2225 – 6606M

Diploma Programme
Programme du diplôme
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Markscheme

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Environmental systems and societies

Standard level

Paper 2

17 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) Identify the category with the lowest proportion of seafood market value in **Figure 1**. **[1]**

Algae;

(b) (i) Using **Figure 1**, calculate the projected increase in the harvest of molluscs between 2019 and 2050. **[1]**

(42 million – 20 million) 22 000 000 / 22 million (T) (accept 19 – 25 million T);

Note to examiners: *units NOT required this question. Do not accept % value.*

(b) (ii) Outline **one** reason for the increase referred to in **1.(b)(i)**. **[1]**

a. Rising world population causes increased demand for food...;
b. ...increased demand for high protein foods;
c. Improved technology/techniques/management for breeding and harvesting molluscs;
d. Greater affluence in some countries as molluscs are often a high-value/preferred, speciality food;
e. Mollusc farming is relatively less environmentally burdening / molluscs are filter feeders so work well in integrated aquaculture facilities/can clean water;

(c) Describe **two** possible reasons for the difference between marine fish capture harvest and aquaculture harvest in **Figure 1**. **[2]**

Marine fish capture is much higher because:

a. Many marine fish can be migratory/have specific niche requirements, so difficult to raise on farms;
b. Industrial capture methods may be cheaper/ large investments needed for setting up aquaculture farms.;
c. Lack of technology/infrastructure not in place for aquaculture;
d. Large size of many marine fish makes farming them difficult and expensive;
e. Demand for wild caught species because of perceived quality/taste/traditions/ environmental reasons, etc.;

(d) Evaluate the use of aquaculture in meeting the projected harvest of global seafood, as shown in **Figure 1**. **[4]**

*Pros **[3max]**:*

a. Seafood demand is expected to rise significantly by 2050, so it can provide new/more sources of food;
b. Aquaculture harvest would reduce stress on wild fisheries/farming land;
c. Provides economic opportunities for coastal nations, particularly developing nations;
d. Waste and nutrients can be cycled, making it more sustainable / usually reduces food miles;
e. More than one species can be harvested in Integrated multi-trophic aquaculture (IMTA);
f. Many forms of seafood have a high protein value;
g. Aquaculture, usually, is more efficient (economically, ecologically) than capture;

*Cons **[3max]**:*

a. May lead to loss of habitat in certain ecosystems;
b. Greater localized aquatic pollution (antibiotics, medicines, nutrient pollution, etc.);
c. Spread of diseases and escaped species (some involving genetically modified organisms);
d. Ethical concerns towards mass fish farming or genetically modified organisms (GMOs);
e. It is not economically viable to farm large marine species like tuna with aquaculture;
f. May raise local water conflicts;
g. Difficult to certify for sustainability/social responsibility;
h. Current frameworks suit better, in most case, large-scale industrial aquaculture (rather than small-scale farmers);
i. Current share of marine fish coming from aquaculture suggests it is unpopular;
j. Aquaculture has high set-up/maintenance costs / requires a lot of resources i.e. fish feed/antibiotics;

***Note to examiner**: Credit any valid advantage or disadvantage. Do not credit simplistic arguments, like more costly, more sustainable, more efficient, etc.*

Credit other valid responses

2. (a) Identify the altitude with the highest concentration of ozone shown in **Figure 2(a)**. **[1]**

22–24 km;

Note to examiners*: Do not credit if units are omitted.*

(b) With reference to **Figure 2(a)**, describe how a decreased concentration of ozone between 20 and 30 kilometers can impact living organisms. **[2]**

a. Ozone in the stratosphere absorbs ultraviolet radiation from the sun / Less ozone means more ultraviolet radiation reaching the earth's surface;
b. Increased UV radiation results in increased incidence of cataracts/mutation during cell division/skin cancer/melanoma;
c. Increased UV radiation can damage plant leaf tissues/algae impairing photosynthesis;
d. This can result in reduced overall productivity in the ecosystem/available up the food chain;

(c) State **one** possible impact of increased ground-level ozone concentration on human health. **[1]**

Damages lungs/lung tissue / irritates respiratory tissue/bronchitis/emphysema / eye irritation / lung cancer / cardiovascular issues;

Note to examiners*: Do not credit conditions relating to UV radiation or global warming i.e. cataracts, skin cancer etc.*

(d) Outline **two** possible reasons for the change in ozone exposure for Ethiopia shown in **Figure 2(b)**. **[2]**

a. Increased population leading to increased air pollution/burning of fossil fuels;
b. Growing urbanization/industrial sector increasing/trapping air pollution/burning of fossil fuels;
c. Relaxed environmental standards leading to reduced mitigation efforts;
d. Higher standards of living/increased car use/leading to increased energy use/consumption;
e. Possible defects in data collection;
f. Climate change increasing days of sunlight (increased UV for formation) / climate change decreasing precipitation that would normally clean the air;

(e) Outline **two** possible ways countries can reduce their ozone exposure, as shown in **Figure 2(b)**. **[2]**

a. Increased investment into renewable technology/energy sources;
b. Stricter laws/taxes for vehicle/industry emissions of NOx & VOCs / Set/enforce stricter ozone air concentration standards;
c. Public policy initiative (e.g. don't drive days/vehicle bans/improved public transportation/promote biking etc.);
d. Technological improvements (e.g. catalytic convertors/scrubbers/electric vehicles);
e. Improve energy efficiency in buildings/appliances;
f. Promote sustainable agricultural practices that do not emit methane (a VOC);
g. Promote sustainable behaviour, like carpooling, reduced use of solvents/paints;
h. Planting trees/greening in cities reduces ozone levels;

3. (a) Identify the household waste category with the highest carbon impact from incineration in **Figure 3**. **[1]**

Plastic;

(b) Describe **one** possible reason why metal waste has lower overall carbon impacts than paper/cardboard waste in **Figure 3**. **[1]**

a. Metal waste is recycled at a much greater level than paper/cardboard waste / metal waste is recycled while paper/cardboard is not / recycling of metal reduces overall carbon impact;
b. More paper/cardboard waste is put into landfill than metal waste / landfill increases the overall carbon impact;

c) Outline **two** disadvantages of using incineration to dispose of plastic, as shown in **Figure 3**. **[2]**

a. Potential release of air pollution/harmful chemicals/carcinogens/toxins/particulate matter into the air;
b. Release of greenhouse gases, accelerating climate change;
c. Reduces potential of plastics to be recycled;
d. Non-biodegradable/toxic ash will be buried in landfills, impacting the environment in the long-term;
e. The facilities are costly to set up/operate / require technology/expertise;

***Note to examiners**: do not credit "pollution" alone.*

d) Outline **two** disadvantages with recycling plastic waste as an approach to decreasing carbon impacts, as shown in **Figure 3**. **[2]**

a. Many plastics cannot be recycled;
b. Difficult to separate different types of plastic;
c. Recycling has other environmental problems which can outweigh carbon impacts (e.g. water pollution, etc.);
d. Plastic waste is a minor/relatively small contributor to carbon impacts compared to other waste categories;
e. Many plastics can be reused, which is more efficient than recycling;
f. Costly/energy intensive/still produces GHG to recycle plastic;

(e) Suggest **two** pollution management strategies that could be used to decrease the carbon impacts from clothing waste in Scotland. **[2]**

a. Laws legislation on types of fabrics used to increase natural/compostable material/sustainable production/limits on consumption;
b. Subsidies/tax incentives for local shops/compostable clothing/recycling/donating used clothes;
c. Awareness campaigns to increase donating/recycling/sustainable fabrics/upcycling;
d. Improve/implement infrastructure to make donating/reusing/recycling easier;
e. Afforestation/carbon capture strategies to absorb atmospheric CO2;

Note to examiners: *Only credit strategies, and not simply "recycling/donating/reusing clothes".*

Section B

4. (a) Identify **four** differences between a climax community and a pioneer community. **[4]**

Climax community has:

a. Greater species diversity/biodiversity;
b. Greater habitat diversity / more niches;
c. Longer food chains / more branched food webs;
d. Greater nutrient cycling / larger decomposer community;
e. Deeper/more developed soil;
f. Greater GPP/biomass/storages of energy;
g. Greater community respiration;
h. More K selected species;
i. (Often) woody shrubs/trees/larger animals whereas pioneer might be more characterised by lichens/mosses etc.
j. Greater resilience (due to the increased complexity);

Note to examiners: *Accept converse statements.*

(b) Explain how a community of herbivores contributes to the stability of the whole ecosystem. **[7]**

a. Herbivores will feed on producers/plants;
b. This will cause a reduction in number/regulate population size of producers…;
c. …which will lead to reduction in herbivores;

d. Herbivores would also pass on biomass/energy to a carnivore community;
e. Their numbers would decrease due to predation…;
f. …which will lead to decrease in carnivores and so on;
g. …thereby regulating the consumer community;
h. These would be examples of negative feedback;

i. Through defaecation/shedding/death they will support decomposer community / provide nutrients for plants;
j. Herbivores may increase distribution of plants through dispersal of seeds;
k. Herbivores may compete with one another regulating their populations;
l. Increases biodiversity/genetic diversity and therefore resilience so less prone to tipping point;
m. Some herbivores (e.g. elephants/bison) maintain savannahs/grasslands by knocking down/grazing on trees;

(c) To what extent is an ecocentric value system more appropriate than other value systems in addressing issues of sustainability? **[9]**

Answers may demonstrate:

- **understanding concepts & terminology** of ecocentrism/anthropocentrism/technocentrism; social/economic/environmental sustainability; biorights; intrinsic value; renewable resources; sustainable yield; recycling; circular economy; low technology; local governance; food miles; vegetarianism/veganism; subsistence living; etc
- **breadth in addressing and linking** range of ecocentric values/strategies with different aspects of sustainability.
- **examples** of ecocentric values and strategies and aspects of sustainable living/development etc
- **balanced analysis evaluating** extent to which an ecocentric value system is more or less beneficial in addressing sustainability than other value systems .
- **a conclusion that is consistent with, and supported by analysis and examples given** e.g. With the high regard in which it holds nature and the environment it is inevitable that ecocentric values and strategies for living are bound to be non-destructive and sustainable.

Please see markbands on page 17.

5. (a) Outline **four** transfers of carbon that will influence its atmospheric storage. **[4]**

Carbon may reduce atmospheric storage through:
a. Dissolving in oceans;
b. Uptake from plants for photosynthesis;

Carbon my increase atmospheric storage through:
c. Release from living organisms from respiration;
d. Release from burning/incineration/combustion of fossil fuels;
e. Release from decomposers from decomposition;
f. Forest fires;
g. Released from livestock/ruminants;

Note to examiners: *There must be an indication of the carbon movement to or from the atmosphere.*

(b) Describe methods that could be used to measure a change in species diversity of invertebrates along a river. **[7]**

a. Sample at regular intervals along river;
b. Take sufficient samples to be statistically significant / repeat at each sampling site;
c. Lay down a quadrat on river bed;
d. Hold net downstream of quadrat;
e. Kick/disturb substrate in quadrat;
f. Identify each species using identification key;
g. Estimate/record abundance of each species;
h Return invertebrates to sample site;
i Use data to calculate Simpson's diversity Index;
j. Standardize sampling such as the same number of kicks/duration of collection/time of day/year;

(c) With reference to named examples, to what extent is local involvement in conservation more valuable than international involvement **[9]**

Answers may demonstrate:

- **understanding concepts & terminology** of conservation; biodiversity; IUCN Red list; CITES; Man and Biosphere programme/reserves; RSPB; WWF; GOs/NGOs; local wilding projects; national parks; ownership; legislation; funding; ecotourism etc;
- **breadth in addressing and linking** range of international and local bodies or indigenous groups with conservation projects and their degree of success.
- **examples** of international and local environmental organisations/projects etc
- **balanced analysis evaluating** extent to which international engagement is more or less beneficial to conservation than local.
- **a conclusion that is consistent with, and supported by analysis and examples given** e.g. While international involvement often brings with it valuable economic and technological resources, having local communities actively invested in the project can be invaluable to its success.

Please see markbands on page 17.

6. (a) Outline the similarities and differences between the terms “crude birth rate” and “total fertility rate”. **[4]**

Up to two marks for definitions:

a. Crude birth rate (CBR) is the average number of births per 1000 individuals;
b. Total fertility rate (TFR) is the average number of children each woman has over her lifetime;

Similarities:
c. Both refer to number of births;
d. Both refer to mean values;
e. Both give some indication of potential for population growth/ reproductive patterns;

Differences:
f. TFR focuses on births per woman whereas CBR focuses on births in whole population;
g. TFR has an element of time, because it is over a woman’s lifetime, whereas CBR is a snapshot;
h. TFR accounts for age distribution (of women) whereas CBR does not;

(b) Evaluate **two** strategies for preventing the formation of photochemical smog. **[7]**

a. e.g. Reduce fossil fuel use/switch to renewable energy sources;
Pros:
b. Addresses the source of the problem;
c. Prevents many other environmental impacts/pollutants (eg. enhanced greenhouse effect/climate change/acid rain);
d. No finite limit to renewable energy resource;

Cons:
e. Involves developing new infrastructure/technology/expertise;
f. May be difficult to persuade people to change their lifestyles;
g. New technology may be expensive in short term;
h Environmental costs of producing/storing waste from batteries/turbines/solar panels/hydroelectric dams;

i. e.g. Use of scrubbers/catalytic converters:
Pros:
j. Catalytic converters remove NOx/VOCs/hybdocarbons/CO from emissions / scrubbers remove SO2/also prevent acid rain;
k. Allows continued use of fossil fuels;
l. Established effective/readily available technology;

Cons:
m. Doesn’t eliminate all greenhouse gases/CO2;
n. Technology has limited lifespan;
o. Still using a non-renewable resource/does not address the source of the problem;
p. Can be expensive for individuals/are often stolen from vehicles for metals;

***Note to examiners**: Note award 4 max per strategy (3 max if only pros or only cons are mentioned). Only credit two strategies, but consider the two highest scoring strategies. Allow credit along similar lines for other strategies*

(c) To what extent are natural limiting factors likely to stabilise human population growth? **[9]**

Answers may demonstrate:

- **understanding concepts & terminology** of natural factors such as disease, pandemics, natural disasters, resource depletion; carrying capacity; Boserup and Malthus models; limiting factors of food production; water supply; pollution; waste management; carbon capture technology; renewable energy sources; catalytic converters; scrubbers; GMOS; vertical farming; aquaponics; desalination; water treatment; green architecture; etc
- **breadth in addressing and linking** a range of limiting factors such as disease; food & water supply; available land for housing; other density-dependent factors; natural disasters; climate/weather conditions; pollution; waste management; urbanisation; with their likelihood of stabilising human population growth.
- **examples** of limiting factors in the areas of pollution; food & water supply; diseases; land availability; waste management and the ways in which they may be overcome etc
- **balanced analysis evaluating** extent to which natural limiting factors can be effective or ineffective in stabilising human population growth.
- **a conclusion that is consistent with, and supported by analysis and examples given** e.g. To a great extent the Boserup model has been supported in that technological development has neutralised many potential natural limiting factors but, rationally, in a system of finite resources there must be an outer limit beyond which we cannot go.

Please see markbands on page 17.

7. (a) Outline **four** disadvantages of hydropower as a source of renewable energy. **[4]**

a. Dams may involve flooding to create reservoirs/destruction of terrestrial ecosystems;
b. May reduce downstream supplies of water;
c. May utilise non-renewable resources in construction;
d. May interfere with natural migration of aquatic species / turbines may kill fish species;
e. May involve high costs for construction/maintenence;
f. May increase build up of silt and become non-functional/decrease sedimentation downstream interfering with nutrient cycling;
g. May force migration of local population;
h. May provide a reservoir for water-borne diseases/vectors;
i. May break/breach and cause flooding downstream;
j. Flooded vegetation/decomposition can release methane/GHG;
k. Dependent on rainfall/can dry up during droughts;

(b) Evaluate rainwater harvesting and desalination as a means of sustainably managing water supply. **[7]**

Rainwater harvesting (4 max):
Pros:
a. Low cost supply of water;
b. Low environmental impact/low technology;
c. Renewable supply / reduces use of potable water;
Cons:
d. Quantity very limited for agricultural purposes;
e. Weather/climate dependent;
f. May contain atmospheric pollutants / isn't generally potable;

Note to examiners*: Award 3 max if only pros or only cons are addressed*

Desalination (4 max):
Pros:
g. Vast supply of sea water available;
h. Produces potable water;
i. Independent of climate/precipitation;
j. Provides water security/independence;
Cons:
k. High cost supply:
l. Limited to coastal location;
m. Disposal of leftover salt;
n. Requires excessive energy supply;
o. Produces significant noise pollution;

Note to examiners*: Award 3 max if only pros or only cons are addressed*

(c) A ‘cycle’ is a concept relevant to many systems. Justify its usefulness in understanding the sustainability of named systems. **[9]**

Answers may demonstrate:

- **understanding concepts & terminology** of cycles; carbon/nitrogen/water cycles; organic & inorganic storages linked by death/decomposition and photosynthesis; convection cells causing atmospheric circulation etc, convection cells in lithosphere causing tectonic movement; oceanic conveyor belt; nutrient upwelling; recycling; circular economy etc
- **breadth in addressing and linking** a range of ‘cycles’ to their role in sustainability for a range of systems.
- **examples** of different cycles occurring in a range of named systems.
- **balanced analysis evaluating** extent to which the concept of a ‘cycle’ does or does not contribute to our understanding of how sustainability is achieved in systems.
- **a conclusion that is consistent with, and supported by analysis and examples given** e.g. A cycle inevitably demonstrates how material or energy flowing out of one storage will eventually return to that storage as an input, and this will lead to long term stability which is at the root of sustainability.

Please see markbands on page 17.

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.