IBO IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

ENVIRONMENTAL SYSTEMS
STANDARD LEVEL
PAPER 3

Name

Number

Friday 10 May 2002 (morning)

1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name and candidate number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section I: answer one Option from Section I in the spaces provided.
- Section II: answer two Options from Section II in the spaces provided.
- You may continue your answers in a continuation answer booklet, and indicate the number of booklets used in the box below. Write your name and candidate number on the front cover of the continuation answer booklets, and attach them to this question paper using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the boxes below.

OPTIONS ANSWERED		EXAMINER	TEAM LEADER	IBCA
SECTION I	. . . .	/15	/15	/15
SECTION II	. . . .	/15	/15	/15
SECTION II	. . . .	/15	/15	/15
NUMBER OF CONTINUATION BOOKLETS USED	. . . .	TOTAL /45	TOTAL /45	TOTAL /45

SECTION I

Options on analysing ecosystems – Options A, B and C

*The compulsory question below relates to the detailed study of ecosystems in a marine, terrestrial or freshwater environment. Select the option on which you will base your answers by marking (×) **one** box only.*

Option		Mark (×) **one** box only
A	Analysing Marine Ecosystems	
B	Analysing Terrestrial Ecosystems	
C	Analysing Freshwater Ecosystems	

1.   The data in the table below were collected by sampling two $400\,m^2$ areas (site X and site Y) in an ecosystem. The numbers of individuals of fifteen species (A-O) were recorded by placing ten $1m^2$ quadrats at random in each area.

Species	Site X (number of individuals)	Site Y (number of individuals)	Site X – six months later (number of individuals)
A	9	0	9
B	46	0	11
C	2	0	11
D	29	0	314
E	41	0	330
F	289	0	794
G	349	1783	1837
H	261	129	0
I	4	8	0
J	3	42	0
K	4	66	0
L	5	4	0
M	3	3	0
N	2	0	0
O	1	0	0
Diversity Indices Simpson's Margalef's	5.23 4.3	1.77 1.77	2.6 1.7

(a) From the option you have studied, suggest an ecosystem from which this data might have been collected. *[1]*

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(b) (i) State the **two** variables that influence a diversity index. *[1]*

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(ii) Site Y and site X (six months later) both have seven species present in total. However, one index shows site Y with a higher diversity and the other index shows site Y with a lower diversity than site X (six months later). Explain this. *[2]*

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(c) (i) Assuming the data has been collected from the ecosystem you named in (a), state **two** factors that might explain the difference in diversity for sites X and Y. *[1]*

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(ii) State **one** human activity and **one** natural factor that might have caused the difference in site X six months later. *[1]*

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(d) In carrying out an investigation of this type, outline **two** methods by which you might identify species that you do not recognise. *[2]*

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(This question continues on the following page)

Turn over

(Question 1 continued)

    (e)   Describe a method for measuring gross and net primary productivity in a named ecosystem.   *[3]*

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    (f)   (i)   State **two** characteristics of species that usually make them suitable for sampling with quadrats.   *[2]*

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            (ii)   Explain how you might ensure that the quadrats were placed at random.   *[2]*

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SECTION II

*This section contains a question on each of options D, E and F. Answer **two** of these questions, related to your chosen options.*

Option D – Impacts of resource exploitation

2. The following data refer to local human populations in two regions of the world.

Population from	*Per capita* grain consumption (kg yr^{-1})	Local grain productivity (kg ha^{-1} yr^{-1})	*Per capita* carbon dioxide emission from fossil fuels (kg C yr^{-1})	Net carbon dioxide fixation by local vegetation (kg C ha^{-1} yr^{-1})
Africa	300	6000	200	6000
North America	600	300	1500	3000

(a) State what is meant by the term *per capita*. [1]

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(b) (i) For the population from Africa, the total area of local land required *per capita* to provide food and absorb the carbon dioxide emissions is 0.083 hectares. Calculate the total area of land required for the population from North America. [2]

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(ii) There is a difference between the total area of land required *per capita* to provide food and to absorb carbon dioxide emissions for the populations of Africa and North America. State **two** reasons for this difference. [2]

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(This question continues on the following page)

Turn over

(Question 2 continued)

    (iii) State how the total ecological footprint for a population can be calculated from the *per capita* footprint. *[1]*

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    (iv) Explain the importance of comparing the total ecological footprint of a population with the area of land that it inhabits. *[2]*

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(c)   State **one** source of energy apart from fossil fuels and suggest **one** advantage and **one** disadvantage of this source. *[3]*

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(d)   Outline **two** differences in the farming strategies that are commonly carried out in Africa and North America. *[4]*

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Option E – Conservation and biodiversity

3. (a) Outline **two** of the main objectives of the World Conservation Strategy.   *[2]*

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(b) The table below shows estimates of worldwide population numbers of some whale species.

Species	Estimated numbers before 1750 (thousand)	Estimated numbers in 1999 (thousand)	Main food source
Blue	228	14	Plankton
Fin	548	120	Plankton, fish
Grey	20	21	Crustaceans
Humpback	115	10	Plankton, fish
Minke	140	725	Plankton, fish
Right	200	4	Plankton
Sei	256	54	Plankton, fish, squid
Sperm	2400	1950	Fish, squid

(i) Identify which species of whale shows the greatest percentage decrease over the period 1750–1999.   *[1]*

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(ii) Other than hunting of whales, suggest **one** other way in which humans may have caused a decline in whale numbers.   *[1]*

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(This question continues on the following page)

(Question 3 continued)

    (iii)   List **three** characteristics that might make some whale species more prone to extinction than others. *[3]*

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    (iv)   Outline **two** special difficulties found in the preservation of open-ocean species. *[2]*

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(c)   The International Whaling Commission issued a ban on all commercial whaling in 1986. Greenpeace has publicised whaling that is still carried out by Norway and Japan partly for research purposes. Compare the role of Greenpeace as a non-governmental organization (NGO) and UNEP as an international organization supported by governments in the preservation of global biodiversity. *[3]*

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(d)   For a named habitat, discuss the arguments for its preservation. *[3]*

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Option F – Pollution

4. The table below shows the atmospheric concentration (in $\mu g\ m^{-3}$) of various pollutants in a city, its suburbs and a surrounding rural area.

Pollutant	City	Suburbs	Rural Area
Suspended particles	102.0	45.0	21.0
Sulfuric acid	10.1	10.0	2.51
Nitric acid	2.4	1.4	0.46
Copper	0.16	0.16	0.06
Lead	1.11	0.21	0.00

(a) (i) Complete the table below to show **one** possible source and **one** effect for each pollutant listed. *[3]*

Pollutant	Source	Effect
Suspended particles		
Sulfuric acid		
Lead		

(ii) With reference to the above data, identify the pollutant which shows the greatest proportional decrease in concentration between the city and the rural area. *[1]*

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(iii) State **two** reasons why the pollutant identified in (ii) shows the changes in atmospheric concentration given in this table. *[2]*

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(This question continues on the following page)

(Question 4 continued)

(b)   For each of the pollutants listed in (a), outline **one** way in which atmospheric pollutant
       concentrations may be reduced.   *[3]*
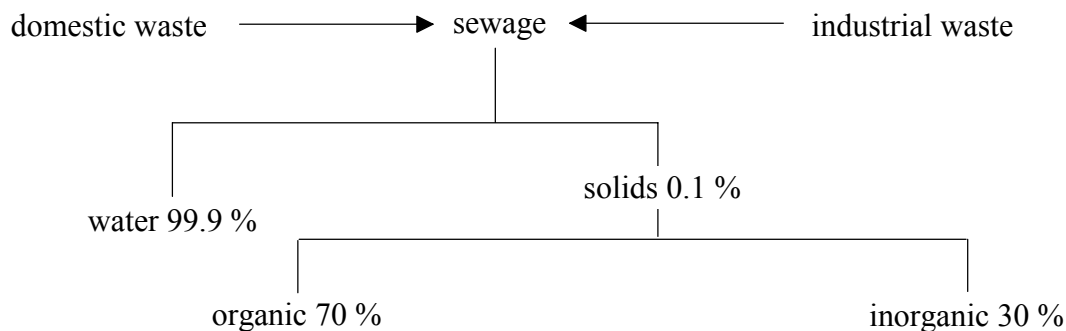
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The composition of raw sewage is shown in the diagram below.

domestic waste ——————▶ sewage ◀—————— industrial waste
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              ┌────────────────────┴────────────────────┐
              | solids 0.1 %
         water 99.9 % |
                                    ┌────────────────┴────────────────┐
                              organic 70 %   inorganic 30 %

(c)   (i)   Explain **two** possible environmental impacts caused by the organic solids found in
              sewage.   *[2]*

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       (ii)   Explain **two** possible environmental impacts caused by the inorganic solids found in
              sewage.   *[2]*

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                                                    (This question continues on the following page)

(Question 4 continued)

    (iii) Outline **two** ways in which the treatment of sewage reduces its environmental impact.   *[2]*

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