Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2023

Environmental systems and societies

Standard level

Paper 2

18 pages

Subject details: Environmental systems and societies SLP2 Markscheme

Mark allocation

Candidates are required to answer:
- **ALL** questions in Section A **[25]** and **TWO** questions in Section B **[40]**.
- The maximum total = **[65]**.

1. Environmental systems and societies uses marking points and markbands to determine the achievement of candidates

When using marking points (<u>All of this paper except</u> Section B, part (c) questions):

i. A markscheme often has more marking points than the total allows. This is intentional
ii. Each marking point has a separate line and the end is shown by means of a semi-colon (;)
iii. Where a mark is awarded, a tick/check (✓) **must** be placed in the text at the **<u>precise point</u>** where it becomes clear that the candidate deserves the mark. **<u>One tick to be shown for each mark awarded</u>**
iv. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

When using markbands (<u>Only</u> for Section B, part (c) questions):

i. Read the response and determine which band the response fits into
ii. Then re-read the response to determine where the response fits within the band
iii. Annotate the response to indicate your reasoning behind the awarding of the mark
Do not use ticks at this point
iv. Decide on a mark for the response
v. At the end of the response place the required number of ticks to enable RM Assessor to input the correct number of marks for the response.

2. An alternative answer or wording is indicated in the markscheme by a slash (/). Either wording can be accepted.

3. Words in brackets ( ) in the markscheme are not necessary to gain the mark.

4. Words that are <u>underlined</u> are essential for the mark.

5. 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 **OWTTE** (or words to that effect).

6. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

7. 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. When marking, indicate this by adding **ECF** (error carried forward) on the script.

8. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the markscheme.

Section A

1. (a) State the category with the highest percentage of vulnerable species in **Figure 1(a)**. **[1]**

Coral (reef-forming);

(b) Outline **two** reasons why Amphibians have the highest percentage of critically endangered species in **Figure 1(a).** **[2]**

a. They require both aquatic and terrestrial habitats/specialised niches so more likely to be affected by habitat loss/limitations;
b. They have permeable/soft skin more vulnerable to disease/UV/pollution;
c. Few amphibians have great public/charismatic appeal attracting protection/conservation efforts;
d. They generally have very limited parental care so offspring more vulnerable/high mortality rates in offspring;
e. They often depend on small bodies of water that are particularly vulnerable to drought/global warming/human development of wetlands;

Note: *Only credit marks that are explicitly related to the vulnerability of amphibians. General factors such as habitat destruction, hunting or climate change alone are TV.*

(c) Using **Figure 1(a)**, state the approximate percentage of threatened crustaceans. **[1]**

28;

Note: *Accept 26–29*

(d) Describe **one** reason for the lack of available data for crustaceans. **[1]**

a. They are mobile species/some have large habitat range;
b. Lack of expertise in identifying species (exacerbated by multiple immature stages in life cycle);
c. The oceans are vast and difficult/expensive to do research in;
d. Many species camouflage with their surroundings / difficult species to capture and tag;
e. Some species inhabit inaccessible regions;
f. Sea-floors beneath ice-sheets round Antarctica have been little explored.

(e) Outline **three** reasons why the trend for corals is different to other categories shown in **Figure 1(b)**. **[3]**

corals …
a. are sedentary/cannot migrate (to avoid pollution or other risks);
b. are r-selected species so high mortality rates (in planktonic phase);
c. (have delicate symbiotic relationship) highly sensitive to small changes in abiotic conditions;
d. are impacted worldwide through ocean acidification (causing bleaching);
e. are impacted worldwide by global warming/climate change /warmer waters (causing bleaching);
f. inhabit areas with high human polluting activity such as urban waste/agricultural run-off/oil spills/aquaculture;
g. have value as souvenirs/trophy/collectors' items;
h. are fragile/easily damaged unintentionally (by boats/nets/storms etc);
i. have very slow growth rates (in sedentary phase);
j. have limited ranges/ocean depths/habitats where they can live;

Credit any response that is consistent with the increasing trend of extinction in corals.
*Do **not** credit "pollution" alone there must be reference to a relevant source of pollutant as in MPf*

(f) **Figures 1(a)** and **1(b)** are based on records for species diversity. Identify **one** other factor that may be measured to assess the diversity of life on Earth. **[1]**

a. genetic diversity;
b. habitat diversity;

*Do **not** accept "evenness/equitability" or "richness" they are already included within concept of species diversity*

2. (a) Describe the overall trend shown in the recorded annually averaged data in **Figure 2**. **[2]**

a. ozone initially declined;
b. ozone stabilized / began to increase slightly;

Note: *do not credit descriptions of the projected values.*
Allow 1 mark for overall decline
Precise dates are not necessary for credit (i.e. accept change occurring around 2000).

(b) State **one** chemical responsible for the trend in the recorded annually averaged data between 1980 and 1990 shown in **Figure 2**. **[1]**

halons/CFCs/HCFCsHBFCs/N_2O/methyl bromide/methyl chloroform/carbon tetrachloride/ chlorine/bromine:

Note: *do* ***not*** *credit HFCs/ODSs*

(c) Outline **one** impact of low concentrations of stratospheric ozone on humans. **[1]**

a. cell damage/premature aging of skin / skin cancer;
b. cataracts / eye damage;
c. immune system suppression;

(d) Identify the year that stratospheric ozone is predicted to return to 1980 levels in **Figure 2**. **[1]**

Accept any year in range 2041-2043;

(e) Describe **two** reasons for the projected change in ozone levels after 2020 in **Figure 2**. **[2]**

a. Montreal Protocol resulted in unprecedented international cooperation to address loss of ozone (and its influence still continues);
b. banned use of CFCs/ phasing out of CFCs/ ozone depleting substances /refrigerants/aerosols/recycling of refrigerants;
c. alternatives to CFCs (HFCs/HCFCs) were developed reducing harm to ozone;
d. education/awareness campaigns led to changes in consumer preferences;
e. ozone reforms due to natural reversible chemical reactions/processes / ODSs eventually begin to break down/dissipate;

(f) Outline **one** factor that may affect the reliability of the model projections in **Figure 2**. **[1]**

a. oversimplification that does not take into account full range of factors;
b. hard to predict consumer/government/industry behaviour;
c. production and release of new ozone depleting substances;
d. countries not following the Montreal Protocol / black market ODSs;
e. difficult to obtain accurate data;

3. (a) State **one** storage of fresh water not shown in **Figure 3**. **[1]**

Lakes/rivers/glaciers/groundwater/aquifers/reservoirs/organisms other than plants;

(b) State **one** input of water into the atmosphere not shown in **Figure 3**. **[1]**

Evaporation (from inland waters/oceans/soil) / sublimation / water vapour from respiration/combustion;

(c) Describe the positive feedback mechanism by which deforestation may decrease the availability of water in certain regions. **[2]**

Fewer trees -> more runoff;
->Less infiltration into soil -> less water for trees -> fewer trees;

OR

More runoff -> Less infiltration to soils;
->Less uptake by trees -> more runoff;

OR

Deforestation -> decreased evapotranspiration;
->Decreased precipitation -> declining tree population;

Credit valid responses in form of full sentences or accurate diagrams. 1 max if positive feedback loop is incomplete.

(d) Evaluate the role of reforestation in the mitigation of climate change. **[4]**

Pros:

a. more trees absorb more CO_2 so reduce global warming;
b. reforestation simultaneously increases biodiversity;
c. requires minimal technology/labour/expense;
d. forests are naturally renewable carbon sink/indefinite lifetime;
e. reforestation requires minimal ongoing maintenance;
f. regulating local weather /decreasing extreme weather patterns;
g. protects against run-off/soil erosion/desertification;
h. it increases evapotranspiration which may increase cloud cover increasing albedo/mitigating warming

Cons:

a. it increases evapotranspiration so more water vapour/greenhouse gases/warming;
b. more trees reduce reflected heat into atmosphere/absorb more heat so increase warming;
c. it reduces land availability for agriculture/urban growth;
d. it is not feasible in all locations/habitats;
e. it requires large areas to make a significant difference;
f. can be an expensive/unpopular solution;
g. can take a long time/period of growth before it has significant impact on CO_2;

Award [3] max if only pros or only cons are given.
Pro MPh and Con MPa may contradict one another but both are valid hypotheses and deserve credit
*Do **not** credit vague responses like "improves air quality" or "reduces air pollutants"*

Section B

4. (a) Outline the transfers and transformations of matter as it enters and flows through the first trophic level of a food chain. **[4]**

Transfers: [3 max]
a. Carbon dioxide diffuses into leaves;
b. Nitrates/phosphates/(inorganic) minerals diffuse/actively transported into roots;
c. Water is taken up/diffuses into roots;
d. Sugars translocated from leaves to other parts of the plant;
e. Water vapour/oxygen diffuses out of leaves;
f. Organic matter is transferred to next trophic level/decomposers through feeding

Transformations: [3 max]
a. Conversion of carbon dioxide/water into organic matter/glucose/oxygen in photosynthesis;
b. Conversion of some organic matter into inorganic matter/CO2/water through respiration;
c. Conversion of glucose to other organic compounds in metabolism;
d. Water evaporates through leaves in transpiration;
e. Conversion of organic matter to inorganic matter through decomposition

Only credit transfers/transformations referring to matter (not energy).

(b) Describe how the emissions from the combustion of fossil fuels may impact the productivity of terrestrial ecosystems. **[7]**

a. CO_2/greenhouse gas emissions lead to increasing global/atmospheric temperatures;
b. Increased temps may cause increase in rate of photosynthesis/increased productivity;
c. …or may cause evaporation of water/desertification/drought;
d. ...extreme temperatures could result in enzyme denaturation/decreasing productivity;
e. CO_2 emissions may increase rate of photosynthesis increasing productivity;
f. Extreme weather events from CO_2 concentration/global warming resulting in droughts/floods/saline inundation/forest fires;
g. NO_x may cause depletion of stratospheric ozone and increased exposure to UV radiation;
h. …which will damage plants & reduce primary productivity;
i. NO_x/hydrocarbons may cause photochemical smog that damages plants/reduces primary productivity;
j. NO_x/hydrocarbons may produce tropospheric ozone further increasing atmospheric temperatures;
k. NOx/SOx are sources of acid deposition that can alter soil pH/damage plants reducing productivity;
l. …also causing the leaching of soil nutrients which reduces productivity;
m. …or causing the release of toxic metal ions that damage plants, reducing productivity;
n. ...reduction in primary productivity is likely to cause loss of secondary productivity;

Accept other reasonable responses linked to productivity of ecosystem.

(c) With reference to named societies, to what extent do the environmental impacts of energy resources influence their choice of energy? **[9]**

The following guide for using the markbands suggests certain features that may be offered in responses. The five headings coincide with the criteria in each of the markbands (although ESS terminology has been conflated with "understanding concepts"). This guide simply provides some possible inclusions and should not be seen as requisite or comprehensive. It outlines the kind of elements to look for when deciding on the appropriate markband and the specific mark within that band.

Answers may demonstrate:

- **understanding concepts & terminology** of renewable/non-renewable energies; wind; solar; hydro; geothermal; fossil fuels; global warming/climate change; acid deposition; ozone depletion; photochemical smog; oil spills; political/economic/geographic factors affecting energy choice; energy security etc
- **breadth in addressing and linking** energy choices of a range of different countries in different locations to environmental impacts and other factors.
- **examples** of named energy sources, and countries energy choices, and environmental impacts; and other influences etc
- **balanced analysis evaluating** extent to which energy choice is determined more by environmental impact than any other influence.
- **a conclusion that is consistent with, and supported by analysis and examples given** *e.g. Although countries are becoming more concerned with regard to environmental impact, while MEDCs may afford environmentally friendly choices, the need in LEDCs to adopt economic solutions tends to be an over-riding factor in energy choices.*

Please see markbands on page 18.

Note: Reward giving specific examples: e.g. UK, Netherlands, France, Scandinavia are leaders in relatively expensive (to install) wind power.

5. (a) With reference to **four** named agricultural strategies, outline how they improve the sustainable use of soils. **[4]**

a. Using organic fertilisers maintains the presence of a decomposer community/humus in soils;
b. Crop rotation/strip cropping prevents the excessive loss of particular nutrients from the soil;
c. Cover crops to replace nutrients/reduce desertification/soil erosion/loss of water from soils;
d. Drip irrigation prevents excessive leaching of nutrients/water loss through evaporation/salinization of soils;
e. Terracing/contour ploughing prevents water erosion/run-off of soils on slopes;
f. No-till farming reduces soil erosion/nutrient loss;
g. Windbreaks prevent wind erosion/loss of soils by winds;
h. Biological pest control avoids pesticide use that can toxify soils/kill non-target species.
i. Manually pull weeds/mulch/use ground cover instead of using herbicides to avoid killing non-target species/toxify soils;
j. Using crops that are tolerant to the climate (local/GMO) to minimize soil damage from irrigation;
k. Rotate pastures for livestock to avoid nutrient loss/soil compaction from overgrazing;

(b) Explain how the process of succession leads to changes in productivity. **[7]**

General:
a. GPP continues to increase throughout the successional stages due to increasing nutrient cycling / improved soil fertility/nutrients leads to greater productivity;
b. NP as a proportion of GP decreases throughout the stages due to increasing respiration from consumers/decomposers;

In primary succession/pioneer community:
c. Abiotic conditions are poor/nutrient levels are low so GPP is low;
d. NP of the community is high/NP as a proportion of the GP is high due to low consumption/respiration;

In intermediate stages:
e. Secondary productivity increases as consumers join food chain;
f. NP/increase in biomass of entire community slows due to consumption of GPP/increased respiratory losses by consumers;

In climax community/final stages
g. Secondary productivity is at maximum as food chains are fully developed;
h. GPP is at maximum due to plant communities reaching carrying capacity;
i. No NP/biomass gains for community as a whole as all PP being consumed/lost to respiration;

(c) With reference to named examples, compare and contrast wild fisheries and aquaculture systems in terms of their efficiency and environmental impacts. **[9]**

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Answers may demonstrate:

- **understanding concepts & terminology** of aquaculture and wild fisheries; monoculture/polyculture; genetically modified organisms; genetic diversity; harvesting efficiency; use of fertilisers/pesticides/antibiotics; genetic degradation through escapees; waste & eutrophication; overfishing; bycatch; etc
- **breadth in addressing and linking** wild fisheries and aquaculture systems with a range of potential impacts on the environment and issues of efficiency.
- **examples** of wild fisheries and aquaculture systems along with examples of associated impacts.
- **balanced analysis evaluating** the relative efficiency and overall environmental impact of wild fisheries versus aquaculture systems.
- **a conclusion that is consistent with, and supported by analysis and examples given** *e.g. When aquaculture is practised at a subsistence rather than commercial level it can be very efficient and have minimum environmental impact, but commercial aquaculture has many environmental impacts probably making it less sustainable than many wild fisheries.*

Please see markbands on page 18.

6. (a) A new parasite is introduced into an ecosystem and manages to infect a host species. Outline how the host and parasite species may reach an equilibrium over time. **[4]**

a. The parasite species may grow slowly to begin with because there are only a few of them to reproduce;
b. They will then grow at an increasing/exponential rate as the numbers reproducing increase;
c. Eventually they may begin to cause a fall in the number of hosts;
d. This will cause a subsequent decline in the number of parasite species;
e. This in turn will allow the host species to recover;
f. This reciprocal/cyclical fluctuation may continue indefinitely;
g. Achieving a negative feedback mechanism/dynamic equilibrium;
h. hosts that are best able to tolerate the parasite are the most likely to survive/reproduce/increase in numbers;
i. parasites that kill their hosts often struggle to reproduce as efficiently, so the milder versions might be more likely to survive/reproduce/increase in numbers;
j. -which in means over time parasites are less deadly and hosts are less affected;

(b) Explain how tectonic plate activity may lead to the formation of new species. **[7]**

a. Volcanic activity may give rise to new habitats eg mountains/islands;
b. Continental drift may bring populations into new climates;
c. Populations may get divided by geographical barriers/uplift of mountains/plates separating;
d. Different parts of the population may find themselves in new habitats/climates;
e. There may be a variety of traits/genetic diversity in the population;
f. Some features/genetic traits may be more adapted/fit for the new habitat/climate/subject to natural selection;
g. Individuals with these adaptive traits will be most likely to survive;
h. These survivors will pass the adaptive features on to their offspring;
i. Over time further adaptations may give rise to a population that is unable to interbreed with original species;
j. Once the populations are unable to interbreed a new species has been formed

(c) Justify the role of different environmental value systems (EVSs) in deciding between in situ and ex situ conservation strategies. **[9]**

The following guide for using the markbands suggests certain features that may be offered in responses. The five headings coincide with the criteria in each of the markbands (although ESS terminology has been conflated with "understanding concepts"). This guide simply provides some possible inclusions and should not be seen as requisite or comprehensive. It outlines the kind of elements to look for when deciding on the appropriate markband and the specific mark within that band.

Answers may demonstrate:

- **understanding concepts & terminology** of ex situ/in situ conservation; ecocentric/anthropocentric and technocentric value systems; biorights; intrinsic value; deep ecology; cornucopian values; stewardship; keystone species; flagship species; reserves; zoos; breeding/re-introduction programmes; gene banks; etc
- **breadth in addressing and linking** a range of in situ/ex situ conservation strategies with different value systems/perspectives on the nature of living things/species.
- **examples** of different value systems; different perspectives on living things and different in situ & ex situ conservation strategies.
- **balanced analysis** evaluating the relative merits and demerits of different value systems and their perspectives on in situ v ex situ conservation.
- **a conclusion that is consistent with, and supported by analysis and examples given** *e.g. While ecocentrics are more likely to value the hands-off approach possible with in situ conservation there are certain cases where a natural habitat is so degraded the only way forward for conserving a given species is the more technocentric ex situ conservation.*

Please see markbands on page 18.

7. (a) Outline how the ecological footprint (EF) of a human population is likely to change through the stages of the demographic transition model (DTM). **[4]**

a. EF is likely to start off very small because of low population;
b. Footprint will be low because of subsistence food production/hunter/gathering;
c. It will then increase with increasing numbers/consumption/development of agriculture;
d. With industrialisation/commercialisation footprint is likely to increase with heavy use of fossil fuels;
e. Development of technology for alternative energy resources may reduce footprint;
f. Technological development in food production/transport may come to reduce footprint;
g. Reduced population growth/declining populations in MEDCs may tend to reduce overall footprint;
h. However, if greater consumerism/materialism/economic growth is still pursued footprint may continue to increase / per capita footprint increases can negate effects of decreased population;

(b) A wild population of fish may provide a sustainable resource for human consumption. Describe practical procedures for estimating the maximum sustainable yield from such a resource. **[7]**

a. Maximum sustainable yield is the greatest amount of harvest that can be taken without reducing potential for further growth of fish population;
b. To measure its MSY one needs to measure net productivity/natural income;
c. Measuring annual change/increase in population size/biomass;
d. Population would need estimating at start and again after end of year/given time period;
e. Population can be measured using mark/release/recapture / Lincoln index;
f. A sample is caught using traps/nets and marked;
g. Trap/mesh size should be selected to only catch adult individuals;
h. They are released and given time to mix with whole population;
i. Traps are re-set/second sample is caught to identify proportion marked;
j. Total population is estimated using equation: $n_1 \times n_2 / n_m$ (number in 1st sample x number in 2nd sample / total marked in 2nd sample);
k. Difference in population (divided by given time) is the net productivity/natural income/MSY.

Note: *Credit can be given if equivalent procedures to measure change in biomass rather than population size are described.*

(c) To what extent do different strategies for the management of solid domestic waste (SDW) influence the sustainability of human populations? **[9]**

The following guide for using the markbands suggests certain features that may be offered in responses. The five headings coincide with the criteria in each of the markbands (although ESS terminology has been conflated with "understanding concepts"). This guide simply provides some possible inclusions and should not be seen as requisite or comprehensive. It outlines the kind of elements to look for when deciding on the appropriate markband and the specific mark within that band.

Answers may demonstrate:

- **understanding concepts & terminology** of sustainability; managing solid domestic waste; recycling; reuse; reduction in consumption; landfills; incineration; waste for energy; import/export of waste; leaching of toxins; greenhouse gases; zero waste; etc
- **breadth in addressing and linking** the pros and cons of a range of waste management strategies with their specific implications for sustainability.
- **examples** of specific waste management strategies adopted by named communities/locations and their impacts on sustainability.
- **balanced analysis of the extent** to which the waste management strategy is increasing or decreasing the sustaiability of a society.
- **a conclusion that is consistent with, and supported by analysis and examples given** *e.g. The most significant of all the strategies is reduction in the initial consumption of resources which is directly leads to greater sustainability. All the others, even recycling, involve some consumption of energy or production of pollution that is unsustainable.*

Please see markbands on page 18.

Section B, part (c) markbands

Marks	Level descriptor
0	The response does not reach a standard described by the descriptors below and is not relevant to the question.
1–3	The response contains: • minimal evidence of knowledge and understanding of ESS issues or concepts • fragmented knowledge statements poorly linked to the context of the question • some appropriate use of ESS terminology • no examples where required, or examples with insufficient explanation/relevance • superficial analysis that amounts to no more than a list of facts/ideas • judgments/conclusions that are vague or not supported by evidence/argument.
4–6	The response contains: • some evidence of sound knowledge and understanding of ESS issues and concepts • knowledge statements effectively linked to the context of the question • largely appropriate use of ESS terminology • some use of relevant examples where required, but with limited explanation • clear analysis that shows a degree of balance • some clear judgments/conclusions, supported by limited evidence/arguments.
7–9	The response contains: • substantial evidence of sound knowledge and understanding of ESS issues and concepts • a wide breadth of knowledge statements effectively linked with each other, and to the context of the question • consistently appropriate and precise use of ESS terminology • effective use of pertinent, well-explained examples, where required, showing some originality • thorough, well-balanced, insightful analysis • explicit judgments/conclusions that are well-supported by evidence/arguments and that include some critical reflection.