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Markscheme

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Environmental systems and societies

Standard level

Paper 2

21 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 **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**, state the crude birth rate (CBR) of South Korea in 1980 and 2024. **[2]**

Year	*Crude Birth Rate*
1980	22.5 - 23
2024	5

(b) Using **Figure 1**, calculate the natural increase rate (NIR) in 1980. **[1]**

(23-7.5/10 =) 1.55 Accept 1.5-1.6

***Note to examiners*:** *Allow 15-16 per thousand (Do not credit just 15-16)*

(c) Explain which stage of the demographic transition model South Korea was in during 1980. **[2]**

Stage three (Late expanding);
Birth rates are falling (rapidly) and the death rates are falling/start stabilizing / CBR is still higher than CDR / NIR is relatively high, but decreasing;

Note to examiners: *If stage is vague (3/4), unnamed or just wrong, there is no credit available for explanation (it is not clear what is being explained).*

(d) Outline **two** national development policies that might have contributed to the changes in the crude birth rates in South Korea between 1960 and 2024. **[2]**

Decreasing birth rates due to:

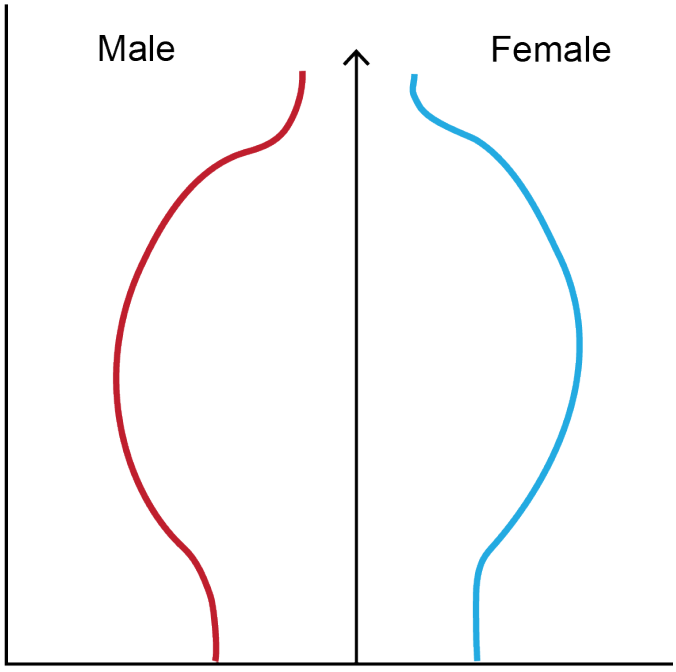
a. Educating women for greater economic and reproductive independence;
b. Providing sex education so people understand how to control how many children to have / improved access to contraception;
c. Direct policies such as governing the number of children women can have;
d. Improved access to healthcare to reduce infant/child mortality rates;
e. public confidence that children will survive into adulthood, reducing the need for multiple children;
f. Investment in social security/pensions so people don't have to depend on children to care for them in later years;
g. Investment in agricultural technology so not as many children are needed to work;
h. Urbanization increasing the cost of raising children;
i. Rapid economic development/industrialization shifting priorities of adults to career;
j. Pro-small family campaigns in media/street posters;
k. Increased legal age of marriage, which increased age of first childbearing;

(e) Sketch the shape of the age–gender pyramid for 2024 that would lead to the predicted total population changes from 2024 to 2100, as shown in **Figure 1**. **[1]**

A population pyramid is shown in the rough shape of a stage 4/5 pyramid, the base and apex must be smaller than the middle (showing a clear decrease in lower and older age classes).

Award 1 mark if base narrows, and 1 mark if apex narrows

Axes do not need labelling for credit



2. (a) Using **Figure 2(a)**, identify which cause of soil degradation makes up the largest percentage globally. **[1]**

overgrazing;

(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 deforestation could impact soil quality. **[3]**

a. Removal of trees reduces shade and can dry out soil;
b. ...dry soils are more vulnerable to wind erosion;
c. The lack of roots to hold soil makes it vulnerable to wind/water erosion /reduced water/nutrient retention capacity;
d. Fewer plants/trees result in less leaf litter returned to the soil reducing organic matter/nutrient availability/water retention;
e. Erosion of topsoil could greatly reduce microorganisms responsible for nutrient cycling;
f. ...leading to (a positive feedback loop of) worsening soil degradation;
g. loss of canopy increases impact of rain (more water erosion);
h. Logging/land-clearing may compact/pave soil reducing decomposing community/nutrients/ability to retain water;

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)x100/10 =) 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 the potential value of aquaculture as a strategy to avoid the levels of unsustainable fishing as seen in 2019 in **Figure 3**. **[4]**

*Strengths **[2 max]**:*

a. Aquaculture can relieve the pressure of capture fisheries to meet demand / which would allow wild stock recovery;
b. Aquaculture provides more stability/control in supply as compared to natural/environmental fluctuations affecting wild populations;
c. Aquaculture can provide employment opportunities that are safer/require less time at sea than capture fisheries;
d. Integrated aquaculture can reduce pollutants/increase diversity of food types;
e. may foster economical development in LEDCs;
f. aquaculture may contribute to more sustainable model of food production/agri-business (both globally and locally);
g. Reduces loss through bycatch;

*Weakness **[2 max]**:*

h. Aquaculture can result in escaped fish becoming invasive/spread disease;
i. Aquaculture can result in nutrient/antibiotic/pesticide pollution;
j. Aquaculture can cause eutrophication through fish/food waste;
k. Aquaculture can reduce diversity of fish population;
l. Aquaculture may require habitat destruction/deforestation/loss of mangroves;

***Note to examiners:** Award one mark for a balanced conclusion appraisal Ex. Aquaculture certainly improves the efficiency of food production but without careful management can cause considerable environmental degradation.*

Section B

4. (a) Outline **four** factors that contribute to an increase in tropospheric ozone. **[4]**

a. Increased burning of fossil fuel would release more NOx & VOCs into the atmosphere;
b. …could be due to population growth/increasing populations;
c. …industrialization / urbanization / more conventional vehicles / reform to a more mechanized agriculture / increased affluence (especially in developing nations);
d. Seasons/time periods when sunlight is more intense/ temperature is higher / e.g. at noon/summer/after the clouds have cleared;
e. …increasing the rate of the photochemical reaction leading to ozone formation;
f. Following weather conditions leading to thermal inversions / e.g. after clear, calm nights;
g. During burning of crop residues which release NOx & VOCs;
h. Agricultural reform towards using more fertilizers/pesticides/livestock that release more ammonia or VOCs…
i. …changing cultivation to corn/soybean/crop that releases more VOCs;
j. …more tilling/unsustainable farming practices releasing more NOx;
k. Building high rise structures in cities that prevent dispersal/raise concentration of air pollutants

Note to examiners: *Accept any other relevant example to those given.*
Do not credit "valleys/low-lying areas" as this is a topographic feature that does not "increase".

(b) Evaluate **two** strategies that could be used to limit the release of pollutants that contribute to stratospheric ozone depletion. **[7]**

Strategy
International ban/phasing out of ozone-depleting substances/CFCs / e.g. Montreal Protocol;
Pros:
Resolves root cause of issue / had immediate effect in closing the ozone hole;
Ensures/promotes global co-operation;
phasing out allowed some adaptation time to countries that needed it;
Cons:
May develop black market in ozone-depleting substances;
Not all countries may agree to ban;
ODSs are useful in many applications (solvents, sprays, foam, coolants) / difficult to find equivalent alternatives;
ODS ban had serious economic repercussions;
Phasing out lasted longer than initially intended in many cases;

Strategy:
Developing/promoting alternative technologies;
Pros:
Will make it easier/more economically feasible to avoid use of CFCs;
Will allow technological progress in applications like refrigeration/air conditioning/industrial cleaning/fire extinguishing;
promote more sustainable solutions / e.g. integrated pest management instead of fumigation with methyl bromide;
Cons:
Depends upon possibility of finding appropriate alternatives / usually alternatives of ODSs are less efficient;

May produce chemicals that have other environmental impacts / e.g. greenhouse effect of HCFCs/HFCs / alternatives for solvents are usually even more toxic;
Research on alternatives is cumbersome/costly;

Strategy:
Enhanced waste management / appropriate disposal/recycling of refrigerators etc;
Pros:
Reduces impacts from release of CFCs/ODSs;
Contributes to principle of circular economy (eliminate waste/pollution / regenerate nature);
promotes sustainability/resource conservation/social responsibility;
opened up a novel business sector/economic opportunities;
Cons:
Doesn't address root cause of issue;
Reduces pressure on communities to avoid CFC technology in first place;
if not done properly increases health hazards/possibility of pollution/habitat degradation;
May be too costly/cumbersome to implement efficiently (at least in large scale or LEDCS with poor infrastructure)

Strategy:
Raising awareness of issue among public/policymakers/industries;
Pros:
Drives collective action toward addressing problem;
Puts economic/market pressure on manufacturers to modify production;
future-proof, if manage to change mindset of society;
Cons:
Doesn't guarantee compliance from large industries;
Doesn't carry same weight of influence/level of efficiency as legislations/bans etc;
not really an option in non-democratic regimes;

Strategy:
Reducing combustion of fossil fuel by promoting (through laws/education/taxes) more EVs/public transportation/walking/carpool/transition to renewable (would lead to less N_2O released);
Pros:
reduces a pollutant N_2O/NOx (which was not earlier recognized as a major ODS);
reduces other air pollutants (GHGs/SO_2) as well;
creates a healthier/cleaner environment;
Promotes a more sustainable society;
Novel economic opportunities/jobs (e.g. in renewable energy production);
Cons:
society momentum resists the switch from a fossil fuel dominated economy;
high upfront cost of new infrastructure (e.g. public EV chargers);
Missing a reliable energy source;
Economic/job losses in oil industries/coal mining;

Note to examiners: *Award 1 for each identified management strategy (2 max) and award 2 max for pros, 2max for cons of each strategy.*
Accept any other relevant example/strategy to those given.

Do not credit vague strategies like "reduction of vehicle emissions" or "improved energy efficiency/reduction of electricity demand" or "reduced pesticide use" unless it is explained HOW reduction is achieved.

Do not credit similar evaluative statements twice in the two different strategies.

(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 21.

5. (a) Outline **two** advantages and **two** disadvantages of using DDT. **[4]**

Advantages:
a. Effectiveness in controlling insect-borne diseases;
b. DDT is relatively inexpensive to produce;
c. DDT has a long-lasting residual effect / provides continuous protection against insects for an extended period of time;
d. it is highly effective in controlling a wide range of insect pests...;
e. ...thus improving agricultural/livestock production

Disadvantages: ***[2max]***
f. DDT is a persistent organic pollutant that can damage environment for years;
g. DDT undergoes bioaccumulation/biomagnification posing risks to higher trophic levels;
h. DDT has been linked to potential health risks in humans/wildlife (e.g. effects on reproductive health, hormone disruption, increased risk of certain cancers);
i. Insects can develop resistance to DDT, reducing its effectiveness as an insecticide;
j. Reducing food available for insectivores;
k. Impacts non-target (insect) species;

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

(b) Explain how a community can impact the quantity of its freshwater supply. **[7]**

Positive impacts
a. Rainwater harvesting can augment local water sources;
b. Implementing water recycling systems can increase availability;
c. Borehole drilling offers additional water resources;
d. Investing in desalination plants can provide freshwater;
e. Constructing water storage facilities;
f. Promoting/raising awareness of water conservation practices;
g. Upgrading water distribution networks enhances access;
h. Utilizing groundwater recharge techniques is beneficial;
i. Enhancing irrigation efficiency conserves water;
j. Collaborating with neighbouring communities fosters resource sharing.

Negative impacts
k. Excessive withdrawal of water from freshwater sources can deplete the available water supply, leading to water scarcity;
l. Discharge of untreated sewage/industrial effluents/agricultural runoff into freshwater bodies can contaminate the water;
m. Clearing forests can disrupt the natural water cycle/reduce groundwater recharge;
n. Rapid urban growth can increase the demand for water, leading to overexploitation of freshwater sources;
p. Building dams can alter river flow patterns/reduce the downstream availability of freshwater for communities;
q. Inadequate/leaky water infrastructure/inefficient water use practices can result in water losses;

Note to examiners: *Award 5 max for positive 5 max for negative. Accept any other relevant example to those given.*
Do not credit evaluative statements not linked to freshwater supply like "aqueducts/desalination plants are expensive to build/maintain / cause air pollution / degrade habitats"

(c) The introduction of a species into an ecosystem could be considered a form of pollution. Discuss this statement. **[9]**

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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 21.

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 soil degradation and soil management strategies? **[9]**

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Answers may demonstrate:

- **understanding concepts terminology:** sustainability, renewable/non-renewable; ecological footprint, natural capital, natural income, soil degradation, erosion, compaction, salinization, nutrient depletion, soil management strategies, conservation tillage, cover crops, crop rotation, monoculture/polyculture; intensive/extensive farming; terracing; contour ploughing; drip irrigation; nutrient management, inorganic/organic fertilisers; soil productivity, pollution, climate change, industrialization; mechanization; fossil fuel use; seed/crop/livestock choices; water use; fertilizers; pest control; pollinators; antibiotics; legislation; levels of commercial versus subsistence food production; food social inequalities; decreased productive land availability.

- **breadth in addressing and linking** sustainability/sustainable yield with a range of degradation impacts and relevant soil management strategies.

- **examples** of different terrestrial food production systems / different potential impacts on soil / different remedial management strategies / e.g. reduced meat consumption / organic farming / locally grown food / food labels / monitoring standards and practising / buffer zones;

- **balanced analysis** of the extent to which sustainability of different food production systems is, or is not, impacted by soil degradation and the extent to which management strategies are, or are not, effective in remediating such impacts / i.e. allow full replacement of resources and full recovery of ecosystems affected.

- **a conclusion that is consistent with, and supported by, analysis and examples given** eg the soil degradation associated with intensive crop production practices significantly reduces sustainability of soils in a variety of ways that limit the future productivity of those soils, but this impact can be averted through effective soil conservation measures.

Please see markbands on page 21.

7. (a) Outline **two** advantages and **two** disadvantages of using a **named** renewable source of energy. **[4]**

Example - Solar:

Advantages of using solar energy:

a. Solar energy is a renewable resource that will never run out;
b. Solar energy produces no greenhouse gas emissions or air pollutants, reducing environmental impact;
c. Once installed, solar panels can provide free electricity for many years / leading to long-term cost savings;
d. Solar panels require minimal maintenance and have a long lifespan / making them a reliable energy source;
e. Using solar energy can reduce dependence on fossil fuels and foreign energy sources / increasing energy security.

Disadvantages of using solar energy:

f. Solar energy is dependent on sunlight, making it inconsistent and unreliable during cloudy or night time conditions;
g. The initial investment in solar panels and installation can be expensive / deterring some individuals or businesses from adopting solar energy;
h. Solar panels require a significant amount of space for installation / limiting their feasibility in densely populated areas;
i. Storing excess solar energy (for use during periods of low sunlight) can be costly and technologically challenging;
j. The production and disposal of solar panels can have environmental consequences / such as the use of toxic materials and waste generation.

Example - Wind:

Advantages of using wind as a source of energy:

a. Wind is a renewable energy source that will never run out, unlike fossil fuels;
b. Wind energy production does not produce greenhouse gas emissions/air pollutants, reducing the impact on the environment;
c. Once wind turbines are installed, the operational costs are relatively low compared to traditional energy sources;
d. Using wind energy reduces reliance on imported fossil fuels, increasing energy security;
e. The wind energy industry creates jobs in manufacturing, installation, maintenance, and other related sectors.

Disadvantages of using wind as a source of energy:

f. Wind energy production is dependent on wind availability, which can be inconsistent and unpredictable;
g. Wind farms require significant land area, which can lead to conflicts with other land uses such as agriculture or wildlife habitats;
h. Some people find wind turbines visually unappealing, leading to aesthetic concerns in certain locations;
i. Wind turbines can generate noise during operation, which may be a concern for nearby residents;
j. Wind turbines can pose risks to birds and bats through collisions or habitat disruption, requiring careful siting and mitigation measures.

Example – hydropower

Advantages of using hydropower as a source of energy:

a. Hydropower relies on the natural water cycle, making it a sustainable and renewable energy option;
b. Hydropower produces minimal greenhouse gas emissions compared to fossil fuels, contributing to lower carbon footprints;
c. Hydropower plants can provide a stable and consistent energy supply, as water flow can be controlled to meet demand;
d. Once the infrastructure is in place, hydropower can be a cost-effective energy source with low operational costs;
e. Hydropower projects can offer additional benefits such as flood control, irrigation, and recreational opportunities.

Disadvantages of using hydropower as a source of energy:

f. Large-scale hydropower projects can disrupt ecosystems, alter river flows, and impact aquatic habitats;
g. Building dams for hydropower projects may require the displacement of communities living in the affected areas;
h. Dam failures can have catastrophic consequences, leading to flooding, property damage, and loss of life;
i. Not all regions have suitable conditions for hydropower development, limiting its widespread adoption;
j. Sediment buildup in reservoirs can reduce storage capacity and affect downstream ecosystems, requiring ongoing management and maintenance efforts.

Note to examiners: *Award credit in similar way for other valid renewable energy sources. Do not credit nuclear – it is non-renewable.*
If more than one source is addressed, just credit the highest scoring.
Award 3 max for responses that do not name a specific renewable source
(2 marks max for disadvantages, 2 marks max for advantages)

(b) Explain how the laws of thermodynamics apply to the flow of energy through ecosystems. **[7]**

a. First law of thermodynamics claims energy cannot be created or destroyed /energy is only transferred or transformed / principle of conservation of energy;
b. e.g. (chemical) energy is transferred from one trophic level to another/along food chains/webs through feeding;
c. e.g. energy is transformed from light to chemical energy in photosynthesis;
d. In any system/process, input of energy equals amount stored plus output of energy (in a given period of time);
e. Because energy cannot be created, ecosystems need a continuous supply of solar energy;
f. Second law of thermodynamics claims that with each transfer/transformation entropy increases/energy to do work is reduced/lost / entropy increases over time in isolated systems / no physical process is 100% effective;
g. Energy is therefore lost as heat, as chemical energy is passed along food chains;
h. The metabolism/respiration of each trophic level involves transformations that release heat;
i. Energy flow is therefore unidirectional from lower trophic levels to higher ones / natural processes are irreversible/one-way;
j. Because of the energy losses total biomass/productivity decreases with each trophic level / 10% rule of ecological efficiency;
k. An open system can decrease its entropy by consuming energy (and releasing waste);

Note to examiners: *Credit any other valid explanation of how the laws of thermodynamics relate to energy flow in ecosystems (not necessarily just in food chains).*

(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 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.