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# MARKSCHEME

## May 2003

## ENVIRONMENTAL SYSTEMS

## Standard Level

## Paper 3

12 pages

**Subject Details: Environmental Systems SL Paper 3 Markscheme**

**General**

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

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- Each marking point has a separate line and the end is signified by means of a semicolon (;).
- An alternative answer or wording is indicated in the markscheme by a "/"; either wording can be accepted.
- Words in ( … ) in the markscheme are not necessary to gain the mark.
- The order of points does not have to be as written (unless stated otherwise).
- If the candidate's answer has the same "meaning" or can be clearly interpreted as being the same as that in the mark scheme then award the mark.
- Mark positively. Give candidates credit for what they have achieved, and for what they have got correct, rather than penalising them for what they have not achieved or what they have got wrong.
- Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.
- Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalised. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded. Indicate this with **"ECF"**, error carried forward.
- Units should always be given where appropriate. Omission of units should only be penalised once. Indicate this by **"U-1"** at the first point it occurs. Ignore this, if marks for units are already specified in the markscheme.
- Do not penalise candidates for errors in significant figures, unless it is specifically referred to in the markscheme.

**Option A – Analysing Ecosystems**

**A1.** (a) 125; ***[1]***

(b) *Award **[2]** for description and **[1]** for evaluation. If no species or ecosystem is named award **[2 max]**. Method must be compatible with ecosystem and species named.*

*Award **[1]** each for any two of the following.*
*description*:
establish grid over area;
use random number table / computer / calculator to select quadrats;
throw quadrats at random / count number / estimate % cover of plants in quadrats;
multiply to get number in total area;
for large plants such as trees, direct count using aerial photographs;
*Any other reasonable method acceptable (e.g. transect with regular quadrats)*

*Award **[1]** for any one of the following.*
*evaluation*:
quadrat method difficult for very large or possibly very small plants;
problems with plants that occur in colonies, tufts;
sometimes apparently separate plants are linked at roots, *e.g.* some European trees and Australian eucalyptus;
problems outside main growing season when plant largely invisible; ***[3 max]***
*Any other reasonable suggestions*

*Note that if a candidate selects an animal species no credit can be given. The only exception might be corals in a coral reef, as corals could be said to have dual plant / animal natures, and some of the "plant" methods might be appropriate.*

(c) *Award **[1]** each for two of the following*.
biodiversity of an area depends on both the number of species occurring and the relative abundance of these species;
some diversity indices take account of relative abundance of species as well as number of species;
*e.g.* Simpson's index / $D = \frac{N(N-1)}{\sum n(n-1)}$; ***[2 max]***

**A2.** (a) the mass (or weight) of organic material in organisms or ecosystems, usually per unit area *(glossary definition)* / *OWTTE*; ***[1]***

(b) organisms vary enormously in the proportion of water they contain, so the biomass less water is usually given / *OWTTE*;
to facilitate comparison of data from different sources; ***[1 max]***

(c) *Award **[1]** each for three of the following.*
curve fluctuates seasonally;
high values (approximately 2.2–2.6) in April–May and September–October;
*i.e.* in southern hemisphere spring and autumn;
low value in January;
in southern hot summer;
other low points May–August;
*i.e.* in southern winter;
fluctuations may reflect life-cycles of insects;
and/or variations in plant productivity;
peaks may represent carrying capacity;
troughs may be result of predation; ***[3 max]***
*Any other reasonable points.*

(d) *Award **[1]** each for four of the following. If there is no evaluation, award **[3 max]**.*
select random quadrats using random number tables / computer;
collect plant material from quadrat;
dry material in an oven;
or use tables to extrapolate dry weight values;
repeat at regular intervals through year;
ideally take several samples each time and calculate mean;
problems with very large plants (trees);
problems with roots and underground biomass; ***[4 max]***
*Any other reasonable points.*

**A3.** (a) *Any appropriate human intervention allowable.*
*e.g.* if forest named: removal of tree cover through forestry operations; ***[1]***
*A little more than one word is expected. Note that answers must use the ecosystem named.*

(b) *Award **[1]** each for four valid points. Award **[0]** if no abiotic factor is named. Allow any abiotic factor appropriate to ecosystem; temperature, pH, salinity, wind velocity, etc.*
for above named example: abiotic factor = light;
use light meter;
take several observations and calculate mean;
importance of before and after clearance observations / measurements;
observations must be consistent *e.g.* same height above ground / with same instrument;
problem of variation in weather conditions; ***[4 max]***

**Option B – Impacts of Resource Exploitation**

**B1.** (a) (i) 124.3 %; *(allow 120 – 130 %)* ***[1]***

(ii) 771.4 %; *(allow 765 – 775 %)* ***[1]***

(iii) *Award **[1]** each for two of the following.*
world agriculture, particularly in developed countries, has become more intensive over the period;
increasing inputs per unit area of agricultural land;
increase in the area under cultivation;
new crops / strains / agricultural procedures which require greater fertilizer inputs; ***[2 max]***
*Any other reasonable suggestion.*

(b) *Award **[1]** each for four of the following.*

*inputs*:
of irrigation / fertilizers have been substantial;

*outputs*:
increase also substantial, but in some cases less than inputs;
*e.g.* cereal increase less than ×3, fertilizer approximately ×9;
land degradation / overfishing / pollution (eutrophication) may be local consequences;
these increases may not be sustainable;
increases in protein foods (meat, fish) have been greater than carbohydrate foods (cereal);
these may reflect growing affluence (especially in developing countries);
increased inputs, including machinery / new crop varieties have increased outputs of food, especially in marginal lands; ***[4 max]***
*Any other reasonable suggestion.*

(c) *Award **[1]** each for three of the following.*
meat is consumed to a much greater extent in developed countries;
greater wealth and food availability in developed countries;
conversely plant foods such as cereals tend to comprise a greater portion of the diet in developing counties;
because they tend to crop lower in the food chain;
and therefore more efficiently;
proportion of fish varies widely;
in some developing countries where local products can be obtained cheaply (*e.g.* in Pacific island nations / other coastal regions) proportion of fish in diet may be quite high;
but in many areas, due to overfishing, prices have risen and amount consumed is falling; ***[3 max]***
*Any other reasonable suggestion.*
*Do not allow a point given in (b) if expressed in exactly the same terms.*

**B2.** (a) (i) *Award **[1]** for two of the following.*
relatively cheap in some localities;
extensive supplies available in some countries;
require fairly simple technology in some circumstances;
already established in many areas of the world so easiest to continue (geographical momentum);
easy to store; ***[1 max]***

(ii) *Award **[1]** for two of the following.*
coal mining and/or oil-rig working dirty / dangerous;
produces carbon dioxide which may cause global warming;
produces particulate matter which causes respiratory problems in humans;
smog;
and sulfur and nitrogen containing compounds causing acid rain;
finite supplies / non-renewable resources;
pollution risks of transporting oil;
*e.g.* Exxon Valdez / Torrey Canyon / Prestige; ***[1 max]***

(b) (i) *Award **[1]** for two of the following.*
very cheap once power stations built (*note however in some countries health and safety aspects are costed separately, but if these were included nuclear power may be more expensive: allow either*);
apart from radioactivity, relatively pollution-free;
small amount of fuel lasts a very long time;
can be coupled with the production of military plutonium *(answers might argue this was a disadvantage – allow either)*; ***[1 max]***

(ii) *Award **[1]** for two of the following.*
immense cost of building power stations and disposal of used fuel;
problems of disposal of spent fuel / radioactive waste (which remains radioactive for thousands of years);
problems of decommissioning old power stations;
health problems from radioactivity;
risks of terrorism;
occasional leaks of radioactivity;
*e.g.* Chernobyl / Three Mile Island / Windscale (Sellafield); ***[1 max]***
*Allow reasonable alternative points, arguments or examples.*

(c) *Allow any source of energy. Award **[1]** each for two of the following. Award **[0]** for just naming a source.*
*e.g.* hydroelectric power: a renewable resource;
providing rainfall / water flow continues, power source continues;
but construction of power stations / dams uses much energy and other resources;
damming and flooding destroys farmland / forests / amenity;
*e.g.* Franklin Dams controversy, Tasmania / Three Gorges Project, China;
but flooded areas may provide sustainable fisheries / recreation;
*e.g.* Western USA / Tasmania;
once constructed, relatively pollution-free; ***[2 max]***
*Points made must be related to sustainability, or lack of it.*

**B3.** (a) the area of land / water required to support a defined human population at a given standard of living / *OWTTE*; ***[1]***

(b) *Award **[1]** each for two of the following*.
would expect the footprint of the developed country's city to be larger;
requires more vegetation to absorb carbon dioxide through burning of fossil fuels;
developed countries consume more meat, which requires more land than grain;
cities in developed countries consume more water *per capita* (for washing, watering gardens, *etc*.)
population of developed countries uses more land for outdoor recreation; ***[2 max]***
*Any other reasonable differences.*

**Option C – Conservation and Biodiversity**

**C1.** (a) 2.075 % *(allow values between 2.0 and 2.1)*; ***[1]***

(b) (i) mammals;
(ii) invertebrates; ***[1]***
*Both answers needed for **[1]**.*

(c) *Award **[1]** each for two of the following.*
mammals are often large / conspicuous;
and sometimes of economic value (fur, meat, skins);
large mammals require substantial area for their support;
many mammals feed at high trophic levels / are *k*-strategists and have low reproductive potential;
and so are more vulnerable to extinction;
mammal species number lower, so loss of a few species more significant;
knowledge of mammals and their extinctions is reasonably complete;
biodiversity of invertebrates is not well known;
many species of invertebrates may have become extinct without being documented;
most insects are small / inconspicuous;
and are of little economic value; ***[2 max]***
*Any other appropriate point.*

(d) *Award **[1]** each for five of the following.*
with the exception of fishes and invertebrates, many more island species have been rendered extinct than continental species;
island biotas are particularly vulnerable because of high degree of endemism;
small size of populations on islands;
less genetic diversity in small island populations;
absence of predators on islands and therefore vulnerability of organisms when these are introduced;
specialized nature of island forms;
small number of fish extinctions on islands due to rarity of suitable habitats;
and small number of species originally; ***[5 max]***
*Any other appropriate point.*

**C2.** (a) variety of species per unit area / *OWTTE*; ***[1]***

(b) *Award **[1]** each for two of the following*.
environmental pressures (*e.g.* predation, climate);
act on variations within a population (*e.g.* size, colour, resistance to disease);
to change the frequency of genetic traits / genes in a population;
where this reaches the point that the forms cannot interbreed, speciation has occurred; ***[2 max]***
*Any other appropriate point.*

(c) (i) *Award **[1]** each for two of the following*.
*natural hazard events*:
volcanic eruptions;
droughts;
floods;

*global catastrophic events*:
glaciation;
meteor impact;
change in climate; ***[2 max]***

(ii) *Award **[1]** each for two of the following*.
habitat fragmentation;
habitat destruction;
monoculture;
introduction of exotic species;
pollution;
hunting / collecting / overharvesting; ***[2 max]***
*Any other appropriate point.*

**C3.** *Award **[1]** each for four of the following. Reward detail, logical argument and named examples.*
large areas usually preferred to small;
as they can conserve a greater variety of habitats / microhabitats;
and higher numbers of individual organisms;
and thus greater genetic variability;
larger areas have smaller proportional length of perimeter;
and thus fewer edge effects than small areas;
*e.g.* disturbance, drift of pollutants;
similarly, compact areas preferred to elongate / irregular;
"corridors" sometimes useful for connecting isolated or small reserves; ***[4 max]***
*Any other appropriate point.*

**Option D – Pollution**

**D1.** (a) point-source originates from a single identifiable site, non-point-source originates from multiple, widely dispersed sites; ***[1]***

(b) (i) copper; ***[1]***

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

(c) *Award **[1]** each for three of the following*.
there is evidence for both point-source and non-point-source pollution;
some heavy metals seem to contaminate the whole area;
albeit at a fairly low level;
levels of cadmium are apparently identical throughout the length of the stream;
this may provide evidence of area-wide (non-point) pollution;
or existence of "background" amount;
but pollutants (Cr, Ni, Cu, Zn, Pb) show appreciably higher concentrations in the lower stream;
this might suggest a point-source somewhere along the length of the stream;
such as from a chemical factory or metallurgical enterprise; ***[3 max]***
*Any other appropriate point*.

(d) *Award **[1]** each for two of the following*.
prevent escape of pollutants at source;
impose legal standards;
adopt lifestyles that reduce demand for products giving rise to pollution;
develop alternative technologies (*e.g.* lead-free petrol (gasoline));
regular monitoring; ***[2 max]***
*Any other appropriate point.*

**D2.** *Award **[1]** each for four of the following. If no example is given, **[3 max]**.*
a biotic index uses presence - absence / relative abundance of organisms in place of actual measurement of pollutants;
organisms vary in their tolerance of different conditions;
so identification / measurement of abundance of organisms at a site provides useful indication of nature of environment;
comparison of polluted and unpolluted sites / same site before and after pollution, provides data;
*e.g.* number of species of lichens on walls / trees / roofs in industrial or urban areas;
provides an index of the severity of atmospheric pollution; ***[4 max]***
*Any other appropriate point.*

**D3.** a measure of the amount of dissolved oxygen required to break down the organic material;
in a given volume of water through aerobic biological activity / *OWTTE*;
high BOD levels often indicate high levels of organic matter (*e.g.* sewage) polluting a water body;
provides indication of the level of eutrophication; ***[3 max]***
*Award **[2]** for definition and **[1]** for explanation.*

**D4.** *Award **[1]** each for five of the following*.
careful measurement of total amount;
relative proportions of paper, glass, metal, plastic, organic waste;
investigate destination(s) of waste;
consider recycling strategies;
estimate proportion recycled;
consider shift to recyclable / reusable materials where possible;
where change anticipated, adopt EIA (EIS) approach;
baseline study before change;
assessment of impacts of change;
monitoring after change; ***[5 max]***
*Any other appropriate point*.
*Award **[0]** if the answer simply <u>describes</u> the waste management strategies (incineration / recycling / separate bins for different materials).*
*The key words are: "how would you evaluate".*