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

N07/4/ENVSY/SP3/ENG//TZ0/XX/M

MARKSCHEME

November 2007

ENVIRONMENTAL SYSTEMS

Standard Level

Paper 3

13 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.
- Words that are underlined are essential for 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 penalized. 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 penalized 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 penalize candidates for errors in significant figures, unless it is specifically referred to in the markscheme.

Option A — Analysing Ecosystems

A1. (a) the heterogeneity/variety of life in an area / *OWTTE*; ***[1]***

(b) (i) site A

$$D = \frac{40\ \ 40-1}{10\ \ 10-1\ +5\ \ 5-1\ +15\ \ 15-1\ +10\ \ 10-1};$$

$$= \frac{40 \times 39}{90+20+210+90}$$

$$= \frac{1560}{410} = 3.80;\ (\textit{Allow 4 / 4.0 / 3.8}) \qquad \textbf{\textit{[2 max]}}$$

*Award **[1]** for correct answer and **[1]** for working.*

(ii) site B

$$D = \frac{40\ \ 40-1}{20\ \ 20-1\ +10\ \ 10-1\ +8\ \ 8-1\ +2\ \ 2-1};$$

$$= \frac{40 \times 39}{380+90+56+2}$$

$$= \frac{1560}{528} = 2.95;\ (\textit{Allow 3 / 3.0}) \qquad \textbf{\textit{[2 max]}}$$

*Award **[1]** for correct answer and **[1]** for working.*

(iii) site A
and *one cause from the following*
differences in:
microclimate (temperature/humidity);
habitat differences;
soil;
pollution levels;
predation levels;
competition;
microhabitat required for some species very restricted (carrion, dung); ***[1]***
Any other reasonable suggestion
Both correct site and cause needed for mark
Allow ECF
Do not credit an answer that just refers to numbers or variety of organisms

(c) (i) capture–mark–release–recapture method / use Lincoln index method;
mark out area of 0.1 ha;
capture sample of beetles using traps/nets/searching in appropriate places *e.g.* dung/carrion/dead wood according to species;
mark with non-toxic paint or some other appropriate method;
allow interval and recapture similar number;
$P = \frac{n_1 \times n_2}{n_3}$; ***[4 max]***
Any other reasonable points

(ii) immigration;
emigration;
deaths;
births/hatching from pupae;
patchy distribution;
difficulty of finding adequate sample; ***[2 max]***
Any other reasonable points

(d) use dichotomous key;
use field guide / illustrated book / internet resources;
refer to expert on the group;
DNA testing;
use factors such as sound / habitat / distribution / time of year / time of day; ***[1 max]***
Any other reasonable points

(e) (i) *Award **[1 max]** for abiotic factor **and** named ecosystem. Ecosystem must not be too vague. Do not credit biotic factors.*
Example: sunlight intensity in eucalypt forest in south-west Australia; ***[1]***

(ii) *Method will depend on the ecosystem selected.*
For the above example:
light intensity varies with height;
measure light intensity with light meter;
measure at regular intervals (2m, 5m) from ground level to top of canopy;
using ladders / extending poles / climbing trees or similar method;
as far as possible under similar conditions each time;
as far as possible repeat several times and take mean; ***[4 max]***
Any other reasonable points

(iii) *Example: clearance of forest / cutting of trees*
would allow sunlight to reach ground level;
light intensity would increase;
however, eventually thick successional community might exclude sunlight;
and light intensity would decrease; ***[2 max]***
*No mark is awarded for name of ecosystem, but if no name is given, award **[1 max]***

Option B — Impacts of Resource Exploitation

B1. (a) (i) 9.58×10^{18} Joules;

(ii) 18.94×10^{18} Joules;

(iii) 2.59×10^{18} Joules; ***[1]***
Three correct values, with units ***[1]***

(b) 50.28 %; *(allow 50%)* ***[1]***
Accept 50.3 %
Allow ECF

(c) production from all sources has increased;
because of increase in population and living standards (E);
increase in production of nuclear power highest in absolute terms;
but rate of increase is slowing;
as disadvantages on nuclear power are appreciated (E);
e.g. following Chernobyl (E);
increase in production of hydroelectric power more modest;
as many suitable locations are already used (E) ;
and opposition to very large dams grows (E);
e.g. Gordon below Franklin in Tasmania (E);
percentage increase in geothermal, solar, *etc.* greatest;
as it starts from a very low base (E);
and represents very new technologies (E); ***[4 max]***
Any other reasonable points
Candidates must have at least one "explain" point (E) for ***[4 max]***

(d) damming of "wild" rivers;
dams may prevent movement/migration of fish (*e.g.* salmon);
dams and reservoirs may prevent movement of silt (*e.g.* Nile valley);
building costs are very high;
many sites are already used;
many sites are very remote / cost of transporting electricity high; ***[3 max]***
Any other reasonable points

(e) (i) *Name of food production system **[1]**. Actual name or clearly locatable details must be given.*
e.g. Thundelarra sheep station, Wubin, Western Australia / Manor Farm, Wyke, Dorset, England / market garden area, Wanneroo, near Perth, Western Australia;
"Dairy Farm" "Plantation" or "Orchard" is insufficient.

*Description **[2]***
Brief description should state what is produced and give some other details.
For the last example (above):
produces fruit and vegetables from smallholdings;
consumed by large population of nearby metropolitan Perth; ***[3 max]***

(ii) *For example for market garden*:
soil of Wanneroo is very infertile sand;
so massive inputs of fertilizers needed;
climate has several months of hot, summer drought;
so substantial input of water by irrigation needed;
pests thrive in warm climate;
so pesticides extensively used;
all above involve substantial energy / material input;
so although economically viable, ecologically not very sustainable; ***[3 max]***
Reward material that shows understanding of concept of sustainability.

(f) (i) the area or land/land and water required to sustainably support a defined human population / OWTTE;
at a given standard of living, including the assimilation of wastes / OWTTE; ***[2]***
(*based on Glossary*)

(ii) ***[1]** for size of footprint*
the size of the footprint of an inhabitant of a developed country will be larger;

***[2]** for explanation*
inhabitant of developed country has higher standard of living / higher income;
and thus will consume more food;
and probably higher proportion of meat;
taken from higher in food chain / requiring larger area to produce;
and so will require larger area per capita to support an individual;
higher car ownership / greater use of power;
implies more CO_2 production;
requiring larger area for assimilation;
Any other appropriate points

Or, reverse:
inhabitant of less developed country consumes less food, *etc.* ***[3 max]***

Option C — Conservation and Biodiversity

C1. (a) (i) species diversity = number of species of organisms per unit;
habitat diversity = number of habitats/ecological niches per unit area/within an ecosystem; ***[2]***

(ii) generally the higher the habitat diversity, the higher the species diversity;
generally in a high mountain range the complexity of vegetation decreases with altitude;
complex tropical forest communities at base provides variety of ecological niches for many species;
or
less complex vegetation at higher altitudes provides fewer ecological niches;
and thus can support fewer bird species; ***[2 max]***
Any other appropriate points

(b) (i) animals with tusks/large tusks are more likely to be killed for their ivory;
natural selection results in the removal of "unfavourable" genes from the population;
organisms carrying these genes tend to die before reaching adulthood;
in modern Africa, genes for tusks/large tusks can be considered unfavourable;
and thus animals with tusks/large tusks will be removed from population / not pass their genes on to the next generation;
over time, therefore, fewer and fewer elephants will have tusks; ***[2 max]***
Any other reasonable points

(ii) small populations become vulnerable because of poor social structure (non-viable sex ratio, *etc.*);
low genetic diversity;
easily wiped out by disease/natural hazards/poaching;
however, an isolated population may become distinctively different;
as it may carry a set of genes not typical of the parent population; ***[3 max]***
Any other reasonable suggestion

(iii) *Must name one purpose and one weakness:*
Purpose ***[1 max]***
reduction of international trade, so that demand will be reduced, and the killing of rare and endangered species discouraged;

Weakness ***[1 max]***
some countries are still outside the Convention;
provisions difficult to implement/enforce, particularly in less economically developed countries;
cumbersome/lengthy procedures for modifying the Convention;
a number of "exceptions" exist *e.g.* import/export of organisms for scientific purposes (Article III part 3 of the Convention); ***[2 max]***
Any other reasonable suggestion

(iv) name of organism/conservation scheme ***[1 max]***;

details of management programme;
response will depend on organisms or scheme selected ***[3 max]***

For example
Chuditch / Western Quoll;

the largest marsupial predator in Western Australia;
at the time of European settlement, Chuditch occurred in approximately 70% of the continent;
by the late 1980s they had become endangered (population less than 6000);
Perth Zoo has bred more than 300 Chuditch for release in the last decade;
since the breeding programme began, Chuditch have been downlisted from endangered to vulnerable (E); ***[4 max]***
Must have one evaluation point for full marks.

(c) Humans interfere with ecosystems in the following ways:
removing some organisms for food or other uses (hunting, timber-cutting);
habitat destruction *e.g.* forest clearance / wetland drainage;
and resultant substitution of artificial ecosystems for natural systems;
artificial systems often have a single dominant food-chain;
e.g. grass → cow → human;
this contrasts with complex food-webs of forest ecosystems;
pesticides remove both target species and others;
artificial ecosystems have lower habitat diversity (farmland, plantations);
and therefore lower species diversity;
crops/livestock have very low genetic diversity;
simplified systems have fewer energy/matter pathways / feedback loops;
and may thus suffer changes from which recovery is impossible; ***[5 max]***
Any other reasonable suggestion
[2 max] *for simple statement of activities*

Option D — Pollution Management

D1. (a) use of lichen abundance and diversity is an indirect method of monitoring air pollution / is an example of a biotic index;
the tolerance of individual lichen species to pollution varies; (E)
the greater the abundance/diversity of lichens the less air pollution; (E)
SO_2 /acid rain is the principal factor; (E)
the graph shows a diverse lichen flora approx 5-10 miles from the city;
low numbers 3-5 miles from city;
very low numbers / lichen desert within 3 miles of city centre;
sandstone and tree substrata appear to have higher natural diversity than asbestos;
but the asbestos flora seems more tolerant of urban environments; (E)
data are for 1960s – a more recent study might show some improvement/increase in diversity; ***[5 max]***
At least two explanation (E) points needed for full marks
Any other reasonable suggestion

(b) (i) 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 (Glossary definition) / OWTTE; ***[1]***

(ii) pollution of a water body by organic material increases the BOD of the water;
e.g. sewage / run-off from livestock / food processing effluent;
BOD is measured at a constant temperature over a set period;
samples from above and below source of pollution might be taken;
series of observations might be taken and mean obtained;
BOD does not measure pollutants that cannot be biologically degraded; ***[3 max]***
Any other appropriate points

(c) prevent any point-source pollution from entering lake, *e.g.* sewage outfalls;
extract N and P from effluent discharging into lake;
discourage overuse of fertilizer in catchment (especially N and P);
use slow-release granulated fertilizers on nearby land;
reduce stock:area ratio in catchment;
change land-use of catchment, *e.g.* substitute woodland for agriculture;
increase through-flow of water;
use natural filters on inputs (*e.g.* reed beds); ***[4 max]***
Any other reasonable suggestion

(d) removing eutrophic mud from the lake bottom;
removing algal film;
oxygenation;
replanting indigenous plant species;
restocking with fish / other fauna; ***[3 max]***
Any other reasonable suggestion

(e) *Advantages*:
can be relatively cheap;
many types of material can be disposed of (*e.g.* paper, plastics, cardboard, wood, fabrics, vegetable material);
requires a relatively small area;
incineration can be integrated with power/hot water production;
leaves relatively small solid residue;
metals may still be extracted from residue;

Disadvantages:
may produce atmospheric pollution;
may be eyesore/aesthetic objection;
unsuitable for many materials (*e.g.* metals, batteries, glass);
destroys materials that might be recycled/reused (paper, some plastics);
if plant far from source, may be costly (and use much energy) to transport waste; ***[4 max]***
Must have at least one advantage and one disadvantage for full marks.
Any other reasonable points