2226 – 4621M

Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

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Environmental systems and societies

Standard level

Paper 2

15 pages

Subject details: Environmental systems and societies SLP2 Markscheme

Mark allocation

Candidates are required to answer:
- **ALL** questions in Section A **[40]** and **ONE** questions in Section B **[20]**.
- The maximum total = **[60]**.

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) (i) Using **Figure 1**, identify the biome with a mean annual precipitation of 100 cm and a mean annual temperature of 0 °C. **[1]**

Taiga;

(ii) With reference to **Figure 1**, distinguish between the climate conditions of a desert biome and a tundra biome. **[2]**

a. Desert biome has high temperature/range (20 – 30 °C) and low precipitation/range (0 – 50cm)

OR

Desert and Tundra both have low precipitation/tundra slightly more rainfall than desert;

b. Tundra biome has low temperature/range (-5 – -15 °C) **and** low precipitation/range (0 – 200cm);

OR

Desert has high temperature, but Tundra has low temperature;

Note to examiners: *Student must reference both temperature and precipitation to gain the mark for the biome.*

(b) With reference to **Figure 1**, outline why primary productivity is highest in the tropical rainforest. **[2]**

a. Primary productivity mainly occurs through photosynthesis;
b. Tropical rainforests have high temperature which speeds up rate (of photosynthesis);
c. Tropical rainforests have high amount of precipitation which is needed for photosynthesis;
d. High insolation/stable temperatures all year leads to continuous photosynthesis/growth;

Note to examiners: *Must have the link between productivity and photosynthesis to gain the mark.*
Do not accept links to species as this is not referenced in Fig. 1

(c) Explain how the tricellular model of atmospheric circulation influences the structure of biomes. **[4]**

a. Tricellular model is made up of Hadley, Ferell and Polar cells;
b. Hadley Cell: Near the equator, warm air rises, creating high precipitation/ low-pressure zone;
c. Low pressure zone leads to rainfall creating the tropical rainforest biome;
d. Ferrel Cell: (Between 30° and 60° latitude) air circulates in the opposite direction to the Hadley cell;
e. ...air moves towards the poles at high altitudes and descends around 30° latitude, creating high-pressure zones;
f. Low precipitation and high temperature/giving rise to desert biomes;
g. Polar Cell: Cold air descends at the poles and moves towards the equator at the surface;
h. ..rising again around 60° latitude/causing low temperatures/low precipitation causing the Tundra biome;
i. This circulation pattern leads to distinct precipitation and temperature zones;

Note to examiners: *1 mark max for an explanation of each cell. If the explanation is naming the biome, there must be a link to either temperature or precipitation.*

2. (a) Identify **one** transfer and **one** transformation in **Figure 2**. **[2]**

a. Transfer:
advection/precipitation/Melted snow runoff surface run off/infiltration/percolation/ groundwater flow/plant uptake;
b. Transformation:
evaporation/condensation/sublimation/snowmelt/transpiration/evapotranspiration;

Note to examiners: *Only mark the first response, if it is wrong and the second one is correct – no mark.*

(b) Outline how gravity contributes to the movement of water through the hydrological cycle in **Figure 2**. **[2]**

a. Gravity causes water and substratum to drain/percolate/infiltrate through soil;
b. Gravity causes water to move through rivers to the sea;
c. Gravity causes water to fall from clouds as rain;
d. Contributes to surface runoff;

Note to examiners: *If student '**states**' the flow, then no mark e. the student states the flow, then no mark, e.g., infiltrate on its own, rate on its own is insufficient.*

(c) Describe how deforestation can alter the flow of water in **Figure 2**. **[2]**

a. As more trees get cut down, less water is released through transpiration;
b. Leading to dry air, less humidity and less precipitation (leading to less clouds);
c. Less trees means less infiltration;
d. ... increased run off/can lead to increased flooding;
e. Less trees means less uptake of water;

Note to examiners: *there must be a clear link to increase/decrease in flow.*

(d) Explain how the water resources shown in **Figure 2** could be further enhanced for human use. **[4]**

a. Dams/reservoirs can be built to conserve water so excess can be released when flow is reduced;
b. Water in dams can be used for human consumption/HEP production/ recreational use/ irrigation of food crops/livestock;
c. Groundwater/aquifers can be drilled to draw up water for human drinking/water to use for crop irrigation/livestock;
d. Desalination plants can be created to convert seawater to drinking water;
e. Desalination is carried out by using a semi-permeable membrane to carry out reverse osmosis;
f. Rainwater harvesting/fog collection with mesh netting;
g. Correct treatment of water to make contaminated water potable;
h. Artificial recharge of aquifers for extraction when required for irrigation of crops /drinking water);
i. Reservoirs with plastic sheeting/plastic balls to reduce evaporation so more water can be used by humans (e.g. use reservoir/dams for recreational purposes) reservoirs;
j. Reforestation improves water percolation/infiltration for aquifer recharge/groundwater storage for extraction when required for use by humans;

Note to examiners: *method of enhancement must be linked to use*

3. (a) State the trophic level of the orca in **Figure 3**. **[1]**

Fifth trophic level/top carnivore/apex predator/quaternary;

(b) Outline why the food web in **Figure 3** has reached the maximum possible number of trophic levels. **[2]**

a. Energy released by cellular respiration/heat unavailable to higher trophic levels;
b. 10 % rule/2nd law of thermodynamics/energy transfer/flow is inefficient;
c. Not all food is harvested/not all consumed/not all absorbed;
d. The higher members of a food-chain tend to be larger and fewer in number;

(c) State the difference between biomagnification and bioaccumulation. **[1]**

Bioaccumulation is the increasing concentration (of non-biodegradable pollutants/toxins in organisms) in fatty cells/tissues of organisms (over time)

AND

Biomagnification refers to the increasing concentration (of non-biodegradable pollutants/toxins) along a food chain/up trophic levels;

Note to examiners: *Must have both points to gain the mark.*

(d) Outline why pollutants such as polychlorinated biphenyl (PCB) could cause problems along the food chain shown in **Figure 3**. **[2]**

a. They are non-biodegradable/stored in body fat cells;
b. Meaning they will accumulate in organisms over time;
c. When these organisms are eaten by another organism, the toxins will be passed on;
d. … and will magnify as they pass from one trophic level to the next;
e. Reaching toxic levels in higher trophic levels/can use death/affect reproductivity at higher trophic levels;

(e) Explain how plastic pollution could have adverse effects on the organisms shown in **Figure 3**. **[3]**

a. Plastic waste can reach the ocean from landfills close to the coast/dumped by ships at sea/washed down by rivers;
b. Larger items can resemble food e.g. polyethene bags resemble jellyfish;
c. In the ocean, large items are broken into microplastics through currents/water movement/UV light;
d. Pollutants/toxins can be absorbed by microplastics;
e. Tiny microplastic fragments can also be mistaken as food;
f. This increases their transmission in the food chain;
g. Leading to higher concentrations in higher trophic levels;
h. Large marine animals caught in plastics (e.g. plastic fishing nets/6-pack rings);
i. Ingested plastic fills stomachs and animals starve to death;
j. Plastic blocks sunlight, reducing photosynthesis/smothering corals who thrive on sunlight;
k. Hard-edge plastic can rub against/scrape corals, causing wounds that can become infected;

Note to examiners: *Accept any relevant marking point.*

4. (a) Using **Figure 4**, calculate the percentage of sand in the sandy soil. **[1]**

60 / 100 = 60 %;

(b) Using **Figure 4**, calculate the percentage of silt in the loam soil. **[1]**

30 / 100 = 30 %;

(c) Explain the role of humus in influencing the properties of a soil. **[2]**

Humus
a. …influences the mineral nutrient retention by decomposition/providing organic material for microorganisms;
b. …influences water retention by holding water within organic material;
c. …influences aeration/soil structure by binding soil particles together and allowing air flow;
d. …regulates temperature by releasing heat during decomposition/thermal insulation;
e. ... can be used as a buffer as it stabilises the soil pH;
f. ... increases porosity therefore increase infiltration;

(d) State **two** anthropogenic inputs to a managed soil system. **[2]**

Any two from:
a. Compost/organic matter/manure;
b. Fertilizer;
c. Other agrochemicals (e.g. pesticides/lime);
d. Water from irrigation;
e. Salt as the result of salinization;
f. Biochar;

5. (a) Using **Figure 5**, identify the year with the smallest proportion of electricity generated from oil. **[1]**

2019;

(b) Calculate the percentage increase in total electricity generation between 2017 and 2021, using **Figure 5**. **[1]**

(153.1 - 145.5) / 145.5 × 100 = 5.22 %/5.2%;

Note to examiner: *do not accept 5%*

(c) With reference to **Figure 5**, outline the trend in the generation of electricity from renewable sources between 2017 and 2021. **[2]**

a. There is little overall change in energy generation from renewables between 2017 and 2021/ generations ranges between 76 – 130 terrawatt-hours over the period;
b. Renewable energy generation remained stable between 2017 – 2019;
c. Renewable electricity generation shows minor fluctuations/has decreased slightly between 2017 and 2021;
d. There is a decrease in electricity production by renewables between 2020 and 2021, despite overall energy generation increasing over this period;

Note to examiner: *Must have date ranges to gain the mark.*

(d) Suggest **two** behavioural changes humans can make that may reduce the consumption of electricity. **[2]**

a. Turning off lights/using natural light;
b. Not using standby on electrical devices;
c. Use low energy intelligent lighting/use energy efficient appliances;
d. Reduce use of heating/air conditioning;
e. Increase use of insulation;
f. Short hot showers to reduce using energy to heat water;
g. Reducing working time/machine in operation/production plants to cut down on use of electricity;

Note to examiner: *Any relevant marking point that shows reduction in electricity. Renewable energy/other forms of energy to create electricity does not imply reduction in use.*

Section B

6. (a) Outline **four** ways in which human activities can affect the resilience of a forest ecosystem. **[4]**

Decreasing resilience (Max 3):

a. Urban development/Deforestation/Land clearance/Farming decreases forest area/ biodiversity/complexity of interactions/developed food webs (deforestation/pollution) decreasing resilience;
b. Farming decreases forest biodiversity (monoculture/use of pesticides…) decreasing resilience;
c. Agroforestry decreases forest biodiversity (inappropriate species selection…) decreasing resilience;
d. Cattle farming reduces plant biomass/competes with other species reducing biodiversity/reduces water resources/produces soil and water pollution… reducing resilience;
e. Burning fossil fuels/acid rain/global warming decreases biodiversity/pollutes water sources/increases evaporation reducing water availability/decreases soil quality decreasing resilience;

Increasing resilience (Max 3):

f. Ecotourism increases forest area increasing resilience;
g. Management of natural parks/ species reintroduction programmes increases biodiversity/increases biomass/water storages increasing resilience;
h. Agroforestry increases forest biodiversity (appropriate species selection)/keystone species/increasing biomass/increases forest area increasing resilience;
i. Building dams/water reservoirs affects water storages increasing resilience;

***Note to examiners**: Accept any other valid responses.*

a. the impact on resilience example + how (increases or decreases) biodiversity/complexity + (increases or decreases) resilience;
b. Human activity example + how (increases or decreases) storage + (increases or decreases) resilience;

***Note to examiners**: Accept converse statements.*
Award [1] for each correct factor identified, up to [4 max].
If valid human activities are identified, but their effect on resilience is not, award [1] for each TWO human activities up to [2 max] (ie FOUR factors). Eg identifying TWO factors and their effect on resilience, along with TWO factors but no specified effect would score [2 + 1 = 3] total OR e.g. TWO factors and their effect, along with ONE with no effect would score [2 + 0 = 2] total OR e.g. FOUR factors with no effect ([1 + 1 = 2] total).

(b) Evaluate the use of an herbivorous species as a management strategy to control an invasive alien plant species. **[7]**

a. Introduction of a species to a new environment may have unintended and deleterious consequences /non-native organism that adversely impacts the ecosystem/biodiversity in an area…;

Strengths
b. More complex food webs increasing ecosystem stability/resilience;
c. More food for predators increases their population increasing stability of the system;
d. Can be used by humans for other purposes (e.g. goats used for milk);
e. The number/population of producers will be regulated less competition between producers increases their stability/increasing energy inputs in the system/photosynthesis;
f. Herbivorous species may decrease alien species by feeding on them/herbivory;
g. Less use of pesticides/decreasing soil pollution/bioaccumulation;
h. Less use of herbicides less chances of killing non-target species if herbivorous is specific;
i. Increased negative feedback loops allow a stable equilibrium in the ecosystem;
j. Requires less financial resources/technology than other measures;
k. The effects are more lasting over time;

Limitations
l. Less population of plant native species less nesting sites/burrows/refuge from top predators/fewer predators;
m. These herbivores may prey on other species increasing competition and decreasing the population/Less population of native species less food for herbivores/less food for predators;
n. The herbivorous may feed on native plant species reducing their population/decreasing biodiversity/Decreasing environmental services from other herbivory species (bees);
o. These herbivores may be negatively affected by adverse abiotic conditions (temperature/extreme weather events/...);
p. These herbivores may be negatively affected by biotic factors (competition/predation/diseases...) reducing their population;
q. Time consuming;
r. Herbivores may introduce diseases decreasing ecosystem stability;
s. Lack of predators/limiting factors can lead to exponential growth of herbivores turning them into pests;
t. Herbivores migrate to other ecosystems/farmlands, becoming a problem;
u. Introducing herbivores should only be done with great care and after extensive investigation of the possible ecological consequences;
v. … e.g. the introduction of rabbits to remote islands has in some cases totally disrupted food chains/named example;

***Note to examiners**: Conclusion: [1 max]*
Max 4 if only limitations or strengths explained.

(c) To what extent can citizen science be used to accurately assess sustainability? **[9]**

- **understanding concepts and terminology**: models, biodiversity, human population, climate change, ecological footprints, local scales, water resources, biodiversity index, wastes production, social, economic, citizen science
- **breadth in addressing and linking** Examples of data collection methods, both at the level of water resources, biodiversity measurement indices, measurement of natural resources and the reliability and quantity of these measurements.
- **examples** Lincoln Index, water quality index, capture recapture, measurement methodologies and technologies...
- **balanced analysis** examples where the measurements can be reliable and allow for a large volume of data versus examples where the complexity of the measurements prevents the data collected from being reliable, or even possible manipulation of the data by interests.
- **a conclusion that is consistent with and supported by analysis and examples given**, “Citizen science enables the collection of a large amount of information in different places and at different times, which improves the understanding of the situation and the analysis of sustainability. But conversely it can be difficult to ensure that this data is not manipulated or reliably giving incorrect analysis.”

Please see markbands on page 15.

7. (a) Outline how a city can be considered as a system. **[4]**

a. buildings/citizens/structures are the components of the system;
b. these components are interrelated/interdependent/form an integrated whole;
c. e.g. may regulate populations/buildings due to population dynamics/resources needs;
d. it has flows/transfers of matter/energy between components/storages;
e. e.g. inputs of water/food/electricity/ from supermarkets to home;
f. components carry out processes/transformations;
g. e.g. evaporation/evapotranspiration/combustion of fossil fuels;
h. it is an open system exchanging matter and energy with surroundings;
i. e.g. absorption of solar energy / cars leaving the city/people emigrating/goods exported (*NB mark for either example of matter or energy, not both*);
j. it has feedback mechanisms to maintain equilibrium/balanced inputs and outputs;
k. e.g. if the population increases too much, there are too few resources and the birth rate is reduced, thus reducing the population, increasing the amount of resources and the population grows again;

***Note to examiners**: Award **[1]** for each correct suggestion that is linked up to a city, up to **[4 max]**.*

*Award **[2 max]** for identifying relevant generic features of system (given above) and **[4 max]** for examples of these Credit alternative examples of equivalent validity/relevance and detail.*

(b) Explain the matter exchange between the atmospheric system and living organisms. **[7]**

a. Ecosystems are open systems in which energy and matter are exchanged;
b. Photosynthesis/cellular respiration transforms matter in ecosystems;
c. Living organisms and the atmosphere are connected through biogeochemical cycles;
d. Photosynthesis allows the flow of CO_2/carbon from the atmosphere to living organisms;
e. Photosynthesis allows the flow of O_2 from living organisms to the atmosphere;
f. Producers/plants/algae/autotrophs are the organisms that are able to take up carbon/CO_2 from the atmosphere (through photosynthesis);
g. CO_2/carbon from the atmosphere is transformed into biomass of living organisms;
h. Cellular respiration causes the flow of CO_2/carbon from living organisms into the atmosphere;
i. Cellular respiration reduces oxygen/O_2 levels in the atmosphere;
j. Combustion of biomass in living organisms increases CO_2/carbon in the atmosphere/reduces O_2 levels in the atmosphere;
k. Decomposition transforms organic matter into CO_2 in the atmosphere;
l. Methane is released into the atmosphere by ruminants/cattle/fermentation/rice paddies;
m. Transpiration/evapotranspiration allows the flow of water vapour from plants into the atmosphere;
n. Precipitation allows the flow of water/H_2O from the atmosphere to be made available again to living organisms;
o. Respiration allows the flow of water/H_2O from living organisms into atmosphere;
p. Ocean organisms store CO_2 from the atmosphere in the form of calcium carbonate/shells/exoskeletons;

***Note to examiners**: Must show how the example of transfer/ transformation links the atmosphere to living organisms to gain the mark. Any relevant point accepted (e.g. links to Nitrogen cycle, phosphorus cycle)*

(c) To what extent is urban planning more affected by global warming than by population growth? **[9]**

- **understanding concepts and terminology** mitigation and adaptation strategies, residential, cultural, productive and social purposes. Migration from rural areas, suburbanization, affordable housing, transport needs, coastal impacts, environmental migration, green areas, droughts,DTM
- **breadth in addressing and linking** Urban changes due to population growth and the different needs for improved economic power and social demands in the city. Facing mitigation and adaptation strategies to the impacts and causes of climate change. Reference to urban changes with objectives common to both situations.
- **examples** suburbanization, uses of land and buildings, physical, domestic, environmental, commercial, industrial, financial and health need, quality and affordable housing, integrated public transport systems, green spaces, security, education and employment, use of renewable resources, reuse and recycling of waste, energy efficiency, involvement of the community, green buildings. GHG examples and mitigation strategies. GW impacts and adaptation strategies.
- **balanced analysis** Reference to changes to meet the needs of the population versus changes aimed at minimising global warming or reducing impacts.
- **a conclusion that is consistent with and supported by analysis and examples given**, “Whereas changes due to population growth are more rapid and clearly linked to population growth in different parts of the world, the effects of climate change will be most evident in those parts of the world most affected by the impacts of climate change.”

Please see markbands on page 15

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.