Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2018

Environmental systems and societies

Standard level

Paper 2

16 pages

Section A

1. (a) Outline the evidence that CO_2 acts as a greenhouse gas. **[1]**

CO_2 absorbs (outgoing) longwave/IR radiation/heat elevating global temperatures;

Accept references to climate / CO_2 data as causal link, eg increase in global CO_2 levels correlate with rises in global temperatures.

(b) State a greenhouse gas other than CO_2. **[1]**

methane / water vapour / nitrous oxide / tropospheric ozone / CFCs / HCFCs / HFCs;

*NB if candidate names more than one gas **only** the **first** one should be assessed (even if the first is wrong and a later one is correct).*

(c) Outline how the mitigation strategy shown in **Figure 1** is different to an adaptation strategy for managing climate change. **[2]**

the mitigation strategy reduces the cause of climate change by removing CO_2/greenhouse gas from atmosphere;
whereas an adaptation strategy reduces negative/maximises positive impacts of climate change / addresses impacts rather than causes of climate change;

*Responses may involve giving examples of either mitigation or adaptation strategies, but to gain the **[2 max]** they must include the characteristic/distinguishing feature of **both** mitigation and adaptation (ie "reducing cause" and "addressing impacts", respectively).*

(d) Identify **two** mitigation strategies to manage climate change, other than carbon capture and storage. **[2]**

reducing energy/fossil fuel consumption through carbon tax/cap & trade;
reducing emissions of NO_x/methane/through catalytic converters/regulations;
alternative energy sources;
geoengineering;
fertilizing oceans;
afforestation/biomass production;

*Award **[1]** for each correct answer that will reduce emission/concentration of GHGs in atmosphere, up to **[2 max]**.*

(e) Outline how the Flows 1 and 2 shown in **Figure 1** may contribute to the capture and storage of atmospheric carbon. **[2]**

(both) flows remove CO_2 released by smokestacks/power plants/fossil fuel combustion / store waste CO_2 underground/beneath impermeable rock/in saline/oil reservoirs;
however, Flow 2 is associated with extraction of fossil fuels that will release more CO_2 (on combustion);

*Award **[1]** for each correct answer, up to **[2 max]**.*

2. (a) State the soil texture that has the following composition: 20 % clay; 55 % silt; 25 % sand. **[1]**

silt loam;

*NB if candidate names more than one soil type, examiners should **only** assess the **first** one listed (even if the first is wrong and a later one is correct).*

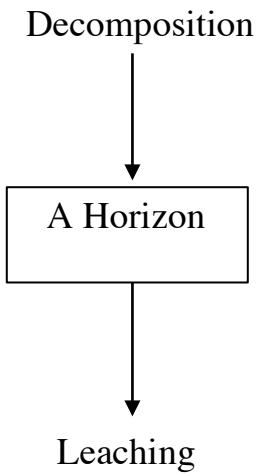
(b) Describe how the addition of sand to a silty clay loam could alter its characteristics for healthy plant growth. **[2 max]**

Positive effects:
it will increase drainage / prevent water-logging;
it will increase infiltration/permeability / reduce loss of water through run-off;
it will increase porosity/air spaces/reduce soil compaction providing more O_2 to roots;
it would allow for increase flow/availability of nutrients;
it will promote detritivore/decomposer/mycorrhizal/microbial communities;
it will allow for easier root penetration;

Negative effects:
it will reduce water-holding capacity so less water for plants;
it will increase possibility of leaching, reducing minerals for plants;
it will reduce stability of soil giving less anchorage to plants;

*Award **[1]** for each correct answer, up to **[2 max]**.*
Although question implies positive effects on soil, credit can be given for negative effects as long as candidates make this clear as in MPs given above.

(c) (i) Draw a flow diagram to show the flows of leaching and decomposition associated with the mineral storage in the "A" horizon. **[2 max]**



*Award **[1]** for each correctly labelled flow with arrows in the right direction.*

(ii) Identify **one** other input to the mineral storage in the "A" horizon. **[N/R]**

leaching/mineral flow/eluviation through from O horizon;
nitrogen fixation (*ie of N diffusing in from atmosphere*);
addition of inorganic/nitrate/phosphate fertilizer;
capillary flow up from B horizon;

Do not credit use of simply "fertilizers" or organic fertilizer/compost etc as this would be an input from decomposition. Do not credit "water" as an input.

(iii) Identify **one** other output from the mineral storage in the "A" horizon. **[1]**

uptake of minerals by plants;
soil erosion;
denitrification;
human activities of mining/soil extraction;
immobilization/microbial conversion of inorganic to organic;

Do not credit cropping/deforestation (as in themselves they are a loss of biomass, not mineral storage). Do not credit drainage/percolation (synonymous with leaching).
*Award **[1]** for correct answer, up to **[1 max]**.*

(d) Outline why leaving arable farmland fallow (unused) between growing seasons could lead to soil degradation. **[2 max]**

roots no longer hold soil in place/stabilize soil;
soil surface uncovered/more exposed to wind/water erosion;
uninterrupted rainfall/percolation will increase leaching of minerals;
greater evaporation may lead to salinization;
reduction/change in soil fauna/microbes;
lack of veg cover may lead to greater evaporation/drying out of soil;

*Award **[1]** for each correct answer, up to **[2 max]**.*

3. (a) Identify **one** producer in the system illustrated in **Figure 3**. **[1]**

algae/seaweed/sea grass;

(b) Outline **one** reason why aquaculture production has increased globally. **[1]**

increased food demand from increasing population/affluence;
health benefits / change of diet preferences;
depletion of marine fisheries / considered more sustainable;
limited arable land for food production;
more economically efficient/profitable;
requires less resources/expertise (boats, fishermen, *etc*) than wild fisheries;
technology/technological methods have improved;

*Award **[1 max]**.*

(c) Describe **two** negative environmental impacts that may arise from integrated aquaculture. **[2 max]**

escaped fish impact wild stocks through genetic degradation/disease/competition;
high density populations lead to more disease;
farmed species may consume/displace food species for local populations;
loss/degradation of habitat due to clearance for aquaculture / nets/cages may trap/endanger local species;
introduction of non-native species;
pollution due to use of medication/growth hormones/pesticides;

NB do not credit high nutrients/eutrophication/low diversity/high BOD or any other impacts that integrated agriculture actually limits or reduces (as indicated in responses to 3d below).
*Award **[1]** for each correct answer identified, up to **[2 max]**.*

(d) Explain why this system may cause fewer environmental impacts than systems that farm only fish. **[4 max]**

polyculture helps maintain biodiversity/complexity/resilience in the environment;
(polyculture) allows for species to recycle wastes of other species;
lobsters/mussels will reduce particles of organic waste/faecal matter/excess feed;
(reduction of particles will) reduce BOD/decomposition and oxygen consumption;
filtration by the mussels will improve water clarity/photosynthesis;
cropping/harvesting algae will prevent build-up of nutrients/eutrophication;
algae will absorb excess CO_2 reducing acidification of water;
algae will release oxygen limiting anaerobic conditions;
food is provided naturally from within system/feeds made up from wild populations are not required;

*Award **[1]** for each correct answer identified, up to **[4 max]**.*

Section B

Part (c) questions in Section B are all to be assessed using the markbands on page 21 with the guidance given below for each question.

4. (a) Outline how **four** different factors influence the resilience of an ecosystem. **[4 max]**

Valid factors:
greater diversity of components/species increases resilience;
complexity of interactions/developed food webs increase resilience;
establishment of keystone species increases resilience;
larger storages/stores / more abundant/productive resources (nutrients, water, sunlight, reproductive rates, biomass *etc*) increase resilience *(NB for credit, there must be indication of abundance in these resources, and if multiple examples are given like those in brackets, there is still only **[1 max]** allowed for this MP)*;
larger size of the system increases resilience;
strong negative feedback systems increase resilience;
strong positive feedback mechanisms may decrease resilience;
human impact degrading structure/diversity/abundance will decrease resilience;
a steady state equilibrium/balanced inputs and outputs (as in climax communities) increases resilience;
systems being close to a tipping point decrease resilience;

Accept converse statements.
*Award **[1]** for each correct factor identified, up to **[4 max]**.*
*If valid factors are identified, **but their effect on resilience is not**, award **[1]** for each TWO factors 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 eg TWO factors and their effect, along with ONE with no effect would score **[2+0=2]** total OR eg FOUR factors with no effect (**[1+1=2]** total).*

(b) Explain how a community of trees in a woodland may be considered a system. **[7 max]**

A community of trees in a woodland has the following features of a system:
individuals/species of trees are the components of the system;
these components are interrelated/interdependent/form an integrated whole;
eg may regulate populations through competition / contribute to succession of community;
it has flows/transfers of matter/energy between components/storages;
eg leaf fall may provide nutrients through decomposition to other trees / pollination/genes/food storage in seeds / glucose is transported from leaves around tree;
components carry out processes/transformations;
eg photosynthesis/respiration/growth;
it is an open system exchanging matter and energy with surroundings;
eg absorption of solar energy / provision of nutrients for non-tree species *(NB mark for either example of matter or energy, not both)*;
it has feedback mechanisms to maintain equilibrium/balanced inputs and outputs;
eg more seed production → more competition between seedlings → fewer viable offspring / death of trees → more light entering canopy → more tree growth;

*Award **[1]** for each correct suggestion, up to **[7 max]**.*
*Award **[4 max]** for identifying relevant generic features of system (given above) and **[4 max]** for examples of these **within a tree community (beware of responses that are looking at entire woodland ecosystem as a system rather than the tree community alone)**. Credit alternative examples of equivalent validity/relevance and detail.*

(c) Disturbance of the composition and processes of the atmospheric system through human activity always disturbs the equilibria of marine systems.

Discuss the validity of this statement with reference to named examples. **[9 max]**

*The following guide for using the markbands suggests certain features that may be offered in responses. The five headings coincide with the criteria given 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 include:

- **understanding concepts & terminology** of greenhouse gases; global warming; thermal expansion; rising sea-level; melting ice caps; salinity; ocean acidification; ozone depletion; UV radiation; global productivity; tropospheric ozone; acid rain (worth noting here that acid rain is NOT a significant cause/contributor to ocean acidification); *etc*
- **breadth in addressing and linking** impacts on atmospheric systems (increased CO_2; global warming; ozone depletion; tropospheric ozone; acid rain; *etc*) with disturbances in marine systems (rising sea level; ocean currents; fish migration; acidification; destruction of coral reefs; phytoplankton / marine food chains; *etc*)
- **examples** of relevant atmospheric pollutants/disturbances; ocean currents; coral communities; migratory fish; marine food chains; *etc*
- **balanced analysis** of the extent to which each atmospheric disturbance causes disturbance in marine systems whether significant, minimal or none at all, acknowledging relevant counter-arguments/alternative viewpoints;
- **a conclusion that is consistent with, and supported by analysis and examples given** *e.g.* generally, the statement is valid regarding large scale disturbances to the atmosphere such as global warming and ozone depletion but more localized disturbances like tropospheric ozone and acid rain have fairly minimal impact; *NB This is only an example of a possible conclusion. Candidates' conclusions do not have to agree.*

Please see markbands on page 21.

5. (a) Distinguish between the terms *niche* and *habitat* with reference to a named species. **[4 max]**

habitat is the kind of (biotic and abiotic) environment in which a species normally lives;
eg lions are found in tropical grasslands;
whereas its niche refers to all its interactions with its (biotic and abiotic) environment;
eg the prey that it eats / its vulnerability to parasites / access to fresh water;
habitat may be shared by many species / niche is more limited to a single species;
eg different cat species inhabit tropical grasslands but only lions hunt in groups and so tend to take larger prey;

*Award **[2 max]** if no examples are given. "Role of species within ecosystem" would be acceptable as definition of species, but not "job" which is anthropomorphic and only addresses impact of species on system, not the mutual relationship.*
Accept any relevant/valid/equivalently detailed examples to those given.
*Award **[1]** for each correct answer, up to **[4 max]**.*

(b) Suggest the procedures needed to collect data for the construction of a pyramid of numbers for the following food chain:

Plants ⟶ Snails ⟶ Birds **[7 max]**

quadrats can be used for counting/sampling snail/plant populations;
need to be randomly distributed within area of system;
total estimated by multiplying mean of samples by total area/sample area;
mark–release–recapture/Lincoln index can be used for bird/snail species;
individuals are caught using traps/nets/bait;
individuals marked by some means that is indelible/harmless/easily visible to investigators;
individuals released/allowed to redistribute before resetting traps;
ratio of marked : unmarked in recapture is recorded and used to estimate total population;
bird populations may be estimated by aerial photographs/birdsong recordings that allow capture/recapture analysis;
bars/histograms proportional to each total population are drawn;

*Award **[1]** for each correct suggestion, up to **[7 max]**.*
Accept alternative procedures of equivalent validity.

(c) Quantitative models are frequently constructed to show the flow of energy and cycling of matter in natural systems.

To what extent can these models be useful in assessing the sustainability of named food production systems. **[9 max]**

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

Answers may demonstrate:

- **understanding concepts & terminology** of models; energy flow through trophic levels; mineral cycles; sustainability; gross and net productivity; sustainable yield; natural capital and income; stock; storages; energy loss; harvesting; depletion of minerals; desertification; inorganic fertilizers; run-off; eutrophication; irrigation; leaching; *etc*
- **breadth in addressing and linking** models of energy flow and cycles of matter with balance of inputs and outputs; sustainability; agricultural strategies/activities; impacts related to energy flow / mineral cycles; other impacts; limitations of models; *etc*
- **examples** of a food production system; associated agricultural practices (sustainable and unsustainable); impacts addressed by models of energy flow / mineral cycles; other impacts; *etc*
- **balanced analysis** of ways in which models of energy flow and mineral cycles reveal sustainability of the food production system or fail to address them accurately, acknowledging relevant counter-arguments/alternative viewpoints;
- **a conclusion that is consistent with, and supported by analysis and examples given** *eg* these models are very effective at quantifying certain aspects of food production related to balancing inputs and outputs but there are many peripheral unsustainable aspects such as soil erosion, transport, use of pesticides that they do not address; *NB This is only an example of a possible conclusion. Candidates' conclusions do not have to agree.*

Please see markbands on page 21.

6. (a) With reference to named examples, distinguish between a *primary* and *secondary* pollutant. **[4 max]**

a primary pollutant is one which is active on emission / directly impacts the environment;
eg CO_2 is released from burning fossil fuels and actively contributes to global warming / CFCs are released from aerosols and actively contribute to ozone depletion;
a secondary pollutant is one formed from a primary pollutant through physical/chemical change;
eg CO_2 combines with sea water to form carbonic acid that leads to impacts on calciferous shelled organisms or corals / NO_x combines with water to form acid precipitation / NO_2 forms PAN/ozone (that contributes to photochemical smog);

*Award **[2 max]** if no examples are given.*
Examples of primary pollutants need to include their direct impact (eg NO_x can be either primary or secondary without such specification) and examples of secondary need to include the process leading to their pollutionary impact).
*Award **[1 max]** for example of primary, and **[1 max]** for example of secondary.*

(b) Explain how organic waste may be an effective fertilizer in terrestrial systems but a source of pollution in aquatic systems. **[7 max]**

*In terrestrial systems **[4 max]**:*
organic waste such as cattle manure/compost can be added to soil as fertilizer;
its decomposition releases nitrates/phosphates/nutrients that promote plant growth;
the slow release will help to prevent run-off/eutrophication/red tide/algal bloom of water bodies;
improves soil quality/structure / making it less prone to erosion/compaction / increases plowability;
it is similar to the natural organic waste in a terrestrial system so may not be a pollutant;

*In aquatic systems **[4 max]**:*
organic waste *eg* sawdust/domestic sewage/agricultural run-off can be discharged into aquatic systems;
increases turbidity/floats on surface/algal growth reduces light penetration and primary productivity of system;
its decomposition leads to bacterial absorption of O_2 / adds high BOD reducing O_2 availability;
this is a limiting factor in aquatic (not terrestrial) systems (negatively) impacting aquatic life;
(decomposition also) releases nitrates/phosphates/nutrients leading to eutrophication/red tide/algal blooms;
domestic sewage/sawmill effluent may contain non-biodegradable organic pollutants/toxins/pathogens;
can pollute drinking water sources for human populations/animal species;

*Award **[1]** for each correct explanation, up to **[7 max]**.*

(c) To what extent can different environmental value systems contribute to both causing and resolving the problem of water scarcity? **[9 max]**

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

Answers may demonstrate:

- **understanding concepts & terminology** of environmental value systems; technocentric; anthropocentric; ecocentric; pro-growth agenda; intensive agriculture; unsustainable extraction; industrialization; water contamination; climate change and rainfall patterns; desalination; rainwater harvesting; water taxes; grey-water cycling; *etc*
- **breadth in addressing and linking** range of environmental value systems with impacts of unsustainable extraction; contamination; distribution of water supply and solutions through technology; changes in behaviour; social controls; *etc*
- **examples** of value systems; impacts on water availability; specific strategies for addressing water scarcity; appropriate technology; *etc*
- **balanced analysis** of extent to which different value systems have promoted causes of water scarcity and/or effectively addressed resolving the issue; acknowledging relevant counter-arguments/alternative viewpoints;
- **a conclusion that is consistent with, and supported by analysis and examples given** *eg* it is the technocentric pro-growth agenda that has largely contributed to the problem of water scarcity and while technocentric solutions are available to address it, it is only the ecocentric solutions that address the root cause and attempt to curb consumption; *NB This is only an example of a possible conclusion. Candidates' conclusions do not have to agree.*

Please see markbands on page 21.

7. (a) Outline **four** different ways in which the value of named resources have changed over time. **[4 max]**

cultural influence *eg* rising environmental awareness led to value of straw as building material;
social influence *eg* animal rights leading to devaluing of animal furs in fashion;
economic influence *eg* increased investment in industrial processes led to higher value of fossil fuels;
technological influences *eg* progress in nuclear technology led to higher value of uranium;
political influences *eg* increasing concern for energy security in US has led to devaluing of oil / increased value of tar sands;
ecological influences *eg* greater understanding of ecosystems/ecology has led to high value attached to biodiversity;

NB As question does not specify further, and syllabus makes reference to marketable value (price), responses made in such terms should be credited.
*Award **[1 max]** if four influences are identified without examples.*
*Award **[1]** for each correct reason identified, up to **[4 max]**.*
Valid influences/reasons may not be categorized in precisely the same way as above, but examples need to demonstrate different kinds of influence to gain separate credit.

(b) The use of renewable resources is not always sustainable due to the activities involved in their production.

Justify this statement for a named source of renewable energy. **[7 max]**

eg hydropower (accept other valid examples of renewable energy):
hydropower is renewable because the water flow is replenished by the water cycle;
building the dam will inhibit migration of fish reducing their populations;
involve the flooding/destruction of terrestrial ecosystems;
cause sedimentation that will lead to more flooding upstream;
involve use of non-renewable building materials;
construction/maintenance involves heavy use of fossil fuels/GHG production;
reduced downstream flow threatening riverine populations/species;
(reduced downstream flow threatening) associated terrestrial systems dependent on water flow *eg* floodplains/wetlands;
building of access roads/growth of recreational activity may lead to damage of terrestrial/riparian systems;
may increase water loss/scarcity through increased evaporation rates;
impacts of dam may reduce sustainability of local populations through *eg* reduced fishing/breeding ground for parasites/loss of agricultural land;

eg solar energy:
solar energy is renewable because of continuous input/insolation;
energy for panel construction/extraction of silicon involves use of fossil fuels/GHG production;
production utilizes plastics derived from (non-renewable) fossil fuels;
manufacture results in plastic waste that is non-biodegradable;
require metals/elements that are non-renewable resources;
(metals/elements) extracted through mining that damages habitats/ecosystems;
manufacture involves use/production of many industrial toxins/hazardous waste;
manufacture/operation requires considerable water supply (for cooling etc);
transport of materials for manufacture/installation impacts environment;
limited life span/decommissioning will lead to further waste;
solar farms can take up/displace large areas of natural ecosystems;

*Award **[3 max]** if example of energy source is non-renewable or unnamed.*
*Award **[1]** for each correct answer given above or for any other points of equivalent relevance, validity and significance, up to **[7 max]**.*
If candidate addresses more than one valid resource, limit total credit to highest scoring one.

(c) Increasing concern for energy security is likely to lead to more sustainable energy choices.

Discuss the validity of this statement, with reference to named countries. **[9 max]**

*The following guide for using the markbands suggests certain features that may be offered in responses. The five headings coincide with the criteria given 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 include:

- **understanding concepts & terminology** of energy security; renewable/ non-renewable energy; sustainability; fossil fuels; nuclear; solar, biomass, hydropower, wind, wave, tidal or geothermal energy; emissions; *etc*
- **breadth in addressing and linking** different countries' issues of energy security with their energy choices and the relative sustainability of renewable/ non-renewable energy sources; *etc*
- **examples** of renewable/non-renewable energy sources; countries' energy choices; issues of energy security; impacts of exploiting energy resources; *etc*
- **balanced analysis** of whether energy choices driven by concern for energy security are more or less sustainable; acknowledging relevant counter-arguments/alternative viewpoints;
- **a conclusion that is consistent with, and supported by analysis and examples given** *eg* although more sustainable renewable energy choices will usually provide energy security, in some countries, because of local availability of non-renewable sources, the concern for security has been met by less sustainable sources *eg* US exploitation of tar sands; *NB This is only an example of a possible conclusion. Candidates' conclusions do not have to agree.*

Please see markbands on page 21.

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.