 1960, world population tripled from 1 billion to 3 billion.

In the 27 years between 1960 and 1987, another 2 billion were added.

Between 1987 and the present, world population grew to around 6 billion.

Question 7

This question tested candidates' knowledge and understanding of per capita GNP and the relationship between the rate of population growth and per capita GNP. This question posed difficulties to candidates.

In Part (a), candidates were unable to define correctly per capita GNP. Consequently, they were unable to explain fully its significance.

In Parts (b) and (c), many candidates failed to recognise and state correctly the relationship between the rate of population growth and per capita GNP. Candidates

found it very challenging to explain the relationship between population growth, per capita GNP and doubling time.

NOTE: The lower the per capita GNP, the lower the doubling time, which implies a faster population rate of growth.

The lower the per capita GNP, the less the ability of the population to meet its basic needs. Infant mortality rates tend to be high and life expectancy low. This is compensated by high fertility rates in an attempt to ensure that enough children survive to contribute to the family. These factors contribute to a high population growth rate.

Question 8

This question tested candidates' understanding of the role of ecological processes and the extent to which man and other organisms depended on these processes.

While most candidates gave satisfactory answers, it was evident that many did not have a clear understanding of what ecological processes were and therefore had difficulty in evaluating the extent to which man and other organisms depended on these processes. Although candidates took a position (either to agree or disagree with the statement), they failed to adequately justify their point of view. Some candidates also failed to identify and refer to specific ecological processes in their responses.

Module 3: Sustainable Use of Natural Resources

Question 9

Part (a) of this question tested candidates' understanding of the concept of Maximum Sustainable Yield (MSY) in relation to the harvesting of a natural resource. In Part (b), candidates were required to identify the MSY and corresponding harvesting effort of a natural resource from a graph that was given. Part (c) required candidates to explain the impact on a resource if harvesting occurs at a specific point as was shown on the graph.

Candidates performed satisfactorily on this question with 49 per cent of them scoring 5 or more of the maximum 8 marks.

Parts (a) and (b) were generally well done. Many candidates were able to explain that MSY was the largest amount of a resource that can be harvested and does not cause a decline in the basic stock of the resource.

In Part (b), many candidates were able to identify the MSY and corresponding harvesting effort. However, some of them lost marks because they failed to state the units correctly from the graph. In Part (c), the majority of candidates experienced difficulty explaining the impact on the resource if harvesting occurred at the given point 'A'.

NOTE: At point 'A', harvesting of the resource is too frequent and is at a level too high for the resource to recover. The minimum viable population threshold is exceeded and the population size will be too low to sustain the population biomass which eventually declines or crashes. At this point, the resource may be said to be overexploited or severely overexploited.

Question 10

This question tested the candidates' knowledge of genetic resources and their importance to the Caribbean region. Candidates were also examined on their ability to classify genetic resources as renewable or non-renewable and consumptive or non-consumptive. The majority of candidates were unable to state the meaning of the term 'genetic resources'.

In Part (b), several candidates classified genetic resources correctly as renewable. However, the majority of candidates did not give an appropriate reason for classifying genetic resources as either consumptive or non-consumptive.

Candidates need to recognize that the genetic resource of the Caribbean are represented as the sum of all genes contained in the various species of flora and fauna in the Caribbean.

Question 11

Part (a) of this question tested candidates knowledge of environmental impacts associated with mining. Part (b) tested candidates understanding of how an Environmental Impact Assessment (EIA) can mitigate environmental impacts associated with mining activities.

Part (a) of this question was well done. The majority of candidates were able to outline two environmental impacts resulting from mining activities. However, candidates simply stated the impact without an outline.

Candidates found Part (b) of this question more challenging. Some candidates demonstrated in their responses that they were aware of what an EIA was. However, they were unable to state clearly how an EIA can mitigate the impacts they identified.

NOTE: An EIA informs policy and decision makers of the feasible alternatives and the need to address, amend or enact policies, measures, laws, legislations or regulations for appropriate mitigative actions.

Question 12

This question tested candidates' understanding of how the factors of location and technology affected the exploitation of a named natural resource. Candidates performed satisfactorily on this question. While most candidates were able to state ways in which location affected the exploitation of a natural resource, not many of them were able to state ways in which technology affected the exploitation of a named resource. Also, some candidates failed to identify the named resource and to relate the stated factors to the exploitation of that named natural resource.

Paper 02

Module 1: Fundamental Ecological Principles

Question 1

In Part (a), candidates were expected to distinguish between 'habitat' and 'niche'. While most candidates recognized that a niche and a habitat were different, they were unable to state distinguishing features.

In Part (b), candidates were expected to make observations of the change in populations over time from the graph presented. Rather than stating four observations regarding the change in the population of both species over time, some candidates simply accounted for one species. Candidates generally concentrated on describing the shape of the curves rather than make observations regarding the change in population. Very few candidates made relevant statements that included numerical observations obtained from the graph.

In Part (c), the majority of candidates failed to recognize that the question dealt with the concept of carrying capacity. Consequently, they did not explain correctly or

give appropriate reasons for the observations in terms of the concept of carrying capacity. Very few candidates attempted to explain that competition was responsible but they stopped short of indicating what was the nature of the competition.

This question was attempted by 73 per cent of the candidates.

NOTE: Emphasis should be placed on the importance of good observation, which comes from practical activities, and proper inferences that come from theory.

While the habitat is defined as the physical location of the organism, the niche refers to the functional role of the organism including the eating habitat, predator – prey relations and physical location. Therefore, the niche incorporates the habitat of the organism, but the habitat is only one aspect of the niche.

Question 2

Parts (a) and (b) of this question examined the candidates' understanding of ecological succession, climax communities and stability of ecosystems. In Part (a), candidates were able to outline appropriate differences between primary and secondary succession. However, very few of the candidates recognized ecological succession as a process. In Part (b), candidates needed to show that as the process of ecological succession progressed, the diversity of the ecosystem increased until a climax community is achieved. This climax community is capable of withstanding stresses thus indicating ecosystem stability. Few candidates were able to discuss the relationship between ecological succession, climax communities and ecological stability.

Approximately 32 per cent of the candidates attempted this question.

NOTE: Ecosystem stability is the ability of an ecosystem to withstand significant changes over time and to repair any damage after any disturbance. Biotic and abiotic factors of a habitat influence the species that live there and also the process of ecological succession. As succession continues, species diversity increases and feeding relationships become more complex. Generally, complex ecosystems with high species diversity tend to be more stable because alternative links between different species exist. Eventually, a stable ecosystem develops which is in equilibrium with its environment and which undergoes little further change and is called a climax community. This stable climax community exhibits ecosystem stability, which is a measure of its sensitivity to disturbance or perturbation.

Question 3

Candidates were expected to give reasons why a food web is generally more useful than a food chain.

Part (a) was well done. Candidates satisfactorily distinguished between a food chain and a food web and also accounted for the usefulness of food webs as against food chains.

In Part (b), the majority of candidates experienced difficulty outlining reasons for assigning trophic levels to each organism in an ecosystem. Very often, candidates interchange the answer for Part (b) with the answer for Part (a). Several candidates did not recognize or indicate that trophic levels are useful in characterizing community structure in terms of energy flow and biomass.

In Part (c), candidates were unable to explain adequately why it was beneficial for humans to eat at lower trophic levels. While candidates recognized that energy was lost at each level, they failed to provide a complete explanation.

The performance on this question was unsatisfactory. The question was attempted by about 93 per cent of the candidates.

Module 2: People and the Environment

Question 4

Part (a) of this question required candidates to define 'total fertility rate' while Parts (b) and (c) tested candidates understanding of factors that influence total fertility rate and population growth rate.

Candidates performed unsatisfactorily on Part (a). They did not define total fertility rate as the average number of children born to each woman during her 'reproductive lifetime'.

Part (b) was fairly well answered by the majority of candidates. Many candidates proposed and discussed a wide range of factors that influenced total fertility rate.

For Part (c), although candidates gained marks, their responses were too general and in many cases not specific to their own country.

Candidates did not appear to grasp the differences between the demographic characteristics of human population and demographic statistics. As a result, responses to Part (c) did not address clearly the relevance of the factor and how the factor affects

population growth rate in the candidates' country.

This question was attempted by 76 per cent of the candidates.

Question 5

In Part (a), candidates were expected to define poverty and in Part (b), to compare two indices of poverty for a country. In Part (c), candidates were required to assess the validity of statements and the conclusion made in a stimulus paragraph regarding growth.

The majority of candidates recognized poverty as the lack of sufficient resources to meet one's basic needs for food, clothing and shelter. However, they were unable to provide a correct comparison of the development indices, GNP and HDI.

In Part (c), many candidates were unable to assess the validity of the statement. Candidates felt that they had to agree with the statement. Even so they did not demonstrate that they knew the trends in population growth.

This question was attempted by 22 per cent of the candidates.

NOTE: People living in acute poverty lack access to basic resources, that is, adequate diet, decent housing, basic sanitation, clean water, medical care and other essentials for human existence. While inability to access proper health care should lead to high levels of infant mortality and lower life expectancy, this does not decrease the growth rate of the populations of poor countries. There is higher population growth in poor countries as more children are produced to ensure a labour force to help on farms and take care of parents. Fertility rates are still high in poor countries. Past and current trends show that the populations of poor countries are large and continue to grow. Hence, poverty will not slow the rate of growth of world population in the future.

Question 6

This question tested candidates' understanding of the features of urbanization, the factors that contribute to urbanization and the negative environmental impacts of urbanization. The majority of candidates adequately identified the features of urbanisation and discussed factors that contributed to urbanization. A few candidates found difficulty differentiating between features of urbanization and factors causing urbanization. In Part (c), the more competent candidates adequately outlined one negative environmental impact and suggested two appropriate solutions to the problem identified.

This was the most popular question in this Module with 96 per cent of the candidates attempting it. Candidates' performance on this question was fair.

Module 3: Sustainable Use of Natural Resources

Question 7

Part (a) and Part (b) of this question focused on natural resources, the importance of natural resources to Caribbean countries and the impact of depletion of natural resources on a named Caribbean country. Part (c) (ii) required candidates to describe a suitable approach by a named country to manage the natural resource identified.

Candidates' responses suggested good knowledge and understanding of the natural resources of and the roles of these natural resources in Caribbean countries. As a result, candidates were able to assess the impact of the depletion of the natural resources. Candidates also proposed varied and appropriate approaches to manage natural resources.

This was the most popular question in this Module and candidates performed very well.

Question 8

This question was designed to allow the candidate to:

- (i) Outline three categories of protected areas according to the IUCN classification.
- (ii) Explain three roles of protected areas in natural resource conservation.
- (iii) Assess the effectiveness of protected areas in conserving natural resources in a named Caribbean country.

Part (a) of this question was done unsatisfactorily. It was obvious that candidates were unfamiliar with the IUCN classification categories. While some candidates were able to give the functions of protected areas many could not identify the corresponding name or category of the protected areas providing the specific function.

Part (b) of this question was generally well done by the candidates who performed well in Part (a). Only a few of the candidates who did not do well in Part (a) were able to explain the roles of Protected Areas in natural resource conservation.

The question was attempted by 32 per cent of the candidates.

Question 9

Part (a) of this question examined candidates' understanding of the concept and characteristics of ecotourism and the role that ecotourism can play as a tool for natural resource conservation in a named Caribbean country.

In Part (a), the majority of candidates adequately explained the concept of ecotourism while outlining its characteristics.

In Part (b), while candidates recognized that ecotourism can be a useful conservation tool, they failed to discuss ways in which it was used effectively in a named Caribbean country. Most candidates alluded to the potential role as a conservation tool rather than show how it is actually being used and in what ways it has been effective.

This question was attempted by 55 per cent of the candidates. Most of them gave satisfactory responses.

DETAILED COMMENTS

UNIT 2

The mean score obtained in Modules 1, 2 and 3 were 51 per cent, 40 per cent and 40 per cent respectively. Candidates performed significantly better in Module 1 than in Module 2. For Paper 01, candidates performed unsatisfactorily in Questions 8, 10, 11 and 12 and in Questions 2, 5, 6 and 7 in Paper 02. Questions 5 and 6 are both from the Module on Sustainable Energy Use.

Some performances were encouraging, however, the majority of candidates struggled with Modules 2 and 3, especially in Paper 02. Candidates' performances suggested a lack of depth in certain areas of the syllabus. There is a need to improve the depth and breadth of coverage in Modules 2 and 3.

Paper 1

Module 1: Sustainable Agriculture

Question 1

This question examined the role of agriculture in the economies of the Caribbean countries. This question was well done by the majority of candidates. Few candi-

dates lost marks because they did not 'outline' but rather 'stated' the role of agriculture.

Question 2

This question assessed candidates' knowledge of the types and characteristics of agricultural systems in the Caribbean. The question was fairly well done.

The types of agricultural systems as defined by the syllabus are subsistence, peasant and commercial. However, in Part (a), some candidates identified cultural practices. Some candidates also identified different aspects of commercial agriculture, such as commercial pastoral and commercial arable as separate types of agricultural systems.

In Part (b), the majority of candidates were able to outline satisfactorily two characteristics of the system they identified in Part (a). Again, some candidates lost marks because their responses were not an outline of the characteristics.

Question 3

This question assessed candidates understanding of the environmental impacts of long term commercial farming on soil. The question was done fairly well by the majority of candidates.

In Part (a), in describing the trend observed from the graph, many candidates did not include numerical information from the graph. This is a general problem when candidates are asked to interpret information in graphical or tabular form. The expected approach in responding to Part (a) is as follows:

Between 1970 and 2000, the yield from Princess Farms had decreased from 80 tonnes to about 10 tonnes, a decrease of 87.5 per cent.

In Part (b), the majority of candidates satisfactorily identified acidification, soil compaction, salinization and water logging as possible causes of the decrease in yield of the farm. In Part (c), however, some candidates' explanations lacked the required depth.

Question 4

This question assessed candidates' knowledge of agroforestry. The performance on this question was quite good.

In Part (a), some candidates' definition of agroforestry was deficient and did not encompass all aspects of agroforestry. An appropriate definition is as follows:

Agroforestry is a land use system where woody perennials are deliberately used on the same land management unit as agriculture, crops and/or animals.

OR

Agroforestry is a technique that uses trees as a major component of the multicrop production system and compares to a natural multi-layer ecosystem.

In Part (b), the majority of candidates satisfactorily outlined three reasons why agroforestry was an environmentally sustainable practice in Caribbean agricultural systems. However, some candidates responses were not specific to agroforestry but to forestry in general.

Module 2: Sustainable Energy Use

Question 5

This question examined candidates' understanding of the characteristics of fossil fuels, oil in particular and the meaning of the terms non-renewable and kinetic energy. This question was poorly done.

In Part (a), many candidates mentioned the renewal rate of oil in relationship to the life span of human beings as the reason why it is considered to be a non-renewable resource. However, this statement does not include two definitive characteristics of non-renewable resources, the fact that they occur in fixed quantities and they are depleted by use.

In Part (b), candidates' responses clearly indicated that they were aware of the definition of the term 'potential energy'. However, the majority were unable to relate their understanding of the term to oil.

Oil is a form of potential energy that is stored in the chemical bonds of the molecules and these bonds are released by combustion.

In Part (c), many candidates were unable to state why oil is an energy source derived from solar energy.

NOTE: Oil is the remains of prehistoric organisms, both plants and animals. The energy stored in oil was initially from the sun and was incorporated through the process of photosynthesis and feeding relationships into the bodies of these organisms.

Question 6

This question examined candidates' knowledge of nuclear fission and fusion and the appropriateness of the use of nuclear energy by Caribbean countries.

In Part (a), many candidates recognised that fission referred to the splitting while fusion referred to combining particles. However, it was incorrectly stated in many responses that the atom was split or combined in both processes. It should be emphasised to candidates that both are nuclear processes.

Nuclear fission is the splitting of an atomic nucleus into smaller fragments, while nuclear fusion is the opposite process, which is the combining of atomic nuclei to produce a larger nucleus. Both processes result in the emission of energy.

In Part (b), many candidates suggested satisfactory reasons why it was not appropriate for Caribbean countries to utilize nuclear energy. However, in many cases their responses were lacking in depth. Below are two examples of the responses expected.

The probability of accidents occurring in nuclear plants is low. However, if they occur, the consequences are enormous and life threatening, both immediately and long after the accident. This will be devastating especially in light of the small size of many Caribbean countries.

Nuclear plants produce radioactive wastes, which are extremely hazardous and must be disposed of safely. Finding safe disposal sites which will not pose a threat to ecosystems and natural resources, such as underground water resources, will be difficult.

Question 7

This question examined candidates' knowledge of cogeneration. The performance on this question was unsatisfactory.

In Part (a), the responses of candidates demonstrated inadequate knowledge since many definitions were not satisfactory. Two satisfactory definitions are stated below.

Cogeneration is a process in which a fossil fuel is used to produce both electricity and useful heat.

Cogeneration is a process in which two types of energy sources, a fossil fuel and a renewable energy source, are used to produce electricity (or other forms of energy).

In Part (b), instead of describing the process of cogeneration, many candidates re-wrote the definition. It seemed that candidates lacked the depth of knowledge required to address this section satisfactorily.

In Part (c), many candidates achieved satisfactory marks.

Question 8

This question assessed candidates understanding of the impact of geographical and technological factors on the supply of electricity in Caribbean countries, as well as alternative approaches to address these factors. This question was poorly done.

In general, candidates struggled to justify their choice of response in Part (a).

An example of an acceptable response is given below.

“Although the technology to supply electricity is well established, many Caribbean countries have mountainous interiors making it difficult and costly to set up electricity transmission systems to access some of these areas. Therefore, the geographical factors are the more significant limiting factor in many Caribbean countries.”

Note that if a candidate selected technological factors and presented arguments to adequately support that factor, the candidate would be credited.

In Part (b), few candidates suggested the use of photovoltaic modules, to solve the problem posed by geographical factors. Candidates were expected to make three statements for the three marks allocated. An example of the expected response is provided below.

“One approach to addressing the problem posed by geographical factors is to set up photovoltaic module systems that can generate electricity to provide the basic needs of persons living in these areas. These systems convert electricity into electricity that can be stored for use. The company will not need to bear the cost associated with expanding power lines over mountainous terrain.”

Module 3: Pollution of the Environment

Question 9

This question assessed candidates’ understanding of the environmental pathways of pollutants. This question was well done with the majority of candidates obtaining more than 3 of the 6 marks available.

Question 10

This question examined candidates' understanding of the mechanism of formation of photochemical smog and the extent to which it poses a threat to the Caribbean region.

The majority of candidates did not even attempt Part (a) where they were required to outline the mechanism by which photochemical smog is formed.

Similarly, candidates performed poorly in Part (b). Photochemical smog forms when there is a high concentration of NO and hydrocarbon in the presence of sunlight. In large cities, where there are many motor vehicles or factories and power plants, the emissions from these sources can develop the conditions for photochemical smog to form. It is therefore likely that large cities in the Caribbean such as Kingston in Jamaica or Port-of-Spain in Trinidad will experience photochemical smog.

NOTE: Candidates may argue that photochemical smog is not a threat to the Caribbean.

Question 11

This question examined candidates' understanding of the characteristics of pollutants. Few candidates demonstrated knowledge of such properties of pollutants such as synergism, persistence, and their ability to bioaccumulate and biomagnify. Pollutants bioaccumulate in the fatty tissues of organisms. This allows the concentration to increase in the organism above the level in the environment. Organisms can therefore receive fatal doses of the pollutant as a result.

Some pollutants exhibit synergistic effects, combining or interacting with other pollutants. Although the level of each may be below the threshold, their combined effect may be greater than their individual effect, causing negative environmental impacts.

Question 12

This question examined candidates' understanding of the causes, sources and impacts of water pollution.

In Part (a), many candidates could identify at least one reason for the dramatic change in dissolved oxygen concentration beyond 20 km as indicated by the graph. The dramatic change suggests a point source of pollution and the decrease in dissolved concentration suggests that the pollutant entering the river has high BOD content, for example, sewage.

In Part (b), many candidates suggested eutrophication as the reason for the change in the dissolved oxygen in the river.

Eutrophication is nutrient enrichment of the water body. This causes excessive growth (bloom) of plants such as phytoplankton and algae. When these organisms die, oxygen is utilised for the process of decomposition resulting in low dissolved oxygen content in the water.

Many candidates did well on Part (c) of this question.

Paper 02

Module 1: Sustainable Agriculture

Question 1

This question tested candidates' understanding of the environmental impacts of pesticide use on the pest and its predator and alternative method of using biological control in agriculture. It was attempted by 52 per cent of the candidates.

Parts (a) and (c) were well done by most candidates. However, in describing the importance of pesticide use in Part (a), it was expected that candidates would have cited the economic value of crops, the potential for extensive loss and hence the need for the reliable, easy-to-use and relatively cheap means of controlling pests, offered by pesticides.

Part (b) was the most difficult for the candidates. The less competent candidates did not interpret the graph adequately. Many candidates made general statements regarding the change in the pest and predator population but did not include specific information such as time periods of population numbers. Below is an example of the approach expected.

The population of the predator decreased from 480 to zero at day 140 or 30 days after application of the pesticide. The population of the pests decreased from 740 to 40 at day 140 or 30 days after the application of the pesticide. The pest population remained constant at this number for 20 days after which it increased over the next 60 days to 800 organisms, while the predator population was completely wiped out. As there is no natural predator to regulate the pest, its population exploded.

Some candidates attributed the growth in the pest population to the pest developing genetic resistance (in all cases described as immunity) to the pesticide. However, this could not be inferred based on the information provided by the graph.

Question 2

This question examined the socio-environmental issue related to agriculture in the Caribbean and their impact on the sustainability of agriculture in the region. The specific issues were health, threats to sustainable livelihood of communities and land availability. About 35 per cent of candidates attempted this question.

In general, candidates were aware of health and land availability issues related to agriculture. Few candidates satisfactorily demonstrated how these issues impacted on the sustainability of agriculture.

The majority of candidates struggled with linking sustainable livelihood of communities with agricultural sustainability. Some of the responses suggested that some candidates misinterpreted the question. Below is an example of the response expected.

Many communities depend on natural resources for aspects of sustenance and subsistence. Some aspects include food, fibre, firewood and water. Agriculture, while contributing to the livelihood of communities, may reduce the availability and or value of natural resources to communities. This may occur, for example, through the pollution of water bodies such as rivers and so decrease their usefulness to communities. Therefore, agriculture poses a potential threat to the sustainable livelihood of these communities.

Question 3

This question tested candidates understanding of no tillage farming, contour farming, organic farming and crop rotation as environmentally sustainable practices in the Caribbean. This question was attempted by 76 per cent of the candidates.

The majority of candidates demonstrated adequate knowledge of these practices but did not 'evaluate' them as sustainable practices as the question required. In evaluating these practices, candidates are expected to discuss the advantages and disadvantages of each in the context of the Caribbean and offer a conclusion as to their sustainability. Many candidates simply outlined the advantages of each practice.

In no tillage farming, the land is not ploughed and the remains of the previous crop such as the root system bind the soil together. Special machines inject seeds, fertilisers and herbicides into slits made in the soil. This method pre-

vents soil compaction, reduces erosion of sediment and nutrients and helps to maintain soil fertility. The decomposition of the previous crop adds nutrients to the soil and so enhances soil fertility. No tillage farming allows more water to be retained in the soil and more crops to be grown per season.

However, the lack of tilling can decrease soil aeration and promote pest infestation.

Module 2: Sustainable Energy Use

Question 4

This question examined candidates' understanding of the environmental impacts of using oil and the advantages and disadvantages of utilizing alternate energy sources to generate electricity. This question was attempted by 69 per cent of the candidates.

In Part (a), candidates were required to outline the trend in energy generation from Table 1. A few candidates included numerical values in their outline when describing the changes in energy generation from oil and hydroelectric generators. Those candidates were able to gain marks specifically reserved for such computations. It must be emphasised to candidates that when provided with stimulus material in graphical or tabular form to analyse, they should support their response with appropriate computations. Candidates could have calculated absolute changes, percentages or relative percentages to support their statements. Two alternate approaches are provided below.

Between 1994 and 1999, electricity generation by oil generators increased from 1475.5MW to 2078.5 MW, an increase of 603 MW or 40.9 per cent based on 1994 figures. In the same period, electricity generation by hydroelectric generators decreased from 114.5 MW to 86.8 MW, a decrease of 27.7 MW or 24 per cent.

In 1994, the total electricity generated was 1590 MW, of which 7.2 per cent was provided by hydroelectric generators and 92.8 per cent by oil generators. By 1999, the energy generation capacity had increased to 2164.9 MW, an increase of 36.2 per cent. The contribution of oil generators during the period had increased to 96 per cent, with the hydroelectric generators supplying only 4 per cent, a decrease of 3.2 per cent.

Part (b) was well done by most candidates. It is important to note that the mark scheme made allowances for alternate views of the candidates which were supported by adequate reasons.

In Part (c) (i), many candidates were able to identify one way that the country could diversify its source of energy. A few candidates seemed to lack an understanding of the concept of diversification and in Part (c) (ii), some candidates were unable to identify three advantages and one disadvantage of the approach identified in (c) (i).

Question 5

This question tested candidates' knowledge of the non-renewable fossil fuel, liquid natural gas LNG. This question was attempted by 33 per cent of candidates. The responses by the majority of candidates suggested that the depth of knowledge required for satisfactory performance was lacking.

In Part (a), the majority of candidates failed to give an appropriate definition of LNG. In Part (b), candidates struggled with assessing the use of LNG as a source of energy based on the criteria of production, transportation and use. Part (c), which required candidates to comment on the appropriateness of Caribbean countries utilising LNG in order to decrease their dependency on oil, was satisfactorily done by a few.

Question 6

This question examined candidates understanding of the concepts of energy efficiency, energy conservation and demand management or 'control of demand patterns'. This question was attempted by 72 per cent of the candidates.

In Part (a), only a few candidates satisfactorily distinguished between 'energy efficiency' and 'energy conservation' and gave appropriate examples. In Part (b), many candidates struggled to explain the concept of demand management and the ways that this could be achieved.

Demand management refers to the actions taken by electricity generating companies to limit the quantity of electricity required by their customers. Some approaches to achieve demand management include the following:

- Provision of incentives to consumers for using energy efficient appliances
- Dissemination of information regarding energy efficient and energy conservation practices
- Funding of research to develop energy efficient measures or devices
- Provision of incentives for decreased consumption

In Part (c), only a few candidates satisfactorily discussed the advantages and disadvantages of demand management.

Successful implementation of a demand management programme will effectively result in a decrease in the quantity of electricity demanded by the population. The present generating capacity may then be able to satisfy the needs of the population. If this is the case, there will be no need to expand generation capacity. The country will save foreign exchange that would have been spent to purchase capital machinery and the money saved can be allocated to other important social programmes.

Additionally, the excess capacity may be adequate to satisfy any increase in demand as a result of population increase or development in the future.

The decrease in demand may warrant a decrease in the quantity of electricity generated. This would require the use of less fossil fuel and result in savings. As a result of the decrease in fuel consumption, there will be a corresponding decrease in air pollution emissions such as carbon dioxide, sulphur oxides and particulates. Effective demand management will result in environmental benefits.

However, if the decrease in demand is such that the company has to run at its generation capacity, the production of the excess electricity represents wasted energy. Similarly, the resulting emissions represent environmental pollution from wasted production.

Effective demand management may also decrease the profit of the power company. This is possible if the decrease in demand is such that the company will still have to operate all its generators to satisfy existing demand. Hence, the savings that would have accrued from shutting down a generator does not materialise.

Module 3: Pollution of the Environment

Question 7

This question tested candidates' knowledge of the importance of water quality parameters, sources, impacts and methods of mitigating water pollution. This question was attempted by 15 per cent of the candidates.

In explaining the importance of the parameters BOD, TSS and TN in Part (a), candidates were expected to define the parameter and then state their relevance as evidence of water pollution. Only a few candidates satisfactorily achieved this and the responses of many candidates suggested an awareness of the parameters but the depth of knowledge was lacking.

In Part (b), candidates appeared to be confused as to the difference between a cause and a source of pollution that could influence the water parameters BOD, TSS and TN. As a result, the distinction was not apparent in their responses.

The cause of high BOD of water bodies is the presence of high concentration of organic matter such as that resulting from sewage pollution. The source could be point source of pollution such as outfall pipes from primary treatment sewage plants.

In Part (c), many candidates satisfactorily described two environmental impacts associated with water pollution. However, some candidates experienced difficulty in suggesting appropriate methods of mitigating the impact they identified.

It should be emphasised to candidates that eutrophication means nutrient enrichment of water bodies. Eutrophication however causes excessive growth of algae and phytoplankton. When they die, the decomposition process removes oxygen from the water resulting in dissolved oxygen deficiency.

Question 8

This question examined candidates' understanding of the greenhouse effect, the factors that contribute to global warming and the possible effect of global warming on Caribbean countries. Eighty-nine percent of the candidates attempted this question.

In Part (a), some candidates were unable to describe the 'greenhouse effect' and its importance in atmospheric temperature regulation. In Part (b), the majority of candidates were able to discuss clearly two factors contributing to global warming. However, some candidates struggled when discussing the extent to which Caribbean countries have contributed to this phenomenon. The examiners accepted candidates' opinion that Caribbean countries have contributed to global warming, when the supporting argument was valid.

Question 9

This question examined candidates understanding of the problems associated with solid waste and methods of disposal. This question was attempted by 93 per cent of the candidates.

Parts (a) and (b) were done fairly well by the majority of candidates. In Part (c), some candidates suggested burning as an appropriate alternative method of disposing of solid waste. This suggestion was unacceptable. Burning and incineration are not considered to be synonymous.

THE INTERNAL ASSESSMENT

Overall, most of the Internal Assessments submitted were of a satisfactory standard. However, there were still some poor pieces. In most instances, the assessment criteria appeared to be clearly understood. Generally, the topics chosen were appropriate and were given adequate treatment. Candidates demonstrated initiative and good judgment with the variety of tasks undertaken.

DETAILED COMMENTS

UNIT 1

Candidates were required to complete a single project that would encompass all three Modules in the Unit. Some candidates did some excellent projects. These projects 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.

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

- Candidates should be more concise and focused in the formulation of research topic.
- Topics selected should allow candidates to include all three Modules and aspects of ecology, human population and resources utilization and development.
- Candidates should demonstrate skills pertaining to laboratory and/or field work, for example, testing, measurement, observation.
- Candidates should use effectively the graphs, charts, tables and statistics with the text/analysis.
- Discussion of findings, conclusion and recommendations should be based only on what was presented in the literature review, and the data collected and analysed.

UNIT 2

For Unit 2, candidates were required to submit a research paper, a journal, a set of laboratory exercises and a project. The overall quality of assignments submitted for Unit 2 was fairly good.

In general, the journals, written papers and projects showed evidence of fieldwork and individual student involvement. The literature review was satisfactory, however, improvement is needed in the referencing of textual material. In most instances, laboratory reports and journals were done satisfactorily. In a few cases, it was apparent that candidates and teachers had difficulty in finding appropriate tasks for the laboratory exercise.

The majority of candidates exhibited weaknesses in analysing and interpreting the results. A few candidates did not submit the required minimum number of pieces for the laboratory exercises and also less than the minimum entries for the journal.

The Project

Generally, the projects submitted were satisfactory. In many instances, the titles were vague and too wide. This resulted in candidates having difficulties with data collection and the presentation of data to address the wide range of issues that the titles indicated. Consequently, some projects failed to justify their titles.

Candidates are reminded that there is a word limit of about 2 500 – 3 000 words. This should guide candidates as to how much information to present in the report.

The purpose of the project must be stated clearly and the variables identified. It is recommended that a section be titled, Purpose of Project or Statement of Task.

While a few candidates clearly described their data collection procedures, this was not true for the majority of candidates. A greater emphasis is needed in the planning and design, so that more appropriate data collection procedures can be employed.

Literature review was attempted but in most cases, it was neither appropriate nor comprehensive. This aspect needs special attention early in the course if any significant improvement is to be seen. Very few candidates referenced material correctly in the text and in the Bibliography. Candidates ought to be cautioned about the importance of referencing and acknowledging another author's work and the dangers of plagiarism.

Another area of major concern was the language and communication of information. Although, there was a reduction in the use of colloquial expressions by most candidates, this was not accompanied by an improvement in the use of standard English

for effective communication of information.

In some instances, candidates included data, which they were unable to analyse and discuss adequately. As a result, the conclusions drawn were either flawed or not based on the data presented. In a few cases, conclusions were not in line with stated objectives of the project. Candidates are advised to pay attention to the statement of purpose and objectives when analysing their data and drawing conclusions. Candidates are reminded to state all findings and present facts to support findings. This would improve the interpretability, reliability and usefulness of findings.

Candidates are reminded that

- conclusions must be clear, based on findings, valid and related to the purpose of the project
- recommendations must be based on findings and must be **fully** derived from findings.

Laboratory Exercises

The syllabus facilitates laboratory exercises in all Modules. For assessment purposes, laboratory exercises submitted were expected to focus on Module 3 in the case of Unit 2. For Unit 1, it is expected that laboratory techniques and investigation be demonstrated in the planning and design, and data collection sections of the project.

In general, most candidates submitted an adequate number of laboratory exercises with satisfactory coverage of the criteria to be assessed. There was an improvement in the measurement and reporting of basic parameters. Only a few candidates submitted less than the minimum number of pieces. While there was an overall improvement in the general quality of the laboratory exercises submitted, there is still room for improvement in the analysis and interpretation of results.

Research Paper

This component was generally satisfactory. However, there was not much evidence of planning and design by some candidates or of effort to obtain data based on field work to supplement secondary data. This reliance on secondary data only reduced the quality of the candidates' analysis and comparison of data. Wherever candidates undertook fieldwork to collect data, they relied solely on questionnaires. This did not allow a variety of data sets to be collected.

Candidates are encouraged to devote more attention to the plan and design of the research paper. This will direct the design for the types of data to be collected while

at the same time allowing for the type of analysis that will be used. Effective planning and design will also lead to effective interpretation and discussion since the scope and purpose of the research paper would have been identified.

Journal

There was an overall improvement in the journals submitted. Most candidates followed the criteria outlined and were able to make relevant entries, observations and interpretative comments. Only in a few cases were follow-up activities not included.

The interpretative comments were generally weak. In some instances, these comments did not correspond to the entries or the observations recorded. Greater attention is needed in the formatting and organization of space. An introduction to the journal would be helpful as this would indicate the scope and purpose of the journal entries to the reader.

CARIBBEAN EXAMINATIONS COUNCIL

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

ENVIRONMENTAL SCIENCE

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ENVIRONMENTAL SCIENCE
CARIBBEAN ADVANCE PROFICIENCY EXAMINATION
MAY/JUNE 2005

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.

DETAILED COMMENTS

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)

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

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

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

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 becomes 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 EnvironmentQuestion 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 = $(1.0 + 1.0 + 0.9 + 0.9) \times 100,000$

Total number of females = $(1.2 + 1.1 + 1.0 + 0.9) \times 100,000$

Total population = 3,800,000 + 4,200,000 = 8,000,000

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

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 simply 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:

- By holding soil together deforestation reduces soil erosion.
- 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 UseQuestion 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, the environmental 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 than 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)**

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2006**

ENVIRONMENTAL SCIENCE

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ENVIRONMENTAL SCIENCE

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2006

INTRODUCTION

Environmental Science is a two-Unit subject with each Unit consisting of three modules: Unit I - 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. The examination for each Unit consists of three papers. Papers 01 and 02 are externally examined by CXC, while Paper 03 is examined internally by the teacher and moderated by CXC.

Paper 01 is comprised of twelve compulsory short-response questions, with four questions based on the contents of each Module. This paper contributes 30 per cent of the total assessment.

Paper 02 is comprised of nine questions, three from each module of which candidates are required to answer two. These are structured essay type items each contributing twenty marks or a total of 120 marks to the paper. This paper contributes 40 per cent of the total assessment.

Paper 03, the school-based assessment, contributes 90 marks or 30 per cent of the total assessment. Unit 1 is examined by a single project report of 2000 – 2500 words. This project should incorporate the relevant practical skills and should focus on at least one objective from any Module in the Unit. Unit 2 is examined by a journal of 2000 – 2500 words which incorporates the practical skills relating to site visits and laboratory exercises. The journal should focus on at least one objective from any Module in the Unit.

GENERAL COMMENTS

UNIT 1

In Unit I, candidates performed best on Paper 03, followed by Paper 01 and then Paper 02. The fact that candidates performed best on Paper 03 is expected since this is the School Based Assessment (SBA), and given the proper guidance candidates should perform significantly better on this paper than the others which are tested under examination conditions.

There was a general decline in the performance of candidates in Unit 1 when compared with the performance in 2005. It is apparent that the basic concepts within the syllabus were not properly grasped by many candidates and this was very evident in their performance in Unit 1 especially in Paper 02.

Candidates performed poorly on many of the test items in Unit 1. Some candidates showed some knowledge but the depth required to answer these questions satisfactorily was lacking. This suggests that some areas of the syllabus probably were not covered to the required depth or candidates are having difficulties grasping basic concepts.

There was no significant variation in the performance of candidates on the Modules.

Generally candidates' performance in this Unit was disappointing. Improvement is still needed in the depth and breadth of coverage and in candidates' ability to explain interactions, interrelationships and infer relationships.

DETAILED COMMENTS

UNIT 1

PAPER 01

Candidates' performance was fair on Questions 1, 3, 9 and 11. Overall, candidates performed best in Module 1, followed by Module 3 and then Module 2. The best performance was in Question 9 and the weakest in Question 12.

Module 1: Fundamental Ecological Principles

Question 1

In Part (a) of this question, candidates were required to identify specific processes occurring in the water cycle. In Part (b) candidates were required to identify the source of energy that drives the water cycle. Part (c) required candidates to outline the processes identified in (a).

While most candidates were able to correctly identify the specific processes and the source of energy in the water cycle many found it difficult to outline how the energy source drives each of the processes.

Note:

- Solar radiation provides energy to move the winds which circulate water in the atmosphere.
- Clouds move about by the winds and deposit their moisture as rain, drizzle, snow, hail, sleet.
- This returns water to reservoirs (lakes, oceans).

Question 2

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

Part (b) tested candidates' understanding of how biotic potential and environmental resistance interact to maintain populations within ecosystem carrying capacity.

Most candidates were able to define the ecological terms but had difficulty in outlining how biotic potential and environmental resistance interact to maintain populations within ecosystem carrying capacity.

Note:

- Natural populations have the capacity for growth under favourable conditions.
- Density-dependent and density-independent factors interact to increase environmental resistance;
- These either lower the birth rate, or increase the death rate, or both, and prevent the population density/size from rising beyond the carrying capacity.

Question 3

In Part (a) of this question, candidates were required to use appropriate examples to explain interactions that occur in two types of feeding relationships, commensalism and mutualism. Most candidates were able to use appropriate examples to explain the feeding interactions.

Part (b) tested candidates' ability to distinguish between predation and parasitism and most candidates were able to answer this question correctly. Sixty-one percent of candidates who attempted this question scored greater than 50 per cent of the available marks for this question.

Question 4

This item tested the candidates' knowledge of the impact of humans on abiotic and biotic components of a natural ecosystem.

Although a few candidates could only identify the impact, the majority were able to identify and outline the impact of humans on natural ecosystems.

Note:

Regarding abiotic components:

- Humans may severely disrupt abiotic conditions by adding substances to the ecosystem (pollution).
- This action can change physical conditions or can alter the chemical balance of the ecosystem.
- Humans may affect the rate of cycling of materials in biogeochemical cycles through extraction of materials or input of materials.
- Humans may impact on the volume of materials to be cycled in biogeochemical cycles.

In relation to biotic components:

- Human activity can directly impact on biotic components by killing or removing organisms.
- Tampering with biotic factors can reduce species diversity and thus simplify ecosystems, making them more susceptible to different forms of ecological stress (the ecosystem becomes less stable).
- Humans can influence biotic components by introducing competitors and pathogenic organisms, which can have devastating effects in disrupting feeding relationships and ecosystem balance.
- Humans can influence biotic components by eliminating competitors and pathogenic organisms. These can disrupt feeding relationships and ecosystem balance.

Module 2: People and the Environment

Question 5

This question was designed to test the candidates' ability to

- (i) select important information from a population profile diagram;
- (ii) use the information to make a prediction about the rate of growth of the population;
- (iii) organise the information in a logical order to account for the prediction of the rate of growth of the population.

This question was done satisfactorily by candidates. The responses suggest that candidates grasped the basic concepts and were able to use the information presented to make predictions about which countries would have the faster growing population.

Question 6

This question tested candidates' knowledge of the reasons for growth in urban populations in developing countries and examined candidates' understanding of the ways in which human populations impact on biogeochemical cycles.

Candidates performed satisfactorily on this question. More than 51 per cent of candidates scored greater than 50 per cent of the total marks. Candidates were able to state reasons for urban population growth and to outline ways in which urban populations impact biogeochemical cycles.

Question 7

In this question candidates were presented with a model and a suggested relationship between the level of poverty and population growth in a poor country. Candidates were required to adopt a position and justify this position.

Candidates' performance in this question was below expectation. Most candidates had difficulty in the applying the required knowledge and less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 8

In this question candidates were required to use demographic statistics to

- (i) calculate the percentage increase of the population;
- (ii) predict the year when the population size would double.

Overall candidates performed poorly on this question. The responses suggest that candidates did not fully understand how to calculate percentage increase 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 doubled.

Note:

Total number of births, b	=	24/1000 x 2,400,000
	=	57,600
Total number of deaths, d,	=	4/1000 x 2,400,000
	=	9,600
Increase in population size	=	(births – deaths) + (immigrants – emigrants)
Increase	=	(57,600 – 9,600) + (100 – 1100)
	=	(48,000 – 1000)
	=	47,000

Percentage increase in population, r, = $47,000/2,400,000 \times 100$

$$r = 1.96 \text{ per cent (approximately 2 per cent)}$$

Doubling time = $70 / \text{percentage increase}$

$$= 70/1.96 = 35.7 \quad \text{OR}$$

$$= 70/2 = 35 \text{ years}$$

The year in which the population will double will be $2000 + 36 = 2036$

OR $2000 + 35 = 2035$

Module 3: Sustainable Use of Natural Resources

Question 9

This question tested candidates' knowledge of the types of natural ecosystems found in the Caribbean and their benefits to society.

Candidates performed best on this question with over 73 per cent of candidates scoring over 50 per cent of the available marks. Candidates were able to identify natural ecosystems found in the Caribbean and to correctly and fully outline the benefits of these ecosystems to society.

Question 10

In Part (a) of this question, candidates were required to list three demographic characteristics of a population that influence its rate of exploitation of natural resources.

In Part (b), candidates were required to outline how each of the listed characteristics in (a) affected natural resource use.

Candidates performed poorly on this question. While some candidates were able to list demographic characteristics of a population they had difficulty explaining how these characteristics influence the rate of exploitation of natural resources and how each characteristic affected natural resource use.

Question 11

This item tested candidates' understanding of the concepts of 'species depletion' and 'species extinction'.

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

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.

The performance on this item was not as expected. Candidates were able to identify the method of cultivation but were unable to describe this. Most candidates were unable to explain why this method of cultivation practised by indigenous people is considered sustainable.

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 occurs;
- 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

Candidates' performance was best in Module 3 followed by Module 1 then Module 2. Candidates' performance was exceptionally poor on Questions 4 and 8. The best performance was on Question 9 where 43 per cent of the candidates who attempted the question scored 50 per cent or more of the available marks. The weakest performance was in Question 8, where only 11 per cent of the candidates obtained greater than 50 per cent of available marks.

Module 1: Fundamental Ecological Principles

Question 1

This question required candidates to

- (a) explain the meaning of 'range of tolerance' and 'limiting factors';
- (b) identify limiting factors for an aquatic ecosystem;
- (c) outline how limiting factors impact on population of organisms in an aquatic ecosystem.

It was attempted by over half of the candidates with 42 per cent of them giving satisfactory responses and 11 per cent of them scoring full marks on this question.

Parts (a) and (b) of this question were generally well done. The weaker candidates were unable to differentiate between 'range of tolerance' and 'limiting factors' and gave incorrect answers.

Note:

Range of tolerance

- There are maximum and minimum limits for physical conditions beyond which no members of a particular species can survive.
- A species may have a wide range of tolerance to some factors and a narrow range of tolerance for others (optimum range).
- Outside the optimum range, are the zone of physiological stress where survival is possible but difficult and the zone of intolerance where an organism will perish.
- Most organisms are least tolerant during juvenile or reproductive stages of their lifecycles.
- Highly tolerant species can live in a variety of habitats with widely different conditions.

Limiting factors

- Too much or too little of any abiotic factor can limit or prevent growth of a population even if all other factors are at or near the optimum range of tolerance.

- Although organisms are affected by a variety of abiotic factors in their surroundings, one factor usually outweighs the others in determining population growth. This is the limiting factor.
- This factor is the primary determinant of growth in an ecosystem.
- Limiting factors are important because they can easily be upset by human activities.

Part (c) of this question posed great difficulty. This part of the question required candidates to apply their knowledge in outlining how limiting factors impacted on the population of organisms in an aquatic ecosystem. Candidates who scored satisfactorily on this question were able to

- (i) write clear and concise statements;
- (ii) link related bits of information;
- (iii) organise information in a logical order.

Question 2

Parts (a), (b) and (c) of this question tested candidates' understanding of feeding relationships and energy transfers demonstrated by pyramids of energy and pyramids of numbers. Part (d) required candidates to account for the difference in the shape of the pyramid of energy and pyramid of numbers for a given situation.

Candidates exhibited satisfactory performance in Parts (a) and (c) of this question which required them to list or state reasons but not to provide an explanation.

Parts (b) and (d) proved challenging to the majority of candidates and these parts of the question were not well done. Candidates experienced difficulties in accounting for the shape of the pyramid of numbers and relating it to the pyramid of energy given.

Forty-three per cent of candidates gave satisfactory responses to this question.

Question 3

In this question candidates were presented with a statement relating to the role of natural ecosystems in human existence. Candidates were required to adopt a position and justify the position adopted.

While candidates were able to identify five reasons why natural ecosystems are vital to the existence of human beings, the majority were unable to justify their statements. Most of the points made were irrelevant and did not support the reasons given. Only 38 per cent of candidates gave satisfactory responses.

Candidates who scored satisfactorily on this question were able to write clear and concise statements and organise information in a concise and logical order.

Module 2: People and the Environment

Question 4

Part (a) of this question required candidates to describe, in terms of birth and death rates, how the rate of a given population that was depicted graphically changed between a given time period.

Part (b) tested candidates' understanding of how social parameters accounted for changes in growth rates.

Part (c) required candidates to outline an environmental impact due to rapid changes in population growth rate of a Caribbean country.

Only 23 per cent of candidates achieved a satisfactory mark on this question. Most candidates did not understand the relationship between birth rates, death rates and population growth and so did not perform well in Parts (a) or (b). Candidates performed much better on Part (c) of this question, however, their responses were far too general.

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. Part (c) required candidates to suggest TWO reasons for the low percentage of Ethiopian women using contraceptives. Part (d) was designed to allow candidates to suggest an approach for 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 child-bearing years (usually considered to be between 15 - 49 years). Few candidates were able to define 'life expectancy' as the average number of years a newborn is expected to live.

Most candidates failed to grasp the relationship between total fertility rate and life expectancy and as a result the responses offered by candidates did not address clearly the relationship between the two demographic factors.

Question 6

This question was designed to test candidates' understanding of population growth and its relationship with sustainable development. Part (a) examined candidates understanding of the relationship between population growth of a country and its ability to achieve sustainable development.

Part (b) tested candidates' understanding of how selected social indicators relating to women will impact on the sustainable development of a country.

Overall, 36 per cent of candidates achieved a satisfactory score on this question.

While many candidates exhibited an understanding of how social indicators impact on sustainable development they encountered difficulty discussing this from a female perspective.

Note:

Level of Education

The level of education impacts on the fertility rate of women since women with more education

- tend to have fewer children;
- usually marry later, so that their number of child bearing years is reduced, and the time between generations is increased;
- have an increased probability of knowing how to control their fertility, improving the health of their family, thus decreasing infant and child mortality;
- have access to other options besides having babies.

Economic Status

- In many societies, women have low social and economic status.
- They are limited to low-paying, low-skilled jobs.
- Marriage is usually the only way for a woman to achieve social influence and economic security.
- Marrying at a young age tends to increase child-bearing age and fertility rates.
- Improving the social and economic status of women provides them with economic opportunities, improving their self-confidence and reducing their fertility rates.

Access to Family Planning Services

- Many women now have access to family planning services.
- Family planning services provide information on reproductive physiology, contraceptive use as well as the actual devices.
- People may be encouraged by socioeconomic factors to want smaller families, but this will not become a reality without the availability of these services.
- It allows control of the number of children produced or/and spacing of children's birth.

- These services are linked to lower fertility rates.
- Represents an effective method of controlling the rate of growth of population.

Module 3: Sustainable use of Natural Resources

Question 7

Candidates' knowledge and understanding of environmental impacts associated with the exploitation of minerals was tested in this question.

Most candidates were unable to describe adequately the given environmental impacts associated with exploitation of minerals in the Caribbean. Most candidates treated this question in a general manner and failed to link the impacts to mineral exploitation.

This question was attempted by over 50 per cent of the candidates and 43 per cent of candidates gave satisfactory answers.

Question 8

Part (a) of this item focused on the reasons for natural resource conservation. Part (b) required candidates to discuss the role of specific natural resource conservation measures.

Many candidates performed well on Part (a) which required candidates to suggest reasons for natural resource conservation.

Part (b) proved to be challenging. Candidates were unable to distinguish between 'rehabilitation' and 'restoration' conservation measures and so were unable to effectively discuss their roles in natural resource conservation.

Overall only 24 per cent of candidates gave satisfactory responses to this question.

Note:

- | | | |
|-----------------------|---|---|
| Rehabilitation | – | practice allows recovery of habitats and population of organisms. |
| | – | contributes to restoration of depleted or degraded ecosystems. |
| | – | promotes conservation of life support systems. |
| | – | promotes/contributes to conservation of rare, threatened or endangered species. |
| Restoration | – | allows for habitats to recover. |
| | – | allows species to reinvade former habitats. |
| | – | creates situations for natural ecosystem to repair itself. |

- promotes basic life supporting systems and repairs degraded natural systems.
- Preservation**
- allows for non-consumptive use of natural resources.
 - promotes natural ecosystem function without human intervention.
 - ensures that natural areas are left intact since as populations increase so does the demand for land and natural resources.
 - by not permitting human use or intervention, natural areas are left intact.
- In-situ and ex-situ conservation**
- allows for the implementation of measures in the management of organisms or landscape to enable protection, enhancement or restoration.
 - allows for the implementation of captive breeding and reintroduction programmes to repopulate areas with certain species.
 - provides genetic resource pools that are useful in maintaining natural populations.

Question 9

This question required candidates to describe environmental impacts associated with the exploitation of forest resources in the Caribbean. Candidates were required in Part (b) to suggest recommendations for addressing the environmental impacts that they discussed in Part (a).

Part (a) of this question was well done. Part (b) was generally well done by the candidates who performed well in Part (a). However, some candidates failed to suggest ONE recommendation for EACH impact identified.

Candidates' performance was the best on this question with 62 per cent achieving a satisfactory score and 43 per cent of the candidates who attempted this question earned over 50 per cent of the total mark.

UNIT 1

PAPER 03B

Generally the majority of candidates' performance was satisfactory and was an improvement over last year's performance. Improvement in the depth and breadth of coverage with respect to certain areas of the syllabus is still needed. Greater effort is necessary to improve candidates' ability to organise and apply knowledge.

Question 1

This question, required candidates to calculate changes in population size over a number of years given a number of population parameters. The majority of candidates used the information appropriately.

Question 2

In Part (a) of this question the information given was used to draw and interpret the bar chart satisfactorily. Candidates, however, struggled to provide an explanation for the trend in the variation of the population.

Question 3

This question tested candidates' knowledge of population sampling techniques for moving and stationary organisms. The responses of most candidates were satisfactory.

DETAILED COMMENTS

UNIT 2

In general, candidates performed best in Module 2 followed by Module 1 and then Module 3.

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. This suggests that some areas of the syllabus were not covered to the depth Paper 01 required.

PAPER 01

In Paper 01, candidates' performance was in the order Module 1, followed by Module 3 and then Module 2. Only a small percentage of candidates exhibited the requisite level of knowledge, comprehension and application.

Module 1: Sustainable Agriculture

Question 1

In Part (a) the majority of candidates correctly identified three characteristics of subsistence agriculture systems. Similarly, in Part (b), the majority of candidates satisfactorily outlined two applications of technology that are used to improve agricultural productivity.

In Part (c), however, some candidates had difficulty stating a disadvantage of one of the technological applications that they had outlined in Part (b).

Candidates should be aware of the advantages and disadvantages associated with the application of all technology to agriculture especially in a Caribbean context.

Question 2

This question assessed candidates understanding of the importance of agriculture to the economies of the Caribbean. This question was well done by the majority of candidates.

Question 3

In this question candidates were required to outline TWO positive impacts and ONE negative impact of genetic engineering on the environment. While it was obvious that many candidates had some knowledge of the application of genetic engineering in agriculture, many struggled to describe its impact on the environment. In general, candidates were more able to describe the positive impacts on the environment than the negative impacts.

Some examples of the negative impacts are:

The introduction of genetically altered organisms with enhanced survival characteristics into the ecosystem may result in the displacement of endemic species and the disruption of natural population balances.

Genetically engineered organisms might mutate, producing changed organisms with unforeseen and unpredictable consequences.

Question 4

This question examined candidates' understanding of the features of sustainable agriculture. The responses of many candidates suggest that they had limited or no knowledge of this concept. A few candidates correctly described three features of sustainable agriculture as required. Some features of sustainable agriculture are given below.

- Ecological soundness: This requires maintenance of the quality of natural resources and enhancing the vitality of the entire agro-system. Soil is managed and the health of crops, animals and people is maintained through biological processes.
- Economic viability: Risks are minimised, thus, reducing financial inputs and expenditure. Farmers produce enough for income and self-sufficiency. Yields of produce must justify inputs.
- Adaptable: Communities should be capable of adjusting to the constantly changing conditions for farming, changing market demands and population growth and policies through the development and use of new and appropriate technologies including social and cultural changes.
- Humane: There must be recognition of the fundamental dignity of all human beings, preserving the cultural and spiritual integrity of society and a respect for all forms for life.
- Socially just: Resources should be distributed equitably to meet the basic needs of society. Adequate capital, technical expertise and market opportunities must be available to all.

Module 2: Sustainable Energy Use

Question 5

In Part (a)(i), many candidates satisfactorily explained energy but only a few correctly distinguished between energy and power. In Part (a)(ii), the majority of candidates adequately distinguished between renewable source of energy and non-renewable source of energy.

In Part (b), candidates were required to provide reasons for the low efficiencies of energy conversion processes. Only a few responded satisfactorily to this section. Many candidates seem not to understand the concept of efficiency in relationship to energy conversion processes.

The efficiency of an energy conversion process is the ratio of the energy output to the energy input. In all conversion processes some amount of energy is converted into forms of energy other than that which is required such as heat. This amount of energy is usually not utilised and become lost to the system. This is usually a substantial proportion of the energy and the amount of useful energy output is small in comparison to the amount of energy input, hence the low efficiency of the process.

Question 6

In Part (a), candidates were provided with a schematic diagram of a fossil fuel generating plant and were required to outline the process occurring at three labelled steps. Only a few candidates described the processes occurring at each of the stages (i), (ii) and (iii).

At (i), combustion of fossil fuels provide heat energy to the boiler; at (ii), the boiler generates high pressure steam from water which is channelled to the turbines, (iii) the steam is used to rotate the coil in a magnet to produce electrical energy.

In Part (b), candidates were required to describe one way in which an electrical generating company may handle electricity demand when it exceeds the company's generating capacity. Some candidates' responses suggest they had no knowledge of this area of the syllabus. However, there were excellent responses from other candidates.

Some demand management measures available to power companies include load shedding and public awareness programmes to shift some domestic demand to off peak hours.

Question 7

This question examined candidates' understanding of the ecological and social cost associated with the use of fossil fuels to generate electricity. The majority of candidates satisfactorily outlined two ecological costs but struggled to provide a social cost. An example of a social cost is outlined below.

Particulate matter is emitted as a by-product of fossil fuel combustion. Particulates cause and aggravate respiratory illnesses and may lead to chronic bronchitis. Society has to bear the cost of treating the disease and the loss in productivity that may result.

Question 8

In Part (a), many candidates demonstrated some knowledge of the relationship between energy use and global warming but many provided an incomplete outline.

In Part (b), some candidates experienced difficulty identifying one environmental impact of global warming of particular concern to all Caribbean countries. Some candidates identified the formation of hurricanes as a concern. However, the Caribbean is a region that has always been affected by hurricanes. The concern in this regard should be the increased frequency of hurricanes and the formation of more powerful ones. Some other concerns are;

- sea level rise damaging coastlines;
- change in seasonal weather patterns.

Generally, candidates who correctly identified the environmental impact satisfactorily described a way of mitigating the effects of the environmental impact they identified.

Module 3: Pollution of the Environment

Question 9

This question examined candidates' comprehension of how the persistence and mobility of a chemical influence its environmental impact. Many candidates demonstrated knowledge of both terms but not many provided a complete response.

Persistence refers to the ability of a pollutant to resist decomposition. Stable pollutants take a long time to breakdown which allows the concentration in the environment to increase to toxic levels through accumulation. The impact of a more stable pollutant will be long term and more significant in comparison to a less stable pollutant.

The ability of a pollutant to move through the environment is called its mobility. By floating on air currents, dissolving in water, or adhering to soil particle, pollutants can move long distances from where they are released. A greater mobility allows a more widespread environmental impact of a pollutant.

Question 10

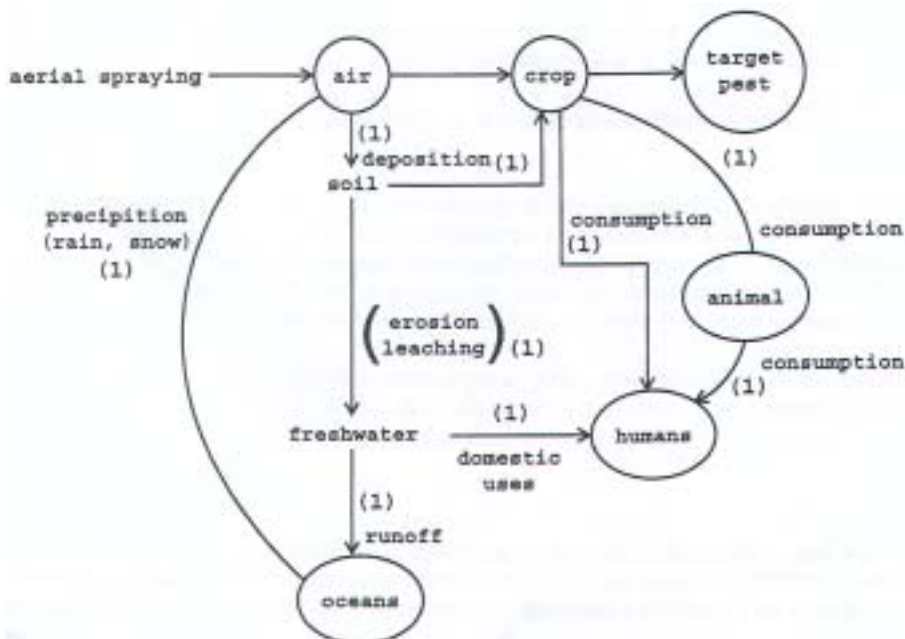
In this question, candidates were provided with a diagram showing an incomplete “intended pathway of a pesticide when aerially sprayed”. Candidates were required to complete two possible pathways by which the sprayed pesticide may enter the oceans and humans. Although some responses were excellent, other responses were incomplete or incorrect. An example of an **incorrect** incomplete pathway is given below:

Pesticide from the crops is transported to the oceans by surface runoff and leaching.

This pathway is incomplete because the link between the pesticide on the crop and in runoff is absent.

A complete statement would be:

Pesticide deposited on plants may be washed off by rain and transported by surface runoff to water bodies such as rivers or to gullies where it flows to the ocean. (See diagram below.)



Possible pathway of pesticide

Question 11

In Part (a), many candidates could not satisfactorily define a secondary air pollutant. In Part (b), some candidates experienced difficulties outlining the formation of a secondary air pollutant. It was, however, encouraging to see that some candidates correctly outlined the formation of the secondary air pollutant using a chemical equation rather than describing the process. This is an indication that some candidates are being provided with the depth of content required.

In Part (c), candidates were required to describe the environmental impact of the secondary pollutant identified in Part (b). Generally, candidates who correctly identified a secondary pollutant satisfactorily responded to this section.

Question 12

This question examined candidates' understanding of the role of legislation and incentives in controlling pollution. This should have been a relatively easy question. However, while there were some excellent responses, there were too many candidates with very poor responses.

UNIT 2

PAPER 02

In Paper 02, candidates performed best on Module 1, followed by Module 3 and then Module 2. Too many candidates continue to struggle especially in questions requiring them to assess, discuss, evaluate or justify. It is recommended that greater emphasis be placed on these types of questions.

Module 1: Sustainable Agriculture

Question 1

This question assessed candidates' understanding of types of soil degradation associated with "excessive irrigation, their occurrence and sustainable agriculture practices to address them."

In Part (a), only a few candidates correctly listed two types of soil degradation associated with irrigation. Some candidates were unable to recall the correct terms to describe the type of soil degradation and resorted to the use of statements.

In Part (b), the majority of the candidates were unable to outline satisfactorily the steps leading to the occurrence of the soil degradation indicated in Part (a).

In general, candidates who adequately explained the occurrence of both types of soil degradation were able to recommend a sustainable agriculture practice to address each of the form of degradation they identified. Twelve per cent of candidates achieved 50 per cent of the total marks.

Question 2

Parts (a) and (b), examined candidates' understanding of mechanisation and the factors that limit the mechanisation of agriculture in the Caribbean. Many candidates submitted an incomplete response indicating that mechanisation was the utilisation of machines in agriculture. A complete definition of mechanisation is as follows:

Mechanisation is the application of engineering principles and technology in agricultural production, storage and processing on the farm.

Part (b) required candidates to apply their knowledge of mechanisation. The majority of candidates were able to describe at least three factors limiting mechanisation of agriculture in the Caribbean. Some additional factors are provided below.

- *Limited incentives for the development of indigenous design and manufacture of farm equipment.*
- *Relatively poor extension services, poor credit facilities or access to credit facilities especially when farmers cannot meet initial payments or collateral.*
- *Appropriateness of technology; need may exist to modify technology to suit particular conditions existing in Caribbean countries.*

Part (c) of this question required candidates to justify the statement below;

“Agro systems are different from natural unmanaged ecosystems.”

Only a few candidates satisfactorily responded to this section. The overall poor performance of candidates on this question was due mainly to the poor performances, on this section. As in previous examinations, candidates continue to experience difficulties when responding to questions testing higher-order cognitive skills.

Twenty-nine per cent of candidates achieved 50 per cent of the total marks.

Question 3

This question examined candidates' knowledge of aquaculture management and the environmental issues associated with this practice in the Caribbean.

The majority of candidates adequately distinguished between aquaculture and mariculture in Part (a).

In Part (b), many candidates struggled to describe three management techniques used for increasing yields in aquaculture. This may in part be due to the use of the expression 'management techniques' instead of 'ways of increasing yields' in aquaculture. Only a few candidates responded satisfactorily to this section. The management techniques for increasing yields in aquaculture falls under the categories of stocking rate, disease control, supplemental feeding, pond environment control, weed control and fish pond fertilisation.

In Part (c), candidates were required to discuss three environmental issues resulting from the practice of aquaculture in the Caribbean. As was the case in Part (b) of this question, only a few candidates responded satisfactorily to this section. Some environmental issues relating to the practice of aquaculture includes the use of chemicals, water demand, management of waste water and competition for land space.

Sixteen per cent of candidates achieved 50 per cent of the total marks.

Module 2: Sustainable Energy Use

Question 4

In Part (a), candidates were provided with a graph showing the projected annual demand for electricity and another showing the projected annual world production of oil for the period 1900 to 2050. Candidates were required to make inferences from both graphs and suggest the impact on Caribbean countries if the projections were realised.

Many candidates satisfactorily demonstrated their ability to interpret information presented in a graphical manner. However, some candidates included in their response a description of the general trend shown by both graphs without extracting critical and specific information presented by the graph.

In Part (b), the majority of candidates suggested appropriate alternatives and adequately discussed their advantages and disadvantages. The performance on this question was the best on this paper. 86 per cent of candidates achieved 50 per cent of the total marks.

Question 5

This was the least popular question in the Module. In Part (a), candidates were required to explain the functions of the control rods and primary water circuits in a nuclear reactor. The majority of candidates responded satisfactorily to this section.

In Part (b), candidates were required to evaluate the following statement:

“Caribbean countries should satisfy their growing demand for electricity through the use of nuclear energy rather than building new conventional fossil fuel power plants.”

In evaluating this statement, candidates were expected to discuss the environmental issues associated with the operation of a nuclear and a fossil fuel power plant. Candidates were expected to address issues such as waste production and disposal, land availability and geology, economic cost and availability of expertise. An example of evaluation based on economic cost is provided below.

Constructing nuclear plants is quite costly. Utility companies would need to recover their cost through higher electricity bills to customers. Such plants are quite large and take years to build. Fossil fuel power plants are much smaller, less expensive and easier to build. In the Caribbean the infrastructure already exists for such plants and it is cheaper to expand fossil fuel plants. Nuclear power plants have a limited life span between 20 to 30 years after which it has to be decommissioned. Decommissioning is expensive because the disposal of all radioactive material produced including the reactor must be executed safely. Fossil fuel plants function for many years and there are no disposal problems associated with decommissioning.

Forty-two per cent of candidates achieved 50 per cent of the total marks.

Question 6

In Part (a), the majority of candidates satisfactorily explained energy conservation and provided a suitable example. However, many candidates did not adequately distinguish energy conservation from energy efficiency.

An acceptable response follows.

Energy conservation is the moderation or elimination of wasteful energy consuming tasks or activities. Energy efficiency refers to the use of technology to accomplish activities or tasks with less energy.

In Part (b), candidates were required to evaluate the following statement:

“The implementation of measures to conserve and use energy more efficiently is the best and cheapest means of making more energy available.”

Only a few candidates adequately responded to this section. A satisfactory response is provided below.

Conservation measures, by saving energy, reduce the demand for fossil fuels. Efficiency measures reduce the amount of energy used for a particular task, decreasing energy demand and fossil fuel use. Reduction in demand will extend the life of fossil fuel reserves. This extends the time to explore and develop new energy alternatives. This buys time to explore and develop new energy alternatives. Conservation and efficiency cost less than the development of new sources or supplies of energy. Economic benefits accrue from the adoption of these measures. These technologies generate business opportunities including development, manufacturing and marketing of these technologies. Energy efficient technologies decrease the emissions associated with the use of fossil fuels and their environmental impact.

In Part (c), many candidates suggested two ways in which the transportation sector in their respective countries could conserve energy. However, candidates must be reminded that a discussion requires assessing both the advantages and disadvantages of suggestions. Forty-one per cent of candidates achieved 50 per cent of the total marks.

Module 3: Pollution of the Environment

Question 7

In Part (a), candidates were provided with a graph showing the percentage coral cover between 1970 and 2000 for a Caribbean Island Z and were required to outline the trend. Many candidates satisfactorily answered this section. However, candidates must be reminded that they are expected to specify the changes shown by the graph in their responses.

The percentage coral cover remained relatively constant at about 78 per cent from 1970 to 1980. Between 1980 and 1985, the coral cover had been reduced to about 35 per cent. There was a five per cent recovery in coverage up to 1990, followed by a decline to a low of about five per cent in 2001.

In Part (b), only a few candidates identified the correct pollutant based on the high turbidity and faecal coliform levels in the coastal waters of Island Z. Many candidates identified the water pollutant as turbidity and faecal coliform rather than sediments and sewage. In Part (c), it was obvious that some candidates did not understand what was meant by the ‘nature’ of the pollutant.

The expected response is that sediments are soils eroded from agricultural lands, forest lands or from degraded river banks.

Generally, candidates who correctly identified the water pollutants in Part (b) satisfactorily explained the relationship between the loss of coral cover and the pollutant.

In Part (d), only a few candidates satisfactorily described the secondary treatment of water to remove faecal coliform before discharge into the environment. Twenty-two per cent of candidates achieved 50 per cent of the total marks.

Question 8

In Part (a) while many candidates adequately explained the function of incinerators, only a few candidates had specific knowledge of a 'refuse derived fuel incinerator'.

In Part (b), candidates were required to discuss the use of incinerators as a MAJOR method of solid waste disposal in the Caribbean. Many candidates examined the advantages and disadvantages of using incinerators as directed. However, only a few candidates offered a conclusion based on their discussion. Thirty-one per cent of candidates achieved 50 per cent of the total marks.

Question 9

In Part (a)(i), all candidates correctly recommended that the game birds caught at Top Hill Estate should not be eaten. However, only a few candidates satisfactorily justified their position by explaining how the processes of biological accumulation and biological magnification could result in the concentration of the pesticide found in the soil exceeding safe levels for the game birds.

In Part (b), many candidates correctly identified bioremediation or phytoremediation as technological processes that can be used to remove hazardous contamination from soil. However, many candidates demonstrated an incomplete knowledge of the process.

In Part (b), candidates were asked about the Basel Convention and the reason for its development. It was clear that some candidates had no knowledge of this convention although they chose to do this question. Ten per cent of candidates achieved 50 per cent of the total marks.

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 is required to improve candidates' ability to organise and apply knowledge.

Question 1

This question was designed to test candidates' understanding of

- (i) the role of coastal vegetation and ecosystems in the maintenance of beaches
- (ii) the potential impacts of anthropogenic activities of sewage disposal and removal of coastal vegetation and sea-grass beds on coral reefs, beaches and coastal waters.

Candidates performed poorly in this question. Many candidates did not address the role of coastal vegetation and ecosystems in the maintenance of beaches.

Question 2

This question was designed to test candidates' ability to

- (i) identify appropriate water quality parameters for monitoring in a particular situation
- (ii) explain the significance of water quality parameters
- (iii) design a monitoring plan to track potential impacts as a result of a specific activity.

Overall, candidates performed well on Parts (i) and (ii) of this question. Most candidates were able to identify appropriate water quality parameters for monitoring and to explain the significance of selected water quality parameters.

Most candidates found it difficult to design a monitoring plan to track potential impacts as a result of the developers' activity. Candidates did not outline adequately the steps expected in a water quality programme. Also candidates did not explain adequately the significance of the parameters they chose. Most candidates appeared to lack the depth of knowledge required to perform well on this question.

Question 3

In Part (a) of this question, candidates were required to make appropriate recommendations to correct the problems experienced as a result of the developers' activity. Candidates were required, in Part (c), to outline five ways in which an Environmental Impact Assessment (EIAs) could have helped in mitigating the impacts.

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

THE INTERNAL ASSESSMENT

It is important to emphasise the paragraph below.

“The Internal assessment is an integral part of student assessment and is intended to assist students in acquiring certain knowledge, skills and attitudes that are associated with the subject. The Internal assessment must relate to at least **ONE** Specific Objective stated in the syllabus. The following are the skills that **must** be assessed by the Internal Assessment for **each** Unit:

- (i) the collection and collation of data;
- (ii) the analysis, interpretation and presentation of such data;
- (iii) the selection of techniques, designs, methodologies and instruments appropriate to different environmental situations;
- (iv) the development of appropriate models as possible solutions to specific environmental problems.

In general, the required criteria were applied effectively. There were a few instances where the marking was too generous.

A few of the Internal Assessment pieces submitted did not conform to the requirements of the respective Unit. The assignments must conform to the criteria outlined in the Syllabus in order to allow candidates to access the full range of available marks.

Few students were penalised for exceeding the word limit. Care should be taken when calculating the final scores after deducting the penalty as there were a few instances of incorrect totals after the deduction of the penalty mark.

There was still a heavy reliance on secondary data and too little evidence of primary data collection. Candidates are again encouraged to design projects that will encourage the collection and collation of primary data. This enables better and more effective data presentation and analysis, one of the weaker areas of assessment.

The recommended formats for different assessment pieces should be used since this allows for easy completion of task by candidates and for standardised evaluation. Whenever the recommended format is not used then the teacher is required to provide the mark scheme used so as to ensure that the candidates' work is adequately assessed. Teachers should ensure that the correct moderation forms are used and observe the instructions for distributing scores to the three modules.

Reminder: The CXC criteria at the bottom of the Moderation Sheet **must** be applied when recording and distributing marks to the three Modules. A remainder of one mark must be allocated it to Module 3. A remainder of two marks, one mark allocated to Module 2 and one to Module 3. Attention is drawn to the fact that **Fractional marks should not be awarded**.

In both Units, a major area of concern is still Communication of Information. Some candidates were able to communicate the information in a fairly logical manner with few grammatical errors. However, there were still too many candidates who presented information with several grammatical errors. This reduced the overall quality of the final report.

DETAILED COMMENTS

UNIT 1

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 was either irrelevant or inadequate.

As in previous years some areas in which the projects in Unit 1 may be improved are indicated in the reminders below:

- 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 while 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 the data that are collected, presented and analysed. **No new material should be introduced in the discussions.**

- Greater attention should be paid to literature review. This is still one of the weak areas in Internal Assessment pieces 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, should be there at least four up-to-date references.

UNIT 2

For Unit 2 please note that there has been a change in the requirements and this is available in an **AMMENDMENT TO THE SYLLABUS IN ENVIRONMENTAL SCIENCE Effective for Examinations from May/June 2006**).

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. 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.

Again, candidates 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 most cases.

LABORATORY EXERCISES

Significant improvement was noted in the overall quality and relevance of laboratory exercises as required in the syllabus. In general, most candidates submitted an adequate number of laboratory exercises with satisfactory coverage of the criteria to be assessed. Only in very 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 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

Some improvement was noted in the overall quality of journal entries. This year, more candidates were able to link journal entries and laboratory exercises. The area of greatest improvement was reflected in the candidates providing the required number of journal entries.

The main area of weakness identified was that of interpretative comments. This may be improved if students develop 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 specific objectives in the syllabus.

It cannot be overemphasised that the syllabus requires 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’. In a few submissions, candidates visited different sites and so could not make any comparisons since they examined different processes and occurrences. This was ineffective as there was no basis for comparisons.

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 of 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.

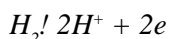
Module 2: Sustainable Energy Use

Question 5

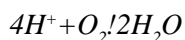
Candidates were tested on the operation and characteristics of a fuel cell as a source of electrical energy. In Part 5 (a), the majority of candidates correctly identified the chemicals, A and B, as hydrogen and oxygen. In Part (b), many candidates did not completely describe the operations of the fuel 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.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2008**

**ENVIRONMENTAL SCIENCE
(TRINIDAD AND TOBAGO)**

ENVIRONMENTAL SCIENCE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2008

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 2 – Sustainable Agriculture, Sustainable Energy Use, and Pollution of the Environment. Both Units are examined by three papers. Papers 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 per cent 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.

This report addresses Unit 2 Paper 01, Paper 02 and Paper 03 written by candidates from Trinidad and Tobago.

GENERAL COMMENTS

UNIT 1

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 infer relationships, distinguish between terms and explain interactions and interrelationships. In some instances candidates were unable to define terms correctly. Greater attention to basic principles is required.

DETAILED COMMENTS

PAPER 01

Module 1: Fundamental Ecological Principles

Question 1

In Part (a) of this question, candidates were required to define 'biotic community', 'population' and 'species'. In Part (b), candidates were required to outline one type of interaction that occurs among members of the fish population in a lake.

Candidates' performance in this question was satisfactory. A few candidates had difficulty defining the terms. Most candidates were able to identify and outline one type of interaction that occurs among members of the fish population. More than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Note:

A biotic community refers to populations of plants, animals and micro-organisms living and interacting in a given area, at a given time.

A population refers to a group of organisms of the same species living and interacting in a given area.

A species refers to a set of organisms with similar genetic characteristics which can interbreed and produce living, viable, fertile offspring.

Question 2

This question tested candidates' understanding of the processes occurring in the carbon cycle, the biological importance of the carbon cycle and reservoirs of carbon in the carbon cycle.

Candidates' performance in this question was good.

In Part (a), most candidates were able to identify the processes occurring in the carbon cycle correctly but in Part (b), most candidates had difficulty stating the biological importance of the cycle. In Part (c), most candidates were able to name two reservoirs of carbon in the cycle.

More than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 3

Figure 2 represented a simplified food chain in a flooded rice field. In Part (a), candidates were required to state the initial source of energy for this food chain, name the process by which energy is incorporated into this food chain and state two reasons why only a small percentage of the energy absorbed by Species A is incorporated into the tissues of Species C. Candidates were also required to state one implication of the inefficient transfer of energy. In Part (b), candidates were required to state two ways in which the energy flow in the rice field is similar to those of a natural forest ecosystem.

Candidates' performance was less than expected. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Candidates struggled to state two reasons why only a small percentage of the energy absorbed by Species A is incorporated into the tissues of Species B. Candidates also had difficulty in outlining one implication of the inefficient transfer of energy.

Note that a small percentage of the energy absorbed is incorporated because:

- *Energy is lost through metabolic processes.*
- *Not all organisms at a trophic level are eaten.*
- *Not all of the material that is eaten is digested.*

As a result, the number and biomass of organisms will decrease at each trophic level because there is less energy available to support greater numbers and biomass.

Question 4

Figure 3 in this question showed the growth curve of a population of yeast cells in a laboratory culture.

Part (a) of this question required candidates to identify the type of population growth curve that was represented in Figure 3. In Part (b), candidates were required to state two conditions under which a population exhibits the type of growth illustrated in Figure 3. In Part (c), candidates were required to explain how population will change if the carrying capacity is exceeded.

Candidates' performance was poor. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Candidates did very well on Part (a) and Part (b). Most candidates had difficulty with Part (c) when they attempted to explain how the population will change if the carrying capacity is exceeded.

Note:

If the carrying capacity is exceeded

- *Limiting factors will begin to operate and influence the health and status of the population.*
- *The rate of population increase will be affected as population numbers will increase more slowly or even decrease.*
- *The population will experience a 'crash' or 'dieback'.*

Module 2: People and the Environment

Question 5

This question was designed to test candidates' ability to

- (i) state the meaning of 'replacement level fertility rate' in Part (a)
- (ii) calculate the percentage of the population in the pre-reproductive years in Part (b)
- (iii) predict how the population is likely to grow over the next ten years in Part (c).

Candidates' performance in this question was below expectation. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

For Part (a), the responses suggested that candidates did not understand the meaning of 'replacement level fertility rate'. For Parts (b) and (c), many candidates had difficulty calculating the percentage of population in the pre-reproductive years and predicting how the population is likely to grow over the next ten years.

Note:

The replacement level fertility rate refers to the number of children a couple must have to replace themselves.

Question 6

Candidates were presented with a graph that showed the percentage of urban population in relation to the total population in four Caribbean countries. Part (a) tested candidates' understanding of population distribution between urban and rural areas. In Part (b), candidates were asked to give three reasons why population growth results in the type of population distribution illustrated in the graph. In Part (c), candidates were expected to outline two environmental impacts associated with the type of population distribution that was illustrated.

Candidates' performance in this question was excellent. More than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 7

Candidates were provided with Table 1 that showed 'per capita CO₂ emissions'. In Part (a), candidates were required to define 'per capita CO₂ emission'. In Part (b), candidates were expected to suggest a reason for the difference in per capita CO₂ emission' of Country A and Country B. In Part (c), candidates were expected to use data from Table 1 to deduce for which country the population has a greater negative impact on the environment and provide justification for their answers..

In Part (a), candidates had difficulty defining 'per capita CO₂ emissions'. Parts (b) and (c) of this question were also poorly done by candidates. Overall, candidates' performance in this question was below expectation. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Note:

'Per capita carbon dioxide emissions' refers to the quantity of released carbon dioxide that is attributable to each individual in a population.

Question 8

Figure 6 showed infant mortality rates in 2002 for two groups of countries. In Part (a), candidates were required to define 'infant mortality rate'. In Part (b), candidates were asked to identify the group of countries in Figure 6 with the average lower population growth rate in 2002. In Part (c), candidates were required to give two reasons why the group of countries identified in Part (b) had the lower population growth rate.

Only a few candidates defined 'infant mortality rate' correctly. Overall, candidates' performance in this question was below expectation. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks. .

Note:

Infant mortality rate is the number of infant deaths per 1000 live births in the population.

Module 3: Sustainable Use of Natural Resources

Question 9

In Part (a), candidates were required to name two major natural resources (except) forest found in Caribbean territories and give two reasons why the resources identified are considered natural

resources. In Part (b) candidates were required to state two ways in which the resources identified in Part (a) are important to Caribbean countries. Part (c) required candidates to state two environmental impacts that result from the extraction and use of forest resources.

Candidates' performance in this question was excellent. Candidates who correctly identified major natural resources in Caribbean territories were able to give correct reasons why they are considered natural resources and also were able to state reasons for their importance to Caribbean countries. Candidates were also able to state satisfactorily two environmental impacts resulting from the extraction and use of forest resources.

Question 10

Candidates were provided with Figure 7 that showed the effect on the daily fish catch of increased harvesting of flying fish stocks.

In Part (a), candidates were required to explain what is meant by the term 'Maximum Sustainable Yield (MSY) in relation to the harvesting of the stock of flying fish. Part (b) required candidates to suggest two reasons why it is best to harvest fish stocks at the Point A shown in Figure 7. In Part (c), candidates were required to outline two environmental impacts of over-harvesting flying fish stocks.

Candidates' performance in this question was good. More than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 11

Part (a) of this question examined students' knowledge and understanding of what is meant by 'restoration of natural resources' and 'rehabilitation of natural resources'. In Part (b), candidates were required to outline one way in which demographic factors can influence the use of natural resources.

Candidates' performance on this item was below expectation. Candidates had difficulty distinguishing between 'restoration of natural resources' and 'rehabilitation of natural resources'. Few candidates were able to outline ONE way in which demographic factors can influence the use of natural resources.

Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Note:

Restoration – is bringing back the natural resource to a former condition. It involves the active manipulation of nature to recreate species diversity and ecosystem processes as close as possible to the state that existed before human disturbance.

Rehabilitation – is the rebuilding of structure and function in an ecological system without achieving complete restoration to its original state. It is the reversal of the deterioration of a resource, even if it cannot be fully restored, and the bringing back of an area to a useful state for human purposes rather than a truly natural state.

Question 12

Candidates were required to outline how the economic instruments, user fees, greening of national budgets, incentives, and penalties and environmental taxes can be used as conservation tools.

Candidates' performance on this question was good.

PAPER 02

Module 1: Fundamental Ecological Principles

Question 1

This question tested candidates' understanding of non-native species and the impacts caused to ecosystems by the introduction of non-native species. Part (d) required candidates to explain the role of natural selection in the adaptation of species to their natural environment.

Most candidates correctly identified non-native species and were able to explain why non-native species may be successful in new environments. Candidates were able to outline impacts on the ecosystem that may result from the introduction of non-native species. However, they had difficulty in explaining the role of natural selection in the adaptation of species to their natural environment.

Overall, more than 50 per cent of candidates achieved a satisfactory score on this question.

Question 2

This question tested candidates' understanding of the relationship between ecosystem stability and species diversity. In Part (a) of this question, candidates were able to correctly define the term 'ecosystem' but most candidates had difficulty defining the terms 'ecosystem stability' and 'ecosystem diversity'.

Note:

Ecosystem stability refers to the

- *ability of biological communities to remain relatively stable and constant over time*
- *constancy or lack of fluctuations in composition or function of an ecosystem*
- *ability of an ecosystem to resist perturbations*
- *ability of an ecosystem to repair damage after disturbance.*

Ecosystem diversity refers to the number and relative abundance of a species in a community.

In Part (b), most candidates correctly stated which ecosystem had the greatest species diversity and gave correct reasons to support their answers.

Candidates had difficulty with Part (c) and most failed to explain correctly how species diversity can influence ecosystem stability.

Note:

Since ecosystem stability increases as species diversity increases, the highest Ecosystem Stability Index (ESI) would be associated with the greatest species diversity.

Overall candidates' performance on this question was poor.

Question 3

This question tested candidates' understanding of the process of cycling of matter through an ecosystem. In Part (a), candidates were required to name two decomposers and state one source of energy for each and explain the importance of the decomposer food chain in the cycling of matter. In Part (b), candidates were asked to state two benefits of natural ecosystems to humans and describe two ways in which humans can disrupt the integrity of natural ecosystems.

Candidates exhibited satisfactory performance in all parts of this question.

Module 2: People and the Environment

Question 4

This question focused on sustainable development and the impact of fertility rates.

Most candidates demonstrated satisfactory understanding of the concept of sustainable development but had difficulty explaining how high fertility rates impact on a country's ability to achieve sustainable development.

Candidates demonstrated good knowledge of measures of population control and were able to respond satisfactorily.

Question 5

Candidates were presented with a Table with data on world population numbers in 1990 and the estimated numbers in 2020.

Part (a) of this question required candidates to calculate the percentage growth in world population attributable to Less Developed Countries between 1990 and 2020. Most candidates did not calculate this correctly.

Part (b) required candidates to explain why this estimated growth in the population of Less Developed Countries should be a cause for concern. This part of the question was done poorly as most candidates either did not understand or failed to grasp why the estimated growth in LDCs should be a cause for concern.

In Part (c), candidates were required to describe one environmental impact associated with the trend in world population growth calculated in 5 (a). Part (d) was designed to allow candidates to suggest an approach to mitigate the environmental impact described in Part (c).

Part (c) and Part (d) were done in a satisfactory manner. Candidates were able to describe an environmental impact associated with the trend of population growth and suggest an approach to mitigate the environmental impact.

Question 6

Part (a) of this question was designed to test candidates' understanding of how culture and religion impact on the rate of growth of a population. Most candidates were knowledgeable about this topic.

Candidates were required, in Part (b), to use the information on Human Development Index (HDI) presented in Table 3 to make three deductions regarding the relative achievement of both countries.

In Part (c), candidates were required to evaluate the statement "the education of women is critical to lowering the population growth rate of Less Developed Countries". They were required to include at least six points in their response.

Part (b) and Part (c) posed a greater challenge to candidates. Candidates did not demonstrate adequate knowledge and understanding of the Human Development Index and so had difficulty deducing relevant information from the Table. Candidates also experienced difficulties in evaluating the statement that was given and in many instances candidates failed to present enough (six) reasons to support the position taken.

Overall, candidates' performance on this question was below expectation and less than 50% of candidates achieved a satisfactory score on this question.

Module 3: Sustainable Use of Natural Resources

Question 7

Candidates' knowledge and understanding of the functions and importance of coral reefs in the Caribbean was tested in this question. In Part (a), candidates were required to describe two functions of coral reef ecosystems in the Caribbean.

In Part (b), candidates were required to explain how any two human activities impact on coral reef ecosystems in the Caribbean.

Part (c) of this question required candidates to describe two methods for conserving coral reef ecosystems in the Caribbean.

Candidates' demonstrated very good knowledge and understanding of the issues related to coral reefs and human impacts in the Caribbean. This question was done very well by candidates. Overall, more than 50% of candidates achieved a satisfactory score.

Question 8

Candidates were tested on their understanding of the concepts of 'consumptive use', 'non-consumptive use' and 'bioprospecting' regarding natural resources.

In Part (a), candidates were required to use the data showing how quantities of two natural resources, A and B, changed over a ten-year period, to identify the resource which is non-renewable and provide justification for their responses.

In Part (b) candidates were required to use suitable examples to distinguish between 'consumptive' and 'non-consumptive' use of natural resources. In Part (c) candidates were required to explain why bioprospecting is considered a non-consumptive use of natural resources.

Candidates demonstrated limited understanding of the concepts tested. Most candidates were unable to interpret the graphical data in order to identify the non-renewable resource and provide a justification for their response. Candidates also found it challenging to explain why bioprospecting is considered a non-consumptive use of natural resources.

Note:

Consumptive use of natural resources refers to use of natural resources in which these resources are utilised and removed from their natural environment. Once used, they are no longer available for use by another person, for example, catching fish for food, limestone for construction and timber harvested for construction.

Non-consumptive use refers to the type of use of natural resources which does not require that the resources be removed from their natural environment or location. These resources are not consumed and so are available for use by another person. For example, use of forest resources for ecotourism, use of coral reefs for snorkelling and diving recreation activities and use of aquatic environments for swimming.

'Bioprospecting' is the use of natural biological resources to extract beneficial chemicals for use in medical and other industries. In bioprospecting only small quantities of the resource is extracted

from the natural environment. Since only small quantities are extracted this does not adversely affect the ability of the resource to replenish itself. Enough quantities of the resource are left for other uses. Hence since bioprospecting does not prevent the natural replenishment of the resource it is considered a non-consumptive use.

Overall candidates' performance was below expectation.

Question 9

Candidates' knowledge and understanding of protected areas and the International Union for the Conservation of Nature (IUCN) classification of protected areas was tested.

In Part (a), candidates were required to identify TWO categories of protected areas as classified by the IUCN.

In Part (b) candidates were required to state the purpose and main feature of each category identified and Part (c) to explain how protected areas promote natural resource conservation.

In Part (d), candidates were required to assess the effectiveness of protected areas in conserving natural resources in the Caribbean. They were required to include three issues associated with the implementation and operation of protected areas.

Candidates' performance on this question was satisfactory. While most candidates were aware of Protected Areas in a general sense, they were unable to identify the specific feature and purpose for the different categories. Candidates did not demonstrate adequate knowledge and understanding to explain how Protected Areas promote natural resource conservation and therefore had difficulty in assessing the effectiveness in conserving natural resources in the Caribbean.

THE INTERNAL ASSESSMENT

Some important features of the Internal Assessment are summarised in the paragraph below:

“The Internal Assessment is an integral part of student assessment and is intended to assist students in acquiring certain knowledge, skills and attitudes that are associated with the subject. The Internal Assessment must relate to at least **ONE** Specific Objective stated in the syllabus. The following are assessed for the Internal Assessment for **each** Unit:

- (i) Collection and collation of data;
- (ii) Analysis, interpretation and presentation of such data;
- (iii) Selection of techniques, designs, methodologies and instruments appropriate to different environmental situations;
- (iv) Development of appropriate models as possible solutions to specific environmental problems.”

In general, the required criteria were applied effectively.

There was a noticeable reduction in use of secondary data and an increase in the evidence of primary data collection. Candidates are encouraged to continue to design projects that will encourage the collection and collation of primary data.

A reminder for teachers: The criteria at the bottom of the Moderation Sheet **must** be applied when recording and distributing marks to the three Modules. When there is a remainder of one, the mark must be allocated to Module 3. A remainder of two marks, one mark must be allocated to Module 2

and one to Module 3. Care should be taken when compiling total scores. Moderators detected many errors in the total scores submitted for students.

The major areas of concern are the Literature Review and Communication of Information. While some candidates were able to communicate the information in a fairly logical manner with few grammatical errors, there were still too many candidates who presented information with several grammatical errors. This reduced the overall quality of the final report.

DETAILED COMMENTS

Improvement was noted in the quality of the assignments submitted. In general, the required criteria for this component were effectively applied. Literature review is still an area of concern in many of the pieces submitted. In these cases, the literature review is either irrelevant or inadequate. There is an immediate need for candidates to improve their writing. This severely affects the quality of the report and at times is not indicative of the CAPE level.

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 title should be more concise and focused.
- Projects chosen should be relevant to Unit 1. This was not so in a few cases.
- The purpose of the project should be clearly outlined and the variables should be clearly defined.
- Data collection in some instances was inadequate and should be addressed.
- Diagrams and illustrations need to be more appropriate and well integrated in the text to increase their effectiveness.
- Comprehensive data analysis is required and this should make use of appropriate statistical tools to improve the result.
- Discussion of findings, conclusion and recommendations should be based **only** on what was presented in the literature review and the data that is collected, presented and analysed. **No new material should be introduced in the discussions.**
- Greater attention should be paid to literature review. This is still one of the weak areas in Internal Assessment pieces 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.

PAPER 03B

There was a general improvement in candidates' responses to questions in this Paper. There was greater depth and breadth of coverage with respect to certain areas of the syllabus. However greater effort must be made by candidates to improve their ability to organise and apply knowledge.

Question 1

In Part (a), candidates were expected to use the information provided to plot an appropriate graph to show the variation in the lizard population from 1996 to 2005.

In Part (b), candidates were asked to describe how the lizard population varied over the ten-year period.

Candidates performed very well in this question. Candidates demonstrated an understanding of drawing graphs and reading information from graphs. Most candidates appeared to possess the depth of knowledge required and performed well on this question.

Question 2

This question was designed to test candidates' understanding of the mark-release-recapture method of population sampling that was used to collect the data that was presented.

Parts (a), (b) and (c) related to the actual procedure for the mark-release recapture method and the assumptions made in estimating population size.

Part (d) focused on a monitoring plan for tracking a lizard population

Overall candidates performed very well on this question. Most candidates demonstrated knowledge of sampling techniques for mobile populations.

Question 3

In Part (a), candidates were required to discuss three conservation strategies that could be implemented to ensure the viability of the lizard population. Candidates were expected to indicate why the strategies chosen were appropriate.

In Part (b), candidates were asked to outline two environmental impacts caused by the operation of the forest concession that would need to be addressed in a rehabilitation programme.

Candidates' performance on this question was satisfactory. Most candidates demonstrated knowledge of conservation strategies and the environmental impacts that can be the result of forest operations.

UNIT 2

DETAILED COMMENTS

PAPER 01

Module 1: Sustainable Agriculture

Question 1

Candidates were required to define the term 'agriculture' and to list three characteristics of commercial farming.

This question was done very well by the majority of candidates.

Question 2

Part (a) of this question assessed candidates' knowledge of the features of agroforestry and Part (b) assessed candidates' knowledge of the reasons why agroforestry is considered a feasible and sustainable agricultural practice.

Candidates' performance on this question was satisfactory. More than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Note:

Agroforestry is a farming system that integrates crops and/or livestock with trees and shrubs. It provides numerous benefits such as increased biological production, better water quality and improved habitat for both humans and wildlife. It provides increased economic stability to farmers by diversifying their income sources. It integrates crops, trees and livestock which results in biological interactions that provide multiple benefits and prevents soil erosion.

Question 3

This question examined candidates' understanding of environmentally sustainable agricultural practices. In Part (a), candidates were asked to study the figure presented and identify the sustainable agricultural practice that was shown. Candidates were asked to outline two steps involved in the sustainable practice and state two reasons why this agriculture practice is considered to be environmentally sustainable.

In Part (b), candidates were asked to complete a table showing some post-harvest management practices in agricultural systems and the associated benefits of these practices.

Candidates' responses to Part (a) of this question were satisfactory. However, too few candidates demonstrated satisfactory knowledge of post-harvest management practices and benefits.

Question 4

This question examined candidates' understanding of the ways in which agriculture contributes to the economy of Caribbean countries.

Candidates demonstrated a good understanding of this topic.

More than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Module 2: Sustainable Energy Use

Question 5

This question examined candidates' knowledge and understanding of the environmental costs associated with the use of fossil fuels to generate electricity. Candidates were required to identify and outline two ecological costs and one social cost.

Candidates' performance in this question was below expectation. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Note:

In examining the environmental costs, it is necessary to consider the environmental impacts associated with the exploration of fossil fuels and also the use of fossils in the electricity generation process.

Question 6

Part (a) tested candidates' knowledge of energy conversion occurring at different stages of the generation of electricity.

Part (b) required candidates to explain why energy conversion processes have low efficiencies.

Candidates' performance in this question was good.

For Part (a), most candidates were able to distinguish between the type of energy conversion occurring. For Part (b), most candidates were able to explain why energy conversion processes have low efficiencies.

Note:

In all energy conversion processes, some amount of the energy is converted into heat which is generally lost to the environment if steps are not taken to capture it. This is usually a substantial proportion of the energy hence the efficiency of conversion is substantially less than 100 per cent.

Question 7

In Part (a), candidates were asked to distinguish between a 'nuclear fission reaction' and a 'nuclear fusion reaction'. In Part (b), candidates were tested on their knowledge of the structure and functions of the parts of a nuclear reactor. In Part (c), candidates were asked to outline one advantage and one disadvantage of nuclear power plants over conventional power plants.

Candidates' performance in this question was satisfactory.

Question 8

Part (a) of this question tested candidates' understanding of 'active use of solar energy' and 'passive use of solar energy'. Candidates' performance on this part was below expectation. Part (b) of this question required candidates to outline two disadvantages of using solar energy. Candidates' performance on this part of the question was satisfactory.

Note:

Active solar energy systems use solar collectors and additional electricity to power pumps or fans to distribute the sun's energy. In passive solar energy systems, no additional mechanical equipment is used to utilize the sun's energy.

Passive solar heating is a system of putting the sun's energy to use without requiring mechanical devices to distribute the collected heat.

Active solar heating is a system of putting the sun's energy to use in which a series of collectors absorb the solar energy, and pumps or fans distribute the collected heat.

Module 3: Pollution of the Environment

Question 9

Candidates were required to define pollution in Part (a) of this question. In Part (b), candidates were presented with data showing some characteristics of three pesticides. Candidates were required to study the data and identify, with reasons, which of the pesticides would most likely continue to pollute groundwater supplies up to a year after the application.

This question was done satisfactorily by candidates. In Part (a), most candidates defined 'pollutant' rather than 'pollution'.

Note:

Pollution is any chemical or physical change in the environment that is harmful to the environment, humans or other organisms.

Candidates demonstrated satisfactory understanding of how the characteristics of pesticides influence their environmental impact. More than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 10

This question tested candidates' knowledge of primary air pollutants and greenhouse gases in Part (a). Part (b) tested candidates' understanding of global warming. Part (c) required candidates to suggest a reason why a device for monitoring background levels of air pollutants is located in a rural, undeveloped area. Many candidates had difficulty distinguishing between global warming and ozone depletion.

Candidates performed poorly on Part (c) of this question.

Note:

There are no major sources of air pollutants in rural areas because of little traffic and/or the absence of factories and industries. Hence the level of pollution will be minimal in these rural areas.

Question 11

Candidates were required to identify two sources of land pollution in Part (a). In Part (b), candidates were required to describe the environmental impact of pollution from one of the sources identified in Part (a). In Part (c), candidates were asked to consider the statement "the Kyoto Protocol will fail to make a significant impact on future global warming". Too few candidates demonstrated any significant knowledge of the Kyoto Protocol and so many candidates were unable to effectively suggest a reason for the belief expressed in the statement.

Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 12

Part (a) of this question required candidates to draw a fully labelled diagram of a landfill for storing hazardous waste.

Candidates performed poorly on Part (b). Too few candidates were able to draw the required diagram and fewer still were able to describe two pathways whereby hazardous material from a landfill can be transported and the impact on receptors in the environment.

Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Note:

The diagram drawn should have included the following components:

- *Heavy clay geology*
- *Waterproof liner*
- *Leachate control system*
- *Gas emission control system*

Note:

There are abiotic and biotic pathways.

Leaks and leachate from the landfill's contents could percolate downwards through the soil. Contaminant can then get into aquifers and hence into drinking water wells, rivers and the sea.

Gaseous emissions from volatile components or biological decay components can escape to landfill and be carried in the air. Organisms would then be exposed to gaseous contaminants or they may dissolve in rain and fall back to the earth.

UNIT 2

PAPER 02

Generally the performance of candidates was less than satisfactory and only a few candidates demonstrated the breadth of knowledge necessary to perform well. There were many candidates whose responses were inadequate. In too many cases, candidates were unable to define terms, distinguish between terms, explain and infer relationships. Greater attention to basic principles is also required. Too few candidates have demonstrated the higher order cognitive skills.

Module I: Sustainable Agriculture

Question 1

This question tested candidates' ability to interpret graphical data and analyse the impact of using inorganic and organic fertilisers.

Part (a) was well done with the majority of candidates stating the required four deductions that could be made about the agricultural yield from the farm. Part (b) was also well done with the majority of candidates being able to distinguish between 'organic' and 'inorganic' fertilisers.

Similarly, many candidates adequately discussed why in-spite of the trend shown by the graph, farmers are still being encouraged to increase their use of organic fertilisers in preference to inorganic fertilisers. Candidates who did not include six points in their response were not awarded full marks for Part (c) of this question. Candidates' performance in this question was satisfactory. More than 50 per cent of candidates scored 50 per cent or more of the available marks.

Question 2

This question tested candidates' ability to interpret graphical data and analyse the contributions made by subsistence and commercial agriculture to the gross domestic product (GDP), employment and foreign exchange earnings in Country A.

Part (a) was well done with the majority of candidates adequately commenting on the contributions of subsistence and commercial agriculture to the gross domestic product (GDP), employment and foreign exchange earnings in Country A. Part (b) was done satisfactorily with most candidates being able to describe how mechanization accounts for the differences in the contributions as shown in the figure presented.

Candidates were able to describe satisfactorily one feature of sustainable agriculture in Part (c). Overall candidates' performance in this question was good.

The more able candidates scored more than 50 per cent of the available marks.

Question 3

In Part (a), candidates were required to explain, using six points, why the officer told residents that their farming practices were responsible for the increased cases of soil erosion and water quality degradation.

In Part (b), candidates were required to justify, using six points, why farmers were advised to practise crop rotation in an effort to improve yields and reduce the problems caused by pest infestation.

In Part (c), candidates were able to name one soil conservation method that is appropriate for the farmers of Toco Village to describe the method while stating the role it plays in soil conservation and in Part (d), to outline two features of no-tillage farming and the reason why no-tillage farming is effective in reducing soil erosion.

Candidates' performance on this question was satisfactory. More than 50 per cent of candidates who attempted this question earned a score greater than 50 per cent of the available marks.

Module 2: Sustainable Energy UseQuestion 4

This question tested candidates' ability to interpret graphical data.

In Part (a), candidates were asked to list the types of fossil fuels and outline the formation of fossil fuels.

Part (b) required candidates to compare the annual consumption of fossil fuel in 1990 with consumption in 2000 and consumption in 2000 with that in 2003.

In Part (c), candidates were required to use an appropriate example and outline the meaning of 'demand management' in relation to energy use and explain how demand management can mitigate the impacts of fossil fuel consumption.

Candidates' performance on this question was below expectation. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 5

This question tested candidates' knowledge of the generation of electricity from hydroelectric sources.

In Part (a), candidates were required to describe the energy conversion process occurring in the hydroelectric power plant, and to make clear the meaning of the terms 'potential energy' and 'kinetic energy'.

Part (b) required candidates to state two advantages and two disadvantages of hydroelectric power generation. Candidates answered this part of the question satisfactorily.

Few candidates were able to assess the suitability of hydroelectricity and solar energy to meet adequately the energy needs of developing countries in Part (c). Candidates' responses were poor.

Question 6

This question assessed candidates' understanding and knowledge of 'energy efficiency' and 'energy conservation'.

Candidates' performance in this question was below expectations.

Few candidates correctly interpreted what is meant by 'power rating of 60W' and 'efficiency of 5 per cent'.

In Part (b), candidates were required to outline two advantages of energy conservation.

Part (c) of this question tested candidates' understanding and knowledge of the concept of 'cogeneration'. Too few candidates were able to say what is meant by cogeneration, outline how it is achieved and to comment on the appropriateness of cogeneration systems for use in Caribbean countries.

Candidates were expected to explain how improving energy efficiency mitigates (reduces) environmental impacts resulting from energy use.

The majority of candidates were unable to correctly state the meaning of the terms.

Candidates' performance on this question was less than expected.

Module 3: Pollution of the Environment

Question 7

This question tested candidates' ability to interpret data presented in tabular form. Candidates were also tested on their knowledge of the environmental pathways of pollutants.

Candidates' performance on this question was poor. In Part (a) most candidates correctly stated four inferences from the data given.

In Part (b), there were many candidates who could not correctly outline two environmental pathways of the pesticide.

In Part (c), few candidates were able to account for the difference in dieldrin concentration in the organisms indicated in the Table. Candidates were required to include three points in their responses. Most candidates provided less than three points.

In Part (d), candidates were required to describe two characteristics of pesticides that account for their environmental impact.

Candidates' performance on this question was poor.

Question 8

This question tested candidates' ability to interpret graphical data.

In Part (a), candidates were required to study the diagram and state two major changes in the composition of solid waste between 1998 and 2007 and state the environmental significance of one of the changes.

Part (b) required candidates to suggest two reasons for the change in the composition of solid waste between 1998 and 2007 and Part (c) to explain why it is necessary to minimise the amount of solid waste produced in Caribbean countries.

Part (d) tested candidates' understanding of recycling and the effectiveness of recycling programmes for the Caribbean.

Candidates performed very well on this question.

Question 9

This question tested candidates' ability to interpret graphical data showing the variation in biological oxygen demand (BOD and dissolved oxygen (DO) concentration with distance from a reference point established to monitor the water quality of a river.

Most candidates correctly stated what information is provided by the BOD of a water sample and identified the type of water pollution source impacting on the river.

Few candidates were able to outline the laboratory process for determining BOD and to account for the change in the DO concentration along the river.

Too few candidates identified and justified their choice of distance from the reference point where it is likely that dead fish will be found floating in the river.

Overall, this question was done poorly by those candidates who attempted it.

THE INTERNAL ASSESSMENT

It is necessary to draw attention again to the fact that for Unit 2 there was a change in the requirements. This change is outlined in an **AMMENDMENT TO THE SYLLABUS IN ENVIRONMENTAL SCIENCE Effective for Examinations from May/June 2006, on the CXC website (www.cxc.org)**. It is recommendable that, where necessary, teachers and students access this document and familiarise themselves with the new requirements.

The overall quality of the submissions for this Unit was good. In most instances, an introduction to the journal was included. This was very useful in indicating the scope and purpose of the entries to the reader. 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. This was reflected in some activities being too simple and a few reflecting the standard and level of advanced proficiency.

There was significant improvement in candidates' analysis and interpretation of 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 the laboratory exercises. These were missing in many instances. In some instances the total scores provided on the moderation sheet were inaccurate and not distributed according to the syllabus guidelines.

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 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

Overall, there was improvement in the quality of journals submitted. The area of greatest improvement was reflected in candidates providing the required number of journal and laboratory entries. There were some candidates who were unable able to link journal entries and laboratory exercises to specific objectives and conduct appropriate, complementary and supporting activities. Teachers and candidates are reminded that the laboratory activities should be associated with the site visits and not treated as independent activities that are not related.

As a result of objectives of site visits not being linked to the specific objectives in the syllabus, some journals and laboratory activities reflected objectives and activities that related more to Unit 1 than to Unit 2. Candidates should always state and be guided by the specific objectives of the syllabus and the objectives for their journal activity. Candidates should always choose appropriate and adequate follow-up activities, present laboratory activities and journal entries in sequence, pay attention when writing accurately chemical formulae for elements, compounds and ions.

There was improvement in the area of interpretative comments. However, there is room for further improvement. It cannot be overemphasised that the syllabus requires 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'. In a few of the submissions, candidates visited different sites and so could not make valid comparisons since they examined different processes and occurrences.

UNIT 2

PAPER 03B

Generally candidates' performance on this paper was below expectation. Again the number of entries was exceptionally small. There was not much overall improvement in the depth and breadth of coverage with respect to certain areas of the syllabus. Greater effort must be by candidates to improve their ability to organise and apply knowledge.

Question 1

Candidates were expected to use the information provided to plot an appropriate graph to show the annual cabbage yield and the quantity of fertiliser applied annually; to outline the relationship between annual cabbage yield and annual fertiliser input in Part (b); to calculate the mean annual nitrate concentration of the Mango River for the years 1995 to 2004 in Part (c); and to make inference regarding the impact of the activities of Green Thumb Farms on the Mango River.

Candidates performed satisfactorily on this question. Candidates demonstrated the ability to use information to plot graphs and then discuss trends shown by the graph.

Question 2

Candidates were required to explain why it is important for the investigation that nitrate concentration data for the river before 1994 be examined; to explain how the changing nitrate concentration impacts on the river ecosystem and the community of Carlings Town and to say how the clarity of the water of the Mangro River is expected to change between 1990 and 2004. Candidates were required to identify the parameter that is used to measure the clarity of the water, explain how the parameter affects the clarity of water and state a unit used to measure the clarity of water.

Overall, candidates performed poorly on this question.

Question 3

In this question, the management of Green Thumb Farms insisted that, based on its location, the activities at the farm are unlikely to cause pollution of the Mango River.

Candidates were asked to state whether or not they agreed with the position of the farm's management and to suggest a reason for the change in the fertility of the farm lands from 1994 to 2004.

Candidates were required to recommend to the management of Green Thumb Farms one method of improving the fertility of the farm while decreasing the impact of farming activities on the river.

Their performance was below expectation on all parts of this question.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2008**

**ENVIRONMENTAL SCIENCE
(REGION EXCLUDING TRINIDAD AND TOBAGO)**

ENVIRONMENTAL SCIENCE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION

MAY/JUNE 2008

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. 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. This paper contributes 40 percent to the Unit.

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

GENERAL COMMENTS

UNIT 1

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 infer relationships, distinguish between terms and explain interactions and interrelationships. In some instances candidates were unable to define terms correctly. Greater attention to basic principles is required.

DETAILED COMMENTS

PAPER 01

Module 1: Fundamental Ecological Principles

Question 1

In Part (a) of this question, candidates were required to define 'biotic community', 'population' and 'species'. In Part (b), candidates were required to outline ONE type of interaction that occurs among members of the fish population in a lake.

Candidates' performance in this question was satisfactory. A few candidates had difficulty defining the terms. Most candidates were able to identify and outline one type of interaction that occurs

among members of the fish population. More than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Note:

A biotic community refers to populations of plants, animals and micro-organisms living and interacting in a given area, at a given time.

A population refers to a group of organisms of the same species living and interacting in a given area.

A species refers to a set of organisms with similar genetic characteristics which can interbreed and produce living, viable, fertile offspring.

Question 2

This question dealt with the carbon cycle and tested candidates' understanding of the processes occurring in the carbon cycle, the biological importance of the carbon cycle and reservoirs of carbon in the carbon cycle.

Candidates' performance in this question was good.

In Part (a), most candidates were able to identify the processes occurring in the carbon cycle correctly but in Part (b), most candidates had difficulty stating the biological importance of the carbon cycle. In Part (c), most candidates were able to name two reservoirs of carbon in the carbon cycle.

More than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 3

Figure 2 represented a simplified food chain in a flooded rice field. In Part (a), candidates were required to state the initial source of energy for this food chain, name the process by which energy is incorporated into this food chain and state two reasons why only a small percentage of the energy absorbed by Species A is incorporated into the tissues of Species C. Candidates were also required to state one implication of the inefficient transfer of energy. In Part (b), candidates were required to state two ways in which the energy flow in the rice field is similar to those of a natural forest ecosystem.

Candidates' performance was weaker than expected. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Candidates struggled to state two reasons why only a small percentage of the energy absorbed by Species A is incorporated into the tissues of Species B. Candidates also had difficulty in outlining ONE implication of the inefficient transfer of energy.

Note that a small percentage of the energy absorbed is incorporated because:

- *Energy is lost through metabolic processes.*
- *Not all organisms at a trophic level are eaten.*
- *Not all of the material that is eaten is digested.*

As a result, the number and biomass of organisms will decrease at each trophic level because there is less energy available to support greater numbers and biomass.

Question 4

Figure 3 in this question showed the growth curve of a population of yeast cells in a laboratory culture.

Part (a) required candidates to identify the type of population growth curve that was represented in Figure 3. In Part (b), candidates were required to state two conditions under which a population exhibits the type of growth illustrated in Figure 3. In Part (c), candidates were required to explain how population will change if the carrying capacity is exceeded.

Candidates' performance was poor. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Candidates did very well on Part (a) and Part (b). Most candidates had difficulty with Part (c) when they attempted to explain how the population will change if the carrying capacity is exceeded.

Note:

If the carrying capacity is exceeded

- *Limiting factors will begin to operate and influence the health and status of the population.*
- *The rate of population increase will be affected as population numbers will increase more slowly or even decrease.*
- *The population will experience a 'crash' or 'dieback'.*

Module 2: People and the Environment

Question 5

This question was designed to test candidates' ability to

- (i) state the meaning of 'replacement level fertility rate' in Part (a)
- (ii) calculate the percentage of the population in the pre-reproductive years in Part (b)
- (iii) predict how the population is likely to grow over the next ten years in Part (c).

Candidates' performance was below expectation. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

For Part (a), the responses suggested that candidates did not understand the meaning of 'replacement level fertility rate'. For Parts (b) and (c), many candidates had difficulty calculating the percentage of population in the pre-reproductive years and predicting how the population is likely to grow over the next ten years.

Note:

The replacement level fertility rate refers to the number of children a couple must have to replace themselves.

Question 6

Candidates were presented with a graph that showed the percentage of urban population in relation to the total population in four Caribbean countries. Part (a) tested candidates' understanding of population distribution between urban and rural areas. In Part (b), candidates were asked to give three reasons why population growth results in the type of population distribution illustrated in the graph. In Part (c), candidates were expected to outline TWO environmental impacts associated with the type of population distribution that was illustrated.

Candidates' performance in this question was excellent. More than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 7

Candidates were presented with Table 1 that showed 'per capita CO₂ emissions'. In Part (a), candidates were required to define 'per capita CO₂ emission'. In Part (b), candidates were expected to suggest a reason for the difference in per capita CO₂ emission' of Country A and Country B. In Part (c), candidates were expected to use data from Table 1, to deduce for which country the population has a greater negative impact on the environment and provide a justification for the answer provided.

In Part (a), candidates had difficulty defining 'per capita CO₂ emissions'. Parts (b) and (c) of this question were also poorly done. Overall, candidates' performance in this question was below expectation. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Note:

'Per capita carbon dioxide emissions' refers to the quantity of released carbon dioxide that is attributable to each individual in a population.

Question 8

Figure 6 showed infant mortality rates in 2002 for two groups of countries. In Part (a), candidates were required to define 'infant mortality rate'. In Part (b), candidates were asked to identify the group of countries with the average lower population growth rate in 2002. In Part (c), candidates were required to give TWO reasons why the group of countries identified in Part (b) had the lower population growth rate.

Only a few candidates defined 'infant mortality rate' correctly. Overall, candidates' performance on this question was below expectation. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks. .

Note:

Infant mortality rate is the number of infant deaths per 1000 live births in the population.

Module 3: Sustainable Use of Natural Resources

Question 9

In Part (a), candidates were required to name two major natural resources (except) forest found in Caribbean territories and give two reasons why the resources identified are considered natural resources. In Part (b), candidates were required to state two ways in which the resources identified in Part (a) are important to Caribbean countries. Part (c) required candidates to state two environmental impacts that result from the extraction and use of forest resources.

Candidates' performance in this question was excellent. Candidates who correctly identified major natural resources in Caribbean territories were able to give correct reasons why they are considered natural resources and also were able to state reasons for their importance to Caribbean countries. Candidates were also able to state satisfactorily two environmental impacts resulting from the extraction and use of forest resources.

Question 10

Candidates were presented with Figure 7 that showed the effect on the daily fish catch of increased harvesting of flying fish stocks.

In Part (a), candidates were required to explain what is meant by the term ‘Maximum Sustainable Yield (MSY) in relation to the harvesting of the stock of flying fish. Part (b) required candidates to suggest two reasons why it is best to harvest fish stocks at the Point A shown in Figure 7. In Part (c), candidates were required to outline two environmental impacts of over-harvesting flying fish stocks.

Candidates’ performance in this question was good. More than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 11

Part (a) of this question examined candidates’ knowledge and understanding of what is meant by ‘restoration of natural resources’ and ‘rehabilitation of natural resources’. In Part (b), candidates were required to outline one way in which demographic factors can influence the use of natural resources.

Candidates’ performance on this item was below expectations. Candidates had difficulty distinguishing between ‘restoration of natural resources’ and ‘rehabilitation of natural resources’. Few candidates were able to outline one way in which demographic factors can influence the use of natural resources.

Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Note:

Restoration – is bringing back the natural resource to a former condition. It involves the active manipulation of nature to recreate species diversity and ecosystem processes as close as possible to the state that existed before human disturbance.

Rehabilitation – is the rebuilding of structure and function in an ecological system without achieving complete restoration to its original state. It is the reversal of the deterioration of a resource, even if it cannot be fully restored, and the bringing back of an area to a useful state for human purposes rather than a truly natural state.

Question 12

Candidates were required to outline how the economic instruments, user fees, greening of national budgets, incentives, and penalties and environmental taxes can be used as conservation tools.

Candidates’ performance on this question was good.

PAPER 02**Module 1: Fundamental Ecological Principles**Question 1

This question tested candidates' understanding of non-native species and the impacts caused to ecosystems by the introduction of non-native species. Part (d) required candidates to explain the role of natural selection in the adaptation of species to their natural environment.

Most candidates correctly identified non-native species and were able to explain why non-native species may be successful in new environments. Candidates were able to outline impacts on the ecosystem that may result from the introduction of non-native species. However, they had difficulty in explaining the role of natural selection in the adaptation of species to their natural environment.

Overall, more than 50 per cent of candidates achieved a satisfactory score on this question.

Question 2

This question tested candidates' understanding of the relationship between ecosystem stability and species diversity. In Part (a), candidates were able to correctly define the term 'ecosystem' but most candidates had difficulty defining the terms 'ecosystem stability' and 'ecosystem diversity'.

Note:

Ecosystem stability refers to the

- *ability of biological communities to remain relatively stable and constant over time*
- *constancy or lack of fluctuations in composition or function of an ecosystem*
- *ability of an ecosystem to resist perturbations*
- *ability of an ecosystem to repair damage after disturbance.*

Ecosystem diversity refers to the number and relative abundance of a species in a community.

In Part (b), most candidates correctly stated which ecosystem had the greatest species diversity and gave a correct reason to support their answer.

Candidates had difficulty with Part (c) and most failed to explain correctly how species diversity can influence ecosystem stability.

Note:

Since ecosystem stability increases as species diversity increases, the highest Ecosystem Stability Index (ESI) would be associated with the greatest species diversity.

Overall, candidates' performance on this question was poor.

Question 3

This question tested candidates' understanding of the process of cycling of matter through an ecosystem. In Part (a), candidates were required to name two decomposers and state one source of energy for each and explain the importance of the decomposer food chain in the cycling of matter. In Part (b), candidates were asked to state two benefits of natural ecosystems to humans and describe two ways in which humans can disrupt the integrity of natural ecosystems.

Candidates exhibited satisfactory performance in all parts of this question.

Module 2: People and the Environment

Question 4

This question focused on sustainable development and the impact of fertility rates.

Most candidates demonstrated satisfactory understanding of the concept of sustainable development but had difficulty explaining how high fertility rates impact on a country's ability to achieve sustainable development.

Candidates demonstrated good knowledge of measures of population control and were able to respond satisfactorily.

Question 5

Candidates were presented with a Table with data on world population numbers in 1990 and the estimated numbers in 2020.

Part (a) of this question required candidates to calculate the percentage growth in world population attributable to Less Developed Countries between 1990 and 2020. Most candidates did not calculate this correctly.

Part (b) required candidates to explain why this estimated growth in the population of Less Developed Countries (LDCs) should be a cause for concern. This part of the question was done poorly as most candidates either did not understand or failed to grasp why the estimated growth in LDCs should be a cause for concern.

In Part (c), candidates were required to describe one environmental impact associated with the trend in world population growth calculated in Question 5 (a). Part (d) was designed to allow candidates to suggest an approach to mitigate the environmental impact described in Part (c).

Part (c) and Part (d) were done in a satisfactory manner. Candidates were able to describe an environmental impact associated with the trend of population growth and suggest an approach to mitigate the environmental impact.

Question 6

Part (a) of this question was designed to test candidates' understanding of how culture and religion impact on the rate of growth of a population. Most candidates were knowledgeable about this topic.

Candidates were required, in Part (b), to use the information on Human Development Index (HDI) presented in Table 3 to make three deductions regarding the relative achievement of both countries.

In Part (c), candidates were required to evaluate the statement "the education of women is critical to lowering the population growth rate of Less Developed Countries". They were required to include at least six points in their response.

Part (b) and Part (c) posed a greater challenge to candidates. Candidates did not demonstrate adequate knowledge and understanding of the Human Development Index and so had difficulty deducing relevant information from the table. Candidates also experienced difficulties in evaluating the statement that was given and in many instances candidates failed to present the (six) reasons required to support the position taken.

Overall, candidates' performance on this question was below expectation and less than 50% of candidates achieved a satisfactory score on this question.

Module 3: Sustainable Use of Natural Resources

Question 7

Candidates' knowledge and understanding of the functions and importance of coral reefs in the Caribbean was tested in this question. In Part (a), candidates were required to describe two functions of coral reef ecosystems in the Caribbean.

In Part (b), candidates were required to explain how any two human activities impact on coral reef ecosystems in the Caribbean, and in Part (c) to describe two methods for conserving coral reef ecosystems in the Caribbean.

Candidates' demonstrated very good knowledge and understanding of the issues related to coral reefs and human impacts in the Caribbean. This question was very well done by candidates. Overall, more than 50% of candidates achieved a satisfactory score.

Question 8

Candidates were tested on their understanding of the concepts of 'consumptive use', 'non-consumptive use' and 'bioprospecting' regarding natural resources.

In Part (a), candidates were required to use the data showing how quantities of two natural resources, A and B, changed over a ten-year period, to identify the resource which is non-renewable and provide a justification for their response.

In Part (b), candidates were required to use suitable examples to distinguish between 'consumptive' and 'non-consumptive' use of natural resources. In Part (c), candidates were required to explain why bioprospecting is considered a non-consumptive use of natural resources.

Candidates demonstrated limited understanding of the concepts tested. Most candidates were unable to interpret the graphical data in order to identify the non-renewable resource and provide a justification for their response. Candidates also found it challenging to explain why bioprospecting is considered a non-consumptive use of natural resources.

Note:

Consumptive use of natural resources refers to use of natural resources in which these resources are utilised and removed from their natural environment. Once used, they are no longer available for use by another person, for example, catching fish for food, limestone for construction and timber harvested for construction.

Non-consumptive use does not require that the resources be removed from their natural environment or location. These resources are not consumed and so are available for use by another person, for example, use of forest resources for ecotourism, use of coral reefs for snorkelling and diving recreation activities and use of aquatic environments for swimming.

'Bioprospecting' is the use of natural biological resources to extract beneficial chemicals for use in medical and other industries. In bioprospecting only small quantities of the resource is extracted from the natural environment. Since only small quantities are extracted this does not adversely affect the ability of the resource to replenish itself. Enough quantities of the resource are left for other uses. Hence, bioprospecting does not prevent the natural replenishment of the resources and is considered a non-consumptive use.

Overall candidates' performance was below expectation.

Question 9

Candidates' knowledge and understanding of protected areas and of the International Union for the Conservation of Nature (IUCN) classification of protected areas was tested.

In Part (a), candidates were required to identify two categories of protected areas as classified by the IUCN.

Candidates were required to state the purpose and main feature of each category identified and to explain how protected areas promote natural resource conservation. Both of these parts were done satisfactorily.

In Part (d), candidates were required to assess the effectiveness of protected areas in conserving natural resources in the Caribbean. They were required to include three issues associated with the implementation and operation of protected areas.

Candidates' performance on this question was satisfactory. While most candidates were aware of Protected Areas in a general sense, they were unable to identify the specific features and purpose for the different categories. Candidates did not demonstrate adequate knowledge and understanding to explain how Protected Areas promote natural resource conservation and therefore had difficulty in assessing the effectiveness in conserving natural resources in the Caribbean.

THE INTERNAL ASSESSMENT

Some important features of the Internal Assessment (IA) are summarised in the paragraph below.

“Internal assessment is an integral part of student assessment and is intended to assist students in acquiring certain knowledge, skills and attitudes that are associated with the subject. The Internal assessment must relate to at least **ONE** Specific Objective stated in the syllabus. The following are assessed for the Internal Assessment for **each** Unit.

- (i) the collection and collation of data;
- (ii) the analysis, interpretation and presentation of such data;
- (iii) the selection of techniques, designs, methodologies and instruments appropriate to different environmental situations;
- (iv) the development of appropriate models as possible solutions to specific environmental problems.”

In general, the required criteria were applied effectively.

There was a noticeable reduction in use of secondary data and an increase in the evidence of primary data collection. Candidates are encouraged to continue to design projects that will encourage the collection and collation of primary data.

A reminder for teachers: The criteria at the bottom of the Moderation Sheet **must** be applied when recording and distributing marks to the three Modules. When there is a remainder of one, the mark must be allocated to Module 3. A remainder of two marks, one mark must be allocated to Module 2 and one to Module 3. Care should be taken when compiling total scores. Moderators detected many errors in the total scores submitted for students.

The major areas of concern are the Literature Review and Communication of Information. While some candidates were able to communicate the information in a fairly logical manner with few grammatical errors, there were still too many candidates who presented information with several grammatical errors. This reduced the overall quality of the final report.

DETAILED COMMENTS

Improvement was noted in the quality of the assignments submitted. In general, the required criteria for this component were effectively applied. Literature review is still an area of concern in many of the pieces submitted. In these cases, the literature review is either irrelevant or inadequate. There is an immediate need for such candidates to improve their writing and expression skills. This severely affects the quality of the report and at times is not indicative of the CAPE level.

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 title should be more concise and focused.
- Projects chosen should be relevant to Unit 1. This was not so in a few cases.
- The purpose of the project should be clearly outlined and the variables should be clearly defined.
- Data collection in some instances was inadequate and should be addressed.
- Diagrams and illustrations need to be more appropriate and well integrated in the text to increase their effectiveness.
- Comprehensive data analysis is required and this should make use of appropriate statistical tools to improve the result.
- Discussion of findings, conclusion and recommendations should be based **only** on what was presented in the literature review and the data that is collected, presented and analysed. **No new material should be introduced in the discussions.**
- Greater attention should be paid to literature review.
- 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.

PAPER 03B

There was a general improvement in candidates' responses to questions in this Paper. There was greater depth and breadth of coverage with respect to certain areas of the syllabus. However greater effort must be made by candidates to improve their ability to organise and apply knowledge.

Question 1

In Part (a), candidates were expected to use the information provided to plot an appropriate graph to show the variation in the lizard population from 1996 to 2005.

In Part (b), candidates were asked to describe how the lizard population varied over the ten-year period.

Candidates performed very well in this question and demonstrated an understanding of drawing graphs and reading information from graphs.

Question 2

This question was designed to test candidates' understanding of the mark-release-recapture method of population sampling that was used to collect the data that was presented. Candidates were expected to:

- (a) State why the mark-release-recapture method was suitable for population monitoring of lizard populations.
- (b) Outline the procedure for undertaking the -release-recapture method.
- (c) State two assumptions that must be made when using the -release-recapture method for when estimating population size.
- (d) Describe four steps of a monitoring plan to track lizard population. Candidates were asked to state one objective for each step of the monitoring plan.

Overall candidates performed very well on this question. Most candidates demonstrated knowledge of sampling techniques for mobile populations.

Question 3

In Part (a), candidates were required to discuss three conservation strategies that could be implemented to ensure the viability of the lizard population. Candidates were expected to indicate why the strategies chosen were appropriate.

In Part (b), candidates were asked to outline two environmental impacts caused by the operation of the forest concession that would need to be addressed in a rehabilitation programme.

Candidates' performance on this question was satisfactory. Most candidates demonstrated knowledge of conservation strategies and the environmental impacts that can result from forest operations.

UNIT 2**DETAILED COMMENTS****PAPER 01****Module 1: Sustainable Agriculture**Question 1

Candidates were required to define the term 'agriculture' and compare commercial farming with subsistence farming. In Part (c), candidates were required to demonstrate their understanding of the factors that have contributed to sugar cane being a major crop in the Caribbean.

This question was done well by the majority of candidates.

Question 2

This question assessed candidates' knowledge of environmental issues associated with the practice of monoculture cropping in the Caribbean. Candidates were required to recommend alternative sustainable practices to address environmental concerns associated with monoculture.

Candidates' performance in this question was satisfactory. More than 50 per cent of candidates who attempted this question scored greater than 50% of the available marks.

Question 3

This question examined candidates' understanding of the features of environmentally sustainable practices. Candidates were asked to outline one reason why certain specified agricultural practices were considered to be environmentally sustainable.

Candidates' responses to this question were satisfactory.

Question 4

Candidates were asked to outline the role of agriculture in the Caribbean in the production of food and non-food materials, employment generation and foreign exchange earnings.

Candidates demonstrated a good understanding of the role of agriculture in the Caribbean. More than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Module 2: Sustainable Energy Use

Question 5

Candidates were required to define the unit 'kilowatt-hour' in Part (a). In Part (b), candidates were expected to use the information presented in Table 3 to state which energy source is most efficient for generating electricity. Candidates were required to identify costs to society associated with the use of the fuel source identified in Part (b) and explain how the cost to society occurs.

Candidates' performance in this question was below expectation. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Note:

A kilowatt-hour is the amount of energy consumed in one hour if the rate of energy used is 1000 watt per second.

Question 6

Part (a) required candidates to distinguish between 'kinetic energy' and 'potential energy'.

Part (b) tested candidates' understanding of how kinetic energy and potential energy are utilised in the generation of electrical energy in a tidal power plant.

In Part (c), candidates were asked to state one environmental advantage of the energy conversion occurring in a tidal power plant.

Candidates' performance in this question was good.

Most candidates were able to distinguish between 'kinetic energy' and 'potential energy' and describe how each type of energy is utilised in the generation of electrical energy in the tidal power plant. Candidates were also knowledgeable of the environmental advantages of energy conversion occurring in a tidal power plant.

Question 7

This question tested candidates' ability to interpret graphical data and outline consequences of the changes in oil prices to non-oil producing Caribbean countries. Part (c) of this question required candidates to describe one way in which non-oil producing Caribbean countries could respond to the high oil prices.

Candidates' performance in this question was satisfactory.

Question 8

This question tested candidates' understanding of the concept and features of energy-efficient buildings.

Candidates' performance on this question was satisfactory. Candidates demonstrated a good understanding of the concept of energy efficiency and energy-efficient buildings.

Module 3: Pollution of the Environment

Question 9

This question examined candidates' comprehension of how the characteristics of chemicals influence their environmental impact.

This question was done well by candidates.

Candidates demonstrated a very good understanding of the how the characteristics of chemicals influence their environmental impact. More than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 10

This question tested candidates' knowledge of the causes of pollution. Candidates were required to complete the given table by stating a specific related activity, the name of the pollutant and the resulting environmental impact for each cause of pollution identified in the table.

Candidates performed very well on this question.

Question 11

This item examined candidates' knowledge and understanding of the concepts of 'bioconcentration' and 'bioaccumulation'.

Candidates' performance on this item was below expectations. Few candidates were able to identify 'bioconcentration' and 'bioaccumulation' as the two processes that were responsible for the concentration of heavy metals at the trophic levels.

Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 12

This question tested candidates' ability to interpret graphical data, analyse the impact of changing concentrations of a particular pollutant (P) and describe steps to be taken to monitor the concentration of this pollutant.

Candidates performed poorly on this item. Too few candidates were able to identify the pollutant and explain how changes in the concentration of pollutant P result in the changes in the dissolved oxygen concentration of the water.

Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

PAPER 02

Module 1: Sustainable Agriculture

Question 1

This question assessed candidates' understanding of the features of sustainable agriculture and the need to practise sustainable agriculture in a named Caribbean country.

Candidates' performance on this question was satisfactory.

Question 2

This question assessed candidates' knowledge of environmental concerns associated with the practice of monoculture cropping in the Caribbean. In Part (b), candidates were required to recommend and justify alternative sustainable agricultural practices to address environmental concerns associated with monoculture.

Candidates performed very well on this question. The more able candidates provided good recommendations and justifications. More than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 3

This question tested candidates' ability to interpret graphical data and to describe trends in fish harvesting in Part (a). In Part (b), candidates were required to explain how two features of aquaculture may have contributed to the trend illustrated in Figure 1. In Part (c), candidates were required to discuss two environmental concerns associated with the practice of aquaculture.

Candidates' performance on this question was below expectation. Less than 50 per cent of candidates who attempted this question scored greater than 50 per cent of the available marks.

Module 2: Sustainable Energy Use

Question 4

This question tested candidates' knowledge of the conventional generation of electricity. This was not a popular question. In Part (a), most candidates correctly identified the type of energy represented by Q3 and correctly stated the relationship among the magnitudes of Q1, Q2 and Q3.

Responses to the other parts of this question were poor. In Part (b), candidates were unable to describe the essential feature of the conventional process of generating electricity. In Part (c), few candidates were able to explain how the efficiency of the energy conversion process in this system can be increased. In Part (d), most candidates did not provide reasons **for** and **against** the country investing further in this method of generating electricity, as was required.

This was the least popular question in the paper. Candidates' responses were poor.

Question 5

This question tested candidates' knowledge of renewable energy sources, non-renewable energy sources and sustainable energy sources in Parts (a), (b) and (c). In Part (d), candidates were required to assess the feasibility of an energy source in terms of technological limitations, geographical restrictions and environmental impacts.

Candidates' performance in this question was satisfactory. Most candidates were able to distinguish between 'renewable energy sources' and 'non-renewable energy sources' and were able to identify sustainable energy resources. Candidates provided satisfactory responses when assessing the feasibility of the energy sources that were identified.

Question 6

This question assessed candidates' understanding and knowledge of energy efficiency and energy conservation.

Candidates' performance in this question was below expectation.

Few candidates correctly interpreted the quantity '60W' with reference to Bulb A and the majority of candidates were unable to use the information given for the three bulbs to explain the term 'energy efficiency'. Candidates also had difficulty explaining ways in which the large-scale use of the 'more energy efficient bulbs' could impact positively on the environment.

Module 3: Pollution of the Environment

Question 7

This question tested candidates' knowledge of the environmental pathways of pollutants and their ability to interpret data and analyse impact of pollutants.

Candidates' performance on this question was satisfactory. Most candidates who correctly identified the pollutants P and Q illustrated in the figure in Part (a) correctly stated the chemical formulae for the pollutants in Part (b); described the environmental impacts of acid rain in Part (c) and explained how one activity in a country could result in acid rain in Part (d).

Question 8

Part (a) of this question tested candidates' understanding of the terms water pollution and water pollutant. Part (b) tested candidates' knowledge of how the characteristics of a pollutant impacts on its concentration in a river system.

Candidates' performance on this question was poor.

Question 9

Part (a) of this question tested candidates' knowledge of the path of solar radiation through the atmosphere to the earth's surface. Most candidates correctly identified the layers **A** and **B** as the troposphere and stratosphere in the diagram. Part (b) examined candidates' comprehension of the chemical processes that occur during ozone destruction. Only a few able candidates correctly described the chemical processes occurring during ozone destruction in the stratosphere.

Part (c) tested candidates' knowledge of the effects of the destruction of the ozone layer on the health of humans. Part (d) required candidates to assess the risk that the populations of the Caribbean countries face as a result of the destruction of the ozone layer. The responses of many candidates suggest that there is confusion between the processes of global warming and ozone depletion. In Part (c), a few candidates correctly discussed the effect of the destruction of the ozone layer on the health of humans. In Part (d), candidates had difficulty assessing the risk that Caribbean countries face as a result of the destruction of the ozone layer.

Note:

The ozone layer is thinnest in areas over the Arctic and Antarctic regions. Countries at high latitudes such as Canada and Australia are at a greater risk of exposure to high levels of ozone. Caribbean countries are closer to the equator and are at low latitudes where the concentration of the ozone is normal and the risk of overexposure to UV radiation is low.

The release of chlorine and other halogen molecules that cause ozone destruction depends on the development of special types of polar clouds at very low temperatures. During the summer months in the presence of sunlight, the chemicals destroy the ozone. High temperature conditions in the Caribbean preclude the formation of free chlorine molecules.

Because Caribbean countries are located near the equator and receive high levels of incident solar radiation all year round, the risk of over-exposure to UV radiation is higher. Due to the higher melanin levels in most Caribbean populations, the risk for skin cancers is still lower than in other countries such as Australia and Canada.

Destruction of the ozone layer can cause terrestrial plants and marine photosynthetic organisms to be damaged and so reduce photosynthetic production. This may disrupt food webs and ecosystems and cause problems for Caribbean populations.

THE INTERNAL ASSESSMENT

It is necessary to draw attention again to the fact that for Unit 2 there was a change in the requirements. This change is outlined in an **AMMENDMENT TO THE SYLLABUS IN ENVIRONMENTAL SCIENCE Effective for Examinations from May/June 2006, on the CXC website (www.cxc.org)**. It is recommended that, where necessary, teachers and students access this document and familiarise themselves with the current requirements.

The overall quality of the submissions for this Unit was good. In most instances, an introduction to the journal was included. This was very useful in indicating the scope and purpose of the entries to the reader. 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. This was reflected in some activities being too simple and some not reflecting the standard and level of advanced proficiency.

There was significant improvement in candidates' analysis and interpretation of 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 the laboratory exercises. These were missing in many instances. In some instances the total scores provided on the moderation sheet were inaccurate and not distributed according to the syllabus guidelines.

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 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

Overall, there was improvement in the quality of journals submitted. The area of greatest improvement was reflected in candidates providing the required number of journal and laboratory entries. There were some candidates who were unable able to link journal entries and laboratory exercises to specific objectives and conduct appropriate, complementary and supporting activities. Teachers and candidates are reminded that the laboratory activities should be associated with the site visits and not treated as independent activities that are not related.

As a result of objectives of site visits not being linked to the specific objectives in the syllabus, some journals and laboratory activities reflected objectives and activities that related more to Unit 1 than to Unit 2. Candidates should always state and be guided by the specific objectives of the syllabus and the objectives for their journal activity. Candidates should always choose appropriate and adequate follow-up activities, present laboratory activities and journal entries in sequence, pay attention when writing accurately chemical formulae for elements, compounds and ions.

There was improvement in the area of interpretative comments. However, there is room for further improvement. It cannot be overemphasised that the syllabus requires 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'. In a few of the submissions, candidates visited different sites and so could not make valid comparisons since they examined different processes and occurrences.

PAPER 03B

Generally, there was 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

In Part (a), candidates were expected to use the information provided to plot an appropriate graph to show the annual production of Phillip's Farm from 1993 to 2007.

In Part (b), candidates were expected to discuss the trend in the

- (i) banana production between 1995 and 2007
- (ii) nitrate concentration from 1992 to 2007.

In Part (c), candidates were expected to discuss the evidence from the graph supporting the claim that the water quality of the Rio Minho has deteriorated.

Candidates performed very well in this question. Candidates demonstrated the ability to use information to plot graphs and then discuss trends shown by the graph. Most candidates possessed the depth of knowledge required to perform well on this question.

Question 2

In Part (a), candidates were required to identify the evidence from the graph indicating that the operations at Phillip's Farm were responsible for any deterioration in the water quality of the Rio Minho.

Part (b) required candidates to provide an explanation for the relationship between banana production and nitrate concentration in the river.

In Part (c), candidates were required to outline one possible environmental pathway of nitrates from the farm to the river and identify two other chemicals that were likely to travel the same pathway as nitrates.

Part (d) tested candidates' knowledge of changes that are expected in a river ecosystem due to changes in concentration of nitrates as illustrated in the given figure. They were expected to explain how the concentration of nitrates was responsible for the observed changes.

Overall, candidates performed well on Part (a) and Part (b). Most candidates had difficulty with Part (d). Candidates did not outline adequately how the concentration of nitrates was responsible for the observed changes.

Question 3

In Part (a), candidates were required to outline five reasons why it was necessary to monitor the quality of water bodies.

In Part (b), candidates were asked to identify four parameters, excluding nitrates, which should be measured in a programme to monitor the water quality of the Rio Minho River and define any three of the parameters that were identified.

In Part (c), candidates were required to outline the procedure to test for ONE of the water quality parameters that were identified.

Candidates performed well on Part (a) and Part (b) of this question. Candidates' performance was below expectation on Part (c) since most candidates did not demonstrate adequate knowledge of procedures to test water quality parameters.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2009**

ENVIRONMENTAL SCIENCE

ENVIRONMENTAL SCIENCE**CARIBBEAN ADVANCED PROFICIENCY EXAMINATION****MAY/JUNE 2009****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.

For the first time Paper 01 of both Unit 1 and Unit 2 consisted of multiple-choice items. Paper 01 consisted of 45 compulsory multiple-choice items with fifteen items based on the contents of each Module. This paper contributed 30 per cent to the total score for the Unit.

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

Paper 03, the Internal Assessment, contributed 90 marks or 30 per cent to the total for the Unit. Unit 1 was examined by a single project while Unit 2 was examined by a journal comprising site visits and laboratory exercises.

GENERAL COMMENTS**UNIT 1**

There was an improvement in the number of candidates who demonstrated the breadth of knowledge necessary to perform well. There were still, however, a few candidates whose responses were inadequate, especially where they were required to infer relationships, read graphs, distinguish between terms and explain interactions and interrelationships. Greater attention to basic principles is still required.

Too many candidates struggled with questions requiring the use of higher-order cognitive skills. It is recommended that in preparing for the examination, greater emphasis be placed on providing guidance and practice in responding to these types of questions.

DETAILED COMMENTS**UNIT 1****Paper 01**

Paper 01 consisted of forty-five multiple-choice items; fifteen items from each module. Candidates' performance in this paper was very good.

Paper 02

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

Module 1 - Fundamental Ecological Principles

Question 1

In Part (a) of this question, candidates were required to explain what was meant by the term ‘limiting factor’ and provide THREE ways in which limiting factors operate.

In Part (b), candidates were required to use Figure 1, which was provided, to describe how the population size of the algal species changes with variation in nutrients.

In Part (c), candidates were required to use Figure 1 to explain how the variation in the population of algae impacts on the population of other species in the ecosystem.

Overall, candidates’ performance in this question was satisfactory. A few candidates had difficulty explaining the concept of limiting factors. Most candidates were able to answer Part (b) and Part (c) satisfactorily.

Note:

A limiting factor can be any one of various factors that limit the distribution or numbers of an organism. Limiting factors can be density dependent or density independent. Density dependent factors are factors which lower the birth rate or increase the death rate as a population grows in size. Examples are the quantity and quality of food. Density independent factors are factors which affect population size irrespective of population density, for example abiotic factors, such as weather, climate and fire. Too much or too little of any abiotic factor can affect the growth of a population even if all other factors are at or near the optimum range of tolerance. Although organisms are affected by a variety of abiotic factors in their surroundings, one factor usually outweighs the others in determining the growth of the population. This factor is the limiting factor and it is the primary determinant of growth in an ecosystem. Limiting factors are important because they can easily be upset by human activities.

Question 2

This question dealt with primary and secondary ecological succession. A table was provided with the percentage forest cover for selected countries in the year 1996. Candidates were required to use a bar chart to illustrate the data provided in the table and then use the information provided in the table to identify the countries where secondary ecological succession is MOST likely and LEAST likely to occur. Candidates were also required to provide FIVE reasons to support their answer.

Candidates’ performance in this question was not very good.

In Part (a) of this question, most candidates were able to distinguish between primary ecological succession and secondary ecological succession.

In Part (b) (i), most candidates were able to correctly illustrate the data using a bar chart. The more able candidates were able to:

- draw bar charts with appropriate and proper use of scales
- correctly label the axes
- plot all data points correctly
- provide an appropriate title for the bar chart.

Part (b) (ii) was challenging for candidates. Many candidates incorrectly identified Haiti as the country MOST likely to have secondary ecological succession and Belize as the country LEAST likely to have secondary ecological succession.

Note:

- From the data provided, Belize had most of its forest intact (96 per cent) and so was most likely to have disturbed areas which would have been in rather close proximity to undisturbed areas
- In secondary ecological succession, colonization of the area occurs by species that are usually in the surrounding area.
- In the case of Belize, there will therefore be good opportunity for species to migrate from the closely surrounding areas and become re-established in the disturbed area.
- It will be possible and easy for tree seeds to be dispersed and transferred from forested areas to the cut disturbed areas.
- This would most likely increase recolonization with previous species, leading to secondary ecological succession.
- In the case of Haiti all of the forest cover is lost and while there may be undisturbed areas, there will be few species in the surrounding areas. This reduces the likelihood of recolonization and secondary ecological succession taking place.

Question 3

Figure 2 represented a simplified predator-prey relationship between snail kites and freshwater snails and showed the variation in population numbers of both snails and snail kites in an ecosystem for the first eight months, January to August, of one year.

In Part (a) of this question, candidates were required to make reference to Figure 2 and describe the variation in the population size of BOTH organisms over the eight-month period.

In Part (b), candidates were required to outline how predation may be of benefit to the prey population.

Note:

- Predation provides a basis for population control in the prey population.
- The predator selectively removes very young, very old or sick prey/individuals (since they are easier to catch).
- This helps to prevent the population from exceeding the carrying capacity.
- This prevents any ensuing population crash since there will be adequate resources for the surviving members of the prey population.

In Part (c), candidates were required to explain how ONE density independent factor may impact the size of the snail population. The difficulty here for some candidates was their inability to identify density independent factors.

Note:

Density independent factors are factors that are not dependent upon the density of the population in question. Some examples of density independent factors are weather, climate, and natural disasters, seasonal changes, hurricanes, and fires. These factors are unrelated to population size and affect everyone in the population regardless of population size.

In Part (d), candidates were required to assess TWO possible impacts on the ecosystem if the population of snails was significantly reduced by draining the waterway. Candidates did not pay attention to the fact that this part of the question asked for impact on the ecosystem and not only on the snail population. As such, many answers stated what would happen to the snails but failed to consider the impact on the ecosystem.

Overall, candidates' performance in this question was satisfactory.

Module 2 - People and the EnvironmentQuestion 4

Figure 3 in this question showed the total fertility rate versus per capita GDP.

Part (a) of this question required candidates to describe the relationship between per capita GDP and the level of poverty existing in countries. While some candidates correctly described the relationship, many were unable to do so.

Note:

- Poverty is the inability of individuals to meet their basic needs for, among other things, food, shelter and clothing.
- Gross Domestic Product (GDP) is the total annual output of a country's economy divided by the population of the country for that year.
- GDP per capita is an estimate of the amount of resources in terms of dollars that is available to each individual in that country.
- The greater the per capita GDP of a country the greater will be the resources available to individuals and the probability of them meeting their needs.
- As the GDP of a country increases, the level of poverty usually decreases.

In Part (b), candidates were required to outline the relationship between total fertility rate and per capita GDP based on the graph in Figure 3.

In Part (c), candidates were required to explain how the level of poverty in countries accounts for the relationship outlined in Part (b) (i).

Candidates did very well on Part (b) (ii) of this question. Most candidates had difficulty with Part (c) when they were required to explain how the level of poverty in countries accounts for the relationship outlined in Part (b) (i). Many candidates had difficulty when asked to interpret information from the graph and in describing the relationship between the two variables.

Candidates' performance in this question was very good. More than half of the candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 5

Figure 4 in this question showed the death rate (DR) and birth rate (BR) of a developing country from the year 1900 to 2000.

In Part (a), candidates were required to describe how the growth rate of the population changed between 1908 and 2000.

In Part (b), candidates were required to calculate the doubling time of the population if its rate of growth remains constant beyond 2000.

In Part (c) of this question, candidates were required to outline TWO factors that may be responsible for the changes in the growth rate of the population since 1928.

In Part (d), candidates were required to assess the role of government policies in controlling population growth rate.

Candidates did very well on Part (d) of this question. However, Part (a), Part (b) and Part (c) posed difficulties for many candidates. Most candidates were unable to interpret the graph. Candidates failed to follow the instruction to begin at 1908. Many candidates also failed to discuss growth rate but focused instead on birth rate in isolation.

Candidates had difficulty with the calculation of ‘doubling time’ in Part (b).

Note:

$$\begin{aligned} \text{Growth Rate} &= \text{Birth Rate} - \text{Death Rate} \\ \text{Growth Rate in 2000} &= 28 \text{ per thousand} - 8 \text{ per thousand} = 20 \text{ per thousand} \end{aligned}$$

$$\text{Doubling time of population} = \frac{70}{\% \text{ annual growth rate}}$$

In 200, the growth rate was 20 per 1000 or 2 per 100 or 2 per cent

$$\text{Doubling time of population} = \frac{70}{2 \text{ per year}}$$

$$\text{Doubling time} = 35 \text{ years}$$

This was the most popular question in Module 2. Candidates’ performance in this question was very satisfactory. More than half of the candidates who attempted this question scored greater than 50 per cent of the available marks.

Question 6

In this question Table 2 presented data for water consumption per capita for developing and developed countries.

In Part (a), candidates were required to calculate the percentage difference in the per capita water consumption between developing and developed countries. This part of the question was poorly done.

In Part (b), candidates were required to describe an environmental impact associated with high per capita water consumption. This part of the question was poorly done. Candidates did not appear to understand what an environmental impact was. Most candidates who attempted this part of the question discussed environmental factors rather than environmental impacts.

Part (c) required candidates to account for the difference in per capita water consumption between developing and developed countries. Candidates performed satisfactorily on this part of the question.

Part (d) required candidates to assess the statement “The high consumption patterns of developed countries are responsible for the world’s environmental degradation” in the light of current world population distribution. This part of the question was the most frequently attempted part.

This was the least popular question in Module 2 but candidates’ performance in this question was satisfactory. More than half of the candidates who attempted this question scored greater than 50 per cent of the available marks.

Module 3 - Sustainable Use of Natural Resources

Question 7

In this question candidates were presented with Figure 5 which emanated from research conducted to investigate the environmental impact of mining two natural resources, gold and gravel.

In Part (a), candidates were required to compare the environmental impact of extracting these two natural resources.

Part (b) required candidates to account for the difference in the level of noise pollution when these two resources are extracted.

Part (c) required candidates to discuss THREE factors (excluding environmental) that the Government should consider before permitting the extraction of these two resources.

Candidates’ performance in this question was very satisfactory. Candidates did very well on Part (a) and Part (b). Some candidates failed to heed the caution in the question – ‘excluding environmental factors’ – and discussed environmental factors. As such, this caused candidates not to score more marks for this question.

Question 8

Table 3 in this question presented information regarding the impact on mangrove ecosystems of a restricted freshwater flow and the discharge of sewage at three locations identified as A, B and C.

In Part (a) of this question candidates were required to describe ONE function of mangrove ecosystems.

This part of the question was well known and was satisfactorily done by candidates.

In Part (b), candidates were required to analyse the information presented in Table 3 and make a logical deduction. Candidates were required to justify their response.

Part (c) required candidates to describe the effects that EACH of the following could have on mangrove ecosystems:

- Reduced freshwater flow through mangrove ecosystems
- Discharge of sewage in mangrove ecosystems.

This part of the question posed some difficulty for some candidates. Candidates failed to adequately describe the effects of each of the actions as stated in the question. Many candidates listed at least four points for each response.

This was the most popular question in the module and candidates' performance in this question was satisfactory.

Question 9

In this question candidates were presented with Figure 6 that showed the percentage of countries marketing both specific ecotourism destinations and traditional tourism destinations between 1985 and 2005.

In Part (a) of this question, candidates were required to comment on the trend in the tourism travel market from 1985 to 2005. This part of the question presented the greatest difficulty for candidates. Candidates had difficulty commenting on the trend shown in Figure 6.

Part (b) required candidates to state FOUR possible reasons for the trend shown in Figure 6. This part of the question was widely known by candidates.

In Part (c), candidates were required to discuss THREE ways in which ecotourism can be used as a tool for the conservation of natural resources.

This was the least popular question in the module. Candidates' performance in this question was very satisfactory.

The Internal Assessment

It is important to emphasise the paragraph below:

“The Internal Assessment is an integral part of student assessment and is intended to assist students in acquiring certain knowledge, skills and attitudes that are associated with the subject. The Internal Assessment must relate to at least **ONE** Specific Objective stated in the syllabus. The following must be assessed by the Internal Assessment for **each** Unit.

- (i) the collection and collation of data;
- (ii) the analysis, interpretation and presentation of such data;
- (iii) the selection of techniques, designs, methodologies and instruments appropriate to different environmental situations;
- (iv) the development of appropriate models as possible solutions to specific environmental problems.

In general, the required criteria were applied effectively.

There was a noticeable increase in the evidence of primary data collection and a reduction in the use of secondary data. Candidates are encouraged to continue to design projects that will encourage the collection, collation and use of primary data.

A reminder for teachers: The CXC criteria at the bottom of the Moderation Sheet **must** be applied **at all times** when recording and distributing marks to the three Modules. A remainder of one mark must be allocated to Module 3. For a remainder of two marks, one mark is allocated to Module 2 and one to Module 3. Care should be taken when compiling total scores. Moderators detected many errors in the total scores submitted for students.

The major areas of concern are the literature review and communication of information. While some candidates were able to communicate the information in a fairly logical manner with few grammatical errors, there were still too many candidates who presented information with several grammatical errors. This reduced the overall quality of the final report.

DETAILED COMMENTS

While the overall standard of the Internal Assessment submissions appears not to have improved greatly, it is heartening to note that there is a substantial number of candidates who submitted work that was of a very high standard. The overall quality and content can be improved by choosing topics that lend themselves to a more scientific and investigative approach.

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

One major concern was the way in which the titles of projects were written. Titles were frequently misleading and written in the form of an objective. The purpose of the project was also not “concise” and often did not have, or sometimes did not clearly state the variables and/or objectives of the research. Note that objectives should be **SMART**, that is, **S**pecific, **M**easurable, **A**ttainable, **R**elevant, and **T**ime-bound.

The literature review, in many instances, was merely a listing of the literature, without much discussion. Candidates also need to pay attention to the format used for citations.

The methodology frequently did not describe how the variables/objectives would be measured or observed and recorded. Also, students very frequently used a questionnaire survey that was inappropriate and, where appropriate, the questions were not formulated to yield the information pertaining to the stated objectives.

Some of the work submitted for Internal Assessment did not demonstrate adequate field investigation and did not demonstrate much creativity and skills in presentation of data; often the presentation was limited to a number of graphs of similar type, graphs that were inappropriate, and photographs without titles. Candidates are encouraged to use the other available formats for presentation of data such as tabulation, cross-section, field sketch, and line transect.

The analysis was fairly adequate, based on the presented data. However, the analysis could have benefited from more variation in techniques (other than percentages).

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

The conclusion often revisited the purpose. However, as was true of the discussion of findings, the conclusion was often based on generalized information on the topic but not the actual findings in the research. It would be helpful here to recall some of the most significant findings.

In a few instances, recommendations were based on limitations. This category of recommendations is more appropriate to be addressed in the methodology. In general, similar to discussion of findings, recommendations were not based on actual findings of the particular research but, instead, on some generalized information on the topic, perhaps from research on a similar topic or from the literature.

Communication of information was satisfactory in some instances. However, it would be helpful to use the jargon/terminology of Environmental Science in order to improve the overall quality of the Internal Assessment projects. It is noted, however, that there are still many instances where candidates demonstrated a very poor standard of writing and communication skills for the CAPE level.

In several instances, the conventional format for references was not applied. Additionally, textbooks and websites were intermixed. In some cases for website references, only the search engine was mentioned.

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 title should be more concise and focused.
- The purpose of the project should be clearly outlined and the variables should be clearly defined.
- Data collection in some instances was inadequate and should be addressed.
- Diagrams and illustrations need to be more appropriate and well integrated in the text to increase their effectiveness.
- Comprehensive data analysis is required and this should make use of appropriate statistical tools to improve the results.
- Discussion of findings, conclusion and recommendations should be based **only** on what was presented in the literature review and the data that is collected, presented and analysed. No new material should be introduced in the discussions.
- Greater attention should be paid to the literature review. This is still one of the weak areas in Internal Assessment pieces 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.

Paper 03/2

There was a general improvement in candidates' responses to questions in this Paper. There was greater depth and breadth of coverage with respect to certain areas of the syllabus. However, greater effort must be made by candidates to improve their ability to organise, apply and communicate information.

Question 1

In Part (a), candidates were expected to use the information provided to plot a bar chart to show the population size of different species at each site.

In Part (b), candidates were asked to calculate the species diversity for EACH site and indicate which of the two sites has the GREATER species diversity.

In Part (c), candidates were required to differentiate between ‘species abundance’ and ‘species diversity’.

Candidates performed very well in this question. They demonstrated an understanding of drawing graphs and reading information from graphs. Most candidates appeared to possess the depth of knowledge required to perform well on this question.

Question 2

This question was designed to test candidates’ understanding of methods available for estimating population sizes of moving and non-moving organisms. Candidates were required in Part (b) of this question to outline the limitations of EACH technique identified in Part (a).

Overall candidates performed very well on this question. Most candidates demonstrated knowledge of sampling techniques for mobile populations.

Question 3

In Part (a) of this question, candidates were required to describe TWO measures that can be implemented to protect and conserve the Red Siskin (*Carduelis cucullatus*).

In Part (b), candidates were asked to design a plan to monitor the population of Red Siskin (*Carduelis cucullatus*).

In Part (c), candidates were required to explain why Site B may have been recommended by the EPA as the preferred site for developing the resort.

Candidates’ performance on this question was satisfactory. Most candidates demonstrated knowledge of conservation strategies and the environmental impacts that can be the result of forest operations.

UNIT 2

GENERAL COMMENTS

There was an improvement in the number of candidates who demonstrated the breadth of knowledge necessary to perform well as was the case for Unit 1, however, there were still a few candidates whose responses were inadequate, especially where they were required to infer relationships, read graphs, distinguish between terms and explain interactions and interrelationships. Greater attention to basic principles is still required.

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 providing guidance and practice in responding to these types of questions.

DETAILED COMMENTS

Paper 01

Paper 01 consisted of forty-five multiple-choice items; fifteen items from each module. Candidates' performance in this paper was very good.

Paper 02

Candidates performed better in Module 1 than in Module 2 or Module 3. Performance on Module 2 was superior to performance on Module 3.

Module 1 - Sustainable Agriculture

Question 1

This question presented some challenges to candidates. For Part (a), most candidates were unable to identify the differences between 'intensive aquaculture' and 'extensive aquaculture'. Responses such as the following were expected:

Aquaculture is the cultivation of the natural produce of water (fish, shellfish, algae, seaweed and other aquatic organisms). There are two kinds of aquaculture: extensive aquaculture based on local photosynthetic production and intensive aquaculture, in which the fish are fed with an external food supply. The management of these two kinds of aquaculture systems is completely different.

- Intensive aquaculture
Intensive Aquaculture can often involve tanks or other highly controlled systems which are designed to boost production for the available volume or area of water resource. Essentially fish densities are high.

- Extensive aquaculture
The available food supply by natural sources, commonly zooplankton feeding on pelagic algae or benthic animals, such as crustaceans and molluscs. Because most fish are carnivorous, they occupy a higher place in the trophic chain and therefore only a tiny fraction of primary photosynthetic production (typically 1 per cent) will be converted into harvestable fish. As a result, without additional feeding the fish harvest will not exceed 200 kilograms of fish per hectare per year, equivalent to 1 per cent of the gross photosynthetic production.

In Part (b), most candidates were able to satisfactorily describe the trends among intensive aquaculture, extensive aquaculture and marine fisheries. However in Part (c), when asked to select which *aquaculture* practice was most harmful to the environment and why, candidates encountered difficulties, at times describing the problems with marine fisheries.

Part (c) of the question was generally well done, although few candidates recognized that this part required an elaboration of the general impact of aquaculture. Responses such as the following were expected:

Aquaculture can be more environmentally damaging than exploiting wild fisheries. Some heavily-farmed species of fish, such as salmon, are maintained in net-contained environments. Unused feed and waste products can contaminate the sea floor and cultured fish can escape from these pens. Escapees can out-compete wild fish for food and spread disease, as well as dilute wild genetic stocks through interbreeding. Farming carnivorous fish like salmon may actually increase the pressure on wild fish, as for farming one kilo of farmed fish up to six kilo of wild fish are used for feeding. The concentrated nature of aquaculture often leads to higher than normal levels of fish waste in the water. Fish waste is organic and composed of nutrients necessary in all components of aquatic food webs. In some instances such as nearshore, high-intensity operations, increased waste can adversely affect the environment by decreasing dissolved oxygen levels in the water column. Onshore recirculating aquaculture systems, facilities using polyculture techniques, and properly-sited facilities (e.g. offshore or areas with strong currents) are examples of ways to reduce or eliminate the negative environmental effects of fish waste.

Question 2

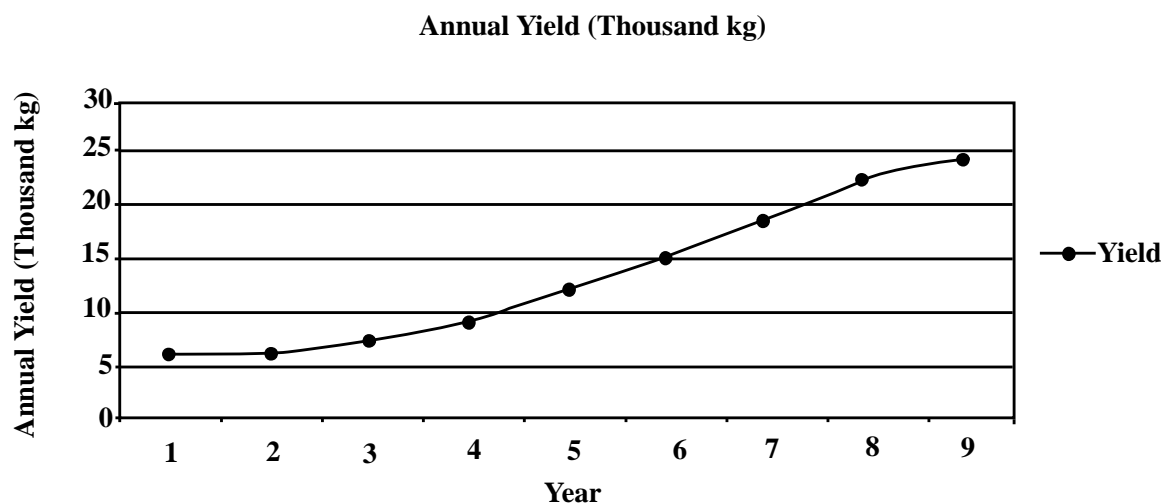
This question was fairly well done. In Part (a), most candidates were able to identify the method they would recommend to the farmer, as well as another environmentally sustainable method of pest control. However, many candidates were unable to give an adequate justification in Part (a) (i).

Part (b) was done better by the candidates, with most candidates identifying environmentally sustainable practices in agriculture systems and adequately explaining their reasons for their choice.

Question 3

This question was generally well done, with most candidates being able to identify hydroponics as the practice being demonstrated in the diagram. However in Part (a) (ii) they encountered some difficulties when asked to outline the features of hydroponics.

Part (b) required students to plot a graph of the data provided. Candidates were generally able to plot a graph, but had difficulties with the finer details, such as labelling the graph and axes, neatly sketching the curve and choosing an appropriate scale. An example of an acceptable graph is given below.



Candidates should note the following when drawing graphs:

- All graphs must have an appropriate title.
- The axes must be labelled appropriately.
- There must be correct point placement.
- The drawing of the curve must be appropriate, smooth and neat.

Candidates were generally able to identify the reasons for the trend in Part (c), as well as reasons why hydroponics is sustainable. Some candidates, however, were unsure about what was required for this answer and simply stated the features of sustainable agriculture.

Module 2 - Sustainable Energy

Question 4

This question was fairly well done, but Part (a) presented some challenges for candidates, since they had difficulty calculating the quantity of fossil fuel utilised by each country, and consequently determining which country used the larger percentage of its fossil fuel for electricity generation. Candidates, however, excelled in listing uses that could be included in the “other” category, identifying a broad range of responses.

For Part (b), candidates generally identified factors affecting the supply of energy to the new industrial estate, but many failed to adequately elaborate on these factors. **This was a general trend with questions that asked candidates to discuss, justify, analyse, and evaluate.** Candidates need to practise answering questions that require higher-order skills.

Question 5

This question presented some challenges to candidates, primarily since many had difficulties reading and interpreting the graph. In Part (a) (i), candidates generally had difficulties calculating the environmental cost of using natural gas as a source of energy:

$$9 - 6 = 3 \text{ US cents/kWh}$$

In Part (a) (ii), candidates at times ignored the fact that their choice and identification should be based SOLELY on the data in the figure, and that the justification should include specific values from the figure.

Recommended form of energy: ***geothermal***

- *geothermal (7.5 cents/kWh) is overall cheaper than solar cells (19.7 cents /kWh)*
- *environmental cost of geothermal (1 cent/kWh) is about the same as solar cells (0.7 cents/kWh)*
- *so geothermal is recommended as its cheaper than the other alternative, and has about the same environmental costs. This is in comparison to coal, which although fairly cheap, has very high environmental costs (9.6 cents/kWh)*

Nevertheless, in Part (b), candidates were generally able to posit factors EXCEPT cost that should be considered in implementing the switch from coal. However, some candidates missed the fact these reasons had to be **based on the form of renewable energy identified in (a) (ii).**

In Part (c), most candidates were able to identify relevant countries where geothermal energy would be a viable alternative (e.g. Grenada, St. Lucia, Dominica, St. Vincent and St. Kitts). Few were however able to adequately justify their choice, while some candidates actually performed an analysis of the options for replacing coal with geothermal energy as it pertained to other factors occurring in the country (e.g. utilizing the volcanic resource for ecotourism, accessibility of the resource, ability of the resource in the country to satisfy demand). This was exemplary and showed that some analysis went into the answer.

Question 6

Part (a) of this question was poorly done by the majority of the candidates. This was primarily because students had difficulty reading values correctly off the graph, and therefore the calculations derived from the graph were incorrect. **Candidates are asked to and should ensure that they equip themselves with rulers and other instruments when entering the examination room.**

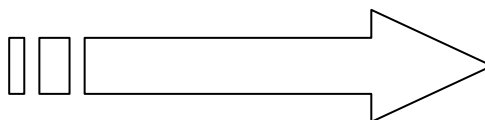
For Part (b), most candidates were able to identify positive and negative impacts of the use of nuclear power on the environment. However, many failed to develop and discuss these impacts.

Module 3 - Pollution and the Environment

Question 7

This question was well done by the majority of the candidates. In Part (a) (i), however, many candidates were unable to rank the different waste types in INCREASING daily mass:

Textile; metal; other/glass; plastic; paper products; wood; yard and food waste



In Part (a) (ii), most candidates were able to identify and calculate the percentage waste type with the SMALLEST daily mass. However, there were candidates who had difficulty identifying the SMALLEST daily mass, and some merely identified the entity with the smallest mass but neglected to calculate the percentage.

Part (a) (iii) was generally well done, with most candidates being able to calculate the length of time required to dispose of 28 tonnes of waste. For Part a (iv), candidates suggested a diversity of reasons for the amount of metal being disposed being low. An example of an expected response is:

Metal is a valuable commodity that is recycled. It is sought extensively by landfill scavengers. Therefore metal would be low in waste in a landfill.

Generally, candidates were able to give an adequate definition for “leachate”, such as:

Leachate is the contaminated liquid formed by percolation of rainwater through the stored landfill waste.

They were also able to identify four pollutants EXCEPT leachate.

Part (c) of the question was exceedingly well done with the majority of candidates identifying the well that was MOST contaminated, and an explanation of how a pollutant can contaminate drinking water in that well. They were also able to explain why the other well was not contaminated.

Question 8

Candidates did fairly well on this question. For Part (a), most candidates were able to define the term “noise pollution”. However, for Part (b) candidates had some difficulty in explaining why noise is considered a pollutant.

In Part (c) (i), most candidates could not identify what distance a homeowner had to be located from the fete, to ensure that he/she was not disturbed by the noise.

Based on the World Health Organisation (WHO) standard of 40 dBA for residential areas, the distance would be 0.64 ± 0.01 km

Most candidates were however able to identify 0.24 ± 0.01 km as the distance a party-goer would have to walk before he began to experience a harmful noise level of 84 dBA

In Part (d), candidates readily identified measures to reduce noise pollution, but often had difficulty outlining how these measures could be used.

Question 9

This question tested the candidates’ knowledge of the ozone layer, ozone depletion and the international legal regime pertaining to ozone depletion.

For Part (a), most candidates were able to identify at least two layers of the atmosphere, but had difficulty identifying the ozone layer on the diagram.

The ozone layer is between 17 to 26 km on the graph. A single line or arrow is not enough, since the layer has a thickness. As such, candidates were expected to show this by using two lines to reflect the thickness of the layer and the region where the layer could be found.

Most candidates could not identify 80 km as the altitude at which ozone concentration is lowest nor describe the relationship between ‘ozone concentration’ and ‘altitude’ in terms such as:

As altitude increases from 0 km to 10 km, ozone concentration decreases to a minimum at 10 km. From 10 km to 22 km, ozone concentration increases to a maximum at 22 km. After this, the ozone concentration decreases again with increasing height in the atmosphere to 80 km.

In Part (b), most candidates could identify discussion points, but few were able to elaborate sufficiently on these points. As noted above, *one general point of note was that candidates had difficulty with questions that required some degree of explanation, that is, questions that asked the candidate to ‘describe’, ‘explain’, ‘discuss’, ‘justify’, ‘evaluate’, ‘assess’ and ‘distinguish’.*

In Part (c), most candidates could identify the Montreal Protocol as the international treaty to protect the ozone layer and reduce ozone depletion, while only a few could comprehensively explain how the treaty worked.

The Internal Assessment

It is necessary to draw attention again to the fact that for Unit 2 there was a change in the requirements. This change is set out in the **AMENDMENT TO THE SYLLABUS IN ENVIRONMENTAL SCIENCE Effective for Examinations from May/June 2006, on the CXC website (www.cxc.org)**. It is advisable that teachers and students access this document and familiarise themselves with the requirements.

The overall quality of the submissions for this Unit was good. In most instances an introduction to the journal was included. This was very useful in indicating the scope and purpose of the entries to the reader. This also helped to focus the candidate in making appropriate observations and interpretative comments. There was evidence of improvement in candidates' analysis and interpretation of results.

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

The topics chosen for the journal were generally appropriate to the subject area and level of examination, but the topics were rarely stated. While there were some reports that were grossly simplistic, others displayed superficial treatment of the topic, whether stated or implied.

It was often difficult to determine how many of the journals and laboratory exercises were organized. Justification for site selection was rarely stated. In too many instances, the laboratory exercises were not related to the site visits, and, in some instances, the site visits were not related to each other; it is clear in the syllabus guidelines that these should be interrelated.

Interpretative comments in the journals needed more depth; this can be achieved by using the laboratory results to help explain field observations.

In general, scores in Unit 2 were higher than scores in Unit 1, perhaps because Unit 2 is more structured in terms of journal entries and laboratory exercises.

Laboratory Exercises

There was some overall improvement noted in the 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 most candidates' work 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 analysis and interpretation.

The laboratory exercises were mostly well done, although many were not related to the site visits. One area that needs improvement in the laboratory exercises is observation and recording. While in most cases, results were recorded, very few had descriptions of the actual laboratory observations.

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

Journal

There was an overall improvement in the quality of journals submitted. The area of greatest improvement was reflected in candidates providing the required number of journal and laboratory entries. There were some candidates who were unable to link journal entries and laboratory exercises to specific objectives and conduct appropriate, complementary and supporting activities. Candidates should be reminded that the laboratory activities should be associated with the site visit and not treated as independent activities that are not related.

Candidates' inability to link objectives of site visits to the specific objectives in the syllabus resulted in many journals and laboratory activities reflecting objectives and activities related more to Unit 1 than to Unit 2. Candidates should always state and be guided by the specific objectives of the syllabus and the objectives for their journal activity. Candidates should always choose appropriate and adequate follow-up activities, present laboratory activities and journal entries in sequence and pay attention when writing chemical formulae for elements, compounds and ions.

There was improvement in the area of interpretative comments. This may be further improved if candidates develop the "habit of keen observation, relevant and precise reporting, concise recording and the ability for critical thinking, problem solving and decision making".

It cannot be overemphasised that the syllabus requires 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". In a few of the submissions, candidates visited different sites and so could not make valid comparisons since they examined different processes and occurrences and thus there was no basis for comparisons.

Paper 03/2

Generally, there was overall improvement in the depth and breadth of coverage with respect to certain areas of the syllabus. However, greater effort must be made by candidates to improve their ability to organise, apply and communicate information.

Question 1

Candidates were provided with some information and were asked to study the information and answer a number of questions which followed.

In Part (a), candidates were asked to state the name of the group of chemical pollutants that Guy could expect to find on his property.

In Part (b), candidates were asked to describe TWO environmental impacts that this group of chemical pollutants can cause.

In Part (c), candidates were provided with some additional information about results of the analyses of soil from Guy's gas station. Candidates were asked to make a conclusion about the level of contamination at Guy's Gas Station.

In Part (d), candidates were required to discuss whether the sampling scheme in Figure 1 would provide appropriate data for a conclusion to be made about the environmental quality of the site.

In Part (e), candidates were asked to design an alternative sampling scheme to determine the environmental quality of the soil at Guy's Gas Station. Candidates performed poorly on this part of the question. Most candidates were unable to present alternative sampling schemes that addressed all of the flaws identified in Part (d).

In Part (f), candidates were asked to explain how the new scheme they designed in Part (e) was better than the previous sampling scheme. The difficulty for most candidates was that they were unable to explain or show that the new scheme was better because it addressed all of the flaws in the previous scheme and showed how the new scheme provided enough data to make a decision on the environmental quality of the site.

Overall candidates' performance on this question was satisfactory.

Question 2

In Part (a) of this question, candidates were required to use the information provided for Question 2 to plot a suitable graph to display the data in Table 2. Candidates were then required to use the graph to determine what MAXIMUM concentration is observed at Sample Point 4 and to state at what depth the contaminant concentration first dropped to zero.

Part (b) required candidates to describe the trend shown in the graph while Part (c) required candidates to explain the trend observed in the data.

Part (d) required candidates to state THREE possible receptors for the contamination observed at Sample Point 4.

Overall candidates performed well on Part (a) and Part (b) of this question. Most candidates had difficulty with Part (d) of this question. Candidates did not outline adequately how the concentration of nitrates was responsible for the observed changes.

Question 3

Figure 2 presented the results of depth analyses of two other points on the site. In Part (a) of this question candidates were required to examine Figure 2 and determine how the MAXIMUM concentration levels varied among Sample Points 4, A and B. Candidates were required to say how the depths at which the MAXIMUM concentration levels occur varied among all THREE sample points.

In Part (b), candidates were required to use the data provided by all three depth analyses to determine the average depth of the excavation and estimate the volume of earth to be excavated in the remediation project.

In Part (c), candidates were required to suggest a strategy for disposal of the material excavated from Guy's Gas Station.

In Part (d) (i), candidates were required to suggest an alternative remediation strategy that could be used to clean up Guy's Gas Station. In Part (ii) candidates were required to compare excavation and soil replacement with the alternative remediation strategy that was proposed by the candidate in Part (d) (i).

Candidates performed well on Part (a) and Part (b) of this question. Candidates' performance was below expectation on Part (c), since most candidates did not demonstrate adequate knowledge of procedures and strategies for the disposal of materials which were excavated from the gas station.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
ADVANCED PROFICIENCY EXAMINATION
MAY/JUNE 2010**

ENVIRONMENTAL SCIENCE

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GENERAL COMMENTS

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 and 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.

This is the second year that Paper 01 of both Units 1 and 2 consisted of multiple choice items. Paper 01 consisted of 45 compulsory multiple choice questions with 15 items based on the contents of each module. This paper contributed 30 per cent to the total score for the unit.

Paper 02 consisted of nine questions, three based on each module. Candidates were required to answer two questions from each module. Each question contributed 20 marks to the total of 120 marks for the paper. This paper contributed 40 per cent to the total score for the unit.

Paper 03, the Internal Assessment, contributed 90 marks or 30 per cent to the total for the unit. Unit 1 was examined by a single project while Unit 2 was examined by a journal comprising site visits and laboratory exercises.

There was an improvement in the number of candidates who demonstrated the breadth of knowledge necessary to perform well. There were still, however, a few candidates whose responses were inadequate, especially where they were required to infer relationships, read graphs, distinguish between terms and explain interactions and interrelationships. Greater attention to basic principles is still required.

Too many candidates continue to struggle with questions requiring the use of higher-order cognitive skills. Some candidates showed a fundamental lack of knowledge of the definitions of key scientific and environmental terms. It is recommended that in preparing for the examination, greater emphasis be placed on key scientific and environmental terms and on providing guidance and practice in responding to questions which require the use of higher-order cognitive skills. In both units, spelling was poor throughout, particularly of some scientific terms.

DETAILED COMMENTS

UNIT 1

Paper 01 – Multiple Choice

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

Paper 02 – Essay Questions

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

Module 1 - Fundamental Ecological Principles

Question 1

In Part (a) of this question, candidates were required to distinguish between 'primary ecological succession' and 'secondary ecological succession'. Most candidates were able to distinguish between the two.

In Part (b) (i), candidates were required to use Figure 1, which was provided, to describe the trend in variation of the alligator population. Candidates were required to use specific values. Part (b) (ii) required candidates to use the information in Figure 1 to determine the carrying capacity of the river. Part (b) (iii) required candidates to use Figure 1 to determine the year in which the carrying capacity was most likely to be achieved. Candidates' performance on this part of the question was poor. Too many candidates were unable to read and interpret the data in Figure 1.

In Part (c), candidates were required to read a statement provided on the phosphorous cycle and the carbon cycle and suggest four reasons to support the statement. Overall, candidates' performance on this question was poor. Candidates did not understand the significance of the difference between the two biogeochemical cycles.

Question 2

Table 1 in Question 2 presented results of a sampling procedure to determine the species of mangroves in three ecosystems, A, B and C.

In Part (a) (i), candidates were required to use the information in Table 1 along with the equation provided to calculate the species diversity for Ecosystem B. In Part (a) (ii), candidates were required to rank the three ecosystems in decreasing order of species diversity. In Part (a) (iii), candidates were required to state which of the three ecosystems was the most stable. In Part (a) (iv), candidates were required to suggest four reasons to support the ranking given in Part (a) (ii).

In Part (b), Table 2 provided results of an ecological study where three amphibians were observed in a grassland ecosystem. Candidates were required to study the information and suggest three inferences that could be made about the competition taking place among amphibians in the grassland ecosystem.

Candidates' performance on this question was good. Most candidates were able to calculate the species diversity of the ecosystems and to rank them in order of decreasing species diversity. Candidates were also able to make appropriate inferences from Table 2.

Question 3

In Part (a) of this question candidates were required to define the term 'ecological niche'. Too many candidates were unable to provide the correct definition. Figure 2 illustrated a predator-prey relationship in a research plot in a savannah. Candidates were required to study Figure 2 and answer the questions.

In Part (b) (i), candidates were required to describe the trend shown in Figure 2. Candidates were required to use specific values in their answer. In Part (b) (ii), candidates were required to state the month in which the population size of the predator was equal to 200. In Part (b) (iii), candidates were required to state the size of the prey population in month 11. In Part (b) (iv), candidates were required to suggest two reasons why the predator population successfully regulated the population of the prey.

Candidates generally performed poorly on this part of the question. Some candidates were unable to read the data from the graph; most candidates described the data without identifying the trends.

In Part (c), the following statement was provided: 'Every living organism has limits to the environmental conditions it can endure'. Candidates were required to provide three reasons to support the statement. Most candidates were able to provide three appropriate reasons.

Overall, candidates' performance on this question was poor.

Module 2: People and the Environment

Question 4

In Part (a) of this question, candidates were required to define the term 'poverty'. This part was well done by most candidates. Part (b) of this question was based on information provided in Figure 3 which showed the percentage of the world's population affected by lack of access to selected social facilities.

In Part (b) (i), candidates were required to use Figure 3 to identify the percentage of the world's population that lacked access to adequate sanitation facilities. Responses to this part of the question were satisfactory.

In Part (b) (ii), candidates were required to calculate the number of people who lack access to adequate housing and electricity. Responses to this part of the question were good.

In Part (b) (iii), candidates were required to determine how many more people lacked access to clean drinking water than to enough food for good health. Responses to this part of the question were generally satisfactory.

Part (c) presented two statements. In Part (c) (i), candidates were required to suggest one reason someone might say Statement 1. In Part (c) (ii), candidates were required to suggest four reasons to support Statement 2. Responses to this part of the question were generally satisfactory.

This was the most popular question in this module. Overall, candidate's performance on this question was very good.

Question 5

Part (a) of this question presented information on an ecological footprint in Figure 4. Candidates were required to study Figure 4 before answering the questions. In Part (a) (i), candidates were required to determine the total ecological footprint for the country with the largest per capita footprint. In Part (a) (ii), candidates were required to calculate the per capita ecological footprint for the country with the smallest total footprint. In Part (a) (iii), candidates were required to describe the trends observed in Figure 4. Candidates were required to use specific values from Figure 4 in their answer. Part (a) of this question posed some difficulty for candidates. Candidates did not read the graph properly. Many candidates did not pay attention to the fact that there were two axes and only read values from one axis. Some candidates appeared confused by the term 'ecological footprint'.

In Part (b) (i), candidates were required to describe two ways in which people impact negatively on the environment. Candidates were required to use three specific examples to illustrate each way. For Part (b) (ii), candidates were required to suggest one mitigation measure for each way in which the negative impact can be caused. Relevant specific examples were required in the response. Many candidates were able to name at least two ways but were unable to give specific illustrative examples.

Overall candidates' performance on this question was satisfactory.

Question 6

Part (a) of this question required candidates to construct an age structure diagram from the data provided in Table 3. This presented difficulty to many candidates. Many candidates were unable to determine appropriate scales while some drew inappropriate graphs (mainly line graphs) to represent the data.

In Part (b) (i), candidates were required to suggest a country that would have an age structure diagram similar to the one that was drawn in (a). For Part (b) (ii), candidates were required to determine if the estimate of the likely rate of population growth in Country X would be high, medium, low or negative. Most candidates recognized and correctly identified a developing country but could not correctly determine that the estimate of the likely rate of population growth would have been high.

In Part (b) (iii), candidates were required to use the age structure diagram that was drawn in Part (a) to explain their response in Part (b) (ii).

Part (c) (i) required candidates to define the term 'total fertility rate'. Many candidates could not define 'total fertility rate' as an estimate of the average number of children a woman will have during her child-bearing years.

In Part (c) (ii), Table 4 was given with information on the average global fertility rate. Candidates were required to study Figure 4 and outline the trend in average global total fertility rate as shown in Table 4. Many candidates failed to observe that the trend showed that over time, the global total fertility rate declined in both developed and developing countries, with the fertility rate in developing countries always higher than the rate in developed countries.

Candidates were required to discuss three factors that would have contributed to the trend observed in Table 4. While many candidates were able to identify the factors that may have contributed to the observed trend they did not discuss these factors adequately.

Overall, candidates' performance on this question was satisfactory.

Module 3 - Sustainable Use of Natural Resources

Question 7

In this question, candidates were presented with Figure 5 which showed a traditional agricultural practice of indigenous peoples in a Caribbean country.

In Part (a) (i), candidates were required to identify the traditional agricultural practice. In Part (a) (ii), they were required to outline how this type of agricultural practice was carried out. These two parts of the question were fairly well done by candidates.

For Part (a) (iii), candidates were presented with a statement 'Indigenous forest dwellers often cause tropical forest destruction because of their traditional agricultural practices.' Candidates were required to indicate whether they agreed or disagreed with the statement. They were required to provide three reasons to support their answer or position. Many candidates could not give reasons to support the position taken. This question provided an opportunity for candidates to apply their knowledge of the slash and burn method of traditional agriculture and to explain how they felt this method impacted on the environment. Candidates either failed to display an understanding of the method or confused the issues with those associated with commercial agriculture.

Part (b) required candidates to study Figure 6 before answering the questions. In Part (b) (i), candidates were asked to describe the trend illustrated in Figure 6. In Part (b) (ii), candidates were required to state the year in which employment in the fisheries sector was greatest. In Part (b) (iii), candidates were required to state the total percentage employment of the forestry sector in 2003 and 2004. Candidates demonstrated limited skills at reading graphs and making deductions from graphs. As a result, many candidates performed poorly on this part of the question.

Part (c) provided candidates with a situation in which an Environmental Impact Assessment (EIA) was required. Candidates were asked to justify the request of the Environmental Protection Agency (EPA). Candidates were required to give two points in their answer. This part of the question was fairly well done by candidates and many demonstrated an understanding of what an EIA is and the role of an EPA.

Overall, candidates' performance on this question was generally satisfactory.

Question 8

Part (a) of this question required candidates to study Figure 7 which showed the amount of fish harvested from traditional marine fishing grounds in Country X. In Part (a) (i), candidates were required to describe the trends in fish harvest shown in Figure 7. In Part (a) (ii), candidates were required to determine in which year the maximum yield of fish was obtained. Part (a) (iii) required candidates to suggest two reasons for the trends shown in Figure 7. Part (a) (iv) required candidates

to identify the production level at which they would recommend that the country continue to harvest its fish resource. Candidates were required to provide three reasons for their recommendation.

Part (a) (ii) was well done by most candidates. Overall, too many candidates failed to demonstrate adequate skills at reading graphs and making deductions from graphs. Many candidates had difficulty reading the graph and describing the trends. Most candidates simply described the data without giving specific trends. Candidates were also challenged to give reasons for the trends that were shown. Most candidates were however able to correctly indicate the level of production they would recommend for the country to continue harvest and also give reasons for their recommendation.

Part (b) of this question required candidates to outline two factors that the government of the Caribbean country may have considered before making a decision to grant permission to private investors to exploit its gold resource. Candidates' performance in this part of the question was very satisfactory.

The overall performance on this question was satisfactory.

Question 9

In this question, candidates were presented with Figure 6 that showed the contributions to the economy made by natural resources over a three-year period for a Caribbean country and were required to study Figure 6 before answering the questions. In Part (a) (i), candidates were required to describe the trends in the contribution made by natural resources in Country P. For Part (a) (ii), candidates were required to determine the percentage contribution made by forestry in Year 1. In Part (a) (iii), candidates were required to calculate the difference in percentage contributions made by minerals in Year 1 and Year 3.

Many candidates had difficulty reading the graph and describing the trends. Most candidates simply described the data without giving specific trends.

In Part (b), candidates were required to suggest three reasons to convince a group of students that the conservation of beaches as a natural resource is necessary for the country. Too many candidates struggled with this part of the question. Candidates did not demonstrate that they were familiar with the role and function of beaches. Too many of them simply identified tourism as the only reason why beaches should be conserved.

Note: the conservation of beaches could be justified for the following reasons:

- Ecological
- Ethical
- Aesthetic
- Economic

Part (c) required candidates to justify the usefulness of (i) education and awareness and (ii) legislation in the management and conservation of beaches in the Caribbean. Candidates demonstrated satisfactory performance on this part of the question. However, too many candidates used the term beach very much in the colloquial sense. This resulted in many candidates stating that fishes live on the beach and that the beach is a habitat for fishes.

The Internal Assessment

General Comments

It is important to emphasise the paragraph below:

The Internal Assessment is an integral part of student assessment and is intended to assist students in acquiring certain knowledge, skills and attitudes that are associated with the subject. The Internal Assessment must relate to at least **ONE** Specific Objective stated in the syllabus. The following must be assessed by the Internal Assessment for **each** Unit:

- The collection and collation of data;
- The analysis, interpretation and presentation of such data;
- The selection of techniques, designs, methodologies and instruments appropriate to different environmental situations;
- The development of appropriate models as possible solutions to specific environmental problems.

In general, the required criteria were applied effectively.

There was a noticeable increase in the evidence of primary data collection and a reduction in the use of secondary data. Candidates are encouraged to continue to design projects that will encourage the collection, collation and use of primary data.

A reminder for teachers: The CXC criteria at the bottom of the Moderation Sheet **must** be applied **at all times** when recording and distributing marks to the three modules. A remainder of one mark must be allocated to Module 3. For a remainder of two marks, one mark is allocated to Module 2 and one to Module 3. Care should be taken when compiling total scores. Moderators detected many errors in the total scores submitted for students.

The major areas of concern are the literature review and communication of information. While some candidates were able to communicate the information in a fairly logical manner with few grammatical errors, there were still too many candidates who presented information with several grammatical errors. This reduced the overall quality of the final report.

Detailed Comments

There was improvement in the overall standard of the Internal Assessment submissions. A substantial number of candidates submitted work that was of a very high standard. The overall quality and content can be improved by choosing topics that lend themselves to a more scientific and investigative approach.

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

One major concern was the way in which the titles of projects were written. Titles were frequently misleading and written in the form of an objective. The purpose of the project was also not 'concise' and often did not have, or sometimes did not clearly state the variables and/or objectives of the research. Note that objectives should be **SMART**, that is, **S**pecific, **M**easurable, **A**ttainable, **R**elevant, and **T**ime-bound.

The literature review, in many instances, was merely a listing of the literature, without much discussion. Candidates also need to pay attention to the format used for citations.

The methodology frequently did not describe how the variables/objectives would be measured or observed and recorded. Also, students very frequently used a questionnaire survey that was inappropriate and, where appropriate, the questions were not formulated to yield the information pertaining to the stated objectives.

Some of the work submitted for Internal Assessment did not demonstrate adequate field investigation and did not demonstrate much creativity and skills in the presentation of data; often the presentation was limited to a number of graphs of similar type, graphs that were inappropriate, and photographs without titles. Candidates are encouraged to use the other available formats for presentation of data such as tabulation, cross-section, field sketch and line transect.

Analyses were fairly adequate, based on the data presented. However, analyses could have benefited from more variation in techniques (other than percentages).

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

The conclusion often revisited the purpose. However, as was true of the discussion of findings, the conclusion was often based on generalized information on the topic but not the actual findings in the research. It would be helpful here to recall some of the most significant findings.

In a few instances, recommendations were based on limitations. It is more appropriate to address this category of recommendation in the methodology. In general, similar to the discussion of findings, recommendations were not based on actual findings of the particular research but, instead, on some generalized information on the topic, perhaps from research on a similar topic or from the literature.

Communication of information was satisfactory in some instances. However, it would be helpful to use the jargon/terminology of Environmental Science in order to improve the overall quality of the Internal Assessment projects. It is noted, however, that there are still many instances where candidates demonstrated a very poor standard of writing and communication skills for the CAPE level.

In several instances, the conventional format for references was not applied. Additionally, textbooks and websites were intermixed. In some cases, for website references, only the search engine was mentioned.

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.
- The research title should be more concise and focused.
- The purpose of the project should be clearly outlined and the variables should be clearly defined.
- Data collection, in some instances, was inadequate and should be addressed.
- Diagrams and illustrations need to be more appropriate and better integrated into the text to increase their effectiveness.
- Comprehensive data analysis is required and this should make use of appropriate statistical tools to improve the results.
- Discussion of findings, conclusion and recommendations should be based **only** on what was presented in the literature review and the data that is collected, presented and analysed. No new material should be introduced in the discussions.
- Greater attention should be paid to the literature review. This is still one of the weak areas in Internal Assessment pieces 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.

Paper 03/2 – Alternative to School-Based Assessment

There was some improvement in candidates' responses to questions in this paper. However, there is still need for greater improvement in the depth and breadth of coverage with respect to certain areas of the syllabus. Greater effort must be made by candidates to improve their ability to organize, apply and communicate information and to demonstrate an understanding of the practical solutions to environmental problems.

Question 1

In Part (a), candidates were expected to use the information provided in Table 1 to plot an appropriate graph showing the variation in the size of the population of tanagers from 1998 to 2007. In Part (b) (i), candidates were asked to describe the variation of the tanager population between 1998 and 2007. In Part (b) (ii), candidates were required to suggest plausible explanations for the variation in tanager population identified in (b) (i). In Part (c), candidates were required to use their graph to estimate the carrying capacity of the ecosystem for tanagers.

Candidates' performance on this question was generally good. Some candidates had difficulty plotting an appropriate graph to represent the data and estimating the carrying capacity.

Question 2

This question required candidates to evaluate the impact of the following actions on the tanager population:

- (a) the introduction of new species;
- (b) clearing of an area of forest;
- (c) presence of the visitors;

Candidates' performance on this question was not satisfactory. Candidates could not evaluate the impacts that were identified on the population.

Question 3

This question required candidates to design a monitoring plan to determine the impact of the development on the tanager population.

Too many candidates failed to provide a response that was satisfactory. Candidates should note that a monitoring plan could include aspects of the following:

- determination of a sampling schedule
- identification of a specific location within a mapped area
- recording of initial numbers of nests and sightings of the tanager
- recording the prevailing conditions at data collection points and times
- introduction of specific conservation measures to reduce threats as the monitoring progresses
- determination of final count of nests, hatchlings and adults
- preparation of education and awareness component and monitoring of its effectiveness
- any other relevant information as necessary.

The overall performance of candidates in this question was not satisfactory.

DETAILED COMMENTS**UNIT 2****Paper 01- Multiple Choice**

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

Paper 02 – Essay Questions

Candidates performed better in Module 1 than in Module 2 or Module 3. Performance on Module 2 was superior to performance on Module 3.

Module 1 - Sustainable AgricultureQuestion 1

This question tested candidates' understanding of biological pest control. Part (a) (i) required candidates to describe the trend in Figure 1 which was provided. This part was done well by most of the candidates who identified the trends and discussed them. For Part (a) (ii), candidates were required to state three pieces of information necessary for the use of biological pest control; this part was generally done well.

In Part (a) (iii), candidates were required to suggest three reasons why the method of control was recommended. This part was also done well by most candidates. Part (a) (iv) required that candidates explain why the biological control agent should always be maintained at level C. Most candidates did not understand the need to maintain a balance between the biological control agent (predator) and the pest (prey) to afford continuous pest control. This part of the question was poorly done.

Part (b) required candidates to suggest two reasons for the use of chemical pest control methods. This part was generally well done. Candidates demonstrated an awareness of the issues around chemical control and the advantages of its application.

The overall performance on this question was very good.

Question 2

This question tested candidates' understanding in three main areas: genetic engineering in agriculture, changes in the size of land under agriculture and the corresponding workforce, and the reasons for practising sustainable agriculture. The question also tested candidates' ability to read a graph and identify and explain trends.

Part (a) required candidates to distinguish between genetic engineering and plant and animal breeding; this part was not done very well. Candidates were able to define the terms but were unable to distinguish between them.

Note

- Genetic engineering is the **laboratory manipulation of genetic material** (genes) to create desirable characteristics in an offspring.
- Plant and animal breeding involves **selecting individuals with favourable** characteristics and **allowing them to reproduce naturally** to produce offsprings with the desirable characteristics.

Part (b) (i) required candidates to describe the trend in Figure 2 which was provided; this part was generally well done.

In Part (b) (ii), candidates were required to state the year in which the average size of farms was four hectares; this part was well done by most candidates — many were able to correctly read the particular data point from the graph.

Part (b) (iii) required candidates to give reasons for the trends in Figure 2; this part was challenging for many candidates. For Part (c), candidates were required to suggest reasons for the practice of sustainable agriculture; this part was poorly done. Candidates were generally unable to identify two reasons for practising sustainable agriculture.

The overall performance on this question was generally satisfactory.

Question 3

This question tested candidates' understanding of conservation tillage and its use as well as mechanization in agriculture. It also tested their ability to identify and explain trends in graphical data, using actual values from the graph.

Part (a) (i) required candidates to comment on the causes of soil degradation as shown in Figure 3 which was provided; this part was generally well done, with strong responses including trends from the graph along with actual data read from it.

In Part (a) (ii), candidates were required to state what mechanism caused the least soil degradation and for Part (a) (iii), they were to state what percentage of soil degradation was caused by soil erosion. These parts were well done with the majority of candidates providing correct answers.

Part (b) required candidates to give two reasons why conservation tillage would be a good measure for reducing soil degradation. The responses provided were generally weak. A significant number of candidates confused the term 'conservation tillage' with regular tillage.

For Part (c) (i), candidates were required to state what is meant by mechanization in agriculture; this part was well done. Many candidates had a general idea of what is meant by mechanization in agriculture. Part (c) (ii) required candidates to suggest four reasons why farmers may not wish to increase the level of mechanization in their farming operations. This part was well done.

Module 2 - Sustainable Energy Use

Question 4

Part (a) (i) required candidates to describe the trend in the rate of light bulbs in Figure 4 which was provided; performance on this part was satisfactory. For Part (a) (ii), candidates were required to state in what year were there sales of five million fluorescent bulbs. In Part (a) (iii), candidates were required to state how many bulbs were sold when sales for both types of bulbs were equal. Parts (a) (ii) and (a) (iii) were well done as most candidates were able to read the graph correctly.

Part (a) (iv) required candidates to suggest reasons for the trends observed in Figure 4; this part was not done very well as most candidates were unable to provide appropriate reasons for the observed trends. In Part (b) (i), candidates were required to state what is meant by 'combined cycle'; this part was poorly done as most candidates were unable to correctly define the term.

For Part (b) (ii), candidates were asked if they would recommend the use of combined cycles for energy generation and to suggest reasons for their answers. Performance on this part was extremely poor as most candidates were unaware of the term 'combined cycle'.

Question 5

This question tested candidates understanding of the factors influencing the location of conventional electricity facilities as well as the environmental impacts of electricity generation. The question also tested candidates' ability to identify and explain trends from data in tabular form.

Parts (a) (i) required candidates to outline the trend in Table 1 which was provided and Part (a) (ii) required candidates to suggest one reason for the trend in (a) (i). These parts were poorly done. Candidates were not able to identify trends from the data in the table. A number of candidates also failed to include specific values in their responses, even though it was stated in the question.

Part (b) (i) required candidates to justify placing a conventional electricity generation plant close to a swamp in a coastal zone. This part of the question presented considerable difficulty to many candidates. This appeared to be due to their inability to understand what was required of them in the question. Many responses provided reasons why a power plant should NOT be sited close to a swamp. In addition, most candidates did not demonstrate a clear understanding of the term '*conventional electricity generation facility*'.

Part (b) (ii) required candidates to outline the environmental impacts to be considered before implementing the conventional electricity generation facility. Many candidates were aware of the environmental impacts of electricity generation and were able to correctly situate these impacts in the context of the question — in a coastal zone, close to a swamp.

Question 6

This question tested candidates understanding of the factors influencing the demand for energy in developing countries as well as the environmental impacts of increasing energy demand. The question also tested candidates understanding of different mitigation methods to relieve these negative environmental impacts and their ability to identify and explain trends from graphical data.

In Part (a), candidates were required to outline the overall demand pattern shown in Figure 5 which was provided. Candidates were generally unable to identify trends from the data in the graph. This graph had three different series and candidates often confused them. In addition, although the question asked for trends, many candidates simply quoted the values of the different data points.

For Part (b), candidates were required to suggest three reasons for the demand pattern in (a); this was very well done. Most candidates were able to provide three valid reasons for the general trends identified in the graph.

In Part (c), candidates were asked to identify and discuss the environmental concerns with regard to the energy demand pattern in Figure 5; for Part (d), they were required to make a recommendation for each concern discussed in (c). Parts (c) and (d) were done very well. Candidates demonstrated an excellent grasp of the environmental issues surrounding fossil fuel use in the Caribbean. In addition, many were able to provide suitable recommendations to mitigate these negative effects.

Module 3 - Pollution and the Environment

Question 7

This question tested candidates understanding of a number of issues associated with air pollution: primary and secondary air pollutants, ozone as a pollutant, acid rain and its effects on vegetation. Candidates' ability to interpret and make inferences from graphical data was also tested.

In Part (a) (i), candidates were required to list two primary air pollutants; this part was generally well done. Most candidates were able to provide two primary air pollutants. For Part (a) (ii), candidates were asked why nitrogen dioxide was considered a secondary pollutant. Many candidates were unable to provide an explanation.

In Part (b) (i), candidates were required to state the conditions under which ozone is not considered to be a pollutant and in Part (b) (ii), they were required to explain the response given in (b) (i). Many students were able to answer Part (b) (i) correctly but were unable to explain their response.

Part (c) (i) required candidates to outline the formation of acid rain; this part was poorly done. Many candidates were unable to correctly outline the formation of acid rain. In Part (c) (ii), candidates were required to explain how acid rain results in the destruction of vegetation. This part was generally well done; most candidates were able to correctly explain how acid rain destroys vegetation.

In Part (d), candidates were provided with a graph, Figure 6, which was used to answer the questions that followed. In Part (d) (i), candidates were asked to identify the experimental site and the control site; this part was done very well, with most candidates correctly identifying both sites.

For Parts (d) (ii) and (d) (iii), candidates were asked to determine the days on which construction began and the days on which construction ended. Most candidates were able to identify these two days correctly. In Part (d) (iv), candidates were required to explain how they arrived at the answers for (d) (i) and (d) (ii). Performance on this section was satisfactory.

Question 8

In Part (a), candidates were provided with the results of a monitoring exercise in a graph, Figure 7.

Part (a) (i) required candidates to state the distance from the sewage plant where the dissolved oxygen concentration is lowest. For Part (a) (ii), they were required to state the lowest dissolved oxygen concentration in the river and in Part (a) (iv), they were required to determine the distance from the sewage plant where the river is completely without fish. Performance on Part (a) was satisfactory as most candidates were able to identify the various data parts on the graph.

In Part (b) (i), candidates were provided with Table 2 and asked to complete the table by providing the name of three water pollutants and one source of each pollutant. Most candidates were able to identify the names of the water pollutants, however, a significant number of candidates were unable to state the sources of the water pollutants.

In Part (b) (ii), candidates were required to outline how two of the pollutants in (b) (i) impact the environment. Performance on this part was very good; most candidates were able to describe the effect of water pollutants on the environment.

In Part (c), candidates were required to explain how a shark can have dangerous levels of mercury without coming into direct contact with the mercury and although the concentration of mercury in the ocean is extremely low. This part was poorly done as most candidates confused the terms bio-accumulation and bio-magnification.

In Part (d), candidates were provided with a table showing different methods for the determination of nitrates in water and the characteristics of these methods. Part (d) (i) required candidates to recommend, with reasons, one of the methods for a new laboratory while Part (d) (ii) required that they state the most important factor to consider when making the recommendation in (d) (i). In Part (d) (i), most candidates were able to correctly identify the best method for the new laboratory. However, in Part (d) (ii), a significant number of candidates failed to identify 'cost' as the most important factor.

Question 9

This question tested candidates understanding of bioremediation, the function of incineration, and its advantages and disadvantages as a waste disposal method. Candidates' ability to interpret and make inferences from graphical data was also tested.

Part (a) (i) required that candidates define the term bioremediation and this was generally well done. Most candidates were aware that bioremediation involved removal of chemicals by biological means.

In Part (a) (ii), candidates were requested to look at the graph provided in Figure 8 and determine how long it took for the TPH level to drop to 60 per cent if its initial level. Performance on this part was very good as most candidates were able to read the information correctly from the graph.

In Part (a) (iii), candidates were required to determine from the graph the loss in actual TPH concentration by the end of the study; performance in this part was poor as candidates did not do the actual calculation but simply took a number from the graph.

In Part (a) (iv), candidates were asked to state how they knew that it was the new bacterial culture that accomplished the reduction shown in Figure 8. This was not done very well. Most candidates could not clearly explain why the loss in TPH observed in the graph could be associated with bacterial activity. Many candidates simply stated that the TPH in the experimental graph declined, but failed to indicate the vital information that *the killed control did not*.

In Part (b) (i), candidates were required to outline the functioning of incineration as a solid waste disposal technique. In Part (b) (ii), candidates were asked to discuss the following proposal. "Incineration is being considered in a number of Caribbean as an alternative to open landfills as a waste disposal technique".

Parts (b) (i) and (ii) were generally well done by the candidates. Most were able to outline the manner in which an incinerator functions, as well as provide well-developed pros and cons for incineration.

Paper 03/1 - Internal Assessment

The overall quality of the submissions for this unit was satisfactory. In most instances, an introduction to the journal was included. This was very useful in indicating the scope and purpose of the entries to the reader. This also helped to focus the students in making appropriate observations and interpretative comments. There was evidence of improvement in students' analysis and interpretation of results.

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

The topics chosen for the journal were generally appropriate to the subject area and level of examination but the topics were rarely stated. While there were some reports that were grossly simplistic, others displayed superficial treatment of the topic, whether stated or implied.

It was often difficult to determine how many of the journals and laboratory exercises were organized. Justification for site selection was rarely stated. In too many instances, the laboratory exercises were not related to the site visits, and, in some instances, the site visits were not related to each other; it is clear in the syllabus guidelines that these should be interrelated.

Interpretative comments in the journals needed more depth; this can be achieved by using the laboratory results to help explain field observations.

In general, scores in Unit 2 were higher than scores in Unit 1, perhaps because Unit 2 is more structured in terms of journal entries and laboratory exercises.

Laboratory Exercises

Overall improvement was noted in the quality and relevance of laboratory exercises. In general, most students 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 most students' work 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, analysis and interpretation.

The laboratory exercises were mostly well done, although many were not related to the site visits. One area that needs improvement in the laboratory exercises is observation and recording. While in most cases, results were recorded, very few had descriptions of the actual laboratory observations.

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

Journal

Overall, there was improvement in the quality of journals submitted. The area of greatest improvement was reflected in students providing the required number of journal and laboratory entries. There were some students who were unable to link journal entries and laboratory exercises to specific objectives and conduct appropriate, complementary and supporting activities. Students should be reminded that the laboratory activities should be associated with the site visit and not treated as independent activities that are not related.

Students' inability to link objectives of site visits to the specific objectives in the syllabus resulted in many journals and laboratory activities reflecting objectives and activities related more to Unit 1 than to Unit 2. Students should always state and be guided by the specific objectives of the syllabus and the objectives for their journal activity. Students should always choose appropriate and adequate follow-up activities, present laboratory activities and journal entries in sequence and pay attention when writing chemical formulae for elements, compounds and ions.

There was improvement in the area of interpretative comments. This may be further improved if candidates develop the "habit of keen observation, relevant and precise reporting, concise recording and the ability for critical thinking, problem solving and decision making".

It cannot be overemphasised that the syllabus requires 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". In a few of the submissions, candidates visited different sites and so could not make valid comparisons since they examined different processes and occurrences and thus there was no basis for comparisons.

Paper 03/2 – Alternative to School-Based Assessment

Generally, there was improvement in the depth and breadth of coverage with respect to certain areas of the syllabus. However, greater effort must be made by candidates to improve their ability to organize, apply and communicate information.

Question 1

This question tested candidates' understanding of the way environmental testing can be used to deduce the source of environmental problems; the nature of eutrophication and its effects on marine environments and the mitigation methods that can be used to prevent it. Candidates' ability to analyse data in graphical and tabular form and interpret trends was also tested.

In this question, candidates were provided with a table which showed the results of a monitoring exercise of water samples.

In Part (a) (i), they were required to state what land use activity was responsible for the fish kills and in Part (a) (ii), they were asked to explain the answer provided for (a) (i).

Parts (a) (i) and (ii) were very poorly done by most of the candidates. Most of them could not recognize that the fish kills were as a result of eutrophication caused by nutrient run-off from the sugar plantation. Candidates did not combine the information from the map and the table to give a reasonable conclusion.

In Part (b) (i), candidates were required to describe the trend in the organic matter results in Table 1 and in Part (b) (ii) they were required to suggest a reason for the trend. Parts (b) (i) and (b) (ii) were not done very well. Most candidates were unable to identify the trend in organic matter results given in the table. This was because the candidates discussed the trends in *nitrate concentration* rather than that of the Biological Oxygen Demand (BOD), which would have been the correct parameter to give information on organic matter contamination in water. This indicated a lack of understanding of the major water pollution parameters and how they are measured.

In Part (c) (i), candidates were required to state the name of the process that caused the fish kills and in Part (c) (ii), they were required to explain how this process resulted in the fish kills. Parts (c) (i) and (ii) were generally well done, with most candidates naming eutrophication as the answer to Part (c) (i); however for Part (c) (ii), some candidates were unable to explain how eutrophication works.

For Part (c) (iii), candidates were asked to recommend and outline a mitigation method to prevent future fish kills. Part (c) (iii) was not done well, with most candidates unable to identify a suitable mitigation strategy.

Question 2

This question tested candidates' ability to present data in graphical form as well as to identify and describe trends from this data. In addition, the question also tested candidates' understanding of the functions of mangrove forests in the environment.

In Parts (a) (i), (ii) and (iii), candidates were required to use the results in Table 2 which was provided to plot a suitable graph, describe the trend in the graph and determine the slope of the graph from results 12 to 20. The performance on these parts was satisfactory. Most candidates were able to present the data in the table in graphical form as required in Part (a) (i). Some candidates were unable to extract the trends from the data as required in Part (a) (ii) and most candidates were unable to determine the slope of the graph for Part (a) (iii).

In Part (b) (i), candidates were required to indicate on the graph the period of the fire that destroyed a significant portion of the mangrove forest and give reasons to support their answer in Part (b) (ii).

Parts (b) (i) and (ii) were not well done. Most candidates were not able to identify when the fire occurred as required in Part (b) (i). The graph showed a sharp rise in nitrate concentration in Month 12, which is when the fire probably took place. Many candidates instead chose Month 40, which is when the nitrate concentration started to decline rapidly. Candidates were confused about the role of the mangrove in the nitrate concentration in the river and this was reflected in their answers. In Part b (ii), many candidates described the function of the mangrove in general and did not relate it to the manner in which it would affect a river — as was clearly the intent of the question.

Question 3

In Part (a) (i), candidates were required to define the term ‘aquaculture’; this part was very well done with most candidates being able to correctly define aquaculture. For Part (a) (ii), candidates were required to use the sketch map provided to suggest a location for an aquaculture business; this part was done very well with most candidates being able to identify a suitable location for the aquaculture business.

In Part (a) (iii), candidates were required to outline the process of tilapia aquaculture and in Part (a) (iv) to provide two advantages and two disadvantages of aquaculture; this part was done very well with most candidates correctly outlining the process of aquaculture and providing appropriate advantages and disadvantages of aquaculture.

In Part (b) (i), candidates were provided with Table 1 which showed world data on wild and farmed fisheries and were required to plot a suitable bar chart to display the data in the table. For Part (b) (ii), they were asked to suggest and plot appropriate values for the year 2010.

Part (b) (i) was satisfactorily done with many candidates correctly representing the data in graphical form. Part (b) (ii) was not very well done; most candidates were unable to suggest and plot appropriate values for 2010.

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
ADVANCED PROFICIENCY EXAMINATION**

MAY/JUNE 2011

ENVIRONMENTAL SCIENCE

UNIT 1

GENERAL COMMENTS

In Unit 1, overall performance was comparable with that of 2010 with 92 per cent of candidates achieving Grades I–V. However, there was a decline in the standard of the school-based assessment due to the fact that the new guidelines for the School-Based Assessment are not being interpreted and applied correctly in accordance with the new syllabus. In terms of module performance, candidates did best on Module 3 (Sustainable Use of Natural Resources), followed by Module 1 (Fundamental Ecological Principles) and then Module 2 (Human Population and the Environment).

DETAILED COMMENTS

Paper 01 – Multiple Choice

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

Paper 02 – Essay Questions

Overall, candidates' performance was best in Module 3 followed by Module 1 and then Module 2.

Module 1: Fundamental Ecological Principles

Question 1

In Part (a), candidates were required to use a graph illustrating how the numbers of two species in a symbiotic relationship changed over time; identify the type of symbiotic relationship illustrated; explain how the symbiotic relationship may have resulted in the illustrated graph; analyse a statement based on the graph and make deductions from the graph about the number of individuals in particular species.

Most candidates were able to correctly identify the type of symbiotic relationship that was depicted but there were too many candidates who could not explain how the symbiotic relationship may have resulted in the graph.

Part (a) (iii) required candidates to interpret the statement *The presence of Species 2 is a limiting factor for Species 1* based on their analysis of the graph. Candidates had difficulty interpreting the statement. This was compounded by the fact that not too many candidates knew what limiting factors were and as a result, many candidates failed to correctly interpret the statement.

Part (b) tested candidates on the principle of energy transfer and energy flow in ecosystems. This part of the question was done very well by candidates.

Question 2

Part (a) required candidates to name and describe an appropriate method for determining and calculating species diversity of non-mobile organisms. Part (b) tested candidates' ability to deduce information on species diversity from a graph. Part (c) tested candidates' understanding of the concept of ecosystem stability.

For Part (a), in most cases, candidates were unable to give an accurate description of the method named.

In Part (b), candidates were unable to read and interpret the data from the graph and this led to them not being able to make the correct calculations.

For Part (c), while most candidates were able to define the term *ecosystem stability*, they were unable to explain why a low species diversity may have resulted in poor ecosystem stability.

Candidates' performance on this question was poor.

Module 2: Human Population and the Environment

Question 3

Parts (a) and (b) of this question were based on age structure diagrams for three countries. In Part (a), candidates were required to name three types of population pyramids that are constructed based on mortality and fertility rates. Most candidates were able to name at least one type of population pyramid.

Part (b) required candidates to make deductions about population growth for each of the three countries represented by the pyramids and to distinguish whether the pyramids represented developing or developed countries, giving reasons for their answers.

In Part (b) (i), many candidates were unable to make correct deductions from the graph. In many instances, candidates did not pay attention to the diagrams and simply discussed trends without linking them to the diagrams and without discussing population growth.

For Part (b) (ii), candidates were able to correctly distinguish population pyramids for developing and developed countries. However, candidates were unable to give appropriate

reasons for their responses. This demonstrated that candidates did not fully understand population pyramids and how to interpret them.

Part (c) was done very well. Most candidates were able to discuss how age of marriage, family planning services and government policy affected human population growth rate. The more able candidates recognized both positive and negative impacts of these factors and were able to present a balanced discussion.

Question 4

Part (a) of this question presented a graph showing the percentage of people living in rural and urban areas in three countries. Candidates were required to complete the diagram by inserting the missing bars for two of the countries; this required them to calculate the percentage of people living in the urban areas for Country B and the percentage of people living in the rural areas for Country C. Candidates experienced some difficulty with this part. Many candidates did not correctly calculate these values because they did not know that the sum of the percentage of people living in rural and urban areas in each country totalled 100 and many candidates failed to complete the diagram correctly.

In Part (a) (ii), candidates were required to compare the distribution of rural and urban population in the three countries. This was challenging for some candidates who were unable to interpret information from the graph.

For Part (a) (iii), candidates were required to explain why the population growth in Country B may have resulted in the distribution illustrated in the graph and this was also challenging for those candidates who were unable to interpret graphs.

In Part (b), candidates were required to describe two environmental impacts associated with the type of population distribution in Country C. Most candidates were able to correctly outline two environmental impacts.

Part (c) tested candidates' understanding of the concept of sustainable development. Most candidates demonstrated a very good understanding of this concept and were able to explain how an increase in the population may affect a country's ability to achieve sustainable development.

Module 3: Sustainable Use of Natural Resources

Question 5

Part (a) required candidates to identify two natural resources for a named Caribbean country and Part (b) required them to give reasons why one of the natural resources identified was important to the named Caribbean country. These parts were done very well.

Part (c) required candidates to study a graph and interpret the information presented. Once again as was demonstrated throughout, most candidates had difficulty with interpreting and reading information from the graph. In addition, many candidates failed to explain how the new environmental policy would have affected the illegal tree harvesting trade. This was primarily the case because many candidates attempted to answer the question without reference to the graph. This also resulted in candidates failing to determine how long it took for illegal tree harvesting to return to the level that existed before the new road was built. Overall, candidates demonstrated limited skills at interpreting graphs and making deductions from graphs. As a result many candidates performed poorly on this part of the question. Overall, candidates' performance on this question was, however, satisfactory.

Question 6

For Part (a), most candidates were able to give a reason why natural resources should be conserved.

In Part (b), a few candidates understood the concept of waste reduction and minimization and were able to explain how the practice could result in natural resource conservation.

Part (c) required candidates to relate waste minimization and waste reduction to industries and discuss measures that could be used to encourage industries to practise waste reduction and waste minimization, while discussing the effectiveness of such measures in the Caribbean. A few candidates were able to adequately explain how industries in the Caribbean can be encouraged to implement waste minimization and waste reduction and to discuss the effectiveness of the use of such measures in the Caribbean.

Part (d) required candidates to analyse the information presented in a diagram on water quality in quarry effluent before and after settling pond treatment and to make deductions from the data presented.

Overall, candidates demonstrated limited skills at interpreting graphs and making deductions from graphs and as a result many of them performed poorly on this part of the question.

Paper 031 – School-Based Assessment

In previous years, the School-Based Assessment (SBA) was a project to be presented in the form of a report with the following parts:

- (i) Title page, name, date, table of contents
- (ii) A statement of the task — purpose of the project
- (iii) Methods of data collection and literature review
- (iv) Presentation and analysis of data
- (v) Discussion of findings and limitations

- (vi) Conclusions
- (vii) Bibliography

The SBA for the revised syllabus assessed for the first time this year consisted of a journal. Reports for a series of site visits and laboratory exercises associated with the site visits were to be recorded in the journal.

The journal comprised:

- (i) An entry for each site visit
- (ii) Laboratory exercises
- (iii) A final report of the set of site visits

Site visits are assessed as shown below:

- | | | |
|--------|----------------------|-----------------|
| (i) | Entry Number | |
| (ii) | Date | |
| (iii) | Site (location) | |
| (iv) | Objective(s) | 1 mark |
| (v) | Activities | 4 marks |
| (vi) | Observations | 2 marks |
| (vii) | Comments | 2 marks |
| (viii) | Follow-up Activities | 1 mark |
| | | 10 marks |

Laboratory exercises are assessed as shown below:

- | | | |
|-------|------------------------------|-----------------|
| (i) | Planning and Designing | 4 marks |
| (ii) | Observation and Recording | 5 marks |
| (iii) | Manipulation and Measurement | 2 marks |
| (iv) | Analysis and Interpretation | 6 marks |
| (v) | Reporting and Presentation | 3 marks |
| | | 20 marks |

(scaled to 10 marks)

The final report is assessed as shown below:

- | | | |
|-------|--|---------|
| (i) | Clarity of the statement of the world problem
(project description) | 2 marks |
| (ii) | Definition of the scope of the project
(purpose of the project) | 3 marks |
| (iii) | Adequacy of information/data gathered and the
appropriateness of the design chosen for investigating
the problem | 3 marks |
| (iv) | Appropriateness of the literature review | 5 marks |
| (v) | Presentation of data/Analysis of data (summary of | |

	the site-visits and laboratory exercises)	6 marks
(vi)	Discussion of findings	8 marks
(vii)	Conclusion	3 marks
(viii)	Recommendations	4 marks
(ix)	Communication of information	4 marks
(x)	Bibliography	2 marks
	Total	40 marks

Candidates' performance on the school-based assessment was satisfactory. Teachers must be reminded that journal entries are to be based on either field visits to one site where changes over time are observed or visits to different sites to compare and contrast similar processes or occurrences. This was done by most students. However, there are still some students with insufficient site visits.

In general, most students submitted an adequate number of laboratory exercises which were mostly well done. In a few instances, the spread of the laboratory exercises was too narrow and the laboratory exercises chosen were too simple for the level of examination.

While most students' work demonstrated adequate coverage of the skills to be assessed, there is still room for improvement in the areas of manipulation and planning and designing.

The quality of the journals submitted was satisfactory. However, there were some students who were unable to link journal entries and laboratory exercises to specific objectives and conduct appropriate, complementary and supporting activities. Teachers and students should be reminded that the laboratory activities should be associated with the site visits and not treated as independent activities that are not related.

Paper 032 – Alternative to School-Based Assessment

Question 1

In Part (a), candidates were expected to use the information provided to draw a bar graph showing the variation in the number of species at two sites.

For Part (b), candidates were asked to calculate species abundance and species diversity. Candidates were required to use the values that were calculated for these two parameters to decide which of the two sites was expected to be more stable. Candidates were also required to justify their answer.

In Part (c), candidates were required to describe a method which may be used to estimate the population size of moving organisms. They were also required to state three assumptions of the method chosen.

Candidates' performance on this question was good. Many of them had difficulty plotting the graph to represent the data.

Some candidates also had difficulty calculating the species diversity and species abundance. It was apparent that some candidates did not know the formula to be used to calculate species diversity. A few candidates also did not understand the concept of species abundance.

Candidates should be aware that when asked to plot a graph marks are generally awarded as follows:

- giving the graph an appropriate title
- correctly labelling the horizontal and vertical axes
- correctly labelling the graphs
- using an appropriate scale on each axis
- plotting all points correctly
- drawing a smooth curve through all points

Question 2

This question was designed to test candidates' understanding and knowledge of how to calculate population parameters and how these parameters interacted to influence population change.

Part (a) required candidates to calculate the following based on information provided in a table: population size, birth rate, rate of natural increase, total population increase. Most candidates were unable to calculate these population parameters.

Part (b) required candidates to make deductions about birth rate and life expectancy from diagrams showing stages of demographic transition. This part of the question proved to be problematic for some candidates.

Part (c) required candidates to explain how fertility rates affected the population growth of developed and developing countries. This part of the question proved to be problematic for most candidates. It was obvious from the responses that candidates did not understand how fertility rates affected population growth in developed and developing countries.

Part (d) required candidates to list ways in which human populations impact negatively on the environment and also explain how lifestyles in developed and developing countries impacted on the patterns of consumption of natural resources. Most candidates were able to answer this part of the question very well.

Question 3

Part (a) of this question required candidates to use information provided to plot a line graph. Candidates were then required to use the graph to determine the rate of construction of houses in the Aripo Savannah from 1975-2000 and to estimate the number of houses in the Aripo Savannah in 2010. Most candidates performed very well on this part of the question.

Part (b) required candidates to state two reasons for the importance of the Aripo Savannah as a natural resource. Part (c) required candidates to describe three measures that the Government of Trinidad and Tobago could use for the management and conservation of the savannah while Part (d) required candidates to choose one of the measures and discuss its likely effectiveness.

Most candidates were able to provide correct answers to Part (b) but Part (c) and Part (d) proved problematic to some candidates. Candidates were unable to provide discussions and descriptions with the scope and depth required at the CAPE level.

UNIT 2

GENERAL COMMENTS

In Unit 2, 93 per cent of the candidates achieved Grades I–V compared with 97 per cent in the 2010. Similar to Unit 1, there was a decline in the standard of the school-based assessment. The new guidelines for the Internal Assessment are being interpreted and applied correctly in accordance with the new syllabus.

Candidates performed best on Module 1 (Agriculture and the Environment), followed by Module 2 (Energy and the Environment) and then Module 3 (Pollution and the Environment).

DETAILED COMMENTS

Paper 01 – Multiple Choice

Paper 01 consisted of 45 multiple-choice items with 15 items from each module. Candidates' performance on this paper was good.

Paper 02 – Essay Questions

Module 1: Agriculture and the Environment

Question 1

Part (a) was done well by most candidates. Most candidates were able to list three characteristics of commercial agricultural systems.

Part (b) was also well done by candidates and they were able to give examples of the use of technology in agriculture and also to discuss how technology could be used to improve agricultural productivity.

Part (c) required candidates to study a graph which compared the yield obtained by a farmer when using inorganic and organic fertilizers. Most candidates were able to make appropriate deductions from the graph about the agricultural yield and also gave valid reasons why organic fertilizer was promoted as a feasible option to the use of inorganic fertilizer.

In their responses, candidates demonstrated an awareness of the issues concerning the use of organic versus inorganic fertilizers. Overall performance on this question was very good.

Question 2

Part (a) tested candidates' ability to read and interpret a graph depicting contributions made by subsistence and commercial agriculture to agroprocessing, food security, Gross Domestic Product (GDP) and employment in a Caribbean country. Part (b) tested candidates' understanding of sustainable agriculture; Part (c) tested candidates' understanding of climate change and its impact on sustainable agriculture; and Part (d) tested candidates' understanding of agroforestry as an environmentally sustainable practice.

Part (a) was done fairly overall. Most candidates were able to identify and explain trends in the graph.

Part (b) was generally done well by most candidates. Part (c) was challenging for some candidates. Even though many candidates had an idea of the impacts of climate change, they were unable to clearly explain how climate change could be a major threat to sustainable agriculture in the Caribbean.

Part (d) was generally well done by most candidates who demonstrated an understanding of the concept of agroforestry and why it is considered an environmentally sustainable practice in agricultural systems.

Module 2: Energy and the Environment

Question 3

Part (a) tested candidates understanding of trends in the use of commercial energy resources. Candidates were required to describe the pattern of commercial energy resource use after studying a graph. This part of the question also tested candidates' ability to interpret a graph and identify and explain trends. Part (a) was generally fairly done by the candidates. The more able candidates were familiar with the skill of interpreting graphical data.

Part (b) was poorly done. Candidates were required to make deductions and inferences from a graph and many of them were not able to correctly answer this question, they did not correctly interpret the information presented.

Most candidates performed better on Part (c) and Part (d) since they were able to identify limiting factors for the use of energy resources and to discuss the relevance of the alternative energy sources.

Question 4

Parts (a) (i) and (ii) required candidates to use an annotated flow diagram to illustrate the conventional generation of electricity using natural gas as the fuel. Parts (a) (i) and (ii) were, in general, poorly done. Candidates were unable to draw and annotate a diagram that showed the conventional generation of electricity using natural gas as a fuel.

It was clear that many candidates could not represent the process of conventional electricity generation using a flow chart because they simply did not understand the process.

Part (b) required candidates to study the information presented in a table on generation and consumption of electricity in various Caribbean countries. Candidates were required to classify countries using given criteria and to present their answers in a suitable table. Some candidates appeared not to follow instructions and did not use the established criteria.

Part (c) required candidates to study a graph which depicted energy generation and consumption for three Caribbean countries and to calculate the difference in electricity generation between Grenada and St Kitts and Nevis. This part of the question required candidates to apply their graph interpretation skills and this posed a problem for some candidates.

Part (d) required candidates to outline one impact of the use of fossil fuel on the environment. This part of the question was done well by many candidates. Most candidates were able to outline impacts such as *global warming*, *habitat destruction* and *pollution* as they related to fossil fuel use.

Module 3: Pollution of the Environment

Question 5

Part (a) tested candidates' understanding of secondary air pollutants. Most candidates performed well on this part of the question.

Part (b) required candidates to use an insert and complete the pathway of a pesticide when sprayed aerially to show how it may enter humans and the ocean. This part of the question was done well by most candidates.

Part (c) was generally well done. Most candidates were able to identify the processes that were labelled.

Part (d) was generally poorly done by most candidates. In Part (d) (i), too many candidates were unable to state inferences that may have been drawn from the results that were presented in a table which showed the concentration of pesticide in organisms from an aquatic ecosystem. In Part (d) (ii), many candidates had difficulty calculating the minimum concentration factor of the pesticide in the tertiary consumers and so had difficulty in Part (d) (iii) which required them to explain the pattern of pesticide concentration in the ecosystem shown in the table.

Question 6

Part (a) tested candidates' graph interpreting and analytical skills using a graph which presented information on the amount of waste produced by three countries for the period 1965–2005. Candidates performed well on Part (a) (i) and (ii) which required them to list three categories of waste produced in the Caribbean and to make three deductions from the information presented in the graph. Part (a) (iii) was challenging for some candidates as they had difficulty using the information presented to estimate the projected waste production in 2010 for County A.

Performance on Part (b) was satisfactory. Most candidates were able to present answers that assessed the effectiveness of legislation, policy incentives and public awareness and education as mitigation measures or solutions for environmental pollution.

Paper 031 – School-Based Assessment

With the revised syllabus, the format of the School-Based Assessment (SBA) for Unit 2 remained largely unchanged except for minor adjustments. The format for the SBA is described on pages 52–56 in the syllabus.

Students' performance on the SBA for Unit 2 was not satisfactory. Some students conducted the requisite number of site visits. However, there are still too many students with insufficient site visits. Teachers and students must be reminded that formal entries are to be based on either field visits to one site where changes over time are observed or visits to different sites to compare and contrast similar processes or occurrences.

Some students submitted laboratory exercises, however the number of students who did not submit the requisite number of laboratory exercises is too high. For those students who submitted laboratory exercises, in some cases, the laboratory exercises were not in any way related to the site visits. Teachers and students need to spend more time developing the following laboratory skills:

- Manipulation and Measurement
- Analysis and Interpretation
- Planning and Designing

The quality of the journals submitted was not satisfactory. Students were unable to link journal entries and laboratory exercises to specific objectives and conduct appropriate complementary and supporting activities.

Teachers and students should be reminded that the laboratory exercises should be associated with the site visits and not treated as independent activities that are not related.

Paper 032 – Alternative to School-Based Assessment

Question 1

This question tested candidates' ability to present data in a graphical form, and to identify and describe trends from this data. Part (a) required candidates to present the data that were presented in Table 1 on the effect of two different fertilizers on crop production in a line graph. Candidates were also required to study the information and recommend the best application rate for the new fertilizer. Candidates were also required in Part (iv) to calculate the difference in crop yields at an application rate of 65kg/ha.

Candidates' performance in this part of the question was satisfactory. Many candidates had difficulty plotting an appropriate line graph to represent the data. Candidates should be aware that marks are generally awarded as follows for the plotting of graphs:

- giving the graph an appropriate title
- correctly labelling the horizontal and vertical axes
- correctly labelling the graphs
- using an appropriate scale on each axis
- plotting all points correctly

- drawing a smooth curve through all points

Some candidates had difficulty calculating the difference in crop yields at an application rate of 65kg/ha. This indicated that they did not know how to read information from graphs.

In Part (b), candidates were required to study some diagrams which illustrated a number of different sustainable farming practices. Candidates were required to name the farming practices; explain how Farming Practice A could allow for maintaining ecological integrity of the farm and also how Farming Practice A differs from Farming Practice B. While most candidates were able to correctly identify and name the different farming practices and distinguish between the two farming practices, some candidates had difficulty explaining how the farming practices could help maintain ecological integrity.

In Part (c) candidates were required to explain why farmers in the Caribbean should be concerned about global warming. This part of the question was done well by candidates.

Question 2

This question tested candidates' ability to interpret data presented in graphical form, and to identify and describe trends from the data. The graphs presented illustrated the amount of carbon dioxide emissions produced by a number of Caribbean countries.

The performance on this question was poor. Candidates were unable to extract information from the graphs, discuss trends and make calculations based on the graph. The majority of the marks gained by candidates in this question were for Part (b) which required candidates to define energy efficiency and identify methods of improving energy efficiency while explaining how the method identified would result in improved energy efficiency.

Question 3

In Part (a), candidates were presented with a table containing information on some characteristics of three pesticides; they were required to state what is meant by 'half-life' and to explain which one of the three pesticides would most likely continue to pollute ground water supplies a year after application. Most candidates did well on these parts of the question. In addition, candidates were required to construct a bar graph to present the information in the table. Candidates' performance on this part was satisfactory.

In Part (b), candidates were expected to consider the properties of pesticides and explain one other characteristic that a farmer should consider if he/she wanted to apply all three pesticides at the same time. Too few candidates understood that the synergistic effect was when two or more pollutants may interact to give a combined effect. The combined effects are sometimes more severe than the sum of their individual effects. Therefore, pollutants that are able to combine in this manner will cause greater environmental impact.

Part (c) presented candidates with a table showing the concentration of Pesticide C in the tissues of two different types of organisms. It required candidates to use the information to calculate the concentration factor for the pesticide in the tertiary consumer. Candidates were also asked to explain why the pesticide concentration in the fish was so high even though no pesticide was applied for the last two years. Most candidates performed well on this part of the question.

CARIBBEAN EXAMINATIONS COUNCIL

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

MAY/JUNE 2012

ENVIRONMENTAL SCIENCE

GENERAL COMMENTS

In Unit 1, overall performance was comparable with that of 2011 with 94 per cent of candidates achieving Grades I–V. In terms of module performance, candidates did best on Module 3 (Sustainable Use of Natural Resources), followed by Module 1 (Fundamental Ecological Principles) and then Module 2 (Human Population and the Environment).

In Unit 2, 92 per cent of the candidates achieved Grades I–V compared with 93 per cent in the 2011.

Candidates performed best on Module 1 (Agriculture and the Environment), followed by Module 2 (Energy and the Environment) and then Module 3 (Pollution and the Environment).

DETAILED COMMENTS

UNIT 1

Paper 01 – Multiple Choice

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

Paper 02 – Essay Questions

Overall, candidates' performance was best on Module 3 followed by Module 1 and then Module 2.

Module 1: Fundamental Ecological Principles

Question 1

Candidates were provided with a graph which showed the variation of the population of duckweed, *lemna minor* with the concentration of agrochemicals in the effluent discharged from agricultural turns in close proximity to the duckweed.

Part (a) tested candidates' understanding of the concept of *limiting factor*. Very few candidates were able to adequately explain the concept. Candidates also did not pay attention to the fact that the question stated *other than agrochemicals* and many used this as an example.

Part (b) required candidates to describe the trend in population size of the duckweed shown in the graph. Most candidates were unable to interpret the data from the graph and therefore could not accurately describe the trend.

Part (c) required candidates to use the information in the graph to explain why the effluent concentration resulted in the observed trend and to explain how the variation in the duckweed population may impact on the population of other aquatic species. This part of the question was poorly done; most candidates were unable to interpret the data and therefore were not able to provide accurate explanations.

Question 2

Part (a) required candidates to distinguish between *gaseous biogeochemical cycles* and *sedimentary biogeochemical cycles* and to give examples of each. This part was well done with most candidates correctly distinguishing between the two types of cycles and giving correct examples.

Part (b) tested candidates' understanding of the *ten per cent rule* for the transfer of energy between trophic levels. Candidates were also required to state this rule and use it to explain why it is more efficient for humans to eat corn than to eat beef.

Candidates' performance on this question was less than satisfactory with less than 40 per cent of those who attempted the question scoring greater than 50 per cent of the available marks. Most candidates were unable to apply their knowledge of the ten per cent rule.

In Part (c), candidates were expected to use a pie chart showing forest area in three Caribbean countries to determine which two countries had a combined total of 50 per cent deforestation, which country would most likely have experienced the greatest loss of biodiversity, and to identify and justify the choice of a country where secondary ecological succession was least likely to occur.

Candidates' performance on this question was satisfactory; most of them were able to determine which two countries had a combined total of 50 per cent deforestation; they were also able to use the pie chart to identify the country with the greatest loss of diversity and the country where secondary ecological succession was least likely to occur, giving correct reasons for their choice.

Module 2: Human Population and the Environment

Question 3

Part (a) required candidates to define *per capita CO₂ emissions*. Candidates' performance on this part was satisfactory with most of them providing an accurate definition.

Part (b) required candidates to use the data in the table to calculate the total CO₂ emissions for the two countries and to use calculators to determine in which of the two countries the CO₂ emissions would have the greater impact on the environment.

Candidates' performance on this part was satisfactory. Many candidates were able to calculate the correct total carbon dioxide emissions and to determine the country where the emission of carbon dioxide would likely have the greater impact.

In Part (c), candidates were given the statement *When assessing the relationship between people and their environment, consideration must be given to abiotic and biotic factors* and were required to explain how extremes of temperature and fertile soil can affect the distribution and activities of human populations. This part was satisfactorily done with most candidates being able to provide accurate explanations.

Part (d) required candidates to discuss why some people believe that poverty tends to encourage population growth. Candidates' performance on this part of the question was poor. Too few candidates were able to expand on their points and make the connection between the statement and their discussion. There were too many assumptions and too little facts in the discussions presented.

Question 4

Part (a) presented information on environmental impacts of over-consumption of natural resources in two countries and candidates were required to determine in which country there would be a greater impact on natural habitats and in which country there would be a greater displacement of native species, giving reasons for their choices. This part was very well done, with the majority of candidates being able to adequately justify their choices.

Part (b) required candidates to outline one way in which a change in lifestyle could mitigate the environmental impacts of over-consumption of natural resources; this part was well done, with most candidates being able to outline one appropriate lifestyle change.

Part (c) required candidates to define the term *sustainable development*. This part was well done with most candidates correctly defining the term.

Part (d) required candidates to explain how fertility rates may impact on a country's ability to achieve sustainable development; this part was not very well done. Most candidates were only able to provide a partial explanation and were therefore only awarded some of the allocated marks.

Part (e) required candidates to suggest, with justification, an appropriate fertility rate that would allow Caribbean countries to achieve sustainable development. While the majority of candidates were able to suggest an appropriate fertility rate, they were not able to adequately justify the suggestion.

Module 3: Sustainable Use of Natural Resources

Question 5

Part (a) required candidates to study the graphic information presented on tree density variation for three Caribbean countries and to use the information to make deductions. Candidates did not perform very well on this part; they demonstrated limited skills at reading graphs and making deductions from graphs.

Parts (b) (i) and (ii) tested candidates' understanding of the concept of consumptive versus non-consumptive use of natural resources. Most candidates performed very well on this part of the question; candidates were able to provide accurate examples of consumptive use of natural resources important to the Caribbean as well as to adequately explain the environmental impacts of tourism as a non-consumptive use of beaches.

In Parts (b) (iii) and (iv), candidates were required to comment on the appropriateness of conservation measures. Performance on this part was satisfactory with some candidates being able to identify which measure was appropriate. However, quite a few candidates did not link the measures to the proposed development.

Question 6

For Part (a) (i), most candidates were able to give correct examples of renewable and non-renewable natural resources.

Part (a) (ii) was poorly done as only a few candidates were able to discuss the effect of geographical and technological factors on the use of natural resources and give suitable responses as required by the question.

Candidates' performance on Part (b) was less than expected. Too many candidates did not demonstrate adequate skills at reading and interpreting the data that was presented in the table. Candidates had difficulty describing the patterns in population growth and gravel extraction and also in explaining the relationship between population growth and gravel extraction as illustrated in the table. Candidates were not able to suggest appropriate ways to mitigate the negative impacts on the environment due to gravel extraction.

Paper 031 – School-Based Assessment (SBA)

Students' performance on the SBA was satisfactory. Teachers must be reminded that journal entries are to be based on either field visits to one site where changes over time are observed or visits to different sites to compare and contrast similar processes or occurrences. This was done by most students. However, there are still some students with insufficient site visits.

In general, most students submitted an adequate number of laboratory exercises which were mostly well done. In a few instances, the spread of the laboratory exercises was too narrow and the laboratory exercises chosen were too simple for the level of examination.

While most students' work demonstrated adequate coverage of the skills to be assessed, there is still room for improvement in the areas of manipulation, planning and designing and analysis and interpretation.

The quality of the journals submitted was satisfactory. However, there were some students who were unable to link journal entries and laboratory exercises to specific objectives and conduct appropriate, complementary and supporting activities. Teachers and students should be reminded that the laboratory activities should be associated with the site visits and not treated as independent activities that are not related.

Paper 032 – Alternative to School-Based Assessment

Question 1

In Part (a), candidates were provided with diagrams of two ecological pyramids and were required to describe how energy flows within an ecosystem, and state, with a reason, which diagram represented a pyramid of biomass. While most candidates were able to accurately describe how energy flows within an ecosystem, only a few candidates were able to correctly identify the pyramid of biomass and give a supporting reason.

In Part (b), candidates were required to use the data on a predator and prey population presented in a table to draw a graph and compare the trends in the population size of the two populations. They were also asked to describe ways in which predation may benefit the prey population. Many candidates had difficulty plotting the graph to represent the data and comparing the trends in the population size of the two populations. However, most candidates were able to correctly describe ways in which predation benefited the prey population.

In Part (c), candidates were required to discuss three ways in which human activities can disrupt the integrity of natural ecosystems. Candidates' performance on this part was good with most candidates being able to adequately describe ways by which human activities disrupt the integrity of natural ecosystems.

Question 2

Part (a) tested candidates' understanding and knowledge of the human development index (HDI) and gender development index (GDI).

Too few candidates demonstrated an understanding of HDI and GDI and the role of these indices in assessing the relationship between population growth, development and poverty. Only a few candidates were able to state three deductions regarding the relative achievement of both countries based on their HDI and GDI.

Part (b) required candidates to discuss how improving access to education for women in less developed countries (LDCs) can contribute to the lowering of the population growth rate of LDCs. This part of the question was very well done by most candidates.

Part (c) required candidates to use the data provided to calculate the estimated percentage growth in the world population attributable to LDCs between 1995 and 2025. Candidates were also required to state the implications of this estimated population growth for an LDC. This part of the question was not done very well. It was obvious from the responses that candidates did not know how to do the calculation and did not understand how the estimated population growth rate could affect population growth in an LDC.

Question 3

Part (a) required candidates to use the information in a graph to compare changes in the quantity of two resources over a ten-year period; this part was poorly done as most candidates were unable to interpret and make deductions from the graph.

Part (b) required candidates to state two reasons why bioprospecting is considered a non-consumptive use of natural resources; only a few candidates demonstrated knowledge of bioprospecting.

Part (c) required candidates to explain how population growth and public awareness can affect the manner in which a country uses its natural resources; this part was very well done by most candidates.

Part (d) required candidates to discuss how the use of environmental legislation can assist efforts for the conservation and protection of natural resources; this part was very well done by most candidates.

UNIT 2**DETAILED COMMENTS****Paper 01 – Multiple Choice**

Paper 01 consisted of 45 multiple-choice items with 15 items from each module. Candidates' performance on this paper was good.

Paper 02 – Essay Questions**Module 1: Agriculture and the Environment**Question 1

Part (a) required candidates to state three characteristics of subsistence agricultural systems and most candidates were able to correctly state the characteristics.

Part (b) required candidates to discuss reasons why natural disasters were threats to sustainable agriculture. Most of the responses to this part were very good with the majority of candidates correctly discussing reasons why natural disasters threatened sustainable agriculture.

Part (c) (i) required candidates to make three deductions about the impact of agriculture on the environment from a pie chart; this part proved difficult for most candidates. Many candidates simply copied the percentages from the chart for their answer.

Part (c) (ii) required candidates to determine the total impact of agriculture on the environment. This part was poorly done by most candidates.

Part (c) (iii) required candidates to provide three reasons why land degradation in the chart was as high as 42 per cent. Most candidates were unable to identify practices that would lead to land degradation and to explain why these practices would lead to land degradation.

Question 2

Part (a) required candidates to state four features of sustainable agriculture; this part was well done with most candidates correctly stating features of sustainable agriculture.

Part (b) required candidates to make four deductions about the use of different types of pest control methods from the data provided in a stacked bar chart. Most responses were good because they included correct and appropriate deductions.

Part (c) required candidates to explain why a decline in agricultural production may be detrimental to the economy of some Caribbean countries. This was satisfactorily done with some candidates being able to provide adequate explanations.

Part (d) required candidates to discuss why agro-forestry and conservation were considered environmentally sustainable agricultural practices. The responses to this part were very good.

Module 2: Sustainable Energy Use

Question 3

Part (a) (i) required candidates to define the term *energy efficiency*; this was poorly done as most candidates were unable to correctly define the term.

Part (a) (ii) required the candidates to use the data provided in a bar chart to determine the percentage of energy output that was in a beneficial form. This response was good as most candidates were able to read the graph and perform the required calculation.

Part (a) (iii) required candidates to use the bar chart to determine how much energy was lost as unnecessary energy waste. This part was poorly done as candidates were unable to do the calculation correctly.

Part (a) (iv) required candidates to suggest three ways in which the country could improve its energy efficiency. Most candidates provided responses that were good, suggesting appropriate ways that could be used to improve energy efficiency.

Part (b) (i) required candidates to define the term *kinetic energy* and this was poorly done as most candidates were unable to provide a correct definition.

Part (b) (ii) required candidates to explain, using a suitably labelled diagram, how wind energy is harnessed to produce electricity. The responses provided were good and contained clear, well and fully labelled diagrams illustrating a windmill, along with appropriate text to explain how the windmill worked to generate the electricity.

Question 4

Part (a) required candidates to provide two reasons why a small Caribbean country would consider diversifying its energy sources and using less fossil fuels. This part was very well done, with most candidates being able to suggest appropriate reasons.

Part (b) (i) required candidates to define the term *renewable energy*. This part was very well done by candidates.

Part (b) (ii) required candidates to identify and justify suitable sources of renewable energy for the island depicted in a diagram. This question was very well done with the majority of candidates accurately identifying, with appropriate justification, suitable sources of renewable energy.

Part (c) (i) required candidates to determine, from a graph, what percentage of commercial energy is derived from renewable sources. This part was poorly done as most candidates were unable to perform the calculation correctly.

Part (c) (ii) required candidates to compare the amount of commercial energy obtained from renewable energy in the United States with that of the rest of the world and to suggest a reason for the difference. This part was not well done as only a few candidates were able to adequately make the comparison and suggest a suitable reason.

Module 3: Pollution of the Environment

Question 5

Part (a) (i) required candidates to define the term *BOD*; this part was poorly done as most candidates were unable to provide a correct definition.

Parts (a) (ii) and (iii) required candidates to use their understanding of *BOD* and the processes which occur in a sewage treatment plant to determine from the graph provided the number of times the sewage treatment plant malfunctioned, explaining how they arrived at this number. These parts were poorly done as most candidates were unable to give the accurate number of times the plant malfunctioned and explain the method used to determine the answer.

Part (a) (iv) required candidates to identify from the graph the first and last days of the longest plant malfunction. This was poorly done as most candidates were unable to identify the first and last days.

Part (a) (v) required candidates to use the graph to determine the average *BOD* concentration when the plant was operating normally. This was done very poorly with the majority of candidates unable to determine when the plant was operating normally.

In Part (b), candidates were given a diagram and asked to describe the pathway of heavy metal pollution in the river. Candidates were also required to explain why the concentration of heavy metals is much higher in oysters in the swamp at the mouth of the river than in the water higher up the river. Candidates' responses were satisfactory for this part as most of them were able to correctly describe the pathway and provide an adequate explanation for the difference in concentration.

Question 6

Part (a) required candidates to define the term *pollutant*; this part was well done as most candidates were able to correctly define the term.

Part (b) required candidates to discuss the statement *the institutional framework within a country can be an underlying cause of air pollution*. This part was poorly done as most candidates did not understand the term *institutional framework*.

Part (c) (i) required candidates to describe the formation of acid rain using appropriate chemical equations. This part was not well done as most candidates were only able to provide a partial description and the responses were not clear and concise.

Part (c) (ii) required candidates to outline an experimental method to determine if there was an acid rain problem in an entire country. This part was poorly done by most candidates as they were unable to correctly describe the experimental techniques required to conduct the investigation.

Paper 031 – School-Based Assessment (SBA)

There was an improvement in the overall performance on the SBA and also in the quality of journals submitted.

Some students conducted the requisite number of site visits. However, there are still too many students with insufficient site visits. Teachers and students must be reminded that formal entries are to be based on either field visits to one site where changes over time are observed or visits to different sites to compare and contrast similar processes or occurrences.

Teachers and students need to spend more time developing the following laboratory skills:

- Manipulation and measurement
- Analysis and interpretation
- Planning and designing

Teachers need to ensure that students always use the most appropriate data collection techniques and a variety of formats to present data.

Paper 032 – Alternative to School-Based Assessment

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

Question 1

Part (a) required candidates to describe the characteristics of a small dairy farm with respect to inputs and productivity. This part of the question was very well done by most candidates.

Part (b) tested candidates' ability to present data in a graphical form. While candidates' performance on this part of the question was fair, some candidates had difficulty plotting a suitable graph to illustrate the data.

Part (c) required candidates to suggest ways in which the farmer whose waste management practices were presented in the stimulus could be improved and to discuss an environmental impact which could result if the waste management practices were not improved. Most candidates performed poorly on this part as they seemed unfamiliar with waste management practices.

Part (d) required candidates to study the scenario that was presented and name environmentally sustainable practices the farmer could implement to address his use of the steep hill for the new expansion and also to discuss an environmental impact that may occur if the farmer does not implement any of the practices that were identified. Candidates' performance on this part of the question was good with most of them being knowledgeable about the topic of environmentally sustainable practices.

Question 2

Part (a) (i) required candidates to interpret data on a graph by describing the trends in energy use of the farmer; this part was poorly done as most candidates were unable to interpret the data in the graph correctly.

Part (a) (ii) required candidates to use the pattern of the graph to make a projection; this part was poorly done as candidates were unable to calculate the number of 50-watt hour solar panels required to meet the projected electricity needs of the farm.

Part (a) (iii) required candidates to explain how photovoltaic cells converted solar energy into electricity; this part was poorly done as most candidates did not know how photovoltaic cells converted solar energy into electrical energy.

Part (a) (iv) required candidates to justify the accuracy of the statement *Petroleum can be described as indirect solar power*. This part was poorly done by most candidates who were unable to provide reasons to justify the accuracy of the statement.

Part (b) required candidates to state factors which affected electricity-generating capacity and demand and to use a labelled diagram to describe the conventional generation of electricity. This part was very well done by most candidates who provided accurate factors that affected electricity-generating capacity and demand, and were able to use a labelled diagram accurately to describe the conventional generation of electricity.

Question 3

Part (a) tested candidates' understanding of the greenhouse effect and the role and composition of greenhouse gases. Most candidates did well on this part of the question. Candidates demonstrated that they were knowledgeable about the topic of the greenhouse effect.

Part (b) required candidates to use the data presented to calculate the average weekly methane emissions and to record the data in an appropriate table. Candidates were also required to plot a bar chart to represent the average weekly methane emissions. Candidates' performance on this part of the question was satisfactory with some of them being able to correctly calculate the average weekly methane emissions and to present the information in the form of a bar chart.

Part (c) required candidates to provide reasons why the farmer should try and capture the methane emissions from his dairy cattle and to outline a method that the farmer could use to capture the methane emissions from his cows.

Candidates' performance on this part was poor; most candidates were unable to give reasons for the capture of the methane emissions and to outline a method for capturing the methane emissions.

CARIBBEAN EXAMINATIONS COUNCIL

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

MAY/JUNE 2013

ENVIRONMENTAL SCIENCE

GENERAL COMMENTS

In Unit 1, overall performance was comparable with that of 2012 — 95 per cent of candidates achieved Grades I–V. In terms of module performance, candidates performed better on Module 3 (Sustainable Use of Natural Resources) and Module 2 (Human Population and the Environment) than on Module 1 (Fundamental Ecological Principles).

In Unit 2, 94 per cent of candidates achieved Grades I–V compared with 95 per cent in 2012. Candidates performed best on Module 1 (Agriculture and the Environment) followed by Module 2 (Energy and the Environment) and then Module 3 (Pollution and the Environment).

DETAILED COMMENTS

UNIT 1

Paper 01 – Multiple Choice

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

Paper 02 – Essay Questions

Overall candidates' performance was better in Module 3 and Module 2 than in Module 1.

Module 1: Fundamental Ecological Principles

Question 1

In this question, candidates were required to study a diagram which illustrated the nitrogen cycle. The processes occurring in the cycle were not named, but labelled as Process I, II and III. Candidates' performance on this question was not satisfactory.

In Part (a) (i), candidates were required to identify the type of bacteria which allowed each of the Processes I, II and III to occur. Too many candidates did not identify the type of bacteria, with some making an attempt to identify the processes, and doing so incorrectly.

Part (a) (ii) required candidates to identify three ways in which human beings may alter the nitrogen cycle. Responses illustrated that candidates' understanding of the nitrogen cycle was limited since few were able to identify the ways in which the nitrogen cycle could be altered.

Part (a) (iii) required candidates to justify the advice given to a farmer with respect to reducing the amount of money spent on nitrogen fertilizers by intercropping with legumes regularly. Many candidates could not justify the advice given to the farmer with respect to utilizing intercropping to reduce money spent on fertilizers.

Part (b) (i) required candidates to utilize information from a table to calculate the species diversity of insects in one of three ecosystems utilizing a given formula; it was not done very well.

Part (b) (ii) required candidates to use the information derived from the calculation in (b) (i), and that provided in the table to identify and justify the ecosystem which is likely to better withstand disturbance. This part was not well done; most candidates were unable to explain which ecosystem was likely to better withstand ecological disturbances.

Question 2

Candidates' performance on this question was satisfactory. Part (a) required candidates to outline the role of natural selection in the evolution and adaptation of species.

Part (b) (i) required candidates to examine a graph showing the percentage impact of human activities on aquatic and terrestrial ecosystems, and identify three deductions. This part was generally well done.

Part (b) (ii) required candidates to interpret the graph and identify the values of two anthropogenic impacts which have the highest impact on the terrestrial ecosystems. This question was well done but many candidates failed to identify and total the percentage values in addition to identifying the activity. The correct response should have been in the following format:

*greatest total impact on terrestrial ecosystems:
pesticide use (40 %) + fertilizer use (30%) = 70%*

Part (b) (iii) required candidates to explain why the discharge of sewage into aquatic ecosystems should not be encouraged. This part was generally well done.

In Part (c), candidates were expected to use a diagram which showed the relationship between the change in the number of fish and the change in the pH. Candidates were required to explain the distribution pattern of the fish with respect to the change in pH in the aquatic ecosystem. This question tested candidates' understanding of the concepts of *limiting factors*, *tolerance ranges* and *environmental resistance*. Most candidates offered explanations based on limiting factors and tolerance ranges; not many candidates offered explanations based on environmental resistance.

Module 2: Human Population

Question 3

Part (a) required candidates to distinguish between *human development index* (HDI) and *gender development index* (GDI). Candidates' performance on this part was satisfactory.

Part (b) required candidates to provide an explanation of how climate and economy affect human population density. This question was generally well done, with candidates identifying and explaining at least one of the two factors.

In Part (c), candidates were given a table outlining the percentage of the population in the urban areas of three countries. In Part (c) (i), they were required to describe the trends for each country based on the information in the table; most candidates were able to give satisfactory responses. However, some candidates missed the qualifier *each* and spoke about one or two countries, instead of all three. In Part (c) (ii), candidates were given the total population of Country B in 1980, and were required to calculate the number of people who lived in rural areas in 1980. Candidates' performance on this part was less than satisfactory. Many candidates erred in their calculation and too many of them did not include units in their responses.

In Part (d), candidates were presented with a suite of four pictures labelled W, X, Y and Z. While the quality of the pictures was not optimal, most candidates were able to identify the two required environmental impacts from the pictures in Part (d) (i). Part (d) (ii) was generally well done; most candidates were able to explain one way by which one of the impacts could be mitigated. However, candidates are cautioned to follow the instructions given in questions. For example "... one way by which one of the impacts ..." meant that a comprehensive explanation of one impact was required.

Question 4

This question dealt with fertility rates, education levels and per capita waste production.

In Part (a), candidates were presented with information on the total fertility rates for women in a country, and were required to state four deductions which could be made from the graph about the relationship between total fertility rate and the level of education of women. Most candidates were able to furnish at least three accurate deductions.

In Part (b), candidates were required to suggest reasons to explain the relationship between the total fertility rate and the level of education of women in the country. This part was adequately done but some candidates were under the mistaken impression that the 'x' axis related to the age of the girls as opposed to the level of education of the girls. As a result, some responses drew a correlation between the age of the woman and her ability to bear children: "... the women in primary school have a low fertility rate, because they were too

young to bear [much] children ...'. These responses meant that candidates completely misread the graph, which was to their detriment.

Part (c) required candidates to explain the relationship between fertility rate and the country's ability to use its natural resources in a sustainable manner. This part was generally well done, with most candidates identifying cogent reasons. However, in many cases, candidates fell down on the expansion of the reason(s), by way of a comprehensive explanation.

Part (d) presented information on the per capita waste production of two countries – A and B. In Part (d) (i), candidates were required to define *per capita waste production*. This was attempted by most candidates, though many could not furnish a complete definition. Candidates may benefit from greater emphasis on the definition of terms and the use of appropriate terminology when answering this type of question.

In Part (d) (ii), candidates were asked to identify the country where waste production would have a greater impact on the environment; they were also required to support their answer by providing three reasons. The majority of candidates was able to identify Country A as the country whose per capita waste production would have a greater impact on the environment, but many were unable to adequately support their answer.

Module 3: Sustainable Use of Natural Resources

Question 5

In this question, candidates were presented with information on the effect of a government's policy on tax incentives on the use of natural resources. Candidates performed poorly.

Part (a) (i) required candidates to describe how a tax incentive worked to manage the use of a natural resource. Candidates' performance was unsatisfactory, as most of them either did not know what a tax incentive was or equated it to a form of taxation. As a result, the definition/explanation of the tax incentive was lacking: *A tax incentive will encourage persons to use the desired technology. This makes it cheaper to use, and will therefore reduce the amount of the natural resource needed by the population.*

Part (a) (ii) required candidates to calculate the average annual increase in solar water heaters for the first five years after the tax incentive policy was introduced. Many candidates faced challenges in reading off the graph and doing the calculation. This skill is one which needs to be focused on and enhanced during classroom sessions. Essentially, candidates needed to read off the following from the graph and complete the calculation:

$$\frac{\# \text{ of water heaters at Year 5} - \# \text{ of water heaters at Year 1}}{\text{Year 5} - \text{Year 1}}$$

In Part (a) (iii), candidates were required to evaluate the effectiveness of the tax incentive in changing the behaviour of the country's citizens with respect to natural resource use. Candidates performed poorly on this part, and most failed to utilize the actual values from the figure provided as required by the question. Candidates demonstrated limited skills at reading graphs and making inferences from graphs. This is an area of skill development that should be focused on during classroom sessions.

Part (b) provided candidates with two questions and corresponding answers which were incorrect. Candidates were required to provide the correct answer, and explain why the given response was incorrect.

- (i) **Question:** What is the difference between a renewable and an inexhaustible resource?

Answer: There is no difference between these terms, they are the same thing.

Most candidates had difficulty distinguishing between renewable and inexhaustible resources, with many providing incorrect examples for either one or both. Accordingly, they could not identify that a renewable resource and an inexhaustible resource were not the same thing.

A renewable resource is one which can be extracted and utilized, but if given enough time it can replenish itself, for example, trees. However, if the rate at which the renewable resource is consumed exceeds its renewal rate, renewal and sustainability will not be ensured.

An inexhaustible resource is one that can never be used up, no matter the rate of consumption, for example, the sun.

- (ii) **Question:** Explain how technological factors can affect natural resource use in the Caribbean.

Answer: Technological factors do affect natural resource use in the Caribbean. For example, issues such as population growth can have a big impact. As populations increase, they require more raw materials and so more resources will be used up to satisfy the growing population.

Most candidates were able to identify that population increase is not a technological factor, but the majority failed to properly articulate an explanation for their response.

Question 6

For Part (a), candidates were asked to present two arguments in support of the following statement:

“I don’t understand why our teacher says that the landscape is a natural resource. You can’t sell a mountain, or make anything out of a beach. I don’t think that our teacher is correct about this.”

Most candidates were able to identify that the landscape (and beach) were essential natural resources for the Caribbean region. However, many missed that the question required a comprehensive explanation of the non-consumptive uses of the landscape as a natural resource (for example, aesthetic, spiritual, recreational, economic, tourism). While it was not intended for there to be a discussion on mountains or beaches specifically, answers regarding the non-consumptive or intrinsic value of the resource were accepted.

Part (b) required candidates to explain by way of an example, the term *non-consumptive* use of natural resources. While the overall responses were an improvement on preceding years, there was still evidence that candidates were not completely familiar with the meaning of this term. This could be seen by the examples posited for non-consumptive uses of natural resources.

A non-consumptive use of a natural resource is one where the use of the resource does not deplete its quality or quantity. Examples include ecotourism activities such as whale-watching, canopy walkways and zip-lining, bioprospecting and research.

Part (c) was unquestionably the best performing part of this question, with most candidates identifying a named natural resource for a named country. Most were also able to adequately explain the importance of this resource to the country. It was also apparent that both teachers and students needed a wider understanding of the occurrence and distribution of resources in the Caribbean region.

Part (d) (i) required candidates to utilize the information provided in tabular format on land area under forest cover to identify the five-year period which saw the greatest decline in forest cover. Candidates were required to show all working in deriving their answer, an instruction which was ignored by many candidates. In Part (d) (ii), candidates were given the total area of the country in order to calculate the percentage of the country under forest cover in 2005. Candidates did not perform as well as expected on this part, with many candidates making mistakes in this simple calculation.

$$\frac{224,000}{512,800} \times 100 = 43.7 \%$$

It may be concluded that candidates demonstrated limited skills at manipulating data and performing calculations. This is another area of skill development that should be focused on during classroom sessions.

Part (d) (iii) was well done. Candidates were asked to give two reasons to support the assertion by an eco-group that the government should promote natural resource conservation with respect to the rate of loss of forest cover. Candidates identified reasons such as *the prevention of depletion/degradation of natural resources, the conservation of ecological components and endangered/threatened species, as well as the protection of the resource for its aesthetic, cultural and sacred values*. In addition, candidates demonstrated knowledge of an impressive array of conservation tools, and many gave examples to support their answer.

Paper 031 – School-Based Assessment (SBA)

The overall presentation of the SBA for Unit 1 continues to show improvement. There was evidence of some very thorough work on the part of the students and also some evidence of effective teacher guidance.

While there was some improvement in the literature review component there were still many instances where the literature review was merely a listing of literature without discussion and relevance to the chosen topic.

The methodology frequently did not describe how the variables and parameters would be measured, observed and recorded. Also, very frequently students used a questionnaire survey that was not always appropriate and, where they were appropriate, the questions were not formulated to yield the information pertaining to the stated objectives.

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

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

The Discussion of Findings in some instances lacked depth of interpretation. Often they were not based on actual findings in the research. It would be helpful here to recall some of the most significant findings.

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

methodology. In general, similar to Discussion of Findings, recommendations were not always based on actual findings of the particular research but, instead, on some generalized information on the topic, perhaps from research on a similar topic or from the literature.

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

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

Paper 032 – Alternative to School-Based Assessment

Question 1

Candidates were presented with data, in a tabular format, of the population size and feeding relationships of selected species of mangrove at a site.

In Part (a), candidates were required to differentiate between *species diversity* and *species abundance*. The majority of candidates were able to define *species diversity*, but few were able to correctly define and contrast the two concepts.

Part (b) required candidates to utilize the information from the table to construct a pyramid of numbers to reflect the trophic levels for Site A. Too few candidates were able to correctly answer this question. Many disregarded the data regarding number of organisms at the site, and drew a classic pyramid, instead of a spindle-shaped one, which would have reflected the data provided.

In Part (c), candidates were asked to outline an appropriate method to estimate the size of the mangrove population. Few candidates were able to identify, and even fewer could explain sampling techniques for immobile organisms, for example, transects and quadrats. Instead, candidates identified sampling techniques for mobile organisms, such as the capture-recapture method and the sweep-net. This is an important skill which needs to be addressed for future candidates.

Part (d) required candidates to identify two limitations to the method listed in (c) and most candidates were unable to state correct limitations.

Part (e) required candidates to give a detailed explanation of the effects to the ecosystem, if a predator of the butterfly that produces the caterpillars of Species A was introduced into the ecosystem. Many candidates attempted this question, but many did not give an answer commensurate with the marks allocated for the section. Candidates are reminded that the marks allocated for a question are a useful guide to answering the question.

Question 2

Part (a) required candidates to define the terms *total fertility rate* and *replacement level fertility*. Few candidates were able to satisfactorily provide a definition for one or both terms, with most candidates giving incomplete or incorrect responses. Candidates may benefit from greater emphasis on definitions and terminology and the use of appropriate terminology when answering this type of question.

Part (b) required candidates to refer to the age–sex structure diagram presented to calculate the

- (i) number of people in the pre-reproductive age group for the country
- (ii) percentage of the population in the pre-reproductive age group if the total population of the country was 72.5 million.

Candidates did not perform well on this part because they had difficulty identifying the pre-reproductive age group and reading the required data off the age–sex structure diagram. While the calculation required for Part (b) (ii) was a simple percentage calculation, most candidates failed to adequately respond to the question. The point is to be made again that most candidates continue to perform poorly on questions requiring calculations. In addition, many candidates had difficulty working with large numbers (millions, billions) and including appropriate units in their responses. Candidates need to pay greater attention to their basic mathematical skills and on how to execute mathematical calculations using data from tables or graphs.

Part (c) required that candidates explain how the population of the country would change over the next ten years. This part was poorly done, with few candidates recognizing that the pyramid was a constrictive pyramid, because the pre-reproductive age group (0–14 years) comprised a smaller percentage than the reproductive (15–44) and post reproductive age groups. The population was therefore an aging one, expected to decrease in the next ten years as fewer persons would move into the reproductive age group.

Part (d) required candidates to analyse tabulated data on the per capita water consumption between developing and developed countries. In Part (d) (i), candidates were required to calculate the per capita water consumption between developing and developed countries. This part was not well done. Part (d) (ii) required candidates to explain the environmental impact associated with high per capita water consumption. This question was moderately done, but

many candidates gave responses which associated increased per capita water consumption with increased pollution. It should be remembered that an increase in per capita water consumption concerns an increase in demand for water, and the need to meet the demand. Impacts should therefore stem from this circumstance.

In Part (d) (iii), candidates were asked to account for the difference in per capita water consumption between developing and developed countries. This part was poorly done, with candidates supplying reasons why developing *instead of* developed countries had higher per capita water consumption. This was despite clear evidence in the table to the contrary, once again demonstrating the inability of many candidates to interpret, analyse and synthesize data presented to them. Therefore, despite higher levels of total population by developing countries, their per capita water consumption is lower than developed countries for many reasons including increased uses for industrial, agricultural and domestic uses, access and availability of water, lack of infrastructure to bring water to users, level of economic development and urbanization.

Question 3

Data were presented in tabular format outlining the amount of fish harvested from a mangrove ecosystem, and the fishing effort in terms of number of boats used.

Part (a) (i) required candidates to use information provided to draw a graph illustrating the data provided in the table. This part was generally well done but candidates lost marks on the details of the graph, such as title, label and scale. Candidates should be aware that when asked to plot a graph, marks are generally awarded as follows:

- An appropriate title — this must be given for the graph
- Correct labelling of horizontal and vertical axes
- Correct labelling of graphs
- Use of an appropriate scale on each axis
- Plotting of all points correctly, and utilizing the dot and circle to identify each point plotted
- Drawing a smooth curve through all points

Part (a) (ii), which required candidates to describe five trends observed from the graph drawn in Part (a) (i), was also well done. Most candidates identified the relationship between the amount of fish harvested and the fishing effort in terms of number of boats used. In Part (a) (iii), candidates were asked to describe the term *maximum sustainable yield* (MSY). The majority of candidates could not provide a satisfactory explanation of the term, that is, *the largest amount of a resource which can be harvested without causing a decline in its stock*. Candidates may therefore benefit from greater emphasis on definitions and terminology. When asked in Part (a) (iv) to utilize the data from the table to identify the maximum sustainable yield, almost all candidates were able to pinpoint 4500 kg as the MSY.

Additionally, in Part (a) (v), most candidates could identify at least two reasons why it is advisable to harvest below the MSY, but many failed to engage in the more detailed explanation required by the question. Part (a) (vi) was well done with most candidates identifying cogent reasons on how human population growth may impact on the fish resource.

Part (b) (i) required candidates to identify an appropriate measure which can be implemented to protect and conserve the mangrove ecosystem. This part was well done. Part (b) (ii) required candidates to explain how the measure identified in Part (b) (i) would work to protect and conserve the mangrove ecosystem; it was also well done by candidates.

This question was very well done by most candidates and was the highest scoring of the three questions on the paper.

UNIT 2

Paper 01 – Multiple Choice

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

Paper 02 – Essay Questions

Module 1: Agriculture and the Environment

Question 1

Part (a) (i) was done well; most candidates were able to list three features of sustainable agriculture. However, it should be noted that a significant number of candidates had the right idea but were unable to use the proper terminology.

Part (a) (ii) required candidates to study Figure 1, which provided the results of a survey to determine the public's perception of the level of importance of a variety of different threats to sustainable agriculture. Most candidates were able to make appropriate deductions from the graph. A significant number of candidates were not clear as to what exactly they were reading from the graph — that it was people's opinions about natural disasters in a particular country, not the actual number of natural disasters that occurred.

Part (a) (iii) was generally done poorly by most candidates; many erroneously equated *external shocks* with a natural disaster, something that would destroy crops. Candidates were often not aware of what constituted an *external shock* and how this would threaten sustainable agriculture. The good responses to this question were not only able to identify suitable external shocks like *price fluctuations* and *external market demand*, but also to indicate why they would be a threat to sustainable agriculture. Average answers did not include this explanation.

Part (b) was generally well done. It required candidates to justify how agriculture could contribute to the economies of Caribbean countries.

Question 2

Part (a) tested candidates' ability to read and interpret a graph depicting fish production from traditional fishing grounds and aquaculture as well as to suggest reasons for the trends in the graph and some environmental impacts of aquaculture. Part (b) tested candidates understanding in certain areas of sustainable agriculture.

Part (a) (i) was generally done well. Difficulty with reading graphs again was evident in some responses. The weaker responses confused the two lines, or simply described the points on the graph, rather than an overall trend. Part (a) (ii) was also generally well done; most candidates were able to correctly relate increasing levels of aquaculture to a variety of reasons. It should be noted that most responses indicated that the candidates were thinking of the graph as illustrating the yield from a specific farm, rather than the industry as a whole. Most of the responses centred around things that would increase one farm's yield, like using growth hormones. Few responses suggested reasons that would be more applicable to an industry, like noting the declining traditional fishery which would encourage more fishermen to consider aquaculture. Part (a) (iii) was not a problem for most candidates. The impacts of aquaculture on the environment were well presented and seemed to be clear to the majority of candidates.

Part (b) (i) was answered correctly by most candidates, who were able to identify the characteristics of commercial agriculture systems. Part (b) (ii) was less well done, though many candidates were able to answer this part correctly, a significant number did not distinguish sustainable methods suitable for hilly terrain. Responses simply presented a variety of sustainable methods, even those that were not applicable to the terrain given in the question.

Question 3

Part (a) tested candidates' knowledge of the operation of a proton exchange fuel cell. Candidates were required to identify some of the inputs and outputs of such a fuel cell, given a semi-labelled diagram. This was somewhat hit or miss, but many candidates were at least able to get one of the components correct.

Part (b) was poorly done. Candidates were required to explain the concept of *secondary energy source* using the fuel cell as an example. Many candidates did not understand the concept of secondary energy source, and in addition, appeared to have very little understanding about fuel cells. This made it difficult for an appropriate connection to be made. The better responses were not only able to define the term, but were able to clearly identify the characteristics of a fuel cell that made it a secondary energy source.

Part (c) was also not well done. In this question, candidates were asked to discuss the feasibility of fuel cell use in the Caribbean, while focusing on the reliability of supply and economic factors. While some candidates were able to give some possible advantages of fuel cell use, in some cases this was not done in the context of supply and economy as required in the question. In addition, many candidates could not correctly assess the reliability of fuel cells in the Caribbean context. It seemed that many candidates had learned about the fuel cell technology, but its application/applicability to the Caribbean was not well understood. Teachers should ensure that sufficient coverage is given to the applicability of alternative energies in the Caribbean context.

Part (d) was moderately done. Candidates were generally able to outline the production and transmission of electricity using the combustion of a fossil fuel. A significant number of candidates did not fully understand how fossil fuels are used to create electricity — a noticeable number of responses suggested that it was ‘heated fuel’ that turned the turbines of the generators.

Parts (e) (i) and (ii) were generally well done. Most candidates were able to construct a suitable sketch of the tabulated data and identify two trends from it.

Question 4

Parts (a) (i) and (ii) required candidates to demonstrate some experimental planning and design skills by outlining the steps and precautions a student would have to take to conduct an experiment to determine which of two bulbs was more efficient. Candidates generally performed well on these questions. However, many of them could not distinguish between an experimental *step* and a *precaution*. A significant number of candidates used the same answers for both parts. More emphasis should be placed on this distinction during planning and design exercises by teachers and students. Part (a) (iii) provided some data from the experiment and asked candidates to determine which bulb was more efficient and from the data, to explain why. Most candidates were able to do this effectively. It appeared that the biggest difficulty for many was in the use of English to clearly explain their findings/conclusions. This should be practised by using more writing activities during SBAs.

Parts (b) (i) and (ii) were not generally done well. These questions required candidates to illustrate their understanding of the various costs involved in generating electricity. Many candidates were not able to use the appropriate terminology to define the types of costs they meant. A variety of synonyms were used. In the second part of the question, candidates had challenges developing points to support their answers. Those who attempted this question did not distinguish between *economic factors*, *social factors* and *political factors*. Many answers focused solely on economic factors, those that mentioned the others often spoke to their monetary cost alone.

Module 3: Pollution of the Environment

Question 5

Part (a) tested candidates’ understanding of two similar terms, *pollutant* and *pollution*, by asking them to distinguish between the two. Candidates were generally not able to do this well; they used circular arguments such as ‘pollution is caused by pollutants’.

Part (b) (i) required candidates to read a double y-axis graph containing data on the population and per capita gross national income for a Caribbean country, in order to determine the overall rates of increase in the per capita GNI over two different time periods.

This part was poorly done. Candidates were not able to read the graph to obtain the appropriate points, particularly given that this was a double y-axis graph. Candidates should ensure that they have a ruler in the examination so that they can get accurate readings from the various axes on a graph. Of the candidates that could read the graph accurately, many neglected to actually find the rate. Candidates should be aware that *rate* is a measurement against time. The average response determined the absolute difference between the two points; the good response followed that up by calculating the rate of increase.

Part (b) (ii) was generally well done. Most candidates were able to identify and discuss the likely causes for a rise in pollution, given the information provided in the graph.

Part (c) (i) was also generally well done; most candidates could correctly identify the group of chemicals associated with the Montreal Protocol.

Part (c) (ii) was poorly done. Many candidates could not describe how the Montreal Protocol works (or any protocol, for that matter), or give a reason as to why this protocol was more successful than any other. Responses often mixed up the Montreal and Kyoto Protocols. Teachers should ensure a good grounding in how international agreements work in general, with specific information about individual protocols, in particular the two most well-known, the Montreal and Kyoto Protocols.

Question 6

This question tested candidates' understanding of water pollution and their skills in planning and design. In Part (a), candidates were required to outline a plan to determine the source of pollution in a river, given certain stimulus. The responses were on the whole too vague; very few gave specific information. In addition, candidates could not use this information to explain how their results would allow for a conclusion to be drawn. This kind of exercise is well suited to discussions on SBAs, and should be encouraged.

Part (b) was done correctly by most candidates; it was not a problem for them to identify three pollutants likely to be found in rivers.

Part (c) was moderately done; many candidates could not explain how contaminants could move from a landfill to fish far downstream. Quite often responses would speak about bioaccumulation and biomagnification, but completely ignore how the contaminants got into the river in the first place.

Part (d) was not a problem for most candidates; they were able to suggest suitable methods to alleviate pollution in a river. Candidates should be reminded that solutions given should be reasonable. For example, suggestions like moving everyone in the village is not a practical solution.

Part (e) was poorly done. Many responses could not clearly connect methane, its ability to absorb light in the IR wavelengths and the greenhouse effect. In addition, there was a lot of confusion about global warming and ozone depletion. Many responses incorrectly suggested that methane had something to do with ozone depletion.

Paper 031 – School-Based Assessment (SBA)

There continues to be improvement in the overall presentation of SBAs. The overall quality and content can still be improved by choosing topics that lend themselves to more scientific and investigative activities.

The literature review is still an area of concern in many of the pieces submitted. Too often the literature review is either irrelevant or inadequate. There is an immediate need for students to improve their writing and expression skills. This severely affects the quality of the report and at times is not reflective of what is expected at the CAPE level.

The methodology frequently did not describe how the variables and parameters would be measured, observed and recorded. Also, very frequently students used a questionnaire survey that was not appropriate and, where they were appropriate, the questions were not formulated to yield the information pertaining to the stated objectives.

Some of the SBAs submitted did not demonstrate adequate field investigation and did not demonstrate much creativity and skill in the presentation of data. Often, the presentation was limited to a number of graphs of similar type, graphs that were inappropriate, and photographs without titles. Students are encouraged to use a variety of formats for the presentation of data.

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

The discussion of findings in some instances lacked depth of interpretation. Often they were based not on actual findings of the particular research but on some generalized information on the topic, perhaps from research on a similar topic or from the literature.

The conclusion in many instances simply revisited the purpose. However, similar to the discussion of findings, it was often based on generalized information on the topic but not the actual findings in the research.

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

Recommendations

- Each activity of the SBA must relate to at least one specific objective.
- Site visits should include experimental work, a field trip where students observe a process, for example, a wastewater treatment plant is not a site visit.
- Site visits need to be more specific and parameters chosen for observation must be more amenable to measurements.
- In addition to stating what is going on or taking place at the site, students must say what they will do at the site.
- The final report for the journal must be informed by the laboratory exercises and the site visits.
- Follow-up activities should indicate what the student will do after each site visit and on the next site visit.
- The research title should be more concise and focused.
- The purpose of the project should be clearly outlined and the variables should be clearly defined.
- Greater attention should be paid to the relevance and appropriateness of the literature review.
- The methods of investigation section must provide specific information about how each variable/parameter will be measured. This can include a list of apparatus and essential steps for collection of the data.
- Careful observations should be taken during laboratory and site visits. Observations are not only the numbers, but can include things like the weather conditions or the specific colour change in a laboratory test. Often, observations of the surroundings at a site can help the student explain the results they get from that site.
- Data presentation should be emphasized. Diagrams and illustrations need to be more appropriate and well integrated in the text to increase their effectiveness. They should be properly labelled, titled and scaled as appropriate. Diagrams, photographs, line drawings and tables all must have a caption to indicate what is being presented. A very useful technique is to present a summary table of data gathered in the field visits and laboratory exercises. In this way the researcher can view the data 'at a glance' and can perhaps glean patterns or essential points. A summary table can be useful in guiding the analysis, and the table itself can be used as an analytical technique.
- Data analysis requires the use of appropriate statistical tools to give improved results. If such tools are used, then this should be specified in the text. For example, the results are presented as the average +/- the standard deviation.

- Discussion of the project findings should present the student's interpretation of their **own** results (not results found in a reference), and what explanation the student can give for an observation. For example, if the data indicates that there is more of a certain species of plant in one area, the discussion should give some indication of why that might be so. Research in the literature can also help students to find reasonable explanations for the things that they observe in the laboratory or the field.
- Discussion of Findings, Conclusion and Recommendations should be based only on what was presented in the literature review and the data that is collected, presented and analysed. No new material should be introduced at this stage.
- Conclusions must always be included in the project report. They must be clear, based on the students' own findings, valid and related to the purpose of the project. It is not simply a restatement of the project objectives.
- Recommendations must be based on the students' own findings and must be fully derived from findings. Recommendations and limitations are two different things.
- Bibliographic references should be written using a consistent convention. There should be at least four up-to-date references. It is recommended that use be made of the style and format contained in the syllabus when writing bibliographic references.

Paper 032 – Alternative to School-Based Assessment

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

Question 1

Candidates' performance on this question was very poor. They were required to demonstrate understanding of organic and commercial farming techniques, as well as the environmental impacts of same. In addition, the question required the plan and design of a simple experiment to determine which of these two farming techniques would have higher productivity.

In Part (a), candidates had to explain why organic farming is more affordable to a small farmer. This part of the question was fairly well done; the responses indicated that many candidates had an understanding of the operations of organic farming and why these were cheaper. However, some responses were not detailed enough and so did not receive full marks. Candidates are reminded to use the mark allocation as an indication of the depth or extent of response that is required.

Part (b) required candidates to list three environmental impacts of commercial farming. This was generally well done; most candidates were able to list these correctly.

In Part (c), candidates had to choose one of the impacts listed in Part (b) and outline how this impact occurs. This part was also fairly well done; where candidates did not perform well, it was due to responses that did not address the whole issue. For example, a response might have spoken about eutrophication, but did not mention how the nutrients got into the water bodies in the first place.

Part (d) was poorly done by most candidates. The responses suggested that candidates did not have a strong grasp of how to go about setting up a simple experiment. In some cases, even the identification of the manipulated, responding and control variables was limited. The most common problem was an inability to specify how exactly the more productive farm would be identified; the responding variable of *crop yield* was not often identified specifically. For example, a significant number of candidates indicated that the most productive farm would be the organic farm because it was ‘healthier’. The ‘healthiness’ of the crop is what was used as the indicator of productivity. Candidates’ understanding of the characteristics of organic versus commercial farming was also weak; many candidates indicated that the organic farm would be more productive.

Question 2

This question tested candidates’ ability to construct an appropriate graph to represent data in a table as well as to identify the trend in the graph. In addition, the question required candidates to demonstrate their understanding of energy conservation, and how this may be achieved using alternative technology (fluorescent bulbs) and renewable energy (solar power). This question was fairly well done by the majority of candidates, primarily because of the significant number of marks allocated to the plotting of the graph. Candidates who performed poorly on this question had difficulty plotting an appropriate graph.

Performance on Part (a) was very poor. Candidates could not define the term *kWh*. Most of the responses simply stated the meaning of the abbreviation, but not its definition.

Candidates performed best on Part (b) and because it and the associated Part (c) were worth half of the marks, candidates who performed well on Part (b) also did well on the question overall. Some candidates had difficulty plotting an appropriate line graph to represent the data. Candidates should be aware that when asked to plot a graph, marks are generally awarded as follows:

- An appropriate title
- Correct labelling of horizontal vertical axes
- Correct labelling of graph
- Use of an appropriate scale on each axis
- Plotting of all points correctly
- Drawing a smooth curve through all points

Part (c) (i) was well done; just about all the candidates could define *energy conservation* correctly.

Parts (c) (ii) and (iii) were done moderately well; most candidates could give at least some of the reasons why use of fluorescent bulbs and solar energy would result in energy conservation. Generally, candidates who lost marks on this question did not fully answer the question or gave responses that did not clearly explain how the energy conservation would occur.

Question 3

This question tested candidates' ability to determine suitable water quality testing points given a sketch map as stimulus, describe water quality testing protocols, and demonstrate their understanding of the type of pollutants produced by organic and commercial farming to predict the likely concentrations of common water quality parameters. This question was poorly done by most candidates.

Part (a) (i) was done fairly well; most candidates were able to correctly define the term *pollutant*. The most common error candidates made was not specifying that pollutants were harmful substances in the environment; they stated only that they were 'substances'.

Part (a) (ii) was done poorly by most candidates. It was clear that the concepts of point and non-point sources of pollution were unfamiliar to many.

Part (b) was done well on the whole; many candidates were able to choose correct points. Candidates should note that suitable points would have had to be impacted by the various farms, but not impacted by the houses. Points that were chosen below the housing areas were not suitable as it would be impossible to determine if the level of pollution was caused by the farm or the houses.

Part (c) was very poorly done; Some candidates did not even attempt it. It is clear that many candidates writing this paper have little or no experience with actual laboratory methods. This puts these candidates at a distinct disadvantage because this paper requires a full awareness of all the methods one would have come across in labs at a school.

Part (d) was fairly well done although some candidates seemed to run out of time and did not submit any response for this part. Of those who did, a significant number were able to correctly match the high nitrates and phosphates and low BOD and faecal coliform levels with the commercial farm using water soluble fertilizers. Unfortunately, of the candidates who correctly matched the river to the water sample, some of these did not receive full marks because their answers were incomplete. The response required candidates to fully use the data in the table to come to a conclusion *and explain it*. This part was sometimes left undone or was not done at the appropriate level. On the other hand, some candidates who did not

arrive at the correct match had equated 'organic' farming with 'clean' and so chose the incorrect river for Sample B.

CARIBBEAN EXAMINATIONS COUNCIL

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

MAY/JUNE 2014

ENVIRONMENTAL SCIENCE

GENERAL COMMENTS

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

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

DETAILED COMMENTS

UNIT 1

Paper 01 – Multiple Choice

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

Paper 02 – Essay Questions

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

Module 1: Fundamental Ecological Principles

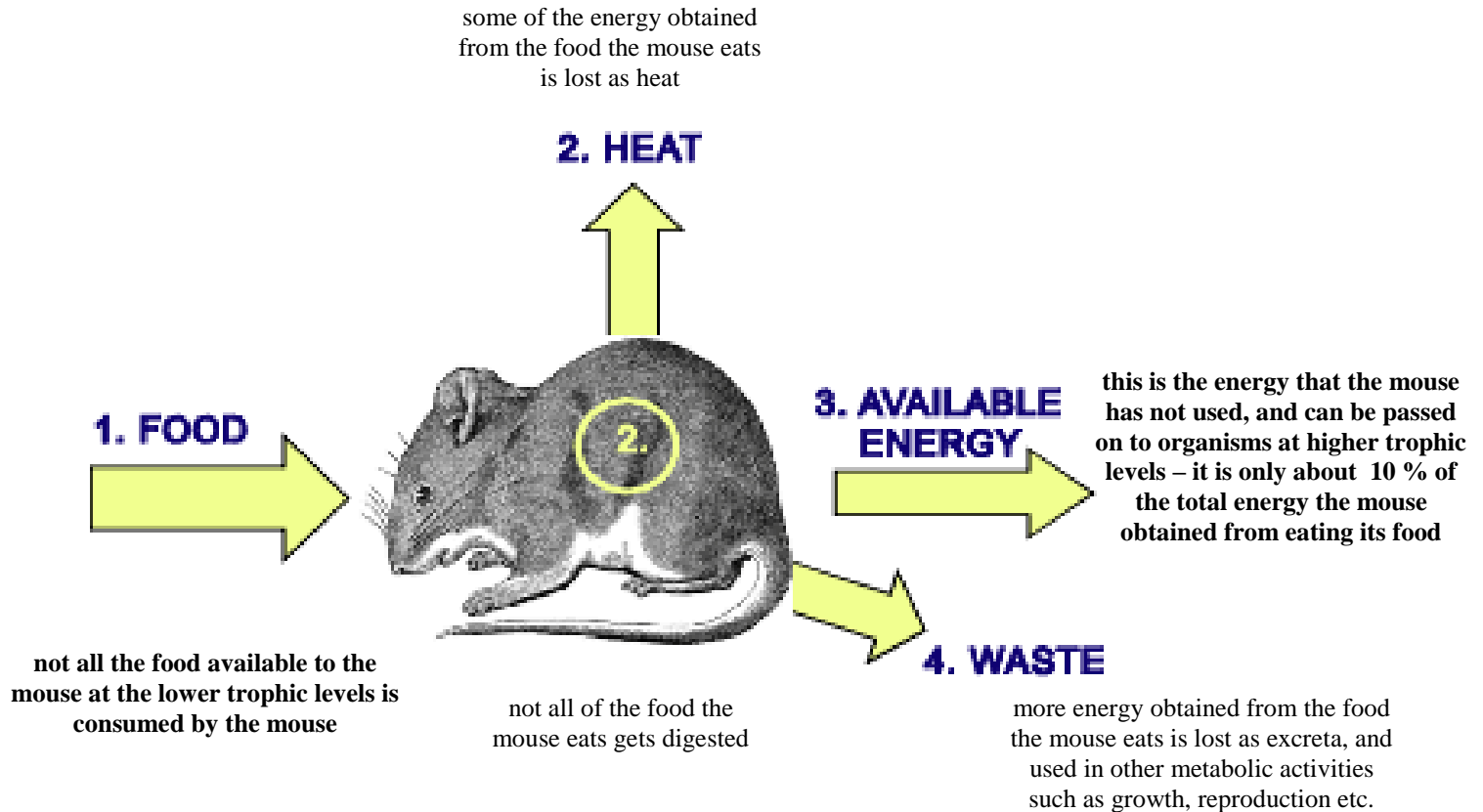
Question 1

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

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

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

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



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

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

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

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

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

where

N = estimate of total population size

M = total number of deer captured and marked on the first visit

C = total number of deer captured on the second visit

R = the number of deer captured on the first visit that were then recaptured in the second visit

However, other suitable formulas were also credited.

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

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

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

Overall, performance on this question was less than satisfactory.

Recommendation

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

Question 2

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

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

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

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

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

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

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

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

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

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

Candidates' performance on this question was good.

Recommendation

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

Module 2: People and the Environment

Question 3

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

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

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

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

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

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

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

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

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

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

Overall performance on this question was satisfactory.

Recommendation

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

Question 4

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

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

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

- *Country A because it has a lower infant mortality rate – therefore infants have a higher chance of surviving to maturity and contribute to population growth.*
- *Country B because it has a higher infant mortality rate, therefore people will have more children in the hope that some survive to maturity. This is symptomatic of most developing countries.*

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

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

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

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

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

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

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

Recommendations

- The examining committee has observed a disturbing trend by some of the candidates in attempting this question. Some utilized information from Question 3 in their responses to the question, presumably because that question also featured a Country A and Country B. The committee recommends that students be advised that unless otherwise stated, information from one question is not to be used in another question. The conclusion of a question is clearly outlined by the statement.
- Students should be reminded of the need to include the correct units when required by the answers, for example, in this question, 87.5 or 88 years.
- The skill of deduction–induction is identified as a skill which needs to be improved on by students.

Module 3: Sustainable Use of Natural Resources

Question 5

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

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

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

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

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

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

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

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

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

Candidates’ performance on this question was satisfactory.

Recommendations

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

$$176,900 + 172,300 + 196,000 = 545,200 \text{ (1) } \underline{\text{tonnes}} \text{ (1)}$$
- It may be concluded that students demonstrated limited skills at manipulating data and performing calculations. This is another area of skill development that should be focused on during classroom sessions. Candidates need to pay greater attention to their basic mathematical skills and on how to execute mathematical calculations using data from tables or graphs.
- Teachers need to ensure that they cover the full gamut of measures and tools identified under Syllabus Objective 3.10 in preparing students for the examination. The use of case studies would be an excellent method of consolidating this objective.

Question 6

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

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

A renewable resource is one which can be extracted and utilized, but if given enough time it can replenish itself, for example, trees. However, if the rate at which the renewable resource is consumed exceeds its renewal rate, renewal and sustainability will not be ensured.

An exhaustible resource is one that can be used up, because its quantities are effectively fixed, and cannot be increased by the natural forces of the environment.

Accordingly, fertile soil can be classed as renewable because its fertility will be replenished quickly through natural processes, but it can be exhausted if the soil fertility is used up faster than it is renewed.

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

A consumptive use of natural resource is one where the quantity and quality of the resource is depleted in its use. Examples include:

- *logging*
- *fishing*
- *quarrying*
- *mining*

A non-consumptive use of a natural resource is one where the use of the resource does not deplete its quality or quantity. Examples include:

- *ecotourism activities such as whale-watching, canopy walkways and zip-lining;*
- *bioprospecting and*
- *research*

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

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

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

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

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

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

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

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

Candidates’ performance on this question was good.

Recommendations

- Candidates need to pay greater attention to their basic skills at manipulating data and executing calculations from tables or graphs.
- Teachers should provide concrete examples when teaching topics and may supplement text material with case studies so that students have support material, relevant examples, and facts.
- Candidates are reminded to read the instructions to questions carefully.
- The examining committee wishes to underscore to teachers and students that the term *beach* has a very specific meaning within the context of the CAPE Environmental Science syllabus. A beach is used to indicate a landform along the shoreline of an ocean, sea, lake, or river, usually consisting of loose particles, which are often composed of sand, gravel, pebbles, or shells. Colloquial uses of the term (which often include the sea or ocean) will not be accepted.
- Candidates need to be able to differentiate between the terms *coal* and *charcoal*:
 - Coal – a combustible black or brownish-black sedimentary rock categorized as a fossil fuel, and composed primarily of carbon. Coal is used as an energy resource for the production of electricity and/or heat, and also for industrial purposes, such as refining metals.

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

Paper 031 – School-Based Assessment (SBA)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Question 1

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

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

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

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

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

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

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

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

Candidate performance on this question was good.

Question 2

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

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

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

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

$$\begin{aligned} \text{Country A} &= 150 \text{ kg of waste} \\ \text{Country B} &= 750 \text{ kg of waste} \\ \text{Total waste produced: } &150 + 750 = 900 \text{ kg} \\ \text{Difference in waste: } &750 - 150 = 600 \text{ kg} \\ \text{Percentage difference: } &600/900 \times 100 = 66.7\% \end{aligned}$$

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

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

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

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

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

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

Candidate performance was less than satisfactory.

Question 3

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

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

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

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

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

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

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

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

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

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

Candidate performance on this question was less than satisfactory.

Recommendations

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

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

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

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

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

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

UNIT 2

Paper 01 – Multiple-choice Questions

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

Paper 02 – Essay Questions

Module 1: Agriculture and the Environment

Question 1

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

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

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

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

Candidate performance on this question was very good.

Recommendation

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

Question 2

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

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

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

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

Candidate performance on this question was very good.

Recommendations

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

Students should be encouraged to read questions carefully.

Module 2: Energy and the Environment

Question 3

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

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

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

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

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

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

Candidate performance on this question was less than satisfactory.

Recommendation

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

Question 4

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

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

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

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

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

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

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

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

Candidate performance on this question was less than satisfactory.

Recommendations

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

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

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

Module 3: Pollution of the Environment

Question 5

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

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

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

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

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

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

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

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

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

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

Candidate performance on this question was satisfactory.

Recommendations

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

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

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

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

Question 6

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

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

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

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

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

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

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

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

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

Candidate performance on this question was less than satisfactory.

Recommendations

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

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

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

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

Paper 031 – School-Based Assessment (SBA)

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

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

Journals

Objectives

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

Activities

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

Observations

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

Comments

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

Follow-up Activities

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

Laboratory Exercises

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

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

Title and Aim

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

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

Materials and Method

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

Observations and Recording

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

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

Analysis and Interpretation

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

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

Final Report

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

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

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

Problem Statement

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

Purpose of the Project

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

Methods of Data Collection

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

Literature Review

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

Presentation and Analysis of Data

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

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

Discussion of Findings

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

Conclusion

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

Recommendations

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

Bibliography

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

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

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

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

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

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

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

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

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

Question 1

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

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

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

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

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

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

Candidate performance on this question was less than satisfactory.

Recommendation

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

Question 2

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

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

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

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

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

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

Candidate performance on this question was less than satisfactory.

Recommendation

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

Question 3

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

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

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

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

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

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

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

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

Candidate performance on this question was satisfactory.

Recommendation

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

CARIBBEAN EXAMINATIONS COUNCIL

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

MAY/JUNE 2016

ENVIRONMENTAL SCIENCE

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GENERAL COMMENTS

In Unit 1, overall performance was better than that for 2015. Eighty-nine per cent of candidates achieved Grades I–V in 2016 and 73 per cent of candidates achieved Grades I–V in 2015. In terms of module performance, candidates performed better on Module 3 (Sustainable Use of Natural Resources) followed by Module 2 (Human Population and the Environment) and Module 1 (Fundamental Ecological Principles).

In Unit 2, 98 per cent of candidates achieved Grades I–V compared with 95 per cent in 2015. Candidates performed best on Module 1 (Agriculture and the Environment) followed by Module 2 (Energy and the Environment) and then Module 3 (Pollution and the Environment).

DETAILED COMMENTS

UNIT 1

Paper 01 – Multiple Choice

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

Ninety-eight per cent of the candidates gained acceptable grades in this paper.

Paper 02 – Essay Items

Overall, candidates' performance was best in Module 2 followed by Module 3 and then Module 1.

Module 1: Fundamental Ecological Principles

Question 1

This question was based on biogeochemical cycles, the concept of carrying capacity, and competition within and between species.

In Part (a), candidates were asked to distinguish between sedimentary and gaseous biogeochemical cycles, and give one example of each type of cycle. In general, candidates were able to identify gaseous cycles, but were unable to adequately distinguish between the two types of cycles.

Part (b) addressed the concept of carrying capacity, and featured a graph as the stimulus material. In (b) (i), students were required to study a figure and make deductions from it. This part was reasonably well done by the candidates, but it is to be noted that in questions of this type candidates need to derive their deductions from the stimulus material.

Part (b) (ii) required candidates to calculate the difference in carrying capacity values based on the data presented in the stimulus material. This part was not well done by most candidates.

$$\text{difference in carrying capacity} = \text{carrying capacity obtained by student A} - \text{carrying capacity obtained by student B}$$

Part (b) (iii) required candidates to suggest two reasons for the difference in carrying capacities obtained by the two students. Again, this part was poorly done, and therefore this is a concept which needs to be highlighted to students in the future.

Part (c) required candidates to distinguish between 'intraspecific' and 'interspecific' competition, and to explain why intraspecific competition was more intense. Candidates were mainly able to identify the difference, but at times struggled to explain why intraspecific competition was more intense.

Question 2

This question tested primary ecological succession, limiting factors and natural selection in the adaptation of species in their natural environment.

Part (a) required candidates to state ways in which primary ecological succession differs from secondary ecological succession. While they were generally able to identify the features of both types of succession, at times candidates failed to state the ways in which the two types of succession differed.

Part (b) of this question required candidates to utilise a stimulus in the form of a graph to perform calculations and explain data derived from the graph.

In Part (b) (i), candidates were required to derive data, calculate and therefore determine the two countries that had a combined total of 70 per cent of their forest intact. Candidates were able to identify the correct answer, but lost marks because they did not follow the instructions requiring them to show their working. As a result, many gained the two marks allocated to identifying the countries, but deprived themselves of the two marks allocated for the calculation.

In Part (b) (ii), candidates were asked to state the country in which ecological succession was most likely to occur and then justify their responses. The majority of candidates were able to make this deduction, and adequately justified their responses.

Part (c) asked candidates to define the term 'limiting factor' and explain how these factors operate in the environment. The performance by the candidates was satisfactory in this response.

Part (d) required candidates to explain the importance of natural selection in the adaptation of species to their environment. This part was not well done, and it was clear that candidates could not distinguish between natural selection, adaptation and evolution.

The correct response is:

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

Question 3

This question tested the concept of per capita freshwater consumption and the role of stated factors on the growth of a population.

In Part (a), candidates were presented with a table comparing the per capita water consumption for developed and developing countries.

Part (a) (i) required candidates to calculate the percentage difference in the per capita consumption in developing and developed countries. Candidates performed poorly in this calculation, which required them to first find the difference in annual per capita water consumption and then find the percentage difference:

The correct response is:

$$\begin{array}{l} \text{difference in annual per capita water consumption} \\ 2840 \text{ m}^3 - 1070 \text{ m}^3 = 1770 \text{ m}^3 \end{array}$$

$$\begin{array}{l} \text{percentage difference} \\ 1770/4610 \times 100 = 38.39\% \end{array}$$

In Part (a) (ii), candidates were required to account for the difference in per capita water consumption for developing and developed countries. Candidates performed moderately in this section, with most offering at least a partial explanation.

In Part (a) (iii), candidates were called upon to discuss the environmental impact as a result of high per capita water consumption. Candidates performed moderately in this response. Candidates are reminded that there are two pages of extra space which may be found at the end of the script. If they are utilising extra space, they should indicate at the end of the original question by an annotation such as “please see extra space” and also clearly indicate in the extra space, the number of the question or questions for ease of reference to the Examining Team.

Part (b) required candidates to explain how two social factors may impact on the growth of the population.

The first, in (b) (i) was 'religion', where candidates were generally able to identify the impact of religion on population growth. However, many did not offer a complete explanation, including identifying *how* the factor influenced population growth positively or negatively.

An example of a correct answer is:

some religions do not believe in the use of the artificial contraception methods, and this is belief promotes high birth rates in women and could lead to *increased* population growth rates.

Part (b) (ii) required candidate to explain the relationship between culture and population growth. Candidates were generally able to identify the impact of culture on population growth, but many gave partial explanations that failed to identify whether culture influenced population growth in a positive or negative manner.

An example of a correct answer is:

some cultures facilitate the education and professional development of women in their childbearing ages which leads to the postponement of having a family, or to having replacement levels of fertility (that is, one or two children) which could lead to *the stagnation or the decrease* in population growth rates.

At times candidates confused religious and cultural factors, and this is an area in which teachers will need to distinguish and clarify them.

Recommendation

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

Question 4

This question examined the concept of sustainable development, the human development index (HDI) and the impact of selected social services, clean drinking water, sanitation services and pollution on human population.

Part (a) asked candidates to write a definition for 'sustainable development.' This question was well done as most candidates were able to either give the Brundtland Commission definition or a definition that identified the environmental, economic and social components of the concept.

Part (b) required candidates to explain why high birth rates may impact on a country's ability to achieve sustainable development. Again, most candidates were able to make a cause and effect link between the high birth rates and sustainable development, but many failed to provide a full explanation, and therefore only achieved marks for a partial explanation or for simply identifying the link.

Part (c) was based on a table which presented the HDI for two countries – A and B. Candidates were required to use the values in the table to make comparisons between the two countries. Candidates did not perform as well as expected on this part of the question and it was evident that they were not clear about the concept of the HDI. Correct responses included:

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

Part (d) required candidates to read off data from a graph which presented information on the world population and how it is affected by the lack of access to selected social services.

In (d) (i), candidates were required to perform a direct read off and identify the percentage of the world's population which lacks access to adequate health care services. Most candidates were able to arrive at the correct answer of 21 per cent.

In (d) (ii), candidates were required to calculate the total number of people who lack access to both clean drinking water and improved sanitation services. Most candidates were able to read off the values (20 % and 40 % respectively) and perform the first part of the necessary calculation (i.e. the summation), but the correct calculation of the number of persons and the derivation of the answer with units often resulted in candidates losing one or two marks. The correct response is:

Percentage of persons who lack access to clean drinking water = 20 %
Percentage of persons who lack access to improved sanitation services = 40 %
Percentage of persons who lack access to BOTH: (20 % + 40 %) = 60 %
 $60/100 \times 7.1 \text{ billion} = 4.26 \text{ billion persons or } 4.26 \times 10^9 \text{ persons}$

In Part d (iii), candidates were given a statement that “poor sanitation services may lead to increased levels of pollution”, and asked to explain three ways in which the impact of pollution may be mitigated. This question was not well done as candidates either did not identify three reasons or did not expand adequately on the three reasons identified. This would have affected a candidate's ability to score the maximum two marks which were available for each impact.

Recommendation

Candidates should ensure that they come to the examination with basic implements such as rulers and silent, non-programmable scientific calculators.

Question 5

This question addressed selected natural resources in the Caribbean, the concepts of ‘non-renewable,’ ‘exhaustible,’ and ‘inexhaustible,’ the importance of natural resources to

livelihood and recreation, the distribution of indigenous peoples in the Caribbean and their management of their natural resources.

Part (a) utilised a diagram illustrating coastal areas with cliffs, forests, hills and a river which runs into the ocean dotted by some oil rigs and a quarry. Candidates were required to identify two types of natural resources illustrated in the figure. This question was well done, with the majority of candidates scoring full marks.

Teachers and candidates are reminded that the term “**beach**” has a very specific meaning within the context of the CAPE Environmental Science syllabus. A beach is used to indicate a landform along the shoreline of an ocean, sea, lake, or river, usually consisting of loose particles, which are often composed of sand, gravel, pebbles, or shells. Colloquial uses of the term ‘beach’ (which often include the sea or ocean) are not accepted.

In Part (b) candidates were asked to choose one of the natural resources identified in (a) to answer the questions in Part (i) and (ii).

In (b) (i), candidates were asked to classify the selected natural resource as ‘renewable’, ‘non-renewable’ and ‘exhaustible,’ or ‘inexhaustible.’

Correct responses are shown in the table below.

Resource	Classification	
	Renewable/non-renewable	Exhaustible/inexhaustible
forest	renewable	exhaustible/inexhaustible
rivers	renewable	exhaustible/inexhaustible
landscape/seascape	renewable	exhaustible/inexhaustible
marine ecosystems	renewable	exhaustible/inexhaustible
air/atmosphere	renewable	exhaustible/inexhaustible
soil (geothermal)	renewable	exhaustible/inexhaustible
oil	non-renewable	exhaustible
mineral resources (gravel, sand, precious metals, stone, etc.)	non-renewable	exhaustible
wind	renewable	inexhaustible
solar	renewable	inexhaustible
tides	renewable	inexhaustible

It is to be noted that there are those resources which are categorised as renewable, but may face danger of complete exhaustion if improperly used, that is, in excess of their replenishment rate or maximum sustainable yield. Examples of such resources may be found in the shaded portion of the table above, and may have been categorised as exhaustible or inexhaustible by candidates. Accordingly, a *renewable resource* is a resource of economic value which can be extracted and utilised, but if given enough time it can

replenish itself, for example, trees. However, if the rate at which the renewable resource is consumed exceeds its renewal rate, renewal and sustainability will not be ensured.

In (b) (ii), candidates were required to use the selected natural resource to explain the difference between 'non-renewable natural resources' and 'exhaustible natural resources.' Most candidates had difficulty explaining the relationship. A correct response is:

a *non-renewable resource* is a resource of economic value that cannot be readily replaced by natural means because their formation takes billions of years

an *exhaustible* resource is one that can be used up, because its quantities are effectively fixed, and cannot be increased by the natural forces of the environment.

Part (c) required candidates to comment on the observation "that natural resources cannot be important for both livelihood AND recreation" by taking a position as to whether it was true or false and then justifying their response by using one of the resources illustrated in the diagram at the beginning of the question. This question was widely attempted by candidates, but many did not achieve full marks as they did not follow the instructions in the question. A full response was expected to include the following elements:

- Candidate needed to take a position, that is, true or false
- A suitable resource needed to be identified
- Identification and discussion of recreation or identification of recreation with a suitable example
- Identification and discussion of livelihood or identification of livelihood with a suitable example

It is to be noted that to obtain the marks for livelihood, the response must connect the activity to earning potential.

An example of a full response is:

This statement is false. Oil is a natural resource of Trinidad, which is important for both livelihood and recreation. For example, people who work at companies which extract oil and natural gas such as Petrotrin or BP depend on the job to support their families so this is their livelihood. An example of recreation is the use of the Pitch Lake, which is the largest natural deposit of asphalt in the world, which is mined for asphalt but is also a tourist attraction, where people come to visit and have fun.

Part (d) featured a table which illustrated the Indigenous population as a percentage of the total population in selected Caribbean countries.

In Part (d) (i), candidates were required to *sketch* a bar chart illustrating the data presented in the table. Most candidates were able to gain the three marks available for the question.

Part (d) (ii) consisted of a calculation, where candidates were required to calculate the number of Amerindians in the population, given that they comprised 0.1 % of approximately 1.3 million people. It was observed that a large number of candidates had great difficulty with this simple calculation. The correct response is:

$$0.1/100 \times 1.3 \times 10^6 = 1300 \text{ persons}$$

Part (d) (iii) asked candidates to outline one practice which Indigenous peoples of the Caribbean use to manage their natural resources. Candidates were able to identify a practice (for example, agriculture, forestry or fishing), and outline how the practice was utilised by the Indigenous peoples. Correct responses included:

when crops are harvested, land is left fallow which allows the nutrients in the soil to regenerate.

Question 6

This question addressed the categorisation of natural resources, threatened species and tools for management and conservation of natural resources in the Caribbean region.

Part (a) presented significant challenges to candidates. Candidates were required to define the term “non-consumptive use of natural resources” and identify one example that illustrated non-consumptive use of natural resources. While the overall correct responses were an improvement on preceding years, there is still ample evidence that candidates were not completely familiar with the meaning of these terms. This could be seen by the definition and examples posited by candidates. A correct response is:

“A non-consumptive use of a natural resource is one where the use of the resource does not deplete its quality or quantity. Examples include: ecotourism activities such as whale-watching, canopy walkways and zip-lining; bioprospecting; and research and use of solar radiation”.

Part (b) dealt with the tools for management and conservation of natural resources in the Caribbean region.

Part (b) (i) identified three tools – sustainable yield management, waste minimization and environmental legislation – which can be used for natural resource management and conservation. Candidates were required to choose one of these tools and explain how the tool works to achieve natural resource management and conservation. Generally, candidates were able to select and develop points relevant to each tool, but at times did not fully develop their responses in order to attain the full four marks. An example of a correct response is:

Laws put in place to control the use of natural resources are mechanisms put in place to monitor the usage of resources. Laws also establish protected areas/national parks; the natural resource is protected because persons

overconsuming or illegally harvesting resources will be penalised and the harmful practice will be reduced.

Part (b) (ii) required candidates to explain how political factors influence the successful use of tools for the natural resource management. This part presented some challenges to candidates, as many were unclear with respect to the relationship between policies and tools. Many, for example, selected legislation, which is a tool utilised to achieve policies. An example of a relevant explanation is:

Political factors include the development of economic and/or environmental policies to address natural resource use. These policies will determine how well the various tools will operate. If the policies make the tools attractive to the public, they will be used. An example is the implementation of a tax deduction on the use of solar energy by the Government of Barbados in 1981 or the decision to remove all taxes on compressed natural gas (CNG), electric and hybrid cars with engine sizes up to 1999cc and to begin the process of converting all government vehicles, fast ferries and water taxis to CNG and/or alternative power sources in Trinidad and Tobago.

Part (c) of this question was based on a graph which showed the number of threatened plant and animal species in three selected Caribbean territories.

In Part (c) (i), candidates were asked to summarise the information in the graph in a suitable table. Most candidates were able to successfully read off the correct information from the diagram and tabulate it, but many lost up to two marks for not placing the appropriate table headings:

Correct responses are shown below:

Country	Number of threatened species		
	Plants	Fish	Mammals
Antigua and Barbuda	4	19	4
Grenada	3	20	3
St. Lucia	6	21	2
OR			
Number of threatened species	Country		
	Antigua and Barbuda	Grenada	St. Lucia
Plants	4	3	6
Fish	19	20	21
Mammals	4	3	2

Part (c) (ii) was also based on the graph at the beginning of Part (c), and candidates were asked to suggest reasons why fish are the most threatened species in all of the selected territories. Candidates' performance in this question was satisfactory, as they were generally able to identify reasons for the trend. However, many candidates lost marks for not expanding on their reason.

An example of a typical answer is:

There may be an increase in predators or exotic/invasive species (for example, lionfish) that will consume the fish, reducing their numbers.

Paper 031 – School-Based Assessment (SBA)

The SBA is an integral part of student assessment in the course covered by this syllabus. It is intended to assist students in acquiring certain knowledge, skills, and attitudes that are associated with the subject. The activity for the SBA is linked to the syllabus and should form part of the learning activities to enable the student to achieve the objectives of the syllabus. In this regard, the SBA should relate to at least one specific objective in the Unit.

The SBA component is compulsory. The assignment is assessed using criteria provided in the syllabus. The following are the skills that are assessed:

- (i) the selection of techniques, designs, methodologies and instruments appropriate to different environmental situations;
- (ii) the collection and collation of data;
- (iii) the analysis, interpretation and presentation of such data;
- (iv) the use of appropriate quantitative techniques;
- (v) the development of appropriate models as possible solutions to specific environmental problems.

In general, the specified criteria were applied effectively.

There was a noticeable reduction on use of secondary data and an increase in the evidence of primary data collection. Candidates are once again encouraged to continue to design projects that will encourage the collection and collation of primary data.

It is important for teachers to pay attention to the section of the syllabus that addresses the descriptors for assessing the journal report. These descriptors provide a very good guide on how marks are to be awarded and what to look for in a good journal report.

Further, the CXC criteria at the bottom of the moderation sheet **must** be applied when recording and distributing marks to the three modules. A remainder of one mark must be allocated to Module 3. A remainder of two marks, one mark allocated to Module 2 and one to Module 3. Care should be taken when compiling total scores. Moderators detected many errors in the total scores submitted for students.

There was a noticeable improvement in the literature review and communication of information aspects of the SBA. However, while the majority of the candidates were able to communicate the information in a fairly logical manner with few grammatical errors, there were still some candidates who presented information with several grammatical errors. This ultimately reduced the overall quality of the final report.

A marked improvement was noted in the quality of the assignments submitted. In general, the required criteria for this component were effectively applied. Although the literature review improved significantly there is still need for some candidates and teachers to pay attention to the relevance of the material that is chosen as literature review to support the pieces of work submitted for evaluation. This resulted in a few instances where the literature review was irrelevant or inadequate. There is still a need for candidates to improve their writing and expression skills. Improvement in this area will definitely improve the quality of the reports and make them more reflective of a report of the standard expected at the CAPE level.

Some areas in which the SBA in Unit 1 may be improved are:

- Ensure that each activity of the SBA relates to at least one specific objective of the syllabus.
- The research title should be more concise and focussed.
- Projects chosen should always be relevant to Unit 1. However, this was not the case in a few of the candidates' work.
- The problem statement should always be clearly stated and should be concise.
- The purpose of the project should be clearly outlined and the variables should be clearly defined.
- Care should be taken when undertaking the laboratory aspect to ensure that different parameters are investigated. Please note that if candidates choose the same parameter to be investigated at different locations this will still constitute one parameter and one laboratory exercise. One variation that might be acceptable is if a different method is used to investigate the same parameter and a comparison is then made of the results obtained.
- Effective planning and design should be addressed. Poor planning and design resulted in data collection in some instances being inadequate.
- Diagrams and illustrations need to be more appropriate and well integrated in the text to increase their effectiveness.
- Comprehensive data analysis is required and this should make use of appropriate statistical tools to improve the result.
- Discussion of findings, conclusion and recommendations should be based **only** on what was presented in the literature review and the data that is collected, presented and analysed. **No new material should be introduced in the discussions.**
- 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 the reported findings.
- Bibliographic references should be written using a consistent convention. In addition, there should be at least four up-to-date references. There were too many

instances where candidates failed to properly write the bibliographic references using a consistent convention.

Paper 032 – Alternative to the School-Based Assessment

The number of candidates sitting the Paper 032 in 2016 remained small – about 28 candidates – but was still considerably higher than in previous years. There has been some improvement in candidates' responses to questions on Paper 032. Best performance was on Question 1, followed by Question 2 and then Question 3. There is still need for greater improvement in the depth and breadth of coverage with respect to certain areas of the syllabus. Greater effort must be made by candidates to improve their ability to organise, apply and communicate information.

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

Overall, candidates did not demonstrate the optimal practical abilities and this was often reflected in the manner in which they addressed questions that dealt with practical applications. Candidates are urged to engage in more practical field and laboratory activities so that they will be in a better position to apply the practical knowledge in the questions. Accordingly, liaisons with schools, colleges, centres of learning or universities which have the facilities or do the practical components, should be encouraged and fostered.

Question 1

This question was designed to test candidates' understanding and knowledge of the following topics within basic ecological principles:

- Ecological pyramids
- The pyramid of numbers
- Species abundance and diversity
- Methods for estimating populations of species

Candidates were presented with data in a tabular format based on an ecological study of two sites, 1 and 2. Candidates were also given the species diversity for Site 1.

In Part (a) (i), candidates were required to utilise the data in the table, stating the scale, to construct a pyramid of numbers for Site 1. The majority of candidates were able to construct the pyramid correctly, and most candidates scored highly in this part of the question. However, many candidates did not state the scale that they used, nor did they attach a title to the pyramid.

Part (a) (ii) asked candidates to calculate the species abundance and species diversity for Site 2. Candidates were given the formula to calculate species diversity and they were generally able to calculate the species abundance and species diversity.

Part (a) (iii) required candidates to use the information provided in the table and from the calculations to explain three differences between the sites. Candidates performed satisfactorily in this part.

Part (b) required a description of the methods for estimating the populations of species in the ecosystem.

Part (b) (i) asked candidates to describe a detailed methodology which could be used to estimate the population of snakes – a motile organism. Most were able to identify the ‘mark-release-recapture’ as the method that could be used for sampling the population because they were motile. However, many did not give a detailed description of the method, nor did they identify the formula used for calculating an estimate of the population. The formula is shown below.

$$\frac{\text{no. in population}}{\text{no. in first sample}} = \frac{\text{no. in a recaptured sample}}{\text{no. already marked in recaptured sample}}$$

In Part (b) (ii), candidates were asked to state four assumptions of the ‘mark-release-recapture’ method. Candidates performed well on this part of the question.

Question 2

This question was designed to test candidates’ understanding and knowledge of the following topics within people and the environment:

- Age-sex structure diagrams
- Demographic transition
- Population statistics
- Urbanisation

Part (a) utilised a diagram displaying four population pyramids representing different stages in the demographic transition. Candidates were asked to explain the shape of the population pyramid at each stage with respect to birth rate and life expectancy. Candidates were generally able to describe the trend, and performance on this part of the question was satisfactory.

Part (b) was based on a table which presented data on world population numbers in less developed and more developed countries in 1995 and 2025.

In Part (b) (i), candidates were required to calculate the estimated percentage growth in world population attributable to less developed countries between 1995 and 2025. Candidates struggled to complete the calculation and there was often an omission of the relevant units in many responses.

Part (b) (ii) required candidates to explain why the estimated growth of the population of less developed countries as calculated in Part (b) (i), should be a cause for concern. Most candidates were able to adequately describe the cause and effect relationship between population growth on the environment, economy and social environment of less developed states.

Part (c) was based on a table which presented data from a survey on prevalent environmental issues in two communities.

Part (c) (i) required candidates to draw a bar chart to represent the results of the table. Most candidates performed well in this question, but it should be noted that many candidates did not label the axes or place a title on their chart.

In Part (c) (ii), candidates were asked to identify three reasons and provide a justification of which of the two communities were most likely to be urban. Most were able to identify community A as the urban community, and justify this answer by reference to relevant reasons.

Recommendation

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

Question 3

This question was designed to test candidates' understanding and knowledge of the following topics within natural resources and the environment:

- Consumptive and non-consumptive use of natural resources
- Maximum sustainable yield
- International agreements

Part (a) required candidates to distinguish, by means of one example for each, the terms 'consumptive use of natural resources' and 'non-consumptive use of natural resources'. There was an improvement in candidates' understanding of the concepts, as candidates generally were able to define the concepts and give relevant examples.

In Part (b), data was presented in graphical format illustrating the total number of species of fish caught in countries A and B over a 12-year period. Candidates were told that the fishing effort was constant over the period.

Part (b) (i) required candidates to compare the trend illustrated in the graph for both countries over the 12-year period. Candidates were generally able to describe the trend, but many lost marks for not including the specific values in their response as directed in the question.

In Part (b) (ii), candidates were required to suggest four possible reasons to explain the trends observed for Country B. This part was satisfactorily done, as most candidates were able to suggest at least two reasons for the trend.

Part (b) (iii) required candidates to define the term 'maximum sustainable yield.' Few candidates were able to satisfactorily provide a definition for this term, with most candidates giving incomplete or incorrect responses, and not understanding the meaning of the term.

Part (b) (iv) required candidates to complete a table, which required them to read off data from the graph presented at the beginning of Part (b). Accordingly, candidates were required to fill in the maximum sustainable yield and the year achieved for both Country A and Country B. This part of the question was generally well done.

Part (b) (v) required candidates to suggest four reasons why fishery resources should be harvested below the maximum sustainable yield (MSY). Candidates also did well in this part of the question.

Part (c) required candidates to identify an international agreement which would assist Country B in addressing international ships which were polluting its marine waters. They were also required to give three reasons for their answer. Many candidates did not attempt this question, and it is obvious that greater emphasis will need to be placed on specific objective 3.10, which deals with international and regional agreements.

Recommendation

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

UNIT 2

Paper 01 – Multiple Choice Items

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

Ninety-four per cent of the candidates gained acceptable grades in this paper.

Paper 02 – Essay Items

Question 1

This question required candidates to illustrate their understanding of concepts relating to alternative farming practices (hydroponics), food security, and how climate change may affect sustainable agriculture.

In Part (a) (i), candidates had to describe the practice of hydroponics – most of the candidates were able to do this correctly. Part (a) (ii) continued on this topic, and asked for four benefits of hydroponics. While many candidates were able to provide four benefits, some candidates provided descriptions of the practice, others confused benefits of hydroponics with those of aquaponics.

Part (b) (i) required the candidate to read and deduce information from a graph. This was generally well done, but a significant number of candidates had difficulty reading the data from the x-axis. Also, because the graph was a stacked bar chart, candidates were able to correctly read the data for Country A, which was to the left; but were less able to do so for Country B, which was to the right.

In Part (b) (ii), candidates were required to demonstrate higher-order thinking and had to use the data from (b) (i) to come to a suitable conclusion as to which country made a greater contribution by food security to the economy. This question was not well done.

From the responses, it seemed that candidates were not aware of what food security was, or how one could determine from the graph which country had had a higher contribution by food security. To obtain full marks in this question, candidates had to:

- express an opinion as to which country had the greater contribution by food security (Country A),
- indicate which of the parameters on the graph would contribute to food security (food materials and agroprocessing), and
- use the data in the graph to identify the higher contribution to food materials AND agroprocessing industries.

Candidates attempting this question often lost marks in providing the wrong country, usually because of misreading the graph, and then using the incorrect parameters, for example, including the production of non-food materials in the determination of higher contribution by food security.

Overall performance on Part (c) was not good; candidates either performed well or poorly – there were few in the middle ground. In this part of the question, candidates had to suggest three reasons why climate change was a threat to sustainable agriculture, for six marks. Each suggestion was worth two marks, which were awarded as follows: indication of the result of climate change (1 mark) for example, changes to local temperatures or weather patterns and an indication of how this would be a threat to sustainable agriculture (1 mark). Many candidates were able to get at least three marks, usually because they were able to identify three effects of climate change on agriculture, or things that would directly affect

agriculture. However, too many candidates could not directly connect their chosen “effect” to threats to sustainable agriculture.

Question 2

Performance on Parts (a) (i) and (ii) was mixed. In Part (a) (i), most candidates were able to correctly read the graph and so deduce the information as required in the question. Where candidates were not able to do so, it was usually due to incorrectly reading the graphs, mixing up the key for each year, or not including actual values from the graph.

Part (a) (ii) was not well done by most candidates. In this part, candidates had to choose three of the negative impacts of agriculture illustrated in the figure provided, and suggest a reasonable explanation for the changes observed in the graph between Year 1 and Year 2. A significant number of candidates did not get full marks for this question, because they either gave very general statements, not related to the information in the graph, or they gave statements that had nothing to do with agriculture.

An example of an expected response is:

In Year 1 more habitat may have been destroyed in the process of clearing lands for agriculture. In Year 2, there may have been less habitat loss because there was no need to clear more areas for agriculture since that was done already in Year 1.

The better responses clearly connected the data from the graph to a reasonable and well-explained suggestion for the difference in the two years of data.

Part (b) was generally well answered by most candidates; it required them to outline three characteristics of commercial agricultural systems.

Part (c) was also generally well done by most candidates. It required the candidate to use two examples to discuss how technology can be used to improve agricultural productivity. This question was worth six marks, so each example had to be fully explained to receive the full marks. Candidates lost marks in this question where the chosen technology was correct, but the link to improvement in agricultural productivity was not made. For example, an incomplete response would have said:

One technology is the use of agrochemicals, particularly fertilisers which provide increased nutrients for plants.

This response is incomplete because it does not specifically state how using agrochemicals will result in increased productivity – to obtain the final mark, this is necessary.

Recommendations

Teachers should expose students to a wide variety of graph types during laboratory sessions.

Students and teachers should be reminded that vague, general answers will not be credited for full marks.

Students and teachers are reminded that if the question specifies values from the graph are to be used in the response, any response without such, even if correct, will not be awarded any marks.

Question 3

In Part (a), candidates were required to outline the series of energy conversions that occur when a kettle boiling on a gas stove starts to whistle. This part was done fairly well although a significant number of candidates were not able to identify the energy conversions between all stages of the process. Many instead described changes in the state of matter that occurred to the water. A small number of candidates misread the question entirely and mistakenly wrote about energy conservation.

Part (b) (i) required candidates to identify the major trend in the data provided in a given figure. This part was generally well done. Where candidates lost marks in this question it was because either the major trend was incompletely identified, or the candidates did not identify the trend, instead describing each point in the graph.

Part (b) (ii) required candidates to use the data in the figure to perform a simple calculation indicating how much spent nuclear fuel accumulated in the United States over a particular time period. Candidates generally used the graph well, and were able to correctly identify the values on the graph. However, a significant number of candidates were not able to use their correct data to get the correct answer. This occurred where candidates added the mass of spent fuel for each of the years between 1985 and 2000, instead of the correct manipulation described below:

$$\text{Mass of spent fuel in 1985} = 1400 \text{ MTU}$$

$$\text{Mass of spent fuel in 2000} = 2200 \text{ MTU}$$

$$\text{Mass of spent fuel accumulated} = 2200 - 1400 = 800 \text{ MTU}$$

Part (c) required candidates to compare and contrast the generation of electricity by conventional and nuclear methods. This question was fairly well done by most candidates.

Common errors included candidates confusing renewable energy and conventional energy, and so comparing electricity production by nuclear energy to solar energy, candidates comparing conventional energy with nuclear energy instead of *electricity generation* by the two methods, and incomplete comparisons where the characteristic of only one method of energy generation was stated.

Part (d) required the candidates to outline three impacts of conventional electricity generation in the Caribbean. This question was generally done well by most candidates. Where candidates performed poorly, it was often due to their responses outlining the

importance of conventional energy, rather than the impact of conventional energy. Responses outlining social, environmental and economic impacts were all awarded marks.

Recommendations

Teachers and candidates are reminded that trends look at changes over time and significant changes during any time period should be identified for full marks.

Candidates are also reminded that they should be guided by the mark allocation and show all necessary working. And finally, teachers and candidates should keep in mind that appropriate units should **always** be included when reporting data.

Question 4

Part (a) required candidates to briefly explain the importance of energy to Caribbean societies, supporting their response with one example. This question was generally done well; candidates were aware of the importance of energy and many attained full marks. Common errors in this question included instances where examples of energy resources were outlined, but there was no focus on the importance of these resources, and more than one example was stated, with none of them being fully developed, so that full marks could not be awarded.

Part (b) (i) required candidates to define the term *energy conservation*. The responses indicated that candidates could provide a sound working definition of energy conservation. Many candidates also gave examples of energy conservation methods and energy efficiency. A few candidates mixed up energy conservation with energy conversion, and so did not attain full marks.

In Part (b) (ii), candidates had to suggest one approach to improve energy conservation in the transportation sector, explain how it would work, and assess its suitability for the Caribbean. Candidates provided generally satisfactory responses; however, many candidates identified transport methods geared at emission reduction rather than energy conservation. Suitability to the Caribbean context (e.g. cost and implementation) was rarely addressed, and so many candidates did not achieve full marks in this question.

Part (c) was based on an experiment to determine whether or not using more energy efficient light bulbs in the home will reduce the homeowner's electricity bill by 50 per cent. In Part (c) (i), the candidates had to provide the aim of the experiment. For this question, the stimulus was used accurately by the majority of candidates to arrive at the correct response. In Part (c) (ii), candidates had to identify the manipulated, responding and control variables in the experiment. This part was not well done generally. Many candidates did not understand the different types of variables used in an experiment. Others confused a control experiment with a control variable. This kind of question is based on the practical skills component of the syllabus, and the failure of many to correctly identify the experimental variables is a cause for concern.

Part (d) required candidates to evaluate the feasibility of a Caribbean country switching from electricity generation using fossil fuel to hydropower. While many candidates were well informed about the advantages and disadvantages of hydropower, many did not use this understanding to address the main thrust of the question, which was the *feasibility* of hydropower in the Caribbean. Those who obtained higher marks in this question were able to use this content to address the feasibility issues by considering economic, geographical, social and political limitations of the use of hydropower versus fossil fuels. There was also some confusion among hydropower, wave energy and tidal energy in the responses provided.

Recommendations

Teachers are advised to utilise the SBA activities to improve on candidates' understanding of these issues.

Question 5

Part (a) of this question looked at issues of environmental receptors, particularly with respect to noise pollution. In (a) (i), candidates were required to define the term *environmental receptor*. This question was fairly well done; some candidates were able to give a full definition, others were not. Poor responses were vague, indicating that the candidate did not really know what a receptor was. The most common error was the idea that the receptor was the pollutant.

In (a) (ii), candidates had to provide an example of an environmental receptor for noise pollution. This question was answered fairly satisfactorily. However, a significant number of candidates gave incorrect answers like inanimate objects, such as houses, or living objects that would not be affected by noise, such as trees.

In the final part of this question, (a) (iii), candidates were asked to outline a procedure by which a restaurant could be assessed to see if it was in violation of noise pollution laws. This part was not handled well by most candidates. Candidates provided spurious methods for measuring noise, for example, seeing how far away the noise could be heard, or seeing how the liquid in a glass of water was agitated in the restaurant due to the noise. The problem is indicative not only of a lack of understanding of the way noise pollution is measured and assessed, but also a lack in the skill in experimental design. This is readily addressed through greater emphasis on experimental design during school lab exercises by students.

In Part (b), the question addressed pollutant transport through ecosystems. Part (b) (i) required candidates to draw arrows to illustrate the movement of pesticides through an ecosystem. Many candidates were able to get most of the marks for this question, but very few were able to get all, as they were not able to find all of the appropriate pathways. Some candidates were not able to correctly identify the direction of movement of the pesticide, others put arrows all over the place, in hopes that the correct answer would be chosen out of the many. Candidates should be reminded that the marker will only give

marks for the correct answer – it is not the job of the marker to choose the correct answer out of a mass of random ones.

Part (b) (ii) asked the candidates to state the starting point for the pollution. This question was well done, and most candidates were able to answer this part correctly.

In Part (b) (iii), candidates were asked to state which compartment would have the highest pesticide concentration, and to give reasons for this higher pesticide concentration. This question was fairly well done. Many candidates were able to come up with the correct answer, which was the birds, as they were exposed to biomagnification through the food chain. There was a considerable amount of confusion between the processes of *biomagnification* and *bioaccumulation*. Candidates are reminded that bioaccumulation is the process whereby a pollutant is accumulated in the body tissue of a particular organism, usually via passive diffusion from, for example, water and air, while biomagnification is the process whereby pollutant concentrations increase in the body of an organism due to its position at the top of the food chain.

Part (c) required candidates to explain how public awareness and education programmes and technological processes can be used to mitigate the impacts of pollution on drinking water. This question was done fairly well, although it also suffered from candidates' inability to provide in-depth responses. Candidates were usually able to come up with appropriate responses to how public awareness programmes can be used. Technological aspects were sometimes misunderstood, particularly with respect to technology as in the case of social media, television and radio. The technological aspects of water and wastewater treatment was what was more intended in this question.

Question 6

This question tested candidates' understanding in a variety of areas; including air pollution, using sulphur dioxide contamination as a prime example, along with international agreements to solve air pollution problems such as global warming and ozone depletion. This question was very poorly done by the majority of the candidates; unlike in many of the past years there were fewer candidates who did not attempt the question at all, but the number who could not complete it remained high.

In Part (a), candidates were required to list three underlying causes of pollution. This question was widely misunderstood by candidates, resulting in many not getting full marks. A common error was that candidates listed examples of causes of pollution, for example, littering or burning garbage. The key to a correct response was for the candidate to consider *why* someone might litter or burn garbage – for example, lack of environmental ethics.

Part (b) (i) required the candidates to use the graph provided to complete a table by correctly assigning concentration values in ppb to sulphur dioxide measurements given in absorbance units. This question was entirely based on practical skills, and was done fairly well. However, a significant number of candidates could not do this simple task. Common problems included that some candidates appeared to “eyeball” the graph, and so misread

the x-axis, some did not draw lines with a ruler, so that they were not horizontal/vertical, while some did not read the minor tick marks on the axes accurately. This is a skill that would be well-practised in the laboratory setting, especially given the nature of the SBAs that are required of the candidates.

Part (b) (ii) required candidates to use the data from Part (b) (i) along with some other stimulus to draw a conclusion about air quality due to sulphur dioxide. Most candidates were able to do this appropriately. Where candidates lost marks, it was due to failure to explain their conclusion.

Part (b) (iii) required candidates to evaluate the effectiveness of legislation to reduce sulphur dioxide emissions from automobiles, given the data in the table. This was fairly well done, in general. Where candidates were not able to attain marks, it was due to a few common factors, namely, not providing a clear statement as to effectiveness, not including actual data from the table, and providing general, vague reasons as to why this trend occurred, rather than using the data to provide specific, relevant reasons, based on the scenario in the question.

Part (c) required candidates to explain why international agreements are required to solve air pollution problems like global warming and ozone depletion. This question was very poorly done. Candidates often explained global warming and ozone depletion, or the Montreal and Kyoto Protocols, rather than explain why these protocols need to be international in scope. Candidates often also repeated themselves, thus not obtaining full marks.

Recommendations

Teachers are encouraged to have their students draw and interpret their own graphs, rather than only using software packages, so students are more aware of how to do graphical manipulation.

Candidates are reminded that, particularly in practical skills questions, their explanations should be grounded in the data or scenario provided, rather than presented as very general statements that might or might not apply in the context of the question.

Paper 031 – School-Based Assessment (SBA)

It is necessary to draw attention again to the fact that there was a change a while back in the SBA requirements. This change is adequately stated in the syllabus. It is advisable that teachers and students pay attention to this change which has been in effect for a while and familiarise themselves with the expected requirements.

The overall quality of the submissions for this Unit was good. In most instances an introduction to the journal was included. This was very useful in indicating the scope and purpose of the entries to the reader. 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. This was reflected in some activities being too simple and some not reflecting the standard and level of advanced proficiency

Generally, there was a significant improvement in candidates' analysis and interpretation of results.

Overall, there were very few candidates who failed to submit the required minimum number of pieces for the SBA components of laboratory report, journal entries and final report.

For the moderation process, it is important that teachers submit mark schemes used for the various components: laboratory exercises, journal entries and final report. These were missing in some instances and this created a problem for the effective moderation of the pieces that were submitted. In some instances, the total scores provided on the moderation sheet were either inaccurate, inaccurately recorded and sometimes were not distributed according to the syllabus guidelines.

Laboratory Exercises

There was a significant improvement noted in the overall quality and relevance of laboratory exercises for Unit 2. 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 was the spread of the laboratory exercises too narrow and the laboratory exercises chosen too simple for the level of examination.

While most candidates work 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, analysis and interpretation.

Journal

There was an overall improvement in the quality of journals submitted. The area of greatest improvement was reflected in candidates providing the required number of journal entries. There were some candidates who were unable able to link journal entries and laboratory exercises to specific objectives and conduct appropriate, complementary and supporting activities. Candidates should be reminded that the laboratory activities should be associated with the site visit and not treated as independent activities that are not related.

Candidates' inability to link objectives of site visits to the specific objectives in the syllabus resulted in a few journal and laboratory activities reflecting objectives and activities related more to Unit 1 than Unit 2. Candidates should always state and be guided by the specific objectives of the syllabus and the objectives for their journal activity. Candidates should always choose appropriate and adequate follow-up activities, present laboratory activities and journal entries in sequence.

There was improvement in the area of interpretative comments. This may be further improved if students develop the habit of keen observation, relevant and precise reporting, concise recording and the ability for critical thinking, problem solving and decision making.

It cannot be overemphasised that the syllabus requires 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. In a few of the submissions, candidates visited different sites and so could not make valid comparisons since they examined different processes and occurrences and thus there was no basis for comparisons.

Some general areas in which the SBA for Unit 2 may be improved are:

- Ensure that each activity of the SBA relates to at least ONE specific objective of the Unit.
- The research title should be more concise and focussed.
- Projects chosen should always be relevant to Unit 2. However, this was not the case in a few of the candidates' work.
- The problem statement should always be clearly stated and should be concise.
- The purpose of the project should be clearly outlined and the variables should be clearly defined.
- Care should be taken to ensure when undertaking the laboratory aspect that different parameters are investigated. Please note that if candidates choose the same parameter to be investigated at different locations this will still constitute one parameter and one laboratory exercise. One variation that might be acceptable is if a different method is used to investigate the same parameter and a comparison is then made of the results obtained.
- Effective planning and design should be addressed. Poor planning and design resulted in data collection in some instances being inadequate.
- Diagrams and illustrations need to be more appropriate and well integrated in the text to increase their effectiveness.
- Comprehensive data analysis is required and this should make use of appropriate statistical tools to improve the result.
- Discussion of findings, conclusion and recommendations should be based **only** on what was presented in the literature review and the data that is collected, presented and analysed. **No new material should be introduced in the discussions.**
- 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 the reported findings.
- Bibliographic references should be written using a consistent convention. In addition, there should be at least **FOUR** up-to-date references. There were too many instances where candidates failed to properly write the bibliographic references using a consistent convention.

Paper 032 – Alternative to the School-Based Assessment

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

Question 1

Candidates' performance in this question was generally good. In this question, candidates were required to demonstrate understanding of sustainable agriculture and the ways in which natural disasters would affect this.

In Part (a), candidates had to list four impacts of agriculture on the environment. This part of the question was done well and most candidates were able to provide four correct impacts.

Part (b) of this question required candidates to use a graphical stimulus showing the number and type of natural disaster in selected Caribbean countries between 1985 and 2014. Part (b) (i) required candidates to deconstruct the data in the graph to construct a suitable table to represent the data. This was generally done well; where candidates lost marks it was because they had not read the question carefully, which called for them to include the **total** number of disasters for each country, not to disaggregate the disasters by type.

Parts (b) (ii) and (b) (iii) were both well done; candidates could read the information on the graph and use it to come to a correct conclusion as required.

In Part (c) (i), candidates were required to list two features of sustainable agriculture. Most candidates could do so, but a significant number listed examples of activities that fitted into the appropriate category. These features (social equity, ecological integrity, economic viability and adaptability) are listed in the syllabus.

Part (c) (ii) asked candidates to discuss the effect of natural disasters on sustainable agriculture. This part of the question was done fairly well; however, there is room for improvement. Weaker responses tended to dwell on one or two effects, for example, loss of crops, while ignoring other effects, such as the inclination to use unsustainable, high-yielding practices.

Part (c) (iii) asked candidates to use a sketch to illustrate and explain an environmentally sustainable practice for agriculture on hillsides. Responses were varied. Some candidates were simply not aware of the correct answer, and so either came up with a variety of irrelevant diagrams, or left this part out altogether. The other area that needed some work in this question was the connection between the diagram and the explanation. The diagram was supposed to be used in conjunction with text to explain the functioning of the practice as well as the reason why it works. The well-prepared candidates were able to make a strong link between these items, but weaker candidates could not.

Question 2

Question 2 tested candidates' ability to discuss energy use with respect to vehicular transportation. Candidates had to calculate energy usage from data given about gasoline energy content, as well as to discuss the use of electric cars as an alternative to gasoline powered vehicles. This question was not done well by the majority of candidates.

The performance in Part (a) (i) was moderate. In this question, candidates had to determine how much energy would have been spent if 50 litres of gasoline were burnt in the engine. The data provided was the volume of the gas tank, the density of gasoline and the energy content of gasoline. Too many candidates were not able to do the simple mathematical manipulation to determine the amount of energy in the given volume of gasoline.

In Part (a) (ii), the performance was worse, as many candidates were not able to convert from megajoules (MJ) to joules. It is clear that many are not aware of the size of the various metric prefixes.

Part (b) focussed on the manipulation of stimulus data that related to electric cars, their use, and the use of conventional electricity production as a means of powering these vehicles. Candidates performed moderately in this section.

In Part (b) (i), candidates had to illustrate the data provided in a table (2007 to 2013) with a suitable graph. The most suitable graph would have been a line graph, given that the data was a time series. However, a number of candidates used bar charts instead. No points were deducted for this, though candidates are reminded that line graphs are more appropriate when data over time is to be represented. Most candidates were able to correctly construct a suitable graph.

Part (b) (ii) required candidates to predict the market share for electric vehicles in 2014. This tested the candidates' ability to extrapolate, based on the earlier information. This part of the question was not done well; indicating that more work needs to be done by candidates to improve their ability to manipulate graphical data so as to obtain relevant information from a graph.

Part (b) (iii) was generally done well, as most candidates were able to read the trend of increasing market share from the graph, and to give the appropriate justification for their response.

Part (b) (iv) required candidates to draw a flow diagram to illustrate the conventional generation of electricity. This was not generally done well. Some candidates simply did not know what the various unit processes were, others described different types of electricity production, like hydropower.

Part (b) (v) asked candidates to suggest a suitable alternative energy for electricity generation that would be suitable for implementation in the Caribbean. Most candidates were able to come up with solar energy. However, the justification of the choice was often not clear.

Question 3

Question 3 focused on candidates' ability to discuss land pollution, and associated issues, such as environmental receptors, monitoring and remediation of land pollution. A number of candidates did not do this question, and those who did attempt it performed moderately.

Part (a) (i) was generally well done. Most candidates were able to identify lead as the main contaminant produced from a car battery manufacturing plant.

Part (a) (ii) was also fairly well done, as most were able to correctly identify three environmental receptors for pollution found in the Blue River. Candidates are reminded that although the pollutant is in the river, it does not mean that the receptors must also be in the river. Humans and animals that drink from the river, for example, can also be receptors for a polluted river.

Part (b) required candidates to use stimulus monitoring data to convert from measurement units to concentration units, construct a suitable graph to illustrate the data, and to derive suitable conclusions from said data. This part of the question was done moderately. Part (b) (i) required candidates to use the equation of a calibration curve to convert absorbance units into ppm values. The equation of the calibration curve was provided so that candidates did not have to generate this. This part of the question was not done well. Even though the equation was provided, a number of candidates could not use it to derive correct concentration values. This is an area that clearly needs more work.

Part (b) (ii) required candidates to construct a suitable bar chart to illustrate the data. This was generally well done. Even if candidates did not get correct values from (b) (i), they were not penalised, once they used their data correctly in their graph.

Part (b) (iii) was generally well done, as most candidates were able to identify the relationship, that is, the further away from the factory, the lower the concentration. A reason for this trend had to be provided in Part (b) (iv). This was not done well. Too many candidates could not come up with a rational reason, given the data provided in the table as well as the stimulus sketch map of the area.

Part (b) (v) required candidates to make a conclusion about the safety of the water supply. Most candidates were able to come up with an appropriate conclusion by comparing the water concentration to that of the standard.

Part (c) required candidates to suggest two measures that could be used to mitigate the pollution in the area. This was not well done.

Recommendations

Candidates are reminded that when a particular scenario is provided in a question, they should use the scenario information to come up with their answers. Providing generic answers that are not relevant to the given stimulus will result in a loss of marks.

C A R I B B E A N E X A M I N A T I O N S C O U N C I L

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

MAY/JUNE 2017

ENVIRONMENTAL SCIENCE

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GENERAL COMMENTS

Environmental Science is a two-unit subject with each unit consisting of three modules. The two units are as follows:

Unit 1 — Fundamental Ecological Principles, People and the Environment and Sustainable Use of Natural Resources

Unit 2 — Sustainable Agriculture, Sustainable Energy Use and Pollution of the Environment.

Both units are examined by three papers. Papers 01 and 02 are external examinations, while Paper 03 is the SBA and is examined internally by the teacher and moderated by CXC.

This is the eighth year that Paper 01 of both Unit 1 and Unit 2 consisted of multiple choice items. Paper 01 consists of 45 compulsory multiple choice items with 15 questions based on the contents of each module. Each module contributes 20 marks to the total 120 marks for the paper. This paper contributes 30 per cent to the unit.

Paper 02 consists of six questions, two based on each module. Candidates are required to answer both questions from each module. Each question contributes 20 marks to the total 120 marks for the paper. The paper contributes 40 per cent to the unit.

Paper 03, which is known as the School-Based Assessment (SBA), contributes 90 marks or 30 per cent to the total assessment. The SBA is an integral part of student assessment in the course covered by this syllabus. It is intended to assist students in acquiring certain knowledge, skills, and attitudes that are associated with the subject. The activity for the SBA is linked to the syllabus and should form part of the learning activities to enable students to achieve the objectives of the syllabus.

The SBA component is compulsory. The assignment is assessed by the teacher, and moderated at the time of marking, using the SBA criteria provided below.

The following skills are assessed:

- Selection of techniques, designs, methodologies and instruments appropriate to different environmental situations
- Collection and collation of data
- Analysis, interpretation and presentation of data
- Use of appropriate quantitative techniques
- Development of appropriate models as possible solutions to specific environmental problems

The SBA for each unit should always relate to at least one specific objective in the unit.

Paper 032, the Alternative to SBA, consists of three questions as follows:

- (i) A practical question
- (ii) A question based on data collection
- (iii) A planning and design exercise

This paper constitutes 30 per cent of the overall assessment of candidates' performance.

DETAILED COMMENTS

UNIT I

This year saw a levelling off in the number of candidates writing Unit 1. There are certain specific objectives with which candidates continue to struggle, which is of ongoing concern to the examiners. In addition, a large number of candidates failed to demonstrate the breadth of knowledge necessary to perform well in the subject, with many providing responses which were inadequate, especially where they were required to apply knowledge, infer relationships, read graphs and explain interrelationships. Greater attention should be given to basic principles and the higher order cognitive skills identified in the syllabus.

Candidates have improved in their strategy for answering all the questions required by the examination, and were able to complete the papers in their entirety. This is worthy of note also within the context of the change in the format of presentation of Paper 02. In the main, candidates attempted all 6 questions in Paper 02.

The examiners strongly recommend that candidates apply a strategy that will allow them to attempt all questions. A prudent strategy is for candidates to allocate equal time to each question, and to start with their 'best' question, and then at the end of the allotted time for each question, they should move on to their next question. In this way they will be able to attempt all of the questions.

In addition, candidates are asked to be cognizant of both the term used to introduce a question, and the amount of marks awarded for that question, since these are clear guides to what is required of them. A list of more commonly used terms and phrases is provided on pages 8–9 of this report.

Overall candidates' performance was best in Module 2 followed by Module 3 and then Module 1.

The major problems with this unit were especially evident in the parts of questions that asked for candidates to make inferences based on data or stimulus provided, to perform calculations and to describe trends based on graphical or tabular data. Candidates generally performed poorly on such questions. In addition, some concepts were simply not familiar to candidates, and greater emphasis needs to be placed on them in the future.

Reading graphs and interpreting information presented was another problem for some candidates. Many candidates had difficulty accurately reading and interpreting information

from graphs. In some instances, candidates read the data on the graph only from one axis, totally ignoring data on the second axis, despite the presence of a key indicating the data associated with each axis.

Once again there was a recurring problem throughout the examination for any question that required candidates to analyse trends in graphical data. Most candidates simply described the data rather than identify the trends in the data. To improve in this particular area, candidates should refrain from stating every single change they observe in the graph. Rather, the entire picture presented should be examined, and any *major* points selected for the analysis of trends.

Many candidates gave general responses and too many candidates ignored the fact that examples could have been used to demonstrate understanding of a concept or to support their answers in some instances. Where examples were used, candidates often provided erroneous or 'made up' information. In addition, there were a large number of candidates who had difficulty comprehensively addressing questions which required them to identify countries of the Caribbean region, and to provide examples from these countries. This was especially evident for module 3, which requires a methodical analysis of the existence, status and threats of natural resources in the Caribbean region. It is suggested that in teaching these sections of the syllabus, teachers carefully identify and underscore the geographical extent of the Caribbean region for the purposes of the relevant module in CAPE Environmental Science.

During the marking exercise, it was also evident that many teachers tend to be more aware of the natural resources of their own territories. It is suggested that CAPE Environmental Science teachers network with each other, and also team teach where relevant to enhance the delivery of the unit. It is advised that teachers utilize strategies to incorporate a wider range of illustrative examples from the CXC member territories and the Caribbean in their teaching, to foster a more broad-based understanding by students. This is especially critical for Module 3 of Unit 1, which relies heavily on a comprehensive grasp of natural resources, their management and conservation in the Caribbean region.

Too many candidates continue to struggle with questions requiring the use of higher order cognitive skills, and often in the internal assessment, the psychomotor and affective skills required in the fieldwork and laboratory component. Candidates seem not to appreciate and/or understand the meaning and requirements of words such as *interpret, illustrate, justify, predict, relate, suggest* and *infer* when used in questions. This lack of elaboration on the part of candidates could also be explained by a shortage of time to attempt questions. It is recommended that in preparing for the examination, greater emphasis be placed on these types of questions. Some exceptional suggestions by examiners for enhancing this aspect of delivery of the course, which are endorsed by members of the examining team include the following:

- Team teaching of the subject — utilizing specialists to deliver particular modules of the unit
- Increasing the emphasis on practical activities, **especially** field exercises
- The use of Paper 032s to consolidate the skills and knowledge garnered from practical activities and field exercises

- The use of the methodology of practising past paper questions to consolidate what was taught in a specific section or module of the syllabus

Teachers are encouraged to network with other teachers doing CAPE Environmental Science within their territories, and other territories doing the subject, to cross-fertilize ideas, share experiences and to utilize the network as resource-sharing and problem-solving mechanisms.

The CAPE Environmental syllabus has a glossary of terms that teachers and candidates should find useful when preparing questions and responses. It is recommended that teachers and students take note of these terms. Paying attention to these terms and what is expected in an answer when they are used will help guide candidates as to the depth and breadth of a required answer. Additionally, the marks allocated for each question are a useful guide to answering questions. Often, candidates spent the lion's share of their time on the lesser weighted parts of a question, and then gave a cursory or an incomplete answer for the heavier weighted component of the question.

A list of some of the more commonly used terms is provided below.

Word	Definition/Meaning	Notes
Assess	Present reasons for the importance of particular structures, relationships or processes.	Compare the advantages and disadvantages or the merits and demerits of a particular structure, relationship or process.
Comment	State opinion or view with supporting reasons.	
Compare	State similarities and differences.	An explanation of the significance of each similarity and difference stated may be required for comparisons which are other than structural.
Deduce	Make a logical connection between two or more pieces of information; use data to arrive at a conclusion.	
Define	State concisely the meaning of a word or term.	This should include the defining equation/formula where relevant.
Demonstrate	Show; direct attention to.	
Derive	To deduce, determine or extract from data by a set of logical steps some relationship, formula or result.	This relationship etc. may be general or specific.

Word	Definition/Meaning	Notes
Describe	Provide detailed factual information of the appearance or arrangement of a specific structure or a sequence of a specific process.	Description may be in words, drawings or diagrams or any appropriate combination. Drawings or diagrams should be annotated to show appropriate detail where necessary.
Differentiate/ distinguish Between/ among	State or explain briefly those differences between or among items which can be used to define the items or place them into separate categories.	
Discuss	Present reasoned argument; consider points both for and against; explain the relative merits of a case.	
Evaluate	Weigh evidence and make judgements based on given criteria.	The use of logical supporting reasons for a particular point of view is more important than the view held; usually both sides of an argument should be considered.
Explain	Give reasons based on recall; account for.	
Illustrate	Show clearly by using appropriate examples or diagrams, sketches.	
Interpret	Explain the meaning of.	
Justify	Explain the correctness of.	
List	Itemize without detail.	
Outline	Give basic steps only.	
Predict	Use information provided to arrive at a likely conclusion or suggest a possible outcome.	
Record	Write an accurate description of the full range of observations made during a given procedure.	This includes the values for any variable being investigated; where appropriate, recorded data may be depicted in graphs, histograms or tables.
Relate	Show connections between; explain how one set of facts or data depend on others or are determined by them.	
State	Provide factual information in concise terms outlining explanations.	

Word	Definition/Meaning	Notes
Suggest	Offer an explanation deduced from information provided or previous knowledge (a hypothesis; provide a generalization which offers a likely explanation for a set of data or observations).	No correct or incorrect solution is presumed but suggestions must be acceptable within the limits of scientific knowledge.

Candidates are reminded that if the space allocated under the responses on Paper 02 are not adequate, there are two pages of extra space which may be found at the end of the script. If candidates utilize extra space, they should indicate at the end of the original question by an annotation such as “Please see extra space” and also indicate in the extra space, the number of the question or questions, for ease of reference.

Paper 02 – Essay

Overall candidates’ performance was best in Module 2 followed by Module 3 and then Module 1.

Module 1: Fundamental Ecological Principles

It was expected that candidates, on completion of this module, should demonstrate an understanding of

- basic ecological concepts
- the processes that govern the interactions of organisms with the biotic and abiotic components of their environment
- the relationship between people and the environment
- the application of acquired knowledge, practical and analytical skills.

Candidates did not perform as well as expected on this module. Many candidates had challenges demonstrating their knowledge of basic ecological concepts, ecological interactions and environmental principles. Too many candidates struggled to define, draw, distinguish and discuss key ecological terms and concepts, and many of them could not explain the relationship between ecological concepts and the natural environment. In addition, it was clear that candidates encountered challenges in manipulating and explaining the practical aspects of this module — an aspect of the syllabus which will need to be strengthened by incorporating it into the SBA component of the subject. The suggestions by examiners for enhancing this aspect of delivery of the course listed above will be of tremendous help in this regard. Understanding these basic concepts is important if the objectives of the module are to be achieved.

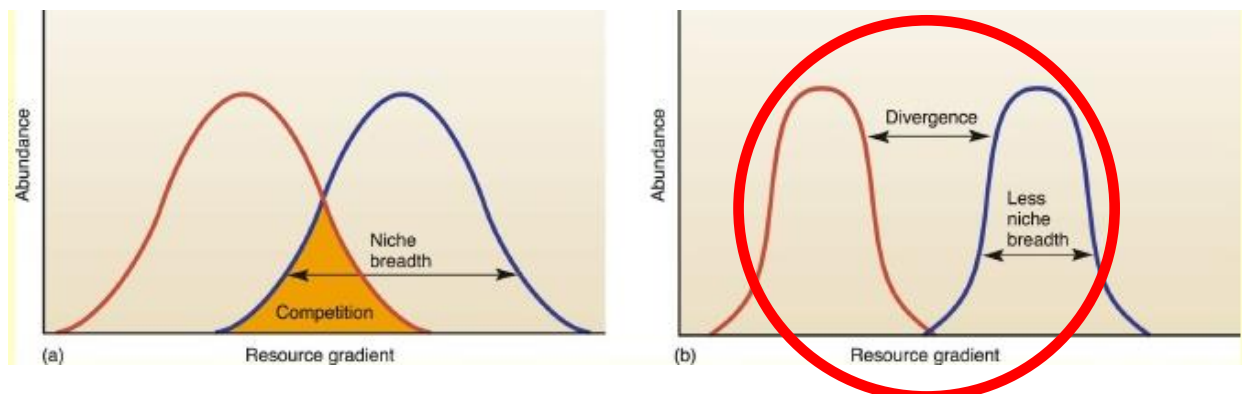
Question 1

Syllabus Objectives: 1.1, 1.6, 1.8, 1.10

This question was based on the concept of ecological niche, competition between species and species diversity. In Part (a), candidates were asked to define the term *ecological niche*. In general candidates were able to supply a definition for the concept.

Part (b) addressed the concept of competitive exclusion with respect to an ecological niche, and featured a graph as the stimulus material. In Part (b) (i), candidates were required to study a figure and identify what a region marked X represented. This part was reasonably well done by candidates, as they were able to identify that this was an area of competition or an area where any limiting factor which is resource based (water, sunlight prey etc.) operated.

Part (b) (ii) required candidates to illustrate by means of a drawing how the niches of the two species will change over time. This part was not well done by candidates which the following diagram illustrates. Candidates were expected to show the effect of competition which will move the curves from their position in (a) to that in (b), which the following diagram illustrates.



This movement occurs, because as the law of competitive exclusion states, no two species will occupy the same niche and compete for the same resources in the same habitat for very long. Therefore, over time, the niches can evolve as species develop new strategies to exploit resources.

Part (c) addressed the concepts of competition between species and adaptation. For Part (c) (i), candidates were asked to identify two types of interactions, other than competition between organisms in communities, that is, predator-prey, symbiosis, or any two examples of symbiosis (parasitism, commensalism or mutualism). This part was well done by the majority of candidates.

Part (c) (ii) required candidates to define one of the types of interactions listed in Part (c) (i), and by means of an example, explain how it may influence the population numbers of an organism in an ecosystem. Many candidates were able to define the interaction and identify the example, but did not provide a satisfactory explanation. An example of a satisfactory response is provided below.

A predator–prey relationship is where one organism feeds on another, for example, a lizard feeding on flies. A population of lizards will feed on flies for food and energy, and as a result the number of flies will decrease.

In Part (c) (iii), candidates were asked to outline the role of adaptation in addressing the interaction discussed in Part (c) (ii). The concept of adaptation continues to not be well understood by candidates.

Adaptation involves the development of features by a population which provides for improved function in the ecosystem. The flies, for example, may adapt mechanisms of eluding the lizards, which will make their rate of survival higher.

Finally, in Part (c) (iv), candidates were asked to discuss the relationship between species diversity and ecosystem stability. In general, candidates illustrated the relationship, but it should be borne in mind that a discuss question of this type for 6 marks requires the definition of both concepts and a complete explanation of the relationship between the two concepts.

Candidates' overall performance on this question, although better than Question 2, was not as expected.

Question 2

Syllabus Objectives: 1.6, 1.9, 1.10, 1.8, 1.14, 1.18

This question presented the results of two types of population sampling methods — the line transect method and the quadrat method — for three species, A, B and C, in a natural savannah ecosystem.

Part (a) (i) required candidates to explain the difference between the line transect method and the quadrat method. While candidates were generally able to identify the features of both methods, many of them failed to explain the differences between the two types of sampling methods. A good method of representing this would be by means of tabulating the two concepts.

Line transect	Quadrat
Systematic method of sampling.	Random method of sampling.
A larger range/area can be sampled.	Sampling is restricted to a particular location.
A broader variety of species may be sampled.	Only the species within the quadrat are sampled (that is, a smaller group of species).

In Part (a) (ii), candidates were asked to calculate the density for Species A and the percentage frequency for Species B. This part was not well done, as it was evident that candidates were not familiar with the formulae:

Density for Species A = the mean number of individuals / m²
 $8 + 5 + 0 + 0 + 4 + 2 + 9 + 11 + 6 + 8 / 10 \text{ m}^2 = 53/10 \text{ m}^2$
 5.3 individuals / m²

Percentage frequency for Species B =
 the number of quadrats in which Species B is found / total species x 100
 $9/10 \times 100 = 90\%$

Part (a) (iii) required candidates to utilize the data in the table to explain the type of interaction between Species A and Species B. Candidates were able to make deductions from the table, and establish that there was a competitive relationship. It is to be noted that in questions of this type, candidates need to derive their deductions from the stimulus materials.

Part (b) (i) required candidates to describe how the data in the two tables may be used to provide information on the distribution of Species A, B and C. This part was relatively well done as the majority of candidates was able to make this deduction, and adequately justified their responses.

In Part (b) (ii), candidates were asked to explain two ways in which human activities disrupt the integrity of the natural ecosystem. This part was the best done for Question 2, as candidates were able to identify and explain human impacts on the ecosystem.

Candidates' performance on this question was not as expected, and it is evident that more emphasis will need to be placed on Specific Objective 1.18.

Module 2: People and the Environment

It is expected that candidates, on completion of this module, should demonstrate an understanding of

- the historical and geographical trends in human population growth and consumption patterns
- the socio-environmental impacts related to population growth
- the factors that affect the growth rate of human populations
- the need for sustainable development
- the application of acquired knowledge, practical and analytical skills

The major problem with this module was evident in the parts of questions that asked for candidates to perform calculations from data presented, identify and describe trends and infer relationships from graphical or tabulated data. The definition of key terms and concepts in this module has improved, but there were still instances where candidates struggled to provide definitions of the terms and concepts tested.

Candidates seemed not to appreciate and/or understand the meaning and requirements of words such as *describe*, *explain* and *discuss* in questions. Candidates may have ignored the depth of the answers required because they simply did not have time to attempt the

questions as they should. This indicates that candidates should practise better time management when preparing for and taking their examinations.

Most candidates performed poorly on questions requiring calculations. In addition, many candidates had difficulty working with large numbers (millions, billions), and including appropriate units in their responses. Candidates need to pay greater attention to their basic mathematical skills and how to execute mathematical calculations using data from tables or graphs.

Question 3

Syllabus Objectives: 2.2, 2.12, 2.13

This question tested the concepts of demographic factors on population, size and urbanization on the environment.

In Part (a), candidates were presented with a diagram illustrating how the population size of a country is influenced by demographic characteristics/factors represented by A, B, C and D. Candidates had to identify the demographic characteristics/factors labelled A, B, C and D, which most were able to do.

Part (b) addressed urbanization and its environmental impacts. In Part (b) (i), candidates had to identify two reasons why urbanization is likely to occur in a Caribbean country. In general, candidates performed well on this part, as they were able to identify and explain the driving factors behind urbanization in the Caribbean region.

For Part (b) (ii), candidates were required to explain three environmental impacts of urbanization in the Caribbean. Candidates were generally able to identify the impacts, to score the three marks. An example of a complete response is as follows:

Increased quantities of untreated sewage can result from urbanization **(1)**, because the increased population in urban areas can put pressure on existing waste treatment systems **(1)**, which can result in untreated sewage being released into the environment posing a public health hazard **or** causing pollution of surface water. **(1)**

Candidates are asked to ensure that their explanation is commensurate with the marks offered for the question, as a partial explanation cannot be fully credited.

In Part (b) (iii), candidates were asked to utilize one of the environmental impacts discussed in Part (b) (ii), and identify a suitable approach which may be used to minimize it. Candidates performed moderately in this section, with most offering a partial explanation. An example of a complete explanation is as follows:

Improvement in waste management **(1)** to address the impact of increased quantities of untreated sewage, as improved collection and treatment of

sewage **(1)** will result in reduced exposure of persons to pollutants and will reduce the likelihood of illness. **(1)**

However, candidates should be careful that they do not combine more than one impact in their explanation, as only one impact can be credited.

Candidates' overall performance on this question was satisfactory.

Question 4

Syllabus Objectives: 2.2, 2.5, 2.7, 2.8

This question utilized a table showing demographic statistics in four Caribbean countries. Candidates were asked to use the data provided to examine the definition, calculation and description of demographic characteristics, in particular *total fertility rate* and *replacement level fertility*.

In Part (a), candidates were asked to define *total fertility rate* and *replacement level fertility*. This part was relatively well done by candidates.

Part (b) explored candidates' ability to calculate changes in demographic characteristics. Accordingly, candidates were asked to calculate the total fertility rate for each country in the table. Most candidates were able to provide the relevant formula and then to execute the calculation successfully.

Part (c) required candidates to utilize the values calculated in Part (b) to determine, with reasons, which of the four countries was at its replacement level fertility. Most candidates were able to identify Country B as its total fertility rate was closest to 2.

Part (d) focused on the significance and impact of total fertility rates, and measures which Caribbean governments can implement to control birth rates. In Part (d) (i), candidates were required to explain the significance of the total fertility rate they calculated for Countries A and C in Part (b). Most candidates were able to identify that Country A is below replacement level, while Country C is above the replacement level, and outlined what these figures would mean.

In Part (d) (ii), candidates were required to describe two environmental impacts that may occur because Country C was above replacement level fertility. Most candidates identified an impact, but many did not offer a complete explanation as follows:

Habitat destruction **(1)** is a potential impact of the fertility rates in Country C because increasing population size means greater needs for housing/resources, which would result in destruction of habitats and displacement of flora and fauna. **(1)**

In Part (d) (iii), candidates were asked to describe one measure which governments can implement to control birth rates. This question allowed candidates to explain control measures which could either increase or decrease birth rates.

The following are examples of such measures:

A measure to *decrease* birth rates

States with high replacement growth rates — the cost of birth control can be subsidized **(1)** and more easily accessible locations can be implemented **(1)**. This will make family planning more accessible and affordable, which will help reduce fertility rates. **(1)**

A measure to *increase* birth rates

States with low or zero/replacement growth rates can provide incentives **(1)** to encourage couples to have children **(1)** which can lead to an increase in fertility rates **(1)**.

Candidates' overall performance on this question was satisfactory.

Module 3: Sustainable Use of Natural Resources

It is expected that candidates, on completion of this module, should demonstrate an understanding of

- the main categories and types of natural resources in the Caribbean
- the location and distribution of the main categories and types of natural resources in the Caribbean
- the value of natural resources to the Caribbean region
- factors affecting the extraction and use of natural resources in the Caribbean region
- the environmental impacts of the extraction and use of natural resources in the Caribbean region
- measures and tools available for sustainable use and conservation of the Caribbean's natural resources
- the concept of ecological sustainability and implications for natural resource use
- the application of acquired knowledge, practical and analytical skills

Candidates continue to struggle with key terms associated with the management and use of natural resources, including *renewable*, *nonrenewable*, *consumptive*, *non-consumptive*, *exhaustible*, and *inexhaustible*. In addition, some candidates had difficulty identifying Caribbean countries, and many struggled to correctly identify the types of natural resources common to specific countries in the region.

Some candidates seemed to have difficulty identifying what was required of them in answering the questions, when certain terms were used. This shortcoming often resulted in poorly elaborated answers. Again, candidates are reminded that a list of commonly used

terms and phrases is provided in this report and on pages 63 – 66 of the 2011 CAPE Environmental Science syllabus. It is also recognized that this lack of elaboration on the part of candidates may also be explained by a shortage of time to attempt questions in Module 3. It is often apparent that because this is the last module on the examination paper; many candidates appeared to attempt these questions last and appeared to have run out of time. This indicates that candidates perhaps should practise better time management when preparing for and taking their examinations. However, as compared with other years, the examining committee observed fewer incidences of incomplete answers for Questions 5 and 6 than in previous years.

Candidates' performance was better on Question 3 than Question 4.

Question 5

Syllabus Objectives: 3.4, 3.8, 3.10

This question addressed selected natural resources in the Caribbean, the environmental impacts associated with natural resource use in the Caribbean and measures and tools available for natural resource management and conservation.

Part (a) featured a table, where candidates were given types of natural resources and asked to identify an example of the natural resources.

Category	Example
Ecosystems	Forests, coral reefs, seagrass beds, mangroves, wetlands Note: sea, river, ocean are also ecosystems
Water	Waterfalls, lakes, river, groundwater, sea, ocean
Landscape	Beaches, cliffs, mountains, valleys

Candidates generally performed well on this part of the question.

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

For Part (b), candidates were given the statements *Most Caribbean states have tourism-based economies. In order to sustain their economies, many beachfront properties are being constructed.* Parts (b) (i) and (ii) were based on this stimulus. In Part (b) (i), candidates were asked to discuss three environmental impacts associated with the construction of beachfront

properties. Candidates generally were able to identify impacts, but many failed to satisfactorily discuss each impact to attain three marks for each impact. The following is an example of a complete answer:

An example of environmental impacts associated with the construction of beachfront properties is beach erosion **(1)** which can result in the disruption of natural beach morphology by construction that may affect wave processes, leading to increased erosion. **(1)** This can impact on habitats and reduce the usability of beaches **(1)**.

In Part (b) (ii), candidates were required to outline one process that may be used to minimize the environmental impacts discussed in Part (b) (i). This part was also reasonably well done, and candidates were able to at least identify and provide a partial explanation of a process, measure or tool available for the conservation of the beach ecosystem. The following is an example of a complete response:

Environmental impact assessments **(1)** can be used to determine if the beach and coastal area are suitable for the construction of hotels **(1)** based on the area's ability to withstand structural disturbance **or** the presence of native/protected species **(1)**.

Part (c) required candidates to utilize a named example to explain how the Ramsar Convention may be used for natural resource conservation in the Caribbean. This part was not well done, and it is evident that Specific Objective 3.10 (xi) needs to be reinforced. An example of an expected response is as follows:

The Ramsar Convention provides for the increased protection of wetlands, including shallow coastal and marine areas. **(1)** A state acceding to the convention is required to designate at least one significant wetland site, **(1)** for example, Caroni Swamp (Trinidad) **or** Buccoo Reef/Bon Accord Wetlands (Tobago), **(1)** which is subject to some form of sustainable management, **(1)**. The convention works towards the wise use of all wetlands **(1)** and encourages international cooperation on transboundary wetlands/shared wetland systems **(1)**.

Candidates' overall performance on this question was satisfactory.

Question 6

Syllabus Objectives: 3.3, 3.8, 3.10

For this question, candidates were given a stimulus describing Country A. Based on this stimulus, candidates were questioned on the concepts of *consumptive* and *non-consumptive* resources, the use of the environmental impact assessment (EIA) as a tool available for natural resource management and conservation, and whether a natural resource can be exploited with the depletion of its ecosystem value.

Part (a) required candidates to distinguish between consumptive and non-consumptive use of natural resources by means of examples. While the overall correct responses were an improvement on preceding years, there is still ample evidence that candidates were not

completely familiar with the meaning of these terms. This could be seen by the definition and examples posited by candidates.

The following response was expected:

Consumptive resource use of a natural resource *depletes* the quality or quantity of the resource, while **non-consumptive** use of a natural resource does not deplete its quality or quantity.

The following are examples of consumptive and non-consumptive use of natural resources:

Consumptive	Non-consumptive
Extraction of bauxite	Ecotourism activities such as whale watching, bird-watching, wildlife observation, hiking, photography, canopy walkways and zip lining
Hunting and trapping	Bioprospecting
Fishing	Research
Logging	Use of solar radiation

Part (b) required candidates to outline two environmental impacts that the bauxite mining described in the stimulus may have on Country A. Generally, candidates were able to select and develop points on each impact, but at times did not fully develop their responses in order to attain the full three marks. An example of an expected response is as follows:

Species depletion and extinction (**1**): consumptive use of the area can result in species depletion where organisms are physically destroyed during mining (**1**), and extinction can occur if species depletion occurs **or** if organisms were endemic to the area (**1**).

Part (c) concerned the use of tools and measures for the conservation and management of natural resources in the Caribbean.

Part (c) (i) required candidates to comment on the environmental impact assessment (EIA) as a tool for natural resource management. Candidates performed moderately in this section, though it was clear that many did not have a complete idea of what the EIA concept entailed:

- An EIA collects information about an area and its characteristics.
- It allows consultation between the developer, stakeholders and decision-makers, and also raises awareness
- An EIA is a proactive approach where the environmental impacts can be assessed prior to construction or operation of the project.
- It helps to provide alternative projects which are more suitable and environmentally sustainable for the area.
- It minimizes adverse outcomes and reduces long-term costs.

Statements that give rise to any of the above points were credited.

In Part (c) (ii), candidates were asked to consider the following statement: *If a natural resource is to be exploited for foreign exchange earnings, it does not have to result in a depletion of its ecosystem value.* They were then required to evaluate the statement using the example of Country A. This part was not well done, and it was clear that many candidates did not understand what the questions was asking of them. An example of an appropriate response is as follows:

When a natural resource is exploited for foreign exchange, it usually results in its removal or a reduction in quality **(1)** and pollution, **(1)** such as is occurring in the exploitation of the bauxite in the country. **(1)** However, that does not have to occur, as it is possible to exploit the resource in the country without environmental degradation. With the large number of rare animals, birds and plants **(1)** in the area, it can be used for ecotourism **(1)** which can bring in foreign exchange from tourism without damaging the resource's ecosystem values. **(1)**

Candidates' overall performance on this question was moderate.

Candidates' performance was better on Question 5 than Question 6.

Paper 032 – Alternative to School-Based Assessment

The number of candidates sitting the Paper 032 in 2017 remained small — about 20 candidates — which was similar to previous years. However, there has been some improvement in candidates' responses to questions in Paper 032. Question 1 performed the best, followed by Question 3 and then Question 2. There is still need for greater improvement in the depth and breadth of coverage with respect to certain areas of the syllabus. Greater effort must be made by candidates to improve their ability to organize, apply and communicate information.

It must be recognized that Paper 032 is an alternative to the School-Based Assessment and as such candidates are required to demonstrate satisfactory understanding of the application of practical applications and solutions to environmental problems. This was not evident in the responses of most candidates.

Overall, candidates did not demonstrate a satisfactory level of practical ability. This was often reflected in the manner in which they addressed questions that dealt with practical applications. Candidates are urged to engage in more field and laboratory practical-based activities so that they will be in a better position to apply practical knowledge in the questions. Accordingly, liaisons with schools, colleges, centres of learning or universities which have the facilities or offer the practical components should be encouraged and fostered.

Question 1

Module 1

Syllabus Objectives: 1.5, 1.8, 1.9, 1.18

This question was designed to test candidates' understanding and knowledge of the following topics regarding basic ecological principles:

- Food webs
- Trophic levels
- Interactions between organisms in communities
- Human interactions within natural ecosystems

Candidates were presented with a diagram of a food web showing the organisms present, and the pathway of a pesticide released when a farmer sprayed his field. Candidates were also given the concentration of the pesticide present in each part of the food web, as well as the surrounding environment.

In Part (a), candidates were required to utilize the diagram, and give an example of organisms which were producers, primary, secondary and tertiary consumers. The majority of candidates was able to identify the organisms correctly, and most candidates scored highly in this part of the question.

For Part (b), candidates were told that there was an observed increase in the pelican population of Country A, and asked to outline five steps which the wildlife division may utilize to monitor the pelican population. Most candidates were able to describe the *mark, release re-capture method*, and how it may be utilized by the wildlife division.

Part (c) required candidates to outline four trends observed in the food web as the pesticide moved along the pathway. In general, candidates were able to identify four trends relevant to the data presented.

Part (d) required candidates to construct a table showing the mass concentration of pesticide present in humans, pelicans, algae in grams per litre and that in surface algae in grams per gram, from the data in the diagram of the food web. This part was moderately done by candidates, but there were some challenges with expressing the quantities in the required units.

Organism	Quantity of pesticide
Human	0.9 g/l
Pelican	0.5 g/l
Algae	0.0005 g/g
Surface water	0.5 g/l

In Part (e) (i), candidates were asked to calculate the percentage of pesticide absorbed by the crops. This part was moderately done, with some candidates finding difficulty with the calculation:

$$\begin{aligned} \text{Pesticide absorbed by the crops} &= (\text{total percentage of pesticide in crops} / \text{total} \\ &\text{quantity of pesticide released}) \times 100 \\ &= (0.9 / 2.8 \text{ kg}) \times 100 = 32.1 \% \end{aligned}$$

In Part (e) (ii), candidates were asked to state how many times higher the concentration of the pesticide in human blood is compared to its concentration in surface water. Many candidates had difficulty with this part of the question. The expected response is as follows:

- Concentration in human blood = 900 mg/l
- Concentration in surface water = 50 mg/l

$$\begin{aligned} \text{concentration factor} &= \\ &\text{either} \\ &\frac{500 \text{ mg/l}}{0.9 \text{ mg/l}} = 555.55 \text{ times} \\ \text{OR} \\ &\frac{500\,000 \text{ g/l}}{900 \text{ g/l}} = 555.55 \text{ times} \end{aligned}$$

In Part (f), candidates were told that pregnant women are often advised to avoid eating shark and other top predator fish. They were then asked to use the information in the food web to suggest an explanation for this. This part was moderately done by candidates, as many were able to describe the effects of bioaccumulation and biomagnification.

In Part (g), candidates were asked to state two possible ecological effects of the pelican population becoming extinct. In general, most candidates were able to identify the effects within the food web on the large fish, small fish and algae resulting from the removal of the pelicans. Candidates performed well on this part of the question.

Question 2

Module 2

Syllabus Objectives: 2.2, 2.5, 2.8

This question was designed to test candidates' understanding and knowledge of the following topics concerning people and the environment:

- Demographic characteristics of the human population
- Population statistics
- Calculations of changes in demographic characteristics
- How the impacts of demographic patterns may be mitigated

Candidates were presented with a table which contained data representing the number of deaths caused by three major types of diseases (infectious, deficiency and lifestyle) for an unnamed Caribbean country.

For Part (a), candidates were asked to calculate the percentage increase in the number of deaths caused by deficiency diseases from 2007 to 2008. This part was moderately done by most candidates.

In Part (b), candidates were asked to state five trends observed in the table. Most candidates were able to infer trends which were relevant to the data presented in the table, for example,

- generally the number of deaths caused by deficiency diseases was the lowest when compared to deaths caused by other types of diseases
- lifestyle diseases accounted for the highest number of deaths

Part (c) required candidates to explain two policies which the government could implement to mitigate the trends identified in Part (b). Candidates performed moderately in this section. An example of an expected response is as follows:

The government policy must include education and awareness. Persons must be taught about the cause and effect of lifestyle diseases as well as ways in which persons can avoid the harmful effects. This can be done through advertisements, seminars, public forums, changes to school curricula.

In Part (d), candidates were required to utilize the data provided for lifestyle and infectious diseases in the table to construct a line graph, using the grid provided. Most candidates performed well on this question as they were able to accurately plot the points, but it should be noted that many candidates did not label the axes or place a title on the graph.

For Part (e), candidates were required to calculate the death rate for 2008 in the unnamed country if the population size of the country was 200 000. Some candidates struggled to complete the calculation, and there was often an omission of the relevant units in many responses.

$$\begin{aligned} & \text{Number of deaths/total population} \times 1000 \\ & 971 + 115 + 3710 = 4796 \\ & 4796/200,000 \times 1000 = 24 \text{ deaths per thousand} \end{aligned}$$

Candidates should provide appropriate units for **all** numerical responses.

In Part (f), candidates were asked to calculate the size of the unnamed country for 2008 given that the population size at the beginning of 2008 was 198 000 and the crude birth rate for 2008 was 12. This calculation was poorly done by candidates.

$$\text{Number of live births in 2008} = \frac{12}{1000} \times 198\,000 = 2376$$

$$\begin{aligned} \text{Estimated population at end of 2008} &= 198\,000 + 2376 \\ &= 200\,376 \text{ persons} \end{aligned}$$

Question 3

Module 3

Specific Objectives 3.6, 3.10

This question was designed to test candidates' understanding and knowledge of the following topics concerning natural resources and the environment:

- The importance of natural resources
- Environmental impact assessments

Candidates were presented with a factoid on an international hotel chain which purchased 100 acres of land on the west coast of Grenada. An environmental impact assessment was required before approval for the proposed project could be granted. Candidates were also given a table showing the results of a cost-benefit analysis between ecotourism and a casino as viable options in the construction of the hotel chain.

Part (a) required candidates to define an environmental impact assessment (EIA). This part was moderately done. An EIA is a process where the environmental *impact of operations or construction* of a project are assessed.

In Part (b), candidates were asked to state three reasons why it was important to conduct an EIA before granting permission to construct a hotel facility. This part did not perform as expected, as candidates had challenges identifying reasons.

The following is an example of an expected response:

- An EIA provides a systematic method of impact assessment.
- It estimates the cost/benefit of alternative actions.
- It facilitates public participation.
- It achieves a balance between development and environmental impacts.

Part (c) was based on a table showing the cost-benefit analysis for ecotourism and casino options for the hotel chain. In Part (c) (i), candidates were required to create a bar chart representing the data on the grid provided. Most candidates performed well on this question as they were able to accurately plot the points, but it should be noted that many candidates did not label the axes or place a title on the chart.

In Part (c) (ii), candidates were asked to calculate the total cost for each option. This simple summation was fairly well done by candidates. It should be remembered, however, that the

total cost would exclude 'expected revenue' (that is, equal the sum of all of the other categories listed in the table).

Part (d) required candidates to utilize the data provided in the table to recommend the more viable option. In making this suggestion, candidates were directed to identify four reasons to support their recommendation. This part was moderately done, and candidates were able to choose either option, once they provided a plausible reason:

Ecotourism is the more viable option because the total cost for the ecotourism hotel is lower than that for the casino hotel.

The casino is the more viable option because the expected revenue from the casino is expected to be almost twice that of ecotourism.

In Part (e), candidates were asked to calculate the difference between the total cost and the expected revenue for ecotourism, if the hotel should operate for a period of two years. This part was poorly done, as many candidates encountered difficulty in the calculation:

$$\text{Total cost for 2 years} = \text{USD}500\,000 + \text{USD}250\,000 + [(\text{USD}50\,000 + \text{USD}5000 + \text{USD}2000 + \text{USD}5000) \times 2] = \text{USD}874\,000$$

$$\text{Difference} = \text{USD}1\,000\,000 - \text{USD}874\,000 = \text{USD}126\,000$$

UNIT 2

Overall candidates performed better in Module 1 followed by Module 2 and then Module 3.

Throughout the paper, candidates showed an inability to read graphs correctly. Candidates did not read values of data points accurately and so had difficulty making their deductions about the data. This problem has recurred over the years, and instructors are asked to address this. Students are supposed to do data analysis in their SBAs; this is an excellent place to emphasize this practical skill. As noted earlier, the ability to describe a trend is being interpreted as 'describe every data point'. A trend is an overall picture and should be presented as such, rather than providing a point by point description of the graph in question.

More work also needs to be done on vocabulary — both discipline and question specific. In a number of cases, candidates showed confusion with regard to the terms of the discipline. Also, the meanings of terms used in the body of the questions themselves were often misunderstood. Key terms like *assess*, *deduce* and *discuss* were often misunderstood. This could be deduced from the responses, which showed that candidates did not recognize what was required. This was most often seen where candidates were asked to *discuss* or *assess*, *explain* or *suggest*.

Students should spend some time in the classroom working on examination skills, in particular time management, the order of answers and gauging question complexity from the mark allocation. Time management is essential — there were many instances of candidates simply running out of time during the examination. Students should be taught to divide the time

equally and to move on when the time is up. Candidates should spend more time selecting the order in which they answer the questions. It appeared that most simply started at Question 1 and went to the end. It is hardly likely that most of the candidates would have found Question 1 their best, and so wasted the best time of the exam (the beginning) on questions on which they may not have been able to score very highly.

Candidates should also spend some more time using the mark allocation to gauge the complexity of the expected answers. Often, candidates wrote two lines for a question worth six marks — while the two lines may have the gist of the answer, it is unlikely to provide enough detail or depth for a candidate to gain full marks. The converse is also often seen, where a candidate will write a page (expending several precious minutes of examination time) for a question worth two marks.

This was the second year since the introduction of the e-marking process and hence the change in the format of the question paper was no longer new to most candidates. The amount of space allotted to a response was better aligned to the mark allocation this year. That being said, candidates should be made aware that there are two pages of extra writing space at the end of the examination paper. If a candidate utilizes the extra pages for a response, it is **strongly** recommended that the candidate so indicate by noting *Please see extra paper* or something similar, to indicate to any marker that there is more to the candidate's response than is first apparent. This also is applicable to candidates who cross out their answers and then write the correction on the extra pages. In addition to this, candidates who use the extra space should **clearly** indicate what question/parts of a question they are answering, for ease of reference for the examining committee.

There was an improvement in the number of candidates who demonstrated the breadth of knowledge necessary to perform well. However, there were some candidates whose responses were inadequate especially where they were required to make inferences, read graphs, distinguish between terms and explain interactions and interrelationships, and perform basic calculations. Greater attention to these basic principles is urgently required.

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 these types of questions.

Paper 02 – Essay

Module 1: Sustainable Agriculture

It is expected that candidates, on completion of this module, should demonstrate an understanding of

- the concepts, types and role of agriculture in the Caribbean
- the environmental impacts of and threats to agricultural systems in the Caribbean
- environmentally sustainable practices in agricultural systems in the Caribbean
- the application of knowledge, practical and analytical skills.

Question 1

Syllabus Objectives: 1.2, 1.3, 1.6

This question required candidates to illustrate their understanding of concepts relating to the importance of agriculture, alternative farming practices (terracing, genetic engineering), and how the use of agrochemicals can impact the environment.

In Part (a), candidates had to give two reasons why agriculture was important to the Caribbean. Most candidates were able to give at least a reasonable response to this question. A significant number of candidates did not achieve full marks due to incomplete or vague answers. The usual problem was that candidates would identify a correct reason, for example, *provides employment*, but fail to explain **why** this is important to the Caribbean.

Part (b) (i) required candidates to draw a diagram to illustrate the sustainable practice of terracing. This question was generally not well answered. The drawings indicated that many did not really understand what terracing was and could not illustrate this with a simple drawing. Candidates were expected to produce a drawing to show that terracing occurs on hillsides, with the 'step-like' nature of the terraces well shown, along with some indication of planting. Some candidates chose to augment their diagrams with annotations; while this was not required in the question, it helped candidates where their diagrams were not clear.

In Part (b) (ii), candidates had to state one other sustainable agricultural practice. Most candidates were able to answer this question correctly. However, some candidates ignored the word *other* in the question statement, and so provided 'terracing' as the answer. Candidates are reminded that where the question states *other*, a different factor/practice must be given.

Part (c) required candidates to outline three ways in which genetic engineering can be used to improve agriculture. Many candidates were able to state three ways. However, many of them were not able to provide enough depth in their responses. For two marks, candidates would have to state a way that genetic engineering could improve agriculture and then give some reason as to why this would be so. For example, a response might be *It helps a plant to produce more food*. One mark would be awarded for this. To achieve the second mark, the response must go on to say *why this will improve agriculture*. Too many candidates did not explicitly indicate this in their responses. Another problem that occurred in this question was that candidates would repeat themselves, for example. "It helps a plant to produce more food. When a species is modified it helps to gain more food if it is taken care of properly." In such a response, only one mark could be awarded.

Part (d) was generally well done. It required candidates to discuss two negative effects of using agrochemicals. To achieve full marks for *each* effect, a candidate had to correctly identify a negative effect caused by agrochemicals, then further elaborate on how this particular chemical/use of chemicals would produce a negative effect. Candidates were generally able to identify an effect, and in many cases, give some explanation. A full explanation was hard to come by. To achieve two 'explanation' marks, a response had to be clear, directly relate the use of a specific chemical or type of chemical to a negative

environmental effect, and give some indication of what that negative effect was. Consider the response below.

It contributes negatively to human health. When some of these chemicals are inhaled, they may disrupt the human respiratory system.

Such a response was awarded only two marks, one for saying that there was an effect on human health and one for saying what that effect was. The third mark, relating the use of a specific chemical to a negative environmental effect was not awarded. The response stated 'these chemicals' but did not specify the chemicals. Not all agrochemicals are hazardous in this way. And the lack of this specificity caused a significant number of candidates to lose marks.

Question 2

Syllabus Objectives: 1.4, 1.5, 1.6

This question required candidates to illustrate their understanding of concepts relating to alternative farming practices (hydroponics), sustainable agriculture, and how selected factors can threaten sustainable agriculture in the Caribbean.

In Part (a), candidates were shown a drawing of a sustainable agriculture practice based on hydroponics. After studying the drawing, candidates had to provide three advantages of the device illustrated. Many candidates were able to correctly identify three advantages; however, candidates often failed to take the response further than a simple statement, and so could not get the full two marks for each advantage. For example, consider the following:

Student Response: More than one crop species is allowed to grow using this system.

Expected Response: The farmer can plant multiple crops in the same location. This will give more value at harvest and sale.

Note that the expected response provides more than just the simple statement of the advantages, but also gives a reason *why* this would be an advantage to the farmer.

Part (b) asked candidates to evaluate the device in the drawing with respect to its ability to produce ecological integrity and economic viability, two tenets of sustainable agriculture. This question was not well done in most cases. The responses tended to be brief and shallow, and did not give a deep analysis, as was required. Consider the following example of a candidate's response, which was only awarded one mark, for the last sentence:

Ecological integrity takes into consideration all ecological species. This ensures not to hurt any of the ecological species in the process of construction. This device would be ecologically integrated as the device is not placed in such a way that disturbs ecological systems.

A sample of an expected response now follows:

In the method shown, less agrochemicals will be required which would result in reduced water pollution as fewer chemicals enter nearby waterways. The system has a smaller footprint and a lower demand for land means that less land degradation will result.

Note that in this response, there is a full explanation of how the device's functioning will result in a lower ecological impact; which function, and how this will result in lower impact. Most candidates did not provide a full response, and so the marks for this part of the question tended to be low.

In Part (c) (i), candidates were asked to list three factors that may threaten sustainable agriculture. Many candidates were able to list three suitable factors. Candidates had difficulty listing things that were not defined on the syllabus as factors that threaten sustainable agriculture. In addition, a number of candidates provided two factors that were basically the same thing, and so could only be awarded marks for one. One such example was providing both *climate change* and *global warming* as factors.

In the final part of the question, Part (c) (ii), candidates had to use an example to explain how one of the factors listed in Part (c) (i) may threaten sustainable agriculture. This part of the question was done fairly. Most candidates could reasonably explain why their chosen factor may be a threat to sustainable agriculture. Candidates are reminded that in questions like this one, it is important that they provide a clear link between their example, their factor, and any threat to sustainable agriculture. A significant number of candidates failed to get three marks for this question because they provided a suitable example, explained how the factor would operate within the context of the example, but failed to show how this would threaten sustainable agriculture.

Module 2: Sustainable Energy Use

It is expected that candidates, on completion of this module, should demonstrate an understanding of the

- nature of energy and its use
- socioeconomic and environmental impacts of the provision and the use of energy the provision
- advantages of using renewable energy sources
- use of their knowledge of the areas covered in practical and analytical situations.

Question 3

Syllabus Objectives: 2.8, 2.9, 2.11

In this question, candidates were required to demonstrate their understanding of concepts concerning energy conservation and efficiency, the social cost of energy, and environmental impacts of fossil fuel use. They were also required to interpret pie charts.

In Part (a) (i), candidates were generally able to calculate the required percentage from the pie chart. Candidates who failed to attain full marks either incorrectly calculated the actual amount of energy used in the transportation sector, or did not show the actual equation, as was required in the question. Candidates are reminded that they should, in general, show all working in a quantitative question, but where the working is specifically requested, failure to show all working will result in the loss of marks.

Part (a) (ii) was an extension of Part (a) (i), and again required candidates to use the pie chart to determine the actual amount of energy used for the residential and industrial sectors, given the total amount of energy used in the whole country. Most candidates had a good idea of what to do; however, some of them had difficulty manipulating scientific notation, and so could not get the correct answer.

In Part (b) (i), candidates had to distinguish between *energy conservation* and *energy efficiency*. Some candidates still have difficulty doing this. Candidates should make an effort to learn clear, concise definitions of these terms. They should also note that when asked to explain a particular term, it is not appropriate to use that term in the explanation. Consider the following response.

Energy conservation involves conserving energy, while energy efficiency means using energy with technology that is more efficient.

This response illustrates a pervasive problem regarding the understanding of these concepts, where candidates are not able to use other terminology to demonstrate their understanding. The expected response is as follows:

Energy conservation is the reduction in the amount of energy consumed while energy efficiency is using less energy to provide the same service.

Part (b) (ii) was the most widely known part of the question and was generally well done, as most candidates could provide two correct energy conservation methods in the energy sector. Where candidates did not get the correct answer, it was usually because they provided a correct energy conservation method, but not one appropriate for the *transportation sector*, as was required in the question. Candidates are reminded to always align their response to the stimulus material in the question.

In Part (b) (iii), candidates were required to explain what was meant by the term *social cost of energy use*. This part of the question was the least known. Most candidates did not know what this term meant and wrongfully attributed this to economic impacts on the citizenry. A full response would have explained that *social cost of energy use* refers to the fact that *there are costs to people and society due to the use of energy*. Suitable examples would include the disruption to towns and villages or health impacts due to the siting of a petroleum processing plant or hydropower dam. Some candidates discussed *environmental impacts* such as habitat disruption and loss of species and did not discuss social impacts. Candidates are reminded that they should always align their response to the stimulus material in the question.

Part (c) was generally well done, as most candidates were able to provide a suitable discussion on two environmental impacts due to fossil fuel use. Where candidates failed to attain full marks, it was due to the inclusion of *social impacts*, most often human health impacts, in their response. Candidates are reminded that the syllabus requires that social and environmental impacts be treated separately. Some candidates produced fairly shallow responses, which did not earn full marks. Candidates are reminded to use the mark allocation to assist in gauging how deep a response is required for any particular question.

Question 4

Syllabus Objectives: 2.1, 2.2, 2.3, 2.8, 2.11

In this question, candidates were tested on their understanding of concepts including energy efficiency, types of energy, mechanisms for reducing energy spending in household lighting and transportation by use of electric vehicles. Candidates were also required to manipulate data in a line chart.

In Part (a), candidates had to identify one primary energy source and distinguish between primary and secondary energy sources. This question was moderately done. A significant number of candidates had difficulty distinguishing between primary and secondary energy sources. Candidates are asked to pay close attention to the syllabus objectives which indicate which terms they should be able to define.

Part (b) required candidates to explain the following statement: *The world's socioeconomic dependency on fossil fuel combustion will make it difficult to reduce carbon dioxide emissions.* This question was poorly done in general. In their response, many candidates simply restated the stimulus given, and were not able to establish the link between civilization's social and industrial activities, fossil fuel use and continued carbon emissions. One example of an expected response is given below, which illustrates the linkages previously described.

Many economic activities rely on fossil fuel combustion for energy which produces carbon dioxide. Countries therefore do not wish to reduce their fossil fuel combustion which might reduce their economic productivity and so carbon dioxide emission reduction would be difficult.

In Part (c) (i), candidates were asked to define the term *efficiency of conversion*. This question was moderately done, as definitions continue to challenge candidates. Greater effort should be placed on learning these, by both students and teachers, during examination preparation. It was also common to see responses that used the term *efficiency* in the response, which is not appropriate.

Part (c) (ii) asked candidates to calculate the efficiency of conversion of lightbulbs used in a Caribbean home, and to suggest two ways that the energy consumption in household lighting could be reduced. This question was also moderately done. Lack of knowledge of the proper definition in Part (c) (i) led to the inability of candidates to correctly set up the calculation for the efficiency of the bulb. Many candidates incorrectly believed that the efficiency was

calculated by subtracting the energy converted to light from the total amount of energy used by the bulb, as in the following:

$$\text{Energy efficiency} = 7200 \text{ MJ} - 432 \text{ MJ} = 6768 \text{ MJ}$$

The correct calculation involved the determination of the *percentage* of energy converted to a useful form, as shown below.

$$\text{Energy efficiency} = \frac{432 \text{ MJ}}{7200 \text{ MJ}} \times 100\% = 6\%$$

The question also asked candidates to suggest two ways that the energy consumption in household lighting could be improved. Many candidates were able to get this correct; however, a significant number of them addressed energy conservation in a wider context, instead of in the specific context of household lighting, and so lost marks. Candidates are reminded that they should always align their response to the stimulus material in the question.

Part (d) (i) asked candidates to interpret a line graph and obtain the price of gasoline in the year 2000. This was well done. Most candidates were able to get the correct value. Candidates who did not attain the mark did not pay attention to the gradation of the scale, and so gave the incorrect value on the y-axis.

In Part (d) (ii), candidates generally performed well. Candidates are reminded that trends require stating changes (rising, falling, remaining constant) in relation to time periods. Reading a point or a number of points on the graph does not reflect a trend.

Part (d) (iii) was generally poorly done. It required candidates to evaluate the suitability of a switch to electric vehicles as a mechanism for reducing energy spending in a Caribbean country. In many instances, candidates restated the stimulus material, and did not actually evaluate the idea. Another common mistake was candidates' discussion of the validity of the *stimulus statement*, and not the suitability of using electric cars to reduce energy spending in the Caribbean. Questions like these which require evaluation are more challenging than those that simply ask a candidate to *state*, and even to *explain*. Candidates should recognize this, and make a greater effort to think carefully about the meaning of the stimulus statement, and to come up with an explicit position statement (it is suitable OR it is not suitable) and follow this with a logical discussion to support the position originally taken. Candidates should bear in mind that responses that attempted to 'sit on the fence', in other words, those that gave arguments on pros and cons were not credited.

Module 3: Pollution of the Environment

It is expected that candidates, on completion of this module, should demonstrate an understanding of the

- major types and sources of pollution
- environmental impacts of pollution

- methods available for monitoring, analysing and mitigating pollution and its environmental impacts
- the application of knowledge, practical and analytical skills in the areas covered.

Performance on this module was the lowest, when compared to performance in Module 1 and Module 2.

Question 5

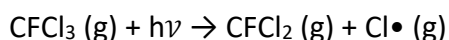
Syllabus Objectives: 3.5, 3.8, 3.9

In this question, candidates were tested on their understanding of CFCs and ozone depletion, as well as the Montreal Protocol as a mechanism for reducing ozone depletion. The practical skill of bar chart construction was also tested using data on solid waste generated in a Caribbean country.

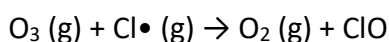
Part (a) was done well. It required candidates to construct a bar chart on a blank grid. Almost all candidates achieved four or five marks out of five. Where candidates lost marks it was due to not including all of the parts of the graph, namely, title, scale, fully labelled x- and y-axes, and completely correct data points. Candidates are reminded to choose an easy-to-read scale that takes up at least 75 per cent of the graph page, for best results.

Part (b) was not done well. It required candidates to use suitable equations to explain how CFCs destroy the ozone layer. Common errors in equation construction included using incorrect chemical equations and/or incorrect CFC formulae. When explaining how CFCs destroy the ozone layer, the two main misconceptions were that CFC molecules themselves would attack ozone, as well as CFCs/Cl radicals attacking oxygen. To perform well on this question, candidates would have had to use both text and equations so as to give a full response. One example of an expected response follows.

When CFCs reach the stratosphere, they are hit with short wavelength UV radiation which breaks chlorine atoms off of the molecule.



These chlorine atoms react with ozone breaking it up and preventing the ozone from reforming.



Part (c) required candidates to state three health risks associated with ozone depletion. Most candidates achieved at least two marks out of three for this question. A common error was stating respiratory ailments instead of immune system damage. Ozone depletion occurs in the stratosphere, 12 km above the surface of the earth. Loss of ozone at that altitude will not affect the respiratory systems of humans on the surface.

In Part (d), candidates were required to explain how the Montreal Protocol helps to reduce ozone depletion. Most candidates did not perform well on this question. Many discussed

greenhouse gases and generic air pollution problems instead of CFCs. While most seemed to know what the Montreal Protocol was, they could not explain how it worked, and how this would result in reduced ozone depletion. Teachers are asked to spend more time on the various protocols and conventions, as there is considerable confusion about these concepts in the syllabus.

Question 6

Syllabus Objective: 3.5

In this question, candidates were tested on their understanding of concepts surrounding solid waste management and disposal, namely landfilling, incineration and recycling, as well as the environmental impacts of these activities.

In Part (a), candidates were asked to use the information provided in the stimulus material in Figures 4 and 5 to identify and discuss two environmental impacts of the activities carried on at the site. Candidates performed reasonably well on this question. Candidates who did not score well either did not base their discussion on the scenario presented in the stimulus, had a poorly developed discussion, or had repetitive statements in their discussion. In this question, candidates were expected to identify problems associated with the leaking landfill and the leaking sewage treatment facility, and discuss their likely effects on the surrounding environment. A common problem was candidates making a statement describing the problem, for example, "Leachate would contaminate the groundwater", which received only one mark, because this response did not give a full discussion about *why* this would be a problem. A more suitable expected response would be *Leachates from the buried waste can move through the porous soil into the ground water supply. If this water is used for human consumption, then humans can be exposed to pathogens or chemicals which are present in the leachate resulting in ill health.*

Part (b) (i) was generally done fairly. The question asked candidates to identify two missing aspects of the landfill in Figure 4. Many candidates were able to identify the absence of a *liner* or *lining* for the landfill, and so attain one out of the two available marks. Few candidates were able to correctly identify any of the other missing landfill features, such as a *leachate collection system, gas vents, clay geology* or *groundwater monitoring wells*.

Part (b) (ii) asked candidates to outline three critical steps in a recycling programme. This question was done poorly. Most candidates scored at most one mark out of the three that were available. 'Sorting' was the most popular response, it appeared that most candidates did not really understand the steps that are needed for a recycling project. Many incorrectly discussed the policy and social issues in a national recycling programme, but did not discuss what would actually happen in a practical sense for recycling to work.

Part (b) (iii) was also poorly done by most candidates. This question asked candidates to evaluate whether large-scale recycling would be feasible in the Caribbean context. It seemed that the term *feasible* in the question was not understood by many candidates. Candidates generally responded with what *should* happen, for example, providing responses like the following.

Large-scale recycling in the Caribbean would be good for the environment, preventing waste from entering the environment and contaminating it. It would also minimize the amount of solid waste, so that we would need less landfill space.

However, this was not what was required in the question. Candidates should have investigated whether or not large-scale recycling *could actually work* in a Caribbean context. With that in mind, a more appropriate expected response is as follows.

This would likely not be feasible in the Caribbean context. The volume of waste produced by individual Caribbean countries is low and so there is not enough recyclable waste to sustain a recycling plant.

Students and teachers are reminded that more attention should be paid to the meanings of the various words that appear in questions, so that appropriate responses may be generated.

In Part (c), candidates were required to state three advantages and three disadvantages of incineration. Candidates generally performed well in this section, even though few candidates achieved the full six marks for this question. Most candidates scored four or five marks here. Some common misconceptions were that incineration would result in a decrease in land pollution and was cheap. It appeared that some candidates confused industrial incineration with backyard open burning, and so were not able to provide suitable advantages and disadvantages.

Paper 03B – School-Based Assessment

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

Question 1

Syllabus Objectives: 1.3, 1.6, 1.7

Overall, candidates' performance on this question was not very good. Candidates were required to demonstrate understanding of the scientific method, how to set up an experiment to determine the reason for an observed decline in land fertility, create charts to illustrate the results and produce an appropriate conclusion from the data.

In Part (a) (i), candidates had to derive a hypothesis based on the scenario provided in the question. This was generally not well done, as many candidates presented an aim, for example, "To test the pH of the soil" instead of a hypothesis *Low soil pH has a negative effect on plant growth/soil fertility*.

Part (a) (ii) required candidates to identify three parameters that should be held constant in this experiment. This was also quite poorly done. Many candidates could not identify suitable control parameters. Teachers are encouraged to ask their students to go through the entire scientific method for a real example or problem in their school, so that students will have a better grasp of what is required for an experimental outline.

Part (a) (iii) asked candidates to identify the manipulated variable in the experiment, and many could correctly identify the pH or acidity of the soil as the manipulated variable.

Part (a) (iv) was poorly done. It required candidates to identify the responding variable in the experiment. Many identified the pH as the responding variable, instead of plant growth, indicating that they had not grasped the concept that the experiment was supposed to prove that low pH (acidic soils) would produce poor growth in plants.

In Part (b), candidates were asked to outline a procedure that would allow them to test their hypothesis. This part of the question was very poorly done. Very few candidates could produce a logical outline of what steps should be followed to actually conduct this experiment. The inability to produce the outline was costly to many candidates, as it was worth 8 out of the 30 possible marks. Candidates are reminded that the Paper 032 questions are designed to test their practical skills and understanding, and so candidates writing this paper should focus on developing this ability and seek to have a greater understanding of the scientific method.

Part (c) required candidates to evaluate a small data set showing pH measurements, and to suggest two reasons for the observed irregularity with the readings for Sample 2. This question was poorly done, as many candidates did not appreciate that the problem was likely due to a malfunction of the instrument or a mistake by the operator. Instead, a wide variety of spurious reasons were given, as to why the same sample measured three times had such a difference in the result.

In Part (d), candidates were required to construct a bar chart using the *average* of the data in Table 1 (data presented in Part (c)). This part of the question was done fairly well by most candidates, showing that there has been some improvement in the graph-construction skills in the candidate population. Where candidates failed to achieve all eight marks for this question, it was usually that an important part or parts of the graph were omitted (for example, title or scale). Another common problem was that candidates did not use the average as was required, and instead plotted bars for all of the data given in the table.

Part (e) asked candidates to assess their experimental results and to come up with a suitable conclusion for this experiment. This part of the question was done fairly; many candidates were able to come up with enough of a conclusion to get one out of the two available marks. Very few candidates were able to get the full mark allocation.

Part (f) was generally done well by most candidates. This question asked for two reasons why soil acidity could affect crop yields. Candidates were generally able to answer this well, which seemed to suggest that while most candidates were able to outline theoretical concepts well,

they had a much weaker grasp of the practical — which is the whole purpose of the Paper 032.

Question 2

Syllabus Objectives: 2.1, 2.3, 2.4, 2.9, 2.11

This question tested candidates' ability to discuss energy use with respect to alternative fuels, their cost, carbon dioxide emissions, global warming and hydroelectric power generation. In addition, candidates had to demonstrate their ability to construct a pie chart from data provided. This question was generally done well by most candidates.

Part (a) (i) was generally done well; most candidates were able to produce a suitable definition of the term *biofuel*.

Part (a) (ii) required candidates to use the data in the graph to determine the difference in production cost for biodiesel and sugar ethanol. Most candidates were able to read the graph properly and so obtain the correct answer. Where candidates did not get the mark for this question, it was generally due to poor reading of the graph — often the incorrect bar was read correctly, leading to the wrong answer.

Part (a) (iii) tested skills similar to Part (a) (ii), requiring candidates to read the graph correctly and produce a sum. Most candidates were able to do this correctly. It appears that the ability to read a graph correctly has improved significantly over the last few years.

Parts (b) (i) and (ii) required candidates to use the data in Figures 1 and 2 to answer some questions. Both of these questions were generally done well. Most candidates were able to correctly indicate why it was not advisable to use lignocellulosic ethanol as a fuel, (it had the highest cost of production and highest carbon dioxide emissions) as well as to say why it was better to use biodiesel instead of sugar ethanol (while biodiesel is more costly to produce, it produces lower carbon dioxide emissions). Where candidates did not attain full marks for these two questions, they either did not base their response on the data from the figures, or did not provide fully outlined answers.

Part (c) required candidates to define the term *global warming*. Most candidates were able to do this correctly. Where candidates failed to achieve full marks, a common misconception was the discussion of ozone depleting substances, the ozone hole, and increased UV radiation as a cause of global warming. Candidates are reminded that ozone depletion and global warming are two very separate processes and problems, and they should not be confused in responses.

Part (d) was also done well; many candidates were able to say which biofuel was likely to contribute most to global warming, by referring to the amount of carbon dioxide emissions for the fuel given in Figure 1.

Part (e) (i) asked candidates to explain, with the aid of a suitable diagram, how potential and kinetic energy are exploited to produce electricity in hydropower plants. This question was

moderately done; while many candidates were able to explain in words, the function and operations of a hydropower plant, very few were able to translate this into a suitable drawing. The diagram was often poorly conceived and in some cases not done at all, which prevented many from doing well on this question.

Part (e) (ii) asked candidates to construct a pie chart using data provided in Table 2. Candidates' performance showed that they either did well or did badly — there were few in the middle ground. Those who did poorly seemed unaware of how to convert the electricity generation data into angles that could be plotted on a pie chart. Another common problem was the obvious lack of the appropriate tools — from the graphs drawn, it was clear that candidates did not possess compasses (to draw proper circles) and protractors (to get the correct angles on the chart). These are common graphical tools that should be present in every candidate's pencil case. Candidates are reminded to practise the construction and interpretation of *all* types of charts, not only the most common, like bar and line charts. Additionally, candidates should come to the examination fully equipped with all tools, not only pens, pencils and a ruler.

Question 3

Syllabus Objectives: 3.5, 3.9

This question focused on candidates' ability to discuss noise pollution and associated issues, such as environmental receptors, the monitoring and mitigation of noise pollution. It was generally done well.

Parts (a) (i) and (ii) were generally well done. These questions involved plotting a graph to illustrate the data given in Tables 3 and 4. Most candidates were able to plot the graph of the data in Table 3. Many used line graphs which is most appropriate for temporal data. Part (a) (ii) asked candidates to include on their graph a line to indicate the appropriate noise level for Area B, which would have been 40 decibels (dBA), as this was a sensitive area. This part of the question proved difficult for some candidates, perhaps because they did not consider these two parts as being parts of a whole. Candidates drew graphs that only considered the data in Table 3, and so when the time came to draw the line for 40 decibels (dBA), a number of candidates found that their y-axis scale did not allow for this, and they were not able to include a correct line.

Part (b) was moderately done. Candidates were asked to identify the trend observed for the noise levels in Area B. Many candidates were able to earn at least one mark on this question. Where there were problems, they occurred because candidates seemed unaware of what it meant to identify a *trend*. Candidates are reminded that a trend is an overall view of the data, not a point-by-point description of the entire data set.

Parts (c) (i), (ii) and (iii) involved using the data in candidates' graph and data in Table 3 to answer a number of questions. These were generally done well by most candidates. Part (c) (i) required candidates to read their own graph to determine the noise level at 1:00 PM in Area B. Candidates who had a correctly drawn graph generally got this question correct. Where candidates got this wrong, they either had not drawn the graph correctly, or did not

use the correct technique for interpolation. Candidates are reminded to use a ruler and pencil to draw tie lines so as to get an accurate reading. Trying to read the graph 'by eyeball' or by using lines drawn by hand is almost guaranteed to cause problems. Part (c) (ii) asked candidates to identify the highest recorded noise level; this was done correctly by almost all candidates. Perhaps this was due to the fact that this question could have been answered by reference to the table, and not the graph.

Part (c) (iii) asked candidates to determine which area had the highest average noise level, and to show all working. This was generally done well. However, there were some common problems that were seen. Some candidates failed to show all working, as requested, and so did not attain full marks. Other candidates had problems with their calculations. Candidates are reminded of the importance of simple statistics in data processing. The use of average and standard deviation should be familiar to all candidates, but is more pressing for Paper 032 candidates, given the focus on practical skills.

Part (d) required candidates to use their graph and the data in Tables 3 and 4 to discuss the noise level observed in Area B. It was not done particularly well. The responses required at least three relevant and complete points in order for candidates to achieve the full six marks. Very few candidates achieved more than four marks for this question. This was generally due to candidates repeating themselves, including discussing material that was not general, and not relevant to the scenario presented, or including material that did not take into account the data that was presented in the tables and graphs. An example of an expected response which gained marks is shown below.

An average noise reading of 90 decibels (dBA) was obtained which is significantly higher than the acceptable level.

This response illustrates that the data in the tables and graph are being considered in this concise, summary statement. Responses like these would have been given the full two marks, and the candidate would have had to have three points like this to be awarded the full six marks.

In Part (e), candidates had to identify one human health risk and one risk to organisms due to high noise levels. This question was moderately done, as most candidates were able to correctly identify one human health risk due to noise, but were less capable with respect to the effects of noise on organisms. High noise can affect both people and animals, and so candidates are reminded to be familiar with the effects on both.

Part (f) was generally well done. Candidates had to identify two mitigation methods for noise pollution in this Caribbean country. Most candidates were able to correctly identify two methods. Where candidates failed to achieve full marks, it was usually due to a lack of follow up in the response. A common response was "education of the public".

This is a correct mitigation approach; however, it is not enough to obtain the full two marks for this piece of the response. A better response would have been as follows.

Educate the public to inform them about the negative impacts of noise, so that persons are more likely to reduce the noise levels.

To be awarded the full two marks for each mitigation method, a candidate would have to do more than just identify the method, they would have had to say a little about how that method would likely result in reduced noise.

Paper 031 – School-Based Assessment

UNITS 1 and 2

The following report presents the comments of the examination team on the School-Based Assessment (SBA) component of the CAPE Environmental Science examination. Since the comments are quite similar for both Unit 1 and 2 SBAs, they are combined here.

The SBA essentially requires a journal with three components — Site Visits (at least four), Laboratory Exercises (at least four) and a Final Report, as stated in the CAPE Environmental Science syllabus. It also requires that all components are related. The site visits may be carried out at either the same site four times at intervals or at four different sites. Similar objectives and activities are to be carried out during each visit so that comparisons can be made in the Final Report. During each site visit, laboratory exercises are to be carried out to measure at least four different variables and, therefore, each variable is to be measured at least four times.

General Findings

1. Perhaps because of the way the three components are listed in the CAPE Syllabus, that is, A. Site Visits, B. Laboratory Exercises, and C. Final Report, about 99 per cent of the students presented their Journal with the three components in similar sequence as listed in the CAPE syllabus. However, some Final Reports did not integrate the information from Site Visits and Laboratory Exercises with the Final Report, and in some Journals the Laboratory Exercises did not relate to the objectives of the Site Visits and Final Report.
2. In some instances, only *one* Laboratory Exercise was conducted four times, that is, the same variable was measured four times, rather than measuring four variables four times across site visits. As a result, the Data Presentation and Analysis in the final report was deficient in comparing the findings of four site visits, whether at the same site four different times or at four different sites.
3. In a few instances, the Laboratory Exercises did not constitute experimentation or measurements but, instead, observations and recording of general information about the site(s). Several students conducted questionnaire surveys with a social science orientation that attempted to measure the ‘perception’ of environmental impacts, rather than the ‘actual’ impacts of environmental phenomena. Moreover, the questions in the survey instruments in some instances did not relate to the objectives of the site visits.

4. Laboratory Exercises in Unit 1 are difficult to relate to Unit 1 topics, particularly Chemistry type or Biology type exercises. In such cases, scientific field methods of investigation, for example, line transects and species diversity can be considered as laboratory exercises.
5. There were some incidents of students reporting three to four labs for each of the four site visits (totalling 12 to 16 labs for individual student project). This is an unnecessary expenditure of effort, as the syllabus calls for a minimum of four labs total, not four labs per site visit. Of course, students and teachers are encouraged to do more than the minimum, just not so much as to make the SBA unduly burdensome.
6. Some projects were not related to the unit topics, for example, air pollution, agriculture, water pollution, testing of material composition and strength materials at a quarry, for Unit 1 SBAs. Some students/schools do inappropriate projects, for example, one project examined the Maroons of Jamaica. The project aim and objectives did not relate to any Environmental Science module, as they must.
7. Some schools investigated school playing fields and man-made canals and ponds as natural habitats. While there is no problem with an SBA examining an area in the built environment, this should not be described as a natural habitat.
8. Some students described their site visits as places outside the Caribbean, for example, India and Africa, without having visited these places.
9. Some students presented laboratory exercises that were not carried out by them but by research agencies or companies.
10. In some projects, all students referred to the same data set in which it appeared that material was copied from other students, with no evidence of individual work and without stating that group work was done.
11. Some students copied verbatim major sections of entire laboratory exercises from other students.
12. There is a general leniency in marking by teachers/lecturers.
13. There is often incorrect use of jargon and a general lack of use of Environmental Science jargon.
14. Plagiarism was evident in some projects. Some papers or sections of papers were verbatim representations of other students' work. In some cases, it was evident that students directly copied and pasted work which was not their own. Teachers need to explain to students the serious implications of plagiarism.

Specific Findings

1. **Problem Statement:** This is more than a title. The title was frequently long and wordy, and in some instances, was written like an objective (beginning with 'to') or as a research question. The problem statement requires a problem description. Therefore, a brief

introductory paragraph describing the problem, in addition to the title would be useful. While there were some reports that were simplistic, others displayed superficial treatment of the topic, whether stated or implied.

2. Many project titles were not stated in such a way as to help the reader to understand what students set out to do in their projects.
3. The purpose was also not concise and often did not have clearly stated variables and/or objectives of the research. Objectives should be SMART, that is, Specific, Measurable, Attainable, Relevant and Time-bound. The objectives can be considered simply as variables that can be measured and/or observed *and* recorded. In some projects, the stated scope of work was too wide to accomplish, for example, investigating biodiversity, the impact of human activities on the environment, and plant succession.
4. The Problem Statement was often missing or written as the Project Purpose; Problem Statement and Project Purpose were often not differentiated.
5. The Literature Review, in many instances, was merely a listing of the literature, without much discussion relating it to the research topic. At least four citations are needed; often the correct format for citations was not used. The Literature Review was often not focused on the research being carried out or the variables being examined. Candidates are reminded that the purpose of a Literature Review is to present a summary of the current body of knowledge about the project topic.
6. The Methods of Investigation section frequently did not describe how the variables/objectives would be measured or observed and recorded. Also, very frequently students used a questionnaire survey that was inappropriate and, where they were appropriate, the questions were not formulated to yield the information pertaining to the stated objectives. If a questionnaire survey is used, the researcher should be careful to use the results only to help validate actual impact or measurements from scientific experimentation. The results of such a survey quantify only the 'perceived' impact, rather than actual impact.
7. The research process was poorly described or outlined by some students.
8. Many SBAs did not demonstrate adequate field investigation.
9. Many SBAs did not demonstrate much creativity and skill in the Presentation of Data; often they had a number of graphs of similar type, that were inappropriate, and many photographs were without titles and/or figure captions. A very useful technique is to present a summary table of data gathered in the field visits and laboratory exercises. In this way, the researcher can view the data set at a glance and can perhaps glean patterns or essential points. A summary table can be useful in guiding the analysis, and the table itself can be used as an analytical technique.
10. In 'Presentation of Data', students were labelling diagrams "Site 1," "Site 2," etc., instead of naming the places where the Site Visits took place. There were no keys, no

labelled axes, and no titles on many diagrams. There was improper use of units and in some instances no units were included.

11. Data Analysis and interpretation of major findings were typically weak or non-existent in most cases. The results of the site visits and lab work should be summarized in this section.
12. Often, raw data was presented as 'Data Analysis'.
13. Analyses could have benefited from more variation in techniques (other than percentages). Some students failed to do any analysis to indicate the parameters of the data, for example, percentage, average, range, trend, etc. What was presented tended to be summaries of purely raw data.
14. The Discussion of Findings lacked depth of interpretation, and very few showed validity and reliability. Discussions were adequately done in some cases, but many students failed to discuss their major findings in depth. The discussion of Site Visit observations was inaccurately done by some students. They failed to discuss and interpret their observations. Often discussion points were not based on actual findings of the particular research but, instead, on some generalized information on the topic, perhaps from research on a similar topic or from the literature. Many discussions looked like Analysis of Data. Validity and reliability are achieved by revoking the literature and making reference to citations and/or by the sampling techniques utilized to ascertain that a single measurement is not an anomaly but representative of the variable that is measured.
15. The Discussion was often more of a literature review. Students often did not discuss the major findings of their research (and the possible implications) in the Discussion of Findings section.
16. The Conclusion often revisited the Purpose. However, similar to the Discussion of Findings, it was often based on generalized information on the topic but not the actual findings in the research. It would be helpful here to recall two or three of the most significant findings.
17. In a few instances, Recommendations were based on Limitations. This category of Recommendations is more appropriately addressed in the Methodology. In general, similar to the Discussion of Findings, Recommendations were not based on actual findings of the particular research but, instead, on some generalized information on the topic, perhaps from research on a similar topic or from the literature.
18. Communication of information was generally good. However, it would be beneficial for students to use the jargon/terminology of Environmental Science in order to improve the overall quality of the SBAs. Note that some SBAs had a very poor standard of writing for the CAPE level.
19. In several instances, the conventional format/style for references was not applied.

Additionally, textbooks and websites were intermixed. In some cases, for website references, only the search engine was stated.

20. It was sometimes difficult to determine how the site visits and laboratory exercises were organized.
21. Justification for site selection was rarely provided. Moreover, a description of how sampling was carried out was missing or deficient.
22. There was little comparison of processes and occurrences among sites.
23. Field Observations were, in many cases, not methodical and were rarely adequate.
24. Field Observations were rarely supported with sketches or illustrations.
25. Many students gave observations where they should have given activities.
26. Observations should not be general information but should be related to the specific research being undertaken. Observations were often general comments unrelated to the research being conducted.
27. Activities reported are activities observed at the site, not activities undertaken by the student/researcher.
28. Interpretative Comments were written as general comments, for example, "It was lunch time," instead of comments related to observations and results.
29. Students do not appear to understand the meaning of follow-up activities mean. Recommendations are often listed where follow-up activities should be described.
30. Interpretative Comments in the Journals needed more depth; this can be achieved by importing Lab Results to help explain Field Observations.
31. In too many instances, the lab exercises were not related to the site visits, and, in some instances, the site visits were not related to each other. It is clear in the syllabus guidelines that these should be interrelated.
32. Students were inappropriately reporting data and results, for example, students documented four laboratory exercises for each site visit.
33. The lab exercises were mostly well done, although many were not related to the site visits. Many lab exercises did not state the observations that were noted in the labs. Often lab reports contained weak analysis and no interpretation.
34. There were cases where examples of procedural steps (for labs) were not outlined; instead, there were general outlines of what was done. Lab procedure steps should be written in the order in which the activities were carried out.

35. Some students gave general titles for labs, for example, 'nutrients' instead of outlining *tests for nutrients*.
36. There is need for improvement in labs with respect to observations and recording. While in most cases results were recorded, very few had description of the actual lab observations. Some students confused *observations* with *results*.
37. Students often wrote 'colour change was noted' but did not report what specific colour changes were seen in their labs under Observations.
38. There were poorly presented labs in terms of neatness and logical sequence of sections.
39. Bibliographies had too little published sources and too many internet sources, for example, Wikipedia. A minimum of four published sources should be cited.
40. There were often no citations in the Literature Review. Where there were citations, these were often not acknowledged in the Bibliography.

Recommendations

It appears that there is wide interpretation of the syllabus by teachers regarding what is required for submission in the CAPE Environmental Science SBAs. Therefore, many students are misguided. Schools that may benefit from training in project conceptualization and field investigation can be identified and training provided by teachers who presented highly successful projects, in conjunction with CXC. Trainers should be standardized and follow the same workshop topics and content, especially in relation to the CXC guidelines for SBAs. The SBA marking team is willing and competent to provide regular group/regional training for CAPE Environmental Science teachers across CXC territories in research and research methodology.