Environmental Systems SL P3

2006 May

School Level 12th IB Diploma Programme

Board Exam

International Baccalaureate (IB Board)

Solved

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

M06/4/ENVSY/SP3/ENG/TZ0/XX

22066412

ENVIRONMENTAL SYSTEMS
STANDARD LEVEL
PAPER 3

Friday 5 May 2006 (morning)

1 hour

Candidate session number

0	0							

INSTRUCTIONS TO CANDIDATES

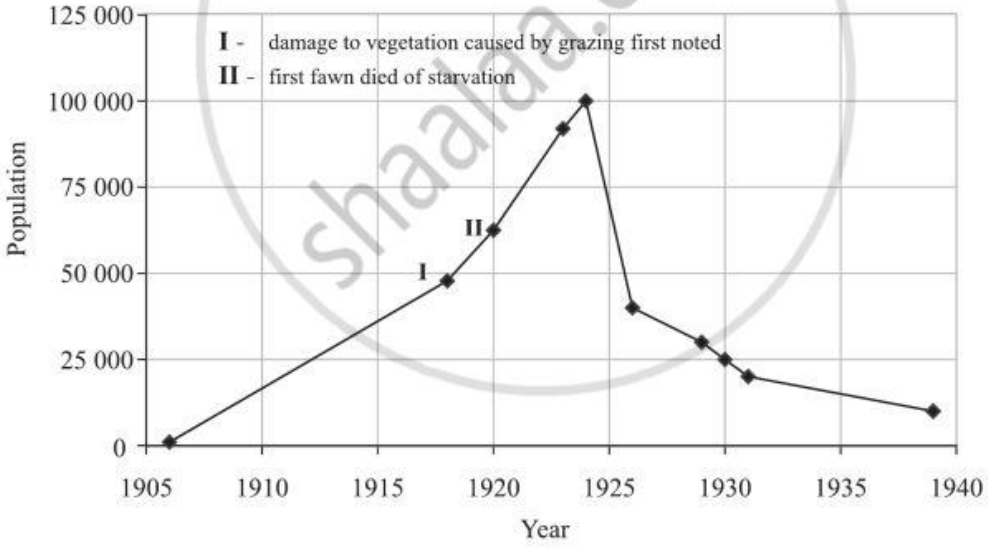
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all the questions from Option A and all the questions from either Option B, Option C or Option D in the spaces provided.
- You may continue your answers on answer sheets. Write your 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.

Option A — Analysing Ecosystems

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

A1. The data in the graph below show the variation in the numbers of mule deer (a herbivore) in an area of the southwestern United States between 1905 and 1940.

[Source: Mule Deer Foundation (2003), http://www.muledeer.org]



[Source: D Lack, (1954), *The Natural Regulation of Animal Numbers*, Clarendon Press, Oxford]

(This question continues on the following page)

(Question A1 continued)

(a) Describe and explain the shape of the graph. *[4]*

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(b) Outline how data for this graph might have been collected. *[3]*

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(c) Suggest what difficulties might be encountered in collecting this type of data. *[3]*

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(Question A1 continued)

(d) Outline how you would measure the net primary productivity of a **named** ecosystem. *[4]*

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(e) (i) For the ecosystem named in (d), identify an abiotic factor that might change over time, and suggest how this change might influence a **named** biotic component in the ecosystem. *[2]*

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(ii) Outline and evaluate a method, which you could use in the field, to gather evidence for your suggestion in (e) (i). *[4]*

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Option B — Impacts of Resource Exploitation

B1. The table below provides data on the carbon dioxide footprint and the total ecological footprint *per capita*, for selected countries in the Asia-Pacific region.

Country	Land area / km^2	Population / millions	CO_2 footprint *per capita* / ha	Total footprint *per capita* / ha
Singapore	693	4.35	11.03	12.35
Sri Lanka	65 610	19.90	0.28	0.95
Australia	7 686 580	19.40	4.79	8.49

Note: 100 hectares (ha) = 1 km^2

[Source: World Wildlife Fund, *Living Planet Report 2000*, Gland, Switzerland and UN publications]

(a) Define the term *total ecological footprint.* *[2]*

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(b) State and explain the differences in the size of the *per capita* CO_2 footprint in the countries shown in the table above. *[4]*

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(c) Identify which country of those listed has the highest total ecological footprint for its entire population. *[1]*

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(This question continues on the following page)

(Question B1 continued)

(d) Identify any countries of those listed that have a total ecological footprint for their entire population that is greater than their land total area. *[1]*

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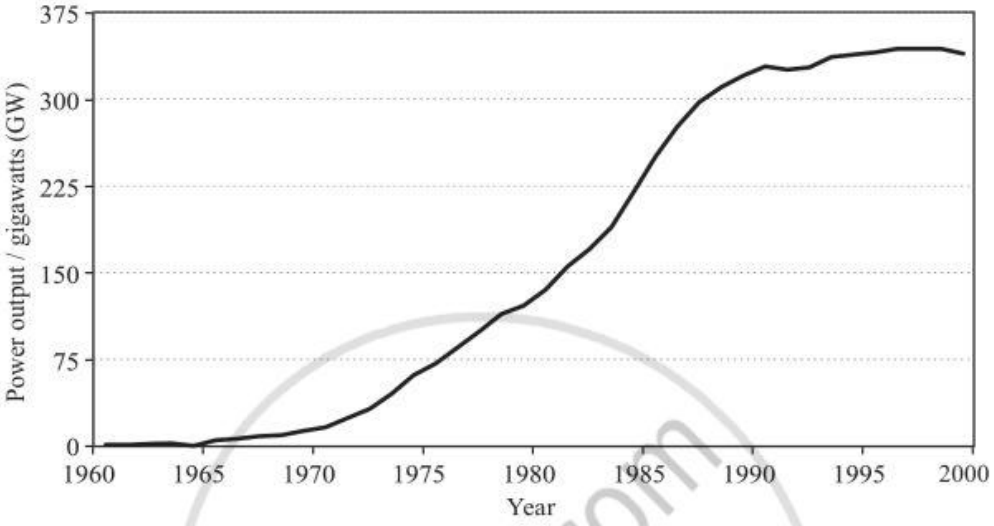
(Question B1 continued)

(e) The graph below shows the change in the amount of electricity produced by the world's nuclear power stations between 1960 and 1998.



[Source: Worldwatch Institute (1999) Nuclear Power Nears Peak, http://www.worldwatch.org/press/news/1999/03/04]

(i) State **three** advantages and **three** disadvantages of nuclear power. *[3]*

Advantages

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Disadvantages

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(This question continues on the following page)

(Question B1 continued)

(ii) Using the data from the graph, suggest how the evaluation of the advantages and disadvantages of nuclear power changed over the period shown. *[2]*

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(f) (i) Name and briefly describe a food production system that you have studied. *[2]*

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(ii) List **three** inputs to, and **three** outputs from, this food production system. *[2]*

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Outputs: . . . . . .

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(g) Describe the effect that this food production system might have on the environment. *[3]*

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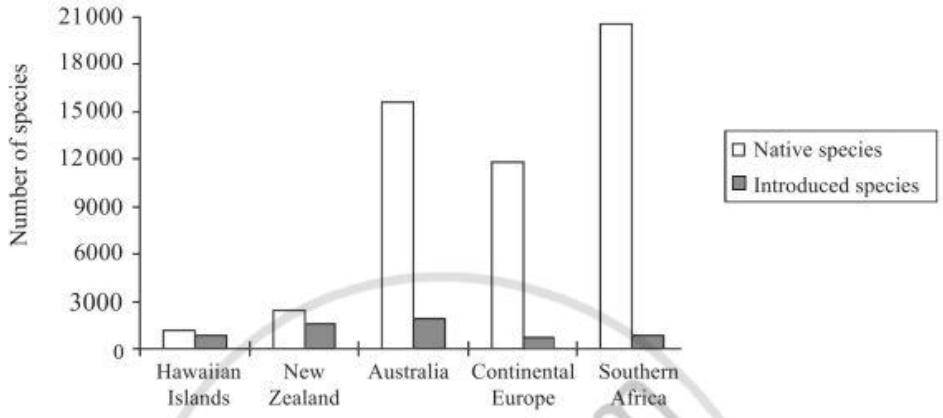
Option C — Conservation and Biodiversity

C1. For selected regions of the world, the bar-chart below provides data for the total number of native plant species (species that occur naturally in the region), and the number of introduced species (species that have been brought in through human activities).



[Source: based on C B Cox and P D Moore, (2000), *Biogeography*, 6th edition Blackwell, Oxford]

(a) Suggest reasons for differences between the regions using the data in the bar-chart above. *[4]*

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(This question continues on the following page)

(Question C1 continued)

(b) (i) Define the terms *habitat diversity* and *species diversity*. *[2]*

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(ii) Outline the evolutionary processes that link habitat diversity to species diversity. *[5]*

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(c) Name a species of plant **or** animal that has become extinct since 1600, and list **two** factors that help to explain why that species became extinct. *[2]*

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(This question continues on the following the page)

(Question C1 continued)

(d) (i) Name a protected area that you have studied. *[1]*

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(ii) Suggest **three** reasons that might explain why the area was selected for protection. *[3]*

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(iii) Evaluate the success of the named protected area. *[3]*

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Option D — Pollution Management

D1 (a) Explain, with the help of an example, the term *non-point-source pollution.* *[2]*

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The table below gives the iron (Fe), and lead (Pb), concentrations (mg kg^{-1}) in the atmospheric fallout (solid particles) at two sampling locations near a mining centre in Sweden.

		April-May	June-July	Aug-Sep	Oct-Nov	Dec-Jan	Feb-Mar
Location 1	Pb	1.1	2.3	2.7	3.1	6.8	6.7
	Fe	26.0	65.0	76.0	86.0	259.0	222.0
Location 2	Pb	45.3	10.0	10.9	10.4	11.0	8.0
	Fe	640.0	104.0	105.0	123.0	131.0	216.0

[Source: Z Lin *et al.*, (1998), *Science of the Total Environment*, **206**, pp 47–58]

(b) Calculate the mean value for the lead concentration for each of the two sampling locations. *[2]*

(i) Location 1: . . . . . .

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(ii) Location 2: . . . . . .

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(This question continues on the following page)

(Question D1 continued)

(e) A company specialising in waste disposal proposes to establish a facility for the incineration of domestic (municipal) waste close to your school. Explain how you would assess the probable environmental effects of such a facility. *[4]*

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(f) Outline **three** strategies for the management of a named example of industrial waste. *[3]*

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M06/4/ENVSY/SP3/ENG/TZ0/XX/M

MARKSCHEME

MAY 2006

ENVIRONMENTAL SYSTEMS

Standard Level

Paper 3

14 pages

Option A — Analysing Ecosystems

A1. (a) first part of graph resembles 'j' curve;
typical "boom and bust"/"increase and crash" graph;
initial low population;
period of exponential increase;
as population increases with few limiting factors (E);
e.g. with minimum effects of predators (E);
perhaps because predators killed off by humans (E);
population peaks in about 1924;
eventually population falls rapidly / crash occurs;
decline might be due to hunting pressure, *owtte* (E);
in due course control factor(s) take(s) effect (E);
e.g. as food supplies exhausted (E);
as population exceeds carrying capacity;
and/or disease/starvation occurs (E);
as death rate > birth rate (E);
population eventually approaches stability;
possibility that there may be an effect of severe weather (E); ***[4 max]***
Any other reasonable points.
At least two explanation (E) points are required for full marks.

(b) "catch and release" method;
sample number of deer caught and marked/tagged without harming them;
released and allowed to mix with population;
recaptured and checked for marks;
use of Lincoln index to calculate number;
use of aerial photos/satellite images;
photos/images could be divided into quadrats;
select sample quadrats using random number tables or similar;
multiply to obtain value for whole region;
use of hunting records;
use of tracks/scats (dung)/fallen antlers to estimate numbers;
statistical/computer modelling;
obtain separate estimates for areas of each distinctive habitat; ***[3 max]***
Any other reasonable points elaborating methods. Any points addressing difficulties with methods should not be credited here but may gain credit under (c).

(c) possibility that marking might interfere with ability to move/feed/reproduce;
some animals may become "capture-prone" or "capture shy";
possibility of immigration/emigration/births/deaths within census period;
hunting records can be unreliable (poaching/illegal shooting *etc.*);
some animals may be hidden from aerial surveillance beneath cover;
if sample quadrat system is used, sample area may not be typical;
deer are social animals and move in herds/groups – leads to under- or over-recording;
indirect method (tracks, scats *etc.*) notoriously unreliable; ***[3 max]***
Any other reasonable points. Points mentioning difficulties under (b) may be credited here.
Do not credit the same point in (b) and (c).

(d) *The methodology must be appropriate for the selected ecosystem. (Terrestrial or* aquatic)

NPP = GPP – R;
NPP measured by selection of typical quadrat/appropriate ecosystem sample;
collection of biomass at start of growing period;
air-drying of organic material;
careful weighing to obtain value for dry-weight biomass per unit area/sample;
collection of biomass from an identical quadrat/sample at end of growing period;
drying and weighing of new sample;
obtain caloric value from tables;
or use bomb calorimeter;
difference related to time gives productivity;
allowance needs to be made for underground material, roots *etc.* / special efforts must be made to obtain this;
and material consumed by herbivores;
repetition of studies and taking of mean for greater accuracy; ***[4 max]***
Any other reasonable points.

N.B. *Do not award a mark for naming an ecosystem, but mark out of* ***[3]*** *if no ecosystem is mentioned. Do not credit details of calculation of secondary productivity (e.g. measure mass of animals, amount of feces produced, etc.).*

(e) (i) *The abiotic factor must be appropriate to ecosystem specified in (d) and must change over time. The link with a biotic factor (i.e. living organisms) must be reasonable. If no ecosystem is named in (d), allow ECF.*

E.g. for a freshwater system:
temperature varies both on a daily and a seasonal basis;
as photosynthesis varies with temperature, the abundance of producers (*e.g.* phytoplankton) and consumers (*e.g.* water fleas) varies seasonally with temperature; ***[2]***

(ii) *Method will depend on factor selected. E.g. for temperature and number of water fleas in freshwater:*

Method ***[2 max]***
use thermometer/thermograph;
repeat at regular intervals;
e.g. at different times of day/times of year;
under identical conditions;
count number of water fleas in a scoop (with net) of water;
preferably at same time as temperature measurements;
under identical conditions each time;

Evaluation ***[2 max]***
Should address issues of:
subjectivity of observation (different people observe/record in different ways);
standardization of procedures;
"generalizability" (avoidance of atypical conditions *e.g.* a shaded area);
difficulties in qualitative measurements (*e.g.* poor light conditions);
correlation not necessarily indicative of causality; ***[4 max]***
Any other reasonable points;

Do not allow full marks for a detailed description of the method, plus evaluation of that method, of a single factor, however detailed. For the full ***[4]*** *the candidate must emphasize the relationship with the second factor. Thus a very full account of the measurement of soil pH, even if some evaluation is included, cannot obtain full marks if there is no comment about the factor supposedly influenced by it.*

Option B — Impacts of Resource Exploitation

B1. (a) the area of land (and water) required to provide all the necessary resources;
and assimilate all wastes (*based on syllabus definition*) / *OWTTE*; ***[2]***

(b) CO_2 footprint varies widely / 0.28 to 11.03 ha;
higher in MEDCs such as Singapore, Australia / lower in LEDCs such as Sri Lanka;
Australia, Singapore have high standard of living;
therefore much energy use for domestic purposes, *e.g.* air conditioning/cooking/refrigeration;
Australia has high private car (automobile) ownership (Singapore less so);
Singapore, Australia highly industrialised;
high energy subsidy in Australia's agriculture (diesel, fertilizers, transport);
difference in capacity of local vegetation to absorb CO_2; ***[4 max]***
Any other valid points

(c) Australia ***[1]***

(d) Sri Lanka, Singapore ***[1]***
Award no mark if only one given, or if Australia is also given.

(e) (i) *Advantages*
once built, cheap to run;
almost no atmospheric pollution;
not confined to a particular locality;
therefore may be a source of employment in economically depressed areas;
amounts of fuel very small in relation to electricity produced;
may be a source of military plutonium *etc.* for weapons;
(allow also as disadvantage – but not both)
may provide a source of isotopes for medicine/industry/research;
sometimes seen as "cleaner" and safer than industries based on coal;
do not reward very vague responses; "not harmful" is insufficient. Do not allow "renewable resource".

Disadvantages
very expensive to construct;
risk of hijacking/terrorist use of nuclear materials;
precautions against these may have civil liberties implications;
expensive and elaborate health and safety measures needed;
consequences of escape of nuclear radiation very serious (Chernobyl, Three Mile Island, Windscale);
problems of decommissioning at end of useful life;
supply of nuclear fuel may eventually run out;
problem of disposal of radioactive waste; ***[3 max]***
Any other reasonable points
*Award **[1]** for each two points (advantages or disadvantages), but allow only **[2 max]** if only advantages or disadvantages are given.*

(ii) early in nuclear power development, advantages seen to outweigh disadvantages;
and many power stations built 1960-1980;
power generation increased rapidly;
later, disadvantages appreciated;
particularly after certain disasters *e.g.* Chernobyl;
power production after about 1988 stabilized as few new stations introduced; ***[2 max]***
Do not allow credit for a simple regurgitation of the data on the graph.

(f) (i) *Nature of answer will depend on example selected. Allow a specific name e.g. Marron (freshwater crayfish) farm, near Margaret River, Western Australia, or a somewhat more general response (e.g. cereal farming in Canadian Prairies). Should give some point of detail other than simply the name for full* ***[2]****.*
e.g. sample descriptions
organisms kept in artificial pools under controlled conditions;
extensive monoculture in areas of flat topography; ***[2]***

(ii) *e.g.* Marron farm
inputs:
stock marron;
food;
fresh water;
power/energy for pumping *etc.*;
labour;
funds/investment;
Any three reasonable points for ***[1]***

outputs:
named examples of pollutants (*e.g.* fecal material, food waste);
heat;
marron for sale to restaurants, *etc*;
waste water;
profits; ***[2 max]***
Any three reasonable points for ***[1]***
If a candidate gives more than three examples, and some are wrong she or he receives credit for those that are correct, even if not the first three.

(g) ***N.B.*** *Do not allow points already rewarded in (f)*
eutrophication of water;
algal blooms;
reduction of biodiversity of water-body;
creation of artificial water-bodies / interference with hydrology;
(unpleasant) odours;
Any other reasonable points ***[3 max]***

Option C — Conservation and Biodiversity

C1. (a) number of native species in Continental Europe/Africa/Australia is high because of large area;
number of native species is high in Continental Europe/Africa/Australia because of wider range of habitats;
number of native species is high in Continental Europe/Africa/Australia because of wider range of climate;
(*Converse: NZ and Hawaii – smaller range of species because of smaller area/range of habitats/climate*)
number of native species high in Australia because of isolation throughout evolutionary history;
number of native species low in NZ/Hawaii as few species can colonise remote islands;
islands more liable to be colonised by introduced species;
high proportion/percentage of total species in NZ and Hawaii are introduced;
because native species may be adapted to specialized environments and are less resistant to competition; ***[4 max]***
Any other reasonable points

(b) (i) habitat diversity = the number of habitats/ecological niches per unit area/in a certain area;
species diversity = the number of species of organism per unit area/in a certain area; ***[2]***

(ii) habitat diversity is an indication of the ecological variety of an ecosystem;
and therefore the number of species it can accommodate;
complex habitats provide more ecological niches for organisms;
habitat diversity may cause isolation of populations;
natural selection ensures organisms are adapted to environment and way of life;
as environmental pressures influence frequency of genetic traits in populations;
reproductive barriers may arise through (divergent) evolution;
so the more environments an ecosystem represents, the greater the possibility of speciation;
e.g. an ecosystem with several layers such as tropical forest is likely to have a higher diversity than single layered ecosystems such as temperate scrub/heathland; ***[5 max]***
Any other reasonable points.

(c) name of species, *e.g.* dodo;

Factors will depend on example selected. E.g. for the dodo:
confined to small island/limited distribution (Mauritius);
small population;
useful source of food for visiting sailors;
extreme tameness;
large and conspicuous;
slow rate of reproduction;
habitat destruction;
competition with introduced organisms (*e.g.* pigs); ***[2 max]***
*Any other reasonable points. Award **[1]** for two factors.*
Note date (1600); be tolerant here. However, dinosaurs are not acceptable.

(d) (i) name of area, *e.g.* Uluru (Ayers Rock, Northern Territory, Australia) ***[1]***
Always allow benefit of the doubt if you have not heard of the protected area. Google may be helpful.

(ii) *Reasons will depend on area. For example, with respect to Uluru:*
spectacular nature/aesthetic appeal of isolated monolith;
geological importance;
relatively undisturbed nature of surrounding habitats (at least by western/European influences);
archaeological importance;
variety of organisms (plants, reptiles);
significance to indigenous peoples;
possibility of taking large areas into management without disturbing long-established ownerships; ***[3 max]***

(iii) *Evaluation of success again will depend on area chosen. E.g., with respect to Uluru:*
designation as a World Heritage Site;
therefore international recognition of its importance;
freehold of land transferred to indigenous (Aboriginal) people;
Aboriginal people involved in management of the area;
recreational pressure/accommodation concentrated in limited locations;
plants/animals/landforms protected;
well drafted protective legislation;
funds from entry fees from visitors used for maintenance of area;

some conflict between western/recreational/tourist values and Aboriginal sacred site values;
thus climbing of Rock still allowed, contrary to Aboriginal preference;
and has resulted in a number of casualties (some fatal); ***[3 max]***
*A simple description of management does not answer the question. Candidates must **evaluate** the **success**, this implies at least some comment on the management practise used.*
Example: "Burning and grazing by sheep are used on some of the heathland nature reserves of the East Suffolk Sandlings" is not sufficient.
"Burning and sheep grazing are sometimes successfully used to maintain the traditional 'open landscape' character of the heather-dominated plant communities on some of the East Suffolk Sandlings nature reserves, and to maintain their characteristic biota, some species of which are locally endangered" – full marks.

Option D — Pollution Management

D1. (a) the release of pollution from numerous widely distributed origins (Glossary) / the contamination of a wide area by a pollutant where no single source can be identified *OWTTE*;
e.g. waste gases from the exhaust systems of vehicles / fertilizer leaching into groundwater from the lawns of a suburb; ***[2 max]***
*Award **[1]** for any reasonable example.*

(b) (i) 3.8 mg kg^{-1} (accept 3.78 mg kg^{-1}) *units required* ***[1]***

(ii) 15.9 mg kg^{-1} (accept 15.93 mg kg^{-1}) *units required* ***[1]***

(c) (i) at both locations and at all times Fe amounts are higher than Pb;
Possible reasons:
both locations are some distance from mine site and Pb, being the heavier material, is precipitated closer than either location 1 or 2;
there is very little Pb in the ore mined / much more Fe than Pb mined and therefore emitted *owtte*;
Pb is removed from the material emitted; ***[2 max]***

(ii) at location 2, precipitation is much higher in April-May than at other times of the year;
Possible reasons:
seasonal variation in wind direction;
amount of mining activity varies over time; ***[2 max]***

(iii) average concentration of Pb is much higher at location 2 than at location 1;
Possible reason:
location 2 is closer to mine site; ***[2]***

Accept any other reasonable points throughout.

(d) monitoring of the level of pollution using biotic index / monitoring using observations on the abundance and types of organisms present;
Example:
monitoring air pollution by noting the number of lichens present;
the more species and the more individuals the less pollution;
i.e. very few species in the "lichen desert" of large cities;
many dozens of species in uncontaminated area (*e.g.* Cornwall, SW Tasmania, Tierra del Fuego); ***[3 max]***

(e) Environmental Impact Statement (EIS)/Environmental Impact Assessment (EIA) approach;
careful pre-development baseline measurements/environmental study;
of abiotic factors, *e.g.* air quality;
biotic factors, *e.g.* biodiversity/rare species;
comparison with similar sites elsewhere;
computer (or other) simulation;
assessment of vulnerability to local impact;
consideration of associated activities, *e.g.* traffic/transport, *etc.*
socio-economic impacts; ***[4 max]***
Any other reasonable points.

(f) *e.g. nuclear waste*:
incorporate in glass or artificial rock;
deep burial in abandoned mines/caves;
shallow burial in places where radiation can be monitored;
surround by lead or similar material;
transport to reprocessing plant; ***[3 max]***
Any other reasonable points.

Must give a reasonable example, "toxins" or "waste" are not sufficient.