



**CARIBBEAN
EXAMINATIONS
COUNCIL**

**Caribbean Advanced
Proficiency Examination®**

SYLLABUS

ENVIRONMENTAL SCIENCE

CXC A25/U2/25

Effective for examinations from May–June 2026



CAPE®

Correspondence related to the syllabus should be addressed to:

The Pro-Registrar
Caribbean Examinations Council
Caenwood Centre
37 Arnold Road, Kingston 5, Jamaica

Telephone Number: + 1 (876) 630-5200

Facsimile Number: + 1 (876) 967-4972

E-mail Address: cxcwzo@cxc.org

Website: www.cxc.org

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Prince Road, Pine Plantation Road, St Michael BB11091

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NOTE TO TEACHERS AND LEARNERS

This document CXCA25/U2/25 replaces CXC A25/U2/10 issued in 2010.

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

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PLEASE NOTE



This icon is used throughout the syllabus to represent key features which teachers and learners may find useful.

Introduction

The Caribbean Advanced Proficiency Examination (**CAPE**[®]) is 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 at the **CAPE**[®] level. 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 **CXC**[®] Associate Degree, awarded for the satisfactory completion of a prescribed cluster of *ten* **CAPE**[®] Units including Caribbean Studies, Communication Studies *and Integrated Mathematics*. *Integrated Mathematics is not a requirement for the **CXC**[®] Associate Degree in Mathematics*. The complete list of Associate Degrees may be found in the **CXC**[®] Associate Degree Handbook.

For the **CAPE**[®] Diploma and the **CXC**[®] Associate Degree, candidates must complete the cluster of required Units within a maximum period of five years. *To be eligible for a **CXC**[®] Associate Degree, the educational institution presenting the candidates for the award, must select the Associate Degree of choice at the time of registration at the sitting (year) the candidates are expected to qualify for the award.* Candidates will not be awarded an Associate Degree for which they were not registered.

Environmental Science Syllabus

♦ RATIONALE

Environmental Science is an interdisciplinary approach to knowledge that helps us explain natural phenomena, understand human activities in relation to these natural occurring phenomena and meet the challenge of survival and progress in a diverse and changing world. It draws on the content of several disciplines to offer a balanced scientific and holistic perspective of environmental problems and issues. Moreover, Environmental Science arouses our natural curiosity, encourages our ability to enquire, to pose questions, and to conduct research required to obtain answers. As a Science, it plays a major role in the evolution of knowledge by empowering us with the skills required for creative and independent problem-solving. The scientific approach utilised leads to the construction of hypotheses, theories and laws that help us to explain the world around us.

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 prerequisites for sustainable development in the *Wider Caribbean Region (WCR)*. Achieving sustainable development requires an appreciation of the *interconnectedness of the environment, society and economy* and the development of the knowledge and skills required for effective management *and policy decisions*.

This **CAPE®** syllabus in Environmental Science presents a coherent course of study which provides a *scientific* knowledge base of the environment and sustainable development (*sustainability*). A *study of the subject* will enable learners to identify, prevent, *address and recommend solutions for* environmental problems. Students will develop long-term transferable skills including ethical conduct, collaboration, problem-solving, critical thinking, creativity and innovation, and communication. The course encourages the use of various student-centred teaching, learning *and assessment* strategies to inculcate the knowledge and competencies that will prove useful in everyday life, while at the same time catering to multiple intelligences and different learning styles and needs. In addition to providing a sound foundation, it prepares students for ultimate careers in diverse fields of relevance to environmental management and to sustainable development of the *Wider Caribbean Region (WCR)*.

The study of **CAPE®** Environmental Science will contribute to the development of the Ideal Caribbean Person as articulated by the CARICOM Heads of Government. *This individual is imbued with respect for human life; has an awareness of the importance of living in harmony with the environment; and demonstrates multiple literacies, independent and critical thinking, questions the beliefs and practices of past and present and brings this to bear on the innovative application of science and technology to problem solving. Such an individual also demonstrates a positive work ethic and the capacity to contribute to the health and welfare of the community, country, and region. This course of study incorporates the UNESCO Pillars of Learning and is designed to contribute to the development of skills needed for a person to learn to know, do, be, live together, and transform themselves and society.*

◆ AIMS

The syllabus aims to:

1. *develop an appreciation for the interdisciplinary nature of Environmental Science, as well as an understanding of the interdisciplinary and holistic nature of the study of the environment;*
2. *stimulate interest in the environment and sustainability (environmental, social and economic);*
3. *provide an understanding of human-environment interactions;*
4. *develop an understanding of environmental issues, and principles of sustainability and apply these (principles) to environmental management, particularly in a Caribbean context;*
5. *provide an understanding of the socio-economic, governance, ecological and ethical issues in Environmental Science;*
6. *develop essential research skills: to identify a research problem, develop a problem statement and related critical research questions, formulate hypotheses or guiding statements, develop or design data collection techniques, collect, collate, analyse and interpret environmental data;*
7. *develop the ability to communicate environmental data, information and ideas logically, appropriately and concisely;*
8. *foster awareness, positive attitudes, values and commitment with respect to the importance of living in harmony with the environment; and,*
9. *assist in the development of skills in collaboration, problem-solving, critical thinking, creativity, innovation and Information and Communications Technology (ICT) to identify, prevent, address, and solve current and future environmental problems.*

◆ 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:

1. Knowledge and Comprehension;
2. Use of Knowledge; and,
3. Practical Skills.

Knowledge and Comprehension

The examination will test candidates' skills and abilities to:

- (a) *Remember – the ability to identify, remember and grasp the meaning of basic facts, concepts and principles.*
- (b) *Understand – the ability to select appropriate ideas, match, compare and cite examples and principles in familiar situations.*

Use of Knowledge (UK)

The examination will test candidates' skills and abilities to:

(a) Apply

The ability to:

- (i) use facts and apply concepts, principles and procedures in familiar and in novel situations;*
- (ii) transform data accurately and appropriately; and,*
- (iii) use formulae accurately for computational purposes.*

(b) Analyse and Interpret

The ability to:

- (i) identify and recognise the component parts of a whole and interpret the relationship among those parts;*
- (ii) identify causal factors and show how they interact with each other;*
- (iii) infer, predict and draw conclusions from environmental data; and,*
- (iv) make necessary and accurate calculations and recognise the limitations and assumptions involved.*

(c) Evaluate

The ability to:

- (i) make reasoned judgements and recommendations based on the value of ideas and information and their implications;*
- (ii) evaluate information from a range of sources to give concise and coherent explanations of scientific phenomena; and,*
- (iii) assess the validity of scientific statements, experiments, results, conclusions and inferences.*

(d) Create

The ability to:

- (i) combine component parts to form a new meaningful whole; and,*
- (ii) make predictions and solve problems.*

Practical Skills

The examination will test candidates' skills and abilities to:

- (a) select techniques, designs, methodologies and instruments appropriate to different environmental situations;
- (b) use instruments to measure environmental parameters;
- (c) collect and collate data;
- (d) analyse, interpret and present data;
- (e) use quantitative techniques appropriately; *and*,
- (f) *design and* develop appropriate solutions to specific environmental problems.

◆ PREREQUISITES 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 *and analytical* skills. *It would be helpful to have foundational knowledge in the Sciences.*

◆ 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 *covers topics related to* Agriculture, Energy, and Environmental Pollution. A Unit comprises three Modules, each requiring 50 hours. *Therefore, the total time for each Unit is expected to be 150 hours. While it is advisable and beneficial for students to complete both Units, each Unit can independently offer students a comprehensive programme of study with appropriate balance between depth and coverage to provide a basis for further learning in this field.*

UNIT 1: Ecology, Human Population and Natural Resources

Module 1	-	Fundamental Ecological <i>Concepts and</i> Principles
Module 2	-	Human Population and the Environment
Module 3	-	Sustainable Use <i>and Management</i> 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.

◆ APPROACHES TO TEACHING THE SYLLABUS

The specific objectives indicate the scope of the content and the activities that should be covered. Students should be exposed to accurate and unbiased content and skills that will empower them to address local, regional and global environmental problems. Although each Unit of the Syllabus is distinct, every opportunity should be made to integrate concepts and show connections across content. The references included throughout the document provide useful examples. Teachers are encouraged to employ a collaborative, highly practical and industry-driven approach to facilitate students' learning.

◆ UNIT 1: ECOLOGY, HUMAN POPULATION AND NATURAL RESOURCES

MODULE 1: FUNDAMENTAL ECOLOGICAL CONCEPTS AND PRINCIPLES

GENERAL OBJECTIVES

On completion of this Module, students should:

1. understand the *key ecological terms and* concepts;
2. understand the processes that govern the interactions *between* biotic and abiotic components of *the* environment;
3. understand the relationship between people and the environment; *and*,
4. develop practical and analytical skills *in understanding and applying fundamental ecological concepts and principles*.

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

1. <i>define</i> key ecological terms and concepts;	Species, population, community, ecosystem, biosphere, atmosphere, hydrosphere, lithosphere, habitat, niche, biome, ecotone, <i>biodiversity, keystone species, and ecological resilience.</i>
2. <i>discuss the components of ecosystems and their interactions;</i>	<i>Components of the ecosystem:</i> (a) <i>biotic:</i> (i) <i>producers;</i> (ii) <i>consumers; and,</i> (iii) <i>decomposers.</i> (b) <i>Abiotic (to include but not limited to):</i> (i) <i>air;</i> (ii) <i>water;</i> (iii) <i>land;</i> (iv) <i>light;</i> (v) <i>temperature; and,</i> (vi) <i>ph.</i>

UNIT 1

MODULE 1: FUNDAMENTAL ECOLOGICAL CONCEPTS AND PRINCIPLES (cont'd)

SPECIFIC OBJECTIVES

Students should be able to:

CONTENT

Relate to Unit 1, Module 1, SO 12.

Relate to Unit 2, Module 3, SO 6.

3. explain energy <i>flows and nutrients cycle</i> within ecosystems;	(a) <i>Incorporation of energy into the ecosystem by photosynthesis and chemosynthesis.</i>
	(b) <i>Construction and interpretation of food chains, webs and ecological pyramids.</i>
	(c) Trophic levels.
	(d) <i>Ten percent rule.</i>
4. discuss types of interactions between organisms in communities;	<i>Types of interactions:</i>
	(a) competition;
	(b) predator-prey; and,
	(c) symbiosis:
	(i) parasitism;
	(ii) commensalism; and,
	(iii) mutualism.
5. discuss the importance of biogeochemical cycles;	(a) <i>Biogeochemical cycles:</i>
	(i) carbon cycle;
	(ii) nitrogen cycle;
	(iii) phosphorus cycle; and,
	(iv) water cycle.
	(b) <i>Importance to:</i>
	(i) <i>natural processes (to include but not limited to soil formation, climate regulation, hydrological regime, gaseous exchange); and,</i>
	(ii) <i>organisms (to include but not limited to nitrifying, denitrifying bacteria and human sustenance).</i>

UNIT 1

MODULE 1: FUNDAMENTAL ECOLOGICAL CONCEPTS AND PRINCIPLES (cont'd)

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

Include basic chemical equations and formulae for biogeochemical cycles.

6. explain the relationship between organisms and their environment;

- (a) Tolerance ranges and limiting factors (*abiotic and biotic*):
 - (i) *zone of abundance*;
 - (ii) *zone of physiological stress*;
 - (iii) *zone of intolerance*; and,
 - (iv) *optimum ranges*.
- (a) Ecological niches:
 - (i) *fundamental niche*; and,
 - (ii) *realised niche*.

Include the use of diagrams and charts to assist with comprehension.

7. explain the process of *species evolution*;

- (a) *Overview of evolution*:
 - (i) *Darwin's theory*; and,
 - (ii) *types of evolution (divergent, convergent and parallel)*.
- (b) *Processes of evolution*:
 - (i) *natural selection*:
 - *conditions needed for natural selection*; and,
 - *process for natural selection*.
 - (ii) *speciation (sympatric, allopatric and parapatric)*; and,
 - (iii) *adaptation*.

UNIT 1

MODULE 1: FUNDAMENTAL ECOLOGICAL CONCEPTS AND PRINCIPLES (cont'd)

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

8. *evaluate* factors affecting population growth in a natural ecosystem;

(a) *Types of population growth, including growth curve:*

- (i) *Exponential; and,*
- (ii) *Logistic.*

(b) *Factors:*

- (i) *biotic potential;*
- (ii) *environmental resistance; and,*
- (iii) *carrying capacity.*

9. *determine* population size using appropriate sampling methods;*

Population sampling methods:

(a) *moving organisms:*

- (i) *capture-mark-release-recapture (Lincoln index method).*

(b) *non-moving organisms:*

- (i) *quadrats; and,*
- (ii) *transects.*

10. *use the Simpson's Diversity Index* to calculate species diversity;

(a) *Definition of species diversity.*

(b) *Simpson's Diversity Index:*

$$D = \frac{\sum n(n-1)}{N(N-1)}$$

Where D – species diversity.

N – total number of organisms of all species.

n – total number of organisms of a particular species.

Value of D ranges between 0 and 1.

UNIT 1

MODULE 1: FUNDAMENTAL ECOLOGICAL CONCEPTS AND PRINCIPLES (cont'd)

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

11. analyse the relationship between species diversity and ecosystem stability;
 - (a) Diversity within species.
 - (b) Diversity between species.
 - (c) Community and ecosystem stability (*constancy and resilience*).
12. explain how ecosystems are self-sustaining;
 - (a) *Features of self-sustaining ecosystems to include but not limited to:*
 - (i) *ecological balance;*
 - (ii) *energy and nutrient availability;*
 - (iii) *recycling of waste; and,*
 - (iv) *interaction between the biotic and abiotic.*
 - (b) Ecological succession:
 - (i) *primary; and,*
 - (ii) *secondary.*
 - (c) Climax communities:
 - (i) *climatic; and,*
 - (ii) *plagio-climax.*
13. *discuss the benefits of ecosystem services to the environment and society;*

Relate to Unit 1, Module 1, SO 2.

Ecosystem services:

 - (a) *provisional (food and non-food products);*
 - (b) *supporting (nutrients, recycling);*
 - (c) *regulating (climate, water); and,*
 - (d) *cultural (ecotourism, heritage, aesthetics, recreation).*

Relate to Unit 1, Module 3, SO 5 (Natural resources).

UNIT 1

MODULE 1: FUNDAMENTAL ECOLOGICAL CONCEPTS AND PRINCIPLES (cont'd)

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

14. <i>explain</i> human interactions within natural ecosystems;	(a) Human beings as part of the natural ecosystems.
	(b) Anthropogenic impact on ecosystems (<i>biodiversity and biogeochemical cycles</i>) and the need to maintain <i>their</i> integrity.
15. investigate <i>at least two</i> ecosystems, including <i>one terrestrial and one aquatic</i> ,*	(a) <i>Characteristics:</i> (i) <i>feeding relationship;</i> (ii) <i>trophic levels;</i> (iii) <i>population distribution;</i> (iv) <i>species diversity;</i> (v) <i>physical (to include but not limited to light, water, temperature, air, humidity, turbidity, Total Suspended Solid) and chemical parameters (to include but not limited to pH, salinity, dissolved oxygen, nutrients); and,</i> (vi) <i>critical factors.</i> (b) <i>Types:</i> (i) <i>terrestrial:</i> - <i>forests;</i> - <i>gullies; and,</i> - <i>savannahs.</i> (ii) <i>aquatic (freshwater and marine):</i> - <i>rivers;</i> - <i>oceans;</i> - <i>coral reefs;</i> - <i>sea grasses;</i> - <i>mangroves;</i> - <i>ponds; and,</i> - <i>swamps.</i>

UNIT 1

MODULE 1: FUNDAMENTAL ECOLOGICAL CONCEPTS AND PRINCIPLES (cont'd)

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

16. measure environmental parameters in a given habitat;*	(a) <i>Species abundance.</i> (b) <i>Measure water quality parameters.</i> (c) <i>Soil moisture.</i> (d) <i>Light intensity.</i> (e) <i>Wind speed.</i> (f) <i>Temperature.</i> (g) <i>Assessment of the different types of wastes (weight and volume).</i>
17. <i>apply scientific method to experimental design and analysis;</i>	<i>Scientific Method (observing, developing hypotheses, predicting, experimenting, analysing, communicating and drawing inferences).</i>
18. present data using appropriate charts, tables, and graphs; and,	(a) <i>Graph types:</i> (i) <i>Line;</i> (ii) <i>Bar;</i> (iii) <i>Scatter plot; and,</i> (iv) <i>Pie chart (sketch).</i> (b) <i>Appropriate labelling:</i> (i) <i>Title;</i> (ii) <i>Scale;</i> (iii) <i>Axis labels; and,</i> (iv) <i>Column and row headings (tables).</i> (c) <i>Drawing of smooth and best fit lines.</i> (d) <i>Selection of appropriate graph type.</i>

UNIT 1

MODULE 1: FUNDAMENTAL ECOLOGICAL CONCEPTS AND PRINCIPLES (cont'd)

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

19. <i>interpret data from appropriate charts, tables and graphs.</i>	(a) <i>Read data from a graph, chart or table.</i> (b) <i>Identify trends and patterns.</i> (c) <i>Estimate rates from a graph.</i> (d) <i>Interpolate and extrapolate data on a graph and make predictions.</i>

Suggested Teaching and Learning Activities

Teachers are advised to engage students in the teaching and learning activities listed below to facilitate their attainment of the objectives of this module. These activities are designed to promote inquiry-based learning and cater to students' various learning styles.

Encourage students to:

1. *Create a glossary of key ecological terms. Have students add to the glossary new technical terms that they have been exposed to at the end of each topic. Encourage students to use their glossary to reinforce learning.*
2. *Work in small groups requiring them to identify topics of interest related to a module focus and formulate hypotheses, develop guiding statements and generate and interpret data. Students should then be required to present their findings creatively.*
3. *Participate in class discussions on current sustainability issues. This could be a debate, panel discussion, or teacher-guided discussion requiring students to highlight the importance of adopting an interdisciplinary approach to the area of focus.*
4. *Participate in field trips/study/site visits, requiring them to prepare a summary of their observation and or present their findings to the class. Students could be asked to:*
 - (a) *Sample an ecosystem to determine population density and distribution.*
 - (b) *Identify species diversity.*
 - (c) *Investigate environmental parameters in a natural aquatic environment.*
 - (d) *Identify and quantify human use of the components of an ecosystem.*

UNIT 1

MODULE 1: FUNDAMENTAL ECOLOGICAL CONCEPTS AND PRINCIPLES (cont'd)

Suggested Teaching and Learning Activities

5. *Work in small groups to construct models of existing ecosystems in specific locations. Students should participate by displaying the models and explaining their concepts.*
6. *View simulations or models of food webs and analyse, based on their observations, possible disruption of feeding relationships. Students should discuss their findings with a peer and recreate the food web to recommend how disruptions can be minimised.*
7. *Study the source(s) and distribution of freshwater supply within a District/Parish/or Administrative Region and its level of dependence on natural water cycles. Students should be presented with case studies, journal articles or general research highlighting the area of focus. Students should then discuss their observations and recommendations with their peers.*
8. *Use digital tools and other creative modes to communicate or present results of sampling, investigations, and practical activities.*

UNIT 1

MODULE 1: FUNDAMENTAL ECOLOGICAL CONCEPTS AND PRINCIPLES (cont'd)

RESOURCES

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Neobold, K.B.	Population Geography: Tools and Issues. Rowman & Littlefield Publishers, 2021.
Odum, E. and Barrett, G.W.	Fundamentals of Ecology (5 th Ed.). Boston, Cengage Learning, 2004.
Wright, R. and Boorse, D.	Environmental Science: Toward a Sustainable Future. Boston, Pearson, 2016.
The Cropper Foundation (TCF)	Sustainable Development. Terms and concept: A reference for teachers and student. Port-of-Spain, Trinidad, 2009.
Theis, T., & Tomkin, J.	Sustainability: A Comprehensive Foundation. Openstax, 2015.

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 environmental and socio-economic impacts of population growth;
3. understand the factors that affect the growth rate of human populations;
4. appreciate the need for sustainable development; and,
5. develop practical and analytical skills *in understanding the human population and the environment.*

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

1. <i>explain the key demographic terms and concepts;</i>	<i>Demography, population, population distribution, population density, migration, emigration, immigration, birth rate, death rate, fertility rates, mortality rates, doubling time, life expectancy, life span, urbanisation, urban growth, and urban sprawl.</i>
2. <i>describe the key characteristics of human population;</i>	<i>Characteristics of human population:</i> (a) <i>age and sex structure (population pyramids);</i> (b) <i>population size;</i> (c) <i>population change;</i> (d) <i>density; and,</i> (e) <i>distribution.</i>
3. <i>compare historical and current trends in human population size;</i>	(a) Historical and current trends in human population growth. (b) <i>Demographic transition model.</i>

UNIT 1

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

- (c) *Current geographical distribution of human population growth:*
 - (i) *in developing nations; and,*
 - (ii) *in developed nations.*
- (d) *Interpretation of demographic graphs, charts and tables:*
 - (i) *age and sex structure;*
 - (ii) *fertility rate, mortality rate, birth rate; and,*
 - (iii) *dependency ratio.*

Relate to Unit 1, Module 2 SO 4, (formulae).

Relate to Unit 1, Module 2, SO 5 (population growth rate).

- 4. *evaluate the factors that affect human population;*

- (a) *Factors affecting human population:*
 - (i) *fertility rates;*
 - (ii) *mortality rates;*
 - (iii) *life span and life expectancy;*
 - (iv) *immigration;*
 - (v) *emigration; and,*
 - (vi) *doubling time.*
- (b) *Other:*

Indirect – Natural hazards and disasters (floods, earthquakes, volcanoes, hurricanes, diseases); war and crimes.

Relate to Unit 1, Module 2, SO 5.

UNIT 1

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

SPECIFIC OBJECTIVES

Students should be able to:

5. calculate changes in demographic characteristics;

CONTENT

- (a) Population size.

- (b) *Population growth rate.*

- (c) Fertility rate:

$$= \frac{\text{number of live births}}{\text{number of fertile women}} \times 1000$$

- (d) Mortality rate:

$$= \frac{\text{total number of death (D)}}{\text{total population (N)}} \times 1000$$

- (e) *Infant mortality rate:*

$$= \frac{\text{number of deaths among children < 1 year}}{\text{live births}} \times 1000$$

- (f) Migration rate:

$$= \frac{\text{number of immigrants} - \text{number of emigrants}}{\text{total population}} \times 1000$$

- (g) *Crude birth rate:*

$$= \frac{\text{number of live births}}{\text{total population}} \times 1000$$

- (h) *Population change:*

$$= (\text{births} + \text{immigration}) - (\text{deaths} + \text{emigration})$$

- (i) Percentage increase in population:

$$= \frac{\text{population change}}{\text{initial population}} \times 100$$

- (j) Doubling time:

$$= \frac{70}{\% \text{ growth rate}}$$

Relate to Unit 1, Module 2, SO 2.

UNIT 1

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

6. assess the factors affecting population growth rate;

- (a) *Socio-economic factors:*
- (i) *level of affluence;*
 - (ii) *social and economic status of women;*
 - (iii) *degree of access to family planning;*
 - (iv) *level of economic development of a country; and,*
 - (v) *level of access to education and health care services.*
- (b) *Cultural factors:*
- (i) *religious practices;*
 - (ii) *customs and traditions; and,*
 - (iii) *gender roles.*

Relate to Unit 1, Module 2, SOs 2 and 3 (human population).

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

Population Control Measures:

- (a) Family Planning measures and methods; *and,*
- (b) Government policies/legislations.

8. assess the *inter*-relationship between population growth and poverty;

- (a) *Absolute and relative poverty (to include the poverty line).*
- (b) *Qualitative and quantitative indicators of poverty:*
- (i) *income;*
 - (ii) *access to education;*
 - (iii) *access to health care; and,*
 - (iv) *access to food, housing, and water.*

UNIT 1

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

9. explain the impacts of urbanisation;
- (c) Per capita, Gross Domestic Product and Gross National Product (GDP and GNP), Human Development Index (HDI), Gender Development Index (GDI).
 - (d) *Poverty cycle for example Marxist and Malthusian.*
 - (a) *Definition of urbanisation.*
 - (b) *Causes of urbanisation:*
 - (i) *natural increase; and,*
 - (ii) *migration.*
 - (c) *Consequences of urbanisation:*
 - (i) *Positive:*
 - *economic opportunities, better social services (health and education) and amenities.*
 - (i) *Negative:*
 - *environmental impacts (air, land and water pollution);*
 - *social impacts to include but not limited to health issues, overcrowding, traffic congestion, unemployment; and,*
 - *increased vulnerability to natural hazards such as floods, hurricanes and earthquakes.*

Relate to Unit 1, Module 1, SO 14.

Relate to Unit 1, Module 3, SO 8.

UNIT 1

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

10. *evaluate* current geographical variations in human consumption patterns;

- (a) *Calculation of* consumption patterns *using* statistics on *per capita*:

- (i) water consumption;
- (ii) food consumption;
- (iii) fuel consumption;
- (iv) greenhouse gas emissions; *and*,
- (v) waste production.

- (b) *Consumption data patterns to determine:*

- (i) *development status of a country; and*,
- (ii) *environmental impact of a country.*

11. *discuss* the *impact of* the environment *on people*;

- (a) *Human adaptation to the environment (including but not limited to how people adapt to the environment, crops they grow, culture, clothes, and shelter).*

- (b) Abiotic and biotic factors that affect the distribution of population and their activities.

- (c) Dependence of people on ecological systems and processes.

Relate to Unit 1, Module 1, SO 13.

Relate to Unit 1, Module 2, SO 9.

UNIT 1

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

12.	explain the relationship between population growth and sustainable development;	(a)	Concept of sustainable development (<i>Our Common Future, Brundtland Report, 1987</i>).
		(b)	Sustainable Development Goals (<i>Mention the 17 Sustainable Development Goals, 2015</i>).
		(c)	Population growth and changing consumption patterns as <i>challenges</i> to sustainable development in a finite world.
		(d)	Strategic Imperatives for Sustainable Development #4 “Ensuring a Sustainable Level of Population” (<i>Our Common Future, Brundtland Report, 1987</i>).
13.	<i>present data using appropriate graphs, charts and tables; and,</i>	(a)	<i>Selection and use of appropriate Graph types:</i>
		(i)	<i>Line;</i>
		(ii)	<i>Bar;</i>
		(iii)	<i>Scatter plot; and,</i>
		(iv)	<i>Pie chart (sketch).</i>
		(b)	<i>Appropriate labelling:</i>
		(i)	<i>Title;</i>
		(ii)	<i>Scale;</i>
		(iii)	<i>Axis labels; and,</i>
		(iv)	<i>Column and row headings (tables).</i>
		(c)	<i>Drawing of smooth and best fit lines.</i>

UNIT 1

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

14. <i>interpret data from appropriate graphs, charts and tables.</i>	(a) <i>Read data from a graph, chart or table.</i>
	(b) <i>Identify trends and patterns.</i> <i>Estimate rates from a graph.</i>
	(c) <i>Interpolate and extrapolate data on a graph and make predictions.</i>

Suggested Teaching and Learning Activities

Teachers are advised to engage students in the teaching and learning activities listed below to facilitate their attainment of the objectives of this module. These activities are designed to promote inquiry-based learning and cater to students' various learning styles.

Encourage students to:

- Work in small groups to conduct a study of a local population based on census statistics. Students should be encouraged to generate population age structure, for all individuals and separately by sex.*
- Participate in class-activities and or complete work sheets requiring them to 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.*
- Interpret World Population Data Sheets, as produced, for example, by the Population Reference Bureau Inc. Students should then participate in a guided class discussion requiring them to share and critique their interpretations.*
- Work in small groups to gather data and participate in a debate on specific issues such as high population growth or high consumerism as principal causes of global environmental problems, using, for example, reports from the 1992 Rio Conference. This can be a graded activity for which a rubric is shared.*
- Conduct case studies of population size management and of related changes in consumption patterns. Students should creatively present their findings.*
- Participate in a debate on the definitions of development and sustainable development, and on the question of what constitutes an acceptable standard of living.*

UNIT 1

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

7. Participate in a guided discussion, *by sharing thoughts and recommendations, on the main issues addressed by (to include but not limited to):*
 - (a) the 1972 Stockholm Conference;
 - (b) the 1980 International Union for the Conservation of Nature (IUCN) World Conservation Strategy;
 - (c) the 1987 Brundtland Report (Our Common Future);
 - (d) the 1992 United Nations Conference on Environment and Development (The Rio Conference);
 - (e) the 1994 United Nations Conference on Small Island Developing States;
 - (f) the 2002 World Summit on Sustainable Development in Johannesburg; and,
 - (g) the 2012 Rio Plus 20 Conference.
8. *Work in small groups to conduct research on religions and cultures within the Caribbean and contribute to discussions on how their customs and traditions impact population growth rate.*

UNIT 1

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

RESOURCES

Chiras, D.	Environmental Science. Action for a Sustainable Future. United States of America, The Benjamin/Cummings Publishing Company Inc, 1994.
Cunningham, W. and <i>Cunningham, M.</i>	Environmental Science. A Global Concern. New York, McGraw Hill, 2021.
<i>Eastern Caribbean States</i>	Biodiversity of the Caribbean. A learning Resource Prepared for Eastern Caribbean States. Canada, EKOS Communications Inc, 2009.
Ehrlich, P. and Ehrlich, A.	The Population Explosion. New York, Simon and Schuster, 1990.
Jordan, C.	<i>Conservation: Replacing Quantity with Quality as a Goal for Global Management.</i> New York, John Wiley and Sons, 1995.
Miller, G. Tyler.	Living in the Environment, Principles, Connections and Solutions (15 th Ed.). California, Wadsworth Publishing Company, 2006.
Nebel, B., and Wright, R.	Environmental Science: The Way the World Works. New Jersey, Prentice Hall, 2000.
The Cropper Foundation (TCF)	Sustainable Development. Terms and concept: A Reference for Teachers and Students. Port-of-Spain, Trinidad, 2009.
Theis, T., & Tomkin, J.	Sustainability: A Comprehensive Foundation. Openstax, 2015.
WWF, IUCN, UNEP	Caring for the Earth: A Strategy for Sustainable Living, 1981.

UNIT 1

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

WEBSITES

<https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf>

https://www.undp.org/sustainable-development-goals?utm_source=EN&utm_medium=GSR&utm_content=US_UNDP_PaidSearch_Brand_English&utm_campaign=CENTRAL&c_src=CENTRAL&c_src2=GSR&qclid=Cj0KCQjw5auGBhDEARIsAFyNm9HM2EaTKeorEVffKUF-Qfslallo0Tb9Vu20T6ng0hMoyMkhizQj9fMaAqN3EALw_wcB

<https://doi.org/10.3390/su10103766>

<https://sdgs.un.org/goals>

<http://www.ejolt.org/2012/11/affluence-and-environmental-impact-2/>

<https://ourworldindata.org/world-population-growth#>

[World population trends \(unfpa.org\)](#)

www.un.org/en/global-issues/population

<https://reliefweb.int/report/haiti/migration-caribbean-current-trends-opportunities-and-challenges>

<https://open.maricopa.edu/environmentalscience/chapter/the-human-population/>

<https://nap.nationalacademies.org/read/9543/chapter/6>

<https://www.unep.org/geo/>

<https://www.unep.org/resources/people-and-planet-unep-strategy-2022-2025>

www.bcrc-caribbean.org

Videos

<https://youtu.be/JpAiBq0hrfQ>

<https://youtu.be/mRcxGJcBDVo>

<https://youtu.be/Fvqit57mpZw>

<https://youtu.be/9e7wqqRdOiq>

UNIT 1

MODULE 3: SUSTAINABLE USE AND MANAGEMENT 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 *the use of* natural resources and the environmental impacts of their use;
3. *grasp the significance of the appropriate measures and tools available for the management, protection and sustainable use of natural resources;*
4. understand the value of natural resources;
5. understand the concept of ecological sustainability and implications for natural resource use; and,
6. develop practical and analytical skills *in understanding the sustainable use and management of natural resources.*

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

1. <i>discuss key terms and concepts related to natural resource management;</i>	<i>Natural resources, natural resource management, conservation, restoration, rehabilitation, preservation, remediation, re-creation, protection, and sustainable use.</i>
2. differentiate between <i>the categories of</i> natural resources;	<i>Categories of natural resources (examples of each):</i> (a) <i>renewable and non-renewable (ability to be replenished by natural processes);</i> (b) <i>exhaustible and inexhaustible (as related to consumption rate);</i>
3. differentiate between the consumptive and non-consumptive use of natural resources;	(a) <i>Consumptive use (logging, fishing, quarrying);</i> (b) <i>Non-consumptive use (bioprospecting, ecotourism, research); and,</i> (c) <i>Temporal dimensions and limitations placed by technology.</i>

UNIT 1

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

4. *discuss the characteristics and distributions of the major categories of natural resources in Caribbean countries;*
- (a) *Categories of natural resources:*
- (i) *biodiversity:*
- *species;*
 - *genetic; and,*
 - *ecosystems:*
 - *terrestrial (forest);*
 - *freshwater (lakes; rivers) marine (coral reefs; and,*
 - *wetlands; seagrass beds; mangroves.*
- (ii) *water:*
- *ground water;*
 - *surface water (lakes, streams, rivers, ocean); and,*
 - *waterfalls.*
- (iii) *minerals and hydrocarbons: bauxite; gold; diamond; limestone; manganese; sand and gravel; oil; natural gas; and,*
- (iv) *soil, landscape and seascape, (beaches, cliffs, mountains).*
- (b) *Location and distribution of natural resources.*
5. *discuss the importance of natural resources in the Caribbean;*
- Importance of natural resources:*
- (a) *Livelihood (Income generating activity).*
- (b) *Gross Domestic Product (GDP).*
- (c) *Foreign exchange earner.*
- (d) *Food security.*

UNIT 1

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

- (e) *Supply of raw materials for industrial processes.*
 - (f) Recreation.
 - (g) Sacred and spiritual values.
 - (h) *Ecosystem functions and services.*
 - (i) Intrinsic value.
 - (j) Research and teaching.
- Relate to Unit 1, Module 1, SO 13 (Ecosystem services).*
- 6. describe ways in which Indigenous People have used and managed natural resources;
 - (a) Agriculture: rotation of fields during slash/burn activities, use of organic fertilizers, intercropping;
 - (b) Use of forest: timber and non-timber forest products (NTFPS); *and*,
 - (c) Fishing: traditional fishing methods.

Case studies from Belize, Dominica, Guyana, St Vincent and the Grenadines and Suriname.
- 7. evaluate factors affecting natural resource use in the Caribbean;
 - (a) *Natural endowment.*
 - (b) Political:
 - (i) government policies on natural resource use;
 - (ii) economic development policies;
 - (iii) environmental and natural resources policies; *and*,
 - (iv) *green budgeting.*

UNIT 1

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

SPECIFIC OBJECTIVES

Students should be able to:

CONTENT

- (c) Economic:
 - (i) role of foreign investment;
 - (ii) export of natural resources as primary products;
 - (iii) sectoral activities - tourism, agriculture, mining, manufacturing, *blue and green economy*; and,
 - (iv) national debt.
- (d) *Social:*
(conflict, crime, violence, education, attitudes, political instability, migration, human resource capacities).

Relate to Unit 1, Module 2.

- 8. assess the environmental impacts of the use of different natural resources;

- (a) *Biodiversity:*
 - (i) introduction of exotic species;
 - (ii) *species depletion and extinction*;
 - (iii) *habitat disruption and destruction*; and,
 - (iv) *disruption of ecosystem processes.*
- (b) *Water:*
 - (i) *pollution and depletion of surface and groundwater*;
 - (ii) *degradation of aquifers*;
 - (iii) *health risks (water borne disease)*; and,
 - (iv) *watershed degradation.*

UNIT 1

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

SPECIFIC OBJECTIVES

Students should be able to:

CONTENT

- (c) *Minerals and hydrocarbons:*
 - (i) *change in land use;*
 - (ii) *deforestation;*
 - (iii) *transformation of landscape;*
 - (iv) *dust and noise pollution;*
 - (v) *pollution from the discharge of process chemicals;*
 - (vi) *sedimentation and siltation;*
 - (vii) *beach loss and change in river course;*
 - (viii) *oil spills; and,*
 - (ix) *social dynamics (displacement of communities and introduction of new settlements).*
- (d) *Soil, landscape and seascape:*
 - (i) *transformation of natural landscape to built environment;*
 - (ii) *soil degradation, erosion and sedimentation; soil productivity;*
 - (iii) *beach erosion; and,*
 - (iv) *degradation and destruction of coral reefs, seagrass beds and mangroves.*
- (e) *Human health risks.*

UNIT 1

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

9. justify the need for natural resource conservation;	(a) The broad concept of natural resource conservation including: <i>sustainable</i> management; rehabilitation; restoration; preservation; <i>and</i> conservation (in-situ and ex-situ). (b) Reasons for resource conservation: (i) ecological: (depletion or degradation of natural resources and the threat to sustainable development; conservation of ecosystem <i>functions and services</i>; <i>and</i> conservation of endangered and threatened species); (ii) ethical: (sacredness; <i>intrinsic value</i> (right to exist)); <i>and</i>, (iii) aesthetical value.
10. <i>discuss the approaches to natural resource management at the individual and community levels;</i>	(a) <i>Individual:</i> (i) <i>change in lifestyles;</i> (ii) <i>the use of substitutes; and,</i> (iii) <i>application of environmentally friendly/appropriate technology.</i> (b) <i>Community based:</i> (i) <i>sustainable yield management;</i> (ii) <i>community-based natural resource management (participation, advocacy, monitoring and evaluation); and,</i> (iii) <i>reduction and minimisation of waste, recycling of solid, liquid and gaseous wastes.</i>

UNIT 1

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

11. *evaluate the approaches to natural resource management at the national level;*

(a) *Policies:*

- (i) Rates and techniques for exploitation of renewable resources; and,

Relate to Unit 1, Module 3, SO 10.

- (ii) Use of economic instruments: user fees; taxes; penalties; *'Polluter Pays' Principle*; incentives; economic valuation of natural resources; environmental accounting and greening of national budgets.

(b) *Legislation:*

- (i) Protected Area Systems (International Union for the Conservation of Nature (IUCN) Classification):

- role; and,
- ecotourism.

- (ii) *Environmental Management and Protection, Regulations and Standards.*

(c) *Planning:*

- (i) Environmental Impact Assessments (EIA) (A brief introduction to EIA as a Planning and decision-making tool to natural resource management and conservation).

UNIT 1

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

- (ii) Land Use Planning and Zoning Regulation; Integrated Development Planning and Integrated Coastal Zone Management.
 - (iii) *Education, public awareness, advocacy and training. (Agenda 21, Chapter 36).*
 - (d) *Multi-lateral Environmental Agreements (MEAs).*
- Relate to Unit 1, Module 2, SO 12.*
- 12. *examine the approaches to natural resource management at an international level;*
 - (a) International environmental and conservation agreements (MEAs):
 - (i) *objectives and general structure;*
 - (ii) *development; and,*
 - (iii) *mode of operation.*
 - Refer to Unit 1, Module 3, SO 11(b).*
 - (b) International agreements relevant to natural resource management:
 - (i) *make mention of the Rio Summit and the following agreements:*
 - United Nations Framework Convention on Climate Change (UNFCCC, Kyoto Protocol and Paris Agreement);
 - United Nations Convention to Combat Desertification (UNCCD); and,
 - Marine Pollution (MARPOL).

UNIT 1

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

- (c) *Overview of the relevance of the following agreements and conventions (mention of how these agreements influence individual and national actions):*
 - (i) United Nations Convention on Biological Diversity (UNCBD);
 - (ii) *Cartagena Convention;*
 - (iii) Ramsar Convention;
 - (iv) United Nations Convention on the Law of the Sea (UNCLOS); *and,*
 - (v) Specially Protected Areas and Wildlife (SPAW).
- 13. *Present data using appropriate graphs, charts and tables; and,*
 - (a) *Selection and use of appropriate graph types:*
 - (i) *Line;*
 - (ii) *Bar;*
 - (iii) *Scatter plot; and,*
 - (iv) *Pie chart (sketch).*
 - (b) *Appropriate labelling:*
 - (i) *Title;*
 - (ii) *Scale;*
 - (iii) *Axis labels; and,*
 - (iv) *Column and row headings (tables).*
 - (c) *Drawing of smooth and best fit lines.*

UNIT 1

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

14. <i>interpret data from appropriate graphs, charts and tables.</i>	(a) <i>Read data from a graph, chart or table.</i>
	(b) <i>Identify trends and patterns.</i>
	(c) <i>Estimate rates from a graph.</i>
	(d) <i>Interpolate and extrapolate data on a graph and make predictions.</i>

Suggested Teaching and Learning Activities

Teachers are advised to engage students in the teaching and learning activities listed below to facilitate their attainment of the objectives of this module. These activities are designed to promote inquiry-based learning and cater to students' various learning styles.

Encourage students to:

1. *Examine case studies of Community Based Natural Resources Management, for example, forests and wetlands and discuss their findings. Or participate in a walk-through of a modified natural area, for example, beach, forest, or watershed, to observe the changes, physical conversion of land and impacts of the resource use. Students should use a matrix table to record changes and impacts.*
2. *Participate in field exercises requiring them to:*
 - (a) *Observe and identify different species;*
 - (b) *Visit and assess community based natural resource management initiatives;*
 - (c) *Visit indigenous communities and observe practices. Students could discuss whether the practices are sustainable; and,*
 - (d) *Visit a resource conservation area under the International Union for Conservation of Nature (IUCN) designation, for examples, botanical gardens, protected land and seascape.*
3. *Students should be asked to creatively present observations or findings individually or collaboratively.*

UNIT 1

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

Suggested Teaching and Learning Activities

4. *Participate in a guided discussion on the main issues relating to the natural obligation under UNFCCC, UNCCD and the UNCBD. Students should be encouraged to recommend how they would address the issues cited.*
5. *Attend lectures by resource persons for example, representatives of natural resource agencies. Students should be given opportunities to ask questions on the topics discussed.*
6. *View videos, simulations and presentations of natural resource management activities and protected areas. Observations and main points should then be discussed.*
7. *Establish or join an Environmental Science Club within the school and conduct activities that raise awareness about sustainable use of natural resources.*
8. *Participate in discussions led by professionals in the field on issues related to natural resource management and sustainability and use the information gained to respond to scenarios given by peers or teacher.*
9. *Participate in on-site or virtual field trips with experts locally or from other territories to discuss sustainable measures and their advantages and disadvantages and further discuss the suitability of the methods.*
10. *Develop a sustainable development plan for the school/household and adopt some simple measures. This could be shared with the class in the form a presentation.*

UNIT 1

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

RESOURCES

- Bossi, R. and Cintro, G. *Mangroves of the Wider Caribbean: Toward Sustainable Management.* Barbados, Caribbean Conservation Association, 1990.
- Breton, Y., Brown, D., Davy, B., Haughton, M., and Ovaes, L. *Coastal Resource Management in the Wider Caribbean: Resilience, Adaptation, and Community Diversity.* Ian Randle, IDRC, 2006.
- Chiras, D. *Environmental Science. Action for a Sustainable Future.* United States of America, The Benjamin/Cummings Publishing Company Inc., 1994.
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- Cutter, S. and William, R. *Exploitation, Conservation, Preservation: A Geographic Perspective on Natural Resource (4th Ed.).* Wiley Edition, Wiley, 2004.
- Ehrlich, P. and Ehrlich, A. *The Population Explosion,* New York, Simon and Schuster, 1990.
- Goodbody, I. and Thomas-Hope, E. *Natural Resource Management for Sustainable Development of the Caribbean,* Canoe Press, University of the West Indies, Mona, 2002.
- Gupta, A. *Ecology and Development in the Third World (2nd Ed.).* New York, Routledge, 1998.
- Hinckly, A. *Renewable Resources in our Future.* New York, Pergamon Press Limited, 1980.
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- Nebel, B., and Wright, R. *Environmental Science: The Way the World Works.* New Jersey, Prentice Hall, 2000.
- Neobold, K.B. *Population Geography: Tools and Issues.* Rowman & Littlefield Publishers, 2021.

UNIT 1

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

RESOURCES

- Theis, T., & Tomkin, J.* *Sustainability: A Comprehensive Foundation. Openstax, 2015.*
- Tivy, J. and O' Hare, G. Human Impact on the Ecosystem, (Conceptual Frameworks in Geography). United Kingdom, Longman Group, 1982.
- WWF (World Wildlife Fund). Local to Global Environmental Conservation. Agenda 21. 2008.

WEBSITES

www.earthwatch.org

www.canari.org

www.panda.org

<https://www.usgs.gov/centers/nmic/latin-america-and-canada-north-america-central-america-and-caribbean#st>

<https://www.canari.org/wp-content/uploads/2016/01/275-Participatory-approaches-to-natural-resource-management-and-sustainable-development-Some-implications-for-research-and-policy.pdf>

https://pdf.usaid.gov/pdf_docs/PA00ZW1M.pdf

<https://link.springer.com/article/10.1007/s00267-017-0866-8>

<https://www.fao.org/3/x0625e/X0625e31.htm>

<https://www.cavehill.uwi.edu/cermes/home.aspx>

<https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf>

♦ UNIT 2: AGRICULTURE, ENERGY AND ENVIRONMENTAL POLLUTION

MODULE 1: AGRICULTURE AND THE ENVIRONMENT

GENERAL OBJECTIVES

On completion of this Module, students should:

1. understand the *agricultural systems within* the Caribbean;
2. *appreciate the importance of agriculture in the Caribbean;*
3. understand the environmental impacts of and threats to agricultural systems in the Caribbean;
4. have knowledge of environmentally sustainable practices in agricultural systems in the Caribbean;
5. *understand how the Sustainable Development Goals (SDGs) align with sustainable agriculture;*
6. *appreciate the use of technology in agriculture; and,*
7. develop practical and analytical skills *in understanding agriculture and the environment.*

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

1. <i>describe the characteristics of agricultural systems in the Caribbean;*</i>	(a) <i>Definition of agriculture and agricultural systems.</i> (b) <i>Characteristics of agricultural systems with respect to:</i> (i) large-scale/industrialised commercial; <i>and,</i> (ii) small-scale: - <i>small-scale commercial;</i> - <i>subsistence (distinguish from small-scale commercial); and,</i> - <i>peasantry (small-scale agricultural production for subsistence and for the market; farming systems of Indigenous peoples (farming and fishing)).</i>

Relate to Unit 1, Module 3, SO6.

Relate to Unit 2, Module 1, SO 2.

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

2. *compare the categories of agricultural systems in the Caribbean;**

- (a) *Categories of agricultural systems:*
- (i) *Traditional agriculture (for example arable farming, pastoral farming and mixed farming, sustainable indigenous farming and fishing); and,*
 - (ii) *Non-traditional methods (practices, intensive and extensive, advantages and disadvantages):*
 - *mariculture;*
 - *aquaculture; and,*
 - *agritourism.*

Relate to Unit 2, Module 1, SO 4 and SO 7.

Relate to Unit 2, Module 1, SO 8.

- (b) *Emerging and Re-emerging approaches:*
- (i) *sustainable agricultural practices (for example, Climate Smart Agriculture (CSA), Vertical Farming, Agroecology, Agro-forestry).*

Relate to Unit 2, Module 1, SOs 4, 6, 7 and 10.

3. *explain the evolution of agricultural systems in the Caribbean;*

Evolutionary change, agricultural systems and characteristics:

- (a) *Historical factors, and their impact on agricultural systems, pre-colonial, colonial, and post-colonial;*
- (b) *Scale, inputs and outputs;*
- (c) *Shift to sustainable approaches such as organic fertilisers, renewable energy,*

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

- technology and sustainable practices for example agritourism, farm to fork/table, tide to table culture and,*
- Relate to Unit 2, Module 1, SO 4 and Unit 1, Module 3, SO 7.*
- (d) *Gender roles.*
4. *explain the importance of agriculture to the Caribbean Region;*
- (a) *Economic:*
- (i) *Production of materials for manufacturing industries;*
 - (ii) *Employment and other income generating activities (for example agro-tourism);*
 - (iii) *Foreign exchange earnings;*
 - (iv) *Contribution to Gross Domestic Product (GDP);*
 - (v) *Production of non-food products (medicine, lumber); and,*
 - (vi) *Recreation/tourism.*
- (b) *Social:*
- (i) *Food Security (to include reduction of food import bill and health and nutrition security.*
 - (ii) *Education and training.*
- (c) *Ecological/Environmental:*
- (i) *Biodiversity.*
 - (ii) *Soil conservation.*
 - (iii) *Ecological services.*

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

5. *examine the use and advantages of technology in agricultural production;**

- (a) *Examples of technology used in agriculture:*
- (i) *plant and animal breeding; and,*
 - (ii) *genetic engineering;*
- (b) *Advantages of technology use.*
- (i) *mechanisation/industrialisation (such as ploughs, harvesters and irrigation systems);*
 - (ii) *precision agriculture (drones, Global Positioning Systems (GPS), Geographic Information Systems (GIS), robotics);*
 - (iii) *digitising of supply chains;*
 - (iv) *Blockchain; and,*
 - (v) *use of agro-chemicals.*

6. *examine the sustainability issues associated with agricultural systems in the Caribbean;*

Sustainability issues of the Caribbean Agricultural Sector:

- (a) *Social.*
- (i) *Positive:*
- *Role of agriculture.*

Relate to Unit 2, Module 1, SO 5 (Role of agriculture).

- (ii) *Negative:*
- *Health risks;*
 - *Impacts of zoonoses and other epidemic or pandemic causing organisms;*
 - *Food insecurity; and,*

UNIT 2

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

SPECIFIC OBJECTIVES

Students should be able to:

CONTENT

Reference to SDGs 1, 2, & 3

- *Threats to sustainable livelihood of communities.*
- (b) *Environmental.*
 - (i) *Positive:*
 - *nutrients cycling;*
 - *soil protection;*
 - *biodiversity;*
 - *carbon sequestration;*
 - *support ecological niche;*
 - *feeding relationships (food web and food chain); and,*
 - *habitat.*
 - (ii) *Negative:*
 - *land take (need for vast amounts of lands for agriculture);*
 - *pollution from inappropriate use of agro-chemicals (pesticides; fertilisers); antibiotics and hormones in aquaculture and mariculture; eutrophication; heavy metal and chemical pollution of waterways, sea and fish;*

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

- habitat destruction; loss of biodiversity; desertification soil degradation: erosion; acidification; salinisation; water-logging; soil compaction, monoculture leading to reduction in soil fertility;
- waste production: waste disposal and management; solid and liquid wastes;
- water degradation: sedimentation; changes in water discharge to coastal zone surface and ground water pollution;
- zoonoses for example, SARS COV2 (from domestic stock, as well as wildmeat);
- land degradation: inappropriate use of land types; hillside farming, slash and burn agriculture;
- reduced water availability; *and*,
- Climate change due to methane production.

UNIT 2

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

SPECIFIC OBJECTIVES

Students should be able to:

CONTENT

(c) *Economic.*

(i) *Positive:*

- *Agritourism/Agrotourism;*
- *Agroforestry;*
- *red economy;*
- *blue economy;*
- *green economy;*
- *food security;*
- *lower food import bill; and,*
- *backward and forward linkage for example tourism manufacturing.*

(ii) *Negative:*

- *subsidies and its impact on balance on trade and government expenditure;*
- *guarantee prices; and,*
- *preferential arrangement.*

UNIT 2

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

SPECIFIC OBJECTIVES	CONTENT
Students should be able to:	
7. <i>discuss how sustainable agriculture aligns with the SDGs;</i>	(a) <i>Definition of sustainable agriculture.</i> (b) <i>Ecological integrity:</i> (i) <i>SDG 13 - climate action;</i> (ii) <i>SDG 14 - life below water; and,</i> (iii) <i>SDG 15 - life on land.</i> (c) <i>Economic viability:</i> (i) <i>SDG 1 - no poverty; and,</i> (ii) <i>SDG 8 - decent work and economic growth.</i> (d) <i>Social equity:</i> (i) <i>SDG 5 - gender equality;</i> (ii) <i>SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all;</i> (iii) <i>SDG 10 - reduced inequalities;</i> (iv) <i>SDG 12 – ensure sustainable consumption and production patterns; and,</i> (v) <i>SDG 15 - life on land.</i>

UNIT 2

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

SPECIFIC OBJECTIVES	CONTENT
Students should be able to:	
8. discuss threats to sustainable agriculture;	(a) Natural <i>hazards</i>, disasters: flood, <i>drought</i>, hurricane, volcano, <i>pandemics</i>, <i>epidemics</i>. (b) Climate <i>variability</i> (to include but not limited to El Nino Southern Oscillation (ENSO): El Nino and La Nina phenomena) and climate change including the issue of temperature rise, sea level rise, change in precipitation patterns. (c) External shocks: global markets, price fluctuations, <i>conflicts</i>. (d) <i>Limited capacity</i> to meet international standards (<i>certification</i>, <i>costs</i>, <i>resources</i>, <i>requirements</i>). (e) Importation of cheap agricultural products. (f) <i>Poor land management policies</i>. (g) <i>Praedial larceny</i>. (h) <i>Pests and diseases</i>.
9. <i>evaluate</i> sustainable practices in agriculture;*	(a) Contour farming. (b) Terracing. (c) Crop rotation. (d) Conservation Tillage. (e) <i>Water conservation/efficient water usage</i>. (f) <i>Carbon farming</i>. (g) Agroforestry (<i>silviculture</i>, <i>silvopastoral</i> and <i>permaculture</i>).

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

- (h) Pest control (biological and genetic) and Integrated Pest Management (*IPM*).
 - (i) Organic farming.
 - (j) Hydroponics.
 - (k) *Aquaponics*.
 - (l) Post-harvest management: waste utilisation and waste minimisation.
- 10. *present data using appropriate graphs, charts and tables; and,*
 - (a) *Selection and use of appropriate graph types:*
 - (i) *Line;*
 - (ii) *Bar;*
 - (iii) *Scatter plot; and,*
 - (iv) *Pie chart (sketch).*
 - (b) *Appropriate labelling:*
 - (i) *Title;*
 - (ii) *Scale;*
 - (iii) *Axis labels; and,*
 - (iv) *Column and row headings (tables).*
 - (c) *Drawing of smooth and best fit lines.*
- 11. *interpret data from appropriate graphs, charts and tables.*
 - (a) *Read data from a graph, chart or table.*
 - (b) *Identify trends and patterns.*
 - (c) *Estimate rates from a graph.*
 - (d) *Interpolate and extrapolate data on a graph and make predictions.*

UNIT 2

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

Suggested Teaching and Learning Activities

Teachers are advised to engage students in the teaching and learning activities listed below to facilitate their attainment of the objectives of this module. These activities are designed to promote inquiry-based learning and cater to students' various learning styles.

Encourage students to:

1. *Participate in field visits to agrochemical factories, or agriculture, aquaculture, and mariculture farms to observe and analyse their operations. Students should be encouraged to present their observations in a written report.*
2. *Identify agro-chemicals used in territory, analyse their composition and discuss the consequences of misuse or abuse.*
3. *Attend lectures by resource persons or subject matter experts on various issues in agriculture. Students should be encouraged to complete teacher guided activities at the end of these lectures for example worksheets or guided discussions.*
4. *Work in small groups to create and present models illustrating for example, soil erosion, hydroponics, organoponics, water conservation.*
5. *Conduct experiments and record their observations for example, fertiliser experiments on plants.*
6. *Participate in brain-storming sessions to explore entrepreneurial opportunities for use of unused production (for example, fruit under trees; non-meat parts of livestock). Recommendations should be written, and students vote to choose their preferences.*
7. *Collect and document information on land use in a community, or country. Students should use their findings to guide a discussion on how prime agricultural land is being used. Students should be encouraged to focus on the pros and cons.*
8. *Conduct investigation using secondary data on various topics of interest and creatively present findings. For example:*
 - (a) *on waste production and management in an agricultural entity; and,*
 - (b) *water quality at agriculture operations.*
9. *Complete assignments requiring them to compare soil types and fertility in different agricultural systems.*
10. *Compare productivity of different farms after viewing simulated farms or participating by attending a field trip.*

UNIT 2

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

RESOURCES

Arms, K.	<i>Holt Environmental Science: Student Edition</i> . Philadelphia, Holt, Rinehart and Winston, 2008.
Byrne, K.	<i>Environmental Science (2nd Ed.)</i> . United Kingdom, Nelson Thornes, 2001.
Chiras, D.	<i>Environmental Science: Action for a Sustainable Future</i> . United States of America, The Benjamin/Cummings Publishing Company Inc., 1994.
Cunningham, W. and Cunningham, M.	<i>Environmental Science: A Global Concern</i> . New York, McGraw Hill, 2021.
Ehrlich, P. and Ehrlich, A.	<i>The Population Explosion</i> . New York, Simon and Schuster, 1990.
Enger, E. and Smith, B.	<i>Environmental Science: A Study of Inter-relationships (12th Ed.)</i> . New York, McGraw Hill, 2010.
Goodbody, I. and Thomas-Hope, E.	<i>Natural Resource Management for Sustainable Development of the Caribbean</i> . University of the West Indies, Mona, Canoe Press, 2002.
Goudie, A. and Viles, H.	<i>The Earth Transformed: An Introduction to Human Impacts on the Environment (1st Ed.)</i> . Cambridge, Massachusetts, Blackwell Publishers Incorporated, 1997.
Jordan, C.	<i>Conservation: Replacing quantity with quality as a goal for global management</i> . New York, John Wiley and Sons, 1995.
Nebel, B. and Wright, R.	<i>Environmental Science: The Way the World Works</i> . New Jersey, Prentice Hall, 2000.
Miller, G. Tyler	<i>Living in the Environment, Principles, Connections and Solutions (15th Ed.)</i> . Boston, Cengage Learning, 2006.

WEBSITE

<https://www.mheducation.com/highered/category.10203.html>

<https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf>

UNIT 2

MODULE 2: ENERGY AND THE ENVIRONMENT

GENERAL OBJECTIVES

On completion of this Module, students should:

1. understand the nature, *form and use* of energy;
2. *understand the key concepts associated with energy;*
3. understand the socio-economic and environmental impacts of *the* provision and use of energy *and energy services;*
4. appreciate the *use of* renewable energy *services;* and,
5. develop practical and analytical skills in *understanding and addressing energy use.*

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

1. describe the nature <i>and</i> form of energy;	(a) Definition and <i>concept of energy.</i> (b) <i>The two main categories of energy:</i> (i) kinetic energy; <i>and,</i> (ii) potential energy. (c) <i>Units of measurement: Joule, MJ, TJ, GJ, Watt, MW, KWh.</i> (d) <i>Forms of energy derived from the two main categories of energy:</i> (i) <i>kinetic</i> (Radiant/Light, Thermal/heat, Motion, Sound, Electrical and Mechanical); <i>and,</i> (ii) <i>potential</i> (Chemical, Mechanical, Gravitational, and Nuclear).
2. <i>explain the concepts of energy conversion and energy efficiency;</i>	(a) <i>The Law of Conservation of Energy.</i> (b) <i>Definition of key concepts:</i> (i) <i>energy conversion as a change of energy from one form to another; and,</i> (ii) <i>energy efficiency.</i>

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

3. *discuss how energy is harnessed from various energy sources;**
- (c) *Examples of energy conversions which occur in everyday activities to include and not limited to boiling water on a stove, turning on the television, running up a hill.*
 - (d) *Calculation of energy efficiency:*
$$\frac{\text{the amount of useful energy}}{\text{total input energy}} \times 100$$
 - (a) *Overview of the various energy sources – non-renewable and renewable sources of energy.*
 - (b) *Non-renewable:*
 - (i) *Fossil Fuels:*
 - *Types (Oil, Coal, Natural Gas, Oil Shales, Tar Sands);*
 - *Formation, Characteristics and Chemical Composition; and,*
 - *Petroleum Product life cycle (location of reserves, extraction, transportation processing and uses).*
 - (ii) *Nuclear energy:*
 - *Fuels with focus on Uranium;*
 - *Nuclear fuel cycle (mining and milling, conversion enrichment, fuel fabrication, fission reprocessing);*

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

- *Nuclear power plant (basic structure and operation); and,*
 - *Advanced Small Modular Reactors (SMRs).*
- (c) Renewable:
- (i) solar energy: harnessing and use:
 - *Passive Systems (Passive Solar Energy); and,*
 - *Active Systems (Active Solar Energy):*
 - *Solar Photovoltaic (PV) Energy (electricity); and,*
 - *Concentrating Solar Thermal Energy (heat).*
 - (ii) wind energy;
 - (iii) hydroelectric energy;
 - (iv) biofuels: biomass fuel, biogas;
 - (v) geothermal energy;
 - (vi) wave;
 - (vii) tidal; and,
 - (viii) ocean thermal energy.

UNIT 2

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

SPECIFIC OBJECTIVES

Students should be able to:

CONTENT

(d) *Other Energy Sources:*

(i) Fuel cells: structure and process, Proton exchange fuel cell; *and*,

(ii) *Waste to energy (refuse derived fuel).*

In articulating between renewable and non-renewable sources of energy, students should be able to distinguish between the concepts of renewability and exhaustibility.

Relate to Unit 1, Module 3, SO 3.

4. *discuss factors that influence energy use in the Caribbean;*

(a) Geographical restrictions.

(b) Technological limitations.

(c) Reliability of supply.

(d) *Social costs.*

(e) *Environmental cost and sustainability (climate mitigation, just transition, SDG 7 and SDG 13).*

(f) Economic (cost of production, *maintenance*).

(g) Political (energy policy of country, *subsidies*).

(h) *External factors (conflicts, market fluctuations).*

5. *explain the importance of energy to society;*

(a) *Definition of energy services (use of energy within societies).*

(b) Socio-economic dependency on energy use (*energy uses in various sectors*):

(i) *Domestic;*

(ii) *Industrial;*

(iii) *Transportation;*

(iv) *Telecommunication; and,*

(v) *Power Generation.*

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

6.	describe the conventional generation and distribution of electricity;*	(a) Conventional generation. (b) Transmission. (c) <i>Distribution systems.</i> <i>Relate to Unit 2, Module 2, SO 3.</i>
7.	discuss factors affecting electricity generating capacity and demand;	(a) Definition of generation capacity and generation <i>demand</i> . (b) Factors affecting generation <i>capacity and demand</i> : (i) Demand patterns; (ii) <i>Grid infrastructure and connectivity</i> ; (iii) Energy storage (<i>batteries, green hydrogen</i>); (iv) Stock piling capability for fossil fuels; (v) Diversity of energy sources; (vi) Economic cost; (vii) <i>Aged/obsolete generation plants; and</i> , (viii) Government policies.
8.	<i>distinguish between</i> conservation and conservation efficiency;	(a) Definitions: energy conservation, energy efficiency. <i>Relate to Unit 2, Module 2, SO 2.</i> (b) <i>Relationship between energy conservation and energy efficiency.</i> (c) <i>Methods of energy conservation/energy efficiency including, but not limited to, transportation energy conservation (use of hybrid vehicles, mass transportation systems (water taxis/ferries, buses), car-pooling:</i>

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

		(i)	<i>domestic/industrial energy conservation (smart plugs, smart metres, use of energy star appliances) improved design and construction techniques applied to buildings, use of natural light and air flow;</i>
		(ii)	<i>applicable to only industrial energy conservation: ensure optimal functioning of equipment, regular maintenance schedules, Energy efficient technologies;</i>
		(iii)	<i>Co-generation, tri-generation; and,</i>
		(iv)	<i>Combined cycles.</i>
9.	outline the impacts of various forms of energy;	(a)	Environmental: (i) <i>Climate change, especially global warming;</i> (ii) <i>pollution;</i> (iii) <i>loss or extinction of biodiversity;</i> (iv) <i>ecosystem destruction, damage, disruption, fragmentation; and,</i> (v) <i>climate mitigation (for example through the development and use of renewables).</i>
		(b)	Socio-economic: (i) <i>Human health issues;</i> (ii) <i>dislocation of communities;</i> (iii) <i>impact on indigenous peoples including loss of ancestral land of spiritual and cultural importance; and,</i> (iv) <i>sustainable livelihood (SDG 1 and SDG 7).</i>

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

10. <i>Present data using appropriate graphs, charts and tables; and,</i>	(a) <i>Selection and use of appropriate graph types:</i> (i) <i>Line;</i> (ii) <i>Bar;</i> (iii) <i>Scatter plot; and,</i> (iv) <i>Pie chart (sketch).</i> (b) <i>Appropriate labelling:</i> (i) <i>Title;</i> (ii) <i>Scale;</i> (iii) <i>Axis labels; and,</i> (iv) <i>Column and row headings (tables).</i> (c) <i>Drawing of smooth and best fit lines.</i>
11. <i>interpret data from appropriate charts, tables and graphs.</i>	(a) <i>Read data from a graph, chart or table.</i> (b) <i>Identify trends and patterns.</i> (c) <i>Estimate rates from a graph.</i> (d) <i>Interpolate and extrapolate data on a graph and make predictions.</i>

UNIT 2

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

Suggested Teaching and Learning Activities

Teachers are advised to engage students in the teaching and learning activities listed below to facilitate their attainment of the objectives of this module. These activities are designed to promote inquiry-based learning and cater to students' various learning styles.

Encourage students to:

1. *Participate in field visits to renewable energy facilities, for example, wind farms, solar water heater manufacturers and photovoltaic (PV) installations to observe practices to reinforce learning.*
2. *Conduct research on renewable energy systems used in their respective country and the extent of their market penetration. Student could also research the energy system within another country and compare to the systems within their country.*
3. *Attend lectures by resource persons on topics such as renewable energy. Have students prepare and peer review questions that they can ask before the lecture.*
4. *Use contour maps to evaluate loss of area in their or a specific country and discuss the effects on coastal areas with regards to rising sea levels using available world chart and map data.*
5. *Work in small groups to construct a simple device to measure energy use. In cases where this is not possible students should observe simulative activities observing construction and use of a simple device.*
6. *Work in small groups to 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. *Conduct investigations, record, and report findings for example:*
 - (a) *on energy use in home and school environments and recommend methods of improving energy use and conservation;*
 - (b) *diversity and percentage contribution of varying energy sources to the total annual generation capacity in your country; and,*
 - (c) *energy use of various sectors.*
8. *Work in small groups to conduct a simple energy audit assessing energy efficiency in buildings.*
9. *Work in small groups to construct and present a model depicting an energy efficient building.*
10. *Work in small groups to research policies governing energy use, transportation, and extraction, and promote energy conservation and efficiency.*

UNIT 2

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

RESOURCES

- Arms, K. *Holt Environmental Science: Student Edition*. Philadelphia, Holt, Rinehart and Winston, 2008.
- Byrne, K. *Environmental Science (2nd Ed.)*. United Kingdom, Nelson Thornes, 2001.
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- WCD (World Commission on Environment and Development). *Our Common Future*, Brundtland Report, 1987.
- WWF, IUCN, UNEP - *Caring for the Earth: A Strategy for Sustainable Living*, 1981.

WEBSITES

<https://ourworldindata.org/>

UNIT 2

MODULE 3: POLLUTION OF THE ENVIRONMENT

GENERAL OBJECTIVES

On completion of this Module, students should:

1. *understand* the major types and sources of pollution;
2. understand the environmental impacts of pollution *and the appropriate mitigation measures*;
3. understand the methods available for monitoring *and* analysing pollution;
4. *acknowledge the role of lifestyle choices and consumerism in pollution*; and,
5. develop practical and analytical skills in *understanding and addressing pollution*.

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

1. <i>explain</i> the general sources and nature of pollutants;	(a) Definitions of pollution, <i>pollutant, point and non-point sources</i> .
	(b) <i>Examples</i> of pollutants, incidences of pollution, <i>point and non-point sources in the Wider Caribbean Region</i> .
	(c) Nature of pollutants: persistence, mobility, synergistic effects, toxicity, <i>carcinogenic, mutagenic and teratogenic effects</i> .
2. <i>explain the movement of pollutants through the environment</i> ; *	(a) Environmental receptors: (i) <i>definition of environmental receptors</i> ; and, (ii) <i>environmental receptors for specific pollutants (for example, micro-organisms, plants, animals, humans, soil, water, buildings)</i> .
	(b) <i>Environmental pathways</i> : (i) <i>definition of environmental pathways</i> ; and, (ii) <i>describe the various pathways of pollution in the environment</i> :

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

- *Biotic (feeding relationships, bioaccumulation and biomagnification); and,*
- *Abiotic (including but not limited to surface runoff, leaching, wind).*

Relate to Unit 1, Module 1, SO23 (food chain/web).

3. outline the underlying causes/drivers of pollution;

- (a) *Resource extraction, transportation, processing and use:*
- *inappropriate technology, industrialisation.*

Relate to Unit 1, Module 3, SO 8 (resources).

- (b) *Population growth.*
- (c) *Unsustainable lifestyle: behavioural and consumption patterns.*

Relate to Unit 1, Module 2, SO 10 (consumption pattern).

- (d) *Institutional Framework:*
- (i) *Environmental standards, policies, legislation (absence and limited implementation); and,*
 - (ii) *Limited economic instruments (lack of incentives – tax rebates, limited implementation of pollution principles).*
- (e) *Lack of environmental ethics.*
- (f) *Lack of environmental education and awareness.*

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

4. *examine* the major sources, impacts and *mitigative measures* of atmospheric pollution; *

- (a) The Atmosphere:
 - (i) structure and composition; *and*,
 - (ii) physical processes *and features* related to the movement of pollutants (*wind, air* effects of topography on the movement of pollutants).
- (b) Primary Air Pollutants:
 - (i) types: carbon monoxide; nitrogen oxides; sulphur oxides; suspended particulate matter; volatile organic compounds (*include formulae of pollutants*);
 - (ii) sources (*to include and not limited to combustion processes, traffic, construction, chemical spill*);
 - (iii) environmental pathways and receptors;
 - (iv) environmental impacts (*for example, Carbon Monoxide (CO) poisoning, acid rain*); *and*,
 - (v) *human health risks*.
- (c) Secondary Air Pollutants:
 - (i) types: photochemical smog, *industrial smog* and acid rain;
 - (ii) mechanism of formation and characteristics including equations;
 - (iii) environmental pathways and receptors;
 - (iv) *environmental impacts (for example, acidification of soil and water, damage to buildings)*; *and*,
 - (v) *human health risks*.

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

(d) Global Impacts of Atmospheric Pollutants:

(i) Global Warming:

- greenhouse effect and earth's heat balance;
- sources of greenhouse gases: anthropogenic and natural;
- *enhanced greenhouse effect and global warming; and,*
- *consequences of global warming (for example, sea level rise, increased temperatures, increased intensities of weather phenomena in the context of the Wider Caribbean).*

(ii) Ocean acidification:

- *occurrence due to increased carbon dioxide;*
- *chemical equation of formation of carbonic acid; and,*
- *effects on coral organisms and organisms with calcareous skeletons.*

UNIT 2

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

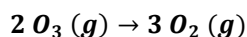
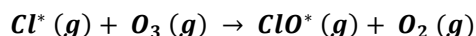
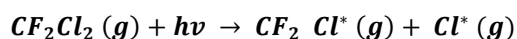
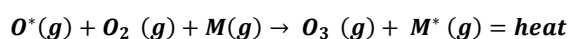
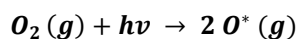
SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

(iii) Ozone Depletion:

- Ozone depleting substances and sources: natural and anthropogenic substances;
- Chemical equation of formation and destruction of ozone; and,
- Formation of Ozone (*Chapman cycle*).
- Destruction of Ozone (*Catalytic Cycle*).



(e) General mitigative measures and monitoring *methods*:

- (i) air quality monitoring methods;
- (ii) *mitigative measures*:
 - *technological*;
 - *education and public awareness*;

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

- *legislation, standards and policy incentive; and,*
 - *emission control, reduction methods and enforcement.*
5. *examine the major sources, impacts and mitigative measures of noise pollution;*
- (a) Sources:
 - (i) industrial;
 - (ii) commercial;
 - (iii) social;
 - (iv) cultural; and,
 - (v) transportation;
 - (b) Intensity measurement and monitoring;
 - (c) *Health risks – human and other organisms (for example, damage to ear drum, public health, stress, behavioural disruption, navigational disturbance);*
 - (d) *Mitigation measures:*
 - (i) Legislation, policies and enforcement;
 - (ii) sound walls;
 - (iii) selection of construction materials;
 - (iv) education and awareness; and,
 - (v) urban design.
6. *describe the properties of water;*
- (a) Properties of water:
 - (i) physical: colour, taste, odour, appearance, turbidity; and,
 - (ii) chemical: pH, dissolved oxygen (DO) content, salinity.

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

7. *examine the major sources, impacts and mitigative measures of water pollution; **

- (a) Water pollutants and their sources:
- (i) *Pollutants* (sediment, heat, nutrients and biodegradable organic matter, pathogens, sewage, toxic chemicals, *micro-plastics and macro-plastics*).
 - (ii) Sources (agriculture, municipal and domestic, industrial, atmospheric):
 - *point and non-point sources.*
 - (iii) Factors affecting concentration of pollutants:
 - volume of emission;
 - volume of receiving *body of water*;
 - residence time; and,
 - rate of degradation and removal of pollutants.
 - (iv) Environmental pathways and receptors.
 - (v) Environmental impacts:
 - eutrophication;
 - deoxygenation;
 - coral reef destruction; *and,*
 - fish kills.
 - (vi) *Human health risks.*

UNIT 2

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

SPECIFIC OBJECTIVES

Students should be able to:

CONTENT

8. *examine the major sources, impacts and mitigative measures of land pollution; **
- (b) *Mitigative measures:*
 - (i) *technological (treatment of drinking water, treatment of sewage and industrial effluent);*
 - (ii) *education and public awareness; and,*
 - (iii) *legislation, policies and enforcement, for example, effluent discharge regulations.*
 - (c) *Water quality monitoring methods to include but not limited to pH, temperature, turbidity, salinity, nitrates, phosphates, Biological Oxygen Demand (BOD); Chemical Oxygen Demand (COD); Total Suspended Solids (TSS) and Dissolved Oxygen (DO).*
- (a) Sources:
- (i) industrial;
 - (ii) agricultural;
 - (iii) municipal;
 - (iv) domestic; and,
 - (v) medical.
- (b) Causes of land pollution:
- (i) atmospheric fallout;
 - (ii) waste disposal (*domestic, industrial, open dumps, sanitary landfills*);
 - (iii) dumping of mineral extraction spoils;
 - (iv) agricultural processes;

UNIT 2

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

SPECIFIC OBJECTIVES

Students should be able to:

CONTENT

Relate to Unit 2, Module 1, SO6;

- (v) oil spills; and,
- (vi) *transportation.*
- (c) Environmental pathways and receptors.
- (d) Environmental impacts:
 - (i) *Reduced aesthetic quality;*
 - (ii) *lowering of land value;*
 - (iii) *change in land use; and,*
 - (iv) *leaching to water bodies and sub soils.*
- (e) *Human health risks.*
- (f) General mitigative measures and monitoring:
 - (i) *mitigative measures.*
 - (ii) Waste minimisation (reduction, recycling, reuse, *upcycling*, rethink).
 - (iii) Environmental Impact Assessments.

(Relate to Unit 1, Module 3, SO 11).

- (iv) Legislation, *policies, enforcement,* incentives and penalties.

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

- (v) Public awareness, education and participation.
 - (vi) Clean up of pollution (bioremediation and phytoremediation).
 - (vii) Incineration.
- 9. assess the effectiveness of measures to mitigate environmental impacts of pollution;
 - (a) Use of data for a specific situation.
 - (b) Pre mitigation conditions/situation.
 - (c) Post mitigation conditions/situation.
 - (d) Appropriate Indicators of change.

Relate to Unit 2, Module 3, SO 4, 5, 6 and 7
- 10. discuss the importance of multilateral agreements regarding different forms of pollution;
 - (a) International Conventions and agreements on pollution:
 - (i) objectives and general structure;
 - (ii) development; and,
 - (iii) mode of operation.
 - (b) International agreements relevant to pollution:
 - (i) United Nations Framework Convention on Climate Change (UNFCCC, Kyoto Protocol and Paris Agreement);
 - (ii) Montreal Protocol; and,
 - (iii) Cartagena Convention.

UNIT 2

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

SPECIFIC OBJECTIVES

CONTENT

Students should be able to:

11. *Present data using appropriate graphs, charts and tables; and,*
- (c) Overview on the relevance of the following agreements and conventions (mention of how these agreements influence individual and national actions):
 - (i) International Convention for the Prevention of Marine Pollution (MARPOL);
 - (ii) Basel Convention; and,
 - (iii) *United Nations Convention on Law of the Sea (UNCLOS).*
 - (a) *Selection and use of appropriate graph types:*
 - (i) *Line;*
 - (ii) *Bar;*
 - (iii) *Scatter plot; and,*
 - (iv) *Pie chart (sketch).*
 - (b) *Appropriate labelling:*
 - (i) *Title;*
 - (ii) *Scale;*
 - (iii) *Axis labels; and,*
 - (iv) *Column and row headings (tables).*
 - (c) *Drawing of smooth and best fit lines.*
12. Interpret data using appropriate charts, tables and graphs.
- (a) *Read data from a graph, chart or table.*
 - (b) *Identify trends and patterns.*
 - (c) *Estimate rates from a graph.*
 - (d) *Interpolate and extrapolate data on a graph and make predictions.*

UNIT 2

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

Suggested Teaching and Learning Activities

Teachers are advised to engage students in the teaching and learning activities listed below to facilitate their attainment of the objectives of this module. These activities are designed to promote inquiry-based learning and cater to students' various learning styles.

Encourage students to:

1. *Work in small groups to investigate and categorise local pollution problems. Students should creatively present their findings.*
2. *Monitor individual waste production (at school or home) weekly and record their observations.*
3. *Participate in guided classroom discussions explaining what was observed at home or in the classroom regarding waste production and recommend solutions.*
4. *Conduct research comparing emissions from compressed natural gas, gasoline, and diesel fuels and make suggestions for improving the emission profile in their country.*
5. *Conduct a literature review to investigate the heavy metal content of vegetation near highways/used to feed livestock. Students should then submit a summary of their findings indicating the likely consequences and provide recommendations.*
6. *Conduct field studies on the collection and disposal of garbage in the community. A short report should be presented of the findings, and suggestions made to improve any shortcomings found by the students.*
7. *Collect information on industries and their potential to produce pollution.*
8. *Work in small groups to research to analyse the effectiveness of local legislation to reduce greenhouse gases.*
9. *Conduct field studies on industries or factories analyse their processes to develop waste reduction strategies.*
10. *Analyse air and water quality in agricultural and or urban areas and work collaboratively to present findings.*
11. *Review relevant literature to establish the size and location of the ozone hole.*
12. *Conduct a field investigation to analyse air and/or water quality in agricultural and/or urban areas and work collaboratively to present findings. Students may compare the findings within or between agricultural and urban areas and suggest reasons for any similarities/differences found. Students may also identify and categorise likely sources of pollutants in water bodies. Air quality parameters may include (but are not limited to): particulate matter, ozone, sulphur dioxide. Water quality parameters may include (but are not limited to): BOD, COD, TSS, pH, turbidity, nitrates, phosphates, dissolved oxygen, solid waste and faecal coliform.*

UNIT 2

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

Suggested Teaching and Learning Activities

13. Conduct experiments to identify the relationship between DO and temperature, *as well as salinity. Students may then discuss the consequences of their findings for Caribbean people living in a tropical environment highly dependent on the marine environment.*
14. Collect information on the level of sewage treatment at selected treatment plants. *Students may discuss the impact of their findings on water quality and human health in their community.*
15. Conduct soil sampling exercise for pollutants and their concentration levels (urban, agricultural, industrial and rural areas). *Students may compare the findings within or between each land use area and suggest reasons for any similarities/differences found.*
16. Conduct a home audit for sources and categories of pollutants. *Students may then share their personal findings with their class and discuss ways that each student may reduce pollution generation at home.*
17. Investigate the extent of recycling activities in the country. *Students may also include identification of waste that could be recycled, and present suggestions to encourage more recycling activities in their community/country.*
18. Brain-storm business opportunities based on *the* use of waste as a resource. *Students may discuss how these opportunities align with circular economies and how this may assist in reducing pollution in their community.*
19. *Conduct literature research to identify their country's strategic plans on climate change. Students may participate in a class discussion to assess the level of success of their country's plans and suggest ways to improve it.*
20. *Conduct literature research to garner information on national policies on pollution control. Students may assess the level of success of their country's policies and suggest ways to improve pollution control.*
21. *Obtain environmental impact assessment data for a selected development activity from the local environmental authority. Students may then review the data collected in these environmental impact assessments and make recommendations on whether the development activity should proceed based on the data presented.*
22. *View An Inconvenient Truth and read ITTC Report, Stern Report. Students may discuss the information presented in the movie and reports, and whether there has been any change in the global situation since the time of the movie/reports.*

UNIT 2

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

Suggested Teaching and Learning Activities

23. *Estimate atmospheric ozone levels using Schoenbein paper. (Potassium iodide/starch impregnated paper changes colour due to the oxidation of the iodide ions to iodine by atmospheric ozone. The iodine reacts with the starch to produce a blue-black colour.)*
24. *Investigate the presence of acid rain in their community/country. Rainwater may be collected, and pH measured. For a more rigorous approach, the rainwater samples may be titrated against sodium hydroxide and their acidity determined.*
25. *Conduct role plays on an environmental issue. Divide students into groups and have them research the environmental issue from the standpoint of a particular stakeholder group. Then hold an 'environmental consultation' to discuss the issue. For example, the issue could be the decision to build a landfill or an incinerator. The stakeholder groups could include: landfill operator, incinerator operator, nearby residents, environmental watchdog group, and Government environmental management agency. Each group would then have an opportunity to present their views, keeping in their 'roles' the entire time.*

RESOURCES

Arms, K.	<i>Holt Environmental Science: Student Edition.</i> Philadelphia, Holt, Rinehart and Winston, 2008.
Chiras, D.	<i>Environmental Science. Action for a Sustainable Future.</i> United States of America, The Benjamin/Cummings Publishing Company Inc., 1994.
Clarke, R.	<i>Marine Pollution.</i> Toronto, Oxford University Press Inc., 1997.
Cunningham, W. and Cunningham, M.	<i>Environmental Science. A Global Concern.</i> New York, McGraw Hill, 2021.
Ehrlich, P. and Ehrlich, A.	<i>The Population Explosion.</i> New York, Simon and Schuster, 1990.
Enger, E. and Smith, B.	<i>Environmental Science, A Study of Inter-relationships (12th Ed.).</i> New York, McGraw Hill, 2010.
Farmer, A.	<i>Managing Environmental Pollution.</i> London, Routledge, 1997.
Goodbody, I. and Thomas-Hope, E.	<i>Natural Resource Management for Sustainable Development of the Caribbean.</i> Canoe Press, University of the West Indies, Mona, 2002.
Jordan, C.	<i>Conservation: Replacing quantity with quality as a goal for global management,</i> New York: John Wiley and Sons, 1995.
Miller, G.	<i>Replenish the Earth.</i> California, Wadsworth Publications, 1996.
Nebel, B. and Wright, R.	<i>Environmental Science: The Way the World Works.</i> New Jersey, Prentice Hall, 2000.

UNIT 2

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

RESOURCES (cont'd)

- 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.

WEBSITES

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

<https://doi.org/10.3390/su10103766>

www.bcrc-caribbean.org

◆ 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 <i>comprises forty-five compulsory multiple-choice items, fifteen based on each Module.</i>	(30%)

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

SCHOOL-BASED ASSESSMENT

(30%)

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

Paper 031 – Unit 1

The assessment for *Unit 1* will be in two parts. *The first part will be a report on Part A, the experimental/practical skills. This report must include all the sections detailed in the mark scheme provided.*

The second part will be a report on Part B, the research skills activity. This report must be based on the case study specified for the particular year of the examination and must consist of all sections detailed in the mark scheme provided.

Paper 031 – Unit 2

This Assessment for Unit 2 will be in two parts. The first part will be a report on Part A, the experimental/practical skills, this report must consist of all the sections detailed in the mark scheme provided.

The second part will be a report on Part B, the research project. This report must be based on the research project designed to either investigate one site several times or more than one site (multiple sites) and must consist of all the sections detailed in the mark scheme provided.

Paper 032

This is an alternate to Paper 031 and is intended for private candidates.

MODERATION OF SCHOOL-BASED ASSESSMENT

Each year a School-Based Assessment Record Sheet will be sent to schools submitting students for the examinations.

All School-Based 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 reassessed 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. All *assignments must be uploaded to the ORS by the stipulated deadline.*

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

- (a) *Knowledge of the entire syllabus is required.*
- (b) *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

- (a) One mark will be assigned for each item.
- (b) The maximum mark available for this paper is forty-five and will be weighted to ninety.
- (c) This paper contributes 30% towards the final assessment.
- (d) The marks will be awarded for Knowledge and Comprehension, *Use of Knowledge* and *Practical Skills*.

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 – 40% 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

- (a) *Comprehensive knowledge of the entire syllabus is required.*
- (b) *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

- (a) Each question is worth 20 marks and the number allocated to each sub-question will appear on the examination paper.
- (b) *The maximum mark for this paper is 120.*
- (c) *This paper contributes 40% towards the final assessment.*
- (d) *The marks will be awarded for Knowledge and Comprehension, Use of Knowledge and Practical Skills.*

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.

SCHOOL-BASED ASSESSMENT

School-Based 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 School-Based 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 School-Based 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 School-Based 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 School-Based Assessment assignments marked by each teacher.

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

The following are the skills that will be assessed:

- (a) the selection of techniques, designs, methodologies and instruments appropriate to different environmental situations;
- (b) the collection and collation of data;
- (c) the analysis, interpretation and presentation of such data;
- (d) the use of appropriate quantitative techniques; and,
- (e) the development of appropriate models as possible solutions to specific environmental problems.

CRITERIA FOR THE SCHOOL-BASED ASSESSMENT

CAPE® ENVIRONMENTAL SCIENCE UNIT) SCHOOL-BASED ASSESSMENT (SBA)

Students will be allowed to work in groups of no more than FOUR. The group assignments can be submitted for marking.

The Unit 1 SBA assignment comprises two types of activities - experimental/practical skills activities and research skills activities, each requiring the submission of a report.

Part A – Experimental/Practical Skills

Students should use a minimum of THREE of the following techniques and apparatus when conducting the experimental/practical skills activity.

Techniques:

1. *Line Transects.*
2. *Belt Transects.*

Apparatus:

1. *Quadrats.*
2. *Nets.*
3. *Pooters.*

Experimental/Practical Skills Activity

Teachers should take students on ONE field/site visit to conduct a practical activity during which students must use the techniques and apparatus listed above. Students will be required to submit a report as guided by the mark scheme. An example of an experimental/practical skills activity is given below.

Ecosystem Study

- (a) *Using a surveyor's tape; measure a straight stretch of forest no less than 10m long.*
- (b) *Place at least three 1m² quadrats along the 10m transect.*
- (c) *Carefully observe the number of live species (plants and animals) within each quadrat.*
- (d) *Slightly remove leaf litter and other surface debris to get to the micro-fauna that may be hidden under the ground cover.*
- (e) *Count the number of different species and individuals of the species occurring within the quadrat.*
- (f) *Record the data using a table.*
- (g) *Calculate species diversity using the formula (Simpson's Diversity Index) below.*

$$D = \frac{\sum n(n-1)}{N(N-1)}$$

D – species diversity

N – total number of organisms of all species.

n – total number of organisms of a particular specie.

- (h) Repeat the ecosystem study once either for the same site or select a different site or a different ecosystem.

Some examples of suggested ecosystems that may be used are listed below:

- (a) Mangrove forest;
- (b) Woodland Forest;
- (c) Beach;
- (d) Pasture; and,
- (e) Savannah.

Note that ecosystems to be studied are not limited to those suggested above.

Mark Scheme for Environmental/Practical Skills Activity

Section	Comment	Marks	Mark allocation
Title	Suitable title for the activity	2	Suitable/appropriate title. (1 mark) Title is concise. (1 mark) No title. (0 mark)
Aim/Purpose/Objective	Detailed aims/purpose/objectives of The activity	2	Aims/purpose/objectives clearly presented and related to the topic. (2 marks) Aims/purpose/objectives included but not clearly stated. (1 mark) No aims/purpose/objectives included. (0 mark)

Section	Comment	Marks	Mark allocation
Materials and apparatus	List of materials and apparatus used	4	Complete list of materials and apparatus presented. (4 marks) Incomplete list of materials and apparatus presented. (1-3 marks) No materials and apparatus presented. (0 mark)
Procedure	Detailed description of procedure	5	The procedure contains all steps taken to complete the experiment/practical task. (5 marks) The procedure contains MOST steps. (4 marks) The procedure contains FEW steps. (1-3 marks) No procedure. (0 mark)
Observations and Results	Presentation of observations and results including calculations	6	<u>Record observations and results accurately. (4)</u> All observations and results are accurate. (4 marks) Most observations and results are accurate (3 marks) A Few observations and results are accurate. (2 marks) Observations and results are inaccurate. (1 mark) No observations and results recorded. (0 mark) <u>Present observations and results concisely (2)</u> Observations and results are presented concisely. (2 marks)

Section	Comment	Marks	Mark allocation
			Observations and results are not concisely presented. (1 mark)
Discussion and Conclusion	Discussion and conclusion that is based on results and observations and linked to objectives.	9	<u>Discussion of results (5)</u> Complete and detailed description of results. (5 marks) Results interpreted and partially discussed. (3-4 marks) Results interpreted but not discussed. (1-2 marks) No interpretation presented. (0 mark) <u>Conclusion supported by results (2)</u> Conclusion(s) present and supported by data. (2 marks) Conclusion(s) present but not supported by data. (1 mark) No conclusion. (0 marks) <u>Conclusions linked to the objective/aim. (2)</u> Conclusion (s) related to objective/aim. (2 marks) Conclusion(s) is/are not related to the objective/aim. (0 mark)
Precautions; Sources of error; Assumptions and Limitations.	Choose any two of the listed headings and give one example of each (for example, one precaution and one limitation).	2	Any TWO listed. (1 mark each)
TOTAL		30	

PART B – Research Skills Activity

This activity is designed to facilitate the process of developing students' skills in research, using case studies. Six case studies are presented in this document — one practice case study and one case study per year for the years 2026–2030.

Teachers should use the practice case study as a teaching tool to facilitate students' understanding of key foundational research skills. On completion of the practice case study, the case study for the specified year is to be completed by students and marked by the teacher. These marks are to be submitted to CXC® and the case study will be moderated by CXC®.

To assist students with fully understanding and developing research skills, a set of expected data is provided for each case. The data which can be collected by students for these case studies is not limited to the set of data provided. Teachers are expected to discuss with students the various types of data that may be collected using different research designs.

PRACTICE CASE STUDY

Background

In the Small Island Developing State of St Rispoli, a problem has arisen because of activities associated with the disposal of solid and hazardous waste in the country's lone landfill. The landfill is used to store both hazardous waste and municipal solid waste. It has attracted several scavengers who, over time, have constructed a sizeable residential district in close proximity to the landfill. In addition, a significant number of these persons make a living from unofficial recycling activities, particularly from metal items recovered from the garbage.

The forcible relocation of a number of these recycling businesses was soon followed by a massive landfill fire, believed to have been purposefully set. The fire caused choking smoke to cover the area to the west of the landfill for more than two weeks. The residents of this area, including the villages of Serrof and Egalliv Gnirps, were incensed by this, as well as being concerned about the possible contamination of the nearby river from hazardous waste stored in the landfill. The residents are insisting that the landfill be closed.

Site description

The area is characterized by rolling hills. The landfill is located near the top of one of these hills. The site area geology consists of a shallow, fertile soil overlying a thick layer of fine to medium sands. These sands are underlain by a continuous clay unit that grades from a silty clay to a more dense, hard clay. Near the landfill, the sands are quite thin (5 m). There is also a much thicker layer of clay (15–20 m) directly beneath the landfill. Between Serrof and Egalliv Gnirps, there is a drinking water well. Water is extracted from the well and chlorinated on site for distribution to the villages in the area. The aquifer which is exploited by the well is separated from the upper sandy layers by 5 m of dense clay. The winds in this area blow predominantly from the northeast.

The Blue River passes through the area and all the residents utilize the river for fishing and recreational activities. The Blue River is also the site of a few popular liming spots that are crowded with weekend visitors enjoying the cool water.

The surrounding areas are mostly rural/agricultural and are considered to be the breadbasket of Rispoli. Most of the residents of Serrof and Egalliv Gnirps make a living from agricultural activities. Short term vegetable crops are the most common crops grown in the area. Figure 1 is a map of the study area for the practice case study.

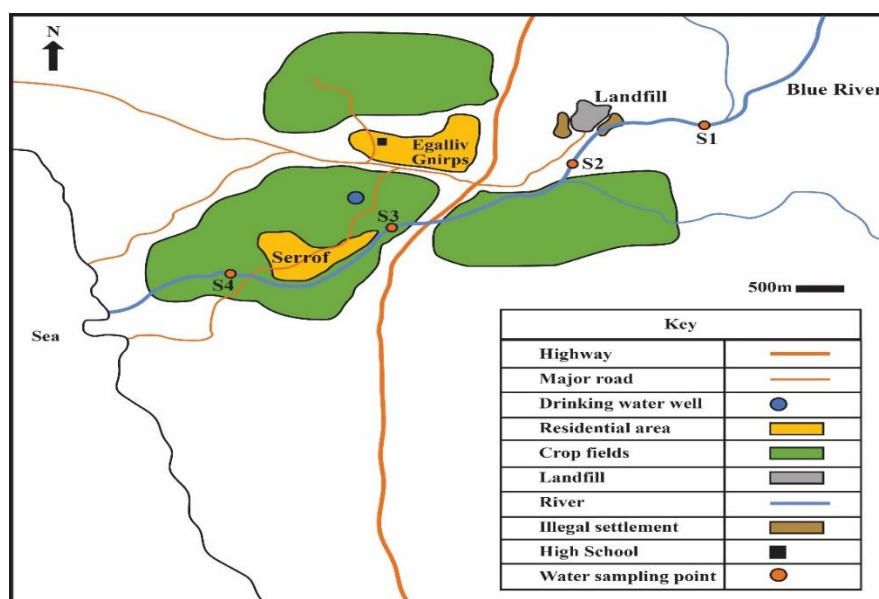


Figure 1. Map of study area for practice case study

Sample Data for the Practice Case Study

TABLE 1: SELECTED WATER QUALITY PARAMETERS FOR SITES ALONG THE BLUE RIVER AND IN THE DRINKING WATER WELL IN THE AREA (All samples collected on the same day.)

Water Quality Parameter	Sites				
	S1	S2	S3	S4	Well
pH	7.8	7.7	7.5	7.5	8.1
Temperature (°C)	23.0	25.1	25.2	26.7	12.5
Dissolved oxygen (mg/L)	6.1	5.6	5.0	5.1	1.4
Nitrate (mg/L)	2.6	3.3	4.6	8.6	4.3
Phosphate (mg/L)	0.2	0.2	0.4	0.6	0.7
Turbidity (NTU)	1.0	23	34.2	51	1.0

TABLE 2: SELECTED AIR QUALITY PARAMETERS MEASURED AT THE HIGH SCHOOL ON SEVERAL DAYS

Air Quality Parameter	Week				
	Week 1	Week 3	Week 5	Week 7	Week 9
Visibility	Good	Fair	Poor	Poor	Good
Carbon monoxide (g/m ³)	93	139	1376	1724	257
Sulphur dioxide (g/m ³)	0.7	1.8	39	48	3.1
Nitrogen dioxide, g/m ³)	19	24	76	100	17
Ozone	Low	Low	Low	High	Low
Particulate matter (g/m ³)	19	29	345	458	80

Read the case study carefully and prepare a report which includes the following information.

1. A Problem Statement
2. Aims and Objectives
3. Hypothesis/Proposition
4. Rationale/Justification
5. Brief Literature Review on the topics highlighted in the case using FIVE peer reviewed sources and/or textbooks
6. Description of the research methodology to be used for the investigation of the case
7. Information relating to the scope of the study (precautions, sources of error, assumptions and limitations)
8. Description of how the results should be presented and analysed
9. Description of how the results should be discussed
10. Conclusion
11. List of recommendations
12. Bibliography

Mark Scheme for Research Skills Activity

Section	Comment	Marks	Mark allocation
Problem Statement	Identification of problem to be to be investigated.	3	Problem statement relevant and clear. (3 marks) Problem statement relevant present but not clear. (2 marks) Problem statement present but not clear or relevant. (1 mark) No problem statement presented. (0 marks)

Section	Comment	Marks	Mark allocation
Aims and Objectives	Description of aims and objectives of the study.	5	<u>Aims related to problem. (2)</u> Aims present and related to problem identified. (2 marks) Aims present but not related to problem identified. (1 mark) <u>Objectives (3)</u> Objectives are specific, measurable and related to aims. • Specific (1 mark) • Measurable (1 mark) • Related to aims (1 mark)
Hypothesis/Proposition statement	Hypothesis/proposition statement based on problem to be investigated.	4	<u>Hypothesis/proposition</u> Hypothesis/proposition based on problem to be investigated. (1 mark) Relationship between dependent and independent variables identified. (1 mark) Hypothesis/proposition is testable. (1 mark) Hypothesis/proposition is manageable and within scope. (1 mark) No hypothesis/proposition. (0 marks)

Section	Comment	Marks	Mark allocation
Rationale/Justification	Detailed explanation on why the research is necessary.	4	<u>Justification (2)</u> Rationale includes justification(s) for the research that are related to the problem identified. (2 marks) Rationale does not include any justification for the research. (1 mark) <u>Benefits (2)</u> Rationale identifies benefits of the research. (2 marks) Rationale does not identify any benefits of the research. (1 mark) No rationale present. (0 mark)
Literature Review	Comprehensive review of at least five peer reviewed sources and/or textbooks on topics related to the problem statement.	7	<u>Appropriateness of Source(s) (2)</u> ALL sources are appropriate/relevant. (2 marks) SOME sources are appropriate/relevant. (1 mark) <u>Number of sources (5)</u> Four-Five sources used. (2 marks) Less than four sources used. (1 mark) <u>Conciseness</u> Information presented is concise. (1 mark) <u>Clarity</u> Information presented has clarity. (1 mark)

Section	Comment	Marks	Mark allocation
			<u>Information Synthesized</u> Information synthesized/structured in an organized manner. (1 mark) No Literature review present. (0 mark)
Research methodology	A detailed description of how the investigation will be completed.	13	<u>Appropriateness/suitability (3)</u> Appropriateness/ suitability of design (quantitative, qualitative, mixed methods). (1 mark) Appropriateness/suitability of data to be collected. (1 mark) Appropriateness of sampling method (e.g. random sampling) (1 mark) <u>Instrumentation (5)</u> (Instruments for data collection- Surveys, interviews OR Instruments for experiments- Equipment and apparatus) Complete description of instrumentation to be used (5 marks) Partial description. (1-4 marks) Instrument identified but not described. (0 mark) <u>Procedure (5)</u> The procedure contains ALL steps. (5 marks) The procedure contains MOST steps. (4 marks)

Section	Comment	Marks	Mark allocation
			The procedure contains a FEW steps. (1-3 marks) No procedure present. (0 marks)
Framework (description) for the presentation and analysis of data	Description of way in which data/results/observations are to be presented.	5	Method for data presentation is appropriate/suitable. (1 mark) Method for data presentation is concise. (1 mark) <u>Specific Method (3)</u> <u>Graph</u> description of formatting and labelling of graph (graph type, axis labels and title) <u>Table</u> description of formatting and labelling of table (table structure, headings and title) <u>Prose</u> description of formatting and structuring of details Note: If students more than one method to present data, the marks should be totalled and weighted back to a maximum of 3.
Description of Data Analysis	Use of simple descriptive statistics (mean, standard deviation, grouping).	1	Appropriate data analysis technique(s) used. (1 mark)
Scope-: Precautions Sources of error Assumptions limitations	Choose any two of the listed headings and give one example of each. (For example, one precaution and one limitation).	2	Any TWO listed. (1 mark each)

Section		Comment	Marks	Mark allocation
Framework Discussion Conclusion	for and	Description of how discussion and conclusion are to be developed.	11	Information linking the study to previous studies in the literature review. (1 mark) <u>Interpretation of results within the context of the case. (5)</u> Results interpreted and completely discussed. (5 marks) <i>Results interpreted and partially discussed. (3-4 marks)</i> <i>Results interpreted but not discussed. (1-2 marks)</i> <i>No interpretation of results. (0 mark)</i> <i>Criteria for accepting or rejecting the hypothesis presented (i.e. is hypothesis supported by results). (1 mark)</i> <u>Conclusion(s) supported by results. (2)</u> Conclusion(s) present and supported by the data in the case. (2 marks) Conclusion(s) present but not supported by the data. (1 mark) <u>Conclusions linked to the aim/objective. (2)</u> Conclusion (s) related to aim/objective. (2 marks) Conclusion(s) is/are not related to the aim/objective. (1 mark)

Section	Comment	Marks	Mark allocation
Recommendations	List at least THREE recommendations relevant to the project	3	ONE mark for EACH relevant recommendation up to a maximum of three.
References	Prepare references for FIVE peer reviewed sources and/or textbooks used in the literature review	2	Correct format (APA format) 3-5 sources correct. (2 marks) 1-2 sources correct. (1 mark) (Award 1 mark only if APA format is not used)
TOTAL		60	

The following case studies 1-5 are to be used for the year specified and the report prepared is to be marked by the teachers using the mark scheme provided above and submitted to **CXC®** for moderation.

- CASE STUDY 1 – 2026;
- CASE STUDY 2 – 2027;
- CASE STUDY 3 – 2028;
- CASE STUDY 4 – 2029; and,
- CASE STUDY 5 – 2030.

CASE STUDY 1 — 2026

Background

Balancing human needs with the preservation of Earth's natural resources is an endeavour that requires an understanding of the interconnectedness of ecosystems. This case study explores how the use of natural resources can potentially impact the environment.

Golden City is located along the southern coast of the Caribbean Island of St Emeralds (see Figure 2). It has an approximate population of 4200 residents living in 900 households. The residents enjoy recreational activities such as fishing and going to the beach. A few fisherfolk earn a living by supplying households, markets and supermarkets with various types of fish such as parrotfish, snapper, jackfish, doctorfish and butterflyfish.

Site Description

In the early 1990s, the government of St Emeralds ambitiously launched a development plan for Golden City, which is the island's capital. The plan included constructing three mega-resorts with 600 rooms each. A large portion of the mangrove forest encompassing about 400 trees was cleared and filled with dredged material to construct two of the three resorts. In addition to the resorts, the area was cleared to build a cruise port and commercial shops along the coast. The development resulted in a booming tourism industry.

By the late 1990s, there was an influx of persons from other parts of the island into Golden City. Additionally, individuals from a lower-income bracket moved into Edgebeach (about 3 km from Golden City) hoping to capitalize on the economic activities in Golden City. In order to survive, the Edgebeach settlers cleared vegetation, built temporary make-shift housing and other structures, engaged in slash-and-burn farming for short-term crops and employed improper garbage disposal practices.

In the early 1990s, the population of Golden City and Edgebeach was approximately 6000; by 2010, this number had doubled (see Figure 2). Over the next ten years, the population continued to grow at a steady rate of ten per cent per annum. This trend is expected to continue.

In 2015, the Tourism Department of Golden City reported that 300 new jobs were created, approximately 1500 visitors arrived weekly and economic activity associated with tourism yielded an average income of USD100 million for the period 2013-2014. While the data suggests that tourism has had a positive impact on the area, some citizens have expressed concerns about the environmental consequences, especially about their favourite fish species disappearing from their plates. The citizens of Golden City met with their mayor to express their concerns. At the meeting, marine biologists from the local university presented the results of a survey of the wetland cover since 1995 (see Table 1) and the abundance of fish species (see Table 2). In the meeting, a group of fishermen explained that their weekly income from the sale of fish normally averaged USD2200. However, they expressed concern about a change in their income over the past five years (see Table 3). The citizens contended that given the trends in the data provided, a third resort would pose a serious threat to the city's natural resources and environmental health.

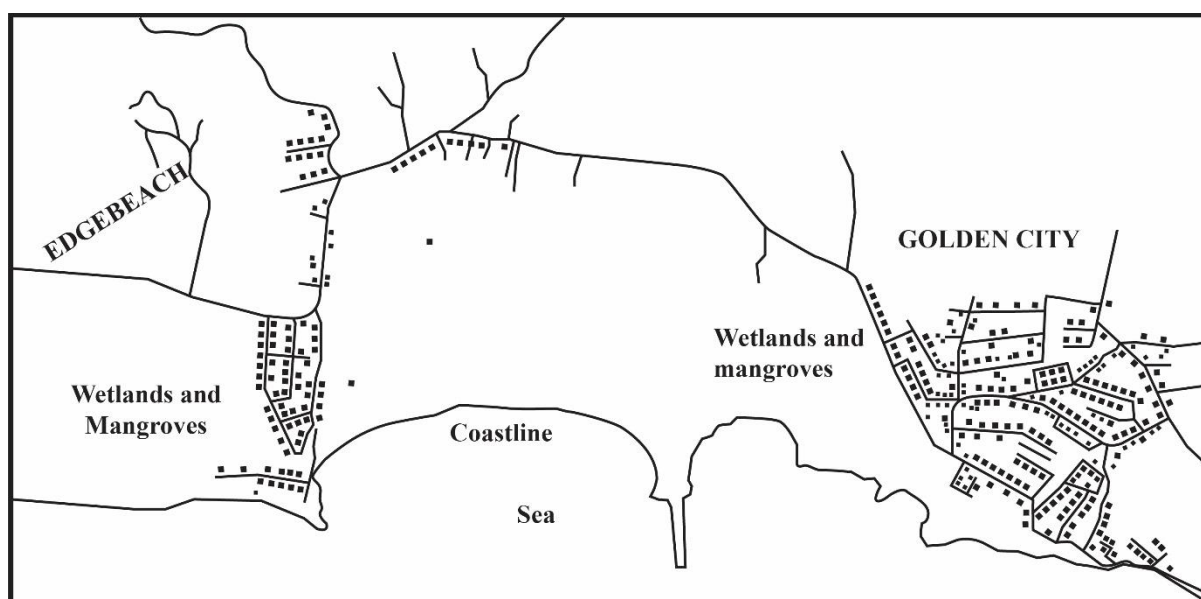


Figure 2. Map of Golden City and Edgebeach, 1995

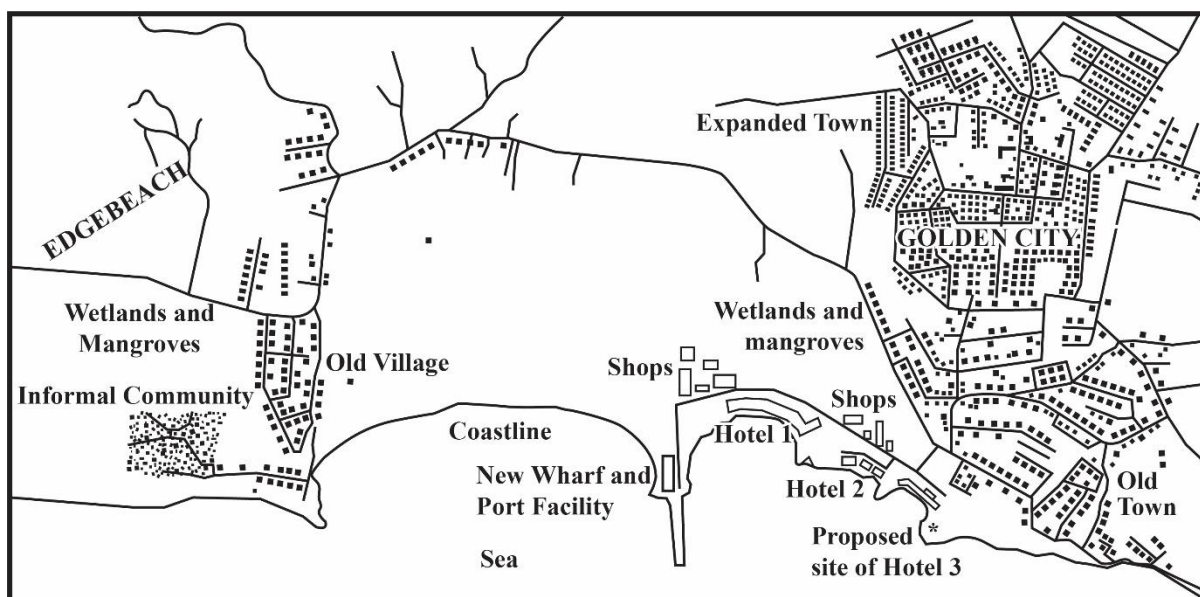


Figure 3. Map of Golden City and Edgebeach, 2015

TABLE 1: WETLAND COVER

Year	Wetland Area (ha)
1995	400
2000	300
2005	280
2010	270
2015	265

TABLE 2: ANNUAL FISH CATCH FROM THE WETLAND

Year	Annual Fish Catch (kg)
1995	100 000
2000	90 000
2005	85 000
2010	81 000
2015	75 000

TABLE 3: INCOME FROM THE SALE OF FISH

Year	Average Weekly income (USD)
2011	1900
2012	1700
2013	1550
2014	1450
2015	1400

CASE STUDY 2 — 2027

Background

Eragon Swamp is situated along the western coast of Riversdale’s Island, approximately 3 km south-west of the capital city, San Pedro. Its elevation varies from sea level to approximately 11 m at its highest point. It covers an estimated area of 84.5 km². It is bounded on the north by Sylvan Highway and on the east by Florence Highway. The Yara River, a large river which originates in the Kingsdale Hills (north of the swamp), has an outflow into the swamp.

Site Description

The swamp is an estuarine system consisting of 54.9 km² of herbaceous marsh, mangrove forests, saline and brackish lagoons as well as intertidal mudflats on the western side, which eventually merge with the sea. The swamp comprises numerous channels and it has a rich biodiversity. It is home to a wide variety of flora and fauna, including birds, fishes, oysters, crabs, worms and snakes. In addition to providing organic food for many organisms, the swamp also provides nurseries. Many ecotourists visit the area and residents depend on the swamp for nutrition and as a source of income.

Over the years, many illegal settlements have been created along the banks of the Yara River. The area lacks infrastructure and residents do not have access to proper utilities such as water, electricity, waste disposal and sewerage. The residents have been using the water from the river basin for washing clothes, cooking, cleaning vehicles and small-scale farming. In addition to the slash-and-burn method, farmers utilize fertilizers and pesticides to boost their crop production. There is also illegal quarrying occurring in the mountains. This activity produces large deposits of sediments. Recreational activities such as fishing and hunting have increased. An overabundance of green algae has also been observed on the surface of the water.

On a daily basis, commuters travelling to and from the capital for work cause dense traffic on the adjacent highways. Most of the vehicles use petroleum products since this is the most cost effective and prevalent form of fuel used in the country. People have been illegally dumping solid waste and toxic chemicals into the river and swamp. This has led to a depletion of the mangrove forest, affecting flora and fauna of the swamp.

As a result, the relevant authority collected samples and analysed various water quality parameters, in order to assess the pollution in the area.

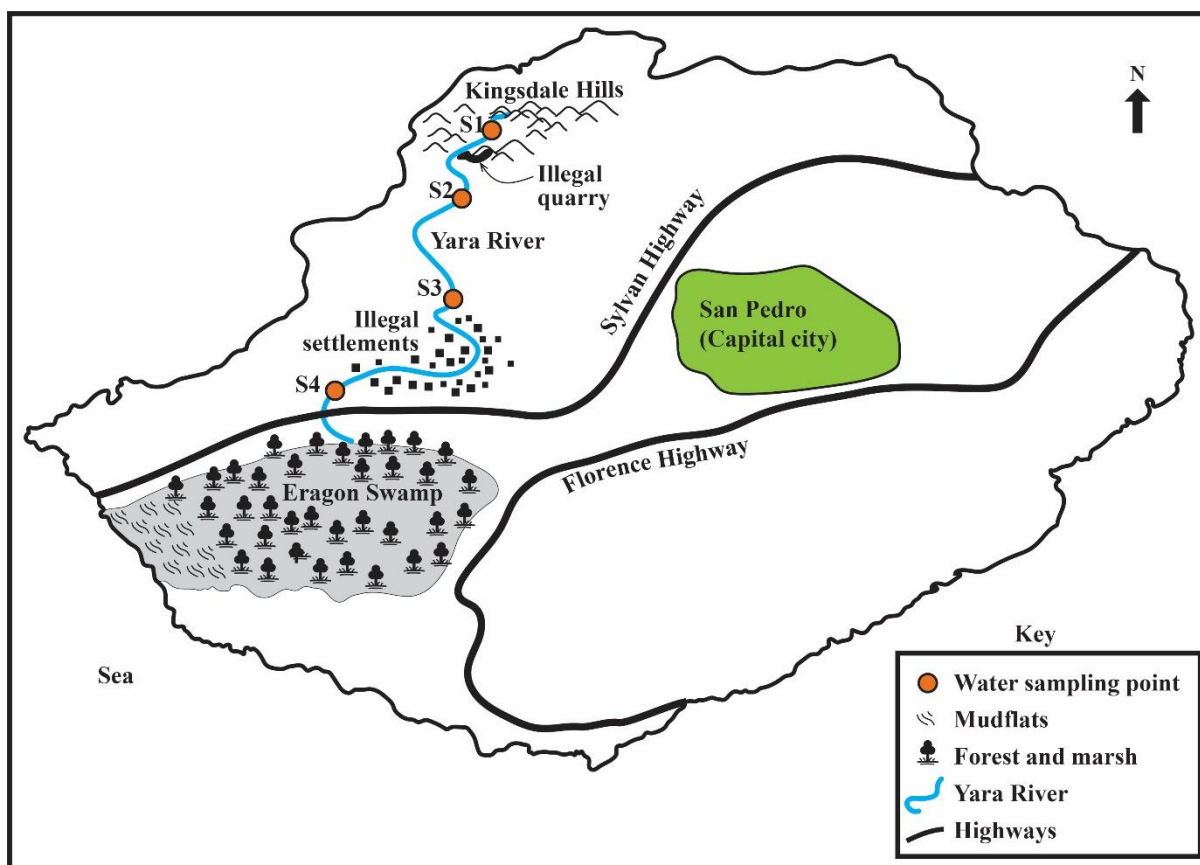


Figure 1. Map of Eragon Swamp and its surroundings

Table 4 summarizes the data obtained from samples collected at sites along the Yara River and in the Eragon Swamp (refer to the map for site locations). All samples were collected on the same day.

TABLE 4: SELECTED WATER QUALITY PARAMETERS AT DIFFERENT SAMPLE SITES ALONG THE YARA RIVER AND IN THE SWAMP

	S1	S2	S3	S4	S5 (Eragon Swamp)
<i>pH</i>	7.6	7.9	8.3	8.6	8.9
<i>Temperature (°C)</i>	25.1	25.7	25.9	26.0	26.9
<i>Turbidity (NTU)</i>	10	15	35	40	48
<i>Dissolved oxygen (mg/L)</i>	5.0	4.0	2.5	2.1	1.0
<i>Chemical Oxygen Demand (mg/L)</i>	546	671	893	954	1003
<i>Faecal Coliform (CFU/100mL)</i>	750	815	939	1042	1105
<i>Nitrate (mg/L)</i>	16.0	17.2	18.6	19.7	20.1

	S1	S2	S3	S4	S5 (Eragon Swamp)
Phosphate (mg/L)	0.60	0.73	0.80	0.84	0.92
Lead (mg/L)	0.54	0.78	0.96	1.07	1.15
Mercury (mg/L)	0.018	0.020	0.029	0.033	0.042
Cadmium (mg/L)	0.019	0.028	0.036	0.045	0.053
Copper (mg/L)	3.65	5.41	6.67	7.86	8.86

CASE STUDY 3 — 2028

Background

Rinwinda is a tropical country in the north-eastern part of the South American continent. The government of Rinwinda is committed to developing the country's hydropower resources to create a reliable source of electric energy. The move to develop these resources is also expected to catalyse economic development and secure a source of clean energy for present and future generations.

Pali Dam is a 118 MW hydropower project located in the Kuribing Amura River basin in Motaro-Siparona in Rinwinda. It is legally owned by Pali Dam Inc., which specializes in constructing, operating, and maintaining hydropower plants. The project is aligned with the country's low-carbon energy strategy.

Description of Project Area

The topography of the area is characterized by steep slopes and deep gorges. It is heavily forested, and approximately one-third of the catchment area lies above 3000 m in elevation. The Kuribing Amura River is quite accessible and indigenous communities are along its banks. A land acquisition of 150 ha was approved for the project and. This facilitated the construction of access roads, the creation of muck disposal sites and the establishment of the Pali Dam Inc. facility. Some of these facilities remain available to local communities (for example, some access roads and the terraced and re-vegetated muck disposal sites). The company has promised to revegetate the area and allow it to revert to a natural state over time.

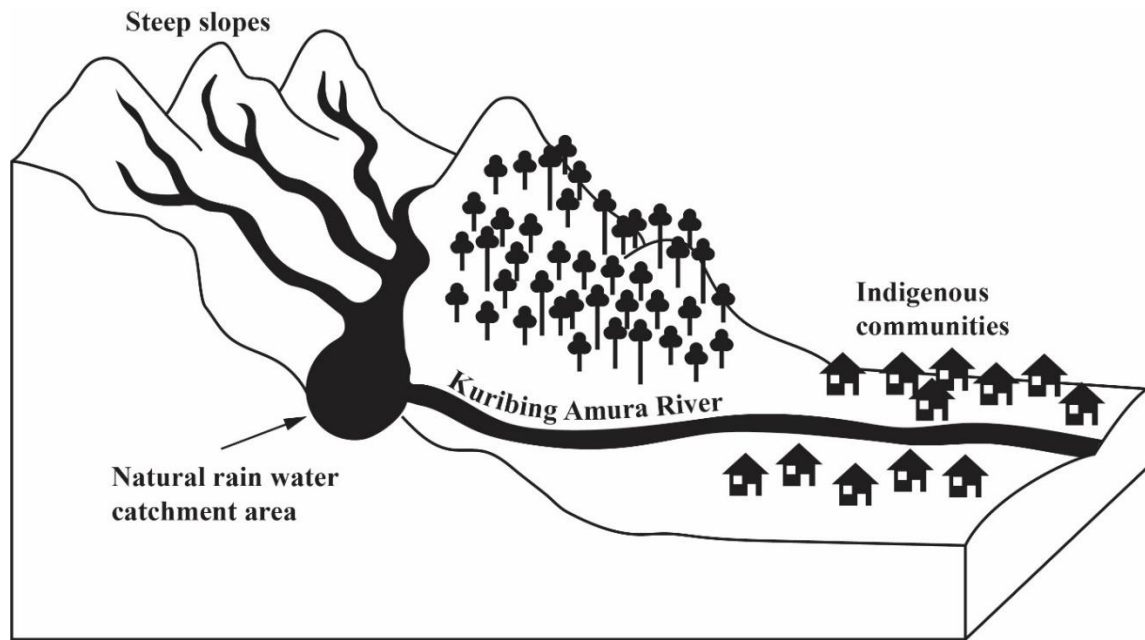


Figure 6. Map of the project area

Plant Detail

The hydroreservoir capacity is 135 million cubic metres. The net head of the project is 250m. The plant generates an average of 900 GWh of electricity annually. It consists of four turbines, each with 29.5 MW of nameplate capacity. The plant began commercial operation in 2023 after the company received its operations licence from the Environmental Management Agency. Figure 7 is a diagrammatic representation of the hydropower plant.

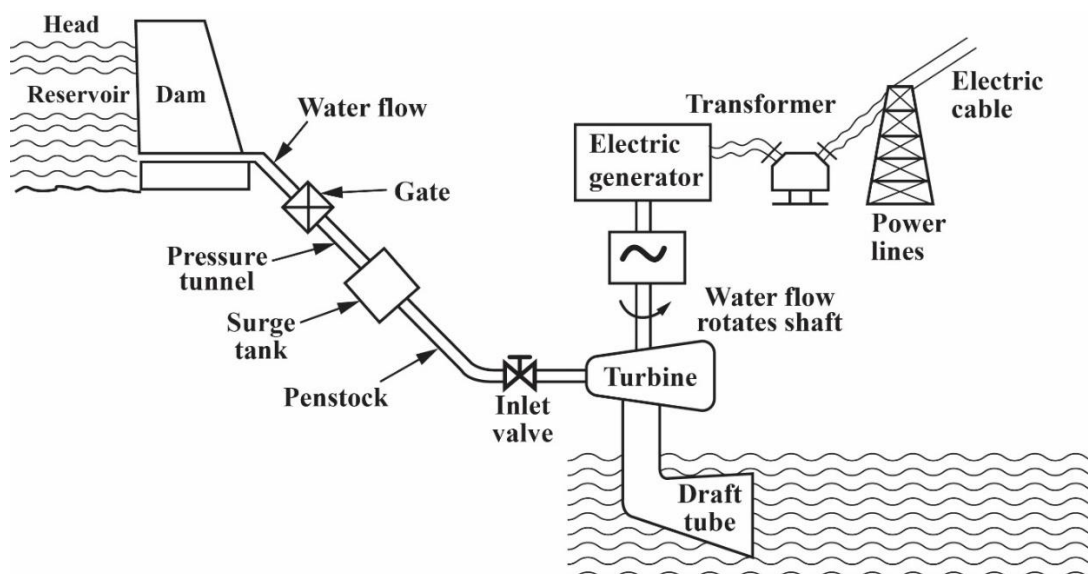


Figure 7. Components of a large hydropower plant

Source: Prajval.in source required

Table 5, which is shown below, is an excerpt taken from the company's performance report and precipitation data from a nearby weather station over an 18-month period.

TABLE 5: COMPANY PERFORMANCE REPORT AND PRECIPITATION DATA FROM A NEARBY WEATHER STATION OVER AN 18-MONTH PERIOD

Month	Generation (GWh)	Capacity Factor (%)*	Reservoir Water Supply Storage (million m ³)	Precipitation Level (mm)
January — 2023	804	78	110	200
February — 2023	827	80	113	226
March — 2023	882	85	121	234
April — 2023	912	88	125	246
May — 2023	947	92	134	323
June — 2023	972	94	135	377
July — 2023	895	87	122	254
August — 2023	827	80	113	200
September — 2023	798	77	110	123
October — 2023	772	75	106	147
November — 2023	768	74	106	151
December — 2023	728	70	100	181
January — 2024	657	64	91	86
February — 2024	668	65	93	44
March — 2024	657	64	91	33
April — 2024	624	60	87	69
May — 2024	620	60	86	71
June — 2024	631	61	88	80

*Capacity factor shows how the plant performs in real time compared to the nameplate capacity. Formula — Actual generation divided by total generation if the plant operates uninterrupted at maximum power.

For example:

January — 2023

- (a) Actual generation = 804 GWh
- (b) Output based on rated capacity — 29.5 MW x 4 turbines x 24 hours per day x 365 days divided by 1000 = 1033.68 GWh
Capacity factor = 804 / 1033.68 multiplied by (x) 100 = 78%

Despite assurances given by Pali Dam Inc. to neighbouring communities that their bio-physical surroundings, health and wellbeing would not be adversely affected, there have been several complaints and protests organised by the neighbouring indigenous communities. The protesters have raised the issue of their access to water being consistently reduced due to altered downstream flows which resulted from reduced precipitation in the area over six months. They believe that this could create water insecurity. Other issues include the influx of workers and related social tensions, and the displacement of people which could affect their livelihoods.

On the other hand, the government of Rinwinda has been highlighting access to clean energy and energy services and the greater reliability of the energy source. As part of its corporate social

responsibility (CSR) initiative, Pali Dam Inc. plans to extend its coverage in 2025 to provide electricity to three agro-processing facilities in Renat, an unserved neighbouring Indigenous community.

CASE STUDY 4 — 2029

The fragile balance of ecosystem biodiversity faces exceptional challenges in light of human pursuit of development. The level of impact underscores the urgent need for sustainable coexistence to ensure the continued flow of natural resources as well as human long-term wellbeing.

Background

Khando is a small tropical island in the Caribbean. The island boasts high levels of biodiversity and endemism within its landscape and seascape. Within recent times, the island has experienced rapid development in the tourism sector, specifically, in the community of Rollins which was chosen for the construction of a luxury hotel and golf course because of its unique location. As a result of this investment, the community has experienced large scale changes in the physical environment.

Site Description

The community of Rollins is located on Khando's western coast. It is bordered inland by the central mountains to the north-east and the Bomund Mangrove forests to the south. The Damant River flows from the tributaries originating in the central mountains and then exits into the sea at the Bomund Mangrove. There are formations of coral reefs that run parallel to the shoreline of the community of Rollins, the most extensive being the Shehan Reef.

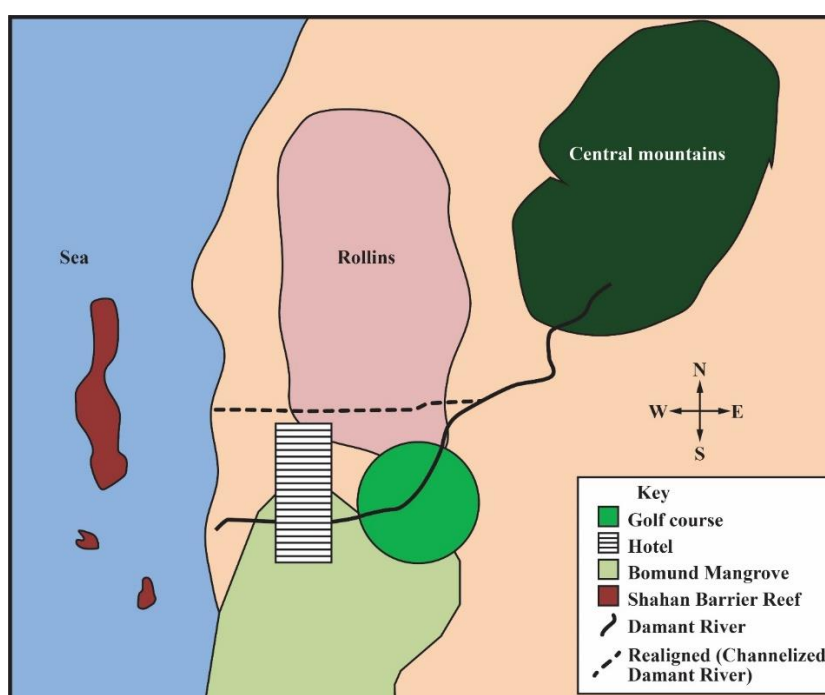


Figure 8. Map of Khando showing the community of Rollins

The Bomund Mangrove is home to many species of plants and animals. It is a designated bird sanctuary as it is home to dozens of species of birds, both local and migratory. An ecological study done 15 years ago identified four birds, three reptiles and one amphibian as endemic species of the island. As a result of the large bird population and the presence of unique species, the mangrove is an important aspect of the community's tourism product, providing opportunities for ecotourism ventures such as nature tours and bird watching. Additionally, the mangrove forest provides the community of Rollins with many goods, including timber and non-timber forest products which are used in the construction and craft industries. The Bomund Mangrove also provides invaluable ecological functions such flood protection and sediment filtration. An ecosystem-economic valuation exercise conducted prior to the hotel development noted that the Shehan Reef was vitally important to the economy of Rollins as it supported the fisheries sector. It showed that the sector contributed up to 54 per cent of the total household income earnings in the community while 27 per cent of the total household income was derived from dives and snorkelling activities around the reef. The valuation exercise further outlined that the reefs and mangroves provided approximately three million dollars in coastal flood protection.

A private investment company was given permission to construct a luxury five-star hotel and golf course in the coastal community of Rollins 15 years ago. The developers acquired over 65 ha of prime coastal lands which included part of the mangrove forest. Over 15 ha of mangrove forest was cleared then filled with dredged sand and sediment. Hundreds of tons of dirt and sand were excavated from the central mountains to complete the filling. This phase of the development resulted in habitat destruction and species loss, as well as mass wasting and sedimentation due to soil loss. The situation of environmental degradation was compounded by the realignment of the Damant River channel which increased the turbidity levels in the marine environment, especially close to the Shehan Reef.

Shortly after the construction of the hotel and golf course, the residents of Rollins began to observe subtle changes in their environment. Large pieces of corals have washed up on the beaches of Rollins. In the mangrove forest, there were fewer sightings of bird species, both local and migratory and a sampling exercise conducted since the development showed a vast reduction in the occurrence of endemic species. A valuation exercise of natural resources showed that since the development, there was a decline in the total income in the fisheries sector despite increased fishing efforts. Additionally, there was also decline in ecotourism earnings from terrestrial resources in the mangrove forest. Added to this, there has been a constant increase in incidences of coastal flooding which has caused hundreds of thousands of dollars in damages. The results of the assessments are provided in the tables below.

TABLE 6: DATA FROM A SAMPLE STUDY CONDUCTED AT THE BOMUND MANGROVE FOREST BEFORE AND AFTER RESORT DEVELOPMENT

Flora		
Species	Number of Individuals of the Species (Abundance)	
	Before Resort	After Resort
<i>Red mangrove</i>	1345	920
<i>Black mangrove</i>	980	700
<i>White mangrove</i>	1212	1002
<i>Buttonwood mangrove</i>	813	412
<i>River mangrove</i>	1101	952
<i>Mangrove fern</i>	2021	2210
Fauna		
Species	Number of Individuals of the Species (Abundance)	
	Before Resort	After Resort
<i>Little stint (Migratory)</i>	89	27
<i>Hawk (Endemic)</i>	62	12
<i>Red-necked stint (Migratory)</i>	182	65
<i>Sandpiper (Migratory)</i>	231	101
<i>Dunlin (Migratory)</i>	98	33
<i>Brown water snake</i>	42	9
<i>Giant yellow warbler (Endemic)</i>	120	68
<i>Mangrove midget cuckoo (Endemic)</i>	71	34
<i>Brown and red pelican (Endemic)</i>	87	22
<i>Whistling frog (Endemic)</i>	23	6
<i>Green leopard snake (Endemic)</i>	45	12
<i>Green iguana (Endemic)</i>	102	84
<i>Orange pod anole (Endemic)</i>	56	21
<i>Bird trapper black snake (Endemic)</i>	39	11

TABLE 7: RESULTS OF AN ECONOMIC AND ECOLOGICAL STUDY CONDUCTED BEFORE THE HOTEL AND GOLF COURSE DEVELOPMENT AND 15 YEARS AFTER THE DEVELOPMENT

Resource	Economic Activity	Contribution to Household Income	
		Before Development (%)	After Development (%)
Mangrove	Bird watching	12	27
	Nature tours	17	22
	Arts and crafts	9	3
Coral Reef	Fishing	54	21
	Dive and snorkelling	8	27
	Total	100	100
	Total Income	22 million (USD)	37 million (USD)

CASE STUDY 5 — 2030

Population growth can have both positive and negative effects on a country's sustainability and on the quality of life afforded to its citizens. The following case study focuses on how the utilisation of newfound natural resources affected the population of St Perseus.

Site Description

St Perseus is a developing island state situated between a continental mass to the west and an archipelago to the east. The island is 3796 mi² in size and in 2011 its population was 252 000. To the north of the island is the Crackenthal mountain range, which is adjacent to a large tropical forest. The mountains and the forest are used for hiking by locals and tourists. The Marenaka River, with its many tributaries, originates from the mountains and runs to the south of the island. There are two reefs adjoining the island, one to the south and one to the east. The river and reefs are used as part of the fishing industry and as part of the ecotourism product.

The island also has a small airport located in the southwest. A small coastal town, called Hermes Town, is located to the south. It has a population density of 50 people per km². To the east, there is a sparsely populated residential area which has a population density of 10 people per km². Within the town, there are a few local shops which cater to the citizens' everyday needs. There is also a major shopping mall which is the main attraction for tourists. The St Andromeda Hospital is located to the east of the town on the outskirts. In 2011, the number of hospital beds per 1000 people was recorded at 8.32 and the number of doctors per 1000 people totalled 14.

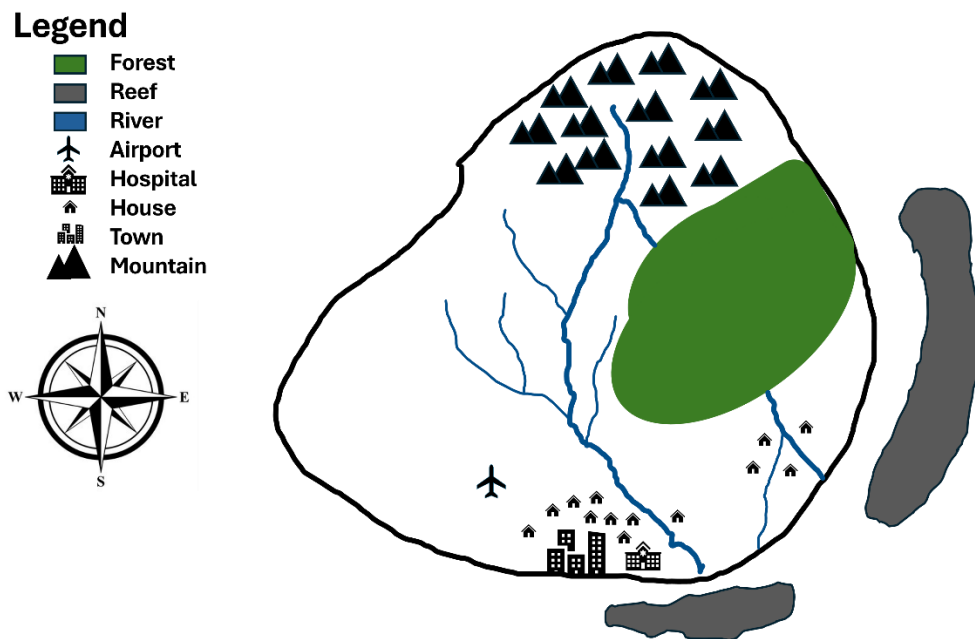


Figure 9. Map of St Perseus, 2011

The main contributors to the country's Gross domestic product (GDP) are ecotourism and agriculture, totalling USD8962. In November 2011, a geological survey found deposits of gold and bauxite in the Crackenthal Mountains. The government decided to extract these resources to boost the country's economic activity. This move was expected to improve the country's standard of living.

After ten years of development and investment by the government, the GDP is now USD28 347. The government has noticed however, that there has been decreasing interest in agriculture among the populous. Conversely, the tourism industry has had a small boost from 106 000 visitors annually in 2011 to 151 400 annually in 2021.

As a result of this newfound wealth, St Perseus' population has increased to 692 000 people. The number of immigrants has also increased over this period. Many people have migrated from neighbouring islands and the continent to seek better opportunities for themselves and their families. As a result, more housing has been built in the eastern, southern and western areas of the island to accommodate the growing population. Hermes Town's population density has risen to 111 km², the residential area to the east has increased to 30 people per km² and the newly developed residential community to the west has a density of 10 people per km². To the north of the town, beyond the residential area, a small shanty development is beginning to form along the river's course. This has started to cause some concern among the neighbouring residents because of the increasing criminal activity.

Legend

-  Forest
-  Reef
-  River
-  Airport
-  Hospital
-  House
-  Shanty house
-  Town
-  Mountain

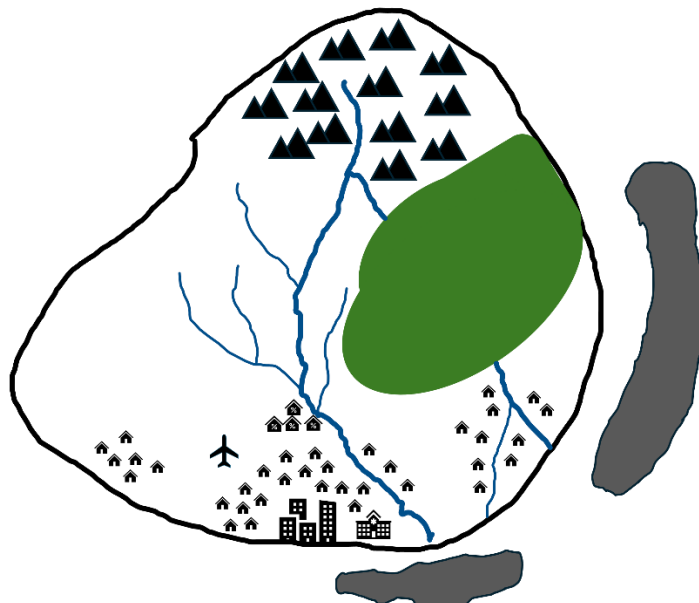
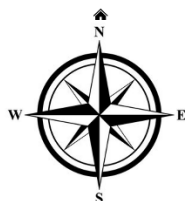


Figure 10: Map of St Perseus, 2021

Since the increase in population, St Andromeda Hospital is starting to experience a slight strain on its available resources. The number of available beds is now 6 per 1000 people and the number of available doctors has dropped to 10 per 1000 persons.

The government conducted a census and collected data on crime for the period 2011 to 2021. As a result of the data collected, the government of St Perseus is concerned about the effects the rapidly increasing population will continue to have on the available services in the next five to ten years.

TABLE 8: POPULATION AND CRIME DATA 2011 TO 2021 FOR ST PERSEUS

Year	Population	Immigrants	Violent Crimes	Petty Crimes
2011	252 000	50	1	600
2012	267 000	75	2	613
2013	282 000	160	2	588
2014	302 000	500	5	690
2015	332 000	1500	5	784
2016	372 000	1600	7	725
2017	422 000	2000	10	750
2018	472 000	3000	11	755
2019	532 000	3000	9	800
2020	602 000	4000	12	912
2021	692 000	10 000	20	998

CAPE ENVIRONMENTAL SCIENCE UNIT 2 SBA ASSIGNMENT

Students will be allowed to work in groups of no more than FOUR. The group assignments can be submitted for marking.

*The Unit 2 SBA assignment comprises two types of activities – **experimental/practical skills activities and an investigative research project**. Students should use their foundational practical and research skills to plan, design and execute the project.*

PART A – EXPERIMENTAL/PRACTICAL SKILLS

These activities will focus on skills for water sampling and water parameters testing. The following parameters will be tested for:

1. Colour;
2. Turbidity;
3. Odour;
4. pH;
5. Biochemical Oxygen Demand (BOD);
6. Chemical Oxygen Demand (COD)
7. Nitrates;
8. Phosphates;
9. Faecal coliform;
10. Total Suspended Solids (TSS);
11. Temperature;
12. Dissolved oxygen; and,
13. Total dissolved solids (TDS).

Teachers *should* have students collect water samples from **ONE** site at different time periods **OR** from **TWO** different sites for comparison purposes. *The students should test the samples collected to determine **a minimum of five** of the listed water parameters in **1–13 above**.*

Mark Scheme for Experimental/Practical Skill activity

Section	Comment	Marks	Mark allocation
<i>Title</i>	<i>Suitable title for the activity</i>	<i>2</i>	<i>Suitable/appropriate (1 mark)</i> <i>Concise (1 mark)</i> <i>No title present (0 mark)</i>
<i>Aim/Purpose/Objective</i>	<i>Detailed aims/purpose/objectives of The activity</i>	<i>2</i>	<i>Aims/purpose/objectives presented and are clearly presented and related to the topic. (2 marks)</i> <i>Aims/purpose/objectives presented but not clearly stated. (1 mark)</i> <i>No Aims/purpose/ objectives presented. (0 mark)</i>
<i>Materials and apparatus</i>	<i>List of materials used</i>	<i>4</i>	<i>Complete list of materials and apparatus presented. (4 marks)</i> <i>Incomplete list of materials and apparatus presented. (1-3 marks)</i> <i>No materials or apparatus presented. (0 mark)</i>
<i>Procedure</i>	<i>Detailed description of procedure</i>	<i>5</i>	<i>The procedure contains all steps. (5 marks)</i> <i>The procedure contains MOST steps. (4 marks)</i> <i>The procedure contains FEW steps. (1-3 marks)</i> <i>No procedure (0 mark)</i>

Section	Comment	Marks	Mark allocation
Observations and Results	Presentation of results and observations including calculations.	6	<u>Record observations and results accurately. (4)</u> All observations and results are accurate. (4 marks) Most observations and results are accurate. (3 marks) A Few observations and results are accurate. (2 marks) Observations and results are present but inaccurate. (1 mark) No observations and results. (0 mark) <u>Present observations and results concisely (2)</u> Results and observations are presented concisely. (2 marks) Results and observations are presented but not concisely. (1 mark)

Section	Comment	Marks	Mark allocation
Discussion and Conclusion	Discussion and conclusion that is based on results and observations and linked to objectives.	9	<u>Discussion of results (5)</u> Results interpreted and completely discussed. (5 marks) Results interpreted and partially discussed. (3-4 marks) Results interpreted but not discussed. (1-2 marks) No discussion of results. (0 mark) <u>Conclusion(s) supported by results. (2)</u> Conclusion(s) present and supported by the data. (2 marks) Conclusion(s) present but not supported by the data. (1 mark) <u>Conclusions linked to the objective. (2)</u> Conclusion (s) related to objective. (2 marks) Conclusion(s) not related to the objective. (1 mark)
Precautions; Sources of error; Assumptions and Limitations.	One of each for any TWO (example one precaution and one limitation).	2	Any TWO listed. (1 mark each)
TOTAL		30	

PART B – Research Project

Teachers will choose either ONE site to be investigated more than once OR several sites to be investigated at least one time to study any topic from either Unit 1 or Unit 2 of the syllabus. Some examples of topics are:

1. *Ecosystems-population distribution, feeding relationships and species diversity.*
2. *Demographic characteristics.*
3. *Factors affecting population growth.*
4. *Human consumption patterns.*
5. *Environmental impact of natural resource use.*
6. *Factors affecting natural resource use and management.*
7. *Issues associated with agricultural systems: pollution, habitat loss, soil degradation.*
8. *Energy efficiency.*
9. *Impact of energy sources.*
10. *Types of pollution and their impact.*

Students will prepare a report with the following information:

1. *Title*
2. *The problem statement*
3. *Aims and Objectives*
4. *The hypothesis/proposition*
5. *Rationale/Justification*
6. *Research Questions*
7. *Using at least **FIVE** peer reviewed sources and/or textbooks prepare a brief literature review on the topic of the investigation*
8. *Provide a description of the research methodology to be used for the investigation*
9. *Provide information relating to the scope of the study. (Precautions; Sources of error; Assumptions and Limitations)*
10. *Present and analyse the results of the investigation*
11. *Provide a detailed discussion of the findings*
12. *Provide a statement of conclusion for the project*
13. *List of recommendations*
14. *Bibliography*

Research Project

Mark Scheme

Section	Comment	Marks	Mark allocation
Title	Suitable title for the research project	2	Suitable/appropriate. (1 mark) Concise (1 mark) No title present (0 mark)
Problem Statement	Identification of problem to be to be investigated.	3	Problem statement relevant and clear. (3 marks) Problem statement relevant but not clear. (2 marks) Problem statement presented but not clear or relevant. (1 mark) No problem statement. (0 marks)
Aims and Objectives	Description of aims and objectives of the study	5	<u>Aims related to problem. (2)</u> Aims present and related to problem identified. (2 marks) Aims present but not related to problem identified. (1 mark) <u>Objectives (3)</u> Objectives are specific, measurable, and related to the aims. • Specific (1 mark) • Measurable (1 mark) • Related to aims (1 mark)

Section	Comment	Marks	Mark allocation
Hypothesis OR Proposition Statement OR Research questions	Hypothesis OR Proposition statement based on problem statement to be investigated. Research questions based on problem statement to be investigated	4	<u>Hypothesis OR proposition OR Research questions</u> Hypothesis OR proposition OR research questions based on problem to be investigated. (1 mark) Relationship between dependent and independent variables identified. (1 mark) Hypothesis/proposition is testable. (1 mark) Hypothesis/proposition is manageable and within the scope. (1 mark) No hypothesis/proposition. (0 mark)
Rationale/Justification	Detailed explanation on why the research is necessary	4	<u>Justification (2)</u> Rationale includes justification(s) for the research that are related to the problem identified. (2 marks) Rationale includes justification(s) for the research but not related to the problem identified. (1 mark) Rationale does not include any justification(s) for the research. (1 mark) <u>Benefits (2)</u> Rationale identifies benefits of the research. (2 marks)

Section	Comment	Marks	Mark allocation
			<i>Rationale does not identify any benefits of the research. (1 mark)</i> <i>No rationale present. (0 mark)</i>
Literature Review	Comprehensive review of at least five peer reviewed sources and/or textbooks on topics related to the problem statement	7	<u>Appropriateness of Source (s) (2)</u> ALL sources are appropriate/relevant. (2 marks) SOME sources are appropriate/relevant. (1 mark) <u>Number of sources (2)</u> Four to Five sources used. (2 marks) Less than four sources used. (1 mark) <u>Conciseness</u> Concise- (1 mark) <u>Clarity</u> Clarity- (1 mark) <u>Information Synthesized</u> Information synthesized/structured in an organised manner. (1 mark) No Literature review. (0 mark)
Research methodology	A detailed description of how the investigation will be completed.	13	Appropriateness/ suitability of design (quantitative, qualitative, mixed methods). (1 mark) Appropriateness/suitability of data to be collected. (1 mark)

Section	Comment	Marks	Mark allocation
			Appropriateness of sampling method (for example, random sampling). (1 mark) <u>Instrumentation (5)</u> (Instruments for data collection- Surveys, interviews. OR Instruments for experiments- Equipment and apparatus). Complete description of instrumentation to be used. (5 marks) Partial description. (1-4 marks) Instrument identified but not described. (1 mark) <u>Procedure (5)</u> The procedure contains ALL steps. (5 marks) The procedure contains MOST steps. (4 marks) The procedure contains a FEW steps. (1-3 marks) No procedure. (0 marks)

Section	Comment	Marks	Mark allocation
Data Presentation	Description of way in which data/results/ Observations are to be presented.	6	Method used for data presentation is appropriate/suitable. (1 mark) Method used for data presentation is concise. (1 mark) <u>Specific Method (4)</u> <u>Graph</u> Title – (1 mark) Labelling of axes – (1 mark) Plotting of graph – (2 marks) <u>Table</u> Title – (1 mark) Headings – (2 marks) Table format – (1 mark) <u>Prose</u> Complete description of observations and results. (4 marks) Incomplete description of observations and results. (1-3 marks) Note: If students use more than one method to present data, the marks should be totalled and weighted back to a maximum of 4.
Data Analysis	Use of simple descriptive statistics (mean, standard deviation, grouping).	5	<u>Calculations</u> Appropriateness (1 mark) Correct formula (1 mark) Correct process (1 mark)

Section	Comment	Marks	Mark allocation
			Correct answer (1 mark) Correct units (1 mark)
Discussion and Conclusion	Discussion and conclusion that is based on results and observations and linked to rationale, comments, and questions in the project.	11	Information linking the study to previous studies in the literature review. (1 mark) <u>Interpretation of results (5)</u> Results interpreted and completely discussed. (5 marks) Results interpreted and partially discussed. (3-4 marks) Results interpreted but not discussed. (1-2 marks) No interpretation of results. (0 marks) Criteria for accepting or rejecting the hypothesis presented (i.e. is hypothesis supported by results). (1 mark) <u>Conclusion(s) supported by results. (2)</u> Conclusion(s) present and supported by the data in the case. (2 marks) Conclusion(s) present but not supported by the data. (1 mark)

Section	Comment	Marks	Mark allocation
			<i>Conclusions linked to the aim/objectives. (2)</i> <i>Conclusion (s) related to aim/objective.</i> <i>(2 marks)</i> <i>Conclusion(s) not related to the aim/objective.</i> <i>(1 mark)</i>
Recommendations	List at least THREE recommendations relevant to the project.	3	ONE mark for EACH relevant recommendation up to a maximum of three.
References	Prepare References for 5 peer reviewed sources and/or textbooks used in the literature review.	2	Correct format (APA format): 3-5 sources correct. (2 marks) 1-2 sources correct. (1 mark) (Award 1 mark only if APA format is not used)
TOTAL		65	

GENERAL GUIDELINES FOR TEACHERS

The teacher is required to mark the *report*, and final marks must be recorded out of 90.

- The school must retain all *report* for at least three months after publication of the results since *report* may be requested by **CXC®** for moderation purposes.
- The specific objectives highlighted by an asterisk are suitable for School-Based Assessment, but the assignments need not assess only these objectives.
- The reliability of the marks awarded is a significant factor in the School-Based Assessment and has far reaching implications for the candidate's final grade. Teachers are asked to note the following:
 - The marks awarded to the *report* must be carefully transferred to the **CXC®** School-Based Assessment forms.
 - The teacher must allocate one-third of the total score for the School-Based 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:
 - When the remainder is 1 mark, the mark is allocated to Module 3.

- (ii) 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:

$35 / 3 = 11$ remainder 2 so 11 marks to Module 1 and 12 marks to each of Modules 2 and 3.

- (iii) The standard of marking should be consistent.

- (c) Candidates who do not fulfil the requirements of the School-Based Assessment will be considered absent from the whole examination.

MODERATION OF SCHOOL-BASED ASSESSMENT

School-Based Assessment Record Sheets are available online via the **CXC**®'s website www.cxc.org.

All School-Based Assessment Record of marks *and sample of projects* must be submitted electronically using the SBA data capture module of the Online Registration System (ORS) *on the Council's Website*. A sample of assignments will be requested by **CXC**® for moderation purposes. These assignments will be re-assessed by **CXC**® Examiners who moderate the School-Based 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.

◆ REGULATIONS FOR PRIVATE CANDIDATES

Candidates who are registered privately will be required to sit Paper 01, Paper 02 and Paper 032. Detailed information on Papers 01 and 02 is given on pages 76-78 of this syllabus.

Paper 032 (Alternate to Internal School Based-Assessment) 30%

This paper will be of two (2) hours duration and will consist of THREE questions, *ONE question per module. These questions will be based on environmental case studies.*

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 of the examination for the year for which they reregister.

Resit candidates must complete Paper 01 and Paper 02 of the examination for the year for which they reregister. CAPE® candidates may reuse any moderated SBA score within a two-year period. In order to assist candidates in making decisions about whether or not to reuse a moderated SBA score, the Council will continue to indicate on the preliminary results if a candidate's moderated SBA score is less than 50 per cent in a particular Unit. Candidates reusing SBA scores should register as "Resit

candidates” and must provide the previous candidate number when registering. Resit candidates must be entered through a school, approved educational institution or the local Registrar’s office.

Resit candidates must be registered through a school, a recognised educational institution, or the Local Registrar’s Office.

◆ ASSESSMENT GRID

The Assessment Grid for Unit 1 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	15 (raw) 30 (wtd)	15 (raw) 30 (wtd)	15 (raw) 30 (wtd)	45 (raw) 90 (wtd)	(30)
Paper 02	40	40	40	120	(40)
Paper 031/032	30	30	30	90	(30)
TOTAL	100	100	100	300	(100)

The Assessment Grid for Unit 2 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	15 (raw) 30 (wtd)	15 (raw) 30 (wtd)	15 (raw) 30 (wtd)	45 (raw) 90 (wtd)	(30)
Paper 02	40	40	40	120	(40)
Paper 031	31(raw) 30 (wtd)	32(raw) 30 (wtd)	32(raw) 30 (wtd)	95 (raw) 90 (wtd)	(30)
Paper 032	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 analysed 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>
<i>examine</i>	<i>inspect and investigate thoroughly, cases and situations presented in order to assess and comment on them</i>	
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 <i>information, words or actions</i>	
justify	<i>show or prove that information is right or reasonable</i>	
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	

<u>WORD</u>	<u>DEFINITION/MEANING</u>	<u>NOTES</u>
plan	prepare to conduct an investigation	plan
predict	use information provided to arrive at a likely conclusion or suggest a possible outcome	predict
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
7 October 2025

CARIBBEAN EXAMINATIONS COUNCIL

Caribbean Advanced Proficiency Examination[®]

CAPE[®]



ENVIRONMENTAL SCIENCE

Specimen Papers and Mark Schemes/Keys

Specimen Papers, Mark Schemes and Key:

Unit 1 Paper 01
Unit 1 Paper 02
Unit 1 Paper 032
Unit 2 Paper 01
Unit 2 Paper 02
Unit 2 Paper 032



TEST CODE **02120010**

SPECIMEN 2026

CARIBBEAN EXAMINATIONS COUNCIL
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®
ENVIRONMENTAL SCIENCE

UNIT 1 – Paper 01

1 hour 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This test consists of 45 items. You will have 1 hour and 30 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 defines

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

Sample Answer



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

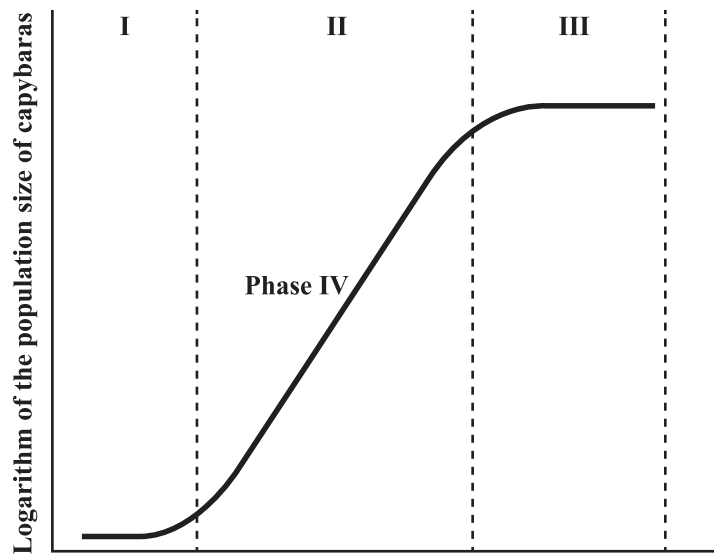
6. If you want to change your answer, erase it completely before you fill in your new choice.
7. When you are told to begin, turn the page and work as quickly and as carefully as you can. If you cannot answer an item, go on to the next one. You may return to that item later.
8. You may use a silent, non-programmable calculator to answer items.

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

1. A distinct geographical region with specific climate, vegetation and animal life is called
 - (A) an ecosystem
 - (B) a biosphere
 - (C) an ecotone
 - (D) a biome
2. The component of the ecosystem that is responsible for incorporating energy into the ecosystem is the
 - (A) decomposers
 - (B) consumers
 - (C) detritivores
 - (D) producers
3. According to the ten per cent rule, the percentage of energy passed from Trophic level 1 to Trophic level 4 is
 - (A) 0.1
 - (B) 1.0
 - (C) 100
 - (D) 1000
4. The association between two organisms in which one organism benefits and the other organism derives neither benefit nor harm is known as
 - (A) parasitism
 - (B) mutualism
 - (C) competition
 - (D) commensalism
5. Diversity within species is known as
 - (A) species diversity
 - (B) genetic diversity
 - (C) biological diversity
 - (D) ecosystem diversity
6. Which of the following actions is LEAST likely to disrupt the nitrogen cycle in a marine ecosystem?
 - (A) A reduction in coastal upwelling
 - (B) An increase in cyanobacteria in the ocean
 - (C) A reduction of phytoplankton in the ocean
 - (D) An increase in the runoff of fertilizers from farms
7. Scientists on a Caribbean island discover two species, A and B, which co-exist. The range of the population of Species A increases when Species B is removed from the island. This relationship between Species A and its environment is referred to as a
 - (A) realized niche
 - (B) zone of abundance
 - (C) fundamental niche
 - (D) zone of intolerance
8. In 2020, a new mineral deposit was discovered deep in the jungle of a Caribbean country. Within a year a new road is constructed through the middle of the forest and the road is heavily traversed by trucks and people relocating near to the mine site. Which of the following types of speciation can these activities result in?
 - (A) Peripatric
 - (B) Allopatric
 - (C) Parapatric
 - (D) Sympatric

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Items **9** and **10** refer to the following diagram of a growth curve of the capybaras (a rodent) found in a Caribbean country.



9. Due to an increase in the poaching of the jaguar, an animal that feeds on the capybaras, there is a change in the population of capybaras. Which of the regions of the graph represents the change in the population of capybaras?
- (A) I
 - (B) II
 - (C) III
 - (D) IV
10. A rapid decline in the jaguar population impacts the Caribbean country as the jaguar is considered a keystone species. Which of the following is LEAST likely to be impacted by the rapid decline in the jaguar population?
- (A) The ecotone
 - (B) The population
 - (C) The ecosystem
 - (D) The community

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Items **11** and **12** refer to the statement below.

In 2021, there was increased seismic activity at La Soufrière in St Vincent and the Grenadines. This activity made the evacuation of residents necessary, as there were multiple explosive eruptions.

- 11.** Which of the following organisms are MOST likely to be the **first** to return after the eruptions?

(A) Shrubs
(B) Grasses
(C) Lichens
(D) Shade tolerant trees

- 12.** Three years after the eruption, the population returned to La Soufrière in St Vincent. Which of the following interactions are ways in which this population may impact the integrity of the new ecosystem?

I. Speciation
II. Maintaining the biogeochemical cycles
III. Disrupting the resettlement of biodiversity

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

Items **13–15** refer to an investigation of a mangrove wetland conducted by scientists. The table below shows the data collected.

Organism	Numbers
Black mangrove	12
White mangrove	3
Red mangrove	7
Buttonwood	4
Nypa palm	9

- 13.** Using Simpson's index,

$$D = \frac{\sum n(n-1)}{N(N-1)}$$

the species diversity of the mangrove wetland is

(A) 0.22
(B) 2.2
(C) 0.45
(D) 4.5

- 14.** Which of the following tools is NOT suitable for obtaining the data in the table?

(A) Quadrat
(B) Line transect
(C) Belt transect
(D) Grab sampling

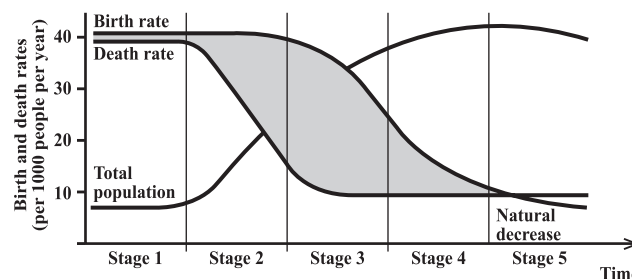
- 15.** Which of the following parameters is LEAST likely to be used by the scientists in their investigation into the health of the mangrove wetland?

(A) Temperature
(B) Water quality
(C) Species abundance
(D) Volume of leaf litter

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16. Urbanization refers to the increase in the
- (A) urban population
 - (B) urban infrastructure
 - (C) size of an urban area
 - (D) number of urban areas
17. Population distribution refers to the
- (A) number of people per unit area
 - (B) number of people in an age group
 - (C) pattern regarding the spread of people
 - (D) pattern of people's settlement in an area
18. Which of the following is an INDIRECT form of population control?
- (A) Natural hazard
 - (B) Family planning
 - (C) Contraceptive use
 - (D) Government policy
19. Which of the following is a cultural factor that affects population growth in the Caribbean?
- (A) Delayed marriages
 - (B) Paid paternity leave
 - (C) Role of women in society
 - (D) Access to family planning
20. Pro-natalist policies are intended to
- (A) increase immigration rates
 - (B) increase population growth
 - (C) decrease immigration rates
 - (D) decrease population growth

Item 21 refers to the following diagram which shows the demographic transition model.



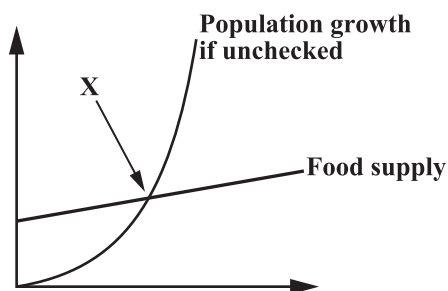
21. The trend in the death rate shown in Stage 2 of the demographic transition model is likely due to
- (A) poor sanitation
 - (B) the spread of diseases
 - (C) a high infant mortality rate
 - (D) improvements in health care

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22. Country X wishes to increase its skilled workforce. Which of the following population control measures would be MOST effective?

(A) Government providing day care facilities
(B) Government incentives and policies
(C) Sexual reproductive health education
(D) Family planning and contraceptives

Item 23 refers to the following graph which shows population growth and food supply.



23. Which of the following will NOT occur beyond Point X?

(A) Low wages
(B) Civil unrest
(C) Food surplus
(D) Resource depletion

24. Which of the following is/are NOT associated with urbanization in the Caribbean?

(A) Water pollution
(B) Increased farming
(C) Housing shortages
(D) Rural development

25. Which of the following landscapes are MOST likely to have **low** population densities?

I. Marsh lands
II. Coastal areas
III. Mountain slopes

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

26. Which of the following is NOT a reason human populations choose for living close to rivers?

(A) Fishing
(B) Irrigation
(C) Transport
(D) Land stability

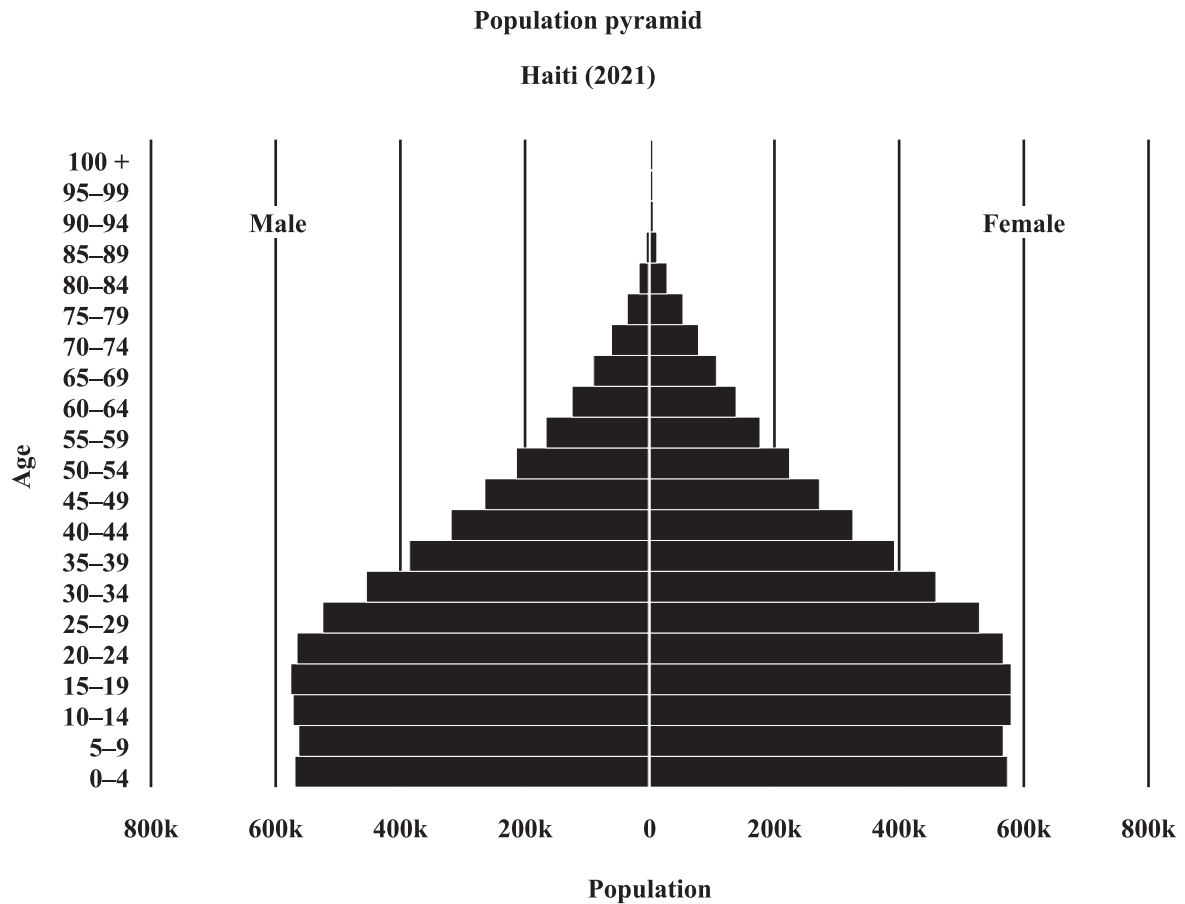
27. Which of the following are ways in which sustainable development may be achieved in the Caribbean?

I. Extraction of fossil fuel resources
II. Increase in mass transport systems
III. Switching to renewable energy sources

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

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Items **28–30** refer to following diagram of the population pyramid for Haiti in 2021.



28. In which of the following age groups is the LARGEST number of individuals found?
- (A) 5–9
(B) 15–19
(C) 75–79
(D) 85–89
29. The number of females in the age group 35–39 is approximately
- (A) 300
(B) 400
(C) 300 000
(D) 400 000
30. Which of the following statements can be deduced from the population pyramid?
- (A) There are more males than females.
(B) Birth rates are lower than death rates.
(C) The fertility rate is at the replacement level.
(D) There is a relatively low life expectancy.

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31. A mining company wishes to make a former mining area safe for humans to live and use. Which of the following types of activities should the company undertake?
- (A) Remediation
 - (B) Preservation
 - (C) Conservation
 - (D) Rehabilitation
32. Which of the following natural resources is/are renewable **and** exhaustible?
- (A) Wind
 - (B) Solar
 - (C) Fisheries
 - (D) Petroleum
33. The government of a Caribbean country is offering tax incentives to entrepreneurs who wish to start non-consumptive business ventures. Which of the following types of businesses is entitled to this tax incentive?
- (A) Quarrying
 - (B) Swamp tours
 - (C) Animal rearing
 - (D) Crop production
34. Which of the following are examples of natural resources found in the Caribbean?
- I. Wetlands
 - II. Mountains
 - III. Ground water
- (A) I and II only
 - (B) I and III only
 - (C) II and III only
 - (D) I, II and III
35. Fisherfolk in a Caribbean country observe a decline in their catch after a nearby mangrove swamp is drained for the construction of homes. Which of the following examples demonstrates the importance of the mangrove forest to fisherfolk?
- (A) Its ecosystem functions and services
 - (B) Its role as a foreign exchange earner
 - (C) Its use as a recreational site
 - (D) Its use as a research site
36. One of the ways in which indigenous peoples have practised agriculture is through the rotation of fields during slash and burn activities. This practice is considered to be sustainable because
- (A) the land is reused for other purposes
 - (B) the land is burned before it is used
 - (C) a large area of land is used in agriculture
 - (D) only a small area of land is used in agriculture

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Item **37** refers to the following table which illustrates the effect of a factor on the use of a natural resource (forests) in four Caribbean countries.

	Country W	Country X	Country Y	Country Z
Crime	Low	Low	High	High
Migration	Low	High	High	Low
% Forest coverage	27.4	18.3	12.6	20.7

37. Which of the following factors is MOST likely being referred to?

- (A) Social
- (B) Political
- (C) Economic
- (D) Natural endowment

38. Watershed degradation is MOST likely associated with

- I. the reduced levels of soil erosion
- II. the reduced availability of fresh water
- III. the increased likelihood of waterborne disease

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

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Item 39 refers to the following picture of the Pitons in Saint Lucia.



39. The Pitons Management Area in Saint Lucia was chosen as a UNESCO World Heritage Site in 2024 based on two of ten selection criteria.

Which of the following criteria was MOST likely used in the selection process?

- (A) A mixed property representing exceptional testimony to a cultural tradition and superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance
 - (B) To contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance
 - (C) To be an outstanding example of a type of landscape which illustrates significant stage(s) in human history
 - (D) To bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared
40. Two out of five households in Barbados use solar water heaters to generate their hot water. What kind of approach to natural resource management is this an example of?
- (A) Change in lifestyles
 - (B) Community-based management
 - (C) Reduction and minimization of waste
 - (D) Application of appropriate technology

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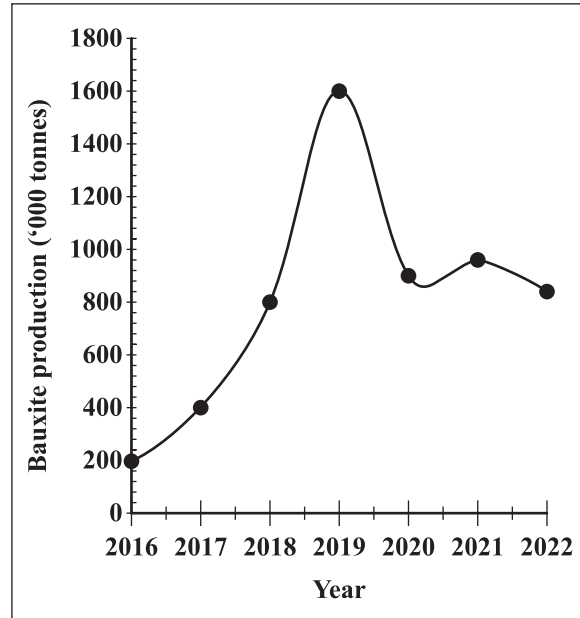
41. A paper manufacturing firm is required to set aside funds to assist in any necessary remediation activities due to the factory's operations. This approach to natural resource management at the national level is based on

(A) taxes
(B) economic valuation
(C) the polluter pays principle
(D) environmental accounting

42. A company wishes to resume limited rice planting on the outskirts of the Nariva Swamp. Which of the following international agreements is MOST relevant to this activity?

(A) Paris Agreement
(B) Ramsar Convention
(C) Cartagena Convention
(D) Specially Protected Areas and Wildlife

Item 43 refers to the following graph which illustrates bauxite production in a Caribbean country from 2016 to 2022.

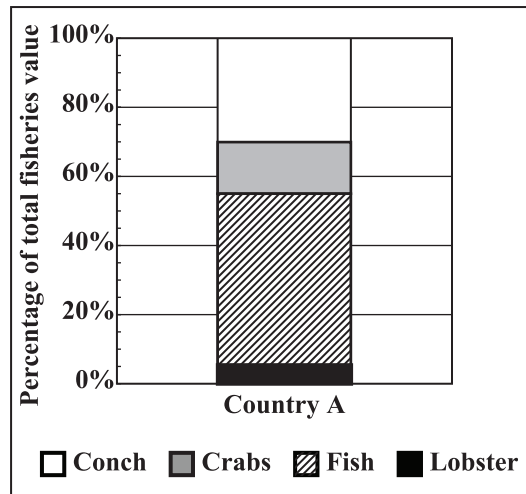


43. At what rate in tonnes/year does bauxite production increase from 2016 to 2019?

(A) 350
(B) 466.7
(C) 350 000.0
(D) 466 666.7

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Item 44 refers to the following graph which illustrates the distribution of the value of four different marine organisms in the fisheries industry in a Caribbean country.

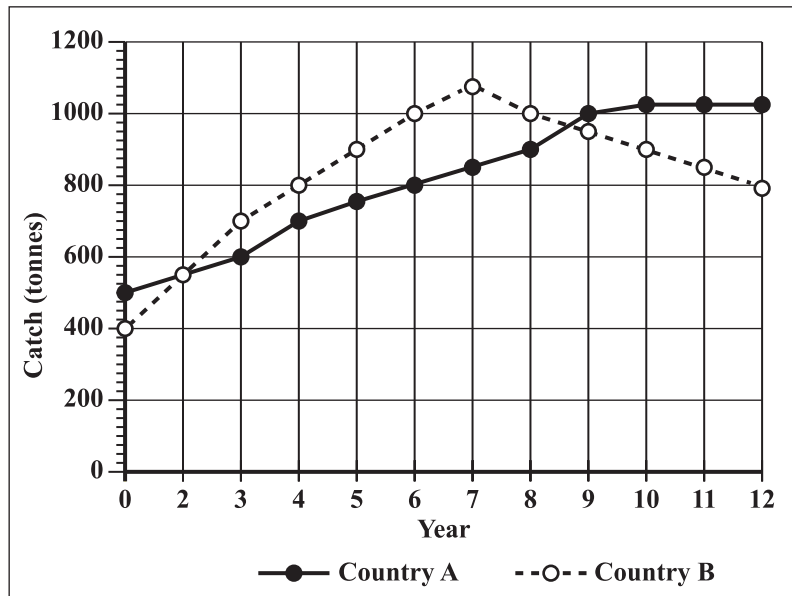


44. What is the percentage value of the crab fishery in Country A?

- (A) 15%
- (B) 30%
- (C) 55%
- (D) 70%

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Item 45 refers to the following graph which illustrates the data for the fisheries production of a specific species of fish caught by two countries, A and B, over 12 years. The fishing effort was constant.



45. Which of the following statements about the fisheries production in these countries is correct?
- (A) Country B's fisheries are operating at a sustainable level.
 - (B) Country B achieved maximum sustainable yield before Country A.
 - (C) Both Country A and Country B have similar maximum sustainable yields.
 - (D) The maximum sustainable yield for Country B is lower than that for Country A.

END OF TEST

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

***DO NOT
WRITE ON
THIS PAGE***

***DO NOT
WRITE ON
THIS PAGE***

CANDIDATE'S RECEIPT

INSTRUCTIONS TO CANDIDATE

1. Fill in all the information requested clearly in capital letters.

TEST CODE

0	2	1	2	0	0	1	0

SUBJECT ENVIRONMENTAL SCIENCE – UNIT 1 – Paper 01

PROFICIENCY ADVANCED

REGISTRATION NUMBER

FULL NAME _____
(BLOCK LETTERS)

SIGNATURE _____

DATE _____

2. Ensure that this slip is detached by the Supervisor or Invigilator and given to you when you hand in this booklet.
3. Keep it in a safe place until you have received your results.

INSTRUCTION TO SUPERVISOR/INVIGILATOR

Sign the declaration below, detach this slip and hand it to the candidate as his/her receipt for this booklet collected by you.

I hereby acknowledge receipt of the candidate's booklet for the examination stated above.

Signature _____
Supervisor/Invigilator

Date _____

Subject & Proficiency:		CAPE Environmental Science (Unit 1)				
Generation Name:		02120010 Specimen Paper 2026				
Version:		FINAL				
Version Date:		25/08/2025				
Item No.	Subject Code	Item Type	Key	Syllabus Reference	Cog. Level	Module
1	ENV SCI	MO2	D	1.1	KC	M1
2	ENV SCI	MO2	D	1.2	KC	M1
3	ENV SCI	MO2	A	1.3	KC	M1
4	ENV SCI	MO1	D	1.4	KC	M1
5	ENV SCI	MO1	A	1.11	KC	M1
6	ENV SCI	MO2	B	1.5	AK	M1
7	ENV SCI	MO6	C	1.6	AK	M1
8	ENV SCI	MO3	B	1.7	AK	M1
9	ENV SCI	MO3	B	1.8	AK	M1
10	ENV SCI	MO3	A	1.1	AK	M1
11	ENV SCI	MO3	C	1.12	AK	M1
12	ENV SCI	MO1	A	1.14	AK	M1
13	ENV SCI	MO6	A	1.19	PA	M1
14	ENV SCI	MO6	B	1.19	PA	M1
15	ENV SCI	MO6	A	1.19	PA	M1
16	ENV SCI	MO2	A	2.1	KC	M2
17	ENV SCI	MO6	C	2.2	KC	M2
18	ENV SCI	MO2	A	2.4	KC	M2
19	ENV SCI	MO2	C	2.6	KC	M2
20	ENV SCI	MO1	B	2.7	KC	M2
21	ENV SCI	MO1	D	2.3	AK	M2
22	ENV SCI	MO2	B	2.7	AK	M2
23	ENV SCI	MO1	C	2.8	AK	M2
24	ENV SCI	MO3	B	2.9	AK	M2
25	ENV SCI	MO1	A	2.1	AK	M2
26	ENV SCI	MO3	D	2.11	AK	M2
27	ENV SCI	MO6	B	2.12	AK	M2
28	ENV SCI	MO6	B	2.14	PA	M2
29	ENV SCI	MO6	D	2.14	PA	M2
30	ENV SCI	MO6	D	2.14	PA	M2
31	ENV SCI	MO1	A	3.1	KC	M3
32	ENV SCI	MO1	C	3.2	KC	M3
33	ENV SCI	MO2	B	3.3	KC	M3
34	ENV SCI	MO3	D	3.4	KC	M3
35	ENV SCI	MO1	A	3.5	KC	M3
36	ENV SCI	MO1	D	3.6	KC	M3
37	ENV SCI	MO6	A	3.7	AK	M3
38	ENV SCI	MO1	C	3.8	AK	M3
39	ENV SCI	MO3	B	3.9	AK	M3
40	ENV SCI	MO3	D	3.10	AK	M3
41	ENV SCI	MO3	C	3.11	AK	M3

Subject & Proficiency:		CAPE Environmental Science (Unit 1)				
Generation Name:		02120010 Specimen Paper 2026				
Version:		FINAL				
Version Date:		25/08/2025				
Item No.	Subject Code	Item Type	Key	Syllabus Reference	Cog. Level	Module
42	ENV SCI	MO1	B	3.12	AK	M3
43	ENV SCI	MO6	D	3.14	PA	M3
44	ENV SCI	MO6	A	3.14	PA	M3
45	ENV SCI	MO6	B	3.14	PA	M3
	Number of Items:					
	Number of M1 Items:		15			Answers:
	Number of M2 Items:		15			A-13
	Number of M3 Items:		15			B-12
						C-10
						D-10



TEST CODE **02220010**

SPECIMEN 2026

CARIBBEAN EXAMINATIONS COUNCIL
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®
ENVIRONMENTAL SCIENCE

UNIT 2 – Paper 01

1 hour 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This test consists of 45 items. You will have 1 hour and 30 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 (D) has been shaded.

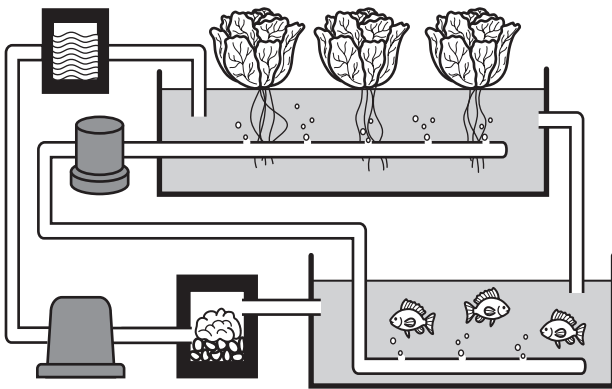
6. If you want to change your answer, erase it completely before you fill in your new choice.
7. When you are told to begin, turn the page and work as quickly and as carefully as you can. If you cannot answer an item, go on to the next one. You may return to that item later.
8. You may use a silent, non-programmable calculator to answer items.

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

1. Which of the following terms describes the farming of pineapples, for foreign markets, using large areas of arable land?

(A) Peasantry
(B) Subsistence
(C) Large-scale commercial
(D) Small-scale commercial

Item 2 refers to the following diagram of an integrated system used by a farmer to cultivate lettuce and tilapia.



2. This system is an example of
- (A) aquaculture
(B) aquaponics
(C) agroforestry
(D) hydroponics
3. Which of the following would have been directly linked to the history of the export of agricultural produce in the Caribbean?
- (A) Pre-colonial factors
(B) Fin to fork initiatives
(C) Robust supply chains
(D) Lack of industrial outputs

4. Agritourism does NOT contribute to

(A) recreation
(B) food insecurity
(C) foreign exchange
(D) biodiversity conservation

5. Which of the following terms refers to the utilization of advanced technology in agribusiness to securely record transactions, and to enhance traceability and transparency?

(A) Blockchain
(B) Genetic engineering
(C) Digitizing supply chains
(D) Global positioning systems

6. A farm buys non-GMO produce from suppliers within a ten-mile radius and utilizes the produce in its restaurant's menu. Which of the following terms CANNOT be associated with this practice?

(A) Agritourism
(B) Farm to fork
(C) Organic farming
(D) Factory farming

7. The Community Agricultural Policy (CAP) encompasses CARICOM initiatives whose major objective is to make agriculture, fisheries and forestry more resilient, from a regional perspective. This includes the 'Twenty-Five by 2025 Initiative' that aims to reduce the region's food import bill by 25% by 2025.

In which of the following areas does this policy NOT align with the importance of agriculture to Caribbean countries?

(A) Social
(B) Economic
(C) Ecological
(D) Technological

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8. A farmer has been experiencing losses from his farm and decides to employ a farm management strategy whereby he will use technologies to automate agricultural operations and improve agricultural production.

Which of the following technologies is the farmer MOST likely to use?

- (A) Mechanization
- (B) Genetic engineering
- (C) Precision agriculture
- (D) Digitization of supply chains

9. In 2022, The Bahamas passed several laws and embarked on initiatives to encourage communities to conserve mangroves and other coastal wetland plants to help improve soil health and productivity, reduce runoff and mitigate the effects of climate change.

Which of the following terms BEST describes these initiatives?

- (A) Crop rotation
- (B) Carbon farming
- (C) Contour farming
- (D) Conservation tillage

10. The Food and Agricultural Organization (FAO) has developed the Securing Sustainable Small-scale Fisheries (SSF) Guidelines as a road map for securing sustainable small-scale fishing for all activities along the value chain, to help eradicate hunger and poverty.

Which of the following is NOT a way in which these guidelines can ensure that fisheries and aquaculture align with the Sustainable Development Goals (SDGs)?

- (A) Social equity
- (B) Economic viability
- (C) Ecological integrity
- (D) Environmental standards

11. Climate change is increasingly becoming a threat to small island developing states (SIDS) such as those in the Caribbean, as climate change increases the economic vulnerability of these state, especially as it relates to their agriculture and tourism industries.

Which of the following threats to the sustainability of agriculture is/are LEAST likely to be triggered by climate change?

- (A) Pest and diseases
- (B) Praedial larceny
- (C) Periods of drought
- (D) Poor land management practices

12. In 2021, Belize embarked on a debt for nature swap which, among other purposes, will lead to better management and conservation of marine diversity, and greater provision for Belizean communities which rely on fisheries for food and livelihoods.

Which of the following is LEAST likely to be compatible with the proposed benefits of the swap?

- (A) Policies which provide for blue and teal carbon ecosystems
- (B) The development of marine spatial plans to help fisheries management
- (C) Providing fishers with secure licences to fish in specific managed access areas
- (D) The development of large-scale, intensive mariculture facilities in coastal marine areas

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Items **13–15** refer to the following table which shows the production in various agricultural sectors in a Caribbean country during the period 2017–2025.

Year	Agricultural Sector			
	Bananas (tonnes)	Non-traditional Crops (tonnes)	Cocoa (tonnes)	Fish (tonnes)
2017	17 487	18 507	31	1732
2018	13 734	27 015	23	1669
2019	11 623	31 003	21	1553
2020	8 324	27 530	17	1269
2021	4 583	29 824	–	1383

Adapted from <https://stats.gov.lc/subjects/economy/agriculture-livestock-and-fishing/agriculture-summary-table>

13. For which agricultural sector was there the LARGEST decline in production during the period 2017–2021?
- (A) Cocoa
(B) Bananas
(C) Fisheries
(D) Non-traditional crops
14. The trend observed in the table for the production of bananas during the period 2017–2021 may be as a result of
- I. agroforestry
II. desertification
III. the impact of zoonoses on production
- (A) I and II only
(B) I and III only
(C) II and III only
(D) I, II and III
15. The steady rise in the production of non-traditional crops is LEAST likely attributed to which of the following agricultural systems?
- (A) Peasantry
(B) Agrotourism
(C) Carbon farming
(D) Precision agriculture

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16. A body possesses gravitational potential energy due to its
- (A) motion
 - (B) position
 - (C) elasticity
 - (D) chemical bonds
17. Which of the following types of energy is produced whenever there is conversion of energy from one form to another?
- (A) Heat
 - (B) Light
 - (C) Sound
 - (D) Electrical
18. Which of the following is a widely used nonrenewable energy source in the Caribbean?
- (A) Coal
 - (B) Wind
 - (C) Solar
 - (D) Natural gas
19. Most volcanic Caribbean islands have not been able to utilize geothermal plants as a MAIN source of energy because
- (A) start-up costs are high
 - (B) the islands are too large
 - (C) it is an unreliable source
 - (D) most volcanoes are dormant
20. During power outages, many users lose internet connectivity. Which of the following energy-dependent sectors does this impact the most?
- (A) Industrial
 - (B) Transport
 - (C) Power generation
 - (D) Telecommunication
21. An architect is designing a new home for a client and has suggested the use of large windows and skylights. Which of the following types of energy will be harnessed?
- (A) Direct wind
 - (B) Active solar
 - (C) Indirect wind
 - (D) Passive solar
22. Many Caribbean countries are increasingly relying on renewable energy to meet their electricity demands. Which of the following factors has/have contributed to this decision?
- I. The high cost of fuel places economic strain on governments.
 - II. Renewable energy sources are more efficient and reliable.
 - III. There is a readily available skilled workforce for maintenance.
- (A) I only
 - (B) II only
 - (C) II and III only
 - (D) I, II and III
23. Country Y is a tourism-based country which utilizes energy to ensure its tourism sector runs efficiently. Which of the following are energy-dependent sectors associated with tourism?
- I. Ground transport
 - II. Hotel air conditioning
 - III. Electronic immigration forms
- (A) I and II only
 - (B) II and III only
 - (C) I and III only
 - (D) I, II and III

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24. An electrical company schedules regular maintenance of its substation power lines to ensure an uninterrupted supply to the consumer. To which of the following parts of the electric power system does this activity refer?

(A) Demand
(B) Generation
(C) Distribution
(D) Transmission

25. A power plant in a small Caribbean territory regularly resorts to load shedding between the hours of 6 p.m. and 8 p.m. on weekdays. Which of the following factors contributes to this cycle?

I. Increased power generation capacity
II. Increased demand from street lighting
III. Increased demand from residential users

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

26. A large trigeneration power plant is being considered to provide electricity, heating and cooling to an industrial estate. Which of the following is the BEST location for the power plant?

(A) Next to waterbodies
(B) Next to the industries
(C) Away from high demand industries
(D) Away from conventional power lines

27. A Caribbean country is seeking to construct a hydroelectric power station along a river which is home to many endemic species. Which of the following is a likely direct environmental impact of this project?

(A) Loss of biodiversity
(B) No carbon emissions
(C) Lower fuel import cost
(D) Displacement of communities

Item 28 refers to the following table which shows the efficiency of various energy sources.

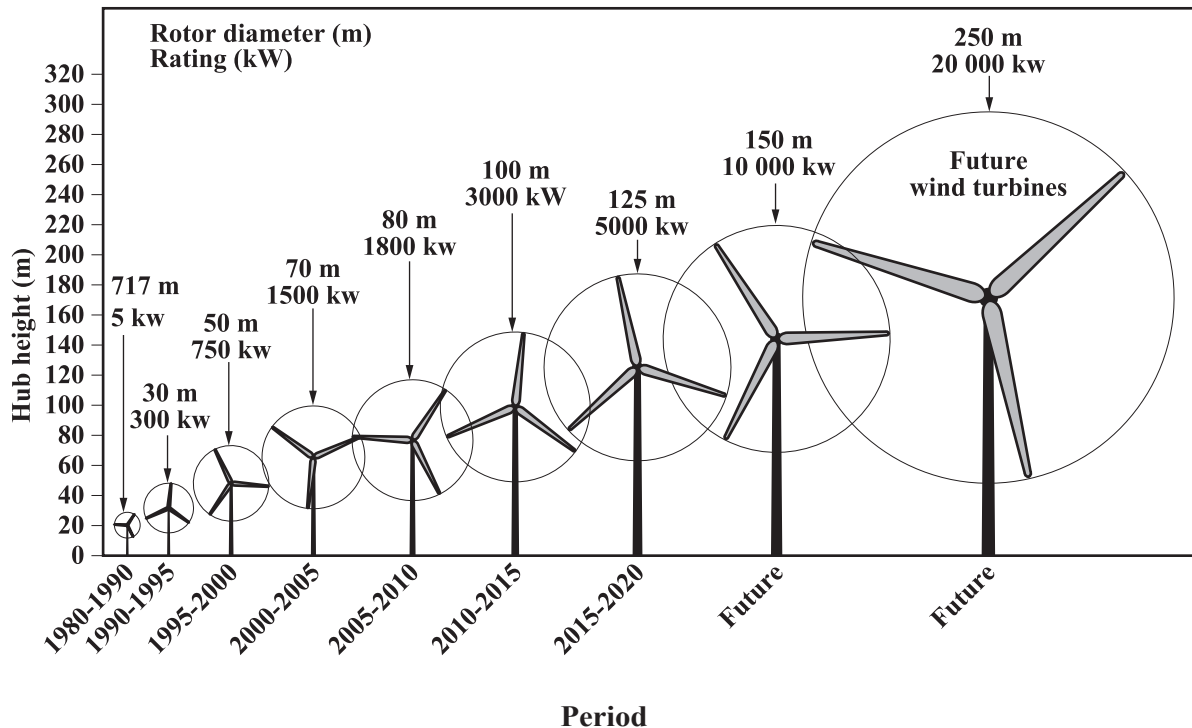
Energy Source	Efficiency (%)
Fossil fuels	30
Nuclear	40
Hydroelectric	90
Solar	23
Biomass	35
Geothermal	20

28. Which of the following shows the correct order of **increasing** efficiency for the three LEAST energy-efficient sources shown in the table?

(A) Fossil fuels, solar, geothermal
(B) Geothermal, solar, fossil fuels
(C) Biomass, nuclear, hydroelectric
(D) Hydroelectric, nuclear, biomass

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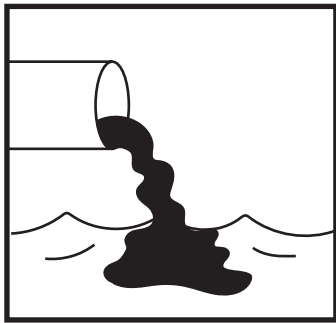
Items 29–30 refer to following diagram which shows the trend in variations of hub height, rotor diameter and plant rating of wind turbines from 1980.



29. Which of the following statements is true of wind turbines for the period shown in the diagram?
- (A) Hub height and rotor diameters are increasing over time.
 - (B) Hub height and rotor diameters are decreasing over time.
 - (C) Plant rating is decreasing as hub height increases over time.
 - (D) Plant rating is decreasing as rotor diameter increases over time.
30. Which of the following periods recorded the LEAST increase in plant rating?
- (A) 1995–2000
 - (B) 2000–2005
 - (C) 2005–2010
 - (D) 2010–2025

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Item 31 refers to the following diagram which illustrates pollution.



31. Which of the following pollutant sources is illustrated in the diagram above?
- (A) Point
 - (B) Water
 - (C) Industrial
 - (D) Non-point
32. A farmer sprays a pesticide on her fields. Which of the following is an environmental receptor for the pesticide?
- (A) Soil
 - (B) Tractor
 - (C) Factory
 - (D) Storage shed
33. Which of the following is an example of a driver of pollution?
- (A) Littering
 - (B) Acid rain
 - (C) Accidental spill
 - (D) Unsustainable lifestyles
34. The term 'secondary air pollutant' is defined as a pollutant
- (A) produced from a point source
 - (B) manufactured in industrial plants
 - (C) released directly into the atmosphere from a source
 - (D) formed when other pollutants react in the atmosphere
35. Which of the following types of pollution can disrupt the navigational ability of whales?
- (A) Air
 - (B) Land
 - (C) Noise
 - (D) Water
36. Which of the following characteristics associated with an institutional framework in the Caribbean may result in the poor management of pollution?
- (A) Rapid population growth
 - (B) The use of appropriate technology
 - (C) A robust national environmental agency
 - (D) Availability of opportunities for environmental education
37. Sahara dust poses a significant risk to people in the Caribbean who suffer from respiratory diseases. Which of the following explains why Sahara dust is a problem although the source of the dust is very far away from the Caribbean?
- (A) It is difficult to stop atmospheric pollution.
 - (B) Atmospheric pollutants are readily transported by wind.
 - (C) Atmospheric pollution tends to remain in localized areas.
 - (D) The sources of atmospheric pollutants are in many locations.

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38. Which of the following explains why many Caribbean countries find it difficult to reduce noise pollution?
- I. Cultural events like carnivals play a big role.
 - II. The ability to enforce regulations is limited.
 - III. Education and awareness regarding noise pollution are encouraged.
- (A) I and II only
 - (B) I and III only
 - (C) II and III only
 - (D) I, II and III

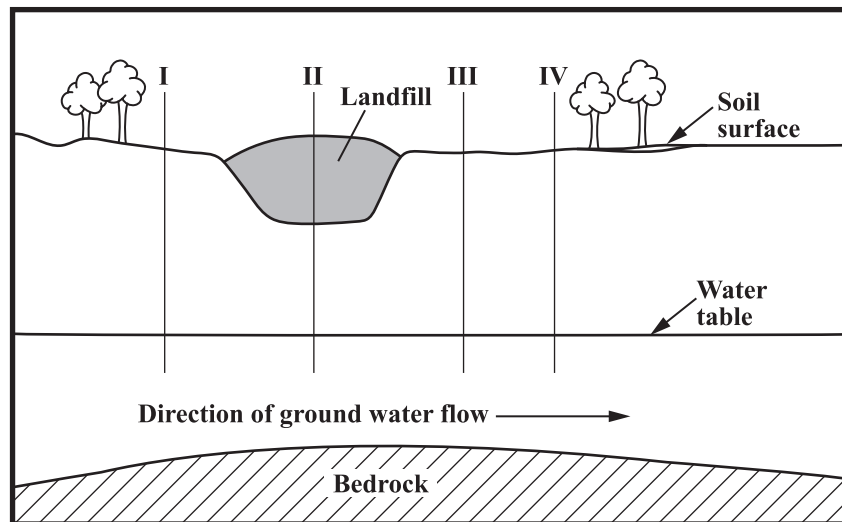
Item 39 refers to the following table which shows some characteristics of four lakes A, B, C and D.

Characteristic	Lake A	Lake B	Lake C	Lake D
Volume of the lake	Large	Large	Small	Small
Volume of waste entering the lake	Low	High	Low	High
Residence time of Pollutant X in the lake	Low	Low	High	High
Rate of degradation of Pollutant X in the lake	High	High	Low	Low

39. Each of the four lakes is receiving a waste stream containing Pollutant X. Given that the concentration of Pollutant X in the waste stream entering each of the lakes is the same, which lake will have the HIGHEST concentration of Pollutant X?
- (A) Lake A
 - (B) Lake B
 - (C) Lake C
 - (D) Lake D

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Item 40 refers to the following diagram which illustrates a cross section of an area where a landfill is located.

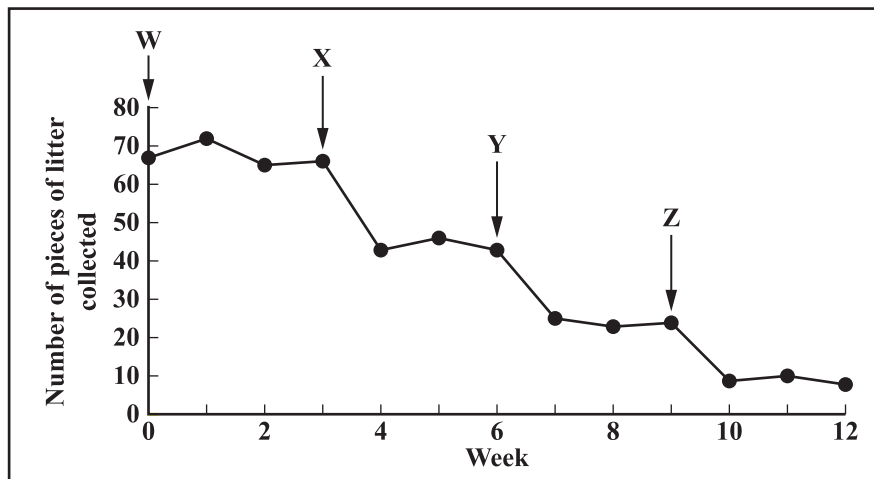


40. Which of the labelled sites on the diagram is the BEST location for the country's water authority to drill a drinking water well?
- (A) I
 - (B) II
 - (C) III
 - (D) IV

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Item 41 refers to the information and graph below.

As part of their SBA, the students in an Environmental Science class started an education and awareness drive to help reduce littering at a popular park in their neighbourhood. The students designed and installed posters informing park users about the hazards of littering. They also raised funds to purchase and install bins in the park. The students then counted the number of pieces of litter in the park over a 12-week period. The graph below presents the data collected during the SBA.



41. Which area on the graph represents the point at which the students MOST likely installed the posters and bins?

(A) W
(B) X
(C) Y
(D) Z

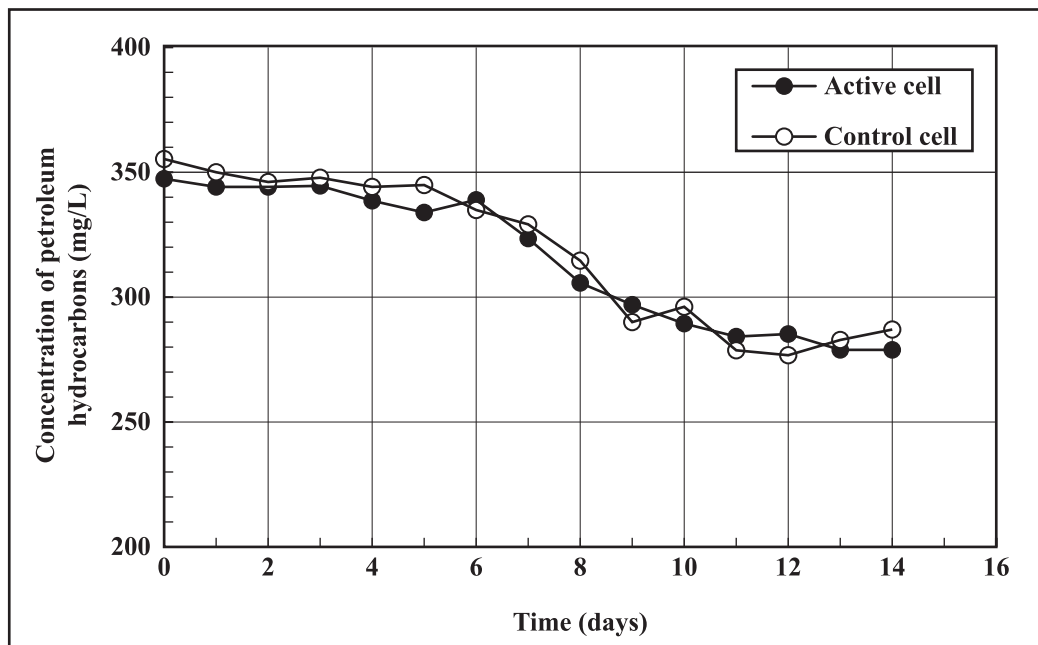
42. In February 2024, a barge overturned just off the coast of Tobago. Oil leaking from the vessel caused wide contamination in the surrounding area.

Which of the following international environmental agreements BEST addresses this issue in the wider Caribbean region?

(A) Montreal Protocol
(B) Ramsar Convention
(C) Cartagena Convention
(D) United Nations Framework Convention on Climate Change

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Item 43 refers to the following graph which illustrates the results of an experiment to determine the effectiveness of a new bacterial community with respect to the biodegradation of petroleum hydrocarbons spilled into the ocean.

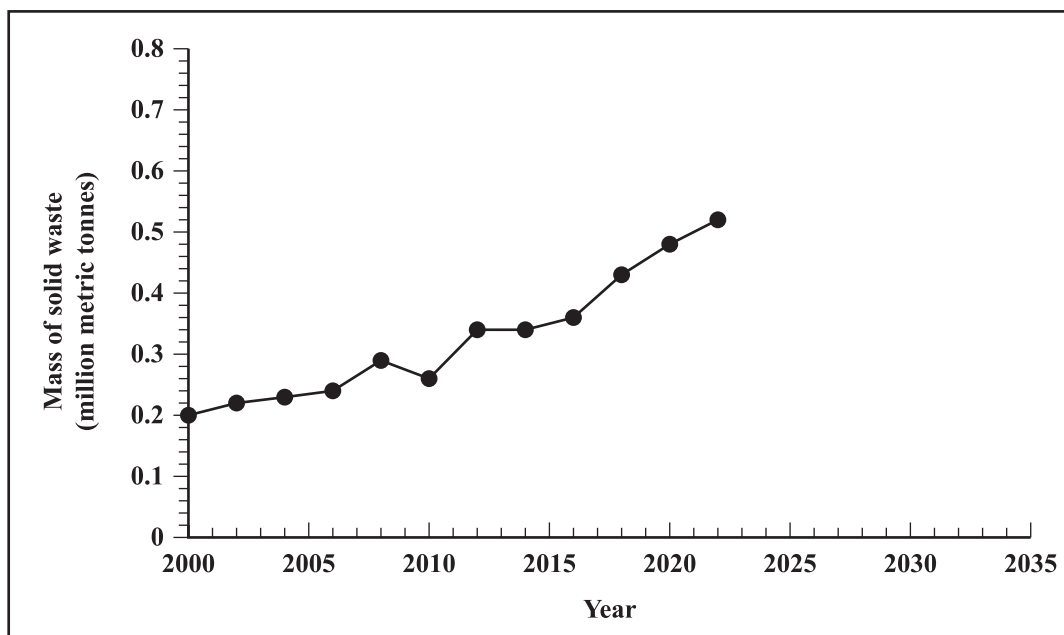


In the experiment, two cells were set up containing the same contaminated sea water. The active cell contained the new bacterial community while the control cell did not.

43. Which of the following conclusions can be drawn from the results shown in the graph?
- (A) The new bacterial community is effective in reducing the concentration of petroleum hydrocarbons.
 - (B) The new bacterial community is not effective in reducing the concentration of petroleum hydrocarbons.
 - (C) The new bacterial community is only able to reduce the concentration of petroleum hydrocarbons to 300 mg/L.
 - (D) The new bacterial community is only effective at reducing the concentration of petroleum hydrocarbons after Day 6.

GO ON TO THE NEXT PAGE

Items 44 and 45 refer to the following graph which illustrates the amount of solid waste disposed in landfills in a Caribbean country from 2000 to 2022.



44. Which of the following is the correct estimate of the mass of solid waste that will be disposed of in landfills in 2030?
- (A) 0.6 tonnes
 - (B) 0.8 tonnes
 - (C) 600 000 tonnes
 - (D) 800 000 tonnes
45. In which period did the LARGEST change in the mass of waste disposed in landfills occur?
- (A) 2006–2008
 - (B) 2008–2010
 - (C) 2010–2012
 - (D) 2016–2018

END OF TEST

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

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SUBJECT ENVIRONMENTAL SCIENCE – UNIT 2 – Paper 01

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Subject & Proficiency:		CAPE Environmental Science (Unit 2)				
Generation Name:		02220010 Specimen Paper 2026				
Version:		FINAL				
Version Date:		25/08/2025				
Item No.	Subject Code	Item Type	Key	Syllabus Reference	Cog. Level	Module
1	ENV SCI	MO2	C	1.1	KC	M1
2	ENV SCI	MO2	B	1.2	KC	M1
3	ENV SCI	MO2	D	1.3	KC	M1
4	ENV SCI	MO1	B	1.4	KC	M1
5	ENV SCI	MO1	A	1.5	KC	M1
6	ENV SCI	MO2	D	1.3	AK	M1
7	ENV SCI	MO6	D	1.4	AK	M1
8	ENV SCI	MO3	C	1.5	AK	M1
9	ENV SCI	MO3	B	1.9	AK	M1
10	ENV SCI	MO3	D	1.7	AK	M1
11	ENV SCI	MO3	B	1.8	AK	M1
12	ENV SCI	MO1	D	1.6	AK	M1
13	ENV SCI	MO6	B	1.11	PA	M1
14	ENV SCI	MO6	C	1.11	PA	M1
15	ENV SCI	MO6	A	1.11	PA	M1
16	ENV SCI	MO2	B	2.1	KC	M2
17	ENV SCI	MO6	A	2.2	KC	M2
18	ENV SCI	MO2	D	2.3	KC	M2
19	ENV SCI	MO2	A	2.4	AK	M2
20	ENV SCI	MO1	D	2.5	KC	M2
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22	ENV SCI	MO2	A	2.4	AK	M2
23	ENV SCI	MO1	D	2.5	AK	M2
24	ENV SCI	MO3	C	2.6	AK	M2
25	ENV SCI	MO1	C	2.7	AK	M2
26	ENV SCI	MO3	B	2.8	AK	M2
27	ENV SCI	MO6	A	2.9	AK	M2
28	ENV SCI	MO6	B	2.11	PA	M2
29	ENV SCI	MO6	A	2.11	PA	M2
30	ENV SCI	MO6	C	2.11	PA	M2
31	ENV SCI	MO1	A	3.1	KC	M3
32	ENV SCI	MO1	A	3.2	KC	M3
33	ENV SCI	MO2	D	3.3	KC	M3
34	ENV SCI	MO3	D	3.4	KC	M3
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37	ENV SCI	MO6	B	3.4	AK	M3
38	ENV SCI	MO1	A	3.5	AK	M3
39	ENV SCI	MO3	D	3.6	AK	M3
40	ENV SCI	MO3	A	3.7	AK	M3

Subject & Proficiency:		CAPE Environmental Science (Unit 2)				
Generation Name:		02220010 Specimen Paper 2026				
Version:		FINAL				
Version Date:		25/08/2025				
Item No.	Subject Code	Item Type	Key	Syllabus Reference	Cog. Level	Module
41	ENV SCI	MO3	B	3.8	AK	M3
42	ENV SCI	MO1	C	3.9	AK	M3
43	ENV SCI	MO6	D	3.11	PA	M3
44	ENV SCI	MO6	C	3.11	PA	M3
45	ENV SCI	MO6	C	3.11	PA	M3
	Number of Items:					
	Number of M1 Items:		15			Answers:
	Number of M2 Items:		15			A-12
	Number of M3 Items:		15			B-10
						C-10
						D-13

SPECIMEN 2026



TEST CODE **02120020**

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

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UNIT 1 – Paper 02

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX questions in THREE sections. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. Do NOT write in the margins.
4. You may use a silent, non-programmable calculator to answer questions.
5. You are advised to take some time to read through the paper and plan your answers.
6. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
7. **If you use the extra page(s), you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

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

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02120020/CAPE/SPEC/2026

MODULE 1

Answer BOTH questions.

1. (a) Define EACH of the following terms.

(i) Habitat

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[1 mark]

(ii) Ecotone

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[1 mark]

(iii) Keystone species

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[1 mark]

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- (b) Figure 1 below illustrates a food web in a mangrove habitat found in a Caribbean country.

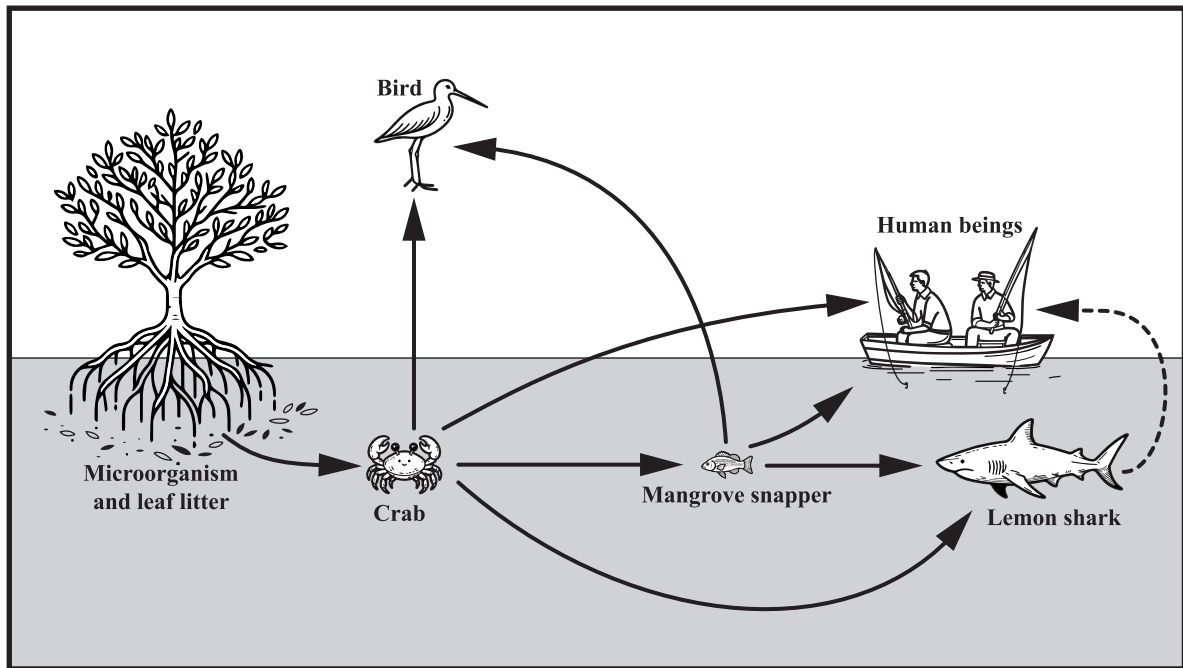


Figure 1. A food web in a mangrove habitat of a Caribbean country

Mangroves are diverse ecosystems and a mangrove is considered an ecotone, which is a keystone species providing essential services for the entire estuarine community. Occasionally referred to as the “kidneys of the coast”, mangroves are magnificent filters and maintain necessary water clarity for offshore corals and nearshore seagrasses (University of Florida, n.d.).

Describe how the microorganisms in the mangrove ecosystem can contribute to EACH of the following.

- (i) The recycling of waste

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[2 marks]

GO ON TO THE NEXT PAGE

- (ii) The availability of nutrients

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[2 marks]

- (c) Identify ONE example of competition in Figure 1 and explain how that competition impacts the carrying capacity of the mangrove ecosystem.

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[3 marks]

GO ON TO THE NEXT PAGE

- (d) In an effort to reduce operating costs, a sewage treatment plant begins dumping wastewater into the mangrove swamp. Explain ONE impact that this wastewater may have on

- (i) the cycling of nitrogen within the mangrove ecosystem

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[2 marks]

- (ii) the optimum range of organisms in the mangrove ecosystem.

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[2 marks]

GO ON TO THE NEXT PAGE

- (e) A scientist wishes to conduct an experiment that will determine the efficiency of energy flow in the mangrove ecosystem.

- (i) Describe an experiment which the scientist can use to determine the level of efficiency regarding energy flow in the mangrove ecosystem.

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[4 marks]

- (ii) The total energy incorporated into the ecosystem is 9000 KJ. Calculate the average energy received by a human being who eats the lemon shark.

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[2 marks]

Total 20 marks

GO ON TO THE NEXT PAGE

2. (a) Define EACH of the following terms.

(i) Logistic growth

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[1 mark]

(ii) Carrying capacity

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[1 mark]

(iii) Biotic potential

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[1 mark]

GO ON TO THE NEXT PAGE

- (b) Read the information below carefully and answer the questions that follow.

The Rupununi Savannah is located in southwestern Guyana between the Rupununi River and the border with Brazil and Venezuela. The vast plains encompass 5000 square miles of virtually untouched grasslands, swamp lands and rain-forested mountains. The plains are also dominated by three main rivers, over 750 lakes, ponds and water inlets. The lakes, ponds and inlets are closed or isolated in dry season.

The savannah usually floods during the rainy season, which occurs from May to August. During this time, the savannah's carrying capacity is greater. The vast grass plains are divided from north to south, by the Kanuku Mountains which are Guyana's most biologically diverse region.

Due to the combination of these factors, the area has one of the highest diversity of fishes in the world when compared with areas of a similar size. This diversity includes at least 400 species of fish (Guyana chronicle, 2021). In addition, the area is home to 250 species of bird life, 18 of which are native to "only the lowland forests of the Guianas" (Conservation International, 2021).

The Rupununi Savannah is also the home of four of Guyana's nine Amerindian peoples—the Wapishana, Macushi, Wai-Wai and Patamona peoples—who have inhabited the area since before European colonization.

Adapted from <https://camacdonald.com/birding/saguyana.htm>

Explain ONE way by which the Rupununi's ecosystem characteristics described above may result in EACH of the following.

- (i) Allopatric speciation

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[2 marks]

GO ON TO THE NEXT PAGE

- (ii) Peripatric speciation

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[2 marks]

- (c) Describe a suitable sampling method which could be used to obtain population data on the bird and fish populations in the Rupununi Savannah.

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[4 marks]

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- (d) A recent survey conducted near the Rewa River, one of the three main rivers serving the Rupununi Savannahs, provided information on several species. Table 1 contains the information on each species.

TABLE 1: SPECIES INFORMATION

Species	Population Number
<i>Arapaima gigas</i>	200
<i>Pteronura brasiliensis</i>	150
<i>Melanosuchus niger</i>	75
<i>Podocnemis expansa</i>	300
<i>Harpia harpyja</i>	191
<i>Panthera onca</i>	111

- (i) Using the Simpson's Index formula below, calculate the species diversity in the area sampled.

$$D = \frac{\sum n(n-1)}{N(N-1)}.$$

[3 marks]

GO ON TO THE NEXT PAGE

- (ii) Use the value of the species diversity calculated in (d) (i) **on page 10** to comment on the stability of the ecosystem near the Rewa River.

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[2 marks]

- (e) Discuss how TWO activities of the Amerindian people living in the Rupununi Savannah may have traditionally resulted in maintaining the integrity of the Rupununi Savannah ecosystem.

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[4 marks]

Total 20 marks

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MODULE 2

Answer BOTH questions.

3. (a) Define EACH of the following terms.

(i) Crude birth rate

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[1 mark]

(ii) General fertility rate

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[1 mark]

(iii) Infant mortality rate

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[1 mark]

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- (b) Table 2 shows the demographic characteristics of two Caribbean countries, Country A and Country B. Statistics were used in an Environmental Science class to compare characteristics of the population and development of the two countries.

TABLE 2: DEMOGRAPHIC STATISTICS FOR CARIBBEAN COUNTRIES A AND B

Statistic	Country A	Country B
Population	281,995	11.2 million
Annual population growth rate %	0.12	1.20
GDP per capita (USD)	22,672.62	1,693.07
Employment in agriculture %	2.72	45.52
Fertility rate	1.63	2.77
Infant mortality rate	10.10	44
Death rate	9.1	8.2
Net migration/persons	-80	-31811

- (i) During a class discussion, Student 1 states, “The difference between the infant mortality rates of the two countries is in direct relation to the difference between their annual population growth rates”. Student 2 states, “Country B’s annual growth rate is as a result of its economic activity”.

Using the data shown in Table 2, explain why EACH statement made by the students is correct.

Student 1

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[2 marks]

GO ON TO THE NEXT PAGE

Student 2

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[2 marks]

- (ii) Using the data shown in Table 2, calculate the difference, in years, between the time it takes Country A to double its population compared with the time it takes Country B to do the same. State ONE assumption that is made in determining your answer.

Assumption

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[5 marks]

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- (iii) Using the information in Table 2, outline the TWO possible reasons for the net migration from Country B.

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- (iv) Outline ONE possible **indirect** population control factor which may account for the death rate of Country A.

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[2 marks]

GO ON TO THE NEXT PAGE

- (v) Outline ONE likely environmental impact associated with human populations that could have an effect on Country B.

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[2 marks]

Total 20 marks

GO ON TO THE NEXT PAGE

4. (a) Define EACH of the following terms.

(i) Poverty

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[1 mark]

(ii) Human development index

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[1 mark]

(iii) Sustainable development

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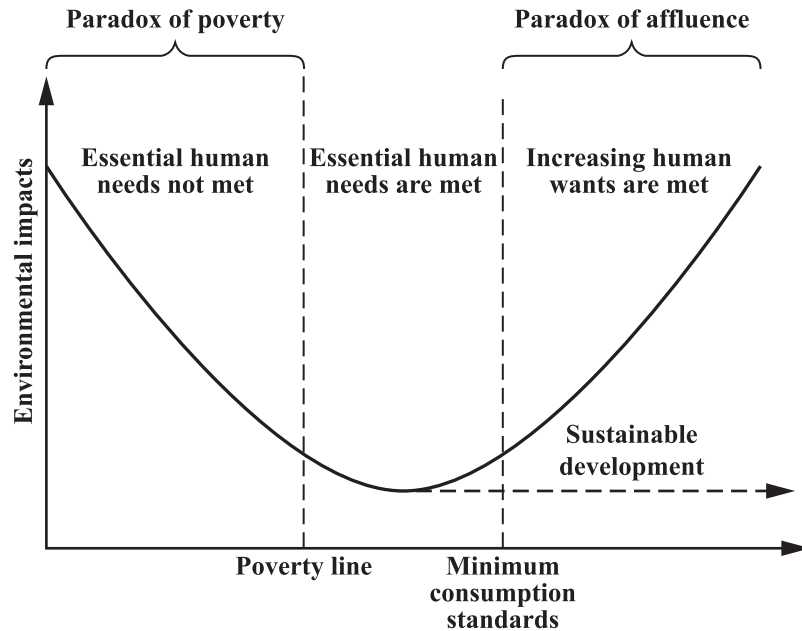
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[1 mark]

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- (b) Sustainable development is achieved through the delicate balance of economic, environmental and social sustainability. Figure 2 illustrates the environmental impact associated with varying economic growth and the associated human conditions. Study the diagram and answer the questions that follow.



Economic growth and technological development

Figure 2. Diagram illustrating the concept of sustainable development

Use Figure 2 to explain how EACH of the following may lead to environmental degradation.

- (i) Poverty

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[3 marks]

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(ii) Affluence

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[3 marks]

- (c) The lionfish (Pterois) is a carnivorous fish which has a high reproductive rate and is native to the Indo-Pacific. It is now an invasive species in the Atlantic Ocean and the Caribbean Sea. Experts speculate that people have been dumping unwanted lionfish from home aquariums into the Atlantic Ocean for more than 25 years. The presence of this species in Caribbean marine ecosystems poses a threat to and creates an opportunity for the region.

Discuss ONE positive impact and ONE negative impact that the dumping of unwanted lionfish may have on human beings.

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[6 marks]

GO ON TO THE NEXT PAGE

- (d) Table 3 shows data for Caribbean Country X which was published in its population census at the end of 2025.

TABLE 3: END OF YEAR POPULATION DATA FOR COUNTRY X, 2025

Population at Beginning of 2025	Number of Births	Number of Deaths	Number of Immigrants	Number of Emigrants
2 500 000	50 000	1 000	3 000	2 700

Use the information in Table 3 to calculate EACH of the following.

- (i) Annual percentage population growth

[4 marks]

- (ii) Population size at the end of 2025

[1 mark]

Total 20 marks

GO ON TO THE NEXT PAGE

MODULE 3

Answer BOTH questions.

5. (a) Define EACH of the following terms.

(i) Exhaustible resource

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[2 marks]

(ii) Remediation

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[2 marks]

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- (b) A student in a school debate argues that the consumptive use of natural resources would inevitably result in a rapid decline in the availability of those resources. State whether the student's premise is correct. Explain your response using a suitable example.

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[5 marks]

- (c) Table 4 presents data on the total fish catch in a Caribbean country, over a twenty-year period.

TABLE 4: TOTAL FISH CATCH IN A CARIBBEAN COUNTRY FROM 2000 TO 2020

Year	Fish Catch (in tonnes)
2000	400
2005	850
2010	1200
2015	925
2020	725

- (i) On the grid provided on page 23, plot a suitable graph to illustrate the data in Table 4.

[5 marks]

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DO NOT WRITE IN THIS AREA

A full-page sheet of white graph paper. The grid consists of thin, light gray horizontal and vertical lines forming small squares. A thicker gray border runs around the perimeter of the page, creating a margin. The grid covers the majority of the page area.

- (ii) Explain TWO ways in which the trend in the fish catch observed in the graph plotted at (c) (i) may have an impact on the economy of the Caribbean country.

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[6 marks]

Total 20 marks

6. Figure 3 illustrates gold production in Guyana from 2010 to 2021. Study the graph carefully and answer the questions that follow.

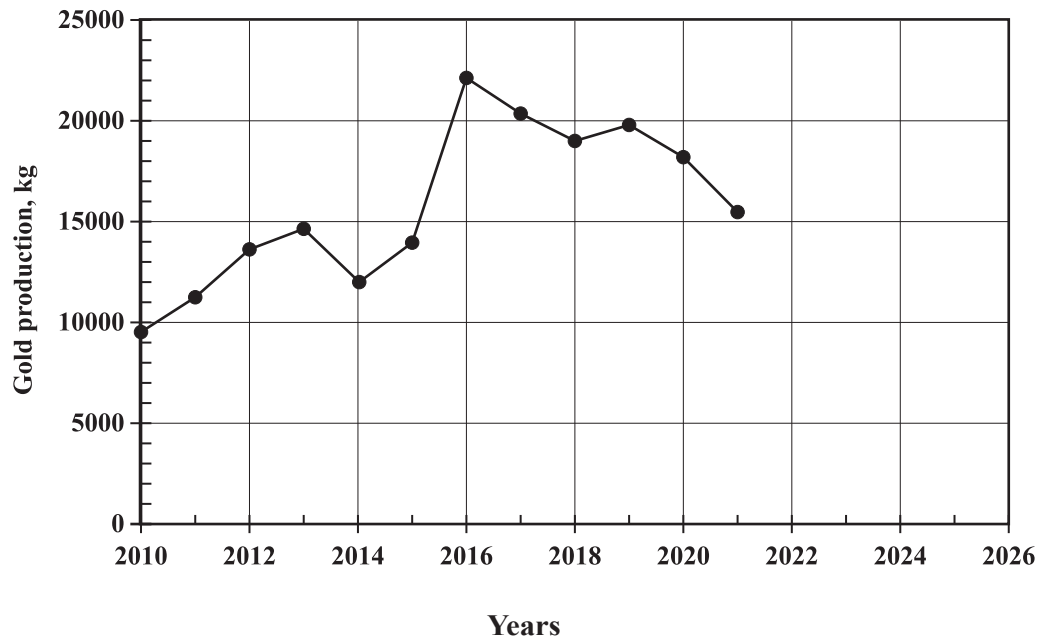


Figure 3: Gold production in Guyana from 2010 to 2021

Source: National Minerals Information Center, US Geological Survey. <https://www.usgs.gov/centers/national-minerals-information-center/south-america#guy>.

- (a) (i) Describe the overall trend of the data in the graph.

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[3 marks]

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- (ii) Define the term 'rehabilitation'.

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[2 marks]

- (c) (i) Choose ONE political **or** social factor affecting natural resource use in the Caribbean and explain how it can affect activities like gold mining.

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[4 marks]

- (ii) State ONE approach to natural resource management at the individual or community level.

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[1 mark]

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- (d) If a country is signatory to a multilateral environmental agreement (MEA), this may influence that country's national actions. Briefly explain how an MEA could result in changes at the national level.

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[2 marks]

Total 20 marks

END OF TEST

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EXTRA SPACE

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Question No.

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SUBJECT ENVIRONMENTAL SCIENCE – UNIT 1 – Paper 02

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Date _____

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CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

ENVIRONMENTAL SCIENCE

UNIT 1 - Paper 02

KEY AND MARK SCHEME

SPECIMEN PAPER 2026

ENVIRONMENTAL SCIENCE
PAPER 02
KEY AND MARK SCHEME

Question 1	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PA
(a) (i)	1.1	<u>Habitat</u> - A habitat is the <u>natural environment in which an organism lives, grows and thrives.</u> OR - A habitat is a place where all the physical and biological components needed for an organism's survival are present. These include <u>food, water, shelter, temperature, and the presence of other species.</u>	Any ONE correct definition, 1 mark	1		
(a) (ii)	1.1	<u>Ecotone</u> Ecotone is the <u>transition area between two biological communities,</u> where two communities meet and integrate.	1 mark	1		
(a) (iii)	1.1	<u>Keystone species</u> A <u>keystone species is an organism that has a large impact on its ecosystem, an impact that is directly proportionate to its abundance or biomass.</u> OR <u>A keystone species is an organism whose presence or absence can have a profound effect on the entire ecosystem. It often influences the populations of other species and the overall health of the habitat.</u>	Any ONE correct definition, 1 mark	1		

ENVIRONMENTAL SCIENCE
PAPER 02
KEY AND MARK SCHEME

Question 1 cont'd	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PA
(b) (i)	1.3	<u>The recycling of waste</u> The microorganisms in the soil of the mangrove ecosystem decompose or break down (1) the fallen leaves and animal waste (1) , turning them into organic matter. (1)	Complete description, 2 marks Partial description, 1 mark		2	
(b) (ii)	1.3	<u>The Availability of Nutrients</u> - Leaf litter broken down by the microorganisms can be eaten by scavengers such as the crab (1) who incorporate nutrients such as nitrogen in the leaf litter and pass it on to birds or small predators when they are eaten. (1) OR - Microorganisms can breakdown leaf litter, leading to the creation of humus in the soil. (1) The humus which can be absorbed by plants from the soil and utilized for various processes. (1)	Complete description, 2 marks Partial description, 1 mark		2	

ENVIRONMENTAL SCIENCE
PAPER 02
KEY AND MARK SCHEME

Question 1 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(c)	1.4	<u>Example of Competition</u> Humans and the lemon shark compete for the mangrove snapper. This is one example of competition. (1) When humans overfish the mangrove snapper, this lowers the carrying capacity of the mangrove ecosystem, (1) causing the number of lemon sharks and birds to decline. (1) OR Humans, birds and the mangrove snapper compete for the crabs. This is one example of competition. (1) If humans overharvest the crabs, this removes a source of food for the birds and the mangrove snapper, (1) causing a lowering of the mangrove ecosystem's carrying capacity. (1)	Example of competition, 1 mark Complete explanation, 2 marks Partial explanation, 1 mark		3	

ENVIRONMENTAL SCIENCE
PAPER 02
KEY AND MARK SCHEME

Question 1 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(d) (i)	1.5	<u>The Cycling of Nitrogen Within the Mangrove Ecosystem</u> Wastewater may contain nitrates which need to be nitrified using nitrifying bacteria. After this process occurs, the nitrates are released into the atmosphere. (1) OR the wastewater can be assimilated into the soil under anoxic conditions. (1)	Complete description, 2 marks Partial description, 1 mark		2	
(d) (ii)	1.6	<u>The Optimum Range of Organisms in the Mangrove Ecosystem</u> Wastewater may contain nitrates that are very water soluble and once the concentration of the nitrates becomes excessive and this will lead to eutrophication/ an explosion in the growth of algae (1). The eutrophication will eventually lead to a decline in the amount of dissolved oxygen (1) which will eventually lead to the decline in the dissolved oxygen available for the aquatic organisms, causing the number of aquatic organisms present to move from their optimum range to the zone of intolerance or the zone of psychological stress. (1) OR Wastewater discharge can cause high turbidity and high nutrient load which can disrupt the natural balance of the ecosystem by algal blooms. This results in the mangroves having more nutrients than they can process and therefore accumulating plaque on their roots, (1) leading to reduced mangrove growth, changes in soil microbial activity.	Complete description, 2 marks Partial description, 1 mark		2	

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Question 1 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
		This can also potentially affect the abundance and diversity of associated fauna, particularly the crab population, due to the altered salinity levels and water quality.				
(e) (i)	1.3	<u>Determining the Efficiency of Energy Flow</u> - Determine their trophic interactions. - Construct the food chains within the food web. (1) - Determine the biomass of each organism in the food chains and use the data to construct a pyramid of biomass. (1) - Use the pyramid of biomass to construct the corresponding pyramid of energy for the ecosystem. (1)	Complete description, 4 marks Partial description, 1-3 marks			4
(e) (ii)	1.3	<u>Average Energy</u> Human beings are at trophic level 4 and therefore will receive 1/1000 of the energy according to the 10 % rule (1) $9000 / 1000 = 9\text{KJ}$ (1)				2
Total				3	11	6

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Question 2 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(a) (i)	1.1	<u>Logistic Growth</u> Logistic growth refers to a pattern of population growth in which the growth rate decreases as the population size approaches the environment's carrying capacity. (1)		1		
(a) (ii)	1.1	<u>Carrying Capacity</u> Carrying capacity is the maximum population size of a species that an environment can support sustainably over time, given the available resources such as food, water, shelter, and other necessities. (1)		1		
(a) (iii)	1.1	<u>Biotic potential</u> Biotic potential is the maximum reproductive capacity of an organism or population under ideal conditions without any limiting factors such as competition, predators, disease, or environmental constraints. (1)		1		

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Question 2 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(b) (i)	1.7	<u>Allopatric speciation</u> The Kanukus, which separate the savannah, can isolate homogenous populations of fish, (1) causing the isolated populations to undergo genotypic or phenotypic divergence, which prevents them from exchanging genes. (1) OR Mammals such as deer and other migratory species will over time become isolated, (1) undergoing genotypic or phenotypic divergence, which prevents them from exchanging genes. (1)	Complete description, 2 marks Partial description, 1 mark		2	
(b) (ii)	1.7	<u>Peripatric Speciation</u> Since the lakes, ponds and inlets are closed or isolated in dry season, this can cause new species to form in smaller peripheral populations in these bodies of water, (1) preventing them from exchanging genes with the main population. (1)	Complete description, 2 marks Partial description, 1 mark		2	

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Question 2 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks																		
				KC	AK	PA																
(c)	1.9	<u>Suitable Sampling Method</u> Capture-recapture sampling (1) . In this method, a random sample of individual animals from a population of unknown size is captured and the individuals are then marked or tagged and released back into the population (1) . Some time after, a second random sample of individual animals from the population is captured. This sample will contain both marked (previously captured) and unmarked (not previously captured) individuals. (1) The ratio (proportion of marked to unmarked) is recorded and analysed. (1)	Complete description, 4 marks Partial description 1-3 marks			4																
(d) (i)	1.10	<u>Species Diversity Calculation</u> <table border="1"><thead><tr><th>N</th><th>n (n-1)</th></tr></thead><tbody><tr><td>200</td><td>200 × 199 = 39 800</td></tr><tr><td>150</td><td>150 × 149 = 22 350</td></tr><tr><td>75</td><td>75 × 74 = 5 550</td></tr><tr><td>300</td><td>300 × 299 = 89 700</td></tr><tr><td>191</td><td>191 × 190 = 36 290</td></tr><tr><td>111</td><td>111 × 110 = 12 210</td></tr><tr><td>N = 1027</td><td>Σ n (n-1) = 205 900</td></tr></tbody></table> = 205 900 (1) / 1 027 (1 026) [205 900 / 1 052 676 (1)] = 0.19 (1)	N	n (n-1)	200	200 × 199 = 39 800	150	150 × 149 = 22 350	75	75 × 74 = 5 550	300	300 × 299 = 89 700	191	191 × 190 = 36 290	111	111 × 110 = 12 210	N = 1027	Σ n (n-1) = 205 900	Numerator 1 mark Denominator 1 mark Answer 1 mark		3	
N	n (n-1)																					
200	200 × 199 = 39 800																					
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111	111 × 110 = 12 210																					
N = 1027	Σ n (n-1) = 205 900																					

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Question 2 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(d) (ii)	1.11	<u>Stability of the Ecosystem</u> The value 0.19 means that this area has a high species diversity. (1) This means that there is a relatively even distribution among the species listed in the table and that no single species dominates, making the ecosystem a stable one. (1)	Complete statement, 2 marks Partial statement, 1 mark		2	
(e)	1.14	<u>Activities of the Amerindian People</u> The Amerindians in the Rupununi area <u>may use the range of the savannah to maintain a hunting and fishing subsistence, harvesting</u> (1) therefore harvesting just enough for a fresh meal, and then either selling or preserving any leftovers. (1) Amerindians in the Rupununi, as far as their land grants permit, <u>may practise traditional slash and burn agriculture</u>, since this is a suitable way of handling the poor fertility of tropical forests. (1) Using this method, the Amerindians clear small patches of forest, grow their crops, and then leave the area fallow to regain its nutrients while they farm in another [regenerated] area of forest. (1)	Any TWO activities discussed, 2 marks each		4	

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Question 2 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
		Amerindians may engage in spiritual and cultural practices linked to the forest, rivers and species found in the Rupununi (1) which causes them to prioritize their conservation or in some cases not hunt or harming specific animals or trees (1)				
Total				3	13	4

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Question 3	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(a) (i)	2.1	<u>Crude Birth Rate</u> The number of live births per 1000 people in a population in a given year (1) OR $\frac{\text{number of live births}}{\text{total population}} \times 1000 \text{ in a year } \mathbf{(1)}$		1		
(a) (ii)	2.1	<u>General Fertility Rate</u> The number of live births per 1000 women aged 15-49/ fertile women in a given year (1) OR $\frac{\text{number of live births}}{\text{number of fertile women}} \times 1000 \text{ in a year } \mathbf{(1)}$		1		
(a) (iii)	2.1	<u>Infant Mortality Rate</u> The number of deaths of infants under age 1 per 1000 live births in a given year. (1) OR $\frac{\text{number of deaths among children <1 year}}{\text{live births}} \times 1000 \text{ in a year } \mathbf{(1)}$		1		

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Question 3 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(b) (i)	2.8	<u>Student 1</u> Country B has a higher infant mortality rate therefore families will have more children in the hope of a few surviving (1). This increases fertility rates (1) and leads to a higher annual population growth rate. <u>Student 2</u> Country B has 45.52 per cent of its population involved in agriculture therefore more individuals are needed. (1) Families have more children to provide labour (1), which increases the annual growth rate.	Complete explanation, 2 marks Partial explanation, 1 mark 2 × 2=4		4	
(b) (ii)	2.5	<u>Calculation</u> Doubling time = 70/% growth rate (1) Doubling time for Country A = $70/0.12 = 583.33$ years (1) Doubling Time for Country B = $70/1.2 = 58.33$ (1) Difference = $583.33 - 58.33 = 525$ yrs (1) Assumption: Annual population growth rate remains constant. (1)	Calculation, 4 marks Assumption, 1 mark			5

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Question 3 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(b) (iii)	2.4	<u>Reasons for the Net Migration</u> Country B has more emigrants than immigrants People will choose to leave in search of 1. better job opportunities (1) as most jobs are low paying and in the agricultural sector (1) 2. better social services (1) , a high infant mortality indicates poor health care. (1)	TWO reasons outlined, 2 marks Complete outline, 2 marks Partial outline, 1 mark		4	
(b) (iv)	2.4	<u>Indirect Population Control Factor</u> Natural disasters such as hurricanes, floods, diseases, earthquakes and volcanoes can cause significant loss of life. This results in an immediate reduction in population. (1) Disasters often damage health care infrastructure, leading to increased mortality, especially among the vulnerable population (infants, the elderly, pregnant women). Lack of access to medical care can also lead to higher death rates from preventable diseases. (1)	Complete outline, 2 marks Partial outline, 1 mark		2	

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Question 3 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(b) (v)	2.11	<u>Environmental Impacts</u> - Deforestation (1) as land is cleared for agriculture (1)/housing (1) - Pollution (1) due to the large population size (1) / use of agrochemicals (1) Habitat Destruction (1) as agroecosystems replace natural ecosystems. (1) Reduction in biodiversity (1) when high yielding varieties/ GMOS are used in agriculture (1)	Complete outline, 2 marks Partial outline, 1 mark		2	
Total				3	12	5

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Question 4	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(a) (i)	2.8	<u>Poverty</u> The inability of individuals to access their basic needs (food, clothing and shelter) because of lack of income. (1) OR A situation where an individual has an income of less than \$2USD/day [to meet basic needs]. (1)		1		
(a) (ii)	2.10	<u>Human Development Index</u> A composite measure of a country's average achievement in health, education and standard of living. (1)		1		
(a) (iii)	2.12	<u>Sustainable Development</u> Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. (1)		1		
(b) (i)	2.12	<u>Poverty</u> People living in poverty do not have adequate resources. (1) They will therefore extract resources indiscriminately, (1) resulting in pollution (1) or resource depletion. (1)	Complete explanation, 3 marks Partial explanation, 1-2 marks		3	

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Question 4 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(b) (ii)	2.12	<u>Affluence</u> With greater affluence, persons have greater consumption patterns. (1) This results in greater demands for resource extraction/ resource depletion (1) and greater waste production/ pollution. (1)	Complete explanation, 3 marks Partial explanation, 1-2 marks		3	
(c)	2.11	<u>Positive Impact</u> The lionfish is edible. (1) Its fast reproductive rate means a large supply of protein for citizens. (1) This contributes to food security/livelihood for people such as restaurateurs and fishermen (1) <u>Negative Environmental Impact</u> Lionfish have no natural predators in the Atlantic Ocean and Caribbean Sea. (1) Therefore their numbers will be unchecked, leading to competition for resources (1) and disruptions of the marine ecosystem because they feed on a variety of marine life that also contribute to food security/livelihood for people such as restaurateurs and fishermen. (1)	For impact discussed, 3 marks Complete explanation, 3 mark) Partial explanation, 1-2 marks		6	

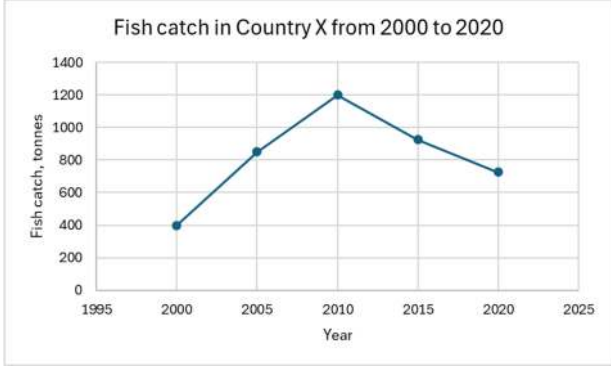
ENVIRONMENTAL SCIENCE
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Question 4 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(d) (i)		<u>Annual percentage population growth</u> $= (50000 + 3000) - (10000 + 27000)$ $= 16000 \text{ (1)}$ $= \frac{\text{population change}}{\text{initial population}} \times 100 \text{ (1)}$ $= 16000 / 2500000 \times 100 = 0.64\% \text{ (1)}$				4
(d) (ii)		Year End Population $2\,500\,000 + 16\,000 = 2\,516\,000$ (1)				1
Total				3	12	5

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Question 5	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(a) (i)	3.2	<u>Exhaustible resource</u> Natural resources that are present in limited amounts (1) but may be exhausted/used up if exploited at a rate faster than they can be replenished. (1)	Complete definition, 2 marks Partial definition, 1 mark	2		
(a) (ii)	3.1	<u>Remediation</u> Remediation is the process or act of resolving/correcting/mitigating (1) an environmental problem. (1) Remediation involves cleaning up pollution or contaminants from soil, water, or air, for example, oil spill remediation. (1)	Complete definition, 2 marks Partial definition, 1 mark	2		
(b)	3.3	<u>Consumptive Use of Natural Resources</u> No. (1) Example (1) Fossil fuels (coal, oil, natural gas) • Timber harvesting • Fishing (overfishing) • Mining Consumptive use of a natural resource refers to the depletion or using up of the resource in such a way that it is no longer available for future use. (1) This decline in natural resources may not occur if responsible use of them is practised (1) and renewable resources are allowed to replenish. (1)	Acceptable examples include logging, quarrying, fishing, mining. Any other reasonable example may be accepted.		5	

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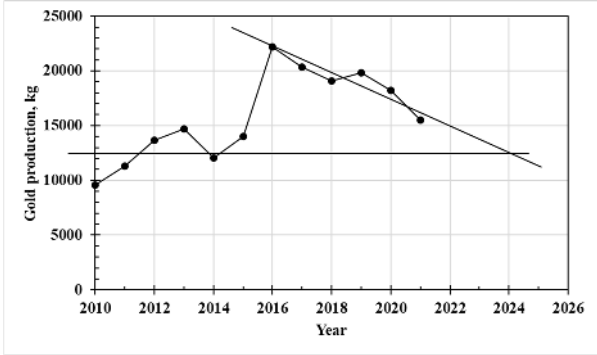
Question 5 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(c) (i)	3.4, 3.13, 3.14		Title, 1 mark Axis labels, 1 mark 3-4 points correct, 2 marks 1-2 points correct, 1 mark			5
(c) (ii)	3.5	<u>Impact of Trend on the Economy</u> - Fishing can be a source of jobs (livelihood, income generating activity). (1) A decline in this activity would cause persons to lose their livelihood (1) and they would be unable to access goods and services. (1) - Fish exports could be a major foreign exchange earner. (1) The decline in this area would reduce gross national product (GNP) (1) and make it difficult for the government to pay for social and other services. (1)	Any TWO impacts, 3 marks each Complete explanation, 3 marks Partial description, 1-2 marks Response must be related to the data in the graph.		6	

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Question 5 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(c) (ii) cont'd		- The fish caught in the country could be used as raw material for local industrial processes. (1) The decline in production would mean reduced production in the industry (1) and therefore reduced income for the country. (1) - The number of fish caught would improve food security. (1) The decline in this area would reduce the availability of fish as a food source in possible malnutrition (1) and may result in increased costs if additional food must be imported. (1)				
Total				4	11	5

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Question 6

Question 6	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(a) (i)	3.14	<u>Overall Trend</u> Gold production increased (1) from 2010, reaching its/the maximum level of production in 2016. (1) There was a steady decline in production from that point onwards. (1)	Complete description, 3 marks Partial description, 1-2 marks			3
(a) (ii)	3.13, 3.14	 12 500 kg. (1) Accept 12 000 – 13 000 kg	Best fit/ extrapolation line, 1 mark Correct estimate, 1 mark Correct units must be included for the estimate mark to be awarded			2

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Question 6 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(b) (i)	3.8	<u>Environmental Impacts of Mining</u> Habitat disruption/ destruction: (1) Gold mining can result in the removal of vegetation and the exposure of soil surface. (1) This will reduce the ability of the area to support animal and plant life. (1) Pollution of surface water: (1) Gold mining requires large amounts of water for washing of the gold-containing soil. (1) The used wash water contains sediments/pollutants that can contaminate rivers. (1) Deforestation. (1) Some gold mines are surface/strip mines, which means the vegetation is removed. (1) The trees are removed, and the soil is left bare and open to the elements. (1) Sedimentation and siltation: (1) Gold mining requires that water be used to separate the gold from the surrounding soil. (1) The wash water contains a lot of sediment, which will impact the river in which it is placed. (1) Soil erosion: (1) Gold mining may require the removal of surface vegetation, leaving the soil bare. (1) Exposed soil is removed by rain/wind action, resulting in erosion and degradation of the soil's fertility. (1)	Any TWO impacts, 3 marks each Complete explanation, 3 marks Partial explanation, 1-2 marks Marks are awarded as follows. Identification of issue, 1 mark How gold mining causes the issue, 1 mark The environmental impact, 1 mark Do not accept any human health impacts.		6	

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Question 6 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(b) (ii)	3.9	<u>Rehabilitation</u> Rehabilitation is the act of restoring something that has been damaged (1) to its former condition. (1)	Complete definition, 2 marks Partial definition, 1 mark	2		
(c) (i)	3.7	<u>Political and Social Factors Affecting Natural Resource Use in the Caribbean</u> Political factors: Government policies, economic development policies, environmental and natural resource policies, green budgeting (1) . Government policies can affect mining by restricting or encouraging particular actions. (1) Policies that favour environmental protection may limit the extent of mining or require expensive remediation, (1) increasing the government spending and limiting production. (1) OR Government policies can affect mining by restricting or encouraging particular actions. (1) Policies that favour economic development may encourage mining, (1) increasing production and possibly increasing environmental degradation. (1) .	Any ONE factor, 4 marks Mark allocation as follows. Identification of factor, 1 mark Complete explanation of factor, 3 marks Partial explanation, 1-2 marks		4	

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Question 6 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
		Social factors: conflict, crime, violence, education, attitudes, political instability, migration, human resource capacities. (1) Conflict/crime/political instability can affect mining by making it difficult to conduct business. (1) This may result in less mining occurring (1) or less concern for the environment, resulting in degradation. (1)				
(c) (ii)	3.10	<u>Natural Resource Management</u> • Change in lifestyles • Use of substitutes • Application of environmentally friendly technology • Sustainable yield management and community-based natural resource management • Reduction/minimisation of waste, recycling.	Any ONE approach, 1 mark	1		
(d)	3.11, 3.12	<u>Use of MEA</u> An MEA requires the country/government to establish laws, policies, processes, infrastructure (1) that will allow the country to meet its international environmental obligations. (1)	Complete explanation, 2 marks Partial explanation, 1 mark		2	
TOTAL				3	12	5



TEST CODE **02220020**

SPECIMEN 2026

CARIBBEAN EXAMINATIONS COUNCIL

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

ENVIRONMENTAL SCIENCE

AGRICULTURE, ENERGY AND ENVIRONMENTAL POLLUTION

UNIT 2 – Paper 02

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX questions in THREE sections. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. Do NOT write in the margins.
4. You may use a silent, non-programmable calculator to answer questions.
5. You are advised to take some time to read through the paper and plan your answers.
6. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
7. **If you use the extra page(s), you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

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

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02220020/CAPE/SPEC/2026

MODULE 1

Answer BOTH questions.

1. (a) Define the term 'peasantry'.

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[2 marks]

- (b) State ONE example of an indigenous fishing practice utilized in the Caribbean region.

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[1 mark]

- (c) The predominant model of plantation agriculture has been the single most transforming factor of agricultural systems in the Caribbean. Explain ONE way in which the plantation model has

- (i) impacted precolonial agricultural systems such as indigenous farming systems in Caribbean countries

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[2 marks]

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- (ii) influenced sustainable practices such as farm-to-table and fin-to-fork culture in Caribbean countries.

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[2 marks]

- (d) The Iwokrama International Centre for Rain Forest Conservation and Development, located to the east of Guyana's Pakaraima Mountains, was once a place of refuge for the indigenous Macushi people.

In 1989, the area was gifted to the Commonwealth and since then, the centre was established to manage the area under the mission "to promote the conservation and the sustainable and equitable use of tropical rainforests in a manner that leads to lasting ecological, economic and social benefits to the people of Guyana and to the world in general by undertaking research, training and the development and dissemination of technologies".

The centre's mission embraces sustainable tourism and focuses on traditional indigenous farming and fishing, as well as non-traditional methods such as agritourism.

- (i) Compare the traditional approach of indigenous farming and fishing with that of agritourism.

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[4 marks]

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- (ii) Discuss ONE sustainability issue that impacts indigenous farming and fishing.

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[3 marks]

- (iii) State ONE way in which the Iwokrama International Centre for Rain Forest Conservation and Development is important to agriculture in Guyana.

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[1 mark]

- (e) Table 1 shows the number of visitors to the Iwokrama International Centre for Rain Forest Conservation and Development during the period 2018 to 2024.

TABLE 1: THE NUMBER OF VISITORS TO THE IWOKRAMA INTERNATIONAL CENTRE FOR RAIN FOREST CONSERVATION AND DEVELOPMENT DURING THE PERIOD 2018 TO 2024

Year	Number of Visitors
2018	79 000
2019	60 500
2020	100
2021	700
2022	12 000
2023	27 000
2024	50 000

On the grid provided on page 5, plot a suitable graph to illustrate the information in Table 1. [5 marks]

Total 20 marks

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[illegible]

2. (a) Define the term 'zoonosis'.

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[2 marks]

- (b) Identify ONE factor which is responsible for food insecurity in the Caribbean region.

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[1 mark]

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- (ii) Explain THREE ways in which focusing on the economic transformation and recovery of MSMEs can result in Caribbean countries attaining Sustainable Development Goal 8 (SDG 8), Decent Work and Economic Growth.

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[6 marks]

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- (d) Figure 1 shows the percentage contribution of various sectors to the gross domestic product (GDP) in 2019, prior to the COVID-19 pandemic in a Caribbean country.

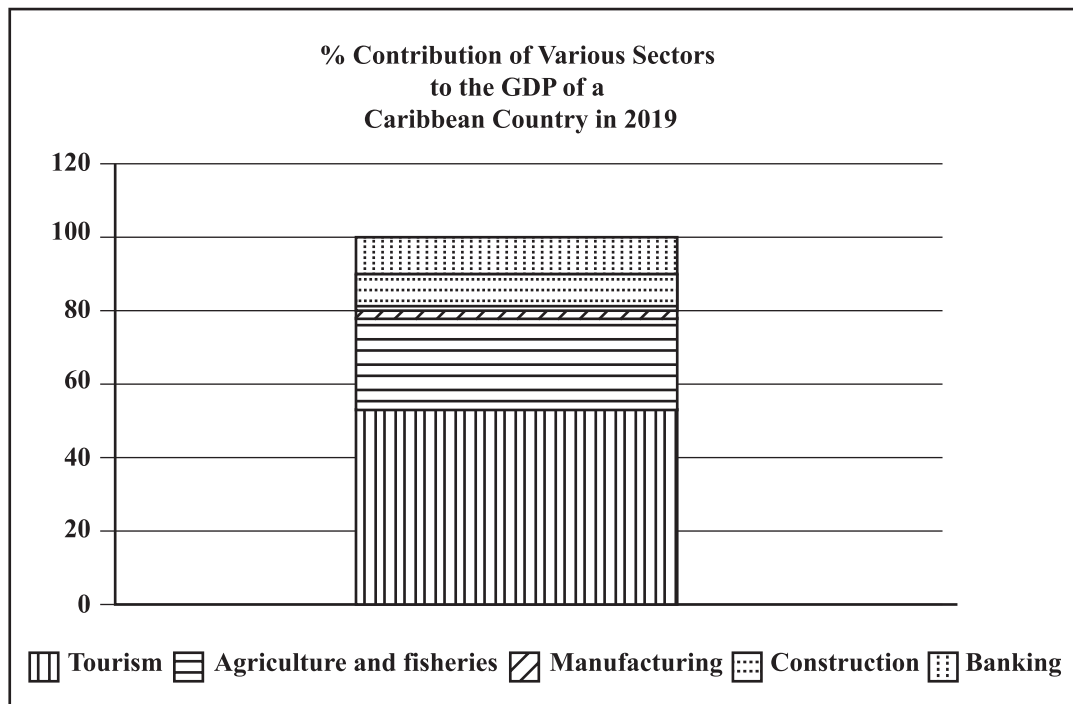


Figure 1. The percentage contribution of various sectors to the gross domestic product (GDP) in 2019

- (i) Assuming that the total GDP of the Caribbean country was 12 million US dollars in 2019, use the information in Figure 1 to calculate the contribution of agriculture and fisheries to the economy.

[3 marks]

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- (ii) Assuming that the contribution of tourism in 2020 fell by 97% from its 2019 value of 6.6 million US dollars, calculate the GDP from tourism in 2020.

[2 marks]

Total 20 marks

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MODULE 2

Answer BOTH questions.

3. (a) An official from the energy sector visited a school during its annual science fair. He stated, “There are many different forms of energy which can be categorized as potential energy or kinetic energy”.

Complete Table 2 by classifying each form of energy listed as either potential energy or kinetic energy. Three of them have already been completed.

Light	Chemical	Nuclear
Gravitational	Thermal	Electrical

TABLE 2: EXAMPLES OF KINETIC AND POTENTIAL ENERGY

Potential Energy	Kinetic Energy
Gravitational	Light
Chemical	

[3 marks]

- (b) Table 3 compares the efficiency of and the operation costs for three different types of bulbs.

**TABLE 3: THE EFFICIENCY OF AND OPERATION COSTS FOR
THREE DIFFERENT TYPES OF BULBS**

	 LED	 CFLs	 Incandescent
Average bulb lifespan (hours)	25 000	8 000	1 200
Energy used as heat	10%	80%	90%
Energy cost (annually for four hours a day at 11.5 cents per kilowatt hour)	\$2	\$2.34	\$10

Calculate the difference in annual cost if a homeowner uses an LED bulb to replace an incandescent bulb for eight hours per day. (Assume energy cost is at the same rate as shown.)

[3 marks]

GO ON TO THE NEXT PAGE

- (c) Bouillante is currently the only geothermal power plant in the Caribbean. It is also the first of its kind to produce electricity at an industrial scale in France. Geothermal-powered electricity production began in 1996 and by 2003, when Bouillante 2 was brought online, total production increased to 15 MW.

Electricity generated by both plants accounts for 6% of total generation in Guadeloupe.

Figure 2 is a schematic diagram of the Bouillante 2 Geothermal Power Plant in Guadeloupe.

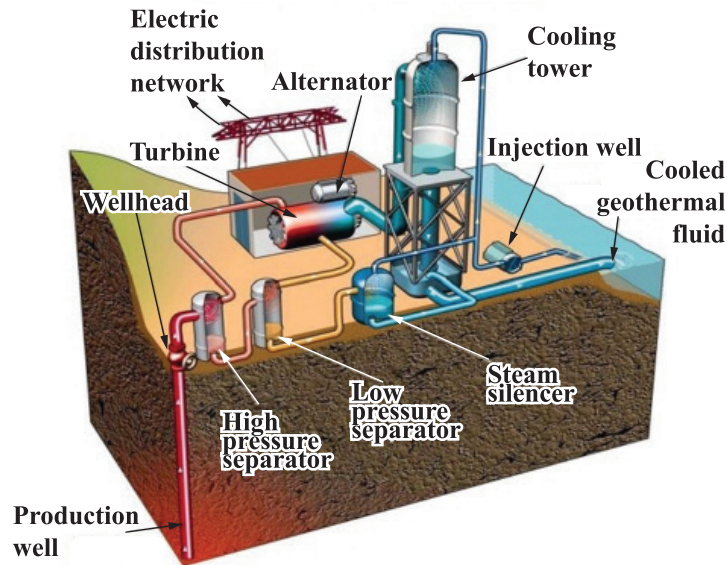


Figure 2. Operations at Bouillante 2 Geothermal Power Plant

Source: Adapted from <http://www.geothermie-perspectives.fr/ADEME/BRGM>

- (i) Using the diagram, explain how geothermal energy is harnessed to provide electricity to homes in Guadeloupe.

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[4 marks]

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- (ii) Outline TWO **positive** environmental impacts of using the geothermal energy production system shown in Figure 2 as a power source.

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[4 marks]

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- (iii) Table 4 shows the electricity generation mix from renewable energy in Guadeloupe for 2020.

**TABLE 4: ELECTRICITY GENERATION MIX FROM RENEWABLES
IN GUADELOUPE FOR 2020**

Energy Source	Generation Capacity (MW)
Biomass	3.7
Geothermal	14.7
Hydropower	10.5
Solar	70.4
Wind	22.1
Total	121.4

Source: <https://www.energy.gov/eere/articles/guadeloupe-island-energy-snapshot-2020>

Using the data in Table 4, complete the portion of the pie chart labelled X in Figure 3 below to show the proportions for wind and solar energy.

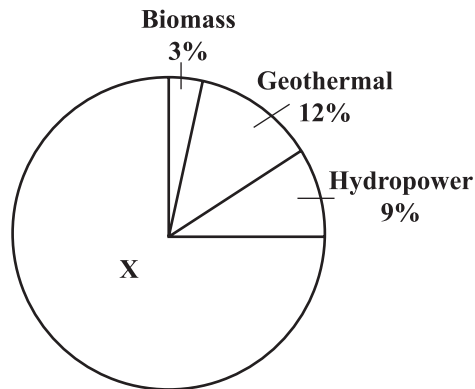


**Figure 3. Pie chart showing the electricity generation mix from
renewable sources in Guadeloupe (2020)**

[2 marks]

- (d) In the ten years of application, Guadeloupe's Building Energy Efficiency regulation, Réglementation Thermique de la Guadeloupe "RTG" approach conducted by the Regional Council of Guadeloupe has induced direct and indirect transformations in the building sector. The success has been used as a guideline for other Caribbean countries.

Outline TWO methods of improving the energy efficiency of buildings in the Caribbean.

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[4 marks]

Total 20 marks

4. (a) Figure 4 shows the components of a fossil fuel power generation plant.

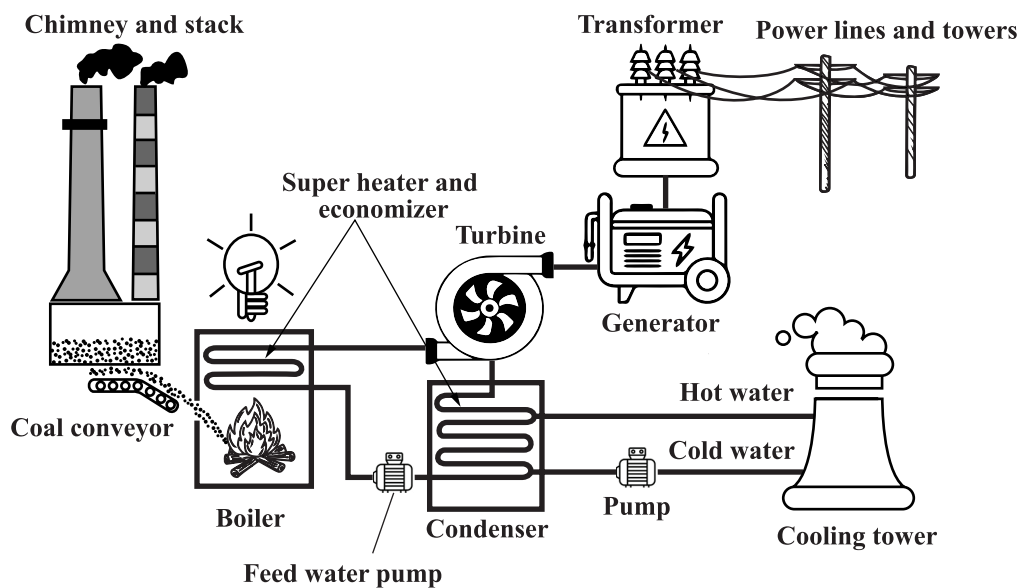


Figure 4. A fossil fuel power plant

- (i) Identify TWO components shown in Figure 4 which make up part of the generation process.

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[2 marks]

- (ii) Name ONE component shown in Figure 4 which is part of the transmission phase of power generation.

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[1 mark]

- (b) Goal 7 of the Sustainable Development Goals adopted by all United Nation members in 2015 is about ensuring access to clean and affordable energy, which is key to the development of agriculture, business, communications, education, health care and transportation. Many Caribbean countries have implemented solar power projects to achieve this goal.

Explain how EACH of the following factors have contributed to the success of these solar power projects.

- (i) Geographical

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[2 marks]

- (ii) Environmental

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2 marks]

- (c) Outline ONE way in which energy is important for EACH of the following sectors in Caribbean countries.

- (i) Agriculture

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[2 marks]

GO ON TO THE NEXT PAGE

- (ii) Health care

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[2 marks]

- (d) In May 2024, The Caribbean Utilities Company (CUC) announced that residential customers could experience outages for up to an hour during peak usage times, typically from 4.30 p.m. to 8.30 p.m. in Grand Cayman. CUC attributed the possible outages to high temperatures, rapid economic growth and delays in updating grid capacity.

Explain how economic growth and aged generation plants contributed to the anticipated load shedding.

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[4 marks]

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- (e) An Environmental Science student conducted a survey within the Hilltop School community about attitudes to three selected renewable energy sources: Solar, Wind and Biofuels.

Analysis of the results shows that people ranked the sources in the following order of preference – Solar: High, Wind: Medium and Biofuels: Low.

Construct a suitable table to illustrate the above findings.

[5 marks]

Total 20 marks

GO ON TO THE NEXT PAGE

MODULE 3

Answer BOTH questions.

5. (a) Figure 5 illustrates the data collected during a monitoring exercise of a river that receives effluent from a point source of pollution. The dissolved oxygen levels in the river were monitored at intervals downstream of the point source, and the recovery of the oxygen in the river was noted. Study Figure 5 carefully and answer the questions that follow.

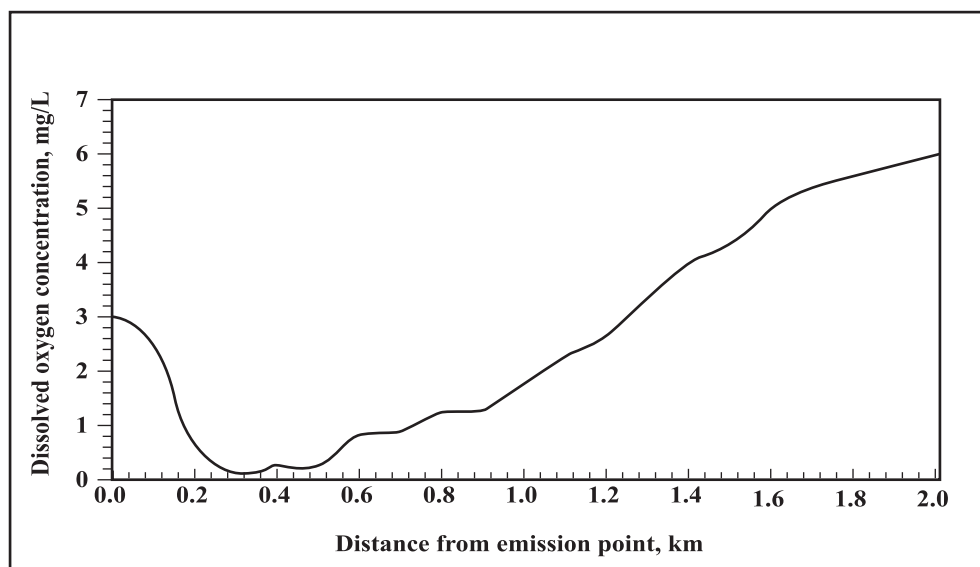


Figure 5. Concentration of dissolved oxygen in a river downstream of a point source of pollution

- (i) Define the term 'point source'.

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.....

[1 mark]

- (ii) Suggest ONE industry that could be the point source in Figure 5.

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[1 mark]

GO ON TO THE NEXT PAGE

- (iii) Determine the **lowest** dissolved oxygen concentration in the river.

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[1 mark]

- (iv) Explain how the waste emitted by the industry suggested in (a) (ii) can result in the reduction in dissolved oxygen concentration seen in Figure 5.

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[4 marks]

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- (v) Calculate the rate of increase of dissolved oxygen from 0.3 km to 2.0 km along the river.

[4 marks]

- (b) Fifteen years ago, when this monitoring exercise was first done, the lowest dissolved oxygen concentration was found to be 4.6 mg/L. A classmate suggests that the change observed in Figure 5 is due to population growth, an underlying cause of pollution.

- (i) State TWO underlying causes of pollution, other than population growth.

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[2 marks]

- (ii) Explain how population growth could have resulted in the change seen in Figure 5.

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[3 marks]

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- (c) Explain how international agreements relevant to pollution work to protect the environment, using the Montreal Protocol as an example.

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[4 marks]

Total 20 marks

GO ON TO THE NEXT PAGE

6. (a) Table 5 illustrates the amounts and types of solid waste disposed to landfills in St. Vincent and the Grenadines in 2020. Study Table 5 carefully and answer the questions that follow.

TABLE 5: SOLID WASTE DISPOSED TO LANDFILLS IN ST. VINCENT AND THE GRENADINES IN 2020

Waste Type	Percentage Distribution
Green waste	21.3
Commercial waste	38.5
Household and institutional waste	32.5
Construction and demolition waste	7.7

*Source: The Statistical Office, St Vincent and the Grenadines.
2020 Compendium of Environmental Statistics.
<https://stats.gov.vc/wp-content/uploads/2022/07/Compendium-of-Environmental-Statistics-2020.pdf>*

- (i) State ONE example of 'green waste'.

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[1 mark]

- (ii) Calculate the mass of green waste disposed to landfills in St Vincent and the Grenadines, given that the total mass of waste was 162 962 tonnes in 2020.

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[2 marks]

- (iii) Explain TWO environmental impacts, other than noise or air pollution, that may occur due to the presence of a landfill in an area.

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[4 marks]

GO ON TO THE NEXT PAGE

- (b) Landfills produce large quantities of potent greenhouse gases and so, are not only a source of land pollution, but also of air pollution.

- (i) Name ONE greenhouse gas emitted by landfills.

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[1 mark]

- (ii) Explain why the emission of the gas named in (b) (i) is an environmental problem.

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[4 marks]

- (c) (i) Landfills are also a source of noise pollution. State ONE other source of noise pollution.

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[1 mark]

- (ii) Outline ONE human health impact that may occur when persons are exposed to noise pollution.

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[2 marks]

GO ON TO THE NEXT PAGE

- (d) To mitigate the noise pollution being experienced by residents close to a landfill, the solid waste management company plants large trees along the boundary of the landfill. It is hoped that this will act as a noise barrier and address some of the noise complaints made by the residents.

Plan and design a study that will enable you to determine if the tree planting exercise is an effective means of noise prevention at a landfill. Write your responses under the headings provided.

Hypothesis

[1 mark]

Procedure

[3 marks]

Expected results

[1 mark]

Total 20 marks

END OF TEST

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

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Question No.

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THIS PAGE***

CANDIDATE'S RECEIPT

INSTRUCTIONS TO CANDIDATE

1. Fill in all the information requested clearly in capital letters.

TEST CODE

0	2	1	2	0	0	2	0

SUBJECT ENVIRONMENTAL SCIENCE – UNIT 1 – Paper 02

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REGISTRATION NUMBER

FULL NAME _____
(BLOCK LETTERS)

SIGNATURE _____

DATE _____

2. Ensure that this slip is detached by the Supervisor or Invigilator and given to you when you hand in this booklet.
3. Keep it in a safe place until you have received your results.

INSTRUCTION TO SUPERVISOR/INVIGILATOR

Sign the declaration below, detach this slip and hand it to the candidate as his/her receipt for this booklet collected by you.

I hereby acknowledge receipt of the candidate's booklet for the examination stated above.

Signature _____
Supervisor/Invigilator

Date _____

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ENVIRONMENTAL SCIENCE

UNIT 2 - Paper 02

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SPECIMEN PAPER

ENVIRONMENTAL SCIENCE
PAPER 02
KEY AND MARK SCHEME

Question 1	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
(a)	1.1	<u>Peasantry</u> The term peasantry refers to the class of rural, agricultural labourers or small farmers who typically work the land, often under traditional or subsistence farming conditions. (1) The peasantry has historically been associated with the lower economic and social status, particularly in agrarian societies. (1) Peasants usually own or lease small plots of land and their livelihood depends on the cultivation of crops, raising livestock, or both. (1)	Any TWO points, 1 mark each	2		
(b)	1.1	<u>Indigenous Fishing Practices</u> • Spearfishing • Cash fishing Use of any from the list below • gillnets • bow and arrow • net and seine net • raati nets • lobster and fish pot/traps • casitas (as bait) • plants or other substances to stun or kill fish • dams/weirs • fish wheels • handheld lines made from either <i>pite</i> (pineapple fibres) or <i>mahot</i> (sea hibiscus) [from canoes and small boats] • Free diving • Whaling	Any ONE practice, 1 mark	1		

ENVIRONMENTAL SCIENCE
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Question 1 cont'd	Syllabus Objective	Suggested Response	Instructions	Marks		
				KC	AK	PS
(c) (i)	1.3	<u>How the plantation model impacted on pre-colonial agricultural systems</u> - Plantation agriculture has a negative impact on indigenous farming practices since it disrupts traditional land use (1), leading to a loss of biodiversity, and a shift towards monoculture crops. (1) - Plantation agriculture led to the displacement of communities (1) and loss of traditional land tenure systems, leading to food insecurity. (1) - Plantation agriculture led to the loss of indigenous crops grown through traditional methods (1), reducing the variety of wild cultivars of many staples such as rice, corn and wheat. (1)	Any ONE complete explanation 2 marks Partial explanation 1 mark		2	

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Question 1 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(c) (ii)	1.3	<u>How the plantation model influences sustainable practices</u> - Plantation agriculture has led to the loss of arable land due to practices of local people (1) who have strived increasingly to revert to traditional methods of agriculture. (1) - The desire to reduce the food import bill and secure livelihoods (1) has led to a social movement and style of eating that emphasize locally sourced food (1) - plantation agriculture was primarily geared to the export market (1) and farm-to-table provides more sustainable supply chains because produce is not shipped over long distances (1) - Large-scale fisheries such as trawling has led to the depletion of some commercial species. This often impacts small-scale fishers (1) since fin-to-fork regimes allow fisherfolk and other small-scale operators to earn a livelihood, while also allowing for the provision of fresh, locally caught seafood to consumers (1)	Any ONE Complete explanation, 2 marks Partial explanation, 1 mark		2	

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Question 1 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(d) (i)	1.3	<u>The traditional approach of indigenous farming and fishing compared with that of agritourism</u> Indigenous farming and fishing practices are based on traditional ecological knowledge (1) which synchronise with nature/ focus on sustainability generally for peasant use (1) while agritourism is usually for economic gain on a larger scale, that is, to sustain small farms and support local economies (1) by utilising a combination of agriculture and tourism to provide accommodation, food, recreation and education. (1)	Complete comparison 4 marks Partial comparison 1- 2 marks		4	

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Question 1 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(d) (ii)	1.6	<u>Negative Sustainability Issues</u> Overfishing and Decline of Fish Stocks: (1) In some regions, traditional fishing practices can contribute to overfishing, especially if the community is unable to regulate fish populations effectively. (1) Overfishing can lead to the depletion of local fish species and disrupt the ecological balance. (1) Land Degradation: (1) In some indigenous farming practices, particularly in tropical regions, the need for more land to grow food (1) can lead to deforestation, soil erosion, and the degradation of ecosystems. (1) Climate Change: (1) Indigenous communities often rely heavily on their environment for subsistence farming and fishing. (1) Climate change, such as rising temperatures, altered rainfall patterns, and sea-level rise, can significantly impact the sustainability of their practices. Changing weather patterns may lead to crop failure or fish migration, challenging traditional ways of life. (1)	Complete discussion 3 marks Partial discussion 1-2 marks		3	

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Question 1 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(d) (ii) cont'd		External Pressures and Commercialization: (1) As indigenous communities become more integrated into the global economy, the commercialization of traditional farming or fishing practices can lead to the depletion of natural resources. (1) Large-scale commercial ventures may exploit fishing grounds or land that indigenous communities use for subsistence, disrupting local ecosystems and diminishing sustainability. (1) Loss of Traditional Knowledge (1): The erosion of traditional ecological knowledge due to globalization, youth migration, or loss of cultural practices can undermine the sustainability of indigenous farming and fishing. (1) The knowledge passed down through generations regarding local ecosystems, crop rotation, fishing seasons, and natural resource management is crucial for maintaining environmental balance. Without it, practices may become unsustainable over time. (1) Water Pollution: (1) In some cases, indigenous communities may rely on water sources that are contaminated by industrial activities or agricultural runoff from neighboring non-indigenous farming. (1) This pollution can harm aquatic life, disrupt fishing practices, and make water unsafe for consumption. (1)				

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Question 1 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(d) (ii) cont'd		Invasive Species: (1) The introduction of invasive species, either intentionally or unintentionally, can negatively impact the sustainability of indigenous farming and fishing practices. (1) These species often compete with native species, either disrupting ecosystems or reducing the availability of resources needed for indigenous livelihoods. (1) <u>Positive sustainability issues</u> Biodiversity Conservation: (1) Indigenous farming and fishing methods often emphasize the importance of maintaining biodiversity. Practices like crop diversification, agroforestry, and rotational fishing contribute to healthy ecosystems. (1) By using traditional knowledge, these communities cultivate a wide variety of crops or maintain diverse fish stocks, helping protect the natural environment and preventing monoculture or overfishing. (1) Soil Health and Regeneration: (1) Many indigenous farming practices, such as intercropping, agroforestry, and the use of organic fertilizers, focus on maintaining healthy soil and preventing erosion. (1) These practices often use locally available materials to improve soil fertility and ensure long-term productivity. (1)				

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Question 1 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(d) (ii) cont'd		Sustainable Fisheries Management: (1) Indigenous fishing practices typically involve seasonal cycles, catch limits, and traditional knowledge of fish habitats, which help preserve fish populations. (1) Many communities have systems in place to ensure fish stocks are not overexploited, with certain areas or species designated as "off-limits" during breeding seasons. (1) Low Environmental Impact: (1) Indigenous farming and fishing methods tend to have a much lower environmental impact compared to industrial agriculture or fishing. (1) For example, traditional fishing techniques, such as using hand lines, traps, or nets, typically have less damage to ecosystems compared to large-scale trawling or deep-sea fishing. Similarly, small-scale, low-input farming minimizes the use of chemical fertilizers and pesticides, reducing environmental pollution. (1) Carbon Sequestration: (1) Indigenous farming practices, like agroforestry (the integration of trees and crops), can sequester carbon, contributing to climate change mitigation. (1) Trees and other vegetation act as carbon sinks, absorbing and storing carbon dioxide from the atmosphere. (1)				

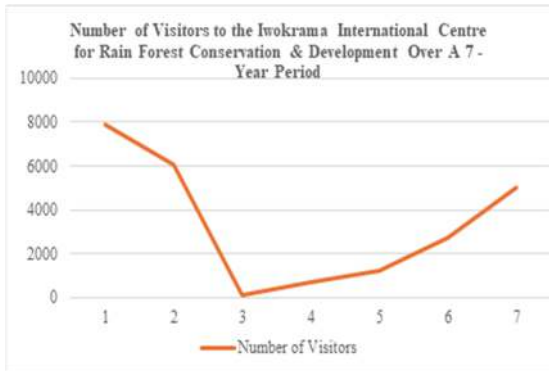
ENVIRONMENTAL SCIENCE
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KEY AND MARK SCHEME

Question 1 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(d) (ii) cont'd		Cultural Resilience and Knowledge Preservation: (1) Sustainable indigenous farming and fishing methods are deeply tied to cultural heritage. (1) The preservation and transmission of traditional ecological knowledge (TEK) about local ecosystems, species, and seasonal cycles contribute to long-term environmental sustainability. (1) Water Conservation: (1) Traditional indigenous farming often incorporates water conservation techniques. These can include practices such as rainwater harvesting, mulching, and the use of natural irrigation systems, which minimize water waste. (1) In fishing, traditional techniques often focus on protecting water quality, ensuring that water resources are used sustainably and do not become depleted or polluted. (1) Promoting Local Food Systems: (1) Indigenous farming often focuses on growing and harvesting foods that are native to the region, promoting local food systems that are resilient and sustainable. (1) By growing food that is adapted to local environmental conditions, indigenous communities reduce reliance on imported goods and minimize the carbon footprint associated with long-distance food transportation. (1)				

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Question 1 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(d) (iii)	1.4	<u>Importance of the Iwokrama International Centre for Rain Forest to agriculture</u> Economic • Employment of Macushi (indigenous peoples) from nearby villages • Development and marketing of non-food products /non-forestry timber products (NTFPs) • Development of agritourism Social • Provide education and training on indigenous agriculture/ fishing or agritourism • Preservation of the cultural heritage of the Macushi (Indigenous peoples) Ecological/environmental • Conservation of wild varieties/biodiversity/ cultivars • Conservation of soil around the area • Provision of ecological services such as water cycling and carbon sequestration	Any ONE importance, 1 mark	1		

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Question 1 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks																		
				KC	AK	PS																
(e)		<u>Graph</u>  <table><caption>Data for Number of Visitors Graph</caption><thead><tr><th>Year Period</th><th>Number of Visitors</th></tr></thead><tbody><tr><td>1</td><td>8000</td></tr><tr><td>2</td><td>6000</td></tr><tr><td>3</td><td>0</td></tr><tr><td>4</td><td>1000</td></tr><tr><td>5</td><td>1500</td></tr><tr><td>6</td><td>2500</td></tr><tr><td>7</td><td>5000</td></tr></tbody></table>	Year Period	Number of Visitors	1	8000	2	6000	3	0	4	1000	5	1500	6	2500	7	5000	▪ Title (1) ▪ <u>both</u> axis labels (1) ▪ 7 points correct (3) ▪ 6 – 4 points correct (2) ▪ 3 – 1 points correct (1)			5
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Question 2	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(a)	1.6	<u>Zoonosis</u> Zoonosis is an infectious disease caused by a pathogen, an infectious agent such as a bacterium, virus or a parasite, (1) that has moved from an animal to a human being. (1)	Complete definition 2 marks Partial definition 1 mark	2		
(b)	1.6	<u>Factors which is responsible for food insecurity</u> - Fragmented land tenure - Poor/exhausted soils - High import costs/ taxation - Market shocks and fluctuations	Any ONE factor, 1 mark	1		
(c) (i)	1.5	<u>Digitizing Supply Chains</u> 1. Improved Tracking and Transparency (1) Fishing: Digital technologies like GPS tracking, RFID tags and blockchain can be used to track fish from catch to consumer. (1) This enhances traceability, ensuring that the fish are sustainably sourced and reducing the risks of overfishing. (1)	Any TWO explanations, 3 marks Complete explanation for either fishing or farming 3 marks Partial explanation 1-2 marks		6	

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Question 2 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(c) (i)	1.5	• Farming: Digitization allows for better tracking of crops from seed to harvest, enabling farmers to trace the origins of their products. (1) It can help confirm whether organic certifications and sustainability practices are being adhered to, providing transparency for consumers and improving market access. (1) 2. Better Resource Management (1) • Fishing: Digitizing data on fish populations, water conditions, and catch sizes allows for more informed decisions regarding fishing quotas, times, and methods. (1) Real-time data can help manage stocks and ensure sustainable harvesting practices. (1) • Farming: Smart farming technologies such as IoT (Internet of Things) sensors, drones, and satellite imaging can help farmers monitor soil conditions, water levels, and crop health. (1) This leads to more efficient resource usage, reducing waste and improving sustainability by optimizing irrigation and fertilizer application. (1)				

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Question 2 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(c) (i)	1.5	3. Enhanced Supply Chain Efficiency (1) • Fishing: Digital tools can streamline the entire fishing supply chain, from catching and processing to transportation and distribution. (1) By improving inventory management and logistics, businesses can reduce waste, improve stock replenishment, and reduce the time from catch to market, ensuring fresher products and reduced spoilage. (1) • Farming: Digital platforms can connect farmers directly with suppliers, distributors, and consumers, eliminating intermediaries and lowering transaction costs. (1) Automation in warehousing, packaging, and delivery can significantly reduce delays and inefficiencies, helping products reach consumers faster and in a fresher state. 4. Data-Driven Decision Making (1) • Fishing: Data from sensors and tracking systems can help fishermen and fleet managers make real-time decisions about where to fish, how much to catch, and which methods to use. (1) Machine learning algorithms can predict fish movements based on environmental conditions, reducing the risk of overfishing and improving catch success rates. (1) • Farming: Digital tools can provide farmers with actionable insights about weather patterns, pest control, crop rotation, and yield predictions. (1) By using data analytics, farmers can make informed decisions on when to plant, irrigate, or harvest, minimizing losses and maximizing productivity. (1)				

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Question 2 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(c) (i)	1.5	5. Sustainability and Environmental Monitoring • Fishing: Digitization enables continuous monitoring of marine ecosystems, helping to assess environmental changes and the impact of fishing activities on marine biodiversity. (1) By integrating data from sensors, satellites, and AI, the fishing industry can identify key areas for conservation, regulate fishing zones, and monitor endangered species. (1) • Farming: Digital systems can help track environmental factors such as water usage, soil health, and carbon emissions. (1) With real-time data, farmers can implement precise, sustainable practices like reduced water consumption, optimized pesticide usage, and reduced greenhouse gas emissions. (1) 6. Supply Chain Resilience and Risk Management (1) • Fishing: Digital tools can improve the fishing industry's resilience to market disruptions, weather events, and regulatory changes. (1) By connecting fishermen with a digital marketplace, they can easily access up-to-date market prices and trends, helping them make better decisions and manage financial risks. (1) • Farming: Digital platforms can help farmers track potential risks such as extreme weather, crop diseases, or price volatility. (1) With access to accurate forecasts and market trends, they can adapt their operations, reduce risk exposure, and make better long-term planning decisions. (1)				

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Question 2 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(c) (i)	1.5	7. Optimized Logistics and Distribution (1) • Fishing: Digital supply chain tools, such as automated logistics platforms and AI-driven optimization, help reduce transportation costs and delivery times. (1) Fishing products can be tracked and rerouted in real-time, minimizing spoilage and ensuring that fish reach consumers while still fresh. (1) • Farming: For farmers, digitized supply chains optimize transportation routes and improve coordination between production and distribution (1). This ensures that fresh produce reaches the market in the shortest time possible, reducing the need for refrigeration and preventing waste. (1) 8. Increased Market Access and Consumer Engagement (1) • Fishing: Through e-commerce platforms, digital marketplaces, and direct-to-consumer models, digitization allows small-scale fishermen to access larger, more diverse markets. (1) They can also engage consumers through digital platforms by promoting the sustainability of their practices, building trust and loyalty. (1) • Farming: Farmers can reach global markets directly through digital platforms, reducing reliance on middlemen and increasing their share of the value chain. (1) Online marketplaces also help consumers access locally grown products, and digital tools allow farmers to directly communicate with buyers, building relationships and increasing profitability. (1)				

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Question 2 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(c) (i)	1.5	9. Increased Collaboration and Knowledge Sharing • Fishing: Digital platforms can help share knowledge and best practices among fishing communities. Whether it's learning about sustainable practices, weather patterns, or fish migration trends, (1) these platforms can foster collaboration between fishers and stakeholders in the supply chain. (1) • Farming: Digitization can enhance collaboration between farmers, researchers, agronomists, and agricultural organizations. (1) Online forums, data-sharing platforms, and agricultural networks can provide farmers with access to new technologies, innovations, and market trends, improving their productivity and sustainability. (1)				

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KEY AND MARK SCHEME

Question 2 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(c) (ii)		<u>Economic transformation and SDG 8</u> 1. Creating Job Opportunities in New Sectors (1) • Diversification of the Economy: Economic transformation often involves diversifying economies away from reliance on a single industry, for example, agriculture (1) and developing sectors such as technology, green energy, services, and manufacturing. This creates a wide range of job opportunities. (1) OR • Entrepreneurship and Innovation: Supporting entrepreneurship and small businesses encourages job creation. Economic transformation encourages innovation and the development of new business models, (1) particularly in high-growth sectors such as technology, renewable energy, and the circular economy, which fosters new employment avenues. (1) 2. Promoting Inclusive Growth (1) • Reducing Inequality: Economic transformation can reduce inequality by improving access to education, healthcare, and economic opportunities for marginalized groups. (1) By ensuring that growth is inclusive and benefits all sectors of society—especially women, youth, and vulnerable populations—economic transformation directly supports SDG 8's goal of equitable economic growth. (1)	Any THREE explanations, 2 marks 1 mark for stating the way, 2 marks for complete explanation			

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Question 2 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(c) (ii)		OR • Access to Skills and Education: A transformed economy can focus on improving education and skill-building programs, particularly in underdeveloped areas, to provide workers with the qualifications and abilities necessary to participate in more sophisticated industries. (1) This leads to better job quality, higher wages, and reduced unemployment rates. (1) 3. Encouraging Sustainable and Green Industries (1) • Green Jobs and Renewable Energy: Transitioning to a green economy—one focused on renewable energy, sustainable agriculture, and low-carbon industries – can create millions of new jobs while reducing environmental harm. (1) Jobs in renewable energy, energy efficiency, waste management, and sustainable agriculture contribute to economic growth while ensuring environmental sustainability. (1) OR • Circular Economy: Promoting a circular economy, where products are reused, recycled, and regenerated, helps create jobs in waste management, recycling, and product remanufacturing, (1) while also ensuring that economic growth does not lead to unsustainable resource depletion. (1)				

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Question 2 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(c) (ii)		4. Improving Labor Market Policies (1) Labor Rights and Decent Work: Economic transformation can promote reforms that strengthen labor rights and create better working conditions across industries. (1) Policies that ensure fair wages, safe working environments, social protections, and the elimination of child labor and forced labor are key to promoting decent work and full employment. (1)				
		OR Social Protection Systems: Transforming the economy can lead to the expansion of social protection systems such as unemployment insurance, pensions, and health care, (1) which are crucial for ensuring decent living standards and reducing inequality. (1) 5. Improving Infrastructure and Connectivity (1) Transport and Logistics: A transformed economy often involves significant investments in infrastructure such as improved transportation networks, digital connectivity and energy infrastructure. (1) These investments increase access to markets, reduce the cost of doing business, and create jobs in construction, logistics, and transport industries. (1)				

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Question 2 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(c) (ii)		OR • Access to Finance: Financial inclusion is another critical aspect of economic transformation. By expanding access to credit, microfinance, and digital financial services, more people – especially those in rural areas or informal sectors – can access capital to start businesses or improve their livelihoods. (1) This contributes to productive employment and reduces economic inequalities. (1) 6. Supporting Sustainable Agriculture and Rural Development (1) • Agri-Tech and Modernization: Economic transformation can lead to the modernization of agriculture through the adoption of new technologies such as precision farming, drones, and sustainable farming practices. (1) These innovations help improve agricultural productivity, create high-quality jobs, and promote the long-term sustainability of rural communities. (1) OR • Value Chain Development: By improving agricultural value chains and connecting farmers to markets, economies can be transformed (1) can increase the income of rural populations, create jobs in agribusiness, and support the development of food processing industries, which boosts both local and national economies. (1)	Any THREE explanations, 2 marks 1 mark for stating the way, 2 marks for complete explanation			

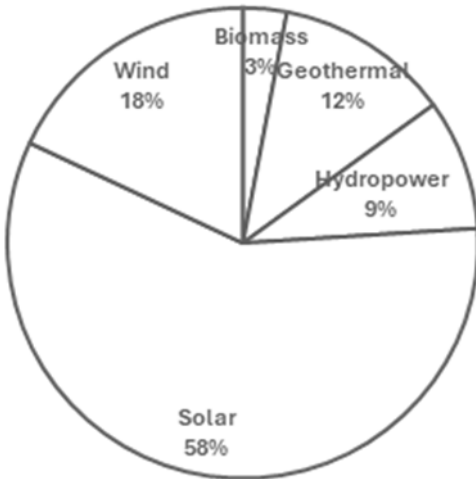
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Question 2 cont'd	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
		7. Improving Health and Well-being (1) • Better Healthcare Access: Economic transformation can lead to investments in public health systems, which in turn creates more jobs in health care and ensures a healthier workforce. (1) A healthier population is more productive and better able to contribute to economic growth. (1)				
(d) (i)	1.11	<u>Calculation</u> 79 - 55 (1) = $24/100 \times 12\,000\,000 = 2.88$ million (1) USD (1)				3
(d) (ii)	1.11	Calculation $6\,600,000 \times 97/100 = 6\,402\,000$ (1) $6\,600,000 - 6\,402,000 = 198\,000$ USD (1) OR $6\,600\,000 \times 3/100$ (1) = 198 000 USD (1)				2
Total				3	12	5

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Question 3	Syllabus Objectives	Suggested Response	Instructions	Marks										
				KC	AK	PS								
(a)	2.1	<u>Energy classification</u> <table border="1"><tr><td>Potential Energy</td><td>Kinetic Energy</td></tr><tr><td>Gravitational</td><td>Light</td></tr><tr><td>Chemical</td><td>Electrical (1)</td></tr><tr><td>Nuclear (1)</td><td>Thermal (1)</td></tr></table>	Potential Energy	Kinetic Energy	Gravitational	Light	Chemical	Electrical (1)	Nuclear (1)	Thermal (1)	1 mark EACH	3		
Potential Energy	Kinetic Energy													
Gravitational	Light													
Chemical	Electrical (1)													
Nuclear (1)	Thermal (1)													
(b)	2.2	Calculation Annual cost of using an incandescent bulb for 4 hrs daily = \$10 Annual cost of using an incandescent bulb for 8 hrs daily = \$10 × 2 + \$20 (1) Annual cost of using an LED bulb for 4 hrs daily = \$2 Annual cost of using an LED bulb for 8 hrs = 2 × 2 = \$4 (1) Difference in cost = \$20 - \$4 = \$16.00 (1)			3									
(c) (i)	2.3	<u>How geothermal energy is harnessed to provide electricity</u> Production wells pump water which has been heated by hot rocks / geothermal activity below the surface (1) to produce steam to the turbine. (1) This induces current production in the alternator (1) which is then distributed via the grid to homes. (1)	Complete explanation, 4 marks, Partial explanation, 1-3 marks		4									

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Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(c) (ii)	2.9	<u>Positive Environmental Impacts</u> - Reduced greenhouse gas emissions/ Reduced air pollution (1) less CO₂, NO, SO₂ emissions than fossil fuel plants (1) - Renewable and sustainable, (1) so it is naturally replenished and cannot be exhausted (1) - Reduced land use; clearing (1) smaller land areas are needed when compared with using other renewable forms such as wind. (1)	Any TWO impacts, 2 marks each Complete outline, 2 marks Partial outline, 1 mark		4	
(c) (iii)	2.10	 A pie chart illustrating the distribution of various renewable energy sources. The largest segment is Solar at 58%, followed by Wind at 18%, Geothermal at 12%, Hydropower at 9%, and Biomass at 3%.	Correct proportion of sectors (1) Labels (1)			2

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Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(d)	2.8	<u>Methods of Improving the Energy Efficiency of Buildings</u> Protecting against solar radiation/heat (1) by solar shading OR using low heat-absorbing building materials (1) Increasing the natural ventilation of the buildings (1) using large windows, OR north-south orientation OR open floor plans/less partitioning. (1) Insulation and Air Sealing by adding insulation to walls, attics and floors, sealing gaps, cracks, and leaks around windows, doors, and ductwork; (1) and using weatherstripping and caulking to prevent drafts (1). Using energy-efficient windows and doors, for example, installing double or triple-glazed windows. (1) Also, to reduce heat loss, use low emissivity (low-E) coatings and choose insulated exterior doors. Using lighting, for example, replacing incandescent bulbs with LED or CFL lights. (1) Also, using motion sensors, timers, or daylight sensors to reduce unnecessary lighting. (1)			4	
Total				3	12	5

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Question 4	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(a) (i)	2.6	<u>Generation</u> - Boiler - Turbine - Generator	Any TWO components, 1 mark each	2		
(a) (ii)	2.6	<u>Transmission</u> - Transformer - Power lines - Towers	Any ONE component, 1 mark	1		
(b) (i)	2.4	<u>Geographical</u> Caribbean countries are located in the tropics (1) therefore they generally receive approximately 12 hours of sunlight year-round, (1) ensuring a near constant supply.	Complete explanation, 2 marks Partial explanation, 1 mark		2	
(b) (ii)	2.4	<u>Environmental</u> Solar energy is an inexhaustible source (1) which does not produce harmful emissions. (1)	Complete explanation, 2 marks Partial explanation, 1 mark		2	
(c) (i)	2.5	<u>Agriculture</u> Energy is required as fuel (1) for machinery. (1) OR Energy is required in the form of electricity (1) which is used for storage/refrigeration/incubation/farm structures. (1)	Complete outline, 2 marks Partial outline, 1 mark		2	

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Question 4 cont'd	Specific Objectives	Suggested Response	Instructions	Marks										
				KC	AK	PS								
(c) (ii)	2.5	<u>Healthcare</u> Energy is required as electricity (1) needed for medical equipment to work and for accommodating hospital care, for example, operations. (1) OR Energy is required as fuel (1) needed for medical transport / evacuation. (1)	Complete outline 2 marks Partial outline 1 mark		2									
(d)	2.7	Load shedding Economic growth will increase peak electricity demand (1) obsolete power plants will have limited generation capacity (1) and will not be able to meet the demand of all customers (1) therefore low priority customers such as homeowners will be removed until generation can match demand (1)	Complete explanation 4 marks Partial explanation 1-3 marks		4									
(e)	2.10	Table showing the preference of renewable energy sources at Hilltop School <table><tr><td>Renewable Energy Source</td><td>Preference Rank</td></tr><tr><td>Solar</td><td>High</td></tr><tr><td>Wind</td><td>Medium</td></tr><tr><td>Biofuels</td><td>Low</td></tr></table>	Renewable Energy Source	Preference Rank	Solar	High	Wind	Medium	Biofuels	Low	Title (1) Correct Headings (1) Data (3)			5
Renewable Energy Source	Preference Rank													
Solar	High													
Wind	Medium													
Biofuels	Low													
Total				3	12	5								

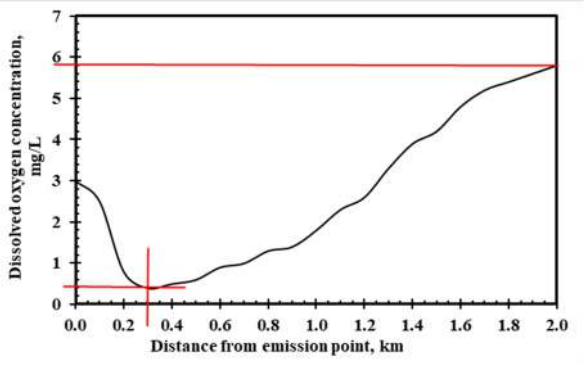
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Question 5	Specific Objective s	Suggested Response	Instructions	Marks		
				KC	AK	PS
(a) (i)	3.1	<u>Point Source</u> Pollution that enters the environment from an easily identifiable/defined location.		1		
(a) (ii)	3.1	<u>Industry</u> • Sewage treatment • Food manufacturing • Beverage manufacturing • Oil refinery • Gas station • Fertilizer/laundry detergent manufacturing	Any ONE industry, 1 mark Any other high BOD waste producer can be accepted.		1	
(a) (iii)	3.11	<u>Lowest Dissolved Oxygen Concentration</u> 0.4±0.05 mg/L Accept 0.35 – 0.45 mg/L	Units must be included.			1
(a) (iv)	3.6	<u>How the waste emitted results in the reduction in dissolved oxygen concentration</u> The sewage treatment/food/beverage/oil/gas station sites produce waste that can be degraded by microorganisms (1) using dissolved oxygen in the process (1) . High amounts of this waste result in an increase in the number of microorganism numbers (1) and so, increased dissolved oxygen is used by these organisms. (1)	Complete explanation 4 marks Partial explanation 1-3 marks		4	

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Question 5 cont'd	Specific Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
		OR The fertiliser/laundry detergent manufacturing/sewage treatment sites produce waste that has phosphate (1). This can result in eutrophication (1) where an increase in algal growth (1) occurs, and when the algae die, it is degraded and can result in a decline in dissolved oxygen. (1)				
(v)	3.11	<u>Calculation</u> Lowest DO = 0.4 mg/L Highest DO = 5.8 mg/L (1) Change in DO = 5.8 - 0.4 mg/L = 5.4 mg/L (1) Change in distance = 2.0 - 0.3 km = 1.7 km (1) Rate of increase = 5.4 mg/L1.7 km = 3.2mgL per km Rate of increase = 5.4 mg/L1.7 km = 3.2mgL per km (1)				4

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Question 5 cont'd	Specific Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
						
(b) (i)	3.3	<u>Sources of pollution</u> • Resource extraction/ transportation/use • Use of inappropriate technology, industrialization. • Unsustainable lifestyles/ behavioural and consumption patterns.	Any TWO causes, 1 mark each	2		
(b) (ii)	3.3	<u>Population growth</u> Population growth increases the use of resources (1) and production of waste (1) . The greater amount of waste would result in a greater loss of dissolved oxygen (1) as seen in Figure 7.	Complete explanation, 3 marks Partial explanation, 1-2 marks		3	

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Question 5 cont'd	Specific Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PS
(c)	3.9	<u>International agreements</u> The Montreal Protocol is an international treaty. It's goal is to protect the stratospheric ozone layer. (1) The protocol works by establishing a mandatory timetable for phasing out the production and consumption of ozone-depleting substances (ODS) like chloro-fluorocarbons (CFCs) and halons (1) . Parties have binding targets to gradually eliminate these chemicals across various industries (1) . There are regular reviews and amendments to adjust phase-out schedules based on scientific advancements and technological developments (1) . In addition, the protocol includes providing financial assistance to developing countries to help them comply with the protocol's requirements through a dedicated fund. (1)	Complete explanation, 4 marks Partial explanation, 1-3 marks (a maximum of 4 marks)		4	
Total				3	12	5

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Question 6	Specific Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(a) (i)	3.7	<u>Green waste</u> • Vegetable peelings • Grass cuttings • Leaves • Kitchen waste	Any ONE example, 1 mark Any other suitable example.	1		
(a) (ii)	3.11	<u>Calculation</u> $21.3/100 \times 162,962 \text{ tonnes (1)}$ $= 34\,710.9 \text{ tonnes (1)}$	Unit must be included for full marks.		2	
(a) (iii)	3.7	<u>Environmental Impacts</u> Reduced aesthetic quality (1) as landfills produce bad smells/unattractive visuals/attract vermin. (1) Conflicting change in land use (1) can lead to the displacement of native species. (1) Waste material leaches to water bodies and subsoils, (1) causing contamination of drinking water/rivers/soils in which crops are grown. (1) Landfill attract vermin such as rats, mice, cockroaches and other pest (1) which pose serious health risks to human beings.	Any TWO Complete explanation, 2 marks Partial explanation, 1 mark		4	
(b) (i)	3.7	<u>Greenhouse Gas</u> • Methane • Carbon dioxide	Any ONE gas, 1 mark	1		

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Question 6 cont'd	Specific Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(b) (ii)	3.4	<u>Why the emission of the gas is an environmental problem</u> Methane gas absorbs IR radiation (1) in the atmosphere. The heat then is re-radiated and reflected (1) back to the earth. This results in an increase in the temperature of the earth's atmosphere (1) and a variety of negative impacts like an increase in the number and severity of storms/rising sea levels/increased droughts/flooding. (1) OR Methane gas is flammable (1) and can encourage landfill fires. The burning of the garbage (1) produces soot, sulphur/nitrogen oxides (1) and other air pollutants. These can cause environmental impacts like acid rain from particulate matter. (1) OR Carbon dioxide gas absorbs IR radiation (1) in the atmosphere. The heat then is re-radiated and reflected (1) back to the earth. This results in an increase in the temperature of the earth's atmosphere (1) and a variety of negative impacts like an increase in the number and severity of storms/rising sea levels/increased droughts/flooding. (1)	Complete explanation, 4 marks Partial explanation, 1-3 marks		4	

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Question 6 cont'd	Specific Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
		OR Carbon dioxide is an acidic gas (1) that can dissolve in the ocean. (1) This reduces the pH of the ocean/causes ocean acidification. (1) This results in negative impacts to organisms like corals/shellfish, whose shells are affected by the more acidic water. (1)				
(c) (i)	3.8	<u>Sources of Noise Pollution</u> • Parties • Restaurants/bars/clubs • Construction • Industrial activity • Sporting events • Transportation	Any ONE source, 1 mark	1		
(c) (ii)	3.8	<u>Health Impacts of Noise Pollution</u> When sound is above a certain level and for an extended length of time, (1) exposure can result in damage to ear drums hearing and can cause migraines/headaches. (1) Medium to long term exposure to loud noise can produce stress/anxiety (1) which can lead to other mental and physical conditions (1) especially in vulnerable groups like children/the elderly. Exposure to loud noise at night can produce low/poor quality of sleep (1) which overtime may lead to behavioural changes. (1)	Any ONE impact, 2 marks Complete outline, 2 marks Partial outline, 1 mark		4	

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PAPER 02
KEY AND MARK SCHEME

Question 6 cont'd	Specific Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(d)	3.8	<u>Hypothesis (1)</u> The presence of the tree barrier will reduce the level of noise measured in the residential area. (1) OR The presence of the tree barrier will have no effect on the level of noise measured in the residential area. (1) <u>Procedure (3)</u> Measure the decibel reading in the residential area (1) before (1) and after (1) the trees are planted. <u>Expected Results (1)</u> If the tree planting exercise is successful, the decibel reading at the residential area will be significantly less (1) than the initial reading. OR If the tree planting exercise is not successful, the decibel reading at the residential area will be the same (1) as the initial reading.				5
Total				3	12	5

SPECIMEN 2026



TEST CODE **02120032**

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UNIT 1 – Paper 032

2 hours

SPECIMEN PAPER

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. Do NOT write in the margins.
4. You may use a silent, non-programmable calculator to answer questions.
5. You are advised to take some time to read through the paper and plan your answers.
6. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
7. **If you use the extra page(s), you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

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

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“*”Barcode Area”*”
Sequential Bar Code

NOTHING HAS BEEN OMITTED.

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Answer ALL questions.

1. (a) Define EACH of the following terms.

(i) Habitat

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[1 mark]

(ii) Species

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[1 mark]

(iii) Ecosystem resilience

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[1 mark]

(b) Port Pared is a traditional farming and fishing village located on the River Poisson, which empties into the Bay of Plenty. The village is nestled at the base of Mighty Mountain on the mainland and is linked to a tied island by a narrow peninsula which encircles the bay and separates the Caribbean Sea to the north from the Atlantic to the south.

As a result, the habitat in the bay, which is connected to the Caribbean Sea by a narrow passage, is distinct and mainly interacts with the nearby bodies of water during times of storms and high seas. This connectivity is fundamentally important for shaping the ecosystem resilience of the Bay of Plenty, including its mangroves, seagrass beds, coral reefs and species of fish.

(i) Name TWO types of interactions which are likely to occur in the coral reefs found in the Bay of Plenty.

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[2 marks]

GO ON TO THE NEXT PAGE

- (ii) Explain why the peninsula which connects Port Pared to the tied island serves as an ecotone.

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[2 marks]

- (iii) Explain how the peninsula may contribute to parapatric speciation.

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[2 marks]

GO ON TO THE NEXT PAGE

- (c) The environmental science students from the Port Pared High School want to design an experiment to compare the biodiversity in the Bay of Plenty with that in the Atlantic Ocean.

- (i) List FOUR key steps which should be used in designing the sampling exercise required to carry out this biodiversity comparison.

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[4 marks]

- (ii) Describe how the science students can measure the turbidity of the water in the Bay of Plenty.

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[2 marks]

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- (d) The experiment yielded the following data on the pelagic phytoplankton species found in the Bay of Plenty and the Atlantic Ocean.

TABLE 1: NUMBERS OF PELAGIC PHYTOPLANKTON SPECIES FOUND IN THE BAY OF PLENTY AND THE ATLANTIC OCEAN

Species	Location	
	Bay of Plenty	Atlantic Ocean
<i>Bacteriastrium delicatulum</i>	36	10
<i>Chaetoceros lorensianus</i>	20	18
<i>Melosira distans</i>	60	16
<i>Paralia sulcata</i>	22	2
<i>Thalassionema nitzschioides</i>	24	8

- (i) Using the information Table 1 and the equation below, calculate the species diversity for the Atlantic Ocean.

$$D = \frac{\sum n(n-1)}{N(N-1)}$$

[3 marks]

- (ii) On the grid provided on page 7, plot a suitable graph to illustrate the results in Table 1. [7 marks]

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A full-page sheet of white graph paper. The grid consists of thin, light gray horizontal and vertical lines forming small squares. There are 20 columns and 20 rows of these small squares, creating a total of 400 large square units across the page. The margins are uniform on all sides.

“*”Barcode Area”*”
Sequential Bar Code

- (e) In 2020, as a result of shortages linked to the COVID-19 pandemic, agriculture in Port Pared was intensified in an effort to provide more local produce to the Caribbean country. This led to the increased use of agrochemicals, which eventually ended up in the Bay of Plenty.

- (i) Explain ONE way in which the increased use of agrochemicals may impact the biodiversity of the Bay of Plenty.

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[3 marks]

- (ii) Outline ONE way in which the use of agrochemicals may have an impact on the phosphorus cycle.

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[2 marks]

Total 30 marks

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2. (a) Define EACH of the following terms.

(i) Urban growth

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[2 marks]

(ii) Population density

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[1 mark]

(b) The COVID-19 pandemic impacted in a variety of ways that threatened the production, distribution and marketing of commodities, exposing the frailty of food security in Port Pared.

In an attempt to guarantee food security, agriculture in Port Pared was transformed by implementing measures to ensure food availability and access. This transformation included the construction of a mariculture facility in the Bay of Plenty and a nearby fisheries processing plant which provides products for the export market.

The agricultural industry thrived, resulting in changes to the population density, and Port Pared grew from a small rural village to an urban centre.

Explain ONE negative impact of urbanization on Port Pared.

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[2 marks]

GO ON TO THE NEXT PAGE

- (c) Table 2, shows some demographic data for Point Pared at the end of 2020 and 2024.

TABLE 2: DEMOGRAPHIC DATA FOR POINT PARED AT THE END OF 2020 AND 2024

Demographic Data	2020	2024
Population at the beginning of 2020	300 000	950 000
Number of births	25 000	15 000
Number of deaths	17 000	22 000
Numer of immigrants	5 000	500 000
Number of emigrants	20 000	1 000

- (i) On the grid provided **on page 11**, sletch a graph to show the changes in the number of births, deaths, immigrants and emigrants in Port Pared in 2020 and 2024. **[5 marks]**

- (ii) State the equation for population change.

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[2 marks]

- (iii) Calculate the annual percentage population growth for the population of Port Pared at the end of 2024.

[5 marks]

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- (d) (i) Explain how the transformation of Port Pared may have resulted in the population change between 2020 and 2024.

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[3 marks]

- (ii) Suggest ONE possible factor that may account for the difference in birth rates in Port Pared when you compare 2020 with 2024.

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[5 marks]

- (iii) Explain how the changes in population growth in Port Pared in 2024 may impact the Human Development Index and Gender Development Index.

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[5 marks]

Total 30 marks

3. (a) Define EACH of the following terms as they relate to natural resource management.

(i) Conservation

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[1 mark]

(ii) Sustainable use

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[1 mark]

(iii) Recreation

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[1 mark]

GO ON TO THE NEXT PAGE

- (b) In 2021, a group from the Port Pared Fisheries & Mariculture Co-operative attended an industry activity in Europe. While there, they learnt about pescaturism, a relatively new development in sustainable tourism, established in the early 1990s in Italy, which has spread to other Mediterranean countries.

Pescaturism is a niche form of tourism that focuses on fishing, seafood and marine-based activities. It combines aspects of travel with the enjoyment of fishing or experiencing the culture surrounding seafood and coastal life. It includes activities such as such activities as fishing tours, seafood tourism and marine exploration.

The group learnt that pescaturism is considered a different activity from fisheries tourism, or recreational fishing (including charter fishing), and that it can pair well with water sports such as snorkelling and whale-watching which is practised in Port Pared.

In addition to recreation, pescaturism can lead to sustainable use, and can maintain the employment of the co-operative's small-scale fishers by contributing to community-based natural resource management and conservation.

These objectives can be achieved through education and public awareness regarding the state and problems of Port Pared's marine sector, including the native ecosystems, with a view to safeguarding the traditional fishing culture of Port Pared's indigenous population.

- (i) Explain why pescaturism may be considered a non-consumptive way to use Port Pared's natural resources.

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[2 marks]

GO ON TO THE NEXT PAGE

(ii) Explain how Port Pared can use pescatourism together with its natural resources for

- research and education

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[2 marks]

- sacred and spiritual values.

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[2 marks]

(c) Explain TWO ways in which the community-based model of natural resource management that was utilized for pescatourism in Port Pared is a sustainable approach.

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[6 marks]

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- (d) (i) Explain how marine protected areas can be used to support pescatourism in the Port Pared area.

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[3 marks]

- (ii) Name the economic instrument which could be used in conjunction with the marine protected area and state how it may be used.

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[2 marks]

- (e) Table 3 shows the revenue Port Pared earned from pescatourism for the period 2017 to 2023.

TABLE 3: REVENUE EARNED FOR THE PERIOD 2017 TO 2023

Year	Revenue (US\$)
2017	400 000
2018	200 000
2019	300 000
2020	100 000
2021	800 000
2022	1 200 000
2023	1 800 000

- (i) On the grid provided **on page 19**, plot a suitable graph to illustrate the information in Table 3. **[8 marks]**
- (ii) Calculate the percentage increase in GDP between 2021 and 2023.

[2 marks]

A full-page sheet of white graph paper. The grid consists of thin, light gray horizontal and vertical lines forming small squares. A thicker black border runs along all four edges of the page, creating a margin around the grid area. The grid covers approximately 90% of the page's width and height.

END OF TEST

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

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- 20 -

EXTRA SPACE

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Question No.

02120032/CAPE/SPEC/2026

Barcode Area

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If you use this extra page, you MUST write the question number clearly in the box provided.

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WRITE ON
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CANDIDATE'S RECEIPT

INSTRUCTIONS TO CANDIDATE

1. Fill in all the information requested clearly in capital letters.

TEST CODE

0	2	1	2	0	0	3	2

SUBJECT ENVIRONMENTAL SCIENCE – UNIT 1 – Paper 032

PROFICIENCY ADVANCED

REGISTRATION NUMBER

FULL NAME _____
(BLOCK LETTERS)

SIGNATURE _____

DATE _____

2. Ensure that this slip is detached by the Supervisor or Invigilator and given to you when you hand in this booklet.
3. Keep it in a safe place until you have received your results.

INSTRUCTION TO SUPERVISOR/INVIGILATOR

Sign the declaration below, detach this slip and hand it to the candidate as his/her receipt for this booklet collected by you.

I hereby acknowledge receipt of the candidate's booklet for the examination stated above.

Signature _____
Supervisor/Invigilator

Date _____

C A R I B B E A N

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ENVIRONMENTAL SCIENCE

UNIT 1 - Paper 032

KEY AND MARK SCHEME

SPECIMEN PAPER 2026

- 2 -

ENVIRONMENTAL SCIENCE
PAPER 032
KEY AND MARK SCHEME

Question 1	Specific Objective	Suggested Response	Instructions	Marks		
				KC	AK	PA
(a) (i)	1.1	<u>Habitat</u> A habitat is the natural environment where an organism lives.		1		
(a) (ii)	1.1	<u>Species</u> A group of organisms that can interbreed and produce fertile offspring		1		
(a) (iii)	1.1	<u>Ecosystem Resilience</u> The capacity of an ecosystem to absorb repeated disturbances or shocks and adapt to change without fundamentally switching to an alternative stable state.		1		
(b) (i)	1.4	<u>Types of interactions</u> • Competition • Predator-prey • Symbiosis	Any TWO interactions, 1 mark each	2		
(b) (ii)	1.1	<u>Why the peninsula serves as an ecotone</u> The peninsula separates the Caribbean Sea from the Atlantic Ocean (1) and is therefore a transition area between two marine ecosystems. (1) OR The peninsula encircles the Bay of Plenty (1) serving as a transition area where different communities meet and integrate in the Bay (1)	Complete explanation 2 marks Partial explanation 1 mark		2	

ENVIRONMENTAL SCIENCE
PAPER 032
KEY AND MARK SCHEME

Question 1 cont'd	Specific Objective	Suggested Response	Instructions	Marks		
				KC	AK	PA
(b) (iii)	1.7	<u>How the peninsula may contribute to 'parapatric' speciation.</u> The peninsula allows only a partial separation of Bay of Plenty (1) still permitting species to come in contact or cross habitats from time to time, but the peninsula reduces the mechanisms which would allow for interbreeding. (1)	Complete explanation 2 marks Partial explanation 1 mark		2	
(c) (i)	1.9, 1.17	<u>Steps in designing the sampling exercise</u> - Identify a cross-section from the Bay of Plenty across the peninsula to the Atlantic Ocean (1) - Identify specific locations within the Bay and the Atlantic Ocean to take measurements of marine populations (1) - Decide whether the method of sampling should be random or systematic (1) - Identify the specialized equipment to be used such as water samplers, sediment grabs, or plankton nets depending on what is being studied (1) - Collect samples at different depths, equidistant from the peninsula, including near the shoreline, or in the centre of the Bay and an equal distance into the Ocean. (1)	Any FOUR steps, 1 mark each		4	

ENVIRONMENTAL SCIENCE
PAPER 032
KEY AND MARK SCHEME

Question 1 cont'd	Specific Objective	Suggested Response	Instructions	Marks		
				KC	AK	PA
(c) (ii)	1.16	<u>How the science students can measure the 'turbidity' of the water</u> • Collect a grab sample in a sample bottle, ensuring that the sediment in the Bay is not stirred (1) • In the lab, transfer the sample into the turbidity meter and take a reading (1) OR • Slowly lower a Secchi disk into the area of water to be sampled until it is no longer visible. Then, slowly raise the disk until it becomes visible again. Repeat the process and then average the two depths for a more accurate measurement. (1) • Record the depth at which this occurs (called the Secchi depth; a higher Secchi depth indicates clearer water and lower turbidity, while a lower depth indicates higher turbidity) (1)	Complete outline 2 marks Partial outline 1 mark		2	

ENVIRONMENTAL SCIENCE
PAPER 032
KEY AND MARK SCHEME

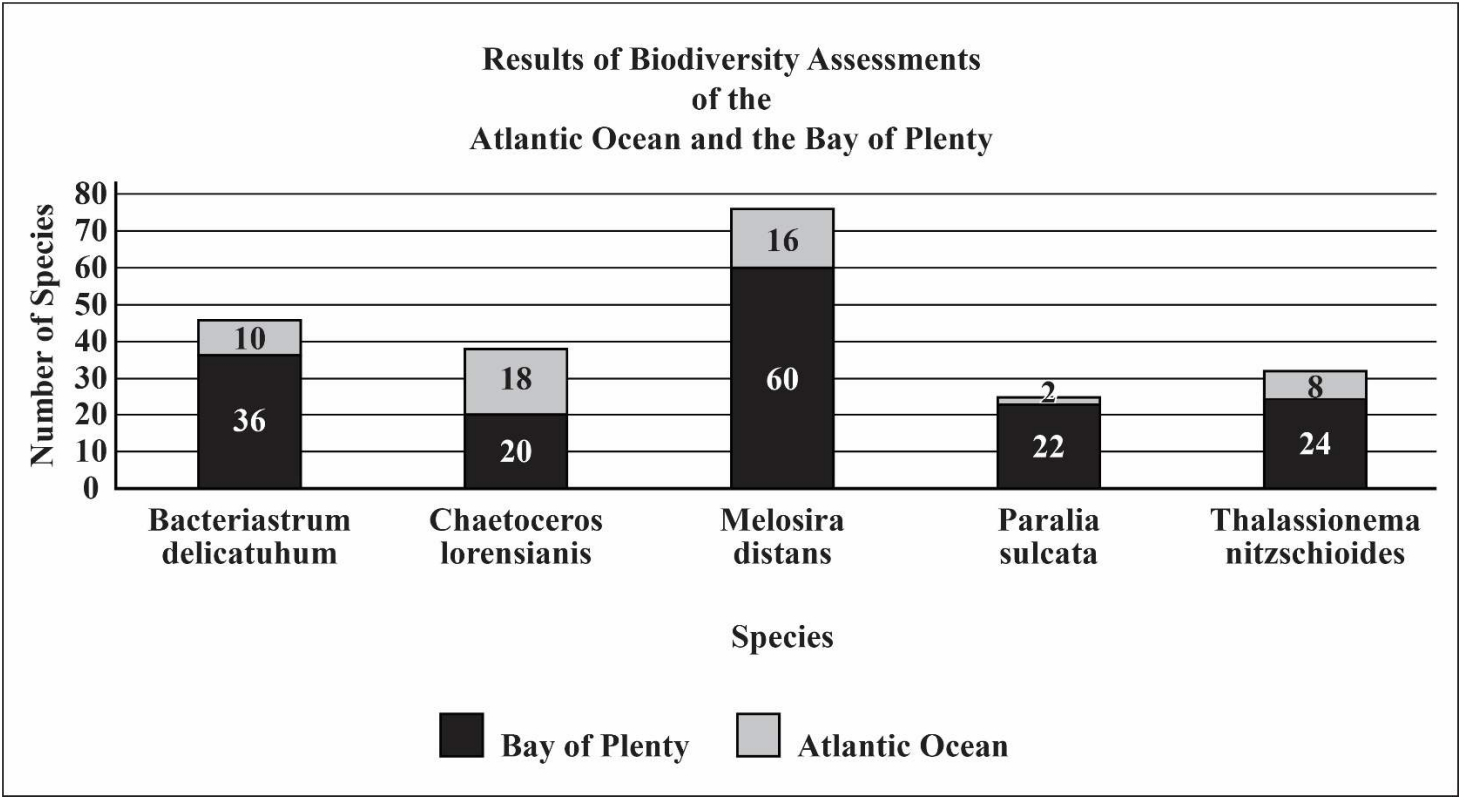
Question 1 cont'd	Specific Objective	Suggested Response	Instructions	Marks																						
				KC	AK	PA																				
(d) (i)	1.10	<u>Calculation</u> <table><tr><td>Species</td><td>Number of individuals</td><td>n (n-1)</td></tr><tr><td><i>Bacteriastrium delicatulum</i></td><td>10</td><td>10 x 9 = 90</td></tr><tr><td><i>Chaetoceros lorensianus</i></td><td>18</td><td>18 x 17 = 306</td></tr><tr><td><i>Melosira distans</i></td><td>16</td><td>16 x 15 = 240</td></tr><tr><td><i>Paralia sulcata</i></td><td>2</td><td>2 x 1 = 2</td></tr><tr><td><i>Thalassionema nitzschioides</i></td><td>8</td><td>8 x 7 = 56</td></tr><tr><td></td><td>N = 54</td><td>$\sum n (n-1) = 694$ (1)</td></tr></table> = 694/ 54 (53) [694/2862] (1) = 0.242 (1)	Species	Number of individuals	n (n-1)	<i>Bacteriastrium delicatulum</i>	10	10 x 9 = 90	<i>Chaetoceros lorensianus</i>	18	18 x 17 = 306	<i>Melosira distans</i>	16	16 x 15 = 240	<i>Paralia sulcata</i>	2	2 x 1 = 2	<i>Thalassionema nitzschioides</i>	8	8 x 7 = 56		N = 54	$\sum n (n-1) = 694$ (1)			3
Species	Number of individuals	n (n-1)																								
<i>Bacteriastrium delicatulum</i>	10	10 x 9 = 90																								
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<i>Thalassionema nitzschioides</i>	8	8 x 7 = 56																								
	N = 54	$\sum n (n-1) = 694$ (1)																								
(d) (ii)	1.6	See graph below	Title (1) <u>both axis labels</u> (1) 5 pairs correct (5) 4 pairs correct (4) 3 pairs correct (3) 2 pairs correct (2)			7																				
(e) (i)	1.14	<u>How the increased use of agrochemicals may impact the biodiversity of the Bay of Plenty</u> • Agrochemicals such as fertilizers and pesticides can contaminate the soil (1) , disrupting food chains by leaching into the Bay of Plenty (1) , which can lead to a decrease in food for organisms in the Bay (1)	Complete explanation 3 marks Partial explanation 1-2 mark		3																					

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ENVIRONMENTAL SCIENCE
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KEY AND MARK SCHEME

Question 1 cont'd	Specific Objective	Suggested Response	Instructions	Marks		
				KC	AK	PA
		OR Agrochemicals such as fertilizers and pesticides can contaminate the water of the river (1), directly killing non-target organisms in the Bay of Plenty (1), which can lead to declines in species, population and overall biodiversity loss (1)				
(e) (ii)	1.5	<u>How the agrochemicals may have an impact on the phosphorus cycle.</u> Agrochemicals such as fertilizers usually contain phosphates which can increased phosphorus deposited into the Bay of Plenty (1) which can over time disrupt the sedimentary phase of the phosphorus cycle (1)			2	
Total				5	15	10

ENVIRONMENTAL SCIENCE
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KEY AND MARK SCHEME



ENVIRONMENTAL SCIENCE
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KEY AND MARK SCHEME

Question 24	Specific Objective	Suggested Response	Instructions	Marks		
				KC	AK	PA
(a) (i)	2.1	<u>Urban Growth</u> The expansion of cities, including the increase in population (1) and the amount of urbanized land (1)	Complete definition 2 marks, Partial definition 1 mark	2		
(a) (ii)	2.1	<u>Population Density</u> Population density is the number of people per unit of area (1)		1		
(b)	2.9	<u>Negative Impact</u> One negative impact of Port Pared's transformation into an urban center is the potential environmental impact on the soil quality (1) as land around the Bay of Plenty is cleared to make space for the rapidly increasing population in the new town (1) OR One negative impact is the establishment of the mariculture facility and fish processing facility which are attracting the increased population (1) since these activities can result in increased runoff into the Bay of Plenty which can impact the fish and other wildlife which live there (1)	Complete explanation 2 marks, Partial explanation 1 mark		2	

ENVIRONMENTAL SCIENCE
PAPER 032
KEY AND MARK SCHEME

Question 2 cont'd	Specific Objective	Suggested Response	Instructions	Marks		
				KC	AK	PA
(c) (i)	2.13	<u>Graph</u> See below for the graph	Title (1) Both Axes (1) 4 pairs correct (4) 3 pairs correct (3) 2 pairs correct (2) 1 pair correct (1)			6
(c) (ii)	2.5	<u>Equation</u> Population change = (births + immigration) (1) - (deaths + emigration) (1)		2		
(c) (iii)	2.5	<u>Calculation</u> (15,000 + 500,000) - (22, 000 + 1 000) = 215,000 (1) Population change/initial population x 100 (1) 215, 000/950,000 x 100 = 53.75 % Year end population + 950,000 (1) 215,000 + 950,000 = 615,000 (1)				4

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ENVIRONMENTAL SCIENCE
PAPER 032
KEY AND MARK SCHEME

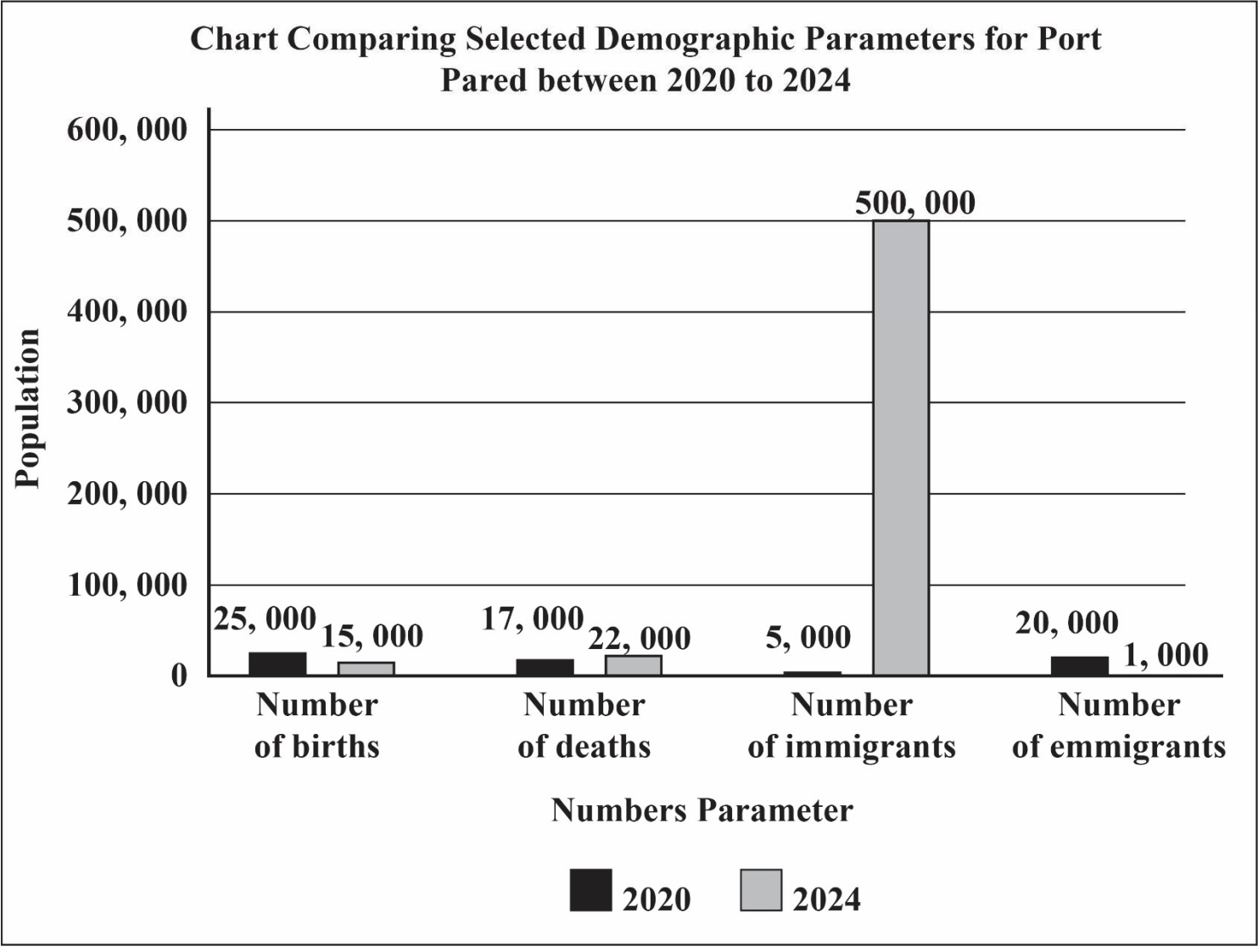
Question 2 cont'd	Specific Objective	Suggested Response	Instructions	Marks		
				KC	AK	PA
(d) (i)	2.4	<u>How the transformation of Point Pared resulted in the population change between 2020 and 2024</u> The transformation of Point Pared may have resulted in increased economic income, (1) This could have led to workers skilled in the mariculture and fish processing industry immigrating into Point Pared (1) since these skills would be required, and the wages in Port Pared may be comparatively attractive (1)	Complete explanation - 3 marks, Partial explanation 1-2 marks		3	
(d) (ii)	2.6	<u>The factor that may account for the difference between birth rates in 2020 and 2024.</u> With the increased economic income in Point Pared, there will be an improvement in amenities (1) such as schools and health centres, (1) and increased access to education and family planning, (1) leading to smaller family sizes, (1) and delayed childbearing due to career aspirations. (1)	Complete explanation - 5 marks, Partial explanation 1-4 marks		5	

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ENVIRONMENTAL SCIENCE
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KEY AND MARK SCHEME

Question 2 cont'd	Specific Objective	Suggested Response	Instructions	Marks		
				KC	AK	PA
(d) (iii)	2.8	<u>How changes in the population growth in Point Pared may impact on the Human Development Index and Gender Development Index</u> With an improved economy, there will be a positive shift in a country's overall well-being, reflected by higher scores in the HDI's key components. (1) Example include increased life expectancy, better education levels, and a higher standard of living (1) as well as the narrowing of the gender gap in key areas such as health, education, and economic participation (1) leading to women achieving closer parity with men in these aspects (1) and therefore improving the Gender Development Index (GDI) (1) OR With a reduction in poverty, the Gender Development Index (GDI) becomes higher (1) since gender equality is directly linked to improved economic opportunities for women. (1) This leads to lower poverty rates across a society (1) which at the same time leads to an increase in the country's overall human development (1) resulting in a higher Human Development Index (HDI) score. (1)	Complete explanation 5 marks, Partial explanation 1-4 marks		5	
Total				5	15	10

ENVIRONMENTAL SCIENCE
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ENVIRONMENTAL SCIENCE
PAPER 032
KEY AND MARK SCHEME

Question 3	Specific Objective	Suggested Response	Instructions	Marks		
				KC	AK	PA
(a) (i)	3.1	<u>Conservation</u> Conservation is the practice of protecting and restoring natural resources like air, water, soil, plants, and animals. (1)		1		
(a) (ii)	3.1	<u>Sustainable Use</u> Sustainable use of natural resources is the practice of using resources in a way that preserves the environment and ensures that future generations have access to them. (1)		1		
(a) (iii)	3.1	<u>Recreation</u> Recreation in natural resource management involves managing lands to accommodate recreational uses as well as interpreting the natural values of these lands for recreation visitors. (1) OR The inclusion of combined social and natural factors into the management of people and natural resources in outdoor spaces like parks and forests.		1		

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Question 3 cont'd	Specific Objective	Suggested Response	Instructions	Marks		
				KC	AK	PA
(b) (i)	3.3	<u>Why pescatourism may be considered a non-consumptive use of the natural resources.</u> Pescatourism is considered non-consumptive because it emphasizes experiencing and enjoying marine life, fishing culture, and coastal ecosystems (1) without depleting or damaging natural resources. This type of tourism focuses on the <i>observation, education, and appreciation</i> of marine environments rather than exploiting them for commercial gain. (1)	Complete explanation 2 marks Partial explanation 1 mark		2	
(b) (ii)	3.5	<u>Research and Education</u> Pescatourism can include elements of environmental education and awareness which can contribute to transforming the attitudes and values (1) of the local communities, the fishing sector and visitors (1) OR The Port Pared co-operative can support research on the ecosystems around the town (1) since they have knowledge of the fishing sector and the species present in the Bay of Plenty. (1)	2 marks for EACH explanation		4	

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ENVIRONMENTAL SCIENCE
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KEY AND MARK SCHEME

Question 3 cont'd	Specific Objective	Suggested Response	Instructions	Marks		
				KC	AK	PA
		<u>Sacred and Spiritual Values</u> Interest in the spiritual and cultural beliefs and practices of Port Pared's indigenous peoples can be incorporated into pescatourism. (1) Also, the welfare of fishers, and the valorization of their profession and socio-cultural heritage can be considered. (1)				
(c)	3.10	<u>Ways in which the community-based model of natural resource management is a sustainable approach</u> The community-based model by the co-operative supports a decentralized approach to management and decision-making (1) which allows the Port Pared community to play a central role in governing and maintaining the resources in the Bay of Plenty (1) while protecting the livelihood and culture. (1) A community-based participatory approach is fundamental to sustainable fisheries in Port Pared since the community members of the co-operative who are dependent on coastal resources are often the most committed (1) and conscientious trustees of those resources (1) especially if they receive direct benefits from their efforts. (1)	Each way explained 3 marks Complete explanation 3 marks, partial explanation 1-2 marks		6	

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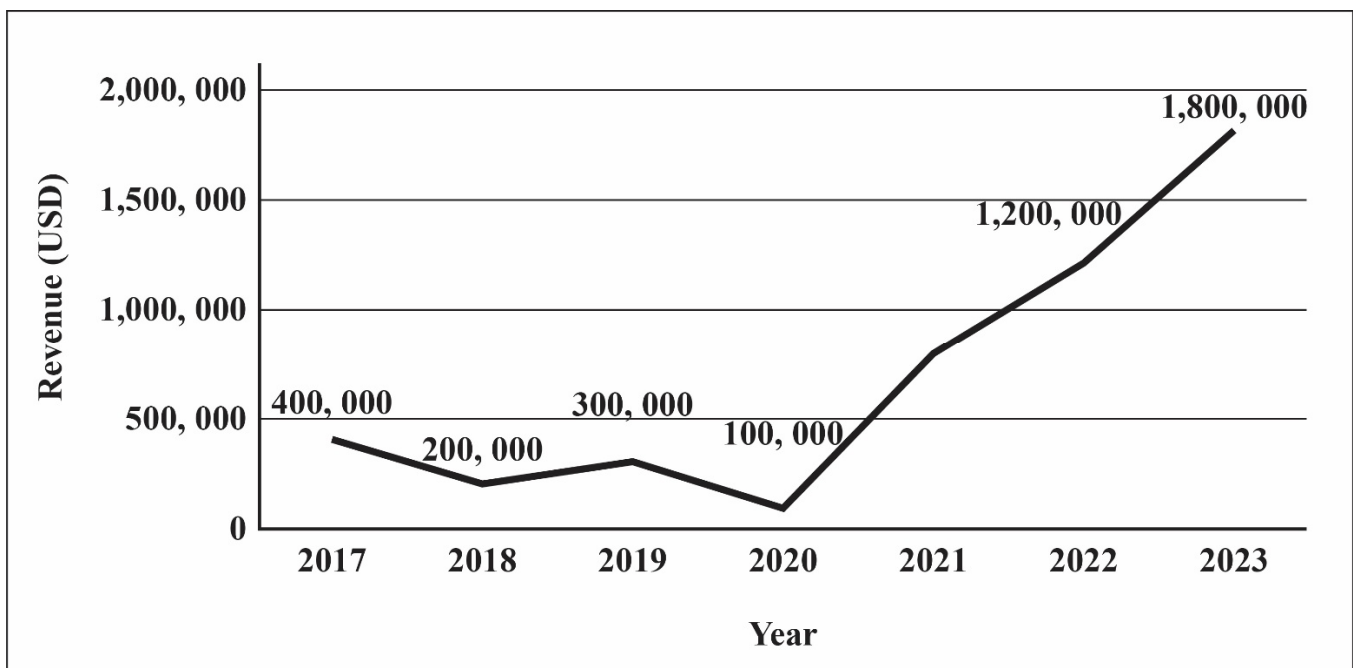
ENVIRONMENTAL SCIENCE
PAPER 032
KEY AND MARK SCHEME

Question 3 cont'd	Specific Objective	Suggested Response	Instructions	Marks		
				KC	AK	PA
(d) (i)	3.11	<u>How marine protected areas can be used to support pescatourism.</u> Marine Protected Areas (MPAs) can protect marine biodiversity from multiple harmful activities and cumulative impacts in the Bay of Plenty, for example, urbanization, the mariculture and fish processing. (1) By complimenting pescatourism which primarily focuses on seafood resources and the regulation of fishing activities (1) and ensuring longer-term protection, restoration, and responsible utilization of the natural resources in the Bay of Plenty (1)	Complete explanation - 3 marks, Partial explanation 1-2 marks		3	
(d) (ii)	3.11	User fees (1) -can be used to help cover the costs of operating the marine protected area. (1)	1 mark for naming the instrument and 1 mark for stating how it is used	2		

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ENVIRONMENTAL SCIENCE
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KEY AND MARK SCHEME

Question 3 cont'd	Specific Objective	Suggested Response	Instructions	Marks		
				KC	AK	PA
(e) (i)	3.13	See below for graph	Title (1) Both Axes (1) 6-7 points correct (6) 4- 5 points correct (5) 4 points correct (4) 3 points correct (3) 2 points correct (2) 1 point correct (1)			8
(e) (ii)		<u>Calculation</u> $1,800,000/800,000$ (1) $\times 100$ $= 225\%$ (1)				2
Total				5	15	10



SPECIMEN 2026



TEST CODE **02220032**

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

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UNIT 2 – Paper 032

2 hours

SPECIMEN PAPER

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. Do NOT write in the margins.
4. You may use a silent, non-programmable calculator to answer questions.
5. You are advised to take some time to read through the paper and plan your answers.
6. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
7. **If you use the extra page(s), you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

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

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02220032/CAPE/SPEC/2026

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Sequential Bar Code

Answer ALL questions.

1. (a) (i) Define the term ‘agroforestry’.

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[2 marks]

- (ii) Explain why agroforestry is considered a re-emerging approach to agriculture.

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[4 marks]

- (b) (i) Define the term ‘carbon farming’.

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[2 marks]

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- TABLE 1: MATERIALS AND APPARATUS AVAILABLE FOR THE AGROFORESTRY EXPERIMENT**

Small plant pots	3 tomato seedlings
Potting soil	3 cabbage seedlings
Water	3 cucumber seedlings
All-purpose fertilizer	Small hand shovel
Ruler	Small hand fork
Access to a small, forested area	Analytical balance

GO ON TO THE NEXT PAGE

- (iii) State the expected results of your study.

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[1 mark]

- (iv) State whether you expect the different types of seedlings to respond in the same way.

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[2 marks]

- (c) (i) Name ONE sustainable farming practice **other than** agroforestry or carbon farming.

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[1 mark]

GO ON TO THE NEXT PAGE

Table 2 illustrates the percentage of total land area used for agriculture in selected Caribbean countries from 1990 to 2020. Study the table carefully and answer the questions that follow.

TABLE 2: AGRICULTURAL LAND AS A PERCENTAGE OF TOTAL LAND AREA FOR SELECTED CARIBBEAN COUNTRIES, 1990 TO 2020

Country	Land used for Agriculture, % Total Land Area						
	1990	1995	2000	2005	2010	2015	2020
Barbados	44.2	44.2	41.9	37.2	34.9	25.6	23.3
Grenada	38.2	32.3	35.3	26.5	29.4	23.5	23.5
Jamaica	43.9	45.9	44.2	43.1	38.9	38.5	38.5
Trinidad and Tobago	15.0	14.8	13.1	10.5	10.5	10.5	10.5

*Data source: Agricultural land (% of land area). World Bank.
https://data.worldbank.org/indicator/AG.LND.AGRI.ZS?end=2022&locations=S3&name_desc=false&start=1961&view=chart*

- (ii) Using Table 2, outline THREE trends that relate to the land used for agriculture.

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[3 marks]

- (d) The data in Table 2 suggests that agriculture plays an important role in Caribbean countries. Explain ONE economic, ONE social **and** ONE environmental role of agriculture in the Caribbean.

Economic

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Social

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Environmental

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[9 marks]

Total 30 marks

GO ON TO THE NEXT PAGE

2. (a) (i) State the law of conservation of energy.

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[1 mark]

- (ii) Outline ONE example that illustrates the law of conservation of energy.

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[2 marks]

- (b) Figure 1 is a flow diagram illustrating the stages in a conventional thermal electricity power plant. The numbers on the diagram refer to the amount of energy stored or transferred by each process. Study the diagram carefully and answer the questions that follow.

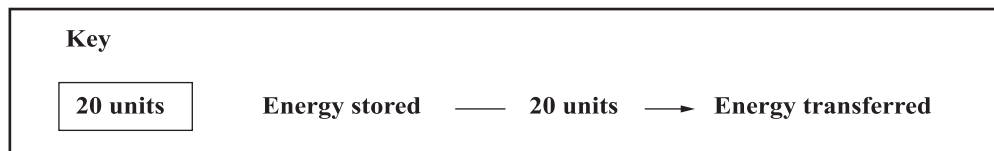
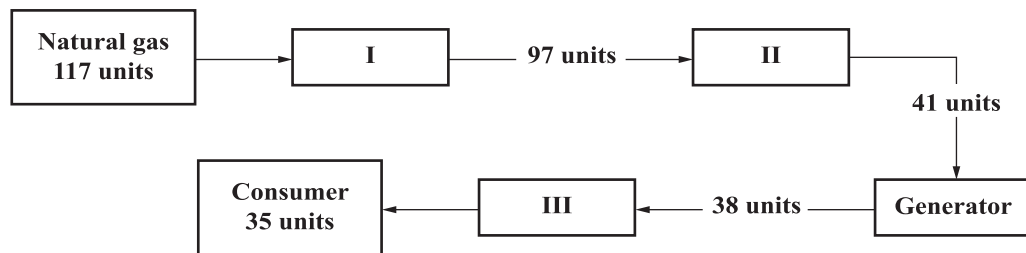


Figure 1. Flow diagram illustrating the stages in a conventional thermal electricity power plant

- (i) Name the THREE stages labelled I, II and III.

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[3 marks]

GO ON TO THE NEXT PAGE

- (ii) Calculate the overall efficiency of the thermal electricity power plant illustrated in Figure 1.

[2 marks]

- (c) Figure 2 is a graph which illustrates the total electricity generation capacity for the English-speaking Caribbean from 2000 to 2022. Study the figure carefully and answer the questions that follow.

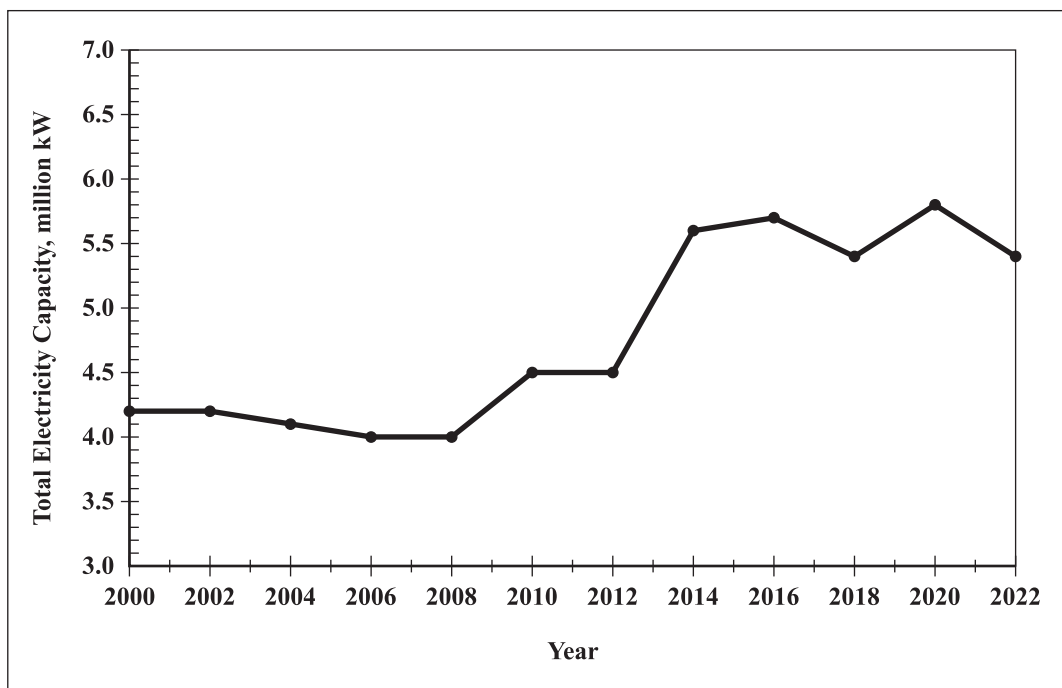


Figure 2. Total electricity generation capacity for the English-speaking Caribbean from 2000 to 2022

<https://www.eia.gov/international/overview/world>

- (i) Identify the year in which the maximum electricity generation capacity was achieved.

[1 mark]

GO ON TO THE NEXT PAGE

- (ii) Determine the rate of change of electricity generation capacity between 2008 and 2016.

[4 marks]

- (iii) Calculate the percentage increase in electricity generation capacity observed between 2000 and 2022.

[4 marks]

- (iv) The electricity generation capacity illustrated in Figure 2 is heavily reliant on fossil fuels. However, there are a few alternative energy sources which are suitable for use in the Caribbean. Suggest ONE source that can be used in the Caribbean to provide electricity and explain how energy may be harnessed from that source. In your response, indicate ONE advantage of using the selected energy source.

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[5 marks]

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- (d) (i) Given the high cost of energy in the Caribbean, many countries seek to encourage energy conservation. Explain TWO ways in which energy may be conserved in the Caribbean.

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[4 marks]

- (ii) Conserving energy may also assist in mitigating some of the negative impacts of the use of energy. Explain ONE environmental **and** ONE social negative impact that may be caused by the use of energy in the Caribbean.

Environmental

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.....

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Social

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[4 marks]

Total 30 marks

GO ON TO THE NEXT PAGE

3. (a) On 7 February 2024, a barge named Gulfstream, that was being towed through Trinidad and Tobago waters, overturned off the southern coast of Tobago. The barge released an unknown amount of fuel oil that impacted several beaches on the south coast of Tobago. Six days after the spill, the oil slick extended as far as 144 km west of Tobago. One ecologically sensitive mangrove area, Petit Trou Lagoon, was also affected. After the spill, there was a noticeable decline in mangrove trees. The towboat and all of the crew of both vessels were never found. Even weeks after the spill, no one came forward to claim the barge nor take responsibility for the spill.

- (i) Government officials are concerned about the possible synergistic effects of these fuel oil compounds on organisms in the area. Define the term 'synergistic effects'.

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.....

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[2 marks]

- (ii) After reading a news article about the spill, prepare a sketch of a flow diagram to illustrate ONE possible pathway that may link the fuel oil in the ocean off Tobago to a person eating a fish sandwich in Trinidad.

The diagram should include at least FOUR environmental receptors.

[5 marks]

GO ON TO THE NEXT PAGE

- (b) The local environmental agency was charged with monitoring the levels of petroleum hydrocarbons in the water. One day in March, water samples were collected in duplicate from sites at increasing distances from the overturned barge. Table 3 illustrates the data that was collected. Study the table carefully and answer the questions that follow.

TABLE 3: DATA COLLECTED FROM MONITORING EXERCISE AT THE OVERTURNED BARGE

Distance from Overturned Barge	Concentration of Total Petroleum Hydrocarbons (TPH), mg/L		
	Sample 1	Sample 2	Average
0	12 025	12 105	12 065
0.5	8 340	8 260	8 300
1.0	3 480	3 420	
5.0	1 000	1 200	
10.0	550	510	

- (i) Complete Table 3 by calculating the missing average TPH concentrations.

[3 marks]

- (ii) On the grid provided on page 15, plot a suitable graph to illustrate the relationship between the concentration of TPH in the ocean and the distance from the overturned barge.

[5 marks]

GO ON TO THE NEXT PAGE

02220032/CAPE/SPEC/2026

“*”Barcode Area”*”
Sequential Bar Code

- (iii) Outline the **major** trend observed in your graph drawn on page 13.

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[2 marks]

- (iv) Suggest ONE reason for the trend outlined in (iii).

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[2 marks]

- (c) Discuss ONE environmental **or** ONE economic impact that may occur in Tobago due to the Gulfstream accident.

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[6 marks]

GO ON TO THE NEXT PAGE

- (d) (i) State TWO underlying causes of pollution that may have contributed to the Gulfstream accident.

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.....

[2 marks]

- (ii) Identify the air pollutant that would MOST likely be produced due to the oil spill.

.....

[1 mark]

- (e) Six months after the oil spill, the local environmental agency wanted to determine if its measures to mitigate the harmful effects of the spill were successful. Suggest ONE indicator that the agency would have used, and explain why it would be suitable for determining success.

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[2 marks]

Total 30 marks

END OF TEST

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

02220032/CAPE/SPEC/2026

“*”Barcode Area*”
Sequential Bar Code

[illegible][illegible][illegible][illegible]

DO NOT WRITE IN THIS AREA

[illegible][illegible]

Question No.

[illegible]

[illegible][illegible][illegible][illegible]

DO NOT WRITE IN THIS AREA

- 18 -

EXTRA SPACE

If you use this extra page, you MUST write the question number clearly in the box provided.

Question No.

02220032/CAPE/SPEC/2026

Barcode Area
Sequential Bar Code

[illegible]

***DO NOT
WRITE ON
THIS PAGE***

CANDIDATE'S RECEIPT

INSTRUCTIONS TO CANDIDATE

1. Fill in all the information requested clearly in capital letters.

TEST CODE

0	2	2	2	0	0	3	2

SUBJECT ENVIRONMENTAL SCIENCE – UNIT 2 – Paper 032

PROFICIENCY ADVANCED

REGISTRATION NUMBER

FULL NAME _____
(BLOCK LETTERS)

SIGNATURE _____

DATE _____

2. Ensure that this slip is detached by the Supervisor or Invigilator and given to you when you hand in this booklet.
3. Keep it in a safe place until you have received your results.

INSTRUCTION TO SUPERVISOR/INVIGILATOR

Sign the declaration below, detach this slip and hand it to the candidate as his/her receipt for this booklet collected by you.

I hereby acknowledge receipt of the candidate's booklet for the examination stated above.

Signature _____
Supervisor/Invigilator

Date _____

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

CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®

ENVIRONMENTAL SCIENCE

UNIT 2 - Paper 032

KEY AND MARK SCHEME

SPECIMEN PAPER 2026

ENVIRONMENTAL SCIENCE
PAPER 032
KEY AND MARK SCHEME

Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
1. (a) (i)	1.2	<u>Agroforestry</u> The cultivation and use of trees/ shrubs (1) with crops/livestock. (1)	Complete definition, 2 marks Partial definition, 1 mark	2		
(a) (ii)	1.2	<u>Why agroforestry is considered a 're-emerging' approach to agriculture</u> Agroforestry was used by indigenous people in the Caribbean (1) to provide for their people. Modern agricultural techniques moved away from this integrated system (1) . Today, with the emphasis on sustainable agriculture and/or climate change (1) people are returning to more integrated and environmentally friendly techniques like agroforestry. (1)	Complete explanation, 4 marks; Partial explanation, 1-3 marks		4	
(b) (i)	1.9	<u>Carbon farming</u> Carbon farming is a system of farming practices that work to improve the rate at which CO ₂ is removed from the atmosphere (1) and is stored in plant material and/or soil organic matter. (1)	Complete definition, 2 marks Partial definition, 1 mark	2		

ENVIRONMENTAL SCIENCE
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Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(b) (ii)	1.2	<u>Study</u> Soil is placed into a number of plant pots (1). Each pot gets one of EACH type of the seedlings (1). The height of the seedling is measured at the start of the experiment (1). The pots are placed under the trees, as if they were planted in the ground (1), and are given the same amount of water and fertiliser. (1) After eight weeks/a suitable timeframe, the height of the plants is measured again. (1) OR Soil is 0. (1)	Complete description, 6 marks Partial description, 1-5 marks			6

ENVIRONMENTAL SCIENCE
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Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(b) (iii)		<u>Expected Results</u> The plants that are growing the best would be the tallest. (1) OR The plants that are growing the best would be the heaviest. (1)				1
(b) (iv)	1.2	<u>Response of the Different Types of Seedlings</u> NO; (1) The conditions under the trees may not be equally suitable for all the plant types, (1) for example, the amount of sunlight.			2	
(c) (i)	1.9	<u>Sustainable Farming Practices</u> • Contour farming • Terracing • Crop rotation • Conservation tillage • Water conservation/efficient water usage • Organic farming • Hydroponics • Aquaponics • Post harvest management • Integrated pest management	Any ONE farming practice, 1 mark	1		

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Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(c) (ii)	1.11	<u>Trends</u> All of the countries show a decline in the amount of land used for agriculture over the period. Although Trinidad and Tobago shows a decline until 2005, the % remains constant after that. Although Grenada and Jamaica show a decline until 2015, the % remains constant after that. Only Barbados shows a decline in the amount of land used for agriculture over the entire period.	Any THREE trends 1 mark each			3
(d)	1.4	<u>Roles of Agriculture</u> <u>Economic</u> Agro-processing and other manufacturing industries require raw materials (1) which will encourage the growth of these materials by farmers. (1) Farmers would find it easier to market their goods for profit, as there is a ready market in the various processing industries. (1)	Marks to be allocated for ONE factor fully explained from EACH section. Complete explanation, 3 marks Partial explanation, 1-2 marks		9	

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Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(d) cont'd		Employment and other income generating activities (1): Agriculture enables many persons in the Caribbean to earn an income (1) which would enable them to provide for their family's welfare. (1) Foreign exchange earnings: (1) Agricultural products may be exported (1) to other countries. Earnings can be used by governments to improve the lives of their citizens (health care, infrastructure, education, etc.) (1) Contribution to Gross Domestic Product (GDP): (1) Agricultural products play a role in local economies, (1) enabling growth of the country. (1) Production of non-food products (medicine, lumber): (1) Agriculture may also produce other useful items that persons can sell locally and internationally (1) and this can provide a livelihood for farmers (1). Tourism: (1) Tourists may be encouraged to visit farms (e.g. cocoa) (1) and this provides an additional income stream for the farmer (1). <u>Social</u> Food security: (1) Local agriculture allows countries to reduce their food import bill (1) and therefore they can spend more on social programmes. (1)				

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Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(d) cont'd		OR Food security: (1) Local agriculture allows countries to have a ready source of nutritious food (1) which will improve the health and wellbeing of residents. (1) Recreation: (1) Many persons in the Caribbean have home gardens (1) and working them can be a source of relaxation and fitness. (1) <u>Ecological/Environmental</u> Biodiversity: (1) When farmers plant a variety of crops, (1) a wide variety of organisms like birds and small animals are more prevalent. (1) Soil conservation: (1) Farms with sustainable practices like the use of cover crops/crop rotation/reduced tillage (1) can improve soil structure and reduce erosion, (1) leading to better soil conservation. Ecological services: (1) Agriculture can contribute to a healthier ecosystem (1) by improving soil/improving biodiversity/managing water use/providing habitats for pollinators/reducing erosion. (1)				
			Total	5	15	10

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Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
2. (a) (i)	2.2	<u>Law of Conservation of Energy</u> Energy can neither be created nor destroyed. OR Energy can neither be created nor destroyed but converted from one form to another.		1		
(a) (ii)	2.2	<u>Examples</u> Burning fuel (1) to heat a pot of water until it boils (1) Using electricity (1) to turn the blades of a fan (1)	Any other suitable example showing change in energy types can be accepted.	2		
(b) (i)	2.6	<u>Stages</u> I: Boiler (1) II: Turbine (1) III: Distribution system/ Transmission (1)	1 mark EACH	3		
(b) (ii)	2.2	<u>Calculation</u> $\frac{35 \text{ units}}{117 \text{ units (1)}} \times 100 = 29.9\% \text{ (1)}$	Correct formula, but incorrect number substitution, 1 mark		2	
(c) (i)	2.11	<u>Year in which the maximum electricity generation capacity was achieved.</u> 2020				1

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Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(c) (ii)	2.7	<u>To determine the rate of change of electricity generation capacity between 2008 and 2016</u> $\frac{5.7(1) - 4(1)}{2016 - 2008} (1)$ $= 0.21 \text{ million } \frac{KW}{\text{year}} (1)$	For full marks, million KW/year must be included.			4
(c) (iii)	2.7	<u>Percentage increase in electricity generation capacity observed between 2000 and 2022</u> $\frac{5.4(1) - 4.2(1)}{4.2} \times 100 (1) = 28.6\%(1)$				4
(c) (iv)	2.3	<u>Alternative Energy Sources</u> Solar (1): Solar cells are made of semi-conducting materials/silicon (1) that allow the solar cells to produce electricity/electrons once the cells are exposed to light (1). A large number of solar cells must be joined together to get a significant amount of electricity/Solar cells can only generate electricity in the daytime/batteries are used to store the electricity for use at a later time. (1) Advantages of solar (1): Use of solar panels does not produce greenhouse gases. OR Solar is a renewable resource. OR Solar may reduce electricity bills.	Marks are allocated as follows: Name of energy source, (1) Explanation of how it works, (3) Advantage of energy source, (1)		5	

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Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(c) (iv) cont'd		Hydroelectric power (1): This works by using the energy of moving/falling water for electricity generation. (1) Water is stored in a reservoir (1) and allowed to flow through pipes to turn a turbine (1) which then spins a generator to make electricity. Advantages of hydroelectric power (1): Hydropower is a renewable source. OR Hydropower is a very reliable source of electricity. OR The reservoirs give potential for flood control/recreation. OR Hydropower does not produce greenhouse gases during electricity production. Wind (1): Wind turbines are built in areas of high air movement. (1) The movement of air (wind) is used to turn the blades of a rotor (1) The spinning rotor turns a generator (1) which makes electricity. Advantages of wind (1): Use of wind energy does not produce greenhouse gases. OR Wind energy is a renewable resource. OR Wind turbines have a small footprint OR Land under turbines can be used for agriculture.				

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Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(c) (iv) cont'd		Geothermal (1) : Wells are drilled into the earth (1) where water heated by the earth's core (1) is used to create steam to drive a turbine/generator (1) to create electricity. Advantages of geothermal energy (1) : Geothermal is a renewable energy source. OR Geothermal energy produces minimal greenhouse gases when producing electricity.				
(d) (i)	2.8	<u>Ways of Conserving Energy</u> Use of hybrid vehicles (1) will reduce the amount of fossil fuel required for personal transportation. (1) Use of carpooling/mass transportation systems (water taxis/ferries, buses). (1) will reduce the number of individual vehicles on the road, (1) hence reducing the amount of fossil fuel required. Use of smart plugs, smart meters, energy star appliances, LED lighting OR improved design and construction techniques applied to buildings, use of natural light and air flow (1) will reduce the demand on electricity providers (1) while still allowing the same function.	Any TWO ways, 2 marks each		4	

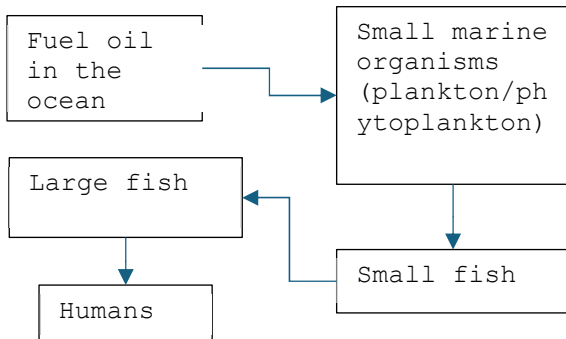
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Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
		Ensure optimal functioning of equipment /regular maintenance schedules in industry OR use of energy efficient technologies (1) this will ensure that the same work is done for less energy. (1) Co-generation/tri-generation/combined cycles. (1) These processes produce electricity and useful heat/cooling (for tri-generation) (1) which will reduce the energy required for the downstream processes.				
(d) (ii)	2.9	<u>Environmental and social negative impacts that may be caused by the use of energy in the Caribbean.</u> <u>Environmental</u> Climate change, especially global warming (1) is caused by the use of fossil fuels. The combustion process produces carbon dioxide which is a potent greenhouse gas. (1) Pollution (1) may be caused by the production of hazardous gases (1) from the combustion of fossil fuels. Pollution (1) may be caused by the extraction/transportation (1) of fuels. Loss or extinction of biodiversity (1) can be caused when habitats are destroyed during extraction/transportation/use of fuels. (1)	Marks can only be awarded for ONE environmental and ONE social impact.		4	

ENVIRONMENTAL SCIENCE
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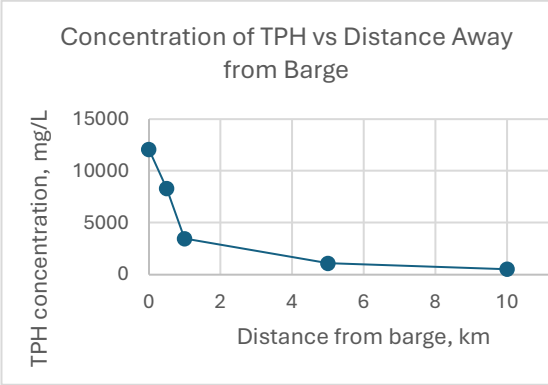
Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(d) (ii) cont'd		Ecosystem destruction, damage, disruption, fragmentation (1) may be caused due to activities during extraction/transportation/use of fossil fuels. (1) <u>Social</u> Human health issues (1) may be caused when persons are affected by air pollutants produced during fossil fuel combustion. (1) Human health issues (1) may be caused when persons are affected by pollution caused by spills during extraction/transportation of fuels. (1) Dislocation of communities OR impact on indigenous peoples including loss of ancestral land of spiritual and cultural importance (1) can be caused when large amounts of land are required for the extraction of fuels/generation of electricity (e.g. hydropower). (1)				
Total				6	15	9

ENVIRONMENTAL SCIENCE
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KEY AND MARK SCHEME

Question	Syllabus Objectives	Suggested Response	Instructions	Marks																													
				KC	AK	PA																											
3. (a) (i)	3.1	<u>Synergistic effects</u> The impact/effect of a mixture of compounds (1) is greater than the impact/effects of the individual compounds. (1)	Complete definition, 2 marks Partial definition, 1 mark	2	5																												
(a) (ii)	3.2	<u>Flow diagram</u>  <pre>graph TD A[Fuel oil in the ocean] --> B[Small marine organisms (plankton/phytoplankton)] B --> C[Small fish] C --> D[Large fish] D --> E[Humans]</pre>	Must have ocean and humans; can have any other two in logical order. (4) Arrows must be present and in the correct direction. (1)																														
(b) (i)	3.11	<table><tr><th rowspan="2">Distance from over-turned barge, km</th><th colspan="3">Concentration of total petroleum hydrocarbons (TPH), mg/L</th></tr><tr><th>Sample 1</th><th>Sample 2</th><th>Average</th></tr><tr><td>0</td><td>12 025</td><td>12 105</td><td>12 065</td></tr><tr><td>0.5</td><td>8 340</td><td>8 260</td><td>8 300</td></tr><tr><td>1.0</td><td>3 480</td><td>3 420</td><td>3 450</td></tr><tr><td>5.0</td><td>1 000</td><td>1 200</td><td>1 100</td></tr><tr><td>10.0</td><td>550</td><td>510</td><td>530</td></tr></table>	Distance from over-turned barge, km	Concentration of total petroleum hydrocarbons (TPH), mg/L			Sample 1	Sample 2	Average	0	12 025	12 105	12 065	0.5	8 340	8 260	8 300	1.0	3 480	3 420	3 450	5.0	1 000	1 200	1 100	10.0	550	510	530	1 mark for EACH average			3
Distance from over-turned barge, km	Concentration of total petroleum hydrocarbons (TPH), mg/L																																
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0	12 025	12 105	12 065																														
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ENVIRONMENTAL SCIENCE
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KEY AND MARK SCHEME

Question 3 cont'd

Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(b) (ii)	3.10	<u>Graph</u> 	Title (1) Axis labels (1) All points correct (3) 3-4 points correct (2) 1-2 points correct (1)			5
(b) (iii)	3.11	<u>Trend</u> The concentration of TPH decreases very quickly close to the barge (1) then decreases more slowly the further from the barge you are. (1)				2
(b) (iv)	3.2	<u>Reason</u> The movement of the waves/water/current in the ocean will mix the fuel oil/TPH and water (1) and so dilute the oil, lowering the TPH concentration. (1) OR The movement of the waves/water/current in the ocean will move the fuel oil/TPH away from the barge (1) and so dilute the oil, lowering the TPH concentration. (1)			2	

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Question 3 cont'd

Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(c)	3.6	<u>Environmental and Economic Impacts</u> <u>Environmental</u> The reef systems (1) in Tobago may be impacted by the hydrocarbons in the fuel oil. These compounds are toxic (1) and may kill or cause other impacts like disease or inability to reproduce. (1) Mangroves (1) are an important Tobago ecosystem. The compounds in the fuel oil are toxic (1) and may kill or damage the trees themselves or the other organisms in the mangroves. (1) Oiling of animals/birds/fish (1) can occur when they are exposed to the fuel oil. The oil coats the feathers/fur making them unable to shed water (1) and the organisms can consume toxic materials when they try to clean themselves. (1) <u>Economic</u> Reduction in income (1): Tobago's economy is driven by tourism (1) and the oil slick on the beaches will reduce people's willingness to spend time there. (1) Fishermen will not be able to fish/sell their fish (1) as the fish may be contaminated by the oil. (1) This will reduce the income obtained by the fishermen (1). Dive operators may see increased job opportunities (1) in assisting with the cleanup/recovery efforts, (1) resulting in greater income. (1)	Complete discussion - up to a maximum of 6 marks Partial discussion, 1-5 marks		6	

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Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(d) (i)	3.3	<u>Causes of Pollution</u> • Resource transportation • Resource use • Lack of environmental ethics • Weak institutional framework	Any TWO 1 mark each	2		
(d) (ii)	3.4	<u>Air Pollutant</u> Volatile organic compounds.	Can accept VOCs	1		
(e)	3.8	<u>Indicators of Success</u> Reduction in TPH levels at the site: (1) A direct measurement of less toxic material in the ocean (1) would indicate that mitigation measures were successful. Reduction in the amount of oil/waste visible on the beaches: (1) This is a visible/qualitative measurement of reduced toxic material in the ocean (1) indicating that the mitigation measures were successful. Reduction in the number of oiled birds/organisms: (1) The presence of the fuel oil will cause large numbers of oiled animals, so less of these indicates less oil/toxic material in the water (1) which suggests that the mitigation measures were successful.	Any ONE indicator, 2 marks		2	

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Question	Syllabus Objectives	Suggested Response	Instructions	Marks		
				KC	AK	PA
(e) cont'd		New growth seen in mangroves: (1) The presence of the toxic material prevents mangrove growth, so new growth indicates that there is less toxic material present, (1) evidence that the mitigation measures were successful.				
Total				5	15	10



Caribbean Examinations Council
Prince Road, Pine Plantation Road,
St Michael BB11091
Tel: (246) 227 1700
Email: cxcezo@cxcc.org