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

MARKSCHEME

MAY 2006

ENVIRONMENTAL SYSTEMS

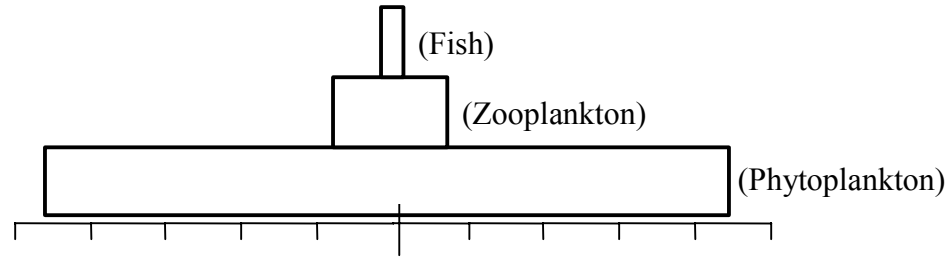
Standard Level

Paper 2

14 pages

1. (a) fish feeding on other species beside zooplankton;
seasonal decline in zooplankton;
decline in zooplankton due to unusual conditions;
zooplankton having higher rate of productivity than fish;
temporary immigration of fish;
fish feeding in other ecosystems; ***[2 max]***

(b) fish productivity $(= 2.2 \times 3.40) = 7.48$ g $m^{-2} yr^{-1}$;
zooplankton productivity $(= 14.0 \times 2.25) = 31.5$ g m^{-2} yr^{-1};
phytoplankton productivity $(= 60.0 \times 3.75) = 225$ g m^{-2} yr^{-1};
*Award **[1]** for two correct values, or **[2]** for all three correct values.*



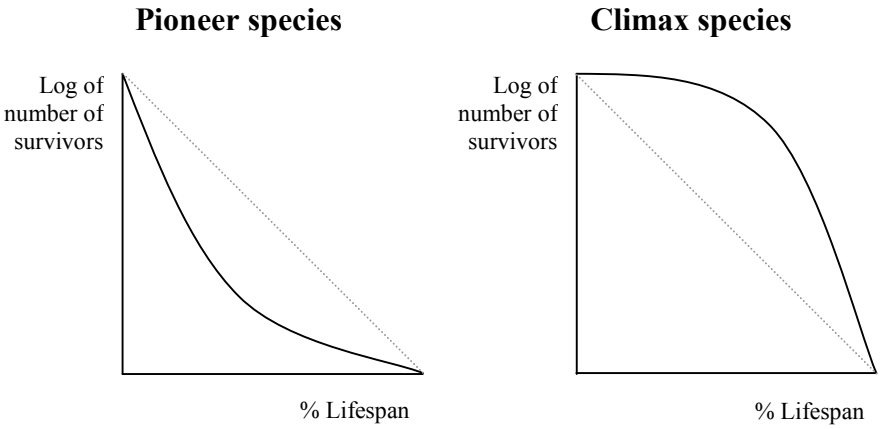
[3 max]
Diagram of the three bars plotted showing conventional pyramid shape as above;

(c) natural capital: 3.4 g m^{-2} / (at end of year 3.4 + 7.48) 10.88 g m^{-2};
natural income: 7.48 g m^{-2} yr^{-1}; ***[2]***
Allow error carried forward (ECF) from 1(b)

(d) ***Either***
food eaten;
fecal waste;
or
increase in biomass/NPP;
respiratory loss; ***[2]***
*Award **[1 max]** if one from each list given.*

2. (a) *Award **[1]** for every two correct responses*:
pioneer species I: positive;
pioneer species II: positive;
climax species III: positive;
climax species IV: negative; ***[2]***

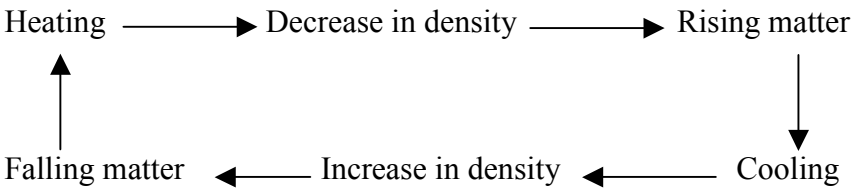
(b) *Award **[1]** for each curve drawn approximating to the shape below, in relation to dashed line. This dashed line is only included as a guide and is not required for award of the mark.*



[2]

(c) (pioneer species are usually r-strategists and climax species are usually k-strategists)
pioneer species are likely to have higher (specific) growth rate / climax species are likely to have lower (specific) growth rate;
pioneer species are likely to invest less in parental care / climax species are likely to show greater investment in parental care;
pioneer species are likely to have competitive advantage in the short term (while the environment is unmodified) / climax species are likely to have long term competitive advantage (achieving the carrying capacity of the modified environment); ***[3]***

3. (a) *Award **[2]** if all six are in correct sequence.*
*Award **[1 max]** if diagram shows sequence of temperature change → density change → movement, but only density changes or direction of movement are incorrect.*



[2]

(b) convection cells cause plates to move over the planet;
this causes the shifting of habitats to new latitudes / new climatic conditions;
and the separation of gene pools;
convection cells also give rise to volcanic activity;
which generates new habitats *e.g.* islands/mountains;
all of which contributes to the evolution of new species which increases biodiversity;
some plate movements *e.g.* those to more extreme latitudes / collisions between plates bring new competitors;
may lead to extinctions which reduce biodiversity;

Accept other reasonable suggestions. ***[4 max]***

4. (a) transformation: condensation/vapour changes to liquid/other phrase implying change of state;
transfer: precipitation/rain/other phrase implying change of location; ***[2]***

(b) *Identified flows could include*
flow D – evaporation;
flow A – evapotranspiration/evaporation from plants/transpiration;
flow B – uptake of water;
[2 max]

Explanations
increase in CO_2 which is a greenhouse gas;
could lead to increase in global temperatures;
flows D and A are directly temperature-dependent so will increase;
flows B will increase due to increase in evapotranspiration/photosynthesis; ***[4]***
If candidates make a good case for any other flows, credit should be allowed.
[2max]

(c) sulfur oxides (with water) may cause acid deposition/rain;
acid in soils/low pH will cause release of minerals;
e.g. aluminium/lead/calcium/magnesium ions;
which will leach from soil;
be taken up at faster rates by plants;
sulfur levels increase in soil; ***[2 max]***

5. (a) *Award **[2 max]** for comparisons and calculations of % growth*

$$\text{Ethiopia} = \frac{170\ 987 - 65\ 590}{65\ 590} \times 100 = 161\%$$ *(allow 160% to 161%)*;

$$\text{Austria} = \frac{7\ 376 - 8\ 102}{8\ 102} \times 100 = -9\%$$ (negative value) *(allow –8% to –9%);*

Ethiopia shows a high/positive growth rate whereas Austria shows a low/negative growth rate;

*Award **[2 max]** for differences in pyramids (shown in diagram or described in words)*

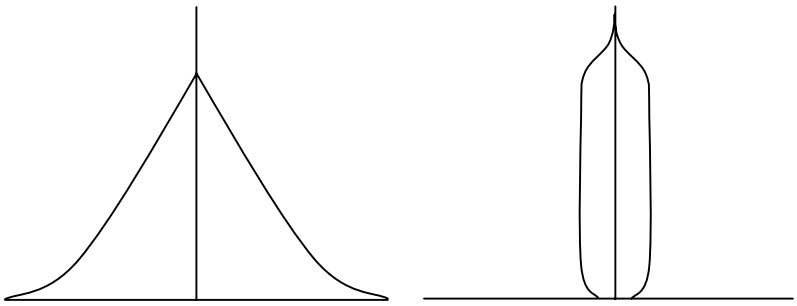
Ethiopian pyramid is shorter than Austrian pyramid (because of higher life expectancy in Austria);

Ethiopian pyramid is triangular and Austrian pyramid is parallel-sided;

Ethiopian pyramid widens towards base but Austrian pyramid becomes narrower at base;

Larger overall area for Ethiopian pyramid / smaller overall area for Austrian pyramid.

Ethiopia **Austria**



*Award **[2 max]** for position in demographic transition model (shown on diagram or described in words)*

Ethiopia likely to be in stage 2 (or 3) Ethiopia is at an early stage where death rates are falling below birth rates;

whereas Austria likely to be at the end of stage 4 (or in a possible stage 5) / Austria is at a very late stage with birth rates falling below death rates; ***[7 max]***

*Award **[1 mark]** for clear and appropriate sketches of pyramids and/or demographic transition model.*

(b) *Award **[3 max]** for each population:*
*Ethiopia: (factors should account for the relatively **high** growth rate)*
Population largely rural/dependent on agriculture which provides incentive for large families leading to high birth rates;
overseas aid may improve health/diet leading to reduced death rates;
poor education/cultural values may limit use of birth control leading to high birth rates;
high infant mortality may encourage families to have more children to compensate, leading to high birth rates;
Any other appropriate point.

Austria: *(factors should account for the relatively **low** growth rate)*
policies that provide greater independence/education for women may lead to lower birth rate;
competitive/expensive urban lifestyles may provide disincentive for having many dependent offspring, leading to lower birth rate;
government policies may provide disincentives for large families by taxation/benefits leading to reduced birth rates;
education regarding/availability of birth control methods may lead to reduced birth rates; ***[6 max]***
Any other appropriate point.
*Factors should not just be stated without explanation of how they lead to the predicted change in the populations. For responses that lack explanation, award **[1]** per two factors but **[2 max]**.*

(c) *Allow **[2 max]** for named examples and **[2 max]** for describing impacts of urbanization.*
decomposer communities providing natural waste assimilation/decomposition;
impact: urbanization may lead to overload of local natural systems of waste assimilation;

vegetation providing flood/erosion control;
impact: urbanization may lead to loss of vegetation and increased run-off.

photosynthesis maintaining balance in CO_2 concentration;
impact: deforestation/increased use of fossil fuels associated with urbanization may limit/overload the system;

hydrological cycle replenishing freshwater supplies;
impact: concentration of population in urban areas may lead to depletion/contamination of local freshwater supplies. ***[4 max]***
Any other appropriate example with associated impact of urbanization.
*Example must be a resource of **ecological** value (**not** economic).*

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

6. (a) *Note: marks are awarded for BOTH "explanations of differences" AND their "links to climatic differences".*

Biomass
Explanation: biomass is greater in tropical forest due to optimum conditions for photosynthesis / lower in temperate forest due to limiting conditions for photosynthesis;
Link: optimum conditions in tropical forest provided by higher precipitation, insolation and temperatures / conditions limited in temperate forest by low temperatures;

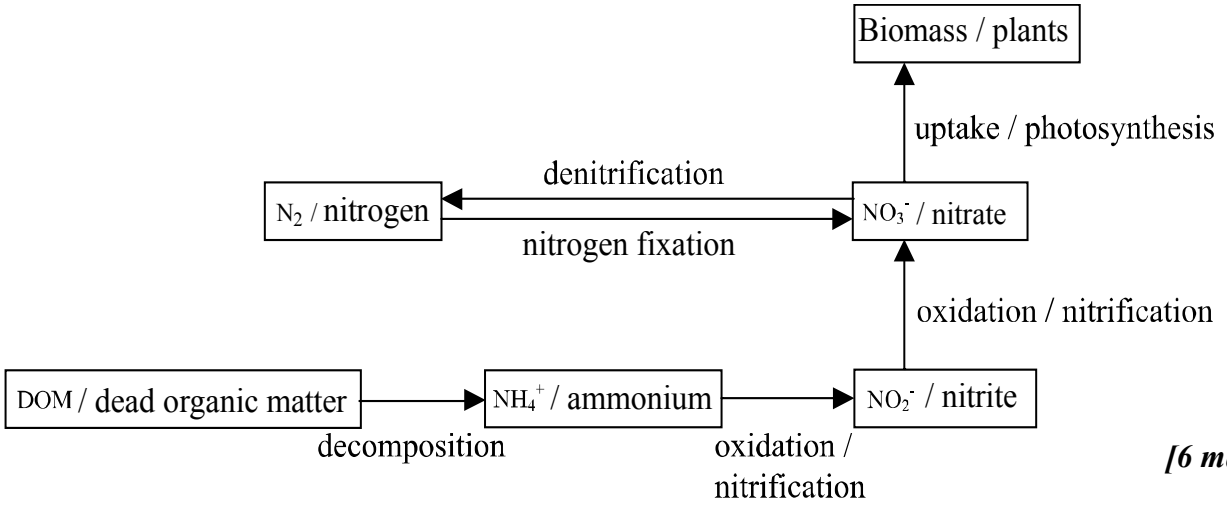
Dead Organic Matter
Explanation: dead organic matter (DOM) is less in tropical forest due to higher rates of decomposition / more in temperate forest due to lower rates of decomposition;
Link: climate provides higher temperatures in tropics which increases rate of decomposition / lower temperatures in temperate forests decreases rate of decomposition;

Explanation: DOM also greater in temperate forest due to deciduous leaf-fall / less in tropical forest because of evergreen vegetation;
Link: greater leaf fall in temperate forests linked to more seasonal variation in climate (winters) / relatively non-seasonal climate variations in tropical forest makes leaf-fall unnecessary;

Soil
Explanation: nutrient storages in soil are smaller in tropical forest due to faster uptake by plants due to their higher photosynthetic rates / larger in temperate forest due to lower photosynthetic rates;
Link: higher rates of photosynthesis in tropical forest related to optimum climatic conditions / and limited conditions in temperate forests;
Link: higher evapotranspiration rates in tropical forest reduce soil nutrient through plant uptake / lower rates of evapotranspiration in temperate forests reduces plant uptake so storages increases soil nutrients;
Link: evapotranspiration is affected by high temperatures in tropical forest / lower in temperate forests; ***[7 max]***
Any other relevant explanations or links should be credited.

(b) temperate forest is in a steady state equilibrium;
because inputs to each storage are balanced by outputs;
tropical forest is not in steady state equilibrium / might be in a dynamic equilibrium;
because inputs and outputs to each storage are not balanced;
e.g. biomass is increasing; ***[4]***
Marks should only be awarded for addressing the information in the diagrams and details regarding the ecology of the systems should ***not*** *be credited here.*

(c) *Award **[1]** for three correct storages, or **[2]** if five or more are correct.*
*Award **[1]** for three correct arrows, or **[2]** if five or more are correct.*
*Award **[1]** for three correct flow labels, or **[2]** if five or more are correct.*



[6 max]

Award credit for other appropriate arrangements of the diagram.

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

7. (a) Overall, *Phaeocytis* (P) has lower maximum growth rate than *Cheatoceros* (C) / C has higher max growth rate than P;

- P shows (0.3-0.22 =) 0.08 divisions day^{-1} less / C shows 0.08 divisions day^{-1} more;
- P shows $\left(\frac{0.3-0.22}{0.3}\times 100=\right)27\%$ lower rate / C shows $\left(\frac{0.3-0.22}{0.22}\times 100=\right)36\%$ higher rate;
- in both cases UVB has caused decrease in growth rate / UVB filter has allowed increase in growth rate;
- P shows $\left(\frac{0.22-0.12}{0.22}\times 100=\right)45\%$ reduction due to UVB / $\left(\frac{0.22-0.12}{0.12}\times 100\right)83\%$ increase with UVB filter;
- C shows $\left(\frac{0.30-0.27}{0.30}\times 100=\right)10\%$ reduction due to UVB / $\left(\frac{0.30-0.27}{0.27}\times 100=\right)11\%$ increase with UVB filter;
- Growth rate in P reduced by 0.1 cell divisions day^{-1} in UVB / increased by 0.1 divisions day^{-1} with UVB filter;
- Growth rate in C reduced by 0.03 cell divisions day^{-1} in UVB / increased by 0.03 with UVB filter;
- P is more sensitive to UVB than C / C is less sensitive to UVB than P; ***[5 max]***

Credit any other valid comparisons regarding growth rate.

(b) *Allow **[4 max]** for impacts on Antarctic marine ecosystem.*
reduced ozone will lead to greater penetration of UVB radiation;
this will cause higher mutation rates / inhibit growth in phytoplankton;
they are the major primary producers of system so less food available for whole food web;
top carnivores will be most at risk, possibly leading to loss of species;
species of phytoplankton more tolerant of UVB will outcompete/displace other species;
likely to cause a general reduction in species diversity for the system, thereby reducing stability;
increased mutation could accelerate evolution/adaptation and lead to increased population growth;

*Allow **[3 max]** for impacts on wider environment*.
plankton provide biggest proportion of global productivity;
act as significant carbon sink, reducing global warming;
many organisms of other ecosystems obtain food from marine systems;
loss of biodiversity represents loss of human resources/loss of global stability; ***[7 max]***
Any other appropriate point.

(c) *Names of agreements not required, but can be credited **[1 max]** e.g.*
Vienna Convention;
Montreal Protocol;
London Amendment;

Successes:
reduced production of many ozone-depleting gases in western countries;
retail of ozone depleting products has reduced;
some evidence ozone hole over Antarctic is decreasing;

Limitations:
some evidence of black market sales to developing countries;
some countries (*e.g.* China) still producing large quantities;
ozone depleting gases have long half-life;
and continue depleting ozone cyclically;
international agreements must be followed by ratification which does not always happen;
even ratified agreements not always implemented;
difficulty in reducing already existing CFCs; ***[5 max]***

*If either successes or limitations are not addressed award up to **[3 max]**.*

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