Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

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Environmental systems and societies

Standard level

Paper 2

19 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 **WTTE** (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) Using **Figure 1(a)**, identify the amount of municipal solid domestic waste generated per capita in Canada. **[1]**

900 (kg/yr);

Note to examiners*: units required for mark*

(b) Outline two strategies that Canada's government could use to reduce the country's per capita waste production. **[2]**

a. Campaigns to educate the public on the reduction/impacts of waste/benefits of recycling/composting;
b. Pass laws to require less material used in packaging/reusing materials / ban single use plastics;
c. Increase taxes on waste production/disposal;
d. Improve/implement/subsidize recycling schemes/facilities/composting;

(c) (i) Describe the trend shown in the use of landfills as income level increases in **Figure 1(b)**. **[2]**

a. As income level increases from low to lower-middle/upper-middle the use of landfills increases;
b. From upper-middle to high the use of landfills decreases;

Note to examiners*: accept a general increasing trend for one mark but must identify the decrease from upper-middle to high for both;*

(c) (ii) Suggest two reasons for the pattern in the use of landfills as income level increases in **Figure 1(b)**. **[2]**

From low to lower-middle/upper-middle income:

a. As incomes rise from low to lower-middle/upper-middle income landfills increase because countries can afford to convert open dumps to landfills;

From upper middle to high income:

b. As incomes rise from upper-middle to high income, landfills decrease because countries can afford more advanced methods/recycling/incineration;
c. As incomes rise from upper-middle to high income landfills decrease because land values might increase, resulting in a desire for more space efficient solutions;

Overall changes:

d. Increase in environmental education (often linked to increase in education) increase more sustainable disposal options;

Note to examiners*: Accept ECF only if the reason linked is valid for the response in c(i).*

(d) Outline one advantage and one disadvantage of using incineration instead of landfills. **[2]**

Advantage:

a. Incineration reduces the volume of the waste / takes up less land;
b. Incineration can be used to generate energy;
c. Incineration produces less methane which is a more potent greenhouse gas than CO_2;

Disadvantage:

d. Incineration of some materials can create more toxic air pollution/GHG/CO2 than landfills;
e. Incineration can have much higher costs than landfills;
f. Incineration still produces (toxic) ash which must go to landfills;
g. Incineration can give the appearance that waste has disappeared that could result in less desire to reduce waste;

2. (a) Using **Figure 2(b)**, state the source that has the highest contribution of phosphorus delivered to the Gulf of Mexico. **[1]**

Pasture;

(b) Using **Figures 2(a)** and **2(b)**, outline two reasons why nutrient pollution in the Gulf of Mexico is difficult to manage. **[2]**

a. The pollution is nonpoint source / making it difficult to focus management effort on single origin;
b. Pollution comes from such a large area/many states, it can be hard to manage/regulate;
c. Since the leading cause of pollution is from agriculture, it might be hard for governments to prioritize river health/protection over farming/food production;
d. The Gulf of Mexico can be far from the source of pollution, so individuals doing the polluting might not be aware of/care about the effects;
e. Expensive/difficult to remove nutrients/restore the ecosystem;
f. Education programs/subsidizing alternative practices to reduce nutrient pollution can be expensive/might not have buy in;
g. Pollution sources can come from more than one country and international agreements/cooperations can be difficult to achieve;

***Note to examiners**: Credit any other reasonable suggestion of equal merit*

(c) Explain how nutrient pollution could impact aquatic food production in the Gulf of Mexico. **[4]**

a. Excess nutrients can lead to algae blooms/eutrophication...;
b. ...blocking sunlight that results in aquatic plant death/reduced primary productivity ;
c. reducing oxygen source in water;
d. Aquatic organisms/fish die/reduced secondary productivity from lack of oxygen;
e. Decomposition triggers positive feedback loop of death and decomposition, reducing oxygen further;
f. Dead zones which kill fish/aquatic organisms negatively affecting food production/capture fisheries;
g. Toxins from certain types of alga form, impacting shellfish harvests due to (paralytic) shellfish poisoning;

***Note to examiners**: Max 3 for only describing eutrophication feedback loop without linking to food production. No credit for biomagnification/bioaccumulation up the food chain*

(d) Outline two management strategies to prevent the release of nutrient pollution into the Mississippi River. **[2]**

a. Planting buffer zones/restore wetlands to absorb nutrient runoff;
b. Applying fertilizer in the dry season to avoid it washing nutrients into river;
c. Contour plowing/plowing across slopes/terracing to prevent runoff;
d. Use of organic fertilizers because they biodegrade slowly;
e. Use of cover crops to hold soil in place/avoid runoff;
f. Drip irrigation to reduce run-off with dissolved nutrients;
g. Moving pastures deeper inland/do not allow livestock to graze close to waterways;
h. Treat sewage for nitrates and phosphates before it enters the river;

Note to examiners: *Credit any other reasonable suggestion that addresses the release of the pollutant (not the production) of equal merit.*

3. (a) Calculate the difference between carbon stored in kelp in the ecosystem with and without sea otters. **[1]**

180 ($g\,C\,m^{-2}$) – 14 ($g\,C\,m^{-2}$) = 166 ($g\,C\,m^{-2}$);

(b) Outline why sea otters are considered a keystone species. **[1]**

a. They protect the integrity of the food web / regulate herbivore populations;
b. Without them the biodiversity is reduced/food web may collapse;
c. Without them the kelp forest/ecosystem structure is severely weakened;

(c) Explain how sea otters contribute to the resilience of the kelp forest ecosystem. **[3]**

a. The presence of sea otters increases the resiliency of the kelp forest ecosystem;
b. The otters control the sea urchin/snail/crab/herbivore population which allows the kelp forest to remain intact;

Resiliency increases with:
c. …greater overall biodiversity with sea otters present;
d. …more biomass/greater storages with sea otters present;
e. …greater productivity leads to greater cycling of nutrients;
f. …more complex food webs/species interactions;

***Note to examiners**: 2 max if no explicit connection to resilience*

(d) Outline how the protection of sea otters could help mitigate climate change. **[2]**

a. more sea otters would result in control of crab/snail/urchin population...;
b. increasing/stabilizing kelp abundance;
c. Increasing primary productivity/photosynthesis;
d. resulting in higher assimilation of carbon dioxide/removal from atmosphere;

Section B

4. (a) Outline two transfers and two transformations in soil systems. **[4]**

Transfers (two max)

a. Biological mixing moves minerals and nutrients to different locations;
b. Leaching/eluviation moves dissolved/suspended minerals in water through the soil;
c. Percolation of water moving through the soil;
d. Absorption of nutrients/water by plant roots;

Transformations (two max)

e. Decomposition is the breakdown of organic matter into inorganic matter;
f. Cellular respiration (by soil organisms) is the conversion organic matter to energy/CO_2;
g. Weathering is the breakdown or dissolving of rocks and minerals;
h. Nutrient cycling is the movement of elements between various compounds within the biotic and abiotic components of the soil.
i. Nitrogen fixation is the conversion of nitrogen gas to ammonia/nitrogen that is useful to organisms;
j. Nitrification is the conversion of ammonia into nitrite/nitrate;
k. Denitrification is the conversion of nitrates into nitrogen gas;

Note to examiners: *The transfers and transformation need to be clearly labeled as such.*

(b) Explain how anthropocentric and ecocentric value systems influence how soil resources are managed. **[7]**

Ecocentric description [2 max]:
a. integrates social, spiritual and environmental dimensions into a holistic ideal;
b. puts ecology and nature as central to humanity / prioritizes biorights;
c. emphasizes a less materialistic approach to life / encourages self-restraint in human behavior;
d. encourages greater self-sufficiency of societies / community action;
e. emphasizes the importance of education;

Ecocentric soil management:
f. soil should be disturbed as little as possible / working with nature should be prioritized;
g. organisms in the soil should be protected;
h. farmers/citizens should be educated in soil conservation/sustainable practices;
i. use of cooperatives/community action in soil conservation;
j. creation of protected/soil conservation areas;

Anthropocentric description: [2 max]
k. An anthropocentric viewpoint argues that humans must sustainably manage the global system;
l. This might be through the use of taxes, environmental regulation and legislation;
m. Debate would be encouraged to reach a consensual, pragmatic approach to solving environmental problems;

Anthropocentric soil management:
n. Quotas/bans may be set regarding quantity/type of fertilisers/pesticides used;
o. Unsustainable farming practices e.g. monocropping may be outlawed;
p. Incentives may be provided for sustainable farming practices/soil conservation methods / e.g. terracing, crop rotation, organic fertilization;

***Note to examiners**: Award [4 max] per EVS. Credit any valid statement and any statement of equivalent significance and validity.*

(c) To what extent are human food production systems more greatly influenced by cultural factors than they are by political, environmental or economic factors? **[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 and terminology:
Food production systems are influenced by factors such as scale; industrialization; mechanization; fossil fuel use; seed, crop and livestock choices; GMOs; water use; fertilizers; pest control; pollinators; antibiotics; legislation; and levels of commercial versus subsistence food production. Each of the above may have cultural, economic, political or environmental enablers.

Breadth in addressing and linking:
Cultural factors (beliefs, traditions, food preferences; religion) with political factors (international agreements, legislations, national security) and environmental factors (local climate, biomes, landscape, topography, soils, degradation) and economic factors (export/import, cash crops, cost of technology, land tenancy, employment).

Examples: Food production systems of different societies, including cultural/political/environmental/economic factors that might drive food production choices; Examples of legislation/laws/subsidies or lack thereof; Examples of economic drivers such as cash crops/subsidies;

Balanced Analysis: Of whether, and to what extent, cultural factors have a greater influence on food production systems than political, environmental and economic factors. Could include a range of societies with different factors that drive selection of food production systems;

A conclusion that is consistent with and supported by analysis and examples given e.g.: Cultural, economic, environmental and political factors all influence the nature of food production systems in complex and integrated ways that are difficult to isolate but perhaps the bottom line is in the environmental factors that ultimately determine what processes and crop choices are possible and effective.

Please see markbands on page 19.

5. (a) Outline four ways in which ecological footprints (EFs) vary significantly by country. **[4]**

Definition of EF [1 max]:
a. The area of land and water required to sustainably support a defined human population at a given standard of living;
b. The measure of EF takes into account the area required to provide all the resources needed by the population and the assimilation of all wastes;

Aspects that will decrease EF in a country;
c. Smaller populations use fewer resources/produce less waste (for total EF);
d. Laws/education campaigns to promote recycling/reducing waste/using fewer resources;
e. More productive biomes can absorb more waste per km^2;
f. Culture/EVS/lifestyles that promotes sustainability will use fewer resources/produce less waste;
g. High level of technology/resources for more sustainable energy generation/waste disposal options;
h. Low economic means so can't afford resources;
i. Low levels of industrialization so fewer resources used/less waste produced;

Note to examiners: *Accept converse statements. Candidate must correctly link the aspect with its effect on size of footprint, resource use, and/or waste reduction.*

(b) Explain how life-supporting services provided by ecosystems may be impacted by human activity. **[7]**

Examples of negative impacts on ecosystem services could include:
a. water cycling/supply may be reduced by climate change/urbanization/overextraction/deforestation/pollution;
b. filtration of water supplies may be reduced by drainage of wetlands/paving;
c. Flood protection could be reduced with soil compaction from cattle/paving/deforestation;
d. Soil erosion protection could be reduced with deforestation/agricultural techniques such as tilling/overgrazing;
e. nutrient cycling could be reduced through deforestation/tillage/monocultures/pollution;
f. oxygen production/air purification can be reduced through deforestation/eutrophication;
g. carbon storage can be reduced through deforestation;
h. natural capital/biodiversity can be reduced through habitat destruction/climate change/overexploitation/introduction of invasive species/poaching;
i. soil fertility maybe be reduced by unsustainable farming practices/pollution;

Examples of positive impacts on ecosystem services could include:
j. Oxygen supply/air purification can be improved with afforestation/rewilding;
k. Water cycling/supply could be improved with afforestation/rewilding;
l. Biodiversity could be improved with afforestation/rewilding;
m. Nutrient cycling can improve with composting;
n. soil formation/retention can increase with contour plowing/use of windbreaks/cover crops

Note to examiners*: Award [1 max] for each identified life-support service with relevant explanation or relevant example. Credit any valid statement of equivalent significance and validity.*

(c) Human population growth always results in a loss of biodiversity.

Discuss the validity of this statement. **[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 and terminology of factors associated with human growth that influence biodiversity such as pollution, climate change, habitat destruction, hunting, fishing, illegal trade, invasive species, overharvesting, mass extinction, background extinction rates; endangered species, species-based/habitat-based, in situ/ex situ conservation, nature reserves, stewardship; keystone species; flagship species; reserves; zoos; breeding/re-introduction programmes; gene banks; CITES; education/raising awareness etc.

Breadth in addressing and linking: wide range of positive and negative impacts on biodiversity associated with range of human activities linked to population growth.

Examples: examples of species/habitats that have been affected by human population growth/encroachment; examples of species recovery efforts/successes/extinction;

Balanced Analysis evaluating the extent to which human population growth has always led to a reduction of biodiversity and the extent to which conservation efforts have reduced this loss.

A conclusion that is consistent with and supported by analysis and examples given e.g.: Current extinction rates are way above background extinction rates and this is largely due to the impacts from a growing human population. Despite a wide range of partially successful conservation efforts the net rate of biodiversity loss is still increasing.

Please see markbands on page 19.

6. (a) Outline the role of clouds in regulating global average temperature. **[4]**

a. clouds play a role in a negative feedback loop moderating earth's temperature;
b. ....as temperature increases, more evaporation increases cloud cover;
c. ...(the high albedo of) clouds can reflect solar radiation cooling the earth;
d. clouds can trap /absorb outgoing heat/IR from escaping the atmosphere warming the earth;
e. low thick clouds contribute more to cooling, while high, thin clouds contribute more to warming.

***Note to examiners**:Award [1 mark] for each valid statement.*

(b) Explain how urban air pollution could lead to significant economic losses. **[7]**

Urban air pollution can cause
a. Heart disease, lung cancer, respiratory diseases...;
b. ... raising medical/healthcare costs...;
c. ...and causing loss of employment/labour productivity;
d. ...premature deaths reducing workforce;
e. Reduction in agricultural productivity/yields may increase food price;
f. Damage to buildings/monuments/equipment needing costly repairs/maintenance;
g. Increased costs of mitigation/cleaning;
h. Cost of end of pipe technologies;
i. Cost of setting, monitoring and policing air quality standards;
j. Cost of education/raising public awareness;
k. Loss of revenue from tourism in heavily polluted venues;
l. Property devaluation of highly polluted cities/areas;
m. Companies offer hardship compensation for working in heavily polluted cities;
n. Industries may be closed down due to excessive emissions;
o. switching to alternative energy sources may be expensive;

***Note to examiners**: Award [1 max] for each identified impact. Credit any valid statement of equivalent significance and validity.*

(c) The *Montreal Protocol on Substances that Deplete the Ozone Layer* (1987) is one of the most successful international agreements on a major environmental issue. Discuss the validity of this statement. **[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 and terminology such as ozone depleting substances (halogenated organic gases/chlorofluorocarbons CFCs); Use in aerosols, gas-blown plastics, pesticides, flame retardants and refrigerants; ozone destruction and reformation and dynamic equilibrium; ozone holes; management strategies, laws, legislation implemented in response to Montreal Protocol; multilateral fund; black market ODS; development of alternatives and their impacts; HFCs; ozone depleting substances not covered by Montreal Protocol (e.g. dichloromethane); other international environmental agreements (e.g. Kyoto protocol/Paris agreement/COP agreements/CITES etc);

Breadth in addressing and linking a range of strategies, laws, legislation implemented in response to Montreal Protocol and their success in reducing ozone depletion; relative success of other international agreements;

Examples national laws and regulations to decrease production and consumption of CFCs; including recycling refrigerants, developing alternatives to CFCs (such as HFCs), gas-blown plastics, halogenated pesticides, propellants and aerosols; examples of illegal markets and continued use; examples of other international environmental agreements;

Balanced Analysis evaluating the extent to which the protocol has been successful in terms of international cooperation; speed and extent of ozone recovery; impacts of alternatives; degree of international cooperation; comparison with other international environmental agreements.

A conclusion that is consistent with and supported by analysis and examples given e.g.: Compared with many of the UN attempts to produce international agreements regarding climate change the Montreal Protocol has been significantly more successful particularly in the extent of international support attained. However, the degree of success in specifically restoring the ozone layer may be limited due to black market sales and impacts of new ODS not covered by the Protocol.

Please see markbands on page 19.

7. (a) Outline how ocean circulation systems affect climate. **[4]**

a. High amounts of sunlight energy are absorbed by the oceans at the equator/tropics;
b. The ocean has an interconnected current, or circulation;
c. Ocean currents distribute that heat/move warm water/humidity/precipitation from the equator/tropics to the poles;
d. Ocean currents transport cold water from the poles back to the equator/tropics;
e. Currents are driven by wind/tides/Earth's rotation/solar energy/water density differences;
f. Regions at higher latitudes therefore have warmer climates than they would be without ocean circulation;
g. Example of warm current from equator toward poles such as Angola or Gulf stream / example of a cold current from poles to equator such as Humbolt;
h. Example of the prediction that the loss of the Greenland ice sheet affecting the Gulf stream resulting in a colder Europe;

***Note to examiners**:Award [1 mark] for each properly identified and explained ocean circulation process that affects climate.*

(b) Explain how plate tectonics have impacted speciation of organisms. **[7]**

Outline of speciation:
a. Speciation is the formation of new species;
b. Speciation often occurs when populations of a species become isolated from each other;
c. The isolated populations face different environmental/selective pressures;
d. Natural selection results in the selection of different favorable traits
e. until populations can no longer interbreed/become different species;

Plate tectonics can impact speciation through:
f. Isolation from the formation of barriers such as mountains/separation of land masses/seas;
g. The creation of new habitat such as new islands or new seas/lakes;
h. Land bridges can bring species together, creating new selective pressures;
i. Climactic/biome changes when land masses move to different latitudes shifting food/resource supply;
j. Natural disasters (e.g. volcanic eruptions) resulting from moving plates could eliminate whole species and create new habitat/conditions/selection pressures;

(c) To what extent could the changing value of freshwater resources lead to conflict between different societies? **[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 and terminology such as inequitable availability and distribution of water resources; water scarcity; water security; impact of climate change and human population growth on water supply; water conservation; grey-water recycling; reservoirs, redistribution, desalination, artificial recharge of aquifers; rainwater harvesting schemes; legislation, convention and agreements at local, national and international level;

Breadth in addressing and linking a range of factors that have led to increasing value/decreasing supply of freshwater along with strategies for reducing water scarcity and maintaining security to reduce social conflict.

Examples of factors affecting value of water; strategies for preventing water scarcity and promoting water security; named social conflicts over water sources.

Balanced Analysis of the extent to which the increasing value of freshwater leads to social conflict and the extent to which this may be mitigated through a range of water-saving strategies and political agreements.

A conclusion that is consistent with and supported by analysis and examples given e.g.: As climate change and growing human populations continue to compound the problem of water scarcity, the value of freshwater as a resource will increase and inevitably attract social conflict. Such conflict may, however, be mitigated through effective water management social agreements.

Please see markbands on page 19.

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.