2226 – 4625M

Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2026

Environmental systems and societies

Standard level

Paper 1

11 pages

Subject details: Environmental systems and societies SLP1 Markscheme

Mark allocation

Candidates are required to answer:
- **ALL** questions
- The maximum total = **[35]**.

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

When using marking points:

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 **precise point** where it becomes clear that the candidate deserves the mark. **One tick to be shown for each mark awarded**

iv. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

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 underlined 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.

1. (a) Using **Figure 2(d)**, identify the abiotic factor that most limits productivity and biodiversity in the Atacama Desert surrounding the city of Antofagasta. **[1]**

Average annual precipitation/(low) precipitation/rainfall/water availability;

Note to examiners: *If two abiotic factors are given, mark only the first response.*

(b) Much of the energy required for the mining industry in northern Chile comes from imported fossil fuels. With reference to **Figure 2(d)**, evaluate the option of solar energy as an energy source for this region. **[3]**

Advantages:

a. There are 7–9 hours of (cloud free) sunlight / limited precipitation/rain clouds, so solar is viable/efficient;
b. Less reliance on imported fuels provides energy security (against price/supply issues that are not controlled by Chile) / more consistent cost/supply for industry
c. Solar energy is more reliable as it is not prone to political instability/conflict in the exporting countries;
d. Once built, solar energy is likely to be cheaper than non-renewables in long-term (as price will go up as non-renewable supply decreases)
e. Solar energy production is sustainable/renewable energy/it will not run out
f. Solar energy produces no GHG/CO_2

Disadvantages:

g. Energy production only during day/cloudless days/is an intermittent supply/unreliable source of energy
h. Solar energy is expensive/not developed
i. Requires large amounts of land;
j. Large solar farms can change desert ecosystems/change microclimate;

Maximum 2 if only advantages or only disadvantages discussed

Note: *Do not accept high altitude means more sunshine available.*

Note to examiner: *Accept statements that give the alternative point e.g. Coal is a more constant source of energy as it is not intermittent / dependent on sunlight*

(c) With reference to **Figure 2(e) and Figure 2(f)**, outline how the Humboldt Current influences the average annual temperature of Antofagasta. **[2]**

a. The Humboldt Current carries cold water northward along the coast;
b. Humboldt Current cools the marine air;
c. The cool air over the Humboldt Current is carried inland by westerly winds;
d. Lowering the average annual temperature in Antofagasta;

Note to examiners**:** *For MPa students must say the Humboldt Current carries cold water NOT cold air. For MPc ,the westerlies carry cool air not cold water.*

(d) Using **Figure 2(g)**, identify the ecosystem with the highest carbon storage in the Punta Arenas region. **[1]**

a. Peatlands and tundra;
b. Forests and shrublands;
c. Steppes and grassland;

Note to examiners: *All responses are acceptable based on how the student interprets "region" in the question. Do not accept only part of the response, e.g. "peatlands", "tundra".*

(e) Using **Figure 2(f) and Figure 2(g)**, explain how the carbon storage process is influenced by climate in the ecosystems around Punta Arenas. **[2]**

a. Cold/cool temperatures decrease the rate of carbon capture due to limited photosynthesis;
b. Cold/cool temperatures reduce losses of carbon to the atmosphere through respiration/decomposition (so more carbon is stored);
c. Permafrost (of tundra)/frozen ground (in the tundra/at high altitudes) prevents decomposition (of stored carbon) and thus keeps carbon from entering the atmosphere;
d. Low sunlight availability/seasonality of sunlight availability results in a reduction in photosynthesis and therefore less carbon storage by plants;
e. High rainfall/precipitation leads to greater/more photosynthesis and therefore more carbon capture (by plants);
f. Cold water has a higher carbon storage capacity;
g. As the climate warms, permafrost may thaw, leading to the release of stored carbon/methane into the atmosphere;

Note to examiners: *Do not accept responses which simply identify the level of productivity of the ecosystem without an appropriate link to climate.*

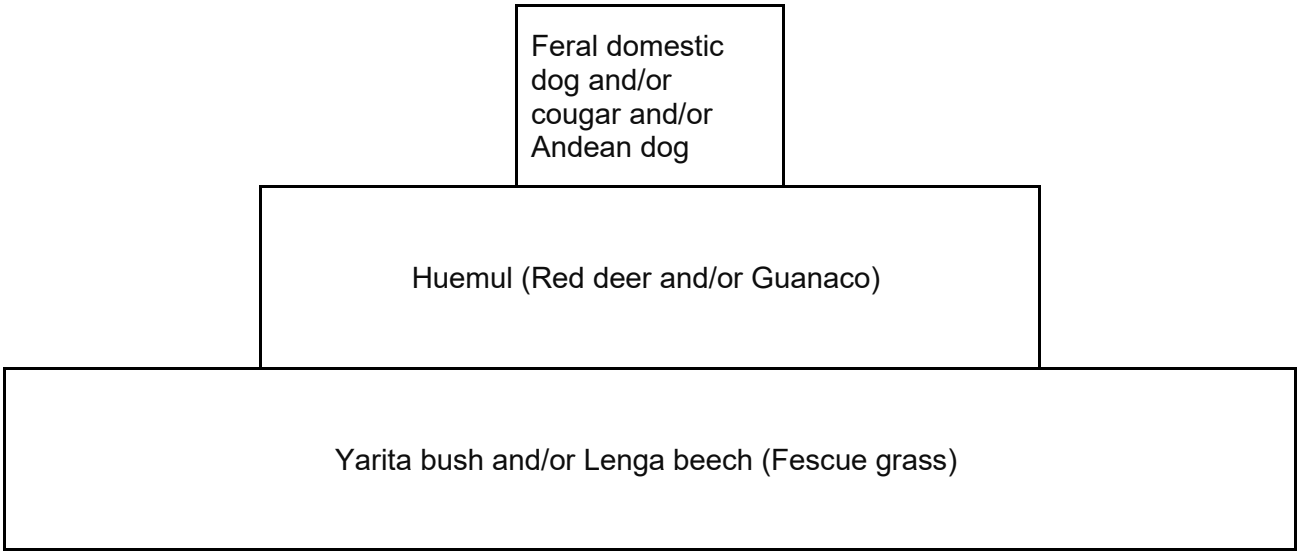
(f) With reference to **Figure 2(h) and Figure 2(i)**, explain how topographical factors in the region impact the development of a sustainable forestry industry. **[3]**

a. Selective cutting/harvesting/removal of trees/planting is more difficult/expensive on steep/mountain slopes;
b. Tree removal/harvest exposes the soil and alters infiltration (and percolation), leading to increased run-off of water/decreasing water storage which impacts re-growth;
c. Regrowth of new/planted trees is limited/slowed by loss of soil/organic material/nutrients due to landslides/erosion/runoff down the slopes;
d. Mountainside/topography/steep slope makes erosion worse/soil replacement slower;
e. Access roads (to move product/trees/equipment) are more difficult to build/maintain due to erosion/steepness;
f. Mountain-based tourism/ecological concerns creates land-use conflicts with forestry (due to different value systems);
g. As mountain regions are typically sparsely populated, there is land available for developing forestry;

Note to examiners: *Allow any other reasonable points linked to the difficulties of forestry in mountain environments/topography. Accept points in the converse, e.g. "flatter/less steep regions are easier to access and therefore less expensive to develop." Do not double-credit alternate arguments.*

2. (a) Using **Figure 3(a) and Figure 3(b)**, draw a pyramid of energy that includes the huemul. **[1]**

Pyramid should have three (or four) levels, with the organisms placed in the appropriate step/level, e.g. bottom step – Yarita bush, Lenga beech, (Fescue grass), second step - Huemul, Red deer, Guanaco, top step - Andean fox, Feral domestic dog, Cougar (Cougar could possibly be on a fourth level).



Note to examiners: *Pyramid must have clear levels or steps. Do not accept food chains.*
Students can approach this question in a variety of ways. Accept any response which either shows clear steps (to indicate the loss of energy at each trophic level) or a triangle which indicates the 90% loss of energy with each transfer. The species must be named (e.g. do not accept "leaves and plants", "dog"), but the student can identify any or all species which interact with the huemul.

(b) With reference to **Figure 3(b)**, outline how the spread of feral red deer across the Andes could impact the huemul population. **[2]**

a. competition with red deer for food source/habitat will lower reproductive rate/survival to reproductive age/decrease population;
b. Red deer much larger, so may attack/kill huemul to defend territories;
c. humans engaging in (red deer) culling programs (of the invasive species) could shoot huemul by error (as they inhabit a similar habitat and are also herbivores);
d. diseases that develop in red deer that move to huemul (as they are similar species) could lower reproductive rate/survival to reproductive age;
e. Huemul predators also prey on red deer, so reduced predation could increase survival/reproductive rates of huemul;
f. Increase in red deer population will increase cougar population thereby causing more predation on huemul/decreasing huemul population;

Allow any other reasonable points referencing huemul population; OWTTE

Note to examiners: *do not accept response that does not refer to a change in population of huemul*

(c) With reference to **Figure 3(c) and Figure 3(d)**, explain how a specific *in situ* conservation strategy could improve the IUCN category of the huemul. **[3]**

Strategies (max 1)

a. Expand habitat (to more historical areas) by protecting land area / rewilding areas between existing population groups / creating corridors between protected areas;
b. Ecosanctuaries to protect them from predators;
c. Employ more rangers/officials/observers to monitor populations/tourism effects
d. Cull or capture and relocate red deer as they move into huemul habitat;
e. Fund/encourage studies of huemul and their habitat;

Improvement for huemul IUCN category (max 2)

f. which would reduce stress on the population;
g. provide opportunity for more reproduction/increase population;
h. increase genetic variability as the groups breed;
i. increase the quality of the habitat;
j. allow for migration;
k. which would reduce competition for food/space;
l. in order to increase knowledge of their biology / reduce chance of disease transmission (which would improve success rate of any strategy);

Note to examiners: *Strategy must be linked to an IUCN criterion (e.g. low population size/distribution issues, low genetic diversity, habitat degradation/compromise, species stress due to interrelationship imbalance) for mark to be awarded.*

(d) Using the information in **Figure 3(e) and Figure 3(f)**, outline the evidence that Chile is making progress towards UN Sustainable Development Goal (SDG) 15. **[1]**

a. The large number of parks, reserves, protected areas and monuments support the "protect" aspect;
b. Expanding national parks helps halt biodiversity loss/ promote biodiversity;
c. Rewilding previously developed land supports the restoration of ecosystems/reverses land degradation;
d. Reserves are managed by the government/National Forest Corporation/Ministry of Agriculture to ensure they are sustainably used;

Note to examiners: *Answer must link the evidence to how it supports SDG15, e.g. Linked to the ideas of "protect", "restore" or "sustainable use". Do not accept the reverse argument (e.g. Not supporting SDG15) as the question asks for examples of support.*

3. (a) Using the information in **Figure 4(a)**, calculate the percentage increase in the number of aquaculture locations, assuming all those awaiting approval are granted permission to proceed. **[1]**

(176+58=234)
((234-58) / 58 x 100 = 303.448)
303 / 303.4 / 303.45 / 303.448 (%);

Note to examiners: *units are not required. Do not accept 303.5, as this is incorrect rounding.*

(b) Describe **two** negative impacts on the marine ecosystems in the fjords from intensified salmon aquaculture. **[2]**

a. The presence of farmed salmon could spread disease to species in marine ecosystem;
b. Escaped salmon may disrupt local food web/compete with native species for local food resources;
c. Escaped salmon can interbreed with native fish species and affect local genetic diversity;
d. Increased human presence with aquaculture equipment/nets/boats can impede water movement/ animal movement/migration of sea mammals, penguins, wild fish;
e. Sea birds may target farmed fish over natural prey (and be killed to limit economic losses), disrupting existing food webs/interrelationships of the ecosystem;
f. Excess/uneaten food/fish waste will impact marine ecosystem by disrupting (biotic) equilibrium of existing ecosystems (algal blooms, eutrophication etc.);
g. Excess/uneaten food/fish waste will cause disruptions to the ecosystems due to bacterial/pathogen content in uneaten food/waste.
h. Excessive use of chemicals/antibiotics/pesticides can have negative impact on the ecosystem by changing abiotic factors of the ecosystem;
i. Sheltered waters mean any pollution/feces/etc., will stay in the area longer and have greater impact on biotic and abiotic factors of the ecosystem;
j. Use of wild-caught fish for aquaculture feed can cause overfishing of native stock/loss of biodiversity;

Note: *do not accept pollution alone without an indication of the type of pollution*

Note to examiners: *responses must be linked to a specific aspect of an ecosystem for credit*

(c) Evaluate the use of maximum sustainable yield (MSY) as a guide to the management of fish harvesting on the coast of Chile. **[3]**

a. The use of MSY requires collecting accurate data on species population number and reproductive rate (recovery rate following harvesting);

Advantages:
b. MSY can provide reliable data that can be used to set fishing quotas for industry;
c. Harvesting MSY can ensure fish population maintains equilibrium/balance for wider marine ecosystem and ecosystem services;

Disadvantages:
d. MSY is a model/too simplistic as it is focused on one species, ignoring the complexity of the ecosystem;
e. Fish populations are difficult to measure due to migration/marine habitat;
f. Reproductive rate/recovery/populations can vary from year to year due to changing ocean abiotic conditions (El Niño/La Niña)/bycatch effects on food web);
g. Migration of species may change food web of target species (which impacts measurements for MSY);
h. Data collection for MSY can be expensive;
i. May cause the loss of income due to a reduction in the size of the fish harvest;

Note to examiners: *Max 2 if only positive or negatives are present*

4. (a) Identify **one** trend in glacial loss percentage from **Figure 5(a)**. **[1]**

a. Loss (relative to 2000) is increasing (each five-year period) / In four out of the five glacier size categories, the greatest loss of ice occurred in the 2015-2020 period / overall decrease in global glacial area;
b. Larger glaciers have a lower percentage loss than smaller glaciers;
c. Smaller glaciers have a higher percentage loss than larger glaciers;

Note to examiners: *mark first answer only. Response must refer to a trend, not a single data point.*

(b) With reference to **Figure 5(c)**, identify **two** forms of natural capital provided by glaciers. **[2]**

a. Freshwater/water/meltwater;
b. Nutrients;
c. Sedimentary material / rocky material and clay;

Note to examiners: *mark first two answers only. Award the mark for the identified natural capital, even if the student links it to natural income (e.g. water for hydropower).*
Do not accept responses which are natural income (e.g. tourism, hydroelectric power generation, etc.)

(c) Using **Figure 5(c)**, describe **two** negative impacts of glacier retreat on the local human communities. **[2]**

a. less water/freshwater available for human needs/agriculture/irrigation;
b. Less water available for hydropower generation/hydroelectricity (reducing energy available for industry/mining);
c. Loss of nutrients (after the glaciers have disappeared) reducing productivity/crop yields;
d. Increased erosion/runoff (due to lack of ground cover) will remove topsoil/O-A horizon/soil which reduces productivity/food availability;
e. Area becomes more susceptible to landslides;
f. Increased flash flood/flood potential (when a lake bursts its sides/boundaries) which can destroy/damage infrastructure/farms/buildings/livestock/crops / flash floods can result in human deaths;
g. land degradation/risks from retreating glaciers/erosion/landslides can reduce the tourism industry/recreation/hiking;
h. Reduction in albedo which can lead to increased summer temperatures for local communities, resulting in deaths/loss of work productivity due to heat;
i. Melting glaciers will result in sea level rise and may force coastal communities to relocate due to flooding/flood risk;

Note to examiners: *Mark only the first two responses. Accept other valid and reasoned human-related impacts explicitly linked to glacial retreat.*

5. (a) Using **Figure 6(a)**, identify the largest source of electrical energy in Chile in 2015. **[1]**

Coal;

(b) Using **Figure 6(a)**, outline **two** trends in renewable electricity production from 2011 to 2023. **[2]**

a. Hydropower was the only renewable in 2011/until 2013;
b. Hydropower remains largest of all renewables;
c. Hydropower has fluctuated /increased slightly/stayed the same;
d. Renewables generated more electricity each year;
e. Renewables increased throughout the time period shown;
f. Wind power increased;
g. Solar energy has increased (more than wind energy);
h. From 2016, solar power energy production is bigger than wind power / from 2016 solar energy has increased significantly;

(c) Using **Figure 6(b) and Figure 6(c)**, discuss possible reasons why the value of the coal mining industry in Chile has changed. **[2]**

a. Increased adoption of alternative/renewable energy sources over time has changed/impacted the value of coal (mining industry);
b. Chile has signed/supported (international) agreements to decrease carbon footprint/be carbon neutral by 2050 close all plants by 2040 thereby changing/impacting the value of the industry;
c. Education/campaigns/shifts in environmental value systems/ethics in the country have turned public opinion towards renewables/away from fossil fuels/coal changing the value of the industry;
d. As coal resources start to run out/access becomes more difficult, the cost of extraction becomes more expensive changing/impacting the value of the resource;
e. Introduction of carbon tax has increased the costs of coal impacting/changing the value of the coal mining industry;
f. Advancements in technology have potentially made renewable energy sources cheaper than coal changing demand/changing its value;
g. Coal may change in value if (global) political instability restricts availability of imports of fossil fuels;

Note to examiners: *Do not accept just a list of reasons for without stating there has been a change in value. The response does not require a direction of change.*

Allow other reasonable responses that reference change in value.

As this is a two-mark question, both increases and decreases or a conclusion are not required.