Diploma Programme
Programme du diplôme
Programa del Diploma

# Markscheme

## November 2022

## Environmental systems and societies

## Standard level

## Paper 2

19 pages

# Subject details: Environmental systems and societies SLP2 Markscheme

**Mark allocation**

Candidates are required to answer:
- **ALL** questions in Section A **[25]** and **TWO** questions in Section B **[40]**.
- The maximum total = **[65]**.

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

*When using marking points (<u>All of this paper except</u> Section B, part (c) questions):*

i. A markscheme often has more marking points than the total allows. This is intentional
ii. Each marking point has a separate line and the end is shown by means of a semi-colon (;)
iii. Where a mark is awarded, a tick/check (✓) **must** be placed in the text at the **<u>precise point</u>** where it becomes clear that the candidate deserves the mark. **<u>One tick to be shown for each mark awarded</u>**
iv. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

*When using markbands (<u>Only</u> for Section B, part (c) questions):*

i. Read the response and determine which band the response fits into
ii. Then re-read the response to determine where the response fits within the band
iii. Annotate the response to indicate your reasoning behind the awarding of the mark
**Do not use ticks at this point**
iv. Decide on a mark for the response
v. At the end of the response place the required number of ticks to enable RM Assessor to input the correct number of marks for the response.

**2.** An alternative answer or wording is indicated in the markscheme by a slash (/). Either wording can be accepted.

**3.** Words in brackets ( ) in the markscheme are not necessary to gain the mark.

**4.** Words that are <u>underlined</u> are essential for the mark.

**5.** If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by **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) Use Figures **1(a)** and **1(b)** to identify Species B and Species C. **[2]**

Species B: Nuttall's cottontail/(Sylvilagus nuttallii);
Species C: black-tailed jackrabbit/(Lepus californicus);

(b) The sagebrush ecosystem provides a habitat for pygmy rabbits. Suggest **one** reason why there might be a greater number of pygmy rabbits in the ecosystem shown in **Figure 1(c)** than in the ecosystem shown in **Figure 1(d)**. **[1 max]**

a. wider variety of food/increased amount of food sources;
b. more cover from predators;
c. easier to dig down because of root systems/less compaction;

(c) Describe **one** method to determine the impact of invasive cheatgrass on sagebrush density. **[3 max]**

a. (choice of study area): compare sagebrush habitat with invasive cheatgrass to one without it/carry out survey before and after introduction of invasive species (control);
b. (sample sites within each study area): randomly/systematically select sampling points/sites;
c. (method of estimation): use quadrat sampling/aerial photos to…;
d. (estimate densities): …determine number/biomass/percentage cover of sagebrush (and cheatgrass) in each sampling point;
e. (increase reliability of statistics): take a large enough number of samples/estimate mean densities of plants;
f. (statistical analysis) identify trends/patterns of density difference through t-test/ negative correlation through Pearson's r/or other valid test;

(d) Distinguish between the biodiversity of the sagebrush ecosystems in **Figures 1(c)** and **1(d)**. **[2 max]**

a. greater overall biodiversity without cheatgrass/in Fig 1c;
b. greater habitat/species/genetic diversity without cheatgrass/Fig 1c
c. greater richness of species without cheatgrass/in Fig 1c;
d. greater evenness of species without cheatgrass/in Fig 1c;

***Note:*** *Accept in the converse*

**2.** (a) Identify one transformation shown in **Figure 2(a)**. **[1]**

evapotranspiration;

***Note:*** *Do not credit evaporation or transpiration alone.*

(b) Calculate the difference in water infiltration between the forest and urban environments. **[1]**

(50% – 15%) = 35% ;

***Note:*** *Only **[1]** so working not required / credit final answer but only if it includes '%' sign Credit can be given if both shallow and deep infiltration are calculated separately (i.e. 15% + 20% respectively)*

(c) Outline how **one** storage in the hydrological cycle decreases with urbanization. **[1 max]**

a. groundwater/aquifers/soil water will decrease due to less infiltration/more runoff;
b. atmospheric storage/humidity will decrease because of reduction in evapotranspiration;
c. biomass storage will decrease because of loss of trees;

*Credit any aspect of urbanisation that will diminish any valid water storage.*

(d) Calculate the percentage of water projected to be used for agriculture in 2025, shown in **Figure 2(b)**. **[1]**

$\frac{2500}{4250}$ x 100 = 58.8% / 59% ;

(e) Suggest **one** reason for the projected decrease in the demand for water in agriculture between 2014 and 2025, shown in **Figure 2(b)**. **[1 max]**

a. improvements in irrigation techniques that use less water;
b. increase in use of crop varieties that use less water/are drought-resistant;
c. cultural shift away from eating meat / thirsty/water-intensive crops;

*Credit can be awarded for any factors that reduce water consumption / increase efficiency of use.*

(f) Outline **two** reasons why water demand shown in **Figure 2(b)** is projected to increase globally from 2014–2040. **[2 max]**

a. increased population increases demands for drinking/food production ;
b. greater demand for meat/water-intensive food items would increase irrigation;
c. drier climate (due to climate change) would increase water requirements for irrigation/watering lawns/drinking;
d. increased urbanization usually entails increased water demand (street cleaning, watering parks and artificial green areas, losses due to water transfer);
e. rising standard of living increases per capita water usage (bathing, pools, washing machines, watering lawns, cleaning paved surfaces);

***Note**: Do not accept reasons resulting in increased water usage for industries and energy generation, as these sections remain stable in figure; only credit reasons that, at least implicitly, link to increased domestic or agricultural water usage.*

(g) Outline **two** strategies to meet an increasing demand for domestic water. **[2 max]**

a. fix leaking pipes to stop water loss;
b. improve water efficiency of appliances/shower heads/toilets to make more available for other needs;
c. provide education/campaign to encourage people to use less / increase prices to decrease demand/introduce legal rationing of water;
d. artificial recharge of aquifers for domestic withdrawal;
e. use grey water so more freshwater is available for use;
f. rainwater capture can increase the amount available, if it would have otherwise been lost to the locality;
g. desalination can increase the amount of fresh water available for domestic use;
h. building of dams/reservoirs to store water;

*Only credit factors that refer to domestic/general water use (not agricultural/industrial).*

**3.** (a) Identify **one** region shown in **Figure 3** that has an ecological footprint less than its biocapacity. **[1]**

South America / Non-EU Europe;

(b) Outline **one** reason why a region whose ecological footprint is greater than its biocapacity is considered unsustainable. **[1 max]**

a. creating more waste than can be absorbed by the land / causing degradation of the environment;
b. using more resources than the land/sea can replace / overexploitation of resources;
c. society would not survive in this region without net import of resources;

(c) Outline **one** way in which a region can exceed its carrying capacity. **[1 max]**

a. importing resources from other regions;
b. exporting its waste products to other regions;
c. increasing range of resources used/technological development, *e.g.* desalination;
d. switching/substitution of resources/discovery of new reserves;
e. adopting more sustainable lifestyles;

***Note*** *Strictly speaking, c,d and e increase carrying capacity, but allow credit for these.*

(d) Productivity contributes to the biocapacity of land. Outline **one** climatic factor that limits the primary productivity of a region. **[1 max]**

a. low precipitation/drought conditions means less water for plants/photosynthesis;
b. low temperatures decrease photosynthetic rates/frozen water is unavailable to plants;
c. low insolation means little light for photosynthesis;
d. very high temperatures at which rate of photosynthesis decreases/less water available through increased evaporation;

*Do not credit naming the factor alone (e.g. low precipitation) ...it must be linked to productivity as in eg's above.*

(e) Evaluate the use of the ecological footprint as a model. **[4 max]**

*Strengths/advantages:* ***[2 max]***

a. a useful snapshot of the sustainability of a population's lifestyle/simple quantitative index of sustainability;
b. a tangible tool for individuals/governments/countries to measure/compare their environmental impact / to identify necessary changes in lifestyle;
c. iconic symbol/image for raising awareness of environmental issues;
d. widely accepted and understood by general public;

*Limitations/disadvantages:* ***[2 max]***

e. does not include all information on the environmental impacts of human activities;
f. only a model so simplified/not precise;
g. approximation of actual figures which cannot be accurately calculated/based on doubtful assumptions;
h. does not show types of resources used / shows only total resources;
i. negative in approach so could be perceived as de-motivating;
j. considers land as productive/valuable only if it is directly useful to humans;

*Appraisal that is substantiated* ***[1 max]****;*

***Example:*** *Although the EF as a model isn't precise, it can provide useful information to help reduce an individual's environmental impact.*

## Section B

**4.** (a) Distinguish between point and non-point sources of pollution with reference to **named** examples. **[4 max]**

a. point source comes from a single source whereas non-point source comes from multiple/dispersed sources;
b. point sources more easily identifiable (than non-point source);
c. point sources are more easily managed (than non-point source);
d. *e.g.* point source such as a sewage pipe/factory smokestack/drainage ditch;
e. *e.g.* non-point source such as runoff of fertilizers and pesticides from agricultural land/soil erosion from improperly managed construction sites/oil and toxic chemicals from urban runoff/vehicle-exhaust emissions;

***Note:*** *Award 3 max if no examples are given*

(b) For a **named** water pollutant, evaluate **two** management strategies to maintain the sustainability of water sources. **[7 max]**

*Strategy:*
a. reducing human activities that produce pollutants / use alternatives to fertilizers and detergents that reduce nitrate and phosphate input/slow-release fertilizers /reduce fossil fuel use to reduce acid preciptitaion;
*Advantage:*
b. stops pollution of resource at source;
c. can save money spent on *e.g.* fertilizers;
*Disadvantage:*
d. can impact livelihoods/food resource productivity;
e. difficulty in changing people's behaviour/lifestyle;

*Strategy:*
f. reducing release of pollution into the environment/treatment to remove nitrates/phosphates/pollutants from emisssions/effluent/planting of buffer zones;
*Advantage:*
g. planting of buffer zones creates a new habitat;
h. prevents eutrophication/impact on ecosystem;
*Disadvantage:*
l. cost of treatment;
j. requires enforcement;

*Strategy:*
k. removing pollutants from the environment/removal of mud from eutrophic lakes/ restoration of ecosystems/reintroduction of plant and fish species/liming of acidified lakes;
*Advantage:*
l. community/biodiversity is restored;
m. will encourage further pollution management to sustain system;
*Disadvantage:*
n. high cost of restorative strategies;
o. full restoration is uncertain/takes time;

***Note:*** *Award **[4]** max for each strategy (1max for named strategy, 2 max for advantage 2 max for disadvantage. Award 4 max if no water pollutant named. Accept any other relevant example/strategies to those given. If two strategies from the same MP are addressed then just give credit for highest scoring one.*

(c) Human activities have improved global air quality during the past 50 years. With reference to examples, discuss this statement. **[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 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 and terminology** of air pollution (definition); human activities that can increase air pollution include combustion of fossil fuels in power stations/industries, use of cars, intensive agricultural practices, fires; ODSs; human activities that can decrease air pollution include afforestation, walking or using the bike, catalytic convertor use, legislation;
- **breadth in addressing and linking** a range of human activities with a variety of positive and negative impacts from different societies on global air quality
- **examples** can discuss issues such as legislation/afforestation/deforestation/behavioural changes in named regions or countries, policies, legislation including Montreal Protocol, Kyoto Protocol, technology, polluter pays principle (the more exhaust you produce the more you pay, *e.g.* in EU), green taxes/heavily taxing processes that produce a lot of pollution, and subsidizing PV panels, solar water heaters, reorienting education systems; wild fires, particulate removal (filters and electrostatic precipitators), NOx control by fitting catalytic convertors on cars to change pollutants to harmless substances: $NO_2$ into $N_2$ and $O_2$, CO into $CO_2$, VOC into water and $CO_2$, sulphur removal through changing fuel, low sulphur coal or change plant to solar, fluidized bed combustion and flue gas desulphurization/scrubbers / limestone together with water is sprayed inside the chimney to convert $SO_2$ into calcium sulphate;
- **balanced analysis:** of extent to which human activities have reduced or increased air pollution over last 50 years.
- **a conclusion that is consistent with and supported by analysis and examples given,** *e.g.* "human activities have greatly increased air pollution, whereas the majority of activities that aim to reduce air pollution seem to be reactive rather than proactive in principle";

*Please see markbands on page 19.*

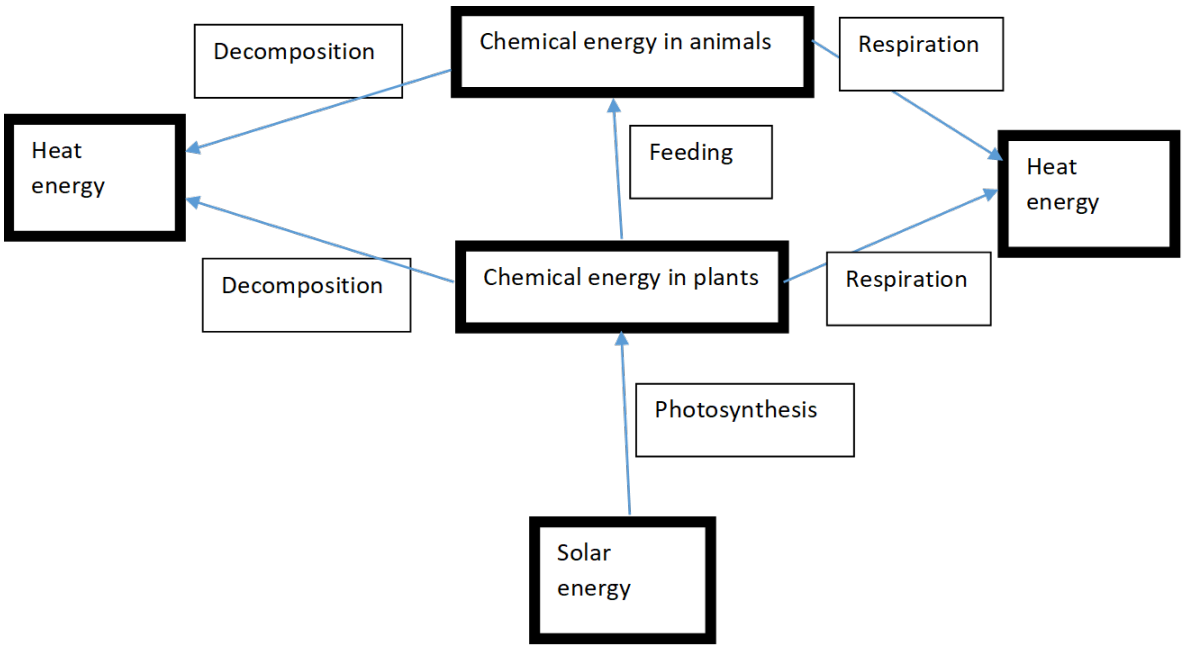
**5.** (a) Describe biotic and abiotic factors with reference to a **named** ecosystem. **[4 max]**

a. abiotic factors are non-living physical factors;
b. named example of ecosystem involving physical factors such as temperature/ sunlight/pH/salinity/precipitation etc.;
c. biotic factors are living factors;
d. named example of ecosystem with biotic factors such as predation/herbivory/parasitism/ mutualism/disease/competition/producers/ consumers/plants/animals etc;

***Note:*** *Accept biome name as a named ecosystem. Examples must be given in context to the named ecosystem. Award 3 max if no ecosystem named.*

(b) Using a system diagram, explain the transfer and transformation of energy as it flows through an ecosystem. **[7 max]**

*example diagram:*




*Award 1 mark for every two correctly identified stores of energy (Solar/plants/animals/Heat) 2 max*
*Award 1 mark for every correctly identified transfer or transformation (photosynthesis/feeding/respiration/decomposition) 4 max*
*Award 1 mark for clarity of diagram.*

*If there is no creditworthy diagram but some verbal explanation 1 mark can be given for every two stores identified and each transfer/transformation process up to a maximum of 4 marks.*

(c) With reference to **named** societies, to what extent do environmental value systems influence the use of resources? **[9 max]**

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*Answers may include:*

- **understanding concepts and terminology** associated with ecocentrism; technocentrism; anthropocentrism; biorights; sustainable yield; agriculture; subsistence/commercial farming; soil conservation; energy production; renewable/non-renewable; water supply; economic growth; self-restraint; dynamic nature of natural capital, energy security, appreciating non-use values, waste management, carrying capacity, ecological footprint etc:
- **breadth in addressing and linking** environmental value systems with sustainable and unsustainable examples of resource selection and use.
- **examples** of different environmental value systems in various named regions/countries and their approaches to the use and selection of different resources.
- **balanced analysis** addressing the extent to which value systems do or do not influence the selection and use of resources.:
- **a conclusion that is consistent with and supported by analysis and examples given**, *e.g.* " Western societies tend to prioritize environmental manager approaches trying to combine the economic benefits of technocentrrism with the regulatory interventions of anthropocentrism. LEDCs policies may become technocentric/utilitarian in their attempt to industrialize and reduce poverty, even if their traditional values and lifestyles may lean toward ecocentrism;";

*Please see markbands on page 19.*

**6.** (a) Outline the role of the greenhouse effect in regulating the temperature on Earth. **[4 max]**

a. the principal greenhouse gases are carbon dioxide/$CO_2$, methane/$CH_4$, water vapour, nitrous oxide/$N_2O$; (*no credit for anthropogenic GHGs, like tropospheric ozone, CFCs, HFCs*)
b. …and are found in the troposphere;
c. sun light (visible/short wavelengths) pass through GHGs/reach the Earth and warm its surface;
d. fwarm Earth surface is re-radiating energy outward as infra-red radiation/heat; (*no credit for "reflection" of light/heat*)
e. GHGs are opaque to/absorb outgoing IR/long wavelength radiation;
f. much of the heat energy is therefore retained/raising the average temperature of the Earth surface (to 15°C);

(b) Using examples, evaluate **two** solid domestic waste disposal strategies as methods to mitigate climate change **[7 max]**

*Credit any waste disposal strategy that reduces $CO_2$ in atmosphere (mitigation) and is clearly linked to domestic waste*

*Strategy:*
a. increased reusing/recycling/reduction of resource use;
*Advantage:*
b. recycling/reducing/reusing prevents release of GHGs through landfill/incineration;
c. recycling/reducing/reusing prevents release of GHGs in production of further materials;
*Disadvantage:*
d. involves sorting and transportation costs;
e requires challenging behavioural changes;

*Strategy:*
f. incineration / use for energy production / combustion/oxidation of methane;
*Advantage:*
g. waste can be used to produce heat or electricity / this could replace the energy produced using coal or other fuels;
i. $CO_2$ produced has lower greenhouse equivalent than methane;
*Disadvantage:*
j. there is some air pollution associated with incineration;
k. reduction in local property value/peoples' negative perception;

*Strategy:*
l. collection of methane from landfills;
*Advantage:*
m. Can be burnt as fuel ($CO_2$ has lower greenhouse equivalent);
*Disadvantage:*
n. requires sophisticated equipment not accessible to LEDCs;
o. would promote further use of landfills instead of decommissioning;

*Strategy:*
p. composting;
*Advantage:*
q. replacing production of inorganic/artificial fertilizers which contributes to climate change;
*Disadvantage:*
r. sorting costs;
s. produces methane;

***Note:*** *Award* ***[4]*** *max per waste disposal option (1 max for named strategy, 2 max for advantage, 2 max for disadvantage) Credit can be given for just naming a strategy (I.e. recycling/incineration/composting) but no credit for 'landfills' unless methane collection is added.*

(c) Using examples, discuss the potential impacts of climate change on ecosystem services. **[9 max]**

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*Answers may include:*

- **understanding concepts and terminology:** climate change; global warming; biome shifts; rising sea levels; flooding; saltwater intrusion; desertification; increased frequency and intensity of extreme weather events; ecosystem services: water purification; soil conservation; nutrient cycling; water cycling; natural pollination, microclimate mitigation, air purification, human mental and physical well-being, recreation, scientific inquiry, wildlife habitat, provision of natural capital;
- **breadth in addressing and linking:** climate change with a range of different impacts on a range of ecosytem services including both positive and negative impacts.
- **examples:** of impacts on a variety of named ecosystems and the services they offer in different parts of the world**.**
- **balanced analysis** of the degree to which climate change will negatively or positively impact a range of ecosystem services in different parts of the world..
- **a conclusion that is consistent with and supported by analysis and examples given,** *e.g.* "Although there may be positive impacts in some areas, like increased biodiversity or improved climatic conditions and productivity in high latitude areas, scientific understanding of ecological resilience would argue that consequences of shifting equilibria are hard to predict (more probably would be negative rather than positive or pass through a large period of instability)";

*Please see markbands on page 19.*

**7.** (a) Outline the mechanism of natural selection. **[4 max]**

*Natural selection occurs through the following mechanism:*

a. natural selection acts on the genetic variation of a population;
b. formed by mutations in previous generations;
c. (when environmental conditions change), some individuals will be fitter/more advantageous than others;
d. thus will survive and reproduce at higher rates;
e. inheriting these advantageous traits to their offspring;
f. hence the frequency of that advantageous character will increase in the population;

*Above points may be credited through an example*

(b) Explain the link between soil fertility, primary productivity and human activity. **[7 max]**

a. soil fertility refers to the ability of soil to support plant growth/primary productivity;
b This will depend upon the nutrient availability in soils;
c …and appropriate availability/retention/drainage of water in soils;
d. ...and appropriate soil pH/low salinity to allow for plant growth;
e. It will also depend upon appropriate soil texture/aeration/malleability;
f …and also the community of soil organisms that maintain its nutrient content/condition;
g. human activities may deplete nutrient content through over irrigation/ overcropping/monoculture/overgrazing;
h. human activities may increase salinity through over-irrigation;
i. human activities may increase soil erosion/compaction through tilling/overgrazing/overcropping/land clearance
j. human activities may lower pH through emissions of NOx/SOx/acid precipitation;
k. human activities may reduce soil water through evaporation due to anthropogenic global warming;
l. human activities may improve nutrient content through fertilization/polyculture;
m. human activities may reduce erosion through drip irrigation/terracing/ wind breaks/contour ploughing;
n. human activities may improve soil texture through conditioners/organic fertilizer;

*Award 5 max if all three factors (fertility/productivity/human activity) are not addressed in links.*

(c) Using examples, discuss how social, cultural, political and economic factors influence societies in their choice of food production systems. **[9 max]**

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*Answers may include:*

- **understanding concepts and terminology**: aquatic and terrestrial food production; intensive or extensive, arable or market gardening, crops or livestock based, subsistence or commercial, organic or inorganic, monocultures or diverse farms, family or corporate ownership, irrigated or rain fed, soil based or hydroponic; use ~~f~~of food labels~~-~~
- **breadth in addressing and linking**: food choices of different societies and the social, cultural, political and economic factors that influence them.
- **examples of** at least one social, cultural, political and economic factor that influences food production systems in different societies
- **balanced analysis** of the extent to which a range of social, cultural, political and economic factors addressing inputs, outputs, diversity, environmental impacts, profitablity of food production system determine choice of food production systems in different societies
- **a conclusion that is consistent with and supported by analysis and examples given**, *e.g.* "Affluence and economic development is a major factor in determining the degree to which livestock products and fish are selected for production since they require significant water and energy inputs that can be too expensive for developing countries. ;

*Please see markbands on page 19.*

## Section B, part (c) markbands

| Marks | Level descriptor |
|---|---|
| **0** | The response does not reach a standard described by the descriptors below and is not relevant to the question. |
| **1–3** | The response contains:<br>• minimal evidence of knowledge and understanding of ESS issues or concepts<br>• fragmented knowledge statements poorly linked to the context of the question<br>• some appropriate use of ESS terminology<br>• no examples where required, or examples with insufficient explanation/relevance<br>• superficial analysis that amounts to no more than a list of facts/ideas<br>• judgments/conclusions that are vague or not supported by evidence/argument. |
| **4–6** | The response contains:<br>• some evidence of sound knowledge and understanding of ESS issues and concepts<br>• knowledge statements effectively linked to the context of the question<br>• largely appropriate use of ESS terminology<br>• some use of relevant examples where required, but with limited explanation<br>• clear analysis that shows a degree of balance<br>• some clear judgments/conclusions, supported by limited evidence/arguments. |
| **7–9** | The response contains:<br>• substantial evidence of sound knowledge and understanding of ESS issues and concepts<br>• a wide breadth of knowledge statements effectively linked with each other, and to the context of the question<br>• consistently appropriate and precise use of ESS terminology<br>• effective use of pertinent, well-explained examples, where required, showing some originality<br>• thorough, well-balanced, insightful analysis<br>• explicit judgments/conclusions that are well-supported by evidence/arguments and that include some critical reflection. |