International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

Environmental Systems and Societies

Standard level

Specimen paper 1s and 2s

For first examinations in 2010

CONTENTS

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

ENVIRONMENTAL SYSTEMS AND SOCIETIES
STANDARD LEVEL
PAPER 1

SPECIMEN PAPER

1 hour

Candidate session number

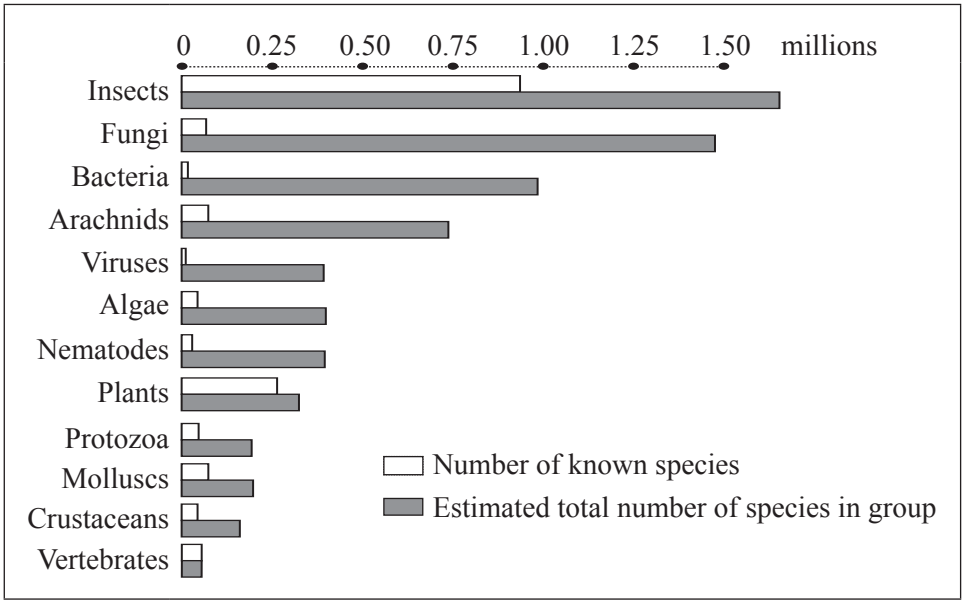
0	0							

INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions 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 number of answer sheets used in the appropriate box on your cover sheet.

1. Figure 1 below shows the numbers of known species in a range of animal and plant groups. Also included on the same figure is the estimated total number of species for each group, this includes the species that have yet to be discovered.

Figure 1



[Source: UNEP printed in the *Economist*, 21 March 1998, page 12]

(a) (i) State which group contains the most known species. *[1]*

. . . . . .

(ii) State which group has the greatest difference between known number and estimated total number of species. *[1]*

. . . . . .

(b) (i) Suggest **one** reason why it is so difficult for scientists to state exactly how many species exist in a group. *[1]*

. . . . . .

. . . . . .

. . . . . .

(ii) Suggest why the number of known vertebrate species may so closely match the estimated total number. *[1]*

. . . . . .

. . . . . .

. . . . . .

(This question continues on the following page)

(Question 1 continued)

(c) Outline a field technique you might use for collecting species diversity data for **one** of the groups listed in Figure 1. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(d) With reference to a **named** ecosystem, identify **one** direct and **one** indirect threat to the ecosystem's biodiversity. *[2]*

Named ecosystem: . . . . . .

Direct threat: . . . . . .

. . . . . .

. . . . . .

Indirect threat: . . . . . .

. . . . . .

. . . . . .

2. Figure 2(a) shows a farming system and Figure 2(b) outlines the activities for the farm in areas A, B and C over a year.

Figure 2(a)

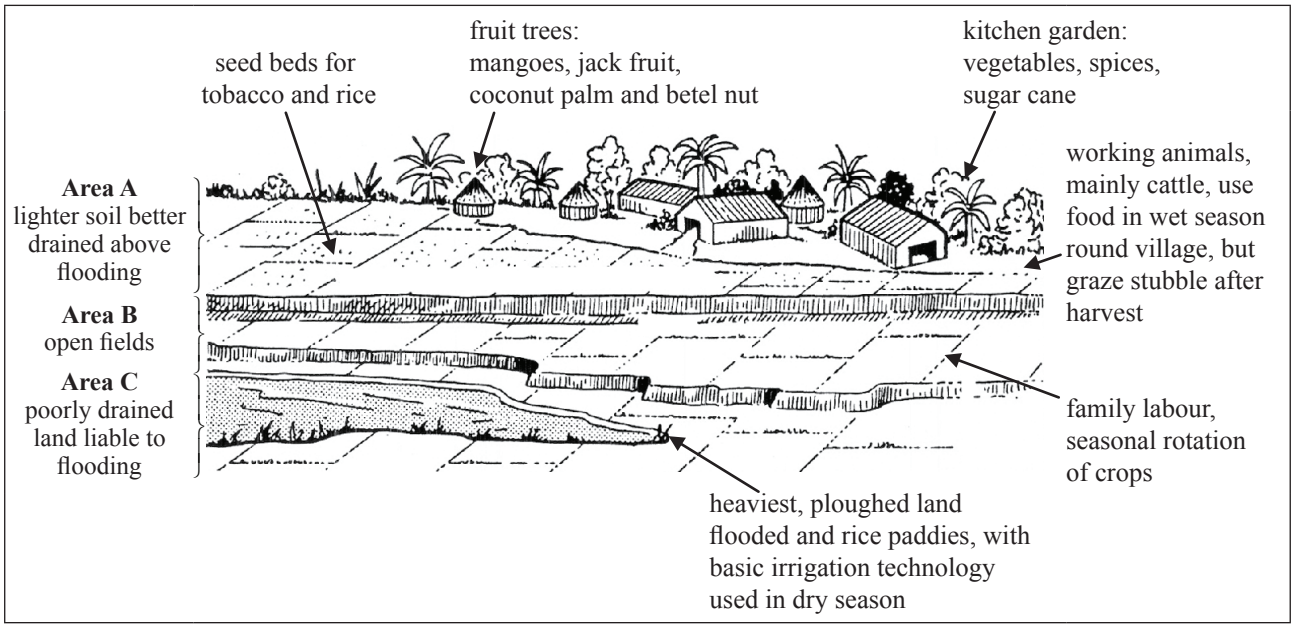


Figure 2(b)

Month	March April May September March	
Season	Pre–monsoon Wet season	Dry season
Area A	cattle in yard, mangoes, vegetables	repairing and thatching, green coconuts, betel nuts
Area B	jute	wheat, tobacco, mustard
Area C	grazing, rice (flooding)	grazing

[Source: Adapted from M Carr, *Patterns, Process and Change in Human Geography*, Macmillan, (1987), page 142]

(a) State, giving **two** reasons, whether this system is more typical of farming in a more economically developed country (MEDC) **or** a less economically developed country (LEDC). *[2]*

. . . . . .

. . . . . .

. . . . . .

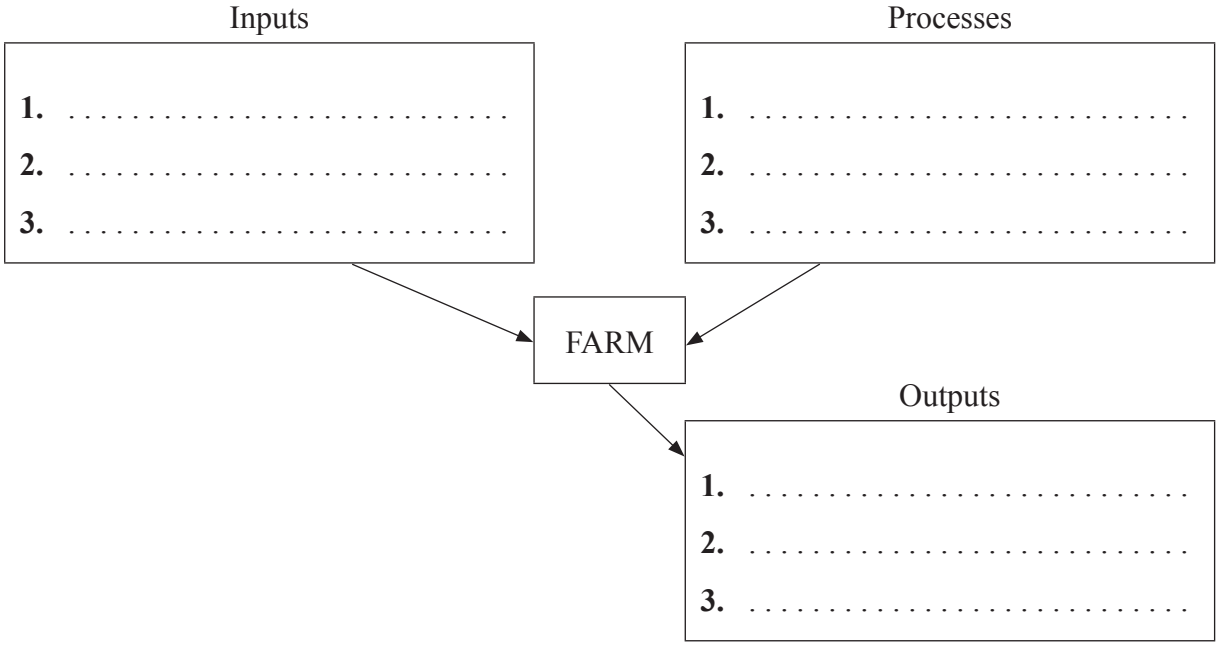
. . . . . .

. . . . . .

(This question continues on the following page)

(Question 2 continued)

(b) Complete the systems diagram below to show **three** inputs, processes and outputs for the farming system shown in Figure 2(a) and Figure 2(b). *[3]*



(c) With reference to Figure 2(a) and Figure 2(b), describe **two** ways in which the farming system has been developed in response to variations in the local environment. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

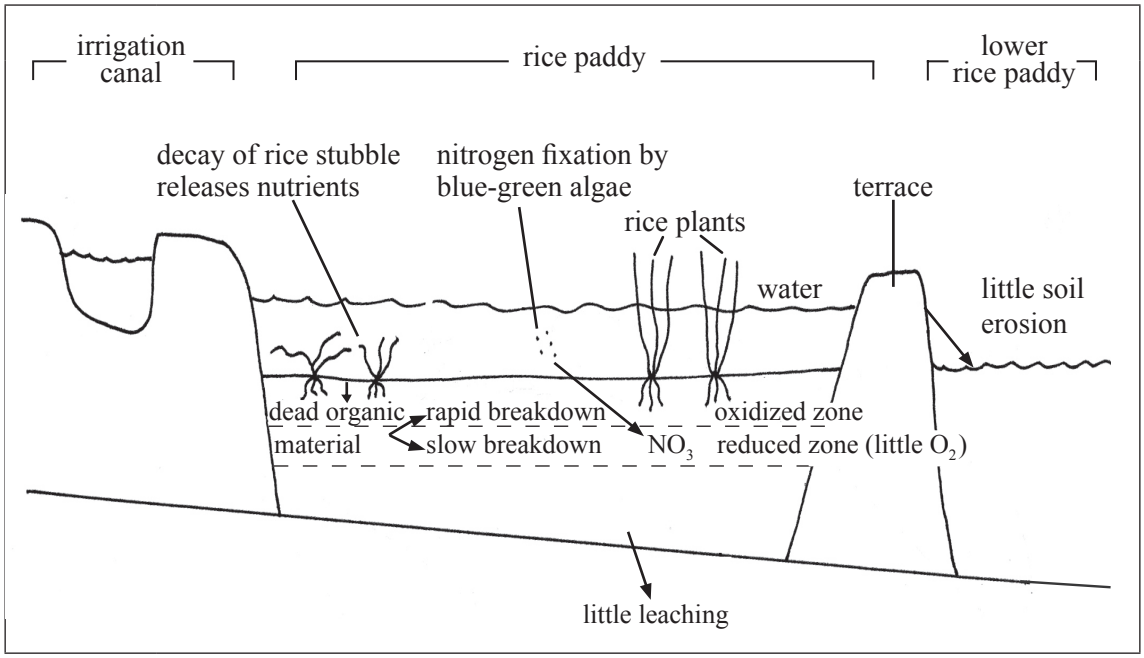
. . . . . .

(This question continues on the following page)

(Question 2 continued)

Figure 3 below shows nutrient cycling in a terraced paddy.

Figure 3



(d) With reference to Figure 3, define

(i) *leaching.* *[1]*

. . . . . .

. . . . . .

(ii) *nitrogen fixation*. *[1]*

. . . . . .

. . . . . .

(e) With reference to Figure 3 explain the following.

(i) There is very little soil erosion in this farming system. *[1]*

. . . . . .

. . . . . .

. . . . . .

(ii) The dead organic material breaks down more rapidly in the oxidized zone. *[1]*

. . . . . .

. . . . . .

Blank page

3. Figure 4 below shows how the sun's energy flows along a food chain and Figure 5 shows one way in which solar energy can be converted into electricity.

Figure 4

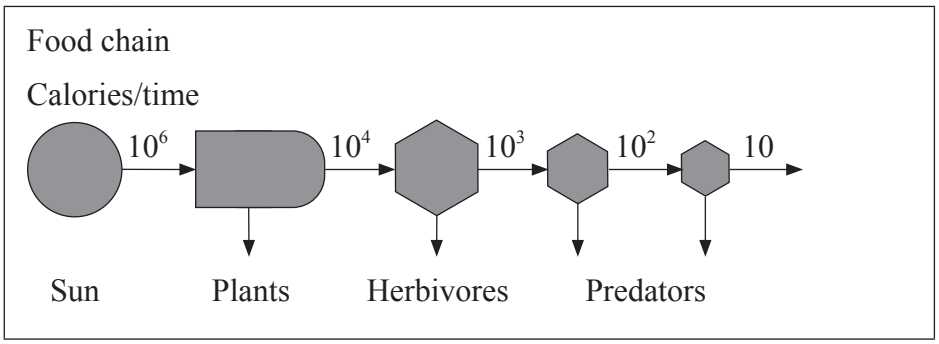
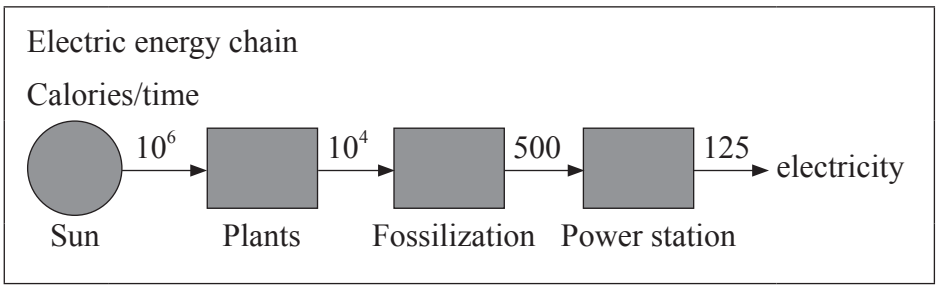


Figure 5



[Source: Adapted from E P Odum, *Ecology*, *A Bridge Between Science and Society*, Sinauer Associates Inc., (1996), page 89]

(a) Describe and explain what is happening to energy along the food chain in Figure 4. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) Describe the process by which the sun's energy is used by plants. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(c) State **two** energy sources that could be used in the power station in Figure 5. *[1]*

. . . . . .

. . . . . .

(This question continues on the following page)

(Question 3 continued)

(d) Explain how the power station in Figure 5 may contribute to a **named** environmental problem. *[3]*

Environmental problem: . . . . . .

Explanation: . . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

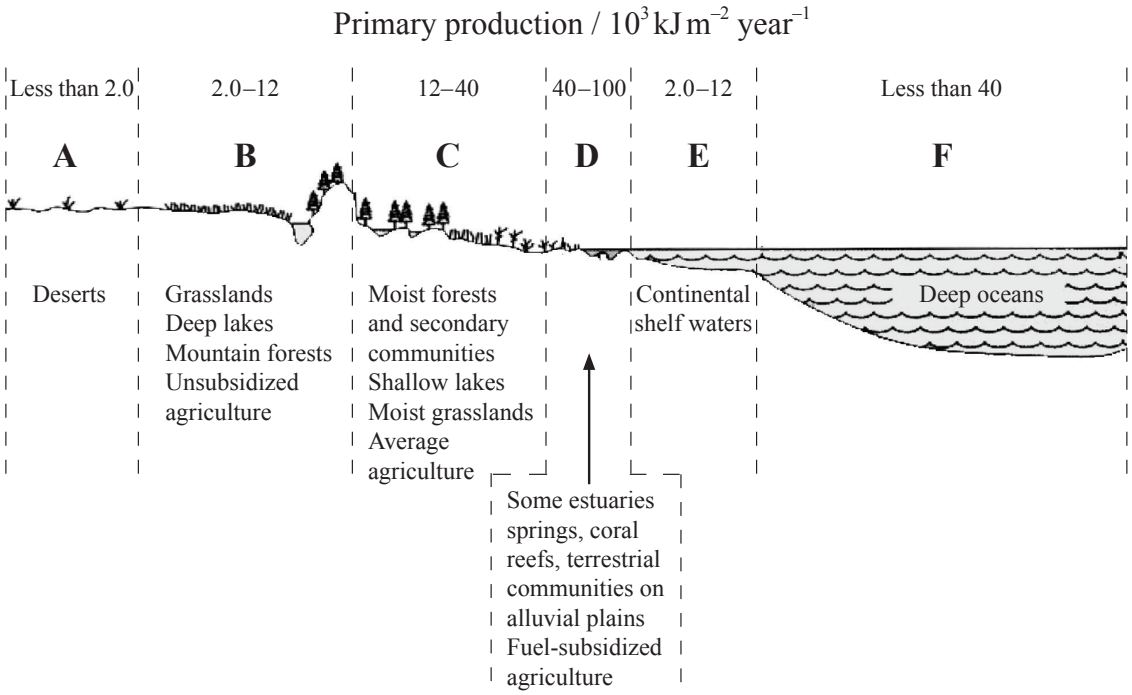
. . . . . .

(This question continues on the following page)

(Question 3 continued)

Figure 6 below shows the world distribution of primary production in different biomes.

Figure 6



[Source: Adapted from E P Odum, *Ecology*, *A Bridge Between Science and Society*, Sinauer Associates Inc., (1996), page 94]

(e) State which of the zones A to F is responsible for the largest proportion of primary production. *[1]*

. . . . . .

(f) Distinguish between *primary productivity* and *secondary productivity*. *[1]*

. . . . . .

. . . . . .

. . . . . .

(This question continues on the following page)

(Question 3 continued)

(g) With reference to Figure 6, explain **two** reasons why some biomes are more productive than others. *[2]*

. . . . . .

. . . . . .

. . . . . .

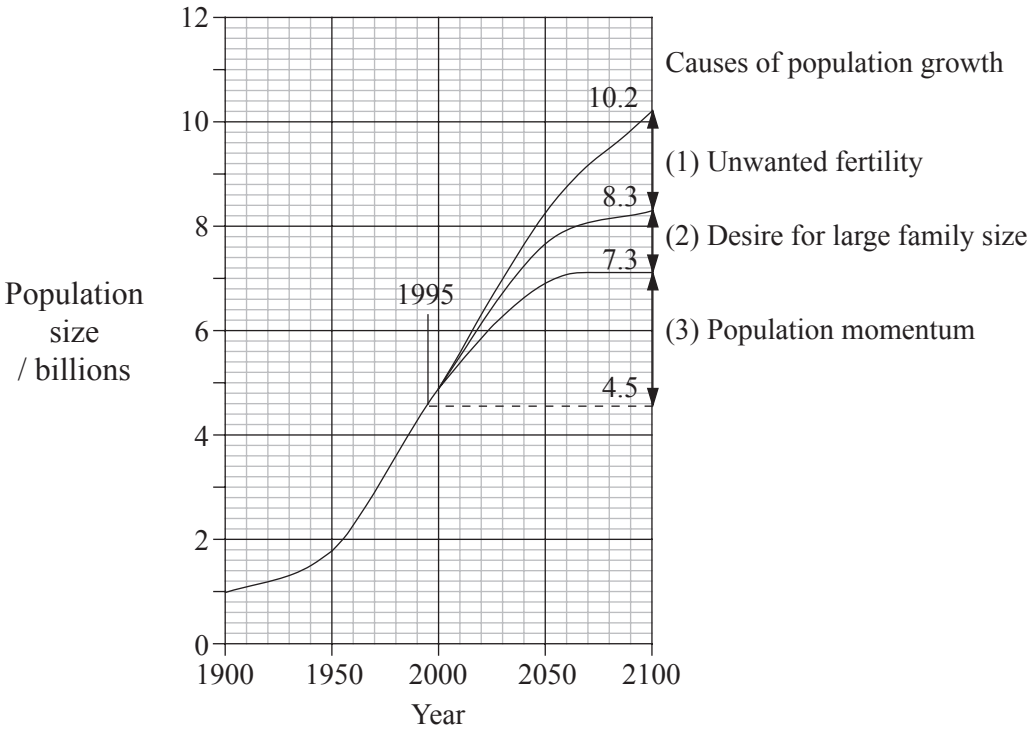
. . . . . .

. . . . . .

. . . . . .

4. Figure 7 below shows a projection for future human population growth and the relative contributions of unwanted fertility, desire for large family size and population momentum to this growth.

Figure 7



[Source: Adapted from J Bongaarts (1994), *Population Policy Options in the Developing World*, *Science,* **263**, pages 771–776, and E P Odum (1996), *Ecology*, *A bridge between science and society*, Sinauer Associates Inc., page 184]

(a) With reference to Figure 7,

(i) state the total expected population size for the year 2050. *[1]*

. . . . . .

(ii) identify which of the **three** factors are expected to account for the highest proportion of the increase in total population growth between 1995 and 2100. *[1]*

. . . . . .

(iii) calculate the potential percentage decrease in population for the year 2100 if efficient birth control had been practised since 1995. *[1]*

. . . . . .

(This question continues on the following page)

(Question 4 continued)

(b) Explain the reasons for **either** unwanted fertility **or** desire for large family size in a **named** country. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(c) Suggest **two** factors which may limit total population growth in the future. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

5. Figure 8 below and Figure 9 opposite are cartoons which each express an environmental message.

Figure 8

[Source: *Thin Black Lines rides again*, Regan, Sinclair, Turner, development education centre, in association with Cartoonists and Writers Syndicate (67 Riverside Drive, New York 10024, fax. no. 010 1 212 595 4218), (1994), page 47]

(a) Suggest what message the cartoonist is trying to depict about attitudes to environmental problems in Figure 8. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

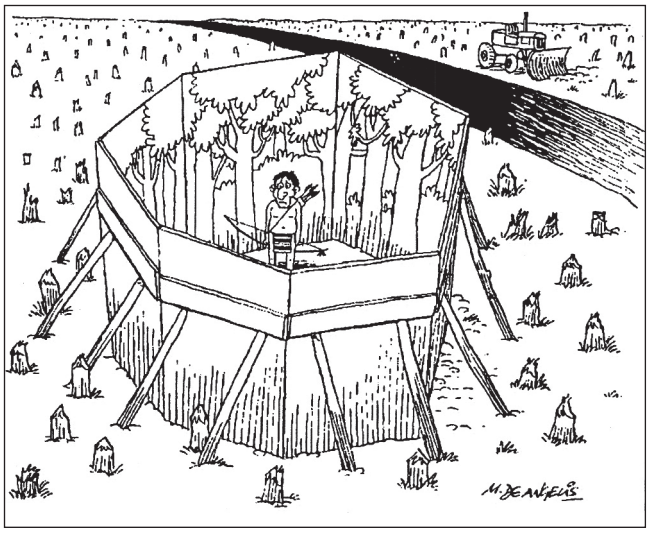
. . . . . .

. . . . . .

(This question continues on the following page)

(Question 5 continued)

Figure 9



[Source: *Thin Black Lines rides again*, Regan, Sinclair, Turner, development education centre, in association with Cartoonists and Writers Syndicate (67 Riverside Drive, New York 10024, fax no 010 1 212 595 4218), (1994), page 51]

(b) Figure 9 is a cartoon which suggests that a conflict exists between resource use and the needs of indigenous people. Explain why such a conflict might exist in tropical rainforests. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

SPEC/4/ENVSO/SP1/ENG/TZ0/XX/M

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

MARKSCHEME

SPECIMEN PAPER

ENVIRONMENTAL SYSTEMS AND SOCIETIES

Standard Level

Paper 1

6 pages

1. (a) (i) insects; ***[1]***

(ii) fungi; ***[1]***

(b) (i) many species simply have not been discovered yet (large areas of tropical forest/deep ocean unexplored for example);
rate of extinction is so rapid that some species become extinct before we have discovered them;
small organisms hard to find/capture/identify; ***[1 max]***

(ii) vertebrates are larger, so are easier to find/catch and classify;
there are fewer species of vertebrate, so the chance of finding all of them is higher; ***[1 max]***

(c) *e.g.* for insects, use a large sweep net to capture;
and then identify using keys the number of species;
count number of individuals in each species;
use Simpson's diversity index (involves total number of insect species and number of individuals);
number of species must be recorded within a given area (*e.g.* number of species in a quadrat/hectare); ***[3 max]***

(d) *No mark for naming an ecosystem, but if no ecosystem is named award* ***[1 max]****.*

e.g. Coral Reef off coast of Philippines

direct threats: ***[1 max]***
aggressive fishing techniques *e.g.* dynamite fishing / cyanide fishing;
collecting shells/coral for souvenirs for tourist industry;

indirect threats: ***[1 max]***
coral reefs then become more vulnerable to storm/cyclone damage / disease / sea temperature changes (due to global warming);
siltation due to mangrove clearance and run-off from coast; ***[2 max]***

2. (a) LEDC
basic/lack of technology generally;
rice farming is typical of LEDCs / where rice is often the staple crop;
cash crops for export such as sugar cane, tobacco;
houses look fairly simple and made from local / cheap materials / thatched roofs;
dependence on working animals;
labour intensive (family labour);
mixed cropping on small scale; ***[2 max]***
*Award **[0]** for only stating LEDC.*

(b) *inputs*: ***[1 max]***
water / technology / cattle (livestock) / sunlight / rain / manure / seed / labour / soil;
*Award **[1]** for any three of the above.*

processes: ***[1 max]***
planting / ploughing / harvesting / irrigating / repair / respiration / run-off / labour;
*Award **[1]** for any three of the above.*

outputs: ***[1 max]***
jute / vegetables / mangoes / Jack fruit / Palm / coconut / sugar cane / spices / crops / waste / income / energy / rice / food / Betel nuts / tobacco / cattle (livestock) / heat / oxygen / carbon dioxide / wheat / mustard; ***[3]***
*Award **[1]** for any three of the above.*

(c) different crops planted at different levels;
rotation of crops to match seasonal rainfall patterns;
monsoonal climate so main crop is rice;
irrigation technology used in dry season;
livestock fed differently at different times of year;
different jobs done at different times of year; ***[2 max]***
Accept other reasonable answers.
Answers must be linked to variations in environment.

(d) (i) when nutrients, dissolved in water, wash down through the soil/paddy and are lost; ***[1]***

(ii) process by which nitrogen in atmosphere is fixed to form nitrate by blue-green algae (and converted into a useable form for plants); ***[1]***

(e) (i) because the terraces are level there is little run-off by water so soil is not washed away / terraces prevent soil erosion / soil collects in paddies; ***[1]***

(ii) oxygen is required by decomposers to break down organic matter (the oxidized zone is closer to the surface and richer in oxygen) / higher BOD in oxidized zone as more decomposers, thus more decomposition; ***[1]***

3. (a) energy is dissipated/lost along the food chain / converted to less useful form;
this is because species at each trophic level are using some of the energy for respiration, and some is lost as heat/waste to the environment; ***[2]***

(b) photosynthesis/primary production is the process by which green plants convert light energy into a usable form/chemical energy/food/organic matter;
requires carbon dioxide, water, chlorophyll and light;
involves production of oxygen; ***[2 max]***
Give credit for chemical equation.

(c) coal / oil / natural gas; ***[1]***
*Award **[1]** for any two of the above.*

(d) *Accept any reasonable environmental problem.*
problem: ***[1 max]***
e.g. noise pollution / air pollution / global warming / acid rain;

explanation: ***[2 max]***
e.g. urban air pollution caused by release of hydrocarbons (from unburned fuel) and nitrogen oxide;
nitrogen oxide reacts with oxygen to form nitrogen dioxide, a brown gas that contributes to urban haze; ***[3]***

(e) zone D; ***[1]***

(f) primary productivity is the gain in energy/biomass by producers/autotrophs whereas secondary is gain by heterotrophic organisms;
primary productivity is the conversion of solar energy whereas secondary involves feeding/absorption; ***[1 max]***

(g) availability of light *e.g.* deep oceans dark below surface limits productivity of plants;
availability of water *e.g.* tropical rainforests receive lots of rainfall each year whereas deserts have little rain which is limiting to plant growth;
temperature *e.g.* rainforests warm throughout the year so have a constant growing season and higher productivity;
nutrient availability *e.g.* estuaries receive lots of sediment from rivers; ***[2 max]***
*Award **[1 max]** for no reference to the biomes in figure 6.*

4. (a) (i) *Accept answers between*
8.0 and 8.5 billion; ***[1]***

(ii) population momentum; ***[1]***

(iii) $10.2 - 8.3 = 1.9$
$\frac{1.9}{10.2} \times 100 = 18.6\%$; ***[1]***

(b) *e.g.* unwanted fertility – poor rural women in Nigeria

may like to be able to limit their family size, but are unable to use family planning because of attitude of their societies (who value male fertility);
religious intolerance to family planning;
because of rural isolation and an inability to access family planning centres;
lack of education about family planning;

e.g. desire for large family size in India

patriarchal society and many offspring seen as a symbol of male fertility;
children seen as a source of income;
farm labour;
seen as security in old age (no social security system);
cultural expectation for sons;
high infant mortality rate so large families necessary to ensure survival of some;
tradition for large family;
few options for women; ***[3 max]***
*Award **[0]** for naming countries.*

(c) natural resources/food will become so scarce that population is limited by hunger;
population limited by wars over scarce resources;
as nations develop economically and move through stages of demographic transition, growth rates can be expected to decline for a variety of socio-economic reasons;
government strategies/policies *e.g.* tax incentives;
greater access to family planning as communications/education/wealth increases;
changing attitudes will reduce desire for large families; ***[2 max]***
Accept any other reasonable suggestions.

5. (a) perhaps cartoonist is suggesting that politicians/society refuse to act because they claim that more research needs to be done first;
despite the fact that evidence (falling birds) is in front of their eyes; ***[2]***
Accept similar interpretations of cartoon, no need to mention acid rain.

(b) conflict might exist because different groups see the resource differently;
economic value of timber/land is incompatible with leaving forest standing for other uses (indigenous cultures);
indigenous tribes need large amounts of space in which to live sustainably;
reserves left for indigenous people may be too small to sustain them;
forest is cut down by outsiders ignoring the needs of indigenous people;
intrinsic value of forest (biorights) is ignored by exploitative users only interested in economic use;
difference between sustainable use of forest (natural income) and users who exploit natural capital;
conflict between short-term and long-term perspective (indigenous people); ***[3 max]***

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

ENVIRONMENTAL SYSTEMS AND SOCIETIES
STANDARD LEVEL
PAPER 2

SPECIMEN PAPER

2 hours

Candidate session number

0	0							

INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all of Section A in the spaces provided. Refer to the resource booklet which accompanies this question paper.
- Section B: answer two questions from Section B. Write 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 numbers of the questions answered in the candidate box on your cover sheet and indicate the number of sheets used in the appropriate box on your cover sheet.

SECTION A

Answer all of Section A in the spaces provided.

The resource booklet provides information on Glen Canyon Dam on the Colorado River, in the United States. Use the resource booklet and your own studies to answer the following.

1. (a) Describe the purpose of an Environmental Impact Assessment (EIA). *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) At the time of construction of Glen Canyon Dam no EIA was undertaken. Outline, giving reasons, **three** variables which should have been measured as part of a baseline study prior to starting construction. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(This question continues on the following page)

(Question 1 continued)

(c) With reference to Figure 5 and other resources in the booklet describe and explain how water discharge and suspended sediment discharge changed as a result of the construction of dams along the Colorado River. *[5]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(d) Use the resource booklet to complete the table below to show how abiotic conditions have changed as a result of the construction of Glen Canyon Dam. *[3]*

Abiotic factor in the Colorado River	**Increased or decreased after construction of Glen Canyon Dam**	**Reason for change**
Size of the beach and sand bar habitats	decreased	Replenishing sediment held back behind dam
Riverine habitat diversity		
Water temperature range		
Nutrient content of water in river		

(This question continues on the following page)

(Question 1 continued)

(e) Identify a non-native species now present within the Colorado River because of the construction of Glen Canyon Dam, and suggest possible impacts this might have on native species. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(f) Discuss, using evidence from the resource booklet, why the decision to construct dams along the Colorado River could be described as a "technocentric" approach to resource management. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(This question continues on the following page)

(Question 1 continued)

(g) With reference to the checklist for "good" dams in Figure 8 and the information from the resource booklet, justify to what extent you consider Glen Canyon Dam to be a "good" dam. *[6]*

SECTION B

*Answer **two** questions. Write your answers on the answer sheets provided. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.*

*Each essay is marked out of **[20]** of which **[2]** are for clarity of expression, structure and development of ideas:*

[0] *Quality of expression, structure and development is poor.*
[1] *Quality of expression, structure and development is limited.*
[2] *Quality of expression is clear, structure is good and ideas are well developed.*

2. (a) Evaluate the role of socio-cultural factors in the development of different food production systems. *[8]*

(b) Compare the attitudes towards the natural environment of **two named** contrasting societies, and discuss the consequences of these attitudes to the way in which natural resources are used. *[10]*

Expression of ideas [2]

3. (a) Outline the general principles behind the World Conservation Strategy. *[4]*

(b) Compare and evaluate the role of global and local approaches to environmental problem solving. Support your answer with examples. *[8]*

(c) Justify the importance of the scientific study of small-scale local ecosystems in environmental problem solving. Support your answer with examples. *[6]*

Expression of ideas [2]

4. (a) Describe the typical features of a climax community. *[4]*

(b) With reference to a **named** ecosystem describe the natural and human threats it faces and discuss the consequences for its future equilibrium. *[10]*

(c) Explain, with the aid of an example, the role of feedback mechanisms in the regulation of ecosystem equilibrium. *[4]*

Expression of ideas [2]

5. (a) Describe some of the contrasting responses to the issue of global warming. *[5]*

(b) Outline the reasons why people have such different opinions on the issue of global warming. *[5]*

(c) Describe what is meant by *carrying capacity* and evaluate the role that technology could play in ensuring that the Earth's carrying capacity is not exceeded by human populations. *[8]*

Expression of ideas [2]

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

ENVIRONMENTAL SYSTEMS AND SOCIETIES
STANDARD LEVEL
PAPER 2

SPECIMEN PAPER

2 hours

RESOURCE BOOKLET

INSTRUCTIONS TO CANDIDATES

- Do not open this booklet until instructed to do so.
- This booklet contains **all** of the resources required to answer question 1.

Figure 1 — Fact File on Glen Canyon

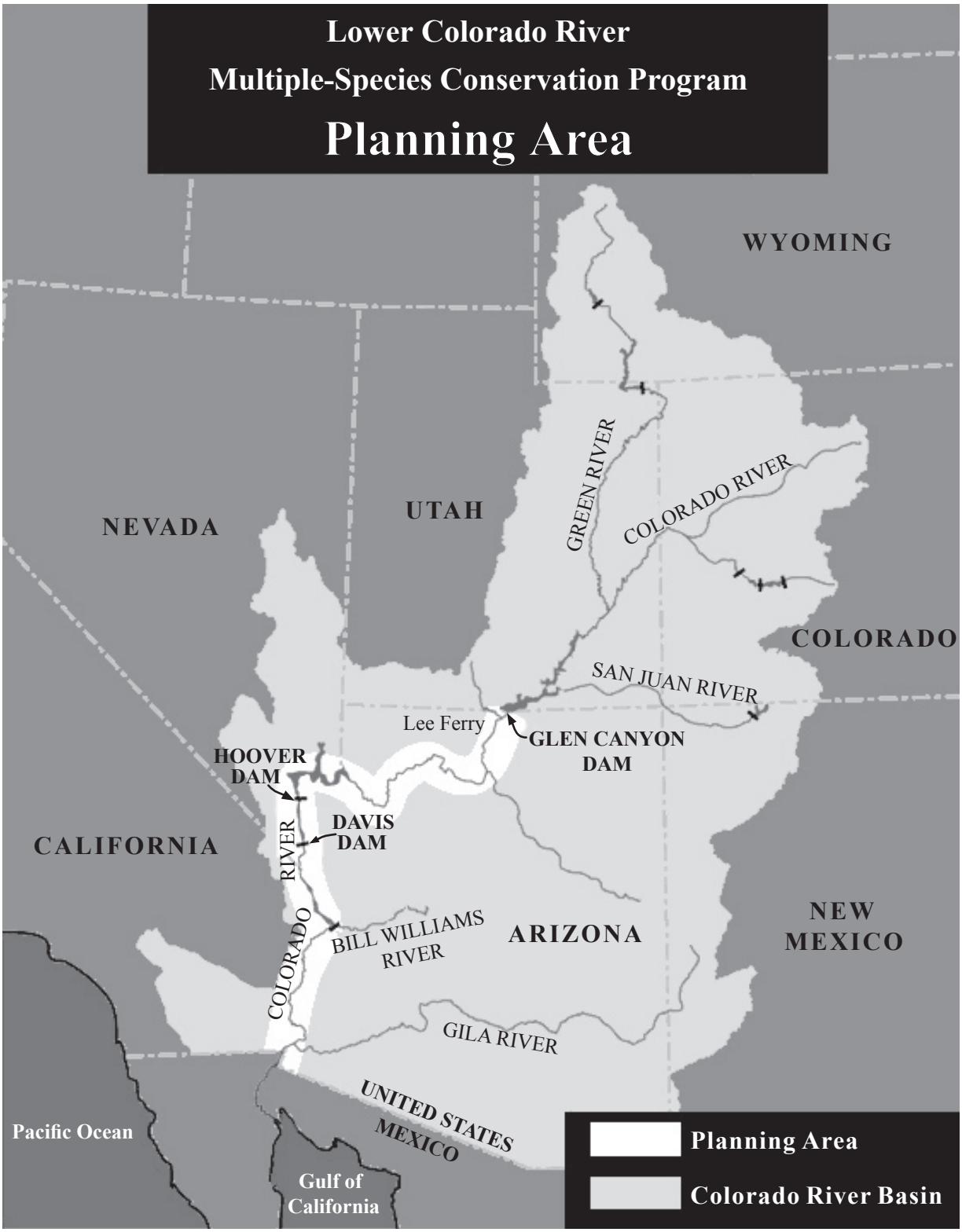
Initial cost: $300 million (in 1963)
Ongoing costs: estimated between $11– $29 million
Height: 216 m
Completed: 1963
Amount of Glen Canyon flooded by Lake Powell: 299 km

Economic benefits:

- The Colorado River provides water for more than 30 million people and without Glen Canyon Dam a lot of this water would be "wasted".
- Glen Canyon Dam allows the southwest of the United States to be developed and populated far more than the pre-dam conditions.
- 85 % of the water is used for irrigation for agricultural production enabling arid regions to become fertile agricultural lands and economically viable.
- Because of the high productivity of these areas, many people in the United States are provided with fruits and vegetables all year round.
- The Glen Canyon Dam power station represents a cheap source of hydroelectric power for much of the southwestern United States and for parts of Mexico, including many poor rural and Native American communities.
- The water supply enabled development of the town of Page, Arizona, which currently has over 8200 residents.
- 4 million visiting tourists (often en route to the Grand Canyon and Monument Valley) bring in $2.5 million each year.
- Many jobs depend on the tourist industry. The largest employers are the National Park Service and the Navajo Generating Station.
- Lake Powell itself provides fishing, boating, water-sports and camping to tourists each year.
- Downstream, recreational fisheries have been improved. Non-native trout have done especially well, further attracting tourists to one of the finest trout fishing sites in the southwest.
- Altered flows provide excellent rapids and runs for rafters and kayakers each year.

[Source: Adapted from the article *"Large Dams in the Western United States"*, produced by Environmental Science students at Kenyon College in 1989, www2.kenyon.edu/Projects/Dams/index.html]

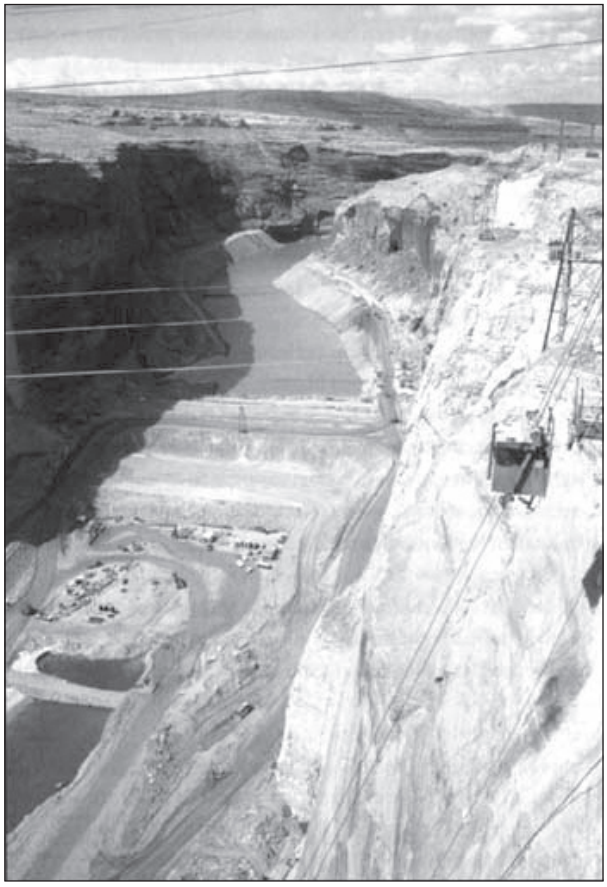
Figure 2 — Map of the Lower Colorado River

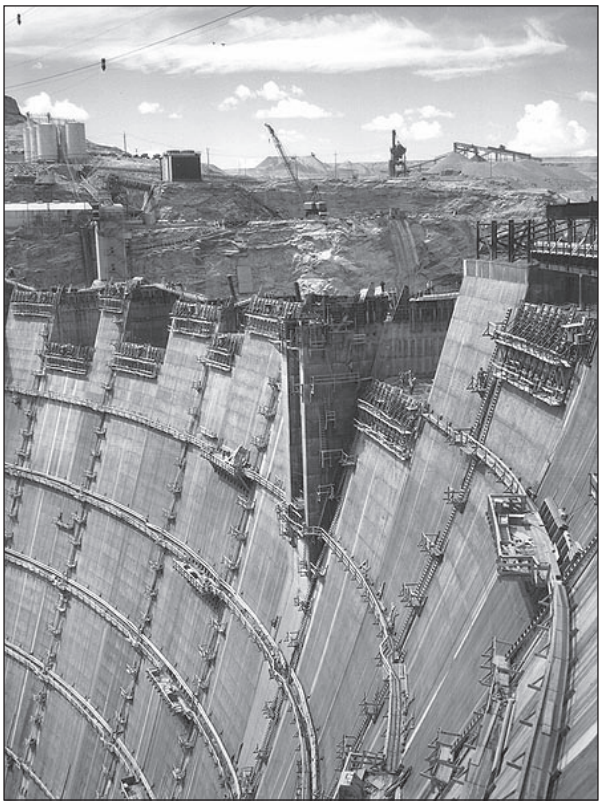


[Source: www.lcrmscp.org/corivmap.gif]

Turn over

Figure 3 — Photographs of Glen Canyon Dam under construction, Lake Powell is behind





[Source: United States Bureau of Reclamation]

Figure 4 — The advantages of hydroelectric power (HEP)
Adapted from a website produced by the National Hydropower Association (US)

A major source of energy

* The United States is the second largest producer of hydroelectric power (HEP) in the world.
* HEP contributes 8–12 % of the United States' electrical generation.
* Globally, one-fifth of electricity is generated from HEP.

Clean and renewable – a sound environmental choice

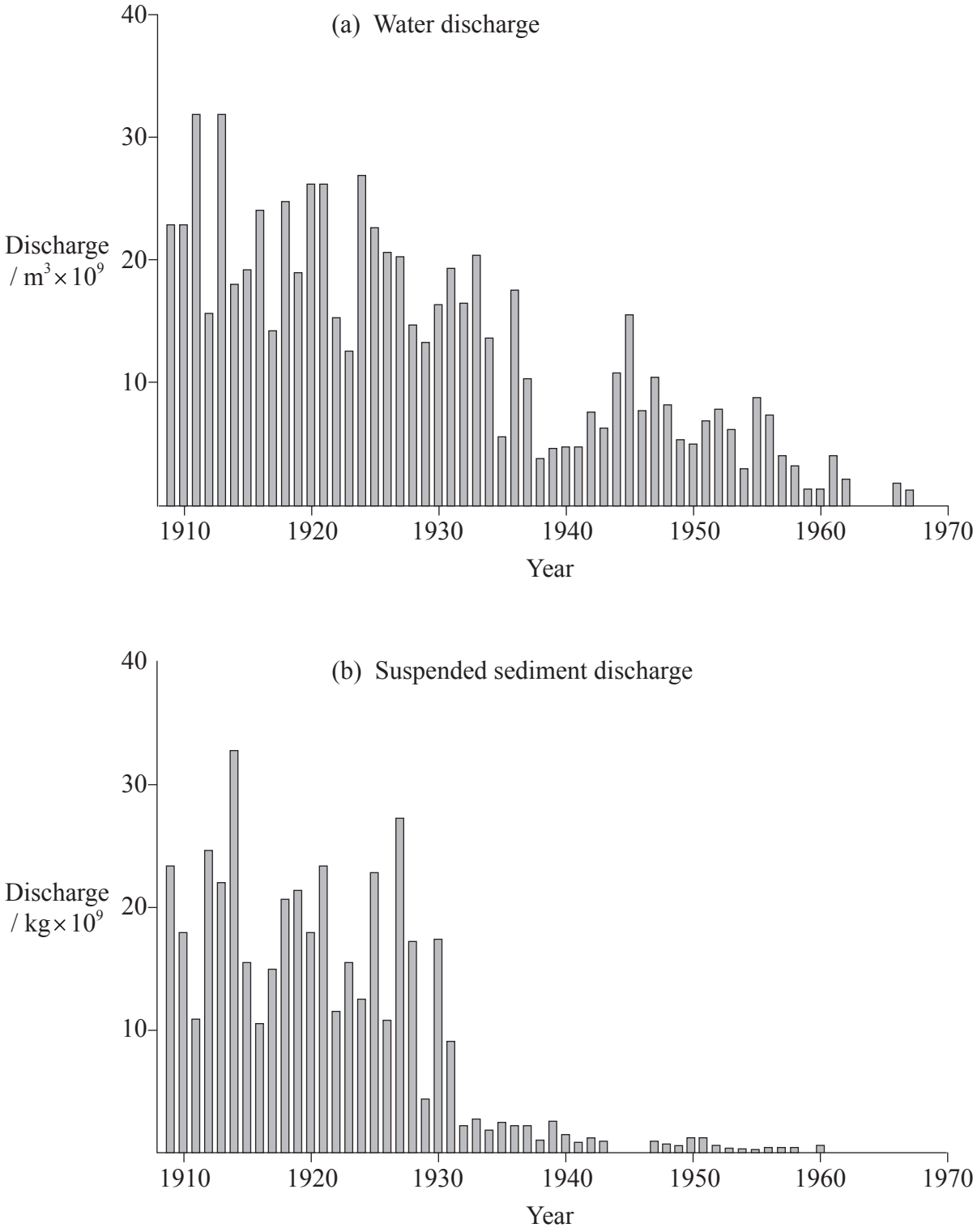
* 93 % of Americans believe HEP is important for meeting future electricity needs.
* HEP is a renewable source of electricity. HEP accounts for 80 % of the United States' total renewable electricity generation making it the leading renewable energy source.
* In 1999, HEP avoided the release of an additional 77 million metric tons of carbon equivalent into the atmosphere. This is equivalent to the annual exhaust of half of the cars on United States roads.
* HEP projects can enhance wetlands and support healthy fisheries. Wildlife preserves can be created around reservoirs, which can provide stable habitats for endangered or threatened species.

Reliable, efficient, secure… and fun!

* Today's HEP turbines are capable of converting 90 % of available energy into electricity – that is more efficient than any other form of generation.
* HEP's operational flexibility – its unique ability to change output quickly – is highly valued and will become even more so in a competitive market. Its unique voltage control, load-following and peaking capabilities help maintain the stability of the electric grid ensuring economic growth and a high quality of life.
* HEP adds to national security. Water from rivers is a purely domestic resource that is not subject to disruptions from foreign suppliers, production strikes or transportation issues.
* There were a total of 81 million recreation user days provided by licensed HEP projects in 1996. Boating, skiing, camping, picnic areas and boat launch facilities are all supported by HEP.

[Source: Adapted from United States National Hydropower Association, www.hydro.org/hydrofacts/facts.asp]

Figure 5 — Historical water discharge and suspended sediment discharge trends as a result of the construction of dams along the Colorado River (including Glen Canyon Dam)



[Source: The United States Geological Survey in Schwarz *et al*., (1991), published in Goudie, *The Human Impact on the Natural Environment*, Blackwell, 1993, page 182]

Figure 6 — The chief environmental impacts of dams

Impacts due to existence of dam and reservoir:
1. Reservoir in place of a river valley (loss of habitat).
2. Changes in downstream morphology of riverbed, delta, coastline due to altered sediment load (increased erosion).
3. Changes in downstream water quality: effects on river temperature, nutrient load, turbidity, dissolved gases, concentration of heavy metals and minerals.
4. Reduction of biodiversity due to blocking of migration of fish (*e.g.* salmon) and because of above changes.

Impacts due to pattern of dam operation:
1. Changes in downstream hydrology: (a) change in total flows; (b) change in seasonal flows (*e.g.* spring flood becomes winter flood); (c) short-term fluctuations in flows (sometimes hourly); (d) change in extreme high flow and low flow.
2. Changes in downstream morphology caused by altered flow pattern.
3. Changes in downstream water quality caused by altered flow pattern.
4. Reduction in riverine/floodplain habitat diversity, especially because of elimination of floods.

[Source: P McCully (1996), *Silenced Rivers, The Ecology and Politics of Large Dams*, London: Zed Books as produced on www.idsnet.org/Resources/Dams/Development/impact-enviro.html]

Figure 7 — Dam impacts

Grand Canyon and Glen Canyon Dams

Physical Properties

The Grand Canyon is 446 km long, 1.5 km deep and 30 km wide.
Shaped by the Colorado River the Grand Canyon was declared a world heritage site in 1919.
Hoover Dam was created in 1941 flooding the lower 20 % of the Grand Canyon.
Glen Canyon Dam was completed in 1963, 24 kms upstream from the Hoover Dam.
No formal environmental impact study was carried out on either of the dams.
Glen Canyon Dam now traps 95 % of the sediments carried by the Colorado River.
Downstream, soil and river fertility is compromised by a lack of organic enrichment from sediment deposition.
River beach and bar erosion is now a problem downstream.
Water temperature downstream is a constant 8 °C because water is extracted from the dams at a depth of 60 m – this water is cold, not having been heated by the sun as surface water would be.
Prior to damming water temperature ranged from 3 °C to 27 °C.
Regulated flows currently keep the Colorado River in Grand Canyon fluctuating between 228 – 570 cubic meters per second ($m^3 s^{-1}$). Before the Glen Canyon Dam, flows fluctuated between 86 – 2571 $m^3 s^{-1}$.

Biological Habitats

River Otter and Muskrat are now absent from the Grand Canyon.
Squawfish, Roundtail Chub and several other species have disappeared.
Many birds (*e.g.* Western Willow Flycatcher), lizards and invertebrates have been lost from the system.
Non-indigenous, generalist, plant and animal species are invading including fish: several exotic trout species, Bluegill, Sunfish and Channel Catfish are now present in the system.
The truncation of the habitat corridor between the Hoover and Grand Canyon Dam has interrupted migration routes and is leading to genetic isolation of certain indigenous species.
Due to the constant cold temperature of the river downstream blue-green algae and Cladophora have replaced the natural warm water food web. The temperature variation would previously trigger native fish reproduction and maintain native insect populations.
The Colorado River runs through Mexico and its delta area was classified as an International Biosphere in 1992. Since the Glen Canyon Dam was built water rarely reaches the delta area.

People and Culture

Indigenous Havasupi people inhabit the Grand Canyon basin.
Navajo and Hualapai people possess land in the Grand Canyon.
Hopi and Zuni have sacred rites in the Grand Canyon.
The presence of the dams have made indigenous people dependent on its water; a trait not previously apparent in their culture.
River erosion is causing the destruction of archaeological sites.

Figure 8 — What is a good dam? A checklist

The following is an edited list of suggestions from *International Dams Newsletter*, 1986.

1. No dam should be built until an adequate assessment of its likely environmental effects has been undertaken *and* made available to the public.

2. Water-development projects should only be undertaken if they can be shown to benefit large sectors of the population instead of the urban elite.

3. Schemes should favour labour-intensive rather than capital-intensive economic activities.

4. They should produce food crops for feeding the local population rather than for export.

5. They should not compromise public health and safety.

6. They should not adversely affect national parks, heritage sites, areas of scientific and educational importance, tropical rainforests or areas inhabited by species threatened with extinction.

7. They must be viable for a minimum of 100 years. They should only be built where it can be guaranteed they will not silt up.

8. They should not be built if their associated irrigation schemes are likely to lead to the salinisation of agricultural land.

9. The funding should be based on sustainable long-term resource enhancement rather than short-term resource exploitation.

10. They should not involve displacing indigenous people from their homelands and endangering their culture, unless compensation is provided and they are better off than before the project.

11. There must be no potential significant engineering or safety problems.

12. They should not be built where they are likely to inflict significant damage to estuarine or ocean fisheries.

13. They should not be built if they are likely to significantly harm the environment of a neighbouring country without its full consent.

[Source: Edited from *International Dams Newsletter,* 1986]

SPEC/4/ENVSO/SP2/ENG/TZ0/XX/M

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

MARKSCHEME

SPECIMEN PAPER

ENVIRONMENTAL SYSTEMS AND SOCIETIES

Standard Level

Paper 2

12 pages

SECTION A

1. (a) (EIA) Environmental Impact Assessment is a process used to establish the impact of a project/development on the environment;
it enables possible impacts on habitats, species and ecosystems to be predicted;
and helps decision makers decide if the development should go ahead;
and if steps to mitigate effects should be put in place; ***[2 max]***

(b) habitat type and abundance – baseline survey would record total area of each habitat type;
species (and endangered species) list – survey would record number of species (faunal and flora) present;
land use – assess land use type / use coverage;
hydrology – assess hydrological conditions in terms of volume/discharge/flows/ water quality;
human population – assess present population;
soil – quality / fertility / pH; ***[3 max]***
Accept other reasonable responses.
*Award **[1]** for each variable with a reason.*

(c) *description*: ***[3 max]***
overall amounts of water flowing in the Colorado River have declined since 1910;
amount of fluctuation between high flows and low flows has declined;
amount of sediment carried in the Colorado River shows a dramatic decline from the mid 1930s;

explanation: ***[3 max]***
the dam has allowed water flow to be controlled so fluctuations are minimized;
so much water is now extracted from the reservoirs that little water reaches the sea;
95 % of sediment is trapped behind the Glen Canyon dam; ***[5 max]***
Award credit if figures from resource booklet are used.

(d)

Abiotic factor in the Colorado River	***Increased or decreased after construction of Glen Canyon Dam***	***Reason for change***
Riverine habitat diversity	decreased	fewer fluctuations/variations in water flow;
Water temperature range	decreased	water extracted from dam is too low for sun to penetrate, so water is very cold / does not vary;
Nutrient content of water in river	decreased	nutrients held with sediments behind dam;

[3]

*Award **[1]** for decreased and a valid reason and **[0]** if decrease is given without a valid reason.*

(e) *non-native species*: ***[1]***
e.g. trout / green alga / cladophora / Bluegill / Sunfish / Channel Catfish;

possible impacts: ***[2 max]***
non-native are out competing native species because they are generalists whereas native species have more specific niches;
non-natives increasing in number as they out compete native species for food;
non-natives dominate as they are better suited to reservoir conditions and native species become extinct;
prey on young of native species reducing their number;
inter-breeding and potential loss of species;
non-natives could bring disease with them that native species are not resistant to; ***[3 max]***

(f) dams are a technological solution to the challenge of managing water and energy demand;
technocentric approach involves controlling natural processes rather than minimizing disturbance;
emphasis (in 1964) was on economic benefits and development goals rather than ecological impact;
evidence from resource booklet could include figures for efficiency of production;
emphasis on power in National Hydropower Association report; ***[3 max]***
Accept other reasonable responses.
Award ***[2 max]*** *if no reference to resource booklet.*

(g) *There must be some discussion of both sides to achieve **[6 max]** but answers can be weighted heavily towards one side or another.*

not a "good" dam because:
no environmental assessment was carried out prior to construction (point 1);
the dam was constructed in a national park and adversely affected areas of scientific importance (World Heritage Site) (point 6);
and has caused native species to become extinct/endangered *e.g.* Southwestern Willow Flycatcher (point 6);
culture of indigenous people has been threatened *e.g.* Rainbow Bridge;
knock on effects on Mexico (point 13) and impact on delta may have had an impact on fisheries (point 12);
possible that Lake Powell will silt up – all sediment trapped see figure 4 showing dramatic drop in sediment after dams constructed (point 7);

a "good" dam because:
large sectors of population have benefited from water supply and electricity (point 2);
often poorest communities (rural, indigenous, Mexican) who have benefited (point 2);
economic activities such as farming and tourism can be labour intensive and lots of jobs are provided (point 3);
fruit and vegetables are provided for domestic economy (point 4);
no evidence from the resource booklet that there are safety or health issues (point 5 or 11);
long-term water and energy demand can be met by this because HEP is a renewable resource (point 9);
indigenous people have benefited from water and electricity (point 10);
Mexico benefits from the electricity – presumably it gave its consent for the dam to be built? (point 13); ***[6 max]***
*Award **[4 max]** if advantages and disadvantages of dam are merely listed with no reference to the checklist.*

SECTION B

General Essay Markscheme
Each essay is marked out of ***[20]*** of which ***[2]*** are for clarity of expression, structure and development of ideas.

[0] Quality of expression, structure and development is poor.
[1] Quality of expression, structure and development is limited.
[2] Quality of expression is clear, structure is good and ideas are well developed.

2. (a) socio-cultural factors will have an influence on tastes / affect new markets *e.g.* desire for more organic food in Europe has lead to growth of organic farming to meet this demand;
growing trend for concern about animal welfare has affected the processes on some farms (*e.g.* free range pens for chickens);
socio-cultural factors can have a more general impact *e.g.* in determining demand for food *e.g.* after WW2 there was a concern in Britain about self-sufficiency and this demand lead to a drive for greater intensification of production (achieved through fertilizers and agribusiness techniques);
socio-cultural factors can lead to problems *e.g.* with increasing levels of farm fragmentation in cultures where land is divided equally between sons;
in the case of Nomadic herders, the Maasai, where quantity (rather than quality) of cattle is a measure of wealth and so this has lead to overgrazing and desertification;
levels of education will determine the amount of exchange of ideas and the extent to which new technologies can be applied *e.g.* The Singaporean Government invests a great deal in promoting new technologies in hydroponics;
indirectly socio-cultural factors such as land ownership, migration patterns, attitudes to land will have an impact on how land is used and the status of farmers and farming *e.g.* native American Indians did not believe that people could "own" land;
but of course socio-cultural factors are not the only ones and factors such as constraints of the natural environment (*e.g.* amounts of rainfall, growing seasons, natural disasters, soil fertility) will shape what farming systems develop *e.g.* fertile soil, good growing conditions will favour intensive crop production;
and economic factors which will determine costs of inputs such as seeds and technology / access to credit;
of course all these factors are interconnected and socio-cultural features will often have developed in response to farming systems as well as shaping them *e.g.* slash and burn agriculture where the conditions of the forest have encouraged shifting cultivation and social structures and cultural practices have developed in response to this; ***[8 max]***
*Award **[4 max]** if no evaluation is attempted or if no examples are used.*

(b) *Answers must be balanced and two appropriate societies contrasted. An answer which merely summarises the differences between ecocentric and technocentric paradigms should not be awarded more than* ***[6 max]****.*

e.g. indigenous shifting cultivator farmers in the Amazonian rainforest in Brazil and urban elites in Brasilia

shifting cultivators: ***[5 max]***
lifestyle and practices are much more closely bound up with their natural environment;
i.e. live "in tune" with the forest, utilising forest materials for construction of their homes, canoes and for medicines;
understanding of how the forest works so adapt farming practices *e.g.* use agroforestry to mimic layering of the forest and protect ground crops from harsh sun and heavy downpours;
recognition that soil is often infertile so farmers shift and allow small pockets of forest to regenerate before returning to the plot some 50 years later;
spiritual role of forest is also a feature of their cultural lives leading to respect for trees and other species;
in conclusion a less destructive and closer connection between social systems and ecological systems;
can crudely and broadly be generalised as "ecocentric";

urban (capitalist) elites: ***[5 max]***
rainforest seen as a resource for development, a source of cash;
lack of understanding for how the natural systems works mean political decisions can lead to wasteful/damaging actions *e.g.* construction of dams, which then become silted up;
establish policies, which encourage urban shanty dwellers to migrate and use the deforested land, but farming is unsuccessful because of lack of fertility of the soil;
political prestige projects and ideology (*e.g.* the frontier mentality about the interior of Brazil) can lead to "standing" value of rainforest being underestimated by urban elites;
can crudely and broadly be generalised as "technocentric"; ***[10 max]***
Obviously within these groups there will be subsets and individuals with different environmental paradigms.

Expression of ideas: ***[2 max]***

Total: ***[20]***

3. (a) established in 1980 by the World Conservation Union (IUCN), who are concerned with importance of conservation of resources for sustainable economic development;
it consisted of three factors:

1. maintaining ecological processes;
2. preserving genetic diversity;
3. and utilizing species and ecosystems in a sustainable fashion;

the strategy outlined a series of global priorities for action;
and recommended that each country prepare its own national strategy as a developing plan that would take into account the conservation of natural resources for long-term human welfare;
it drew attention to a fundamental issue: the importance of making the users of natural resources become their guardians;
without the support and understanding of the local community, those whose lives are most closely dependent upon the careful management of natural resources, the strategies cannot succeed; ***[4 max]***

(b) some environmental problems are global in terms of the scale of the effects rather than local, so international cooperation in addressing them makes sense;
e.g. global warming is going to have far reaching global impacts so a united response to monitoring and mitigation is more likely to be effective;
international agreements can help to motivate governments to take action and honour their commitments *e.g.* to cut CO_2 emissions / Montreal protocol, rather than burying their head in the sand about an issue;
international organisations *e.g.* UNEP have the resources to mobilise and coordinate action in environmental research, when individual nations, especially LEDCs, might not have access to funds/expertise;
when problems cross borders *e.g.* smuggling of endangered species, international cooperation is vital (CITES);
however, local solutions have a valuable role to play *e.g.* often problems are caused at local scale, so local people should be involved in addressing the problem, the World Conservation Strategy recognises this;
often the motivation for addressing problems starts at the local level *e.g.* when individuals feel passionately about an issue;
some issues *e.g.* recycling and landfill are local issues so a global strategy would be cumbersome, bureaucratic and inappropriate; ***[8 max]***
*Award **[5 max]** if no examples are used.*

(c) small scale studies allow for in-depth detailed investigations;
understanding processes and interconnectedness at a local level is vital if threats to that ecosystem are to be effectively mitigated *e.g.* understanding relationship between two interdependent species will enable you to predict what will happen if one of them becomes extinct;
on a practical level, scientists have to be able to undertake studies at a manageable level *i.e.* by investigating specific hypotheses, *e.g.* you could not design a research programme that was just going to investigate "oceans";
for groups lobbying about a particular environmental issue, their concerns will not be taken seriously unless grounded in rigorous fieldwork and fact;
this is one of the problems with conflicting evidence on the issue of global warming;
similarly for political decisions to be taken there needs to be a body of evidence and understanding on which these decisions are based;
lots of studies of small-scale ecosystems form jigsaw pieces in a bigger picture of how larger scale ecosystems *e.g.* biomes are being affected by human actions;
studying small-scale ecosystems enables environmental change *e.g.* in response to pollutants, to be monitored over time;
these studies can inform human actions to ensure that practices change in the right way to mitigate the problem *e.g.* studies of consequences of applying lime to acidified lakes; ***[6 max]***
Accept other reasonable responses.

Expression of ideas: ***[2 max]***

Total: ***[20]***

4. (a) greater biomass;
higher levels of species diversity;
soil conditions are more favourable *e.g.* with greater organic content;
better soil structure / greater water retention;
lower pH;
plant species will be taller and longer living;
more *K*-strategists / few *r*-strategists;
greater community complexity and stability/equilibrium;
greater habitat diversity; ***[4 max]***

(b) *e.g.* Great Barrier Reef off the coast of Queensland, Australia

human threats: ***[4 max]***
such as tourism, coral very fragile and easily damaged by divers' fins / touching coral / breaking bits off for souvenirs;
over fishing can disrupt the balance of species in the food chain;
inadvertent damage from anchors and pollution from boats;
run-off of fertilisers from sugar plantations on the coast;
sewage and pollution from coastal settlements such as Cairns can lead to excessive nutrients and algal blooms;
increased sedimentation due to deforestation of mangroves to make space for tourist developments make water cloudy reducing productivity;
disrupting the interdependence of coral ecosystem with sea grass beds and mangrove ecosystems;
global warming increases sea temperatures leading to coral bleaching;

natural threats: ***[4 max]***
all of these make coral more vulnerable to natural threats such as disease;
natural predators *e.g.* crown of thorns starfish;
structural damage from storms/cyclones;
increased sea temperatures due to El Niño;
can lead to coral bleaching;
which has knock on effects on the fish species who depend on the reef for food, protection and nurseries for young;

consequences: ***[3 max]***
coral reefs are able to withstand some threats but the collective effect of human and natural processes can lead to damage of the reef and species, which depend on it, and the breakdown of the ecosystem;
when the "critical threshold is reached" (when even if threats stop ecosystem will not recover);
loss of biodiversity;
the valuable role that the ecosystem provides *e.g.* in conjunction with mangroves sea grass beds as a line of coastal defence;
as an economic resource; ***[10 max]***

(c) *Award credit if diagram is used to illustrate the concept of negative feedback.*
feedback is the return of part of the output from a system as input, so as to affect succeeding outputs;
positive feedback tends to amplify/increase change;
negative feedback on the other hand tends to damp down/neutralise any deviation from an equilibrium and promote stability;
it is negative feedback therefore which leads to the regulation of equilibrium within ecosystems;
e.g. effect of a storm on a rainforest – high winds blow down a tree, leaving a gap in the canopy, this lets in more light, encouraging new growth;
rates of growth are rapid as light levels are high, so new saplings compete to take place of old tree in the canopy and equilibrium is restored; ***[4 max]***
A range of possible examples may be used.
Award ***[2 max]*** *if no example used.*

Expression of ideas: ***[2 max]***

Total: ***[20]***

5. (a) some politicians believe action should be taken immediately by all nations to curb emissions of CO_2;
to change lifestyles and plan to reduce fossil fuel dependence;
whereas others argue that it is unreasonable to expect LEDCs to curb emissions until they have developed economically like the MEDCs have done;
most scientists are now convinced that there is a causal link between CO_2 levels and global temperature change;
whereas some scientists argue that relationships are more complex and that the effects of global warming are unclear;
even that recent temperature changes are merely parts of natural fluctuations in the earth's temperature;
some ordinary citizens feel they have a responsibility to change the way in which they live to reduce their personal contribution to the problem;
others do not believe that actions at an individual level can make much difference;
others do not prioritise environmental issues including global warming;
responses by organisms rather than people, migration / extinction / adoption; ***[5 max]***

(b) opinions will depend to a large extent on what scientific evidence they find most convincing;
this will depend on their specialised knowledge and their level of education;
overall awareness of the issue, which can also depend on the profile of environmental issues in the media;
environmental paradigms can shape how they read scientific literature;
their attitudes to our relationship with the environment (*e.g.* whether we should live in harmony with it or control it using technology);
environmental paradigms will stem from cultural context including prevailing religious attitudes (*e.g.* whether we have any moral obligation to future generations);
the growth of the environmental movement (which has grown exponentially in profile and influence) has played a large role in raising awareness of the issue;
cultural / religious group *e.g.* Allah is in control;
where people live might affect their views *e.g.* near the sea;
socio-economic status *e.g.* extreme poverty leads to short-term view / wealth leads to faith in money to solve problem;
age *e.g.* young more concerned than old; ***[5 max]***
Accept other reasonable responses.

(c) carrying capacity is the maximum number of species that can be sustainably supported by a given environment;
it is determined by availability of resources (*e.g.* food, water, space) to the population in an area;
a country is said to be overpopulated if the carrying capacity is exceeded;
it is a problematic term for human populations because technology has a huge influence on the resources that are available to human populations;
our tastes and demand for particular resources changes at such a rapid rate;

at a country level technology can help to ensure carrying capacity is not exceeded;
e.g. by importing new resources with transport technology;
but at a global level technology can be used to intensify the way in which we use resources *e.g.* increased agricultural production on the same plot of land by using HYV rice;
substitutions of resources *e.g.* developing alternative energy technologies to fossil fuels;
technology can also play a part in reducing human population size *e.g.* through contraception/medicines (reducing infant mortality and thereby reducing the incentive for high birth rates in many poor countries);
technology alone may not be the full solution, attitudes to resource use may need to be altered; ***[8 max]***
*Award **[3 max]** for describing carrying capacity and **[6 max]** for role of technology.*

Expression of ideas: ***[2 max]***

Total: ***[20]***