M09/4/ENVSY/SP2/ENG/TZ0/XX+

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MARKSCHEME

May 2009

ENVIRONMENTAL SYSTEMS

Standard Level

Paper 2

17 pages

Subject Details: Environmental Systems SL Paper 2 Markscheme

Mark Allocation

Candidates are required to answer **ALL** questions in Section A **[30 marks]** and **ONE** question in Section B **[20 marks]**. Maximum total = **[50 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 markscheme, 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.

SECTION A

1. (a) (i) *sustainability*
the extent to which a given interaction with the environment exploits and utilises the natural income without causing long-term deterioration of the natural capital; (Glossary) ***[1max]***
Need not be verbatim, but must have both concepts of:
exploitation of resources/natural income and without deterioration of natural capital;

(ii) *carrying capacity*
the maximum number of a species or "load" that can be sustainably supported by a given environment; (Glossary) ***[1max]***
Need not be verbatim, but must have both concepts of:
maximum load or number of individuals and that can be supported in the long term by an environment, ecosystem or resource;

(b) *Award **[2 max]***
low stable/lag phase / 1939–1949;
low numbers so low reproductive rate;
energy put into modifying environment/locating resources, *etc.*, rather than growth;
possibly displacing other species through competition;
population kept low by human hunting/egg collection;
high levels of predation/competition (from other species);
recolonization of island, following population crash (caused by natural hazard/human activity);

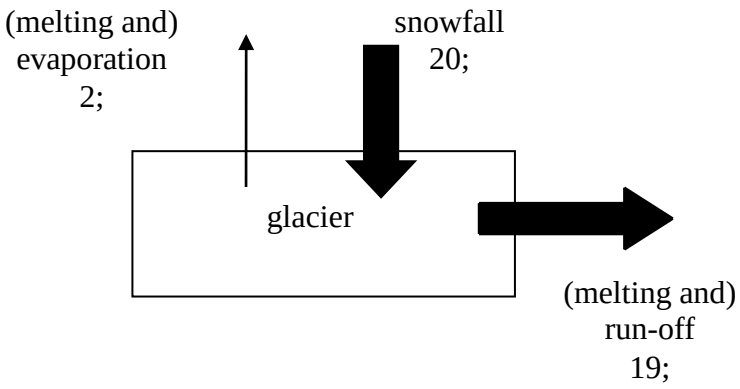
*Award **[2 max]***
rapid growth/exponential/log phase / 1959–1985/1959–1994;
reduced competition/predation;
improved food supply;
larger numbers so higher reproductive rate;
possible increase in conservation efforts/protection;
possible change in climate;

*Award **[2 max]***
stable/maximum/steady state/equilibrium phase / 1994–2004/2004 (onwards);
competition for/limited nesting sites;
reaching carrying capacity of environment;
limited food supply;
other appropriate density-dependent factors / negative feedback mechanisms; ***[6 max]***

Any other reasonable suggestions.
Credit may be awarded if the phases are identified by annotating the graph.

(c) because 2000/number of birds taken is a sustainable yield/less than maximum sustainable yield for this resource;
the "crop" can be taken without damaging the productivity of the stock of breeding gannets; *(OWTTE)*
inward migration of gannets from colonies located elsewhere, to fill vacant niches left by those taken for food; ***[1max]***

2. (a)



Appropriate diagrammatic representation of flows and storages; ***[1]***
Arrows in right directions; ***[1]***
Correct labeling, with values; ***[1]***
Arrow widths proportional to values; ***[1]*** ***[3 max]***

(b) the glacier would retreat/get smaller in volume/lose mass ***[1]***

3. density of bushes varies from less than 1 to 5 per $100m^2$;
density increases with rainfall / shows a positive correlation with rainfall / is directly proportional to rainfall;
there is likely to be severe competition for water between plants in a desert region; (E)
rainfall/water is a limiting factor; (E)
hence low density in areas on lowest rainfall; (E)
the correlation is not exact / considerable scatter in data;
there is one anomalous point/outlier;
other factors *e.g.* production of growth inhibiting toxins / spread of roots / soil type may reduce/increase density; (E)
possibility of human activities having an effect/clearing/burning; (E) ***[4 max]***
Any other reasonable answer.
Must have at least one "explain" point (E) for full ***[4]*** *marks.*

4. (a) (soil =) the loose aggregate of mineral particles / a mixture of inorganic material/sand, silt and clay;
and organic material/living and dead organisms;
in which terrestrial plants generally grow; (Glossary) ***[2 max]***

(b) stage 1: initial weathering – the mechanical disintegration and/or chemical decomposition and/or biological weathering (*e.g.* by lichens) – of rocks to yield mineral particles (followed by erosion and deposition);
stage 2: colonization and activities of organisms (=biotic component);
stage 3: accumulation/decomposition of the organic component; ***[3]***

(c) (i) *transfer*:
downward movement/percolation of water through the soil;
wind-blow of sediment;
movement of sediment by ice particles in soil / frost heave;
leaching/downward-movement through soil of minerals/nutrients/iron/ silica/aluminium compounds;
upward movement of salts to surface as the result of evaporation;
Any other reasonable answer.
*Reject **biotic** processes.* ***[1 max]***

(ii) *transformation*:
oxidation/reduction of minerals;
dissolution of minerals from rock/soil particles;
hydrolysis/other chemical reactions;
chelation of minerals (by clay particles);
e.g. reaction between acidic rainwater and limestone;
Any other reasonable answer.
*Reject **biotic** processes.* ***[1 max]***

5. (a) *Allow **[1]** for an actual name (toponym) or reasonable location and brief description.*
e.g. Wytham Wood, Oxford, UK, mixed deciduous woodland;
Herdsman Lake, Perth, Western Australia, freshwater lake surrounded by swampland;
small secondary woodlot near Woodbridge, Connecticut, USA;
"*Wood" or "Lake" in "name of country"/"tropical rainforest" without a location is insufficient for credit.* ***[1max]***

(b) *Award **[1]** for any **three** abiotic factors appropriate for the ecosystem selected.*
e.g. for Wytham Wood
soil pH / temperature / rainfall / sunshine / aspect; ***[1]***

(c) *name of organism e.g.* (wood)mice;
affected by rainfall which floods burrows and impedes breeding; ***[2]***
*Award **[1]** for name of organism and **[1]** for effect of factor.*
*Reject **tree**, **shrub**, **bird**, **fish**, and other very generic names.*

(d) *e.g.* predation/competition/disease/parasitism;
(*e.g.* predation by tawny owls) reduces numbers of mice; ***[2]***
*Award **[1]** for named biotic factor and **[1]** for effect of factor – direction of change in abundance e.g. increase/decrease/reduce must be specified.*

SECTION B

General Essay Markscheme

Each essay is marked out of ***[20]*** of which ***[3]*** are for expression and development of ideas (EDI).

[0] No expression of relevant ideas.
[1] Expression and development of relevant ideas is limited.
[2] Ideas are relevant, satisfactorily expressed and reasonably well developed.
[3] Ideas are relevant, very well expressed and well developed.

Reward detail, sound environmental or ecological concepts, and good examples even if not stated exactly in the form given in the markscheme.

6. (a) succession = (orderly) process of change over time in a community or ecosystem; (Glossary)
zonation = the arrangement or patterning of communities (into a series of parallel or sub-parallel bands or zones); (Glossary)
in response to change, over a distance, in some environmental factor/on an environmental gradient;
pattern of distribution could be due to species colonizing areas of different conditions (zonation);
or conditions could be changing due to colonization of species over time (succession);

*Award **[2 max]** for examples of zonation e.g. zonation around a pool.*
open water with aquatic plants / sedges around margin of pool / presence of trees;
fewer (emergent) plants with increasing depth of water;
environmental gradient from open water, through marginal swamp to dry land;

*Award **[2 max]** for examples of succession e.g. succession around a pool.*
pool may be changing over time/becoming shallower as dead vegetation accumulates;
and marginal vegetation advances into pool/colonizes previously deeper areas;
open water = pioneer community;
tall grasses/sedge swamp = seral community;
woodland = eventual climax;

*Allow **[4 max]** for points on either succession or zonation.*
Allow credit for similar concepts drawn from any other successional/zonational ecosystem. ***[6 max]***

(b) *Award **[3 max]** for points on biodiversity.*
biodiversity initially very low;
as only a few specialized forms are adapted to initial stage/pioneer community;
increases as communities succeed one another;
slight time-lag as organisms from earlier successional stage remain;
possible slight decline as climax reached;

*Award **[3 max]** for points on biomass.*
plant biomass initially very low in pioneer stage;
increases steadily through seral communities/as succession proceeds;
possibly slight decline as climax is reached;
animal biomass increases as food-chains develop and lengthen;
decomposer biomass increases;

*Award **[3 max]** for points on productivity.*
GPP and NPP/primary productivity begin low and then increase;
secondary productivity begins low and then increases;
eventually, secondary productivity reaches maximum in climax community;
so that all NPP is consumed along food chain;
net productivity of whole community (therefore) becomes high in intermediate stages of succession;
then decreases toward zero in climax community;
as inputs and outputs come into balance;
because respiration continues to increase throughout succession, but gross productivity reaches a maximum in intermediate stages;
gross productivity of whole community begins low and increases to maximum in climax community;
Any other reasonable answer.

Credit should be awarded if marking points are illustrated using diagrams or sketch graphs. ***[7 max]***

(c) *early succession:*
r-selected/*r*-strategists;
rapid growth rate;
reproduce relatively early in life;
large numbers of progeny;
numbers increase rapidly to take advantage of temporary habitats/successful competitors in temporary habitats;
little or no parental care;
adapted for wide dispersal;
often display J-curve population growth;
e.g. large number of young saplings growing after fire or clearance in temperate forest (birch, ash trees);

late succession:
K-selected/*K*-strategists;
slower growth rate;
longer time to maturity;
but successful competitors in stable habitats;
fewer progeny;
numbers increase much more slowly;
longer period of parental care;
e.g. mammals (fox, wolf, bear) only 4 or 5 cubs per season, several years to maturity;

Any other reasonable answer.
*Award **[3 max]** if no named examples given.* ***[4 max]***

*Expression of ideas **[3 max]***

7. (a) ozone (O_3) occurs naturally in the stratosphere (upper atmosphere);
at very low concentrations (less than one part per million);
normally ozone is regenerated (in the stratosphere) at the same rate as it is destroyed;
maintaining equilibrium between ozone and oxygen levels;
when man-made chemicals, often used as refrigerants/aerosols/cleaning solvents/ fire-fighting chemicals/fumigants escape into the atmosphere;
e.g. chlorofluorocarbons (CFCs)/chlorinated solvents/halons/methyl bromide/any halogenated gas;
these chemicals interfere with ozone formation;
reducing the amount of ozone formed/disrupting equilibrium (between ozone and oxygen);
additional correct chemical details *e.g*. equations / formation of halogen+oxygen compounds;
one chlorine/bromine/fluorine atom can break down many thousands of ozone molecules / chlorine/bromine/fluorine act as catalysts/are not changed themselves;
CFCs have a long/>100 years residence time/half life;
the "ozone-hole" is most extensive in Polar regions / particularly Antarctica; ***[7 max]***
Any other reasonable answer.

(b) stratospheric (upper atmosphere) ozone plays an important role in limiting the amount of solar ultraviolet radiation that reaches the Earth's surface;
UV radiation can cause damage to plant tissue;
particularly when combined with some other type of stress (*e.g.* caused by rise in temperature);
could cause damage to crops/natural vegetation;
phytoplankton (microscopic plants that form the basis of the marine food chain) may be particularly vulnerable;
reduction of plankton numbers may disrupt marine food chains (including damaging commercial fish stocks);
UV radiation can weaken the human immune system/cause skin cancer/cataracts/eye cancer; ***[4 max]***
Any other reasonable answer.

(c) prevention of ozone depletion generally more successful in terms of achieving intergovernmental agreements/bans;
e.g. Montreal Protocol, 1987 (and subsequent revisions);
greater variety of gases causing global warming;
global warming / greenhouse gases released from widespread human activities;
e.g. fossil fuel use, animal and rice farming;
ozone depleting gases come from less widespread activities (*e.g.* refrigeration, aerosols);
e.g. refrigeration, aerosols;
alternatives have been found to CFCs;
causes of global warming are more ambiguous/less clear-cut due to natural fluctuations in global mean temperatures/natural sources of global warming/greenhouse gases;
use of fossil fuels has huge political/economic significance;
on a national and international level;
although some attempts have been made to control emissions;
e.g. United Nations Convention on Climatic Change, 1992;
Kyoto Protocol to the UN Convention, 1997;
some major polluters did not ratify Kyoto, although they ratified Montreal Protocol;
neither global warming nor ozone depletion produce effects that are immediately apparent;
making it harder to persuade people/governments that rapid action is necessary; ***[6 max]***

Any other reasonable answer.
For full credit, the challenges and successes of strategies for dealing with ozone depletion and global warming must be explicitly compared and contrasted. For responses that address only one of the two issues or make no comparisons award ***[4 max]****.*

Expression of ideas ***[3 max]***

8. (a) *Award **[4 max]** for inner Earth*:
radioactive decay generates heat;
conduction of heat outwards from core;
convectional currents in upper mantle/asthenosphere transfer heat;
heat escapes from lithosphere (crust of the earth);
especially at constructive plate margins;
and regions of volcanic activity;
friction generates heat at subduction zones *(strictly a transformation but allow)*;
energy released from crust (as kinetic energy) by earthquakes;
and plate movements/subsidence/faulting/folding;
Any other reasonable suggestion.

*Award **[4 max]** for atmosphere*:
almost all energy comes from solar radiation;
highest insolation in tropics / lowest in polar regions;
convectional cells move energy latitudinally/from equator towards poles;
brief details of Hadley cell/tricellular model;
transfer of energy by surface winds/jet streams/Rossby waves;
driven by pressure differentials;
large amounts of energy also moved in depressions/tropical cyclones;
release of latent heat by condensation/freezing of moisture in atmosphere;
absorption of latent heat by evaporation/melting of moisture in atmosphere;
radiation/absorption of sensible/radiant energy by atmospheric gases;
frictional drag of atmosphere against surface of Earth/Coriolis forces;
release of energy by lightning/electrical storms;
Any other reasonable suggestion.

*Award **[4 max]** for oceans*:
heat energy also moved from tropics towards poles by ocean currents;
main propelling agent for currents is wind system;
therefore important links between atmospheric and oceanic system;
convectional cells in oceans also move energy vertically and horizontally;
El Niño events transfer energy;
e.g. as warm water is pushed to other side of Pacific Ocean by wind;
gyres/oceanic conveyor belts/upwelling currents transfer heat energy;
convection currents are driven by density differences due in part to temperature differences;
salinity changes also cause density changes that drive convection currents;
high heat capacity of water means that energy transferred by currents/waves/tides may be large;
even when temperature differences are small;
Any other reasonable suggestion. ***[11 max]***

Credit should be awarded if marking points are illustrated using diagrams or sketch graphs.

(b) high energy input (heat and light) at low latitudes;
heat input at low latitudes causes convection and hence high precipitation/rainfall;
so rates of photosynthesis/productivity are very high;
so tropical rainforest is typical vegetation type in tropical regions/low latitudes;
but desert biomes occur beneath descending arm of same convection cell, because rainfall is very low and insolation very high;
so rates of photosynthesis/productivity are very low;
energy input decreases towards poles/higher latitudes;
so middle and high latitudes have lower productivity;
and temperate deciduous forest/woodland has lower productivity than tropical rainforest;
and coniferous/boreal forest is lower still;
tropical and temperate grassland have higher productivity than desert;
because they have seasonal rainfall and moderate insolation, allowing moderate rates of photosynthesis;
at very high latitudes/within Arctic and Antarctic Circles, energy input is very low;
periods of permanent darkness mean temperature and light levels are often too low for photosynthesis;
so tundra vegetation has very low productivity;
Any other reasonable answer. ***[6 max]***

Credit should be awarded if marking points illustrated using diagrams or sketch graphs.

Expression of ideas ***[3 max]***