International Baccalaureate®
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MARKSCHEME

MAY 2008

ENVIRONMENTAL SYSTEMS

Standard Level

Paper 3

13 pages

Subject Details: Environmental Systems SL Paper 3 Markscheme

Mark Allocation

Candidates are required to answer questions from **TWO** of the Options **[2 x 20 marks]**. Maximum total = **[40 marks]**

1. A markscheme often has more marking points than the total allows. This is intentional. Do **not** award more than the maximum marks allowed for part of a question.

2. Each marking point has a separate line and the end is signified by means of a semicolon (;).

3. An alternative answer or wording is indicated in the markscheme by a slash (/) - either wording can be accepted.

4. Words in brackets ( ) in the markscheme are not necessary to gain the mark.

5. Words that are underlined are essential for the mark.

6. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

7. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by writing **OWTTE** (or words to that effect).

8. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

9. Occasionally, a part of a question may require an answer that is required for subsequent marking points.
   If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. Indicate this with **ECF (**error carried forward).

10. Only consider units at the end of a calculation. Unless directed otherwise in the mark scheme, unit errors should only be penalized once in the paper. Indicate this by writing **-1(U)** at the first point it occurs and **U** on the cover page.

Option A — Analysing Ecosystems

A1. (a) *In each case, allow **[1]** for identifying strategy, and **[1]** for explanation.*

(i) D;
it investigates a range of distances from the river / data can be used to test correlation of distance with abundance / variables other than distance from the river are relatively controlled / belt-transect appropriate for environmental gradient; ***[2]***

(ii) C;
quadrats are randomly positioned in area / scattered throughout area / sampling not likely to be biased by any atypical patches within area; ***[2]***

(iii) A;
quadrats are spread out in the two areas of investigation / equal sampling is given to each of the two areas for fair comparison; ***[2]***

Examiners will need to be tolerant and reward candidates who understand the concepts, even if they are expressed rather differently from the above.

(b) (i) *percentage frequency*: would require a record of the number of samples/quadrats in which a species existed and the number in which it did not;

percentage cover: would require an estimate of the percentage area occupied by the species in each quadrat (*e.g.* with a divided quadrat); ***[2]***

(ii) *Advantages*:
usually quicker;
clear, objective observations required/exact number (compared to subjective estimates of area);

Disadvantages:
does not take into account the size of individuals (can give misleading emphasis in a community to species with small individuals);
does not take into account abundance **within** each quadrat; ***[2 max]***

A2. (a) arrange aquaria/terraria with appropriate range of temperatures;
control other variables than temperature;
find wet weight of populations of consumers at start and at end of a period;
calculate dry weights from wet weights (using data from literature or further experiment);
calculate increase in dry weight of consumers (net productivity);
find wet weight of food provided and remaining at end;
calculate dry weight of food eaten;
find dry weight of faeces;
subtract dry weight of faeces from food eaten (gross productivity); ***[6 max]***
Do not accept primary productivity (i.e. plants)

(b) that physical/abiotic factors (affecting productivity) are similar to those in ecosystem;
that other organisms/biotic factors in ecosystem would not significantly alter productivity;
that data used for calculating dry weights is accurate for this particular species/these individuals;
that productivity in period of investigation is typical for whole year;
Any other reasonable assumption (but do not credit assumptions that could have been eliminated by careful application of method e.g. reading of weighing scales/balance may have been inaccurate/careless). ***[2 max]***

(c) biomass is the weight/mass of organic matter alone;
whereas dry weight measurements include minerals;
an exact estimate of biomass (purely organic matter) is not practically possible;
dry weight biomass = biomass after removal of water; ***[2 max]***

Option B — Impacts of Resource Exploitation

B1. (a) *Examiners should note that the data in the bar-chart are for daily consumption; the question asks for annual.*

Belgium:
$(10.4\times365\times10^6\times4000=)\ 15184\times10^9\ /\ 1.5184\times10^{13}\ /\ 15.184\times10^{12}$ kJ *(units required)*;

Burundi:
$(6.4\times365\times10^6\times3000=)\ 7008\times10^9\ /\ 7.008\times10^{12}$ kJ *(units required)*;

*Some credit should be allowed to those who have omitted the conversion from daily to annual. Award **[1 max]** overall if candidate has not calculated the "total annual energy" and omitted "x 365" from either/both calculation but all other values are correct e.g.*

Belgium:
$(10.4\times10^6\times4000=)\ 41.6\times10^9\ /\ 4.16\times10^{10}$ kJ *(units required)*;

Burundi:
$(6.4\times10^6\times3000)=19.2\times10^9\ /\ 1.92\times10^{10}$ kJ *(units required)*;

As the question does not require the working to be shown, answers without working may be credited. ***[2 max]***

(b) greater intake in Belgium will mean more food is required;
this will require a greater area to produce it;
and greater area to assimilate waste;
which will lead to a larger ecological footprint;
Award equal credit if expressed as converse for Burundi (i.e. "Lesser intake in Burundi…etc."). ***[2 max]***

(c) *Food production*: ***[2 max]***
due to higher technology/energy subsidy in farming;
Belgium is likely to have greater production per unit area;
leading to a smaller footprint;

CO_2 emissions: ***[2 max]***
due to more industrialised society;
Belgium's emissions are likely to be greater;
leading to larger footprint;

CO_2 absorption: ***[2 max]***
due to tropical ecosystems in Burundi;
vegetation likely to be more effective at absorbing CO_2;
leading to smaller footprint;
Award credit for other responses appropriately linking factor to country and size of footprint. ***[6 max]***

(d) genetically modified crops;
irrigation;
increasing productivity of food;
greater use of fertilisers;
increasing productivity of food;
greater inputs of energy subsidy;
giving higher productivity of food;
better/more transportation of food by AID agencies;
giving better distribution to those below minimum requirement;
improved storage techniques;
allowing better distribution over time;
political pressure from humanitarian/environmental groups;
increasing responsibility of wealthier countries for less wealthy/charity;
improved democratic structures lead to more equitable distribution of food;
Award credit for other responses appropriately linking factor to reduction of malnourishment. ***[4 max]***

B2. *Award **[1 mark]** for identifying each factor and **[1 mark]** for accompanying explanation up to a maximum of 3 factors (i.e. **[3 max]** for listing factors; **[3 max]** for accompanying explanations).*

solar energy reaching vegetation;
likely to be less in aquatic systems due to reflection;
and absorption by water;
leads to lower efficiency of aquatic systems;

energy lost by organisms for support/movement;
likely to be less in aquatic systems due to denser medium;
leads to higher efficiency of aquatic systems;

trophic level at which food is harvested;
generally higher in aquatic systems;
due to human tastes;
leads to lower efficiency of aquatic systems;

transfer of energy from producers to herbivores;
generally more efficient in aquatic systems (due to less indigestible support material);
leads to greater efficiency of aquatic systems;
Award credit for any other reasonable suggestions and appropriate explanations. ***[6 max]***

Option C — Conservation and Biodiversity

C1. (a) (i) there may be more grassland habitat in total in the region;
commercial value of rainforests may be a disincentive for protecting them;
grasslands may be easier to police than forests (*e.g.* against poachers);
greater areas of forest may have already been destroyed before protection programmes began;
grasslands may have more popular/"high status" organisms (*e.g.* zebra, giraffe, large carnivores, *etc.*);
therefore may generate more tourist income per unit area; ***[2 max]***
Any other reasonable suggestions.

(ii) *Calculations*:

Grassland: $\frac{150\,\text{km}^2}{300\,\text{km}^2} \times 100 = 50\%$ *(allow 45–55%)*;

Rainforest: $\frac{50\,\text{km}^2}{50\,\text{km}^2} \times 100 = 100\%$ *(allow 95–105%)*; ***[2 max]***

(iii) percentage increase in rainforest greater because:
it began with a smaller area (so a small increase represents a larger percentage increase);
increased interest in ecotourism for rainforests;
pressure from environmental groups to "save the rainforest"; ***[1 max]***

(iv) rainforests contain high diversity of species;
these species are unique to the habitat;
and represent a high proportion of the total world biodiversity;
biodiversity of tropical rainforests less well-documented than other ecosystems;
rainforests have significant effect on wider climate;
which affects the survival of many other species;
rainforests are diminishing globally at a considerable rate;
source of useful products/genes; ***[2 max]***

(b) *Transition zone*:
permanent settlements cause high impact;
by limiting their size, impact on boundary of buffer zone is reduced;
reduces impacts of pollution/disturbance on margins of buffer zone;

Buffer zone:
allowing research increases knowledge of species and ecosystems;
which can be used for better conservation;
tourism can provide revenue / raise public interest;
which can aid in further conservation;
sustainable exploitation by locals encourages their support for the project;

Core zone:
minimal immediate human activity protects the most vulnerable species (even the most intensively conserved areas may need occasional management *e.g.* control of bush fires, elimination of exotic species);
maintains an untouched deposit of diversity that can feed into buffer zone;
some ecological studies require natural/ near-natural environments;

At least one point from each zone to gain full marks. ***[4 max]***

C2. (a) habitat diversity;

because different habitats tend to have different species;
so more habitats will generally include greater variety of species;
similarly, different species tend to have different genes;
so more species will generally include greater variety of genes;
*Award **[1 mark]** each for any two explanations.*
*If "species diversity" is identified, no mark should be awarded for it, but either of the last two marking points may be credited for **[1]**.* ***[3 max]***

(b) *Natural selection*:
some genetic types will be better adapted and thus contribute to next generation more than others;
hence gene frequencies/genetic types in a species will change over time;

Isolation:
plate tectonics (or other environmental events) may cause part of a population to become isolated;
this isolated population may be exposed to different agents/pressures of natural selection;

Speciation:
these isolated populations may undergo genetic change to a point that they can no longer breed with those of their ancestors' type;
by definition these will then be a new species;

Environmental change:
changes in environment lead to changes in direction of natural selection;
leading to new adaptations and possible further speciation (as above); ***[4 max]***

Any other reasonable points or valid examples can be credited.
Must mention at least two of the processes for full marks.

(c) *Advantages*: ***[1 max]***
often it can generate great public appeal (*e.g.* pandas, tigers, *etc.*);
natural habitats may be so diminished/deteriorated that the species is unlikely to survive;
it may support detailed scientific research/reintroduction programmes;

Disadvantages: ***[1 max]***
maintenance of species may be difficult in captivity;
population and therefore gene pool of species will be very small;
it ignores the value of other species in the habitat / and the role it would normally play in that habitat for other species;
difficulties of re-introduction to wild;

[2 max]

Option D — Pollution Management

D1. (a) both show an annual increase in use throughout most of the period shown;
the annual increase is generally declining for both regions;
*(**N.B.** do not credit responses that claim the use of fertilisers is decreasing)*
western Europe shows a decrease in use of fertilisers for a short time around 1990;
developing countries consistently show a greater annual increase;
developing countries show greater fluctuations in their annual increase / western Europe shows a steadier decline in annual increase; ***[2 max]***

(b) annual increase for 1970 is 12.5% *(allow 12–13%)*;
$\frac{12.5}{100} \times 40000 = 5000$;

Total used = $40000 + 5000 = 45000$ tonnes
(allow 44800-45200 / 4.5 x 10^4 tonnes / 45 k tonnes);
[1 mark] *for correct percentage and* ***[1 mark]*** *for correct total.* ***[2 max]***
(There is no need to insist on evidence that the graph was used, e.g. by seeing a ruled line or similar.)

(c) inorganic fertilisers are released into environment through human activity;
in quantities that would not naturally occur within the environment;
in quantities greater than can be rendered harmless by the environment;
and has an appreciable effect on the organisms within it;
and cause disturbance to the equilibrium of systems;
resulting in reduced/altered biodiversity; ***[2 max]***

(d) N and P drain into aquatic systems;
promote rapid growth of phytoplankton/algae;
death of these algae contributes to dead organic matter;
leads to similar events with zooplankton;
larger plants die from lack of light;
increased dead organic matter speeds up decomposition;
rapid increases in population of decomposer organism populations / bacteria;
O_2 used up by respiring decomposers;
animals die due to lack of O_2;
diversity of the system is greatly reduced; ***[6 max]***

(e) BOD = Biochemical Oxygen Demand; (*Allow* Biological)
BOD is the quantity of oxygen required by decomposers for the full decomposition of organic matter within a sample;
due to high inputs to storages of dead organic matter BOD is likely to be relatively high/will increase; ***[2 max]***

D2. (a) *No mark is available for naming pollutants, but if no pollutant is named a maximum of **[2 marks]** should be awarded. The same pollutant need not be used for each of the three stages.*

*Production **[1 max]***
recycling could lead to less need for production (*e.g.* plastic);
producing less damaging alternatives for human use;
using different raw materials;
increasing price of commodity/taxing production of pollutant;

*Release **[1 max]***
scrubbers/catalytic converters (*e.g.* sulphur oxides);
end pipe monitoring;
legislation/fines;

*Long term impact **[1 max]***
liming (*e.g.* acid rain);
restoration;
sealing off inputs;
Award credit similarly for any other valid strategies for the pollutants named. ***[3 max]***

(b) *Depends on strategies chosen but the following are examples that could be credited:*
recycling can be very expensive;
impacts of "less damaging" alternatives may be discovered later (*e.g.* some alternatives to CFCs have been found to be damaging to the environment);
cost of fines and taxing can be passed on to consumer and provide little disincentive to large international companies;
scrubbers and converters limited to small range of pollutants;
monitoring often has to be very thorough/regular/expensive to be effective;
restoration, again very expensive and often very limited in its success;
liming can cause damage in immediate locality;
sealing off inputs to specific ecosystems only possible with certain systems/pollutants and pollutant is still present in the wider environment; ***[3 max]***