N09/4/ENVSY/SP3/ENG/TZ0/XX

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ENVIRONMENTAL SYSTEMS
STANDARD LEVEL
PAPER 3

Wednesday 11 November 2009 (morning)

1 hour

Candidate session number

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INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all the questions from Option A and all the questions from either Option B, Option C or Option D in the spaces provided.
- You may continue your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the letter of the Option answered in the candidate box on your cover sheet and indicate the number of answer sheets used in the appropriate box on your cover sheet.

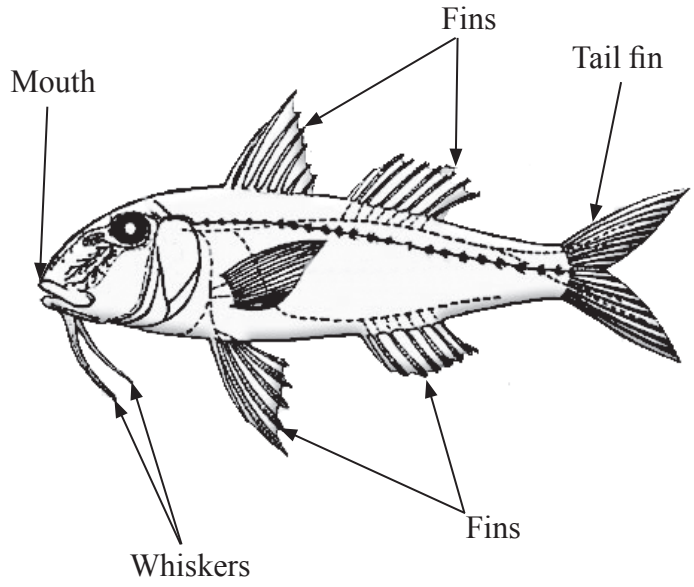
0116

Option A — Analysing Ecosystems

The compulsory question below relates to the detailed study of ecosystems.

A1. (a) (i) Using the key below, deduce the names of the unidentified species of fish shown in the table opposite. *[4]*

1	Fish has pointed ends to tail fin Fish has rounded ends to tail fin	Go to 2 Go to 3
2	Fish has forked tail fin Fish has flat ended tail fin	Go to 4 **Chinook**
3	Fish has whiskers Fish has no whiskers	**Bullhead** Go to 5
4	Fish has a single fin close to mouth Fish has no fins close to mouth	**Muskellunge** **Lake Trout**
5	Fish's body length is more than twice its height Fish's body length is less than twice its height	**Largemouth Bass** **Sunfish**



[Source: adapted from www.srd.gov.ab.ca/fishwildlife/fishingalberta/fishidentification/images/diagram_fish.jpg]

(This question continues on the following page)

(Question A1 continued)

	Species	Water temperatures tolerated / °C
	. . . . .	24–29
	. . . . .	21–27
	. . . . .	18–27
	. . . . .	16–24
	***Chinook***	7–13
	***Lake Trout***	4–10

[Source: images of fish adapted from www.takemefishing.org]

(ii) A student suggests that the last statement (5) in the key could be replaced by:

The fish is large
The fish is small

Explain why this might **not** be a satisfactory way of distinguishing between these two fish. *[1]*

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(b) The species shown are found in different freshwater lakes, thousands of kilometres apart. The range of species that occur in a particular lake depends on biotic and abiotic factors.

(i) State which **two** species of fish shown above can tolerate the widest range of temperatures. *[1]*

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(This question continues on the following page)

(Question A1 continued)

(ii) Using the temperature data, deduce which **two** species of fish could survive throughout the year at each of the two latitudes in the table below. *[2]*

Latitude / °N of equator	**Species most likely to survive**	
60–70	1.	2. . . . .
0–30	1.	2. . . . .

(iii) State, giving a reason, the times of year when temperature measurements should be made to collect reliable data on the temperatures tolerated by these fish. *[2]*

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(iv) Explain why temperature measurements should be repeated over a number of years to determine the temperature range tolerated by the fish. *[1]*

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(This question continues on the following page)

(Question A1 continued)

(c) Global climate change is expected to reduce the biodiversity of many ecosystems over the next fifty years.

(i) State **one** factor, other than a low number of different species in an ecosystem, that indicates low ecosystem biodiversity. *[1]*

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(ii) Describe how changes in the biodiversity of an ecosystem caused by global climate change could be measured quantitatively. *[3]*

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(d) As well as measuring changes in biodiversity, scientists also monitor changes in the productivity of ecosystems.

(i) State what is meant by *biomass*. *[1]*

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(ii) State what is meant by *net secondary productivity.* *[2]*

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(iii) Explain how data on changes in the biomass of consumers such as fish can be used to calculate changes in net secondary productivity in an ecosystem. *[2]*

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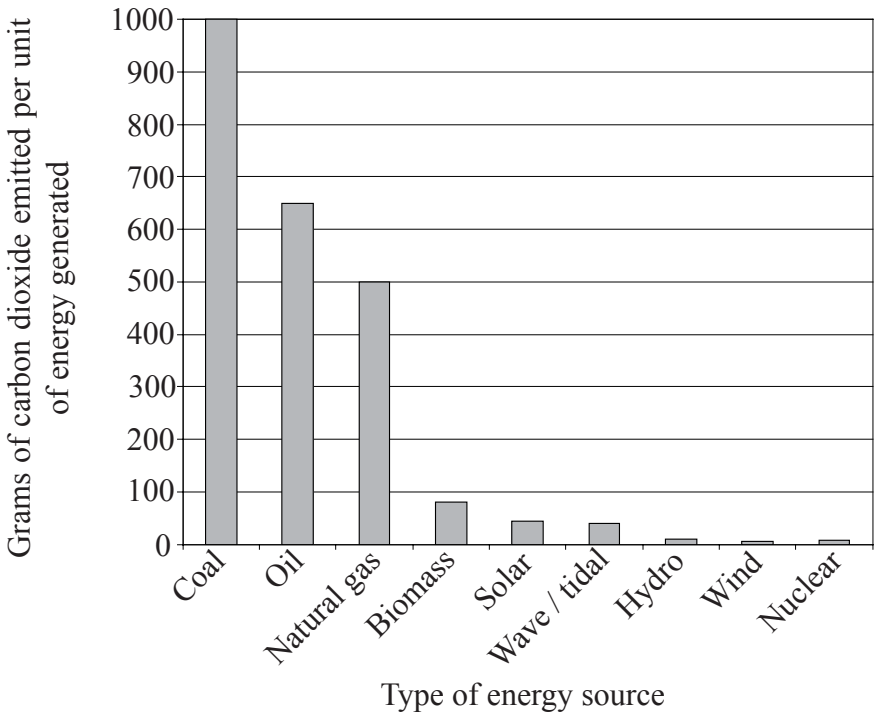
Option B — Impacts of Resource Exploitation

B1. The bar chart below compares the carbon dioxide emissions from different energy sources used to generate electricity in Europe, USA and Australia.



[Source: Parliamentary material is reproduced with the permission of the Controller of HMSO on behalf of Parliament.]

(a) (i) Use the graph to compare the quantities of carbon dioxide emitted from fossil fuel and non-fossil fuel sources used to generate electricity. *[2]*

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(ii) Outline why nuclear and renewable energy sources release carbon dioxide, even though they do not burn carbon-based fuels to produce electricity. *[1]*

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(This question continues on the following page)

(Question B1 continued)

(iii) In the table below, outline **two** disadvantages of generating electricity from **two** of the **renewable** resources named in the bar chart opposite. *[4]*

Name of renewable resource	Disadvantage
. . . . .	1. . . . .
	2. . . . .
. . . . .	1. . . . .
	2. . . . .

(b) (i) Define *per capita* ecological footprint. *[2]*

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(ii) Explain why a country that generates most of its electricity from fossil fuels will have a greater ecological footprint than one that uses mainly nuclear or renewable sources. *[2]*

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(iii) Populations living in countries with a large *per capita* ecological footprint often eat large quantities of meat. Explain how this affects the size of the ecological footprint. *[2]*

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(Question B1 continued)

(c) Suggest **two** ways in which food production systems could be changed to provide a larger and more reliable supply of food in the future. *[2]*

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(d) In 2001, there were 1.8 ha of land of average productivity available for each person on the planet.

In the same year, China had a population of 1293 million people and needed 0.65 ha *per capita* to absorb the carbon dioxide produced from fossil fuels and 0.8 ha *per capita* for food, fibre and timber production.

(i) Calculate China's **total** ecological footprint. *[1]*

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(ii) China has only 0.8 ha of land of average productivity per person.

Describe the implications for the future of China's population, and suggest ways in which possible problems of excessive pollution and shortage of resources could be reduced. *[4]*

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Option C — Conservation and Biodiversity

C1. (a) (i) Outline the difference between *species diversity* and *genetic diversity*. *[2]*

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(ii) Part of an old forest is burned down and is replanted with trees of only one species. Explain why habitat diversity, species diversity and genetic diversity are likely to be lower in the new forest than in the old one. *[3]*

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(Question C1 continued)

(b) The table below shows seasonal variations in the biodiversity index of the invertebrates in a freshwater ecosystem in the northern hemisphere.

Site	May	Jul	Sep	Nov	Jan	Mar
1	4.40	3.75	3.90	2.11	3.37	3.45
2	3.37	1.19	2.37	3.05	3.34	3.86
3	3.81	2.57	3.67	3.47	2.61	3.12
4	4.13	1.91	3.62	3.33	2.33	4.46

[Source: Reproduced by permission of the Proceedings of the Oklahoma Academy of Science and the Oklahoma Academy of Science]

(i) State which site shows the greatest range of diversity over the year. *[1]*

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(ii) State in which month the biodiversity index is highest at each site. *[1]*

Site 1: . . . . . .

Site 2: . . . . . .

Site 3: . . . . . .

Site 4: . . . . . .

(iii) Suggest **two** reasons, other than human impact, that could account for the differences in biodiversity between the sites. *[2]*

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(This question continues on the following page)

(Question C1 continued)

(c) On an island in the Caribbean with high biodiversity, scientists have been investigating natural selection. One species of lizard (Brown anole) found on the island lives mostly on the ground, as it has no natural predators. Variations in the lengths of the lizards' legs are due to genetic diversity within the population. Following the introduction of a larger predator, scientists observed that at first, lizards with long legs became more common than those with short legs.

Brown anole (*Anolis sagrei*)

[Source: *http://www.flmnh.ufl.edu/herpetology/FL-GUIDE/Flaherps.htm*.E]

(i) Explain how the proportion of lizards with long legs might increase through natural selection. *[2]*

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Later in the study, scientists observed that the lizards were spending more time climbing in shrubs and trees than on the ground and that short-legged lizards were again more common than long-legged lizards.

(ii) Suggest why short-legged lizards eventually became more common again. *[2]*

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(d) Outline **two** reasons why conservation of habitats may be more important in conserving biodiversity in the long term than conserving individual species. *[2]*

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(Question C1 continued)

(e) (i) Name a protected area that you have studied and outline its important features. *[1]*

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(ii) Describe **two** ways in which the protected area you have named above has helped to conserve species or habitat diversity. *[2]*

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(iii) Explain **two** features of your named protected area that limit its effectiveness in conserving biodiversity. *[2]*

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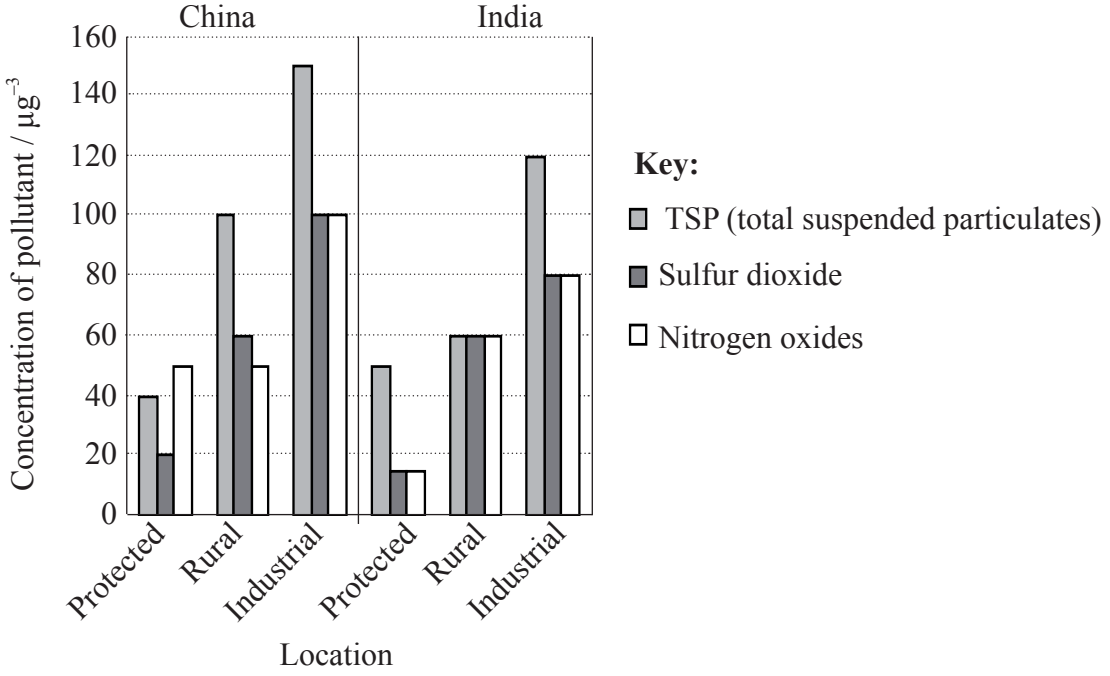
Option D — Pollution Management

D1. The bar chart below shows the levels of certain atmospheric pollutants in China and India in protected, rural and industrial areas. Protected areas include nature reserves and national parks.



(a) (i) State which pollutant shows the greatest range of values in China. *[1]*

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(ii) Calculate the level of TSP in rural areas as a percentage of the level in industrial areas for India. *[1]*

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(Question D1 continued)

(b) State **three** possible sources of these pollutants. *[1]*

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(c) Describe and explain the differences between the levels of the pollutants in the **three** different locations for **China**. *[3]*

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(d) Describe an indirect method that could be used to measure the impact of pollutants such as sulfur dioxide and nitrogen oxides on an ecosystem. *[3]*

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D2. The International Lake Environment Committee (ILEC), in cooperation with the United Nations Environment Programme (UNEP), undertook an environmental survey of the world's lakes. All the lakes surveyed showed an increase in the levels of eutrophication over the past fifty years.

(a) State **two** types of chemical compounds that could cause eutrophication. *[2]*

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(b) Describe the role of the compounds named above in the process of eutrophication. *[2]*

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(c) Evaluate the impacts of eutrophication. *[3]*

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(d) Describe and explain how lakes affected by eutrophication can be cleaned and restored. *[4]*

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