



MARKSCHEME

May 2007

ENVIRONMENTAL SYSTEMS

Standard Level

Paper 2

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Subject Details: Environmental Systems SL Paper 2 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:

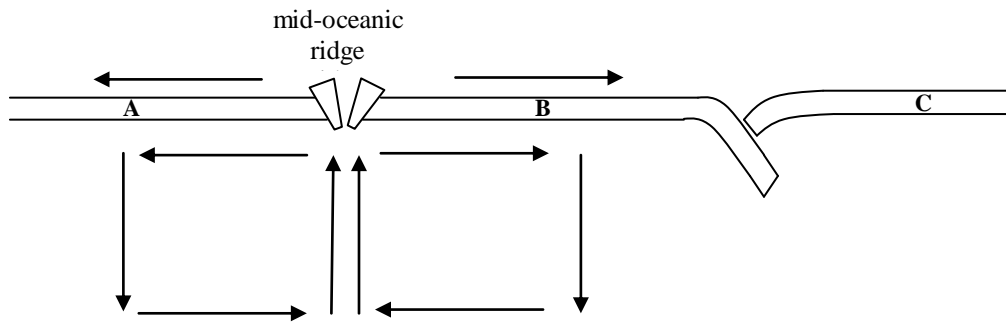
- ◆ Each marking point has a separate line and the end is signified by means of a semicolon (;).
- ◆ An alternative answer or wording is indicated in the markscheme by a “/”; either wording can be accepted.
- ◆ Words in (...) in the markscheme are not necessary to gain the mark.
- ◆ Words that are underlined 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 penalizing 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.

SECTION A

1. (a) open, due to inputs/outputs of matter/air/water (and energy); [1]
- (b) inputs would include more CO₂ than outputs;
 due to net productivity/photosynthesis; (E)
 inputs would include less O₂ than outputs;
 due to net productivity/photosynthesis; (E)
 inputs would include more liquid water than outputs;
 due to absorption by plants; (E)
 inputs would include less water vapour than outputs;
 due to evapotranspiration; (E)
 inputs would include more light energy/electricity;
 whereas outputs would include more heat energy;
 due to respiration; (E)
 due to conversion of light/electrical energy to heat; (E)
 inputs greater than outputs in early stages;
 due to growth occurring/biomass increasing; (E) [4 max]
Any other appropriate differences
 [2 max] for differences
 [2 max] for appropriate explanation. (E)
- (c) negative (feedback); [1]
- (d) (i) in energy transformations (in food chains), not all energy can be converted to a useful form / some chemical energy (in food chains) is lost as heat energy;
 so not all energy is transferred from one trophic level to the next;
 so the energy available to each successive trophic level decreases; [2 max]
- (ii) the size of the ecotone limits the size of the primary producer community;
 which limits the amount of energy that can be made available at the bottom of the food chain;
 and since there are losses at each trophic level, this limits the number of trophic levels that can be supported; [2 max]

2. (a) (i) between 80–120 yrs = $\frac{225-5}{40} = \frac{220}{40} = 5.5 \text{ t ha}^{-1} \text{ yr}^{-1}$;
allow 5.3 – 5.7 t ha⁻¹ yr⁻¹ [1]
- (ii) between 200–240 yrs = $\frac{0}{40} = 0 (\text{t ha}^{-1} \text{ yr}^{-1})$;
allow $\pm 0.1 \text{ t ha}^{-1} \text{ yr}^{-1}$
units required for values other than zero [1]
- (b) initially growth rate increases due to more favourable habitat created by pioneer species;
 low intraspecific competition for light/nutrients;
 reducing interspecific competition with alder/dryas;
 few herbivores/parasites, *etc*;
 in pioneer phase, GP substantially exceeds R because of high ratio of photosynthetic to non-photosynthetic tissue;
 towards end of period, growth rate decreases due to reaching carrying capacity;
 high intraspecific competition for light/nutrients;
 interspecific competition with hemlock;
 limited resources;
 more herbivores/parasites;
 at climax, energy inputs and outputs (GP and R) are equal so no net productivity; [2 max]
Any other reasonable points
- (c) it is likely to be an *r*-strategist;
 with a high specific growth rate;
 producing large numbers of offspring;
 with small parental investment (food store) per individual;
 all these strategies contribute to more effective dispersal; [2 max]
Any other reasonable points
- (d) conversion of gaseous/atmospheric nitrogen into nitrates/proteins / assimilation of atmospheric nitrogen;
Accept any one of the following for the second mark
 produces nitrates which are essential for plant growth/makes soil more fertile;
 when there would otherwise be few available from the bare rock / poor soils;
 water-logged/anaerobic soils (common in post-glacial conditions) favour denitrifying bacteria so tend to be low in nitrogen; [2 max]

3. (a) Award [1] for correct direction of plate movement.
Award [1] for rising magma at point of mid-oceanic ridge.
Award [1] for pair of correctly drawn convection cells.



[3]

- (b) volcanic activity at ridge releases new materials into ocean;
rising magma at ridge releases geothermal energy into ocean;
subduction of plate B transfers sedimentary material from ocean into lithosphere;
Tsunamis caused by earthquakes at plate boundaries add kinetic energy to ocean;
water incorporated into mantle at plate boundaries;

[2 max]

- (c) subduction/destructive convergence/plate B forced under plate C and incorporated into mantle;

Award [1 max] for one of the following:

- formation of deep ocean trenches;
volcanic activity leading to formation of mountains/islands;
converging land masses may lead to new combinations of species/biotic components of habitats;

[2 max]

4. (a) carbon dioxide/ CO₂;

[1]

- (b) comparison: [1 max]

acid rain emissions have been reduced by a greater percentage/more successfully than greenhouse gases;

reason: [1 max]

NO_x and SO_x can be effectively removed from fossil fuel emissions whereas CO₂ cannot (as yet);

data show percentage reduction, but if greenhouse emissions were higher in the first place then actual amounts of reduction would need to be higher to show same percentage reduction;

[2 max]

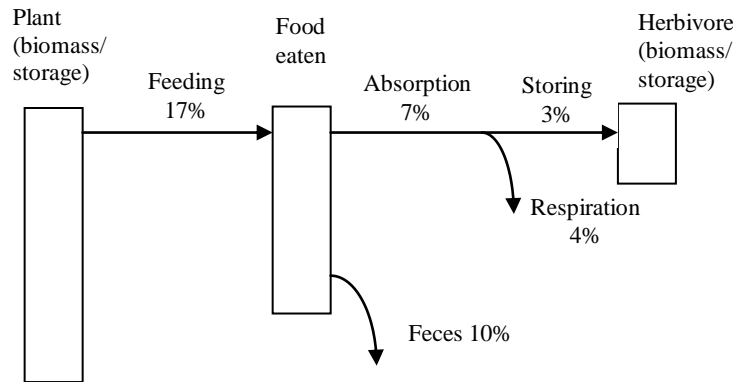
Credit should not be given for reasons affecting **both** acid rain and greenhouse gases e.g. use of alternative energy sources.

- (c) reduced use of inorganic fertilizers in agriculture;
use of scrubbers in commercial activities involving fossil fuels (mining, manufacturing, electricity supply);
use of low-sulfur coal in electricity supply;
use of low-sulfur diesel in transport;
use of catalytic converters in transport;
change to natural gas instead of oil/coal in domestic heating/electricity generation;
more efficient boilers/engines producing less NO_x ;
use of alternative/renewable/nuclear energy sources to replace fossil fuels;
legislative control of emissions;
- Any other reasonable answers related to activities shown on graph*

[2 max]

SECTION B

5. (a) *Diagrams may vary considerably but the following is an example which fully meets the marking requirements.*



*Award [1] for two correctly labelled flows, [2] for four or more.
 Award [1] for two correctly indicated values, [2] for four or more.
 Award [1] for indicating plant and herbivore storages.
 Award [1] for indicating any appropriate intermediate storages e.g. food eaten/food absorbed.
 Award [1] for clarity with which flows are shown on diagram.*

[7 max]

N.B. Respiration may be shown as a flow from herbivore biomass but do not credit feces if shown as a flow from herbivores, since it has never been part of herbivore biomass.

- (b) gross productivity for a herbivore population refers to the total biomass absorbed / food eaten – fecal waste;
 from these data it is 7 % of the original plant biomass;

sustainable yield is the amount of biomass that can be harvested without depleting the original stock / it is the amount of new biomass gained / the net productivity;
 from these data it is 3 % of the original plant biomass;

[4]

- (c) *Award up to [4 max] for verbal description.*
 As plant population increases there is more food for herbivores;
 so herbivores can reproduce more rapidly;
 as herbivore numbers increase they will deplete plant population;
 decrease in plant population will limit food for herbivores;
 leading to decrease in herbivores;
 this is an example of negative feedback;
 leading to population oscillations about a stable mean/equilibrium;
 it is also an example of a density dependent factor;

[6 max]

Award up to [2 max] for quality and content of appropriate sketch graphs (e.g. showing sinusoidal waves out of phase) or diagrams (e.g. demonstrating a negative feedback cycle).

Expression of ideas: [3 max]

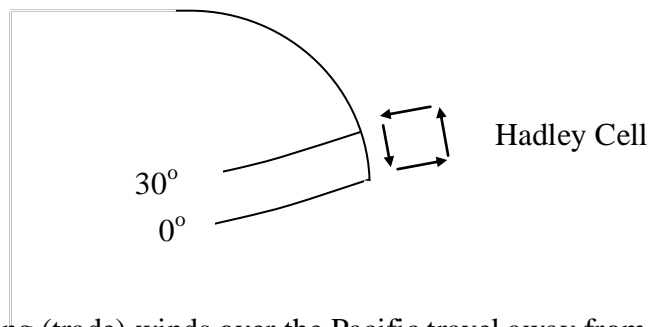
6. (a) statistics of crude birth rates and death rates / natural increase rates;
 will indicate a growth that can be extrapolated;
 age / sex pyramids;
 will provide indication as to numbers in population coming up to reproductive age;
 demographic transition models;
 will help to predict likely socio-political changes affecting growth rate;
 computer simulations using variety of trends;
 statistics regarding trends in health care;
 level of industrialization;
 economic change;
 education of women;
 import/export of resources; [6 max]
Any other reasonable points
- (b) 1950: $0.1+0.2+0.2+0.2+0.5+1.4 = 2.6$ (allow 2.3 – 2.9) billion;
 2050: $0.1+0.5+0.9+2.0+0.6+4.8 = 8.9$ (allow 8.6 – 9.2) billion;

$$\% \text{ increase} = \frac{8.9-2.6}{2.6} \times 100 = \frac{630}{2.6} = 242\% \text{ (allow 210\% – 280\% and ECF);}$$
 [3]
- (c) Europe being more industrialized favours smaller family size/Asia being more agriculturally dependent favours larger family size;
 education and resources for family planning may be significantly more limited for Asian population than Europe;
 status of women may be higher in Europe than Asia giving women more control over family planning;
 and may also mean male children are favoured in Asian populations so that numbers of children are increased to improve chance of male child;
 general education and career opportunities may be greater in Europe than Asia leading to delayed marriages and family commitments;
 aid programmes to Asia may lead to rapid reduction in death rates without parallel fall in birth rates;
 religious/political influences promoting large families / prohibiting family planning may have greater influence in a less industrialized continent like Asia;
 high infant mortalities may lead to overcompensation and birth of more children in Asia; [8 max]
Any other reasonable points that address influences leading to predicted difference in growth rates (e.g. it is not sufficient to simply state they are at different stages of development, or birth rates/death rates differ, because these are not specific influences)

Expression of ideas: [3 max]

7. (a) biomass represents natural capital and net productivity represents natural income;
tropical rainforests account for the largest proportion of natural capital;
and the second highest source of natural income;
deserts contribute very small proportions of natural capital;
deserts contribute very small proportions of natural income;
although open oceans account for very little capital;
their natural income is the highest of all;
although upwelling zones have fairly high productivity per unit area;
due to their small size they contribute the least to both natural capital and income; **[5 max]**
Any other reasonable points

- (b) *Marks may be given for following points either written as text or as a clearly drawn and correctly labelled diagram.*
the major circulation pattern at these latitudes is the Hadley cell;
at 0° warm moist air rises due to low density;
as it meets cold air above, water condenses;
leading to high precipitation in region of equator;
which leads to high productivity of tropical rainforests;
remaining warm dry air descends around 30° latitude;
lack of water limits productivity of deserts at this latitude;
Any other reasonable points
Award [1] for diagram such as follows:



[6 max]

- (c) strong (trade) winds over the Pacific travel away from Peruvian coast;
driving warm surface waters westward;
this creates an upwelling current of cool water at the coast;
which is rich in nutrients;
increasing productivity of zone;
in an El Niño event, (trade) winds are weak or reversed;
so warm surface waters travel back in eastward direction preventing the upwelling;
and reducing productivity; **[6 max]**
Any other reasonable points

Expression of ideas: [3 max]
