

Principal examiner reports for teachers

Principal examiner reports for teachers summarise what candidates did well and what candidates needed to improve for this examination series only.

This report is to be used in conjunction with the question paper and mark scheme.

For guidance on teaching and learning we provide resources for many of our syllabuses.

Resource	Where to find it
Grade descriptions – Grade descriptions describe the level of performance typically demonstrated by candidates achieving the different grades awarded for a qualification.	School support hub Select: Subject > Resource finder > Syllabus and specimen materials
Schemes of work – Schemes of work are designed to support you in your teaching and lesson planning.	School support hub Select: Subject > Resource finder > Teaching and learning
Lesson planning – Guidance on how to plan a lesson.	Lesson planning
Resource plus – There may be additional resources such as teaching packs containing lesson plans, resources and worksheets and videos for aspects of your syllabus.	School support hub Select: Subject > Resource finder > Teaching and learning
Teaching tools	Teaching Tools
Exemplar candidate responses	School support hub Select: Subject > Resource finder > Teaching and learning
Learner guide – A guide for students to help them understand what the course involves.	School support hub Select: Subject > Resource finder > Teaching and learning
Community forums – Do you have a question or something to share? Our online forums are great way to keep up to date with your subject and the global Cambridge community.	Community forum on the school support hub
Access to scripts for this series.	Access to scripts service
Results analysis is available for some syllabuses.	Results analysis
Test maker is available for some subjects.	Test maker

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ENVIRONMENTAL MANAGEMENT

Paper 8291/11 Principles of Environmental Management

Key messages

What candidates did well

Section A

- Candidates demonstrated factual knowledge and used detailed technical terminology.
- Candidates were able to competently analyse unfamiliar data and draw conclusions from the data.
- Candidates were mathematically capable; most were able to calculate a range and read a graph correctly to obtain the values required for the calculation.
- Most candidates were competent at drawing bar charts, selected the correct data to plot and used a sharp pencil and ruler.

Section B

- Candidates had written a general introduction with background information and focused on specific impacts or strategies related to the question being asked with explanation of the advantages and disadvantages of each of their ideas.
- Candidates had familiarised themselves with a range of specific case studies across the key topic areas of the syllabus and chosen relevant case studies to include in their response.

What candidates needed to improve

Section A

- Candidates should ensure they are familiar with the command words listed in the syllabus.
- Candidates should make good use of technical terminology and give detailed explanations rather than using imprecise terms such as 'causes harm', 'kills', 'affects', 'contamination', 'environmentally friendly' or unqualified references to cost, pollution or time.

Section B

- Candidates should include relevant, specific case studies to illustrate the point they are making.
- Candidates should aim to discuss both sides of the argument, including the advantages and disadvantages of a range of relevant strategies or suggest whether they are successful or unsuccessful with supported reasoning.
- Candidates should also draw their ideas together in the conclusion rather than writing a general conclusion which simply restates ideas already written about.

Comments on specific questions

Section A

Question 1

(a) **Comprehensive responses**

- Most candidates identified the correct definition for a biome and ticked the correct box.

Limited responses

- Some candidates ticked more than one box.

(b)(i) Comprehensive responses

- Most candidates used the graph and the key to identify the correct biomes and rainfall levels.

Limited responses

- Some candidates incorrectly identified the desert as the biome with the lowest mean annual temperature.
- A few candidates incorrectly gave the name of a biome for the third part of the question instead of the highest mean annual precipitation for tundra.

(ii) Comprehensive responses

- Most candidates were able to read the correct values for the mean annual temperature of deserts from the graph and then calculate the range correctly.

Limited responses

- Some candidates ignored the command word to calculate the range and simply gave the highest and lowest values.
- Some candidates incorrectly calculated the range as 26°C, not understanding that when one of the values is negative, they should be added together.

(c) Comprehensive responses

- Some candidates understood the correct sequence of secondary succession from pioneer species, soil development, colonisation by different plants followed by animals and concluding with the establishment of a climax community.
- Some candidates were able to use technical terms such as 'pioneer species', 'intermediate community' and 'climax community' correctly.

Limited responses

- Some candidates simply described the forest regrowing without giving a correct sequence, for example, trees before pioneer species.
- Other candidates incorrectly referred to colonisation by other species or organisms rather than referring to animals.
- Some candidates described the impact of fire on the forest rather than secondary succession that follows.

(d)(i) Comprehensive responses

- Some candidates demonstrated an understanding of the work of the International Tropical Timber Organisation (ITTO), mainly regarding timber trade regulations, sustainable harvesting, afforestation and promoting education.

Limited responses

- Some candidates were clearly not familiar with the ITTO and did not understand that the role of the ITTO is advisory, assisting countries in formulating policies and regulations rather than making and enforcing laws.
- Some candidates included general descriptions about conserving biodiversity, and some digressed into wildlife conservation such as banning hunting or captive breeding programmes which were not relevant to the question.

(ii) Comprehensive responses

- Some candidates were able to draw on their knowledge of specific causes of the decrease in the global area of tropical forests including illegal logging, climate change and lack of enforcement of policies.
- Some candidates clearly expressed the idea of increasing demand for land or resources.

Limited responses

- Some candidates simply focused on the demand for resources, land or agriculture without considering the increased demand.

Question 2

(a) Comprehensive responses

- Some candidates had clearly learnt the syllabus definition of food security.

Limited responses

- A few candidates gave the definition of sustainability in the context of food supply.
- A few candidates did not specify food security, instead referring to water or energy security or resources in general.

(b)(i) Comprehensive responses

- Some candidates were able to analyse the data given and comment on the validity of the candidate's conclusion.

Limited responses

- Some candidates did not read the question carefully so the responses for 'supports' and 'does not support' were written the wrong way round.
- Some candidates did not use the data in the table to compare Australia to the other countries.
- A few candidates quoted data from the table about countries such as China which did not answer the question, as the question was about Australia.

(ii) Comprehensive responses

- Most candidates were able to plot the bar chart accurately, with axes correctly labelled and with a suitable scale on the y-axis.

Limited responses

- Some candidates did not read the question carefully and either plotted both sets of data or plotted the total mass of food waste per year in million tonnes instead.
- Common errors included: axes not fully labelled, choice of a non-linear scale on the y-axis or not starting the y-axis at zero, plotting errors of heights of bars, particularly the odd numbers such as 33 or 59, and bars drawn without gaps between them.

(c)(i) Comprehensive responses

- Some candidates recognised that this question was specific to disposing of food waste in landfill sites rather than the negative impacts of landfill sites in general.
- Common correct answers included the idea that food produces methane as it rots, food waste attracts rats or seagulls and rotting food waste causes an unpleasant odour.

Limited responses

- Some candidates suggested other uses of food waste as alternatives to disposal in landfill sites, such as composting, which did not answer the question.
- Some candidates gave vague references to air pollution, soil pollution, harmful gases and cost.

(ii) Comprehensive responses

- Some candidates showed an understanding of using food waste as animal feed and were able to describe a range of limitations.
- Common correct answers included the idea that food waste may contain toxins or bacteria, and the likely lack of nutritional value or suitability of the food waste for some animals.

Limited responses

- Some candidates misunderstood the question; it was clear that they thought the question was about using food waste to feed wild animals rather than domesticated livestock.
- Some candidates suggested the idea that animals would become reliant on the food waste and stop hunting.

(d)(i) Comprehensive responses

- A few candidates were familiar with the strategy of biological control as the use of living organisms as a means to naturally manage pest populations.
- A few candidates were able to describe both benefits and limitations of this strategy.

Limited responses

- Most candidates had the misconception that the strategy of biological control was about genetic modification of crops.
- Some candidates referred to other agricultural techniques such as hydroponics or types of irrigation.

(ii) Comprehensive responses

- Some candidates linked irrigation and the provision of water to crops with photosynthesis and therefore growth.
- Some candidates also made the link with the idea that uptake of water from the soil is essential for plants to obtain nutrients from the soil.

Limited responses

- Some candidates simply described irrigation with the idea that irrigation prevented drought or managed water supply without explaining the underlying mechanism by which water increases yield.

Question 3

(a) Comprehensive responses

- Some candidates demonstrated knowledge and understanding of the chemical sequence by which atmospheric nitrogen forms acid deposition.
- Some candidates were able to explain the main chemical reactions that take place to produce acid deposition and, in addition, the conditions under which these reactions take place.

Limited responses

- Some candidates did not use the correct technical terms such as mixes with, rather than reacts with or did not state the correct reactants such as oxygen and water.
- Some candidates confused acid deposition with other unrelated atmospheric processes such as the formation of photochemical smog or ozone depletion.
- Some candidates talked about the involvement of sulphur and sulphuric acid, even though the question was about nitrogen.

(b)(i) Comprehensive responses

- Some candidates who linked chlorophyll to photosynthesis showed an understanding that a reduction in the concentration of chlorophyll leads to a reduction in the rate of photosynthesis.
- Some candidates also went on to explain the importance of chlorophyll in capturing light energy and how the lack of photosynthesis impacts ecosystem productivity.

Limited responses

- Some candidates simply focused on acid deposition killing plants and poisoning animals without making the link with photosynthesis.
- Some candidates did not understand the term ecosystem productivity and simply discussed energy transfers in a food chain.

(ii) Comprehensive responses

- Most candidates were able to state other impacts of acid deposition.
- Common correct answers included chemical weathering of buildings, damage to fish gills, reduced crop yields and a reduction in fish populations.

Limited responses

- Some candidates repeated impacts from the previous question.
- A common error was insufficient technical terminology, using harms humans, damages plants or habitat loss without specifying the mechanism or named impact.
- Some candidates gave answers outside the scope of the question, attributing effects such as climate change, global warming or erratic weather patterns.

Question 4

(a) Comprehensive responses

- Most candidates who noted the command word 'describe' and correctly identified the positions of the world's continents were able to give the distribution of low, medium and high albedo.

Limited responses

- Some candidates linked albedo to climate rather than location, for example cold areas or deserts.
- Candidates could improve their responses with the correct use of geographical terminology such as north and south rather than top and bottom or above and below.

(b)(i) Comprehensive responses

- Some candidates demonstrated a clear understanding of geo-engineering strategies and correctly explained the mechanism of solar radiation reflection.

Limited responses

- Common errors or misconceptions included a link with ozone depletion or that albedo enhancement reduces greenhouse gases in the atmosphere.

(ii) Comprehensive responses

- Most candidates recognised that bubbles are temporary, that scale could be limited and that there are possible negative consequences on marine organisms or food chains.
- Some candidates considered the idea that the technology is new so it is unproven and could be unreliable.

Limited responses

- Some candidates simply focused on cost, vague impacts on animals and on the difficulty of attaching the devices.
- Some candidates were unable to use their knowledge of the syllabus to make appropriate suggestions about an unfamiliar context.

(iii) Comprehensive responses

- Most candidates suggested marine cloud brightening, space mirrors or stratospheric aerosols as examples of other geo-engineering strategies.
- Some candidates suggested carbon capture or carbon storage.

Limited responses

- Some candidates suggested strategies to reduce carbon emissions such as electric cars or reduction in use of fossil fuels by using renewable energy sources, which are not geo-engineering strategies.
- Some candidates used imprecise terminology and referred to mirrors in the atmosphere rather than space and other candidates omitted the word stratospheric when referring to aerosol injection.

(c)(i) Comprehensive responses

- Some candidates were able to give a definition that included the idea of changing lifestyle to live with the consequences of climate change rather than trying to limit or reduce climate change.

Limited responses

- Some candidates confused adaptation with mitigation, prevention or management of climate change.
- Some candidates referred to adaptation of plants and animals rather than humans.

(ii) Comprehensive responses

- Most candidates described specific adaptations to the consequences of climate change such as rising sea levels and increased temperatures.

- Common correct answers included building coastal defences, improving irrigation systems, growing drought-tolerant crops or implementing early warning systems for extreme weather conditions.

Limited responses

- Some candidates described mitigation techniques or how animals might adapt through colour change, migration or changing diets.
- Some candidates simply suggested warm weather clothing which is not specific enough as an adaptation to climate change.

Section B

Question 5

Comprehensive responses

- Candidates often started with a short definition of high-income country (HIC) and low-income country (LIC) and included named examples of each.
- Candidates showed an understanding of current problems for HICs and LICs and the economic reasons for the issues.
- Candidates carefully described the causes and impacts of climate change, how HICs and LICs contribute, both through emissions of greenhouse gases and actions to mitigate it and evaluated their scale.
- Candidates often focused on the issues that LICs face with an increased demand for energy as they struggle to grow their economies, often dependent on non-renewable sources of energy, coupled with rapid population growth.
- Candidates referenced specific case studies for both HICs such as France, Germany, Norway, the UK and the USA (scale of emissions, reduced vehicle emissions, investment in renewable energy and electric cars) and LICs such as Bangladesh, Haiti, Sudan, Zimbabwe (limited energy options, high reliance on coal and increased deforestation) through newly emerging economies such as Nigeria and middle-income countries or MICs such as Brazil and China.
- Many candidates recognised that HICs tend to have more robust regulations and many are committed to lowering greenhouse gas emissions through development of renewable energy sources and carbon neutral technologies.
- Candidates acknowledged that although LICs may produce more carbon emissions today, HICs have a historical responsibility. HICs often import raw materials and low-cost goods that have been mined or manufactured in LICs so they are indirectly responsible for greenhouse gas emissions from their sources.
- Candidates considered both HICs and LICs in a balanced way, reaching a clear and supported conclusion.

Limited responses

- Some candidates misinterpreted the question and instead of evaluating whether LICs have a greater contribution to climate change compared to HICs, they assessed whether LICs or HICs are more impacted by climate change.
- Candidates included discussion about air pollution and acid deposition, along with a debate about chlorofluorocarbons (CFCs), ozone depletion and the Montreal Protocol.
- Some candidates simply discussed the types of economies at length rather than how each contributed to climate change.
- Some candidates incorrectly stated that LICs have smaller populations than HICs.
- Some candidates incorrectly referred to Africa as a country rather than a continent.
- Some candidates focused on ideas covered elsewhere in the question paper such as geo-engineering and albedo enhancement which were not relevant to the question.

Question 6

Comprehensive responses

- Candidates often started with a definition of water security or water insecurity and demonstrated an in-depth knowledge and understanding of the causes of water insecurity including climate change and droughts, water pollution, population growth and competition for water for domestic, agricultural and industrial purposes.

- Some candidates discussed the increasing pressure on water supply resulting from the rise in use of artificial intelligence, which consumes significant amounts of water through data cooling, electricity generation and hardware manufacturing.
- Impacts of water insecurity were well known and case studies were used to good effect such as the East African Water Crisis affecting Djibouti, Ethiopia, Kenya and Somalia, natural contamination of groundwater by arsenic in Bangladesh and issues of water shortages in Cape Town, California, Chile, Mexico City and Singapore.
- A wide range of water usage reduction strategies were considered including domestic strategies, for example shorter showers and low-flow flush toilets; agricultural strategies, for example drip irrigation and night irrigation techniques; and municipal or government strategies, for example improved water distribution infrastructure, rationing and tariffs.
- Some candidates gave well-thought-out balanced evaluations which contrasted the water-secure populations and the water-insecure populations, often making the point that in drought-stricken areas people are already using the minimum amount of water they can survive on, so it is not possible for them to reduce their water usage any further.

Limited responses

- Some candidates did not distinguish between reduction strategies in water usage and alternative strategies such as rainwater catchment, improved water supply from groundwater abstraction, construction of new dams and reservoirs and desalination.
- Some candidates gave one-sided evaluations and conclusions that reduction in water usage strategies are either successful or unsuccessful.

ENVIRONMENTAL MANAGEMENT

Paper 8291/12 Principles of Environmental Management

Key messages

What candidates did well

- Many candidates demonstrated factual knowledge and used detailed scientific terminology.
- Analysis of unfamiliar context was demonstrated well.
- There was good use of provided diagrams, charts, tables and photographs to support answers.
- Most candidates demonstrated good knowledge of hydroponics for managing food security.
- Most candidates were proficient at constructing a bar chart using a ruler.
- Candidates demonstrated good knowledge of invasive species and the causes and impacts of energy insecurity.
- Many candidates had good knowledge of how stratospheric ozone depletion occurs.

What candidates needed to improve

- Candidates should understand how to answer a question based on the command word used.
- Some candidates need to read questions carefully and ensure their answers directly address what is being asked. For example, **Question 6** addressed renewable energy resources in context of energy security, not climate change.
- Candidates would benefit from a deeper understanding of the benefits and limitations of a wider range of strategies for managing energy security, other than renewable energy.
- Candidates need to review bioaccumulation and biomagnification and understand the differences.
- Many candidates were unable to correctly name the independent variable.
- Candidates would benefit from reviewing why stratospheric ozone depletion is greatest over Antarctica.
- Candidates should review the differences between the shapes of a pyramid of energy and a pyramid of biomass.

Comments on specific questions

Section A

Question 1

(a) (i) Comprehensive responses

- Most candidates identified process 1 (one) as representing condensation.

Limited responses

- Some candidates incorrectly identified condensation as process 2, 6 or 7.

(ii) Comprehensive responses

- Some candidates correctly named one or both processes.

Limited responses

- Most candidates incorrectly named one or both processes.
- Common examples of incorrect responses included ground water, water flow or through-flow for process 3 and infiltration or ground water flow for process 4.
- Common incorrect responses confused process 3 for process 4 and vice versa.

(b) Comprehensive responses

- Some responses correctly suggested that process 7 (run-off) would increase because grazing reduces plants which decreases interception.

Limited responses

- Most candidates incorrectly described farm infrastructure, vegetation or animals as blocking the flow of water down the mountain or livestock drinking the water.

(c) (i) Comprehensive responses

- Most candidates clearly understood the benefits of hydroponics to manage food security.
- Many gave comprehensive answers describing four or more clear points.
- Most responses understood the benefits of growing food without soil under controlled conditions using limited water and space.
- Many made the most of **Figure 1.2** to support their answers.

Limited responses

- Very few responses were vague.

(ii) Comprehensive responses

- Many responses gave the correct word equation for photosynthesis.

Limited responses

- Some candidates incorrectly gave the chemical formula for photosynthesis.

(iii) Comprehensive responses

- Many responses ticked the correct two boxes demonstrating knowledge of aerobic respiration.

Limited responses

- Some candidates ticked one correct box and one incorrect box.

Question 2

(a) (i) Comprehensive responses

- Some responses gave the correct units for population density.
- Most correctly calculated the population density of Qatar to one decimal place.

Limited responses

- Many gave incorrect or incomplete units for population density.
- Common incorrect responses included omitting 'people' or giving 'population' with the correct units for area (km²).

(ii) Comprehensive responses

- For support: most candidates correctly suggested Argentina's population is greater than that of Greece.
- For does not support: most responses were also able to suggest that Greece's population density is greater than that of Argentina.

Limited responses

- Some responses had confused population for population density and vice versa.
- Some candidates had not given comparative statements for one or both required responses. For example, 'Argentina has a large population' is not comparative to that of Greece.

(b) (i) Comprehensive responses

- Many responses gave good comparisons using correct age ranges for evidence.
- Most comprehensive responses identified a much larger male population overall than female population.
- Many picked out specific sections of the population pyramids giving correct age ranges and descriptions, such as 0 – 19 similar for both male and female.

Limited responses

- Some answers were too vague in not describing specific age ranges to back up their statements. For example, the 'working age population' or the 'younger population' or the 'older population' is not specific enough.
- Very few responses provided manipulated data to back up correct comparisons.

(b)(ii) Comprehensive responses

- Many suggested the migration (of males) into Qatar for employment.

Limited responses

- Many responses included cultural reasons such as ideas about preference for males over females or that females emigrated out of Qatar.

(c) Comprehensive responses

- Most candidates explained several relevant reasons for both a narrow top and wide base in a country with low income economy (LIC) or presented the opposite argument for a country with high income economy (HIC).
- Many responses provided comprehensive explanations.

Limited responses

- Some responses were vague such as 'LICs lack of resources'.
- Some had confused explanations for narrow top and wide base.

Question 3

(a)(i) Comprehensive responses

- Some candidates stated the number of tourists as the independent variable.

Limited responses

- Many candidates stated the dependent variable (number of penguin nests) or another variable such as years or time.
- Some responses were too vague in stating 'tourists' or 'tourism' as the independent variable.

(ii) Comprehensive responses

- Half of the responses explained either support for, or no support for, the hypothesis, giving relevant information or data.
- Most correct responses identified an overall increase in the number of tourists with an overall decrease in the number of penguin nests as not supporting the hypothesis.
- Good use was made of **Figure 3.2** in support of answers.

Limited responses

- Some candidates mixed up the evidence, providing explanations for supporting the hypothesis which do not support it.
- Others gave relevant explanations without indicating if they supported or did not support the hypothesis. Such responses did not fulfil the requirements of the question.

(iii) Comprehensive responses

- Many suggested one or two other relevant ways tourism negatively impacts Antarctica.
- Most correct answers suggested littering and/or noise pollution.

Limited responses

- Many answers were too vague, using phrases such as 'disturbs the ecosystem'.
- Many also suggested carbon dioxide emissions from boats cause climate change.
- Candidates need to review their knowledge of the global causes of climate change rather than localised events.

(b)(i) Comprehensive responses

- Many candidates fully described how ozone depletion occurs.
- Most correct answers demonstrated comprehensive knowledge of each stage, giving correct scientific substances and reactions.

Limited responses

- Some responses confused reactants, describing ozone depletion by carbon dioxide or methane. Others made a contradiction by listing chlorofluorocarbons (CFCs) alongside an incorrect substance.
- Some were not specific enough about the release of chlorine atoms or chlorine radicals.
- Others described the consequences of ozone depletion, which did not answer the question.

(b)(ii) Comprehensive responses

- Many responses demonstrated good knowledge of why ozone depletion is greatest over Antarctica, describing air circulation patterns using correct nomenclature such as the Polar Stratospheric Clouds and the Polar Vortex.
- Most candidates described low temperatures as a reason.

Limited responses

- Some answers were too vague without naming air circulation features.
- Others had limited knowledge on this subject.

(c)(i) Comprehensive responses

- Some candidates identified all three parts to the question correctly.
- Many candidates identified one or two parts.
- Use of **Figure 3.3** was good.

Limited responses

- Many responses did not identify four tertiary consumers, providing only a partially correct answer with one, two or three tertiary consumers.
- A common mistake was naming the toothfish as a tertiary consumer, whereas this is a secondary consumer.
- Some candidates did not correctly identify any of the three parts.

(ii) Comprehensive responses

- Some candidates correctly described the shape of the pyramid of energy as being inverted to that of the pyramid of biomass.

Limited responses

- Most responses did not answer the question, instead describing how energy moves through a food chain or a description of trophic levels.

(iii) Comprehensive responses

- Many responses gave correct explanations, demonstrating good knowledge of the transfer of energy through food chains and the differences in energy efficiency between short and long food chains.

Limited responses

- Some answers were too vague, stating energy is lost through a food chain without describing a stated way, nor that less energy is lost in short food chains.

Question 4

(a) Comprehensive responses

- Most candidates made good use of **Figure 4.1** to give a range of valid comparisons.
- Many manipulated data from the charts to give a comparative data quote, such as China disposes of plastic waste by landfill 13% less than the rest of the world.

Limited responses

- A common mistake was quoting data directly from **Figure 4.1** without manipulation of the percentage values.

(b) Comprehensive responses

- Many responses gave at least one reason such as more plastic waste is recycled in the USA.
- Another common answer was based on an economic reason such as more financial incentives for recycling or fines for illegal dumping.

Limited responses

- Many answers were vague, such as 'education of the public' without qualification.
- Another common vague response was 'fines' or 'incentives' without explaining what these were for.

(c) Comprehensive responses

- Most presented 4 neat bars drawn with a ruler of equal width and 4 correct plots.

Limited responses

- A common mistake was bars touching. This makes a histogram, not a bar chart. A histogram is not appropriate for discrete data.
- Another common mistake was to draw the bars without straight lines; therefore, bars were not of equal width. Candidates should always use a ruler to draw bar charts.
- Some plotted the data as single points.

(d)(i) Comprehensive responses

- Many answers demonstrated partial knowledge of bioaccumulation, describing the build-up of toxins in a single organism over time through persistent intake of toxins.
- Some described the process fully without confusion with biomagnification.

Limited responses

- Most answers confused bioaccumulation with biomagnification. Biomagnification is the accumulation of the concentration of toxins up the food chain.

(ii) Comprehensive responses

- Most candidates stated one or two effects of plastic in the oceans other than bioaccumulation.
- A common answer was choking due to ingestion.
- Another common answer was entanglement.

Limited responses

- Some answers were vague such as 'pollutes' or 'kills marine life'.
- Other vague answers included 'destroys habitat' or 'harms biodiversity'.

(iii) Comprehensive responses

- Most responses suggested several benefits and limitations of using biodegradable plastics to reduce plastics in the ocean.
- Common answers for benefits was they degrade or dissolve and that means impacts are not permanent.
- A common answer for limitations was that they are expensive to produce.
- Other common answers for limitations were good descriptions of how biodegradable plastics can still negatively impact marine life, or that they may release harmful substances.

Limited responses

- Many answers were vague such as 'does not harm marine life' for benefits and 'expensive' for limitations.
- Few answers suggested use of plant products or sustainability for benefits.
- No responses mentioned benefits of conserving fossil fuels for production of conventional plastics and resulting lower energy and carbon dioxide emitted.
- No responses mentioned limitations of available land for crops.

Section B

Question 5

Comprehensive responses

- Many candidates demonstrated good knowledge of how invasive species threaten biodiversity such as competition with native species for a named resource, for example food and habitat.
- Many named one or more examples of invasive species and their effect on the environment. The Cane Toad in Australia was a popular answer.

Limited responses

- Some candidates discussed other threats to biodiversity with climate change, population increase and urbanisation being common answers. Some recognised the importance of international protocols and legislation for protecting biodiversity.
- Very few responses made balanced judgements on the extent of these threats to biodiversity. Candidates would benefit from reviewing of a range of threats to biodiversity at global, regional or local scales.

Question 6

Comprehensive responses

- Candidates demonstrated good knowledge of the benefits and limitations of renewable energy.
- Many named one or more renewable energy sources and provided working examples from a range of countries and projects, both at regional and local scales. The Three Gorges Dam (China) providing hydroelectric power was a popular answer.
- Some discussed these benefits and limitations in terms of energy security, addressing the question.

Limited responses

- Many candidates discussed renewable resources in the context of climate change and reducing carbon emissions, which did not answer the question.
- Very few responses named other strategies for managing energy security and therefore presented unbalanced arguments. Candidates would benefit from reviewing of energy security management at government level as well as local level, and reasons for variation in strategies.

ENVIRONMENTAL MANAGEMENT

Paper 8291/13 Principles of Environmental Management

Key messages

What candidates did well

- Many candidates demonstrated factual knowledge and used detailed scientific terminology.
- Analysis of unfamiliar context was demonstrated well.
- There was good use of provided diagrams, charts, tables and photographs to support answers.
- Most candidates demonstrated good knowledge of hydroponics for managing food security.
- Most candidates were proficient at constructing a bar chart using a ruler.
- Candidates demonstrated good knowledge of invasive species and the causes and impacts of energy insecurity.
- Many candidates had good knowledge of how stratospheric ozone depletion occurs.

What candidates needed to improve

- Candidates should understand how to answer a question based on the command word used.
- Some candidates need to read questions carefully and ensure their answers directly address what is being asked. For example, **Question 6** addressed renewable energy resources in context of energy security, not climate change.
- Candidates would benefit from a deeper understanding of the benefits and limitations of a wider range of strategies for managing energy security, other than renewable energy.
- Candidates need to review bioaccumulation and biomagnification and understand the differences.
- Many candidates were unable to correctly name the independent variable.
- Candidates would benefit from reviewing why stratospheric ozone depletion is greatest over Antarctica.
- Candidates should review the differences between the shapes of a pyramid of energy and a pyramid of biomass.

Comments on specific questions

Section A

Question 1

(a) (i) Comprehensive responses

- Most candidates identified process 1 (one) as representing condensation.

Limited responses

- Some candidates incorrectly identified condensation as process 2, 6 or 7.

(ii) Comprehensive responses

- Some candidates correctly named one or both processes.

Limited responses

- Most candidates incorrectly named one or both processes.
- Common examples of incorrect responses included ground water, water flow or through-flow for process 3 and infiltration or ground water flow for process 4.
- Common incorrect responses confused process 3 for process 4 and vice versa.

(b) Comprehensive responses

- Some responses correctly suggested that process 7 (run-off) would increase because grazing reduces plants which decreases interception.

Limited responses

- Most candidates incorrectly described farm infrastructure, vegetation or animals as blocking the flow of water down the mountain or livestock drinking the water.

(c) (i) Comprehensive responses

- Most candidates clearly understood the benefits of hydroponics to manage food security.
- Many gave comprehensive answers describing four or more clear points.
- Most responses understood the benefits of growing food without soil under controlled conditions using limited water and space.
- Many made the most of **Figure 1.2** to support their answers.

Limited responses

- Very few responses were vague.

(ii) Comprehensive responses

- Many responses gave the correct word equation for photosynthesis.

Limited responses

- Some candidates incorrectly gave the chemical formula for photosynthesis.

(iii) Comprehensive responses

- Many responses ticked the correct two boxes demonstrating knowledge of aerobic respiration.

Limited responses

- Some candidates ticked one correct box and one incorrect box.

Question 2

(a) (i) Comprehensive responses

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Limited responses

- Many gave incorrect or incomplete units for population density.
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- Many picked out specific sections of the population pyramids giving correct age ranges and descriptions, such as 0 – 19 similar for both male and female.

Limited responses

- Some answers were too vague in not describing specific age ranges to back up their statements. For example, the 'working age population' or the 'younger population' or the 'older population' is not specific enough.
- Very few responses provided manipulated data to back up correct comparisons.

(b)(ii) Comprehensive responses

- Many suggested the migration (of males) into Qatar for employment.

Limited responses

- Many responses included cultural reasons such as ideas about preference for males over females or that females emigrated out of Qatar.

(c) Comprehensive responses

- Most candidates explained several relevant reasons for both a narrow top and wide base in a country with low income economy (LIC) or presented the opposite argument for a country with high income economy (HIC).
- Many responses provided comprehensive explanations.

Limited responses

- Some responses were vague such as 'LICs lack of resources'.
- Some had confused explanations for narrow top and wide base.

Question 3

(a)(i) Comprehensive responses

- Some candidates stated the number of tourists as the independent variable.

Limited responses

- Many candidates stated the dependent variable (number of penguin nests) or another variable such as years or time.
- Some responses were too vague in stating 'tourists' or 'tourism' as the independent variable.

(ii) Comprehensive responses

- Half of the responses explained either support for, or no support for, the hypothesis, giving relevant information or data.
- Most correct responses identified an overall increase in the number of tourists with an overall decrease in the number of penguin nests as not supporting the hypothesis.
- Good use was made of **Figure 3.2** in support of answers.

Limited responses

- Some candidates mixed up the evidence, providing explanations for supporting the hypothesis which do not support it.
- Others gave relevant explanations without indicating if they supported or did not support the hypothesis. Such responses did not fulfil the requirements of the question.

(iii) Comprehensive responses

- Many suggested one or two other relevant ways tourism negatively impacts Antarctica.
- Most correct answers suggested littering and/or noise pollution.

Limited responses

- Many answers were too vague, using phrases such as 'disturbs the ecosystem'.
- Many also suggested carbon dioxide emissions from boats cause climate change.
- Candidates need to review their knowledge of the global causes of climate change rather than localised events.

(b)(i) Comprehensive responses

- Many candidates fully described how ozone depletion occurs.
- Most correct answers demonstrated comprehensive knowledge of each stage, giving correct scientific substances and reactions.

Limited responses

- Some responses confused reactants, describing ozone depletion by carbon dioxide or methane. Others made a contradiction by listing chlorofluorocarbons (CFCs) alongside an incorrect substance.
- Some were not specific enough about the release of chlorine atoms or chlorine radicals.
- Others described the consequences of ozone depletion, which did not answer the question.

(b)(ii) Comprehensive responses

- Many responses demonstrated good knowledge of why ozone depletion is greatest over Antarctica, describing air circulation patterns using correct nomenclature such as the Polar Stratospheric Clouds and the Polar Vortex.
- Most candidates described low temperatures as a reason.

Limited responses

- Some answers were too vague without naming air circulation features.
- Others had limited knowledge on this subject.

(c)(i) Comprehensive responses

- Some candidates identified all three parts to the question correctly.
- Many candidates identified one or two parts.
- Use of **Figure 3.3** was good.

Limited responses

- Many responses did not identify four tertiary consumers, providing only a partially correct answer with one, two or three tertiary consumers.
- A common mistake was naming the toothfish as a tertiary consumer, whereas this is a secondary consumer.
- Some candidates did not correctly identify any of the three parts.

(ii) Comprehensive responses

- Some candidates correctly described the shape of the pyramid of energy as being inverted to that of the pyramid of biomass.

Limited responses

- Most responses did not answer the question, instead describing how energy moves through a food chain or a description of trophic levels.

(iii) Comprehensive responses

- Many responses gave correct explanations, demonstrating good knowledge of the transfer of energy through food chains and the differences in energy efficiency between short and long food chains.

Limited responses

- Some answers were too vague, stating energy is lost through a food chain without describing a stated way, nor that less energy is lost in short food chains.

Question 4

(a) Comprehensive responses

- Most candidates made good use of **Figure 4.1** to give a range of valid comparisons.
- Many manipulated data from the charts to give a comparative data quote, such as China disposes of plastic waste by landfill 13% less than the rest of the world.

Limited responses

- A common mistake was quoting data directly from **Figure 4.1** without manipulation of the percentage values.

(b) Comprehensive responses

- Many responses gave at least one reason such as more plastic waste is recycled in the USA.
- Another common answer was based on an economic reason such as more financial incentives for recycling or fines for illegal dumping.

Limited responses

- Many answers were vague, such as 'education of the public' without qualification.
- Another common vague response was 'fines' or 'incentives' without explaining what these were for.

(c) Comprehensive responses

- Most presented 4 neat bars drawn with a ruler of equal width and 4 correct plots.

Limited responses

- A common mistake was bars touching. This makes a histogram, not a bar chart. A histogram is not appropriate for discrete data.
- Another common mistake was to draw the bars without straight lines; therefore, bars were not of equal width. Candidates should always use a ruler to draw bar charts.
- Some plotted the data as single points.

(d)(i) Comprehensive responses

- Many answers demonstrated partial knowledge of bioaccumulation, describing the build-up of toxins in a single organism over time through persistent intake of toxins.
- Some described the process fully without confusion with biomagnification.

Limited responses

- Most answers confused bioaccumulation with biomagnification. Biomagnification is the accumulation of the concentration of toxins up the food chain.

(ii) Comprehensive responses

- Most candidates stated one or two effects of plastic in the oceans other than bioaccumulation.
- A common answer was choking due to ingestion.
- Another common answer was entanglement.

Limited responses

- Some answers were vague such as 'pollutes' or 'kills marine life'.
- Other vague answers included 'destroys habitat' or 'harms biodiversity'.

(iii) Comprehensive responses

- Most responses suggested several benefits and limitations of using biodegradable plastics to reduce plastics in the ocean.
- Common answers for benefits was they degrade or dissolve and that means impacts are not permanent.
- A common answer for limitations was that they are expensive to produce.
- Other common answers for limitations were good descriptions of how biodegradable plastics can still negatively impact marine life, or that they may release harmful substances.

Limited responses

- Many answers were vague such as 'does not harm marine life' for benefits and 'expensive' for limitations.
- Few answers suggested use of plant products or sustainability for benefits.
- No responses mentioned benefits of conserving fossil fuels for production of conventional plastics and resulting lower energy and carbon dioxide emitted.
- No responses mentioned limitations of available land for crops.

Section B

Question 5

Comprehensive responses

- Many candidates demonstrated good knowledge of how invasive species threaten biodiversity such as competition with native species for a named resource, for example food and habitat.
- Many named one or more examples of invasive species and their effect on the environment. The Cane Toad in Australia was a popular answer.

Limited responses

- Some candidates discussed other threats to biodiversity with climate change, population increase and urbanisation being common answers. Some recognised the importance of international protocols and legislation for protecting biodiversity.
- Very few responses made balanced judgements on the extent of these threats to biodiversity. Candidates would benefit from reviewing of a range of threats to biodiversity at global, regional or local scales.

Question 6

Comprehensive responses

- Candidates demonstrated good knowledge of the benefits and limitations of renewable energy.
- Many named one or more renewable energy sources and provided working examples from a range of countries and projects, both at regional and local scales. The Three Gorges Dam (China) providing hydroelectric power was a popular answer.
- Some discussed these benefits and limitations in terms of energy security, addressing the question.

Limited responses

- Many candidates discussed renewable resources in the context of climate change and reducing carbon emissions, which did not answer the question.
- Very few responses named other strategies for managing energy security and therefore presented unbalanced arguments. Candidates would benefit from reviewing of energy security management at government level as well as local level, and reasons for variation in strategies.

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Key messages

What candidates did well

- Some candidates demonstrated factual knowledge and used detailed scientific terminology.
- Some candidates showed their working in calculations so that an error carried forward could be applied where appropriate.
- Good responses did not merely repeat information in the question; they added explanations to this where needed. Many answers showed a good understanding of syllabus terms and topics.
- Some candidates were proficient at constructing a pie chart and completing a bar chart using a ruler.
- Analysis of unfamiliar context was demonstrated well by some candidates.
- Some made good use of provided diagrams, charts and tables to support their responses.
- Candidates demonstrated good knowledge of invasive species and how climate change increases the number of wildfires.

What candidates needed to improve

- Candidates should check they have attempted every question. There were a number of no responses to questions throughout the question paper.
- Identifying benefits and limitations of environmental management strategies in unfamiliar contexts is an area of the syllabus that candidates need more practice in.
- Candidates should avoid using up, down, left and right for distribution questions and instead refer to compass points north, south, east and west.
- Many candidates would benefit from further practice in drawing pie charts, especially the rank ordering of the elements.
- Some candidates needed to use the correct number of significant figures when rounding numerical answers.
- Descriptions of field techniques and sampling strategies were not well known. Candidates are expected to be familiar with the data sampling techniques listed in LO2.4 of the syllabus.
- Some candidates repeated the question in their answers. Clear and concise responses, such as bullet points, can help candidates address all required points, particularly in questions that require more than one idea.
- Candidates should organise their ideas systematically and logically. They should avoid using terms that have a specific meaning in science unless they are used in an appropriate context, for example accurate, reliable, valid. Vague terms such as 'to harm/affect/damage/pollution' should always be qualified with what this impact is or what is polluted.
- Candidates should interpret the questions with care and study the information provided in detail. They should utilise the information provided to formulate their answers, not simply copy figures and parts of the question as their answers.
- There was a common misconception that carbon dioxide destroys ozone, indicating confusion between ozone depletion and global warming.
- Many candidates needed to provide a sequential description of how to use a beating tray.
- In all the questions requiring mathematical manipulation of data, there were a range of incorrect answers as well as the correct one.
- When an explanation is required, candidates need to explain their response, not simply make a brief statement or write a single word.

Comments on specific questions

Question 1

(a) Comprehensive responses

- Some candidates were able to describe a renewable resource as a resource that can naturally replenish.

Limited responses

- Some candidates used vague terms such as 'can be used again' or 'can be recycled' or 'can renew'.

(b) Comprehensive responses

- Most candidates could describe one way investment in wind and solar resources can help a country become carbon neutral. The most common response was to state that solar and wind are renewable.

Limited responses

- Some responses referred to 'they do not use carbon' which was not the same as 'wind and solar resources are not carbon-based'.
- Responses were often short, with just general details about reducing pollution and global warming.

(c) Comprehensive responses

- Full definitions referred to reliability, availability and affordability of energy.

Limited responses

- Many candidates gave incomplete definitions of energy security, often omitting the concept of affordability.
- Some candidates gave a definition of general sustainability.

(d)(i) Comprehensive responses

- Some candidates were able to read off the energy generated for 2015 and 2022 and then use these values to determine the percentage increase.

Limited responses

- Many candidates did not appear to be familiar with how to approach this type of calculation.
- Some candidates did not include their workings, which made it difficult to award marks for correct methods if an earlier error was made.

(ii) Comprehensive responses

- The majority correctly plotted the bar at 230 GW.

Limited responses

- Fewer used straight lines for their bars. Many did not use a ruler. Some candidates did not give a bar of equal width to the other bars and with the same spacing between 2022 and 2023.

(e)(i) Comprehensive responses

- Many candidates were able to use **Figure 1.2** to compare the predicted maximum quantity of electricity for wind and solar for China and the rest of the world. Many manipulated the figures to work out differences.
- Good responses made it clear whether China or the rest of the world, for wind or solar, was being compared.

Limited responses

- Some candidates quoted data directly from **Figure 1.2** without any manipulation or comparison. For example, 'China for wind is 310 GW and for solar is 228 GW'. This data quote is a direct lift from the figure and does not include any comparison from the candidate. For example, 'China is 1.1 times greater than rest of world for wind' is comparative and not a direct lift of information already stated in **Figure 1.2**.

(ii) Comprehensive responses

- Most candidates could suggest one reason why the actual quantity of electricity generated from wind was less than predicted.
- 'Variable wind speed' and 'breakdown of equipment' were the most common responses.

Limited responses

- 'It is a prediction', was insufficient as it repeats the question.

(f) (i) Comprehensive responses

- The majority correctly identified 13 regions.

Limited responses

- None was seen.

(ii) Comprehensive responses

- Most candidates were able to demonstrate the required mathematical skills in their responses to this question.
- Candidates who showed their workings for the question were often able to obtain error carried forward for correct application of significant figures.

Limited responses

- Many candidates were not able to give their answer to 2 significant figures and/or used incorrect data.

(iii) Comprehensive responses

- A few candidates gave sensible benefits and limitations.
- The most common benefit was that 'there is a large area of land that can be used to put wind turbines on'.
- Good responses included a limitation such as 'there would not be enough workers to maintain the infrastructure'.

Limited responses

- Many responses did not contain sufficient detail and used vague terms such as 'low impact' or 'less pollution' for a benefit or 'unsuitable landscape' with no reason why the landscape may be unsuitable, for a limitation.
- Some thought that the electricity generation would be confined to the area where it was generated.

Question 2

(a) Comprehensive responses

- Some candidates recognised that natural gas is non-renewable, so the process depletes this resource.
- Most candidates noted that use of natural gas increased global warming.
- Some very good responses noted that high temperatures require energy.

Limited responses

- Many responses gave negative impacts of using fertilisers rather than the production of fertilisers, as specified in the question.

(b) (i) Comprehensive responses

- A minority of candidates recognised that there would be little waste.

Limited responses

- Many irrelevant responses were seen such as 'it's easy to spread' or 'it gave a good balance'. Most did not understand the significance of the ratio.

(ii) Comprehensive responses

- A minority were able to present the sectors of the pie in rank order with the largest sector first, beginning at noon and proceeding clockwise.
- Some candidates could plot the sectors correctly and draw the sectors with straight lines.

- More were able to match the key to the sectors.

Limited responses

- Successful drawing and presentation of a pie chart is an area of the syllabus for which most candidates need more practice.
- A number of candidates did not use a ruler to draw the section boundaries within their pie chart.

(c) (i) Comprehensive responses

- Many candidates recognised that no fertiliser was added.

Limited responses

- A few incorrectly thought a different fertiliser was used.
- Some candidates referred to 'normal conditions' without specifying what these conditions were. Responses needed to clearly state the relevant conditions.

(ii) Comprehensive responses

- Some candidates could suggest that a greenhouse is a controlled environment and that this enables control of conditions such as temperature or quantity of water.

Limited responses

- Some responses confused controlled environment with 'the control'.

(iii) Comprehensive responses

- Most recognised that polyhalite increased plant height.

Limited responses

- Some candidates should specify how polyhalite affects height.

(iv) Comprehensive responses

- The majority suggested that **C** is not used as it produced the lowest height plant.

Limited responses

- Responses such as 'It was the worst' did not explain why C was considered the least suitable option.
- Some responses stated 'decreases plant height' indicating a change in height. Candidates needed to interpret the data more carefully.

(v) Comprehensive responses

- Good responses referred to being able to identify anomalies.

Limited responses

- The term 'accuracy' has a specific meaning and repeating an investigation does not increase accuracy. It does, though, increase reliability and validity.

(d) Comprehensive responses

- Most candidates gave the correct order.

Limited responses

- A minority reversed the order.

(e) (i) Comprehensive responses

- Some responses referred specifically to reducing 'visual pollution' or 'noise pollution'.
- Good responses also recognised that there was less risk of fragmentation.

Limited responses

- Candidates should be encouraged to give clear, detailed explanations that directly address the question.
- Some responses referred to 'less pollution' without specifying the type of pollution. Some responses also referred to 'less impact' without explaining what the impact was. Candidates should provide specific details and explanations.

- Some candidates copied text directly from the question rather than demonstrating additional knowledge or skills in their responses.

(ii) Comprehensive responses

- Good responses referred to an increase in jobs and economy in the local area.

Limited responses

- It was common for candidates to repeat answers from **(i)** rather than answer the question in terms of benefits to local people.

Question 3

(a) Comprehensive responses

- Some candidates were able to explain that land or vegetation dries out and drought conditions would increase.
- Some responses also referred to winds from increased extreme weather, spreading fires or increased chances of lightning.

Limited responses

- A minority could not give a full explanation.
- Some answers were not specific enough and referred to 'getting hotter'. Others referred to an increase in temperature although the idea that this is for a long period of time was left out.

(b)(i) Comprehensive responses

- 9 was correctly stated by the majority.

Limited responses

- 8 or other numbers were also seen.

(ii) Comprehensive responses

- A good response suggested that 2023 was anomalous and that the data shows no pattern.

Limited responses

- Sensible suggestions were rare and the same point was often repeated twice, with different wording. For example, '2023 is unusually high' and '2023 is higher than other years'.

(c) Comprehensive responses

- Most candidates could suggest two negative impacts of wildfires.
- 'Loss of property' and 'loss of habitat' were common responses.

Limited responses

- A few responses repeated 'death' which had already been referred to in the question.

(d)(i) Comprehensive responses

- Good responses used compass directions such as 'north', 'south', 'east' and 'west' to describe the distribution of rainfall.
- These responses also used the key to guide their descriptions. For example, 'above average in the north' or average in the interior of the country.

Limited responses

- Referring to 'up', 'down', 'left' or 'right' should be avoided when describing a distribution on a map.
- Limited responses used vague language such as, 'most rain at the top of the country'.

(ii) Comprehensive responses

- Some good responses were seen to this question.
- Many candidates recognised that water would become contaminated and could state a source of pollution, such as sewage.
- Very good answers also referred to the lack of water for irrigation or another stated purpose.

Limited responses

- Vague answers such as ‘the water gets dirty’ were insufficient.

(iii) Comprehensive responses

- Some candidates were able to recognise that tree roots absorb water and improve soil structure.
- Very good answers went on to discuss increased interception and infiltration and a decrease in run-off with the presence of trees.

Limited responses

- Few candidates could give a full explanation as to how planting trees reduces the risk of flooding.
- Many candidates wrote generically about trees rather than specifically about roots absorbing water.
- Key terminology from the syllabus was often missing or incorrectly used.
- It was often not clear whether planting trees increased or decreased a stated process.

Question 4

(a) Comprehensive responses

- Some candidates could state a random method of number selection for random sampling, such as a random number generator.
- Some were also able to clearly describe dividing up the forest with a method that gives equal-sized areas such as a grid.

Limited responses

- Some candidates gave incomplete descriptions of random sampling. Responses such as ‘use a quadrat’ or ‘use a map’ were seen without further explanation.
- Some referred to using AI or a computer. Such answers did not make it clear that this was to randomly select coordinates or areas on a grid.

(b) Comprehensive responses

- A good description would refer to hitting one plant for a stated period of time, such as 5 minutes; counting the total number of insects; identifying them using a book or computer source and repeating at different locations and subsequently calculating a mean.

Limited responses

- Descriptions of the beating tray method varied, with responses not always providing sufficient detail to demonstrate understanding of the technique.
- Candidates should aim to give sufficiently detailed descriptions of methods that would enable them to be followed by another person.
- Key elements missing from the majority of answers were the length of time the tree should be beaten for and the method of identification.

(c) (i) Comprehensive responses

- Most candidates circled 3340.

Limited responses

- Some candidates omitted this question.

(ii) Comprehensive responses

- Some candidates could give one reason why the total number of individual insects in a pitfall trap is greater than a beating tray.
- Good answers recognised that the trap may contain a bait and that insects cannot escape once in the trap. A few recognised that the pitfall trap is left for longer than the beating tray is used for.

Limited responses

- Vague responses were common and it appeared that many candidates were not familiar with either a pitfall trap or a beating tray.

- It was insufficient to state 'there are more insects on the ground' or 'most insects live on the ground'

(iii) Comprehensive responses

- Some candidates suggested that larger insects could not be captured or recognised the risk of harm to the insects once inside the trap.

Limited responses

- Some candidates would benefit from further familiarity with the stated data collection methods in the syllabus as some responses suggested that insects are able to easily escape from a pitfall trap.

(d)(i) Comprehensive responses

- 40 was correctly calculated by the majority.

Limited responses

- A few candidates worked back from the value of $(n / N)^2$. In doing so, they did not realise that due to rounding, this gives a value of 39 which does not then give the total of 1090 in the column for n.

(ii) Comprehensive responses

- Some candidates were able to calculate D.

Limited responses

- Incorrect rounding was frequently seen.

(iii) Comprehensive responses

- Most recognised that a lower value of D means there was less biodiversity.

Limited responses

- A few candidates were not familiar with Simpson's Index.
- Some indicated lower population.

(e) Comprehensive responses

- Many candidates showed a clear understanding of how invasive species reduce biodiversity. For example, 'they have no natural predators so can outcompete native species for food and water. They also prey on native species.'

Limited responses

- Some explanations stopped after explaining two points and gave answers that did not contain depth.
- For example, 'they compete with native species' without explaining what this competition involves or that they outcompete the native species.
- It was insufficient to state invasive species 'kill' or 'attack' native ones, without explaining how this takes place and how it reduces biodiversity.

Question 5

(a) Comprehensive responses

- Stratosphere was known by many.

Limited responses

- Troposphere, mesosphere and incorrect spellings of stratosphere were common.

(b) Comprehensive responses

- CFCs was known by most candidates.
- Other correct ozone-depleting substances were also given.

Limited responses

- Many incorrect substances were stated.

- There was a common misconception that carbon dioxide or methane destroys ozone, indicating confusion between ozone depletion and global warming.

(c) Comprehensive responses

- A few knew that a concentration less than 100 Dobson Units indicates an ozone hole.

Limited responses

- Many incorrect values were stated.

(d)(i) Comprehensive responses

- Candidates were generally able to give some evaluation of the effectiveness of the international agreements.
- Good responses stated that both reduced skin cancer compared to no restrictions and that Copenhagen was the most effective as cases were close to zero.
- A few also gave manipulated comparative data. For example, 'Montreal compared to Copenhagen has 1950 more cases'.

Limited responses

- Some candidates gave data quotes that was simply lifted from the figure without additional commentary. For example, 'Montreal is 2000 and zero in 2100'.

(ii) Comprehensive responses

- The majority stated cataracts.

Limited responses

- Some candidates should include more specific details of symptoms rather than general terms such as 'eye irritation'.
- Some candidates referred to skin cancer, which had already been given in the question.

(e) Comprehensive responses

- Many responses suggested that there was a lack of experimental evidence.

Limited responses

- Vaguer responses referred to 'no one had the knowledge'.

(f) Comprehensive responses

- Most candidates gave sensible suggestions such as 'the ozone hole had not been discovered'.

Limited responses

- A few responses erroneously referred to conspiracy theories.

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Key messages

What candidates did well

- Some candidates demonstrated factual knowledge and used detailed scientific terminology.
- Good responses did not merely repeat information in the question; they added explanations to this where needed. Many answers showed a good understanding of syllabus terms and topics.
- Some candidates were very proficient at constructing a line graph using a ruler.
- Analysis of unfamiliar context was demonstrated well by some candidates.
- Some made good use of provided diagrams, charts and tables to support their responses, such as the data in the context of the elephant seal and dive depth, but also the flying AirCar and climate change.

What candidates needed to improve

- Candidates should check they have attempted every question. There were a number of no responses to questions throughout the question paper.
- Identifying benefits and limitations of environmental management strategies in unfamiliar contexts is an area of the syllabus that candidates need more practice in.
- Candidates should interpret the questions with care and study the information provided in detail. They should utilise the information provided to formulate their answers, not simply copy figures and parts of the question as their answers.
- There was a common misconception of how nitrogen monoxide was formed in the atmosphere, as well as confusion of acid deposition and its effect on marine life.
- When an explanation is required, candidates need to explain their response, not simply make a brief statement or write a single word.

Comments on specific questions

Question 1

(a) (i) Comprehensive responses

- Some candidates were able to suggest a negative impact of tourism on elephant seals. A common response indicated the impact of litter or waste from tourism being toxic if ingested by elephant seals.

Limited responses

- Many candidates provided limited detail and were vague in their responses, for example pollution by tourists damaged the habitat or scaring the elephant seals endangered them.

(ii) Comprehensive responses

- Some candidates demonstrated a secure knowledge of the Antarctic Treaty and how it managed the impact of human activity.
- The most common responses were 'no nuclear testing' and 'disputes over sovereign territory'.

Limited responses

- Many candidates focused on legislative aspects or perceived rules of the Treaty rather than how the Treaty managed the human impact.

(b) (i) Comprehensive responses

- Most were able to state the day with the coldest temperature.

Limited responses

- Occasionally, there were a few candidates that misread the graph values.

(ii) Comprehensive responses

- Most candidates accurately identified the maximum dive depth.

Limited responses

- Occasionally, there were a few candidates that misread the graph values.

(iii) Comprehensive responses

- Most candidates were able to select appropriate words to complete a conclusion about the data.

Limited responses

- A few candidates were not able to recognise the correlation between dive depth and ocean temperature.

(iv) Comprehensive responses

- Most candidates demonstrated secure knowledge of the use of radio trackers to collect data, with common responses identifying attachment of the device onto the seal.
- Other responses commonly integrated the use of GPS to pinpoint locations.

Limited responses

- A few candidates confused where the location of the tracker was by making reference that it was located somewhere in the ocean and not attached to the seal.

(c) Comprehensive responses

- A significant number of candidates were able to suggest the impacts of increasing ocean temperatures with common answers being migration, seals diving deeper or less food availability.
- A few were able to provide a reason linked to the impact, for example migration due to ice sheets/shelves melting or increased predation due to increase in invasive predators.

Limited responses

- Many candidates cited increased temperatures as the reason though this is given in the stem of the question.
- Limited responses generally were able to cite impacts without articulating a developed reason.

(d) Comprehensive responses

- Many candidates were able to make a comparison between method 2 and method 1, with 'time consuming', 'less likely to miscount' and 'use of artificial intelligence' being common evaluations made.

Limited responses

- Some candidates focused on a comparison of the two methods by means of cost rather than the actual analysis of methodology.
- A few candidates attempted to evaluate the carbon footprint of both methods without sufficient evidence of data to make a comparison.

(e) (i) Comprehensive responses

- A few candidates were able to draw a line of best fit.

Limited responses

- Many candidates extrapolated back to zero or beyond the last point or outside the data range.

(ii) Comprehensive responses

- Some candidates were able to recognise from the line of best fit why the two methods gave similar results, citing positive correlation or the same number of seals for each method being similar. In some cases, this was articulated by stating that the ground count and aerial count for 1000 were similar/same.

Limited responses

- Many candidates suggested that all the results were close to each other and did not make the distinction that counts for 500 or 1500 were similar.

(f) Comprehensive responses

- Most candidates were able to determine where the optimum conditions were based on the location of elephant seals from the figure.

Limited responses

- Incorrect location of optimal conditions was made by some candidates through incorrect linkage of seal numbers or through incomplete knowledge of compass points.

Question 2

(a) (i) Comprehensive responses

- Most candidates demonstrated secure knowledge of plotting data on a bar chart, using a ruler in most cases and drawing the same bar width.

Limited responses

- A few candidates plotted incorrect bar heights given the data or, more often than not, drew incorrect bar widths.

(ii) Comprehensive responses

- The majority of candidates recognised that Japan had a decreasing population or that the death rate exceeded the birth rate.

Limited responses

- A few candidates did not provide evidence of a negative population change and quoted 0.5% instead of – 0.5%.

(iii) Comprehensive responses

- The majority of candidates recognised that low income economy countries (LIC) had high rates of population change.
- Many responses provided a direct comparison using data from the graph to fully evidence the differences between a high income economy country (HIC) and an LIC or an LIC and a middle income economy country (MIC).

Limited responses

- Some candidates did not directly answer the question and instead explained reasons for the differences in population change such as anti-natalist legislation, or lack of contraception or vice versa.

(b) Comprehensive responses

- Most candidates were able to correctly calculate a percentage increase given data.

Limited responses

- Candidates generally showed their workings, although they made an error when calculating percentage increase.

(c) (i) Comprehensive responses

- Some candidates recognised that the same carbon-based fuel for Aircars resulted in emission of carbon dioxide or other greenhouse gases.

Limited responses

- Quite a few candidates stated that carbon-based fuels were associated with climate change; however, the term carbon-based fuel was in the stem of the question.
- Very few candidates used the information in the question that AirCar can carry two people, suggesting that more vehicles would be required.

(ii) Comprehensive responses

- The question required two elements, benefit and reason. Many candidates suggested at least one benefit with a reason, and the most common response was less road traffic congestion, as Aircar could fly or have a quicker journey time.

Limited responses

- Many candidates provided a benefit without a described reason.

(d)(i) Comprehensive responses

- Many candidates identified the correct pH at which deposition is defined as acid deposition.

Limited responses

- Some candidates identified the correct pH although they thought it was greater than the definition level.

(ii) Comprehensive responses

- Many candidates identified a type of dry acid deposition, with gas being the common example used.

Limited responses

- A significant number of candidates assumed smog to be a form of dry acid deposition.

(iii) Comprehensive responses

- There were a few good responses to this question.
- Oxygen and nitrogen from the atmosphere were often given in the context of the question.

Limited responses

- Many candidates would benefit from further study of the chemical process in this context to develop a secure knowledge in this area.
- Some candidates often thought that nitrogen and oxygen were mixed with water.

(d)(iv) Comprehensive responses

- Many candidates expressed sulphur dioxide as gas X.

Limited responses

- Carbon dioxide was commonly given as gas X, although there were other incorrect substances stated.

(v) Comprehensive responses

- Most candidates identified nitric acid as acid Y.

Limited responses

- Other incorrect substances were stated.

(vi) Comprehensive responses

- Some candidates demonstrated knowledge of the impacts of acid deposition in aquatic environments, the most common response referring to damage or dysfunction of fish gills.

Limited responses

- Very few candidates evidenced knowledge on the impacts of acid deposition to an aquatic environment, with many candidates suggesting it decreases pH or acidifies water.

(e) (i) Comprehensive responses

- Most candidates correctly identified volatile organic compounds.

Limited responses

- Some candidates provided no response to the question.

(ii) Comprehensive responses

- Most candidates recognised sunlight as a requirement of photochemical smog.

Limited responses

- Some candidates provided a vague response and gave 'light'; however, the source is especially relevant, such as sunlight as opposed to a domestic form of light.

(iii) Comprehensive responses

- Eye and lung irritation were the responses most candidates gave, reduction of crop yield or deterioration of rubber and building materials were occasionally evidenced.

Limited responses

- Some candidates were vague and just gave cancer as an impact of smog, whilst others included an impact on plants without specifically citing a reduction in crop yield.

Question 3

(a) (i) Comprehensive responses

- Candidates gave well-developed answers as to why China produced more carbon emissions than the United Kingdom.
- The most common responses included increased industrialisation, increased number of cars/usage and increased population.

Limited responses

- Where population or a difference had been made, candidates did not always provide sufficient detail in their responses. For example, referring to the difference in high population, it was not specified whether China or the United Kingdom has the higher population difference.

(ii) Comprehensive responses

- Many candidates were able to conclude that both China and India had emissions that were increasing.
- Likewise, candidates often compared the USA and United Kingdom evidencing reduced emissions.
- Often candidates also recognised fluctuating emissions in the USA compared to other countries.

Limited responses

- Principally, some candidates described the trend for one country, for example India over a period of time, rather than comparing individual countries' emission trends in relation to each other.

(b) Comprehensive responses

- Most candidates provided detailed answers to this question which commonly included using public transport to work, airing/drying clothes outside, reducing shower times, etc.

Limited responses

- A few candidates included use of electric cars or solar panels; these were not specifically shown within **Figure 3.2**.

(c) Comprehensive responses

- Most candidates were able to suggest that greenhouse gases were emitted as part of the manufacturing process associated with the digital carbon footprint, whilst many also included emissions of gases through charging of digital accessories or using them.

Limited responses

- A few candidates discussed carbon emissions in more general terms rather than focusing on the question that required candidates to discuss use and data transmission of electronic devices.

(d) Comprehensive responses

- Many candidates were able to include reflection of solar radiation by stratospheric aerosols or reflection from particles themselves. Candidates would further benefit from reviewing the underlying principles of geo-engineering strategies.

Limited responses

- A few candidates implied the use of stratospheric aerosols were linked to reducing climate change aligned with chlorofluorocarbons (CFCs) and implications of ozone. Responses generally demonstrated an incomplete knowledge of geo-engineering strategies.

(e) (i) Comprehensive responses

- Many candidates evidenced a good analytical comparison of strategies to reduce climate change, demonstrating strong interpretative skills. Common responses recognised geo-engineering as the most effective strategy, together with recognising a lag phase, particularly with removing carbon dioxide from the atmosphere.

Limited responses

- A significant number of candidates did interpret the graph incorrectly, often citing geo-engineering as being the least effective strategy. Candidates would benefit from further revision and interpretation of graphical data.

(ii) Comprehensive responses

- Only a few candidates included different variables being a cause for different predictions for climate computer models.

Limited responses

- Many responses were vague and indicated differences in certain factors without elaborating, for example differences in data.

(iii) Comprehensive responses

- Many candidates demonstrated knowledge of reasons why predicting climate change is difficult. Common responses included lack of historical data together with time delay between cause and effect.

Limited responses

- Many candidates included computer accuracy as being the other reason for inaccurate predictions without much development or explanation.

Question 4

(a) Comprehensive responses

- Most candidates demonstrated a strong understanding of what is meant by food security, including the aspect of safe and nutritious food.

Limited responses

- The main omission with the definition of food security was not including access at all times.

(b) (i) Comprehensive responses

- The majority of candidates were able to provide a rank order for food wastage.

Limited responses

- Very few respondents provided an incorrect rank order or omitted the question.

(ii) Comprehensive responses

- Many responses evidenced an understanding of what constitutes a fair trial or investigation. Common responses included restaurant location, as well as the amount of food or number of customers.

Limited responses

- Some candidates included untruthful responses, which are subjective analysis with no further detail, whilst others included averaging results for greater accuracy rather than reviewing the methodology in depth.

(c) Comprehensive responses

- Many candidates correctly identified how to construct a pie chart. Responses often included use of a key or sectors decreasing in size clockwise.

Limited responses

- Many candidates included the percentage to each section, rather than labelling the section with the category.

(d) Comprehensive responses

- Included fully labelled axes together with correct choice of scale and correct data plotting. Most candidates had used a ruler to draw lines and the line graph was clear.

Limited responses

- A few candidates included temperature on the Y axis despite instructions. Other common issues were use of an incorrect scale which affected the interpretation and reading of the graph.

(e) (i) Comprehensive responses

- Most candidates were able to provide at least one limitation for canning as a strategy. These commonly included lack of nutritional value, loss of taste or issues surrounding contamination of the product with metal during storage.

Limited responses

- A few candidates indicated loss of quality if the container was not sealed adequately although the question indicated it was sealed.

(ii) Comprehensive responses

- The majority of candidates included cost of energy or lack of freezing resources available to explain why the frozen strategy might not be suitable for a remote location.

Limited responses

- A few candidates discussed high temperatures melting frozen food without providing any reasoning.

(iii) Comprehensive responses

- Some candidates demonstrated good use of data and described limited shelf life of the salted and smoked strategy, whilst others mentioned alteration of taste or issues surrounding health.

Limited responses

- Some candidates discussed food preferences very generally with no development such as high salt concentration or alteration of taste.

(f) Comprehensive responses

- A few candidates demonstrated a secure knowledge of food intensification, often referring to aspects of genetic engineering of crops or intensive fertiliser applications. A few candidates understood increased production within the same area or unit area of land.

Limited responses

- Some candidates were confused by the term and thought that intensification was due to a short crop or production time – which can also be part of conventional or extensive farming practices.

(g) Comprehensive responses

- Many candidates were able to comprehend that growing biofuel crops was at the expense of food crops ultimately.

Limited responses

- A significant number of candidates did not understand the term biofuels at all or mistakenly thought that biofuels could be a source of food themselves.

ENVIRONMENTAL MANAGEMENT

Paper 8291/23 Management in Context
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Key messages

What candidates did well

- Some candidates demonstrated factual knowledge and used detailed scientific terminology.
- Good responses did not merely repeat information in the question; they added explanations to this where needed. Many answers showed a good understanding of syllabus terms and topics.
- Some candidates were very proficient at constructing a line graph using a ruler.
- Analysis of unfamiliar context was demonstrated well by some candidates.
- Some made good use of provided diagrams, charts and tables to support their responses, such as the data in the context of the elephant seal and dive depth, but also the flying AirCar and climate change.

What candidates needed to improve

- Candidates should check they have attempted every question. There were a number of no responses to questions throughout the question paper.
- Identifying benefits and limitations of environmental management strategies in unfamiliar contexts is an area of the syllabus that candidates need more practice in.
- Candidates should interpret the questions with care and study the information provided in detail. They should utilise the information provided to formulate their answers, not simply copy figures and parts of the question as their answers.
- There was a common misconception of how nitrogen monoxide was formed in the atmosphere, as well as confusion of acid deposition and its effect on marine life.
- When an explanation is required, candidates need to explain their response, not simply make a brief statement or write a single word.

Comments on specific questions

Question 1

(a) (i) Comprehensive responses

- Some candidates were able to suggest a negative impact of tourism on elephant seals. A common response indicated the impact of litter or waste from tourism being toxic if ingested by elephant seals.

Limited responses

- Many candidates provided limited detail and were vague in their responses, for example pollution by tourists damaged the habitat or scaring the elephant seals endangered them.

(ii) Comprehensive responses

- Some candidates demonstrated a secure knowledge of the Antarctic Treaty and how it managed the impact of human activity.
- The most common responses were 'no nuclear testing' and 'disputes over sovereign territory'.

Limited responses

- Many candidates focused on legislative aspects or perceived rules of the Treaty rather than how the Treaty managed the human impact.

(b) (i) Comprehensive responses

- Most were able to state the day with the coldest temperature.

Limited responses

- Occasionally, there were a few candidates that misread the graph values.

(ii) Comprehensive responses

- Most candidates accurately identified the maximum dive depth.

Limited responses

- Occasionally, there were a few candidates that misread the graph values.

(iii) Comprehensive responses

- Most candidates were able to select appropriate words to complete a conclusion about the data.

Limited responses

- A few candidates were not able to recognise the correlation between dive depth and ocean temperature.

(iv) Comprehensive responses

- Most candidates demonstrated secure knowledge of the use of radio trackers to collect data, with common responses identifying attachment of the device onto the seal.
- Other responses commonly integrated the use of GPS to pinpoint locations.

Limited responses

- A few candidates confused where the location of the tracker was by making reference that it was located somewhere in the ocean and not attached to the seal.

(c) Comprehensive responses

- A significant number of candidates were able to suggest the impacts of increasing ocean temperatures with common answers being migration, seals diving deeper or less food availability.
- A few were able to provide a reason linked to the impact, for example migration due to ice sheets/shelves melting or increased predation due to increase in invasive predators.

Limited responses

- Many candidates cited increased temperatures as the reason though this is given in the stem of the question.
- Limited responses generally were able to cite impacts without articulating a developed reason.

(d) Comprehensive responses

- Many candidates were able to make a comparison between method 2 and method 1, with 'time consuming', 'less likely to miscount' and 'use of artificial intelligence' being common evaluations made.

Limited responses

- Some candidates focused on a comparison of the two methods by means of cost rather than the actual analysis of methodology.
- A few candidates attempted to evaluate the carbon footprint of both methods without sufficient evidence of data to make a comparison.

(e) (i) Comprehensive responses

- A few candidates were able to draw a line of best fit.

Limited responses

- Many candidates extrapolated back to zero or beyond the last point or outside the data range.

(ii) Comprehensive responses

- Some candidates were able to recognise from the line of best fit why the two methods gave similar results, citing positive correlation or the same number of seals for each method being similar. In some cases, this was articulated by stating that the ground count and aerial count for 1000 were similar/same.

Limited responses

- Many candidates suggested that all the results were close to each other and did not make the distinction that counts for 500 or 1500 were similar.

(f) Comprehensive responses

- Most candidates were able to determine where the optimum conditions were based on the location of elephant seals from the figure.

Limited responses

- Incorrect location of optimal conditions was made by some candidates through incorrect linkage of seal numbers or through incomplete knowledge of compass points.

Question 2

(a) (i) Comprehensive responses

- Most candidates demonstrated secure knowledge of plotting data on a bar chart, using a ruler in most cases and drawing the same bar width.

Limited responses

- A few candidates plotted incorrect bar heights given the data or, more often than not, drew incorrect bar widths.

(ii) Comprehensive responses

- The majority of candidates recognised that Japan had a decreasing population or that the death rate exceeded the birth rate.

Limited responses

- A few candidates did not provide evidence of a negative population change and quoted 0.5% instead of – 0.5%.

(iii) Comprehensive responses

- The majority of candidates recognised that low income economy countries (LIC) had high rates of population change.
- Many responses provided a direct comparison using data from the graph to fully evidence the differences between a high income economy country (HIC) and an LIC or an LIC and a middle income economy country (MIC).

Limited responses

- Some candidates did not directly answer the question and instead explained reasons for the differences in population change such as anti-natalist legislation, or lack of contraception or vice versa.

(b) Comprehensive responses

- Most candidates were able to correctly calculate a percentage increase given data.

Limited responses

- Candidates generally showed their workings, although they made an error when calculating percentage increase.

(c) (i) Comprehensive responses

- Some candidates recognised that the same carbon-based fuel for Aircars resulted in emission of carbon dioxide or other greenhouse gases.

Limited responses

- Quite a few candidates stated that carbon-based fuels were associated with climate change; however, the term carbon-based fuel was in the stem of the question.
- Very few candidates used the information in the question that AirCar can carry two people, suggesting that more vehicles would be required.

(ii) Comprehensive responses

- The question required two elements, benefit and reason. Many candidates suggested at least one benefit with a reason, and the most common response was less road traffic congestion, as Aircar could fly or have a quicker journey time.

Limited responses

- Many candidates provided a benefit without a described reason.

(d)(i) Comprehensive responses

- Many candidates identified the correct pH at which deposition is defined as acid deposition.

Limited responses

- Some candidates identified the correct pH although they thought it was greater than the definition level.

(ii) Comprehensive responses

- Many candidates identified a type of dry acid deposition, with gas being the common example used.

Limited responses

- A significant number of candidates assumed smog to be a form of dry acid deposition.

(iii) Comprehensive responses

- There were a few good responses to this question.
- Oxygen and nitrogen from the atmosphere were often given in the context of the question.

Limited responses

- Many candidates would benefit from further study of the chemical process in this context to develop a secure knowledge in this area.
- Some candidates often thought that nitrogen and oxygen were mixed with water.

(d)(iv) Comprehensive responses

- Many candidates expressed sulphur dioxide as gas X.

Limited responses

- Carbon dioxide was commonly given as gas X, although there were other incorrect substances stated.

(v) Comprehensive responses

- Most candidates identified nitric acid as acid Y.

Limited responses

- Other incorrect substances were stated.

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Limited responses

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