

# Markscheme

November 2025

**Environmental systems and societies**

**Standard level**

**Paper 2**

© International Baccalaureate Organization 2025

All rights reserved. No part of this product may be reproduced in any form or by any electronic or mechanical means, including information storage and retrieval systems, without the prior written permission from the IB. Additionally, the license tied with this product prohibits use of any selected files or extracts from this product. Use by third parties, including but not limited to publishers, private teachers, tutoring or study services, preparatory schools, vendors operating curriculum mapping services or teacher resource digital platforms and app developers, whether fee-covered or not, is prohibited and is a criminal offense.

More information on how to request written permission in the form of a license can be obtained from <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

© Organisation du Baccalauréat International 2025

Tous droits réservés. Aucune partie de ce produit ne peut être reproduite sous quelque forme ni par quelque moyen que ce soit, électronique ou mécanique, y compris des systèmes de stockage et de récupération d'informations, sans l'autorisation écrite préalable de l'IB. De plus, la licence associée à ce produit interdit toute utilisation de tout fichier ou extrait sélectionné dans ce produit. L'utilisation par des tiers, y compris, sans toutefois s'y limiter, des éditeurs, des professeurs particuliers, des services de tutorat ou d'aide aux études, des établissements de préparation à l'enseignement supérieur, des fournisseurs de services de planification des programmes d'études, des gestionnaires de plateformes pédagogiques en ligne, et des développeurs d'applications, moyennant paiement ou non, est interdite et constitue une infraction pénale.

Pour plus d'informations sur la procédure à suivre pour obtenir une autorisation écrite sous la forme d'une licence, rendez-vous à l'adresse <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

© Organización del Bachillerato Internacional, 2025

Todos los derechos reservados. No se podrá reproducir ninguna parte de este producto de ninguna forma ni por ningún medio electrónico o mecánico, incluidos los sistemas de almacenamiento y recuperación de información, sin la previa autorización por escrito del IB. Además, la licencia vinculada a este producto prohíbe el uso de todo archivo o fragmento seleccionado de este producto. El uso por parte de terceros —lo que incluye, a título enunciativo, editoriales, profesores particulares, servicios de apoyo académico o ayuda para el estudio, colegios preparatorios, desarrolladores de aplicaciones y entidades que presten servicios de planificación curricular u ofrezcan recursos para docentes mediante plataformas digitales—, ya sea incluido en tasas o no, está prohibido y constituye un delito.

En este enlace encontrará más información sobre cómo solicitar una autorización por escrito en forma de licencia: <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

## 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 (All of this paper except 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 **precise point** where it becomes clear that the candidate deserves the mark. **One tick to be shown for each mark awarded**
- iv. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

*When using markbands (Only 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 underlined are essential for the mark.
5. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by **WTTE** (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) Using **Figure 1(a)**, identify which age range makes up the largest percentage of the population of South Korea in 1960 and 2024. [2]

Year	Age group
1960	0-5;
2024	50-54;

- (b) Outline **two** national development policies that might have contributed to the changes shown in the pyramids from 1960 to 2024. [2]

*Decreasing birth rates due to:*

- a. Educating women for greater economic/reproductive independence;
- b. Providing sex education so people understand how to control how many children to have;
- c. Provide access to family planning services/birth control/abortion services so women can control how many children they have;
- d. Direct policies such as governing the number of children women can have;
- e. Investment in social security/pensions so people don't have to depend on children to care for them in later years;
- f. Investment in agricultural technology so not as many children are needed to work;

*Decreasing death rates / increase in elderly people / longer lifespans due to:*

- g. Improved access to healthcare / increasing the number of hospitals/clinics;
- h. Improved infrastructure for sanitation / access to clean water;
- i. Investment in social security/pensions so elderly can take care of/support themselves;

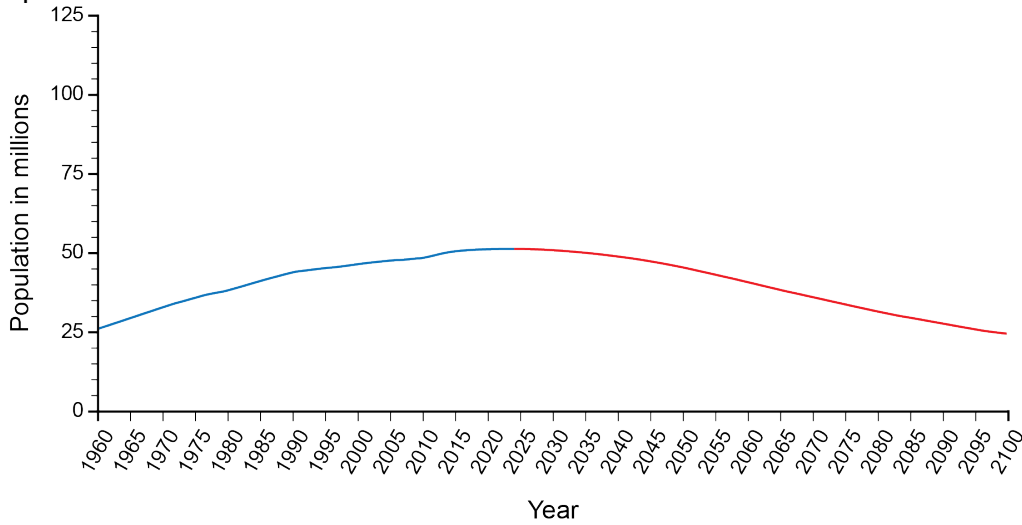
**Note to examiners:** Award marks only if the national development policy is identified, and the candidate gives some explanatory detail about how it affects population outcomes. Do not award non-policy statements such as improved economy or cultural trends

- (c) Describe the trend in population numbers between 1960 and 2024, as shown in **Figure 1(b)**. [2]

- a. Increasing/positive trend (in general or within a valid timeframe)
- b. Steep/sharp increase until 1990;
- c. Slows down/begins to level off at 1990;
- d. then level/constant/plateaus from 2010/2015 (to 2024);

**Note to examiners:** one mark max if no reference to dates included in response

- (d) Using information from **Figure 1(a)**, sketch a line on **Figure 1(b)** to demonstrate the expected total population between 2024 and 2100. **[1]**



[Source: © 2024 by PopulationPyramid.net, made available under a Creative Commons license CC BY 3.0 IGO: <http://creativecommons.org/licenses/by/3.0/igo/>.]

**Note to examiners:** Allow credit for any line that shows a clear decrease immediately following 2024.

- (e) Outline **one** strength and **one** weakness of using models, such as the age–gender pyramids shown, to predict the growth of human populations over time. **[2]**

**Strength [1 max]**

- a. These models give an overview/snapshot/visual representation of population trends/gender balance/age structure;
- b. They allow a comparison of population trends/gender balance/age structure with other countries/historic populations;
- c. Allow for predictions in population trends (e.g. more individuals at reproductive age can indicate an increasing population);
- d. They allow planning for age specific services such as schools/housing etc.;

**Weakness [1 max]**

- e. The models don't take into account future changes in policies/major events such as disease/war/migration;
- f. The models might not have captured all the births/deaths in the country / initial data gathering may be unreliable;
- g. As models, they are a simplified reflection of reality;

**Note to examiners:** accept valid examples that represent the markpoints above;

2. (a) Using **Figure 2(a)**, identify which type of soil degradation makes up the largest percentage globally. [1]  
Water erosion;
- (b) Outline **two** farming techniques that could reduce soil erosion. [2]
- a. Add windbreaks/trees /shelterbeds to reduce wind erosion;
  - b. Plant cover crops/mulch to reduce wind erosion / intercepts raindrops (reducing water erosion);
  - c. Terrace slopes/use contour ploughing to reduce water erosion / reduce water flow;
  - d. Reduce tillage/use conservation tillage to protect the soil surface and allows water to infiltrate/reduces water erosion / reduces physical disturbance of soil (e.g. by tillage machinery) / improves water holding/infiltration capacity of soil;
  - e. Rotational grazing/managing stocking density reduces soil compaction (by preventing overgrazing);
  - f. Drip irrigation to reduce water erosion;

**Note to examiners:** Do not credit techniques that are not clearly linked to soil erosion (e.g. crop rotation). As an “outline” there needs to be a little more than simply stating a technique.

- (c) State the trend of microorganism biomass with increasing depth in **Figure 2(b)**. [1]  
Inverse/decreasing/the greater the depth the less biomass;
- (d) State **one** process that could reduce the mineral storage from the A horizon. [1]
- a. Erosion;
  - b. Leaching;
  - c. Plant uptake;
  - d. Eluviation;
  - e. Denitrification;
  - f. Acidification;
- (e) Outline **one** role that microorganisms play in soil ecosystems. [1]
- a. Decomposition of dead organic matter (preventing its accumulation/improving soil structure/water retention ability);
  - b. Conversion of organic matter into inorganic minerals (mineralization) (for plant uptake);
  - c. Perform nutrient cycling making nitrogen/phosphorus/nutrients available for plants;
  - d. Nitrogen fixation enriches soil with nitrogen;
  - e. Nitrification releases nitrates for plant uptake;
  - f. Denitrification removes soil nitrates;
  - g. Source of food to higher trophic levels;

- (f) Explain how overgrazing could impact soil quality. [3]
- a. Overgrazing removes plants from the system/reduces plant cover;
  - b. Reduced plant cover/fewer roots can lead to wind/water erosion;
  - c. Fewer plants mean less organic matter returned to the soil reducing nutrient availability/water retention;
  - d. Overgrazing can lead to soil compaction;
  - e. Soil compaction could reduce porosity/water infiltration/soil holding capacity / increase run-off /water erosion;
  - f. Soil compaction could increase water logging could reduce available nitrogen/nitrification/nitrogen fixation/increase denitrification;
  - g. Erosion/compaction of topsoil could greatly reduce microorganisms responsible for nutrient cycling;
  - h. Erosion can reduce the mineral and nutrient availability to soil;
  - i. Feces from animals can add nutrients/fertilizer to soil / can affect soil pH;

3. (a) Using **Figure 3**, calculate the percentage difference between the marine capture fishery stock considered overfished in 1974 and 2019. [1]

(1974 = 10%  
2019 = 35%  
35 % - 10% or 90% - 65%) = 25(%);

**Note to examiners:** Working and “%” are not required for full credit.  
Because “percentage difference” is ambiguous, credit may also be given if candidate carried out the following working:

$((35-10) \times 100 / 10 =) 250(\%)$

- (b) Outline **two** reasons for the change in overfished stock between 1974 and 2019, as shown in **Figure 3**. [2]

Increased marine capture/overfishing because:

- a. Increased population increasing the demand for food;
- b. Increased demand in fish by consumers (because it fashionable/healthy);
- c. Increased use of fish for animal feed/aquaculture;
- d. Increased of subsidies/economic incentives to promote more fishing;
- e. More intensive/unsustainable fishing technologies / e.g. long-lines/trawling/gill nets/satellite imaging;
- f. reduced MSY due to lower reproductive potential/dwindling fisheries (positive feedback of past fishing pressure);

**Note to examiners:** No credit unless points imply an increase in marine (over)fishing

- (c) Evaluate a management strategy for capture fisheries that could be used to reduce the levels of unsustainable fishing from 2019 as shown in **Figure 3**. **[4]**

Valid strategy that could increase sustainability [1 max]  
One mark per outlined strength [2 max]  
One mark per outlined weakness [2 max]  
Valid balanced conclusion [1 max]

**Note to examiners:** Credit the evaluation of any one valid strategy, if more than one, award the highest marked. See examples below:

*Example Strategy:*

- a. Use quotas/fish at/below maximum sustainable yield;

*Strengths [2 max]:*

- b. Setting quotas below maximum sustainable yield reduces the amount of fish caught;  
c. Allows fisheries re-stocking/gives time for fish to breed;  
d. Forces regular data collection allowing informed management decisions;

*Weaknesses [2 max]:*

- e. Difficult/expensive to monitor or enforce quotas/types of fishing gear/no fishing zones;  
f. Difficult to estimate MSY / If MSY is overestimated the stock will be overfished;  
g. MSY ignores system complexity/role of the organism;

*Award one mark for a balanced conclusion; Ex. Although marine protected areas can be difficult to monitor, if done successfully it promotes biodiversity and increases fish stocks.*

*Example Strategy:*

- h. Restrict types and sizes of fishing gear/mesh sizes;

*Strengths [2 max]:*

- i. Allows fisheries re-stocking/gives time for fish to breed;  
j. Having larger mesh sizes allows young fish to escape;  
k. Decreases bycatch/capture of non-target species;  
l. No trawling decreases habitat destruction;

*Weaknesses [2max]:*

- m. Difficult to enforce and monitor on the sea;  
n. Larger mesh size may still allow bycatch of larger species;  
o. Might decrease income for fishermen;

*Award one mark for a balanced conclusion; Ex. Gear restrictions are an important tool in protecting small fish and fragile habitats, however, they are incapable of controlling the quantity of fishing effort or the total catch.*

## Section B

4. (a) Outline how decreasing stratospheric ozone may impact living organisms. [4]
- a. Decreased stratospheric ozone increases UV radiation that reaches the earth from the sun;
  - b. UV radiation can harm sensitive species such as marine organisms (e.g. phytoplankton/coral reefs)/amphibians;
  - c. UV radiation can damage chloroplasts decreasing plant growth/crop yields/photosynthesis;
  - d. decreased plant growth/sensitive species can have knock on effects on the food chain/web/decrease access to food;
  - e. UV radiation can cause mutations/skin cancer/cataracts;
  - f. UV radiation can weaken the immune system;
- (b) Pollution can be managed at three different levels: altering human activity; controlling release of pollutant; and clean-up & restoration. Describe strategies at each of these levels that may be employed in addressing photochemical smog. [7]

*Altering human activity may include [3 max]:*

- a. Altering human activities is meant to stop use of fossil fuels / release NO<sub>x</sub>/VOCs in the first place;
- b. Education to raise public awareness about photochemical smog;
- c. Promoting renewable energy sources / limiting emissions from energy production;
- d. Promoting the use of energy efficient technology/electric cars;
- e. Passing legislation such as clean air policies/traffic limitations/congestion pricing;
- f. Promoting/creating infrastructure to reduce car use/increase use of public transport/carpooling/cycling/electric vehicles;

*Controlling release of pollutant [3max]:*

- g. Controlling the release is meant to minimize how much of the pollutant is released into the environment;
- h. Legislation/taxation to limit industrial/vehicle emissions/fuel quality;
- i. Use of catalytic converters to remove nitrogen oxides from emissions;
- j. Use of scrubbers in industrial outlets to remove VOCs/NO<sub>x</sub> from emissions;

*Clean-up and restoration [3 max]:*

- k. Clean-up and restoration is to recover ecosystems/address the damage done after the pollution has been released into the environment;
- l. Tree planting/urban greening/reforestation to absorb pollutants;
- m. Green infrastructure/architecture e.g. green roofs to absorb pollutants;
- n. Health treatments to address respiratory issues;

**Note to examiners:** Accept any other relevant example/strategy of equal merit.

- (c) To what extent are different value systems effective in their approach to managing air quality?

[9]

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 mark band and the specific mark within that band.

*Answers may demonstrate:*

- **understanding concepts terminology** of EVSs values/perspectives/worldviews, anthropocentric; technocentric; ecocentric; cornucopian; ecological managers; air quality; atmospheric pollutants; particulate matter; ozone; nitrogen dioxide; sulphur dioxide; carbon monoxide; volatile organic compounds; pollution management strategies; altering human activities responsible for pollution; 'end-of-pipe' strategies preventing release of pollutants; restoring damaged ecosystems; characteristic management strategies for different EVSs i.e. ecocentric (restraint in resource use/biorights/renewable resources/recycling etc.) through anthropocentric (legislation/taxation/carbon credits/fines/emission standards etc.) to technocentric (catalytic converters/scrubbers/renewable energy/electric vehicles/carbon capture etc.).
- **breadth in addressing and linking** varying EVSs (at least two) with a range of different characteristic principles/approaches and respective different strategies for managing air quality;
- **examples** of varying EVSs/values/perspectives/attitudes leading to varying choices of strategies managing a range of air pollutants;
- **balanced analysis evaluating** the extent to which the various strategies associated with different EVSs are, or are not, effective in managing air quality.
- **a conclusion that is consistent with, and supported by analysis and examples given** e.g. All EVSs can make some effective contribution to managing air quality except at the far end of the EVS spectrum where cornucopians would support the notion that we avoid any curtailment of human activity and simply await the development of technological solutions or remediations.

***Please see markbands on page 19.***

5. (a) Outline **two** point sources and **two** non-point sources of water pollution in a city. **[4]**

*Point sources [2 max]:*

- a. Factories/manufacturing plants may release pollutants directly into water bodies;
- b. Inadequately treated sewage and wastewater from treatment plants can contain pollutants and be released directly into water bodies;
- c. Accidental spills of oil/petroleum products from pipelines/storage tanks/tankers;
- d. Improper disposal of hazardous waste/garbage/chemicals into storm drains or waterways.

*Non-point sources [2 max]:*

- a. Urban runoff can carry litter/oil/chemicals from streets/parking lots/rooftops into storm drains/water bodies;
- b. Urban greenspace runoff can carry excess fertilizers/pesticides from agricultural activities into rivers and streams;
- c. Sediment/debris/construction materials from building sites can be washed into water bodies;
- d. Urbanization/land development can increase impervious surfaces like roads and buildings, reducing natural infiltration/increasing surface runoff that can carry pollutants into waterways, impacting water quality in the city;

**Note to examiners:** Accept any other relevant example to those given.

- (b) Evaluate the strategies that can be used to meet an increasing demand for freshwater. [7]

One mark for naming a valid water conservation/supply enhancement strategy [1 max]

One mark per each outlined strength [2 max per strategy]

One mark per each outlined weakness [2 max per strategy]

*See examples below:*

*Example strategy:*

- a. Implementation of water-saving technologies in households/low flow shower heads/dual flush toilets;

*Strengths [2 max]:*

- b. Reduces the amount of water used, so there is more water available;  
c. Often can be inexpensive fixes;  
d. Easy to implement at a small scale;  
e. Reduces water bills;

*Weaknesses [2 max]*

- f. Individuals may not like the resulting effects (e.g. low water pressure etc)  
g. Requires wide adoption to be effective on a large scale;

*Example strategy:*

- h. Rainwater harvesting;

*Strengths [2 max]:*

- i. Low setup costs/low-cost supply of water;  
j. Low environmental impact/not high technology;  
k. Renewable supply / reduces the use of potable water;

*Weaknesses [2 max]:*

- l. Quantity limited for agricultural uses;  
m. Weather/climate dependent;  
n. May contain atmospheric pollutants / isn't generally potable;

*Award one mark overall for a balanced conclusion; Example: Meeting an increasing demand might involve both water conservation strategies and enhancing the water supply; [1 max]*

**Note to examiners:** *Credit up to three valid and specific water conservation/supply enhancement strategies. If they list more than three, credit the highest scoring strategies. Examples might include agricultural practices, infrastructure improvements, awareness campaigns, taxes, legislative policies, desalination, aquifer recharge, wastewater treatment, etc:*

- (c) The introduction of a species into an ecosystem could be considered a form of pollution. Discuss this statement.

[9]

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 mark band and the specific mark within that band.

*Answers may demonstrate:*

- **understanding concepts terminology:** definition of pollution; chemical/thermal/biotic pollution; anthropogenic; toxicity; environmental impacts; alien/invasive/native species; competition; competitive exclusion; predation; disease; disruption; biodiversity; genetic diversity; pest control; steady state equilibrium; resilience; adaptability; habitat degradation,
- **breadth in addressing and linking** a range of advantageous and disadvantageous aspects of various introduced species with characteristic features of environmental pollution
- **examples** of a number of introduced species and a range of their characteristic negative and positive impacts on the equilibrium of ecosystems.
- **balanced analysis evaluating** the extent to which introduced species may, or may not, validly be identified as a form of pollution, acknowledging both similarities and differences from other forms of pollution, and advantages and disadvantages to natural ecosystems.
- **a conclusion that is consistent with, and supported by, analysis and examples given** e.g. While it is important to recognise that alien species may have potential benefits on ecosystems and human societies, a number of factors indicate that alien species being classified as pollutants as they are anthropogenic in origin and have detrimental effects on the equilibrium of native ecosystems and biodiversity.

***Please see markbands on page 19.***

6. (a) Outline four factors that enable a human population to increase its terrestrial food production. [4]
- a. Technological advancements: Innovations in agriculture, such as mechanization/irrigation systems/ genetically modified crops;
  - b. Improved crop varieties: Developing high-yielding crop varieties that are resistant to pests, diseases, and environmental stresses;
  - c. Water conservation practices e.g. drip irrigation/terracing/contour ploughing;
  - d. Education and training: Providing farmers with access to agricultural education/ training, and information on best practices can improve their skills and knowledge;
  - e. Application of fertilizers can enhance soil fertility;
  - f. Proper use of pesticides control pests increasing crop yields
  - g. Government policies/subsidies/incentives for farmers to increase production;
  - h. Maintaining biodiversity through crop rotation/agroforestry;
  - i. Expansion of farmland / land reclamation / draining wetland for the purpose of crop farming/animal rearing;
  - j. Soil conservation measures to maintain/improve soil health;

- (b) Explain how human activities can impact the Nitrogen cycle. [7]

*Humans can impact the N cycle in a number of ways:*

- a. Burning fossil fuels releases nitrogen oxides into the atmosphere;
- b. ...these oxides react with water to form nitric acid, which precipitates as acid rain;
- c. Acidification / plastic/heavy metal/PAH/pesticide pollution of soils damage soil microbiota responsible for nitrogen cycling;
- d. Deforestation/harvesting removes plants/animals from the environment as stores of organic nitrogen / can result in runoff/leaching of nitrogen into waterways / decreases dead organic material (which contains proteins) to be decomposed/;
- e. Afforestation increases stores of organic nitrogen / increases organic material (containing nitrogen) to be decomposed;
- f. Humans release nitrogenous waste entering environments through sewage effluent;
- g. Inorganic fertilizers applied to crops, enter water bodies through runoff and leaching/cause eutrophication;
- h. Haber(-Bosch) process fixes atmospheric nitrogen into ammonia to synthesize inorganic fertilizers;
- i. Eutrophic waters develop nitrogen rich sediment that, through upwelling/positive feedback, repeats eutrophic event;
- j. Overgrazing/mechanisation can cause compaction of soils damaging nitrogen-cycling microbiota;
- k. Planting leguminous crops increases stores of nitrates in soils / through biological nitrogen fixation (Rhizobium living in root nodules);
- l. Sustainable farming techniques / e.g.no/reduced tillage/mulching/cover crop/crop rotation enhances N retention in topsoil (reduces erosion) / increases microbial decomposition (through improved soil structure/moisture);
- m. Intensive/industrial animal production systems emit nitrous oxides/ammonia to environment;

**Note to examiners:** *Accept any other human activity along with valid and significant impact*

- (c) To what extent is the sustainability of terrestrial food production systems influenced by socio-political, economic and ecological factors. [9]

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 mark band and the specific mark within that band.

*Answers may demonstrate:*

- **understanding concepts terminology** of agricultural practices, intensive/extensive/subsistence/organic farming, mono/poly culture, GMOs, soil fertility, use of pesticides/herbicides, socio-political factors, cultural factors, population growth and urbanization, land use policies, government policies, economic factors, market forces, investment in research and development, access to credit, ecological factors, climate change, water scarcity, soil degradation, biodiversity loss.
- **breadth in addressing and linking** a range of socio-political, economic, and ecological factors contributing to the sustainability of food production systems.
- **Examples** of different food production systems, cultural factors, demographics, education, policies and laws, taxes and subsidies, market costs of goods and technology, market stability, ecological factors such as water availability, climate, soil properties.
- **balanced analysis** of the extent to which sustainability of different food production systems is, or is not, impacted by socio-political, economic, and ecological factors.
- **a conclusion that is consistent with, and supported by analysis** The sustainability of terrestrial food production systems is a complex issue that is influenced by a wide range of factors. The development of policies and programs to improve the sustainability of food production systems should take all these factors into consideration.

***Please see markbands on page 19.***

7. (a) Outline **two** advantages and **two** disadvantages of nuclear power as a choice of energy production.

[4]

*Advantages [2max]:*

- a. Low greenhouse gas emissions, reducing climate impacts;
- b. High energy output/efficient for small amount of fuel;
- c. Stable/reliable/consistent source of energy, increasing energy security;
- d. Once built, it is relatively cheap to produce energy;
- e. Low to no air pollution/SO<sub>x</sub>/NO<sub>x</sub>/particulate matter;

*Disadvantages [2 max]:*

- f. It is a non-renewable resource so the supply is finite;
- g. Safety/health concerns with exposure to radioactivity/nuclear accidents;
- h. Radioactive waste can cause environmental degradation;
- i. Thermal pollution can affect aquatic ecosystems;
- j. Expensive to construct and decommission / expensive to manage/store radioactive waste;
- k. Requires highly skilled labor/expertise which can limit use;
- l. Public concerns/opposition to nuclear proliferation/creation of nuclear weapons;

- (b) Explain the ways in which energy is lost as it moves through an ecosystem.

[7]

- a. The second law of thermodynamics indicates that energy is “lost”/becomes less useful from a system when transformed / entropy increases from a system in any transformation;
- b. Not all sunlight is captured by plants for photosynthesis / light can be reflected or absorbed by surfaces/land/water;
- c. Plants use sugars/food energy for respiration which is lost as heat;
- d. Some chemical energy ingested by animals is lost as heat due to respiration;
- e. Mammals/birds use considerable energy for thermoregulation/homeostasis;
- f. Not all parts of plants/animals can be consumed/digested by a consumer;
- g. Undigested material is lost as feces;
- h. Decomposers use energy for respiration, causing its loss as heat;
- i. Extreme temperatures/water scarcity/nutrient availability can stress organisms, increasing energy used in respiration;
- j. Generally only 10% of the energy is passed between trophic levels;

**Note to examiners:** Allow these points in diagram only if it is clearly annotated.

- (c) With reference to **named** examples, evaluate the waste management strategies adopted by different societies. [9]

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 mark band and the specific mark within that band.

*Answers may demonstrate:*

- **understanding concepts terminology** of solid domestic waste; wastewater; radioactive waste; food waste; waste management strategies/policies; packaging; collection; storage; disposal; incineration; landfills; reduction; reuse; recycling; composting; biogas production; environmental education, alternatives to fertilizers/detergents; management of eutrophication; wastewater treatment; reduction of food waste (consuming less meat, promote organically/locally grown food);
- **breadth in addressing and linking** a range of different waste management strategies adopted by a range of societies and their respective advantages and disadvantages **NB. If candidates address a wider interpretation of “waste” beyond solid domestic waste be prepared to give credit for equivalent knowledge statements and arguments. Do not penalise candidates for limiting their response to solid domestic waste, however.**
- **examples** of different waste management strategies associated with named different societies/nations.
- **balanced analysis evaluating** the advantages and disadvantages of various management strategies from a range of societies.
- **a conclusion that is consistent with, and supported by analysis and examples given** e.g. Solid waste management strategies vary from the individual to the regional to the national – with a number of actors including government and businesses as key actors in driving the strategy. Nonetheless, efforts should be forthcoming at all levels in order for the strategy to be successful.

***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	<p>The response contains:</p> <ul style="list-style-type: none"> <li>• minimal evidence of knowledge and understanding of ESS issues or concepts</li> <li>• fragmented knowledge statements poorly linked to the context of the question</li> <li>• some appropriate use of ESS terminology</li> <li>• no examples where required, or examples with insufficient explanation/relevance</li> <li>• superficial analysis that amounts to no more than a list of facts/ideas</li> <li>• judgments/conclusions that are vague or not supported by evidence/argument.</li> </ul>
4–6	<p>The response contains:</p> <ul style="list-style-type: none"> <li>• some evidence of sound knowledge and understanding of ESS issues and concepts</li> <li>• knowledge statements effectively linked to the context of the question</li> <li>• largely appropriate use of ESS terminology</li> <li>• some use of relevant examples where required, but with limited explanation</li> <li>• clear analysis that shows a degree of balance</li> <li>• some clear judgments/conclusions, supported by limited evidence/arguments.</li> </ul>
7–9	<p>The response contains:</p> <ul style="list-style-type: none"> <li>• substantial evidence of sound knowledge and understanding of ESS issues and concepts</li> <li>• a wide breadth of knowledge statements effectively linked with each other, and to the context of the question</li> <li>• consistently appropriate and precise use of ESS terminology</li> <li>• effective use of pertinent, well-explained examples, where required, showing some originality</li> <li>• thorough, well-balanced, insightful analysis</li> <li>• explicit judgments/conclusions that are well-supported by evidence/arguments and that include some critical reflection.</li> </ul>