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National
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Mark

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S826/76/02**Environmental Science
Paper 2**

Date — Not applicable

Duration — 2 hours



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Fill in these boxes and read what is printed below.

Full name of centre

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Town

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Forename(s)

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Surname

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Number of seat

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Date of birth

Day

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Month

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Year

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Scottish candidate number

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Total marks — 80

Attempt ALL questions.

Question 8 contains a choice.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. Score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Do not remove any exam materials. You must leave this booklet on your desk; if you do not, you could lose all the marks for this paper.

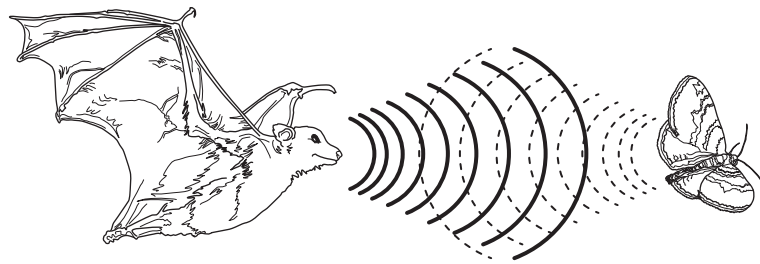


* S 8 2 6 7 6 0 2 0 1 *

Total marks — 80
Attempt ALL questions
Question 8 contains a choice

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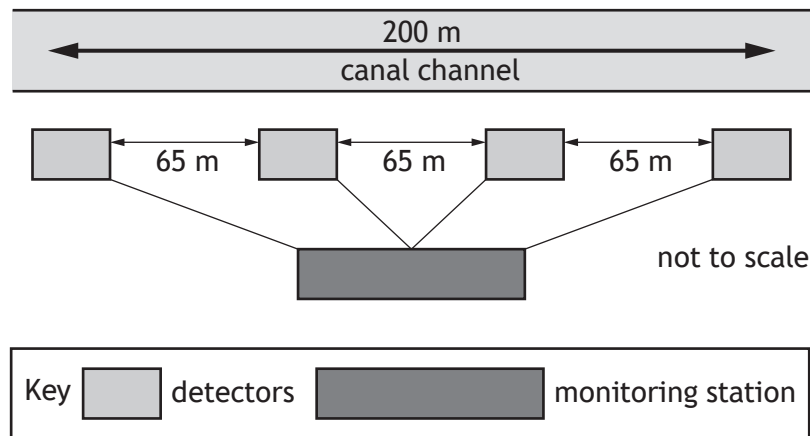
1. A survey of Scotland's bat populations was carried out along a canal system over a 3-year period.
 - (a) Most bat species are nocturnal, feeding at night on insects they detect by echolocation. In echolocation, bats emit high frequency sounds that reflect from their surroundings, and the bats then detect the echoes. Individual bat species can be identified from the distinctive pattern of frequencies emitted.



Key — outgoing signal - - - - - reflected signal

Echolocation sounds can be detected with microphones.

Sound detecting equipment was arranged as shown in the diagram. Detectors linked to a monitoring station recorded the number of times a bat passed each detector. Species identification was confirmed either by observation using red torchlight or by capturing the bats in fine netting.



- (i) State one type of qualitative sampling technique used in the survey.

1



1. (a) (continued)

- (ii) Describe one feature of the survey that increased the reliability of the results, and one feature that increased the validity of the approach.

2

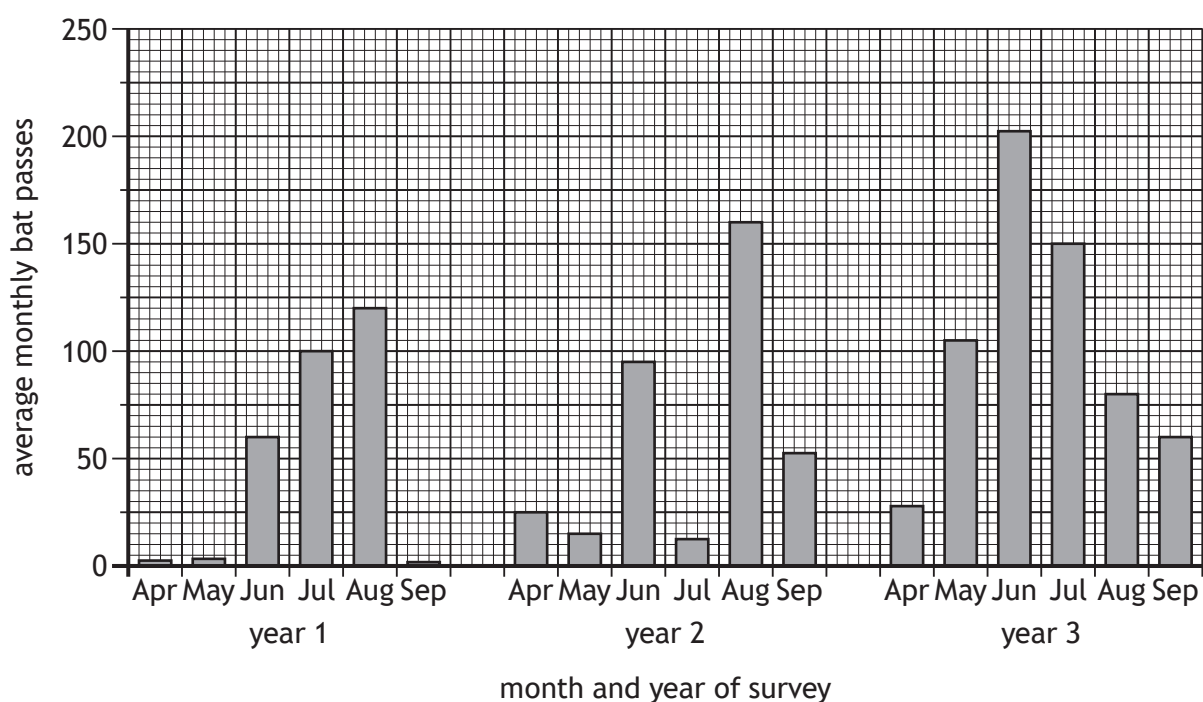
Reliability:

Validity:

- (iii) Suggest why red torchlight was used to identify the bats in preference to using fine netting.

1

- (b) The graph shows the average number of monthly bat passes per year over the survey period.



- (i) Describe **two** trends shown in the graph.

2

1:

2:



* S 8 2 6 7 6 0 2 0 3 *

1. (b) (continued)

- (ii) Calculate, as a simple whole number ratio, the bat passes recorded during the month of August over the 3-year survey period.

Space for working

	:		:	
year 1		year 2		year 3

- (iii) Explain how **one** named abiotic factor could account for the fluctuations in numbers of bats recorded during the survey period.



2. The Circular Economy (Scotland) Act 2024 underpins Scotland's commitment to move to a circular economy by 2030.

A route map has been produced that identifies priorities to help move to a circular economy. The Route Map has four strategic aims:

- to reduce and reuse
- to modernise recycling
- to decarbonise waste disposal
- to strengthen the circular economy.

(a) State what is meant by the *circular economy*. 1

(b) Previous initiatives to reduce food waste have not been as successful as hoped. Describe how food waste sent to landfill can contribute to the enhanced greenhouse effect. 1

(c) Producer responsibility schemes aim to increase recycling rates by 76% by 2030. These schemes place responsibility for the collection, recycling, and disposal of a manufactured product on the producer rather than the consumer. Suggest why placing responsibility on producers rather than consumers is likely to be more effective. 1

[Turn over



2. (continued)

- (d) The table shows annual figures for incineration of waste by local authorities in Scotland between 2014 and 2024.

Waste incinerated in Scotland (tonnes) by year					
2014	2016	2018	2020	2022	2024
658 506	683 225	711 504	1 259 270	1 408 297	1 863 306

Calculate, to the nearest whole number, the percentage change in waste incinerated between 2014 and 2024.

1

Space for calculation

- (e) Suggest why decarbonising waste disposal helps meet the purpose of the waste hierarchy.

2

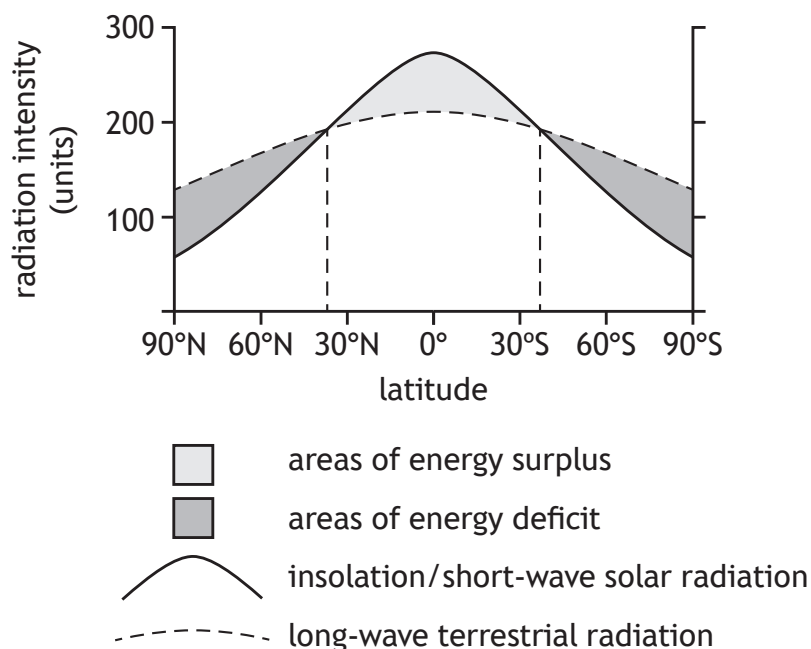
- (f) Alongside the Route Map, the Scottish Government published an environmental report as part of a Strategic Environmental Assessment (SEA). Describe the difference between an SEA and an Environmental Impact Assessment (EIA).

1



3. Solar energy is not equally distributed across the surface of the Earth.

The graph shows that the area lying between 38° north and south of the Equator receives a surplus of solar energy, while the areas towards the poles are in deficit.



- (a) (i) State the type of biome typically found at 25° north of the Equator.

1

- (ii) Describe **two** reasons for the solar energy deficit shown in the polar regions.

2

1:

2:

[Turn over



* S 8 2 6 7 6 0 2 0 7 *

3. (a) (continued)

- (iii) The tri-cellular model explains the distribution of heat energy from areas of energy surplus to areas of energy deficit.

Draw an annotated diagram of the tri-cellular model.

3



3. (continued)

- (b) Milankovitch cycles describe cyclical variations in Earth-Sun geometry that occur over thousands of years. These impact on the amount of solar energy reaching the Earth's surface.

The cyclical variations include changes in:

- the shape of Earth's orbit around the Sun
- the tilt of Earth's axis towards or away from the Sun
- the orientation of Earth's axis of rotation

- (i) Describe the impact that **one** of these cyclical variations has on the amount of solar energy reaching the Earth's surface.

2

- (ii) Milankovitch cycles have a long-term impact on natural climate change.

State one factor that can have a short-term impact on natural climate change.

1

- (c) Albedo plays a significant role in climate change.

- (i) State what is meant by *albedo*.

1

- (ii) Explain why a low albedo contributes to climate change.

3



* S 8 2 6 7 6 0 2 0 9 *

4. The table shows the preferred habitat requirements of some species of moorland birds.

Species	Feeding preferences	Preferred height of heather for shelter or nesting (cm)	Preferred size of heather patches on moor
Black grouse (<i>Lyrurus tetrix</i>)	heather, 20–30 cm in height	above 30	small
Golden plover (<i>Pluvialis apricaria</i>)	heather, less than 10 cm in height	less than 10	large
Twite (<i>Linaria flavirostris</i>)	grass seeds and insects in grassland between heather patches	above 15	large
Merlin (<i>Falco columbarius</i>)	small birds, eg twite	less than 30	small
Hen harrier (<i>Circus cyaneus</i>)	large birds, eg grouse, golden plover	above 60	small
Red grouse (<i>Lagopus lagopus scotica</i>)	heather, 10–30 cm in height	above 25	small

(a) Using information from the table:

- (i) identify which **two** species have the most similar habitat requirements

1

- (ii) construct a food web involving **five** species

2



4. (a) (continued)

(iii) explain why the hen harrier prefers small heather patches.

1

(b) (i) Moorland is often managed to sustain the largest possible population of red grouse for recreational shooting. The vegetation is burned on a rotational basis to create a patchwork of heather of different ages.

Explain why a patchwork of heather both maximises red grouse numbers on a moorland and increases biodiversity.

(A) maximises red grouse numbers:

1

(B) increases biodiversity:

1

(ii) Grouse shooting is managed so that only birds that are surplus to the carrying capacity of the moorland are shot.

Define *carrying capacity*.

1

(iii) Red grouse are territorial. Mated red grouse will defend an area of moorland that is suitable to meet the habitat requirements of themselves and their young. No other red grouse are tolerated within the territory.

(A) State the biotic factor described in this example.

1

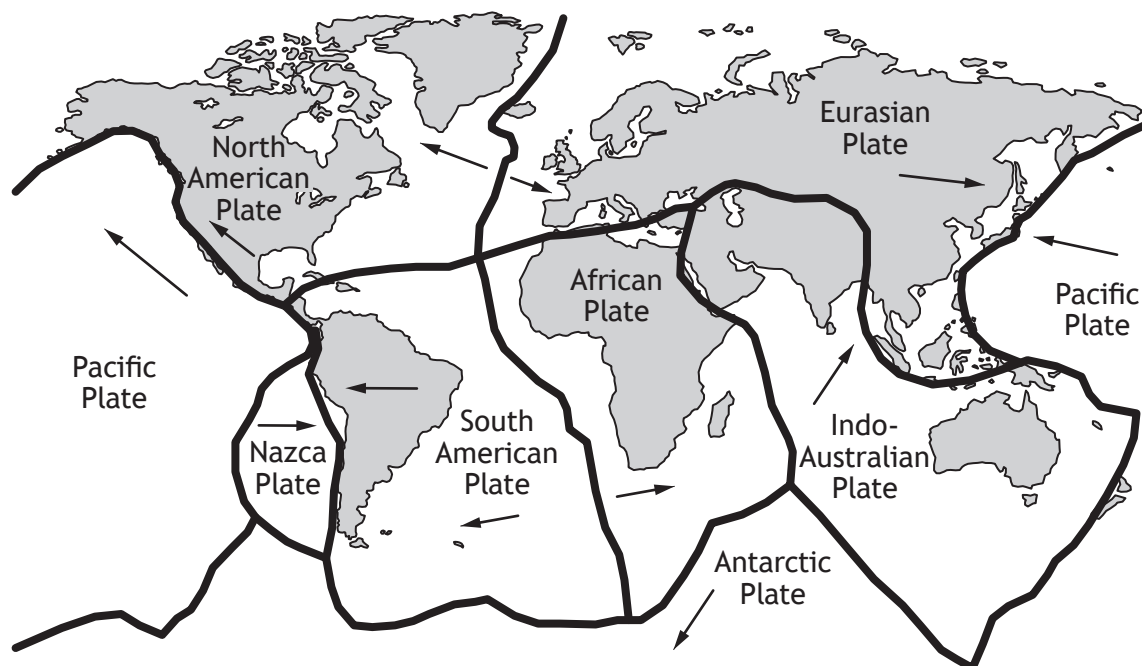
(B) Explain how the factor stated in (A) limits the population of red grouse on the moor.

1



5. (a) The Earth's crust and upper part of the mantle is divided into tectonic plates. Movement of these plates has an impact on the environment.

The diagram shows the direction of movement of the major tectonic plates.



- (i) Name the type of plate boundary found where the Eurasian Plate and North American Plate meet.

1

- (ii) Describe the tectonic activities likely to occur at the Nazca Plate-South American Plate boundary.

3

5. (continued)

- (b) (i) Gold deposits have formed at the Nazca-South American Plate boundary. Describe the processes that can result in the deposition of metallic minerals of economic value at plate boundaries.

2

- (ii) Describe **two** environmental issues associated with the mining of mineral deposits.

2

- (c) Rocks at the Earth's surface are susceptible to weathering.

- (i) Describe one role that precipitation plays in weathering.

1

- (ii) Explain why physical weathering can speed up the rate of chemical weathering.

2

[Turn over



6. Water covers over 70% of the Earth's surface, but 97% of it is too salty to drink.

(a) (i) State the process by which fresh water can be extracted from seawater.

1

(ii) Brine is a highly saline by-product of the extraction process.

Suggest why brine could have a negative impact if released into the environment.

1

(iii) Salt can be harvested by dehydrating brine.

Suggest why salt production could have both a positive and negative economic impact.

2

Positive impact:

Negative impact:

(b) The table shows levels of water withdrawal in 2022 by continent.

Continent	Total water withdrawal by sector in 2022						Total water withdrawal (km ³ yr ⁻¹)
	Agricultural		Industrial		Municipal		
	km ³ yr ⁻¹	% of total	km ³ yr ⁻¹	% of total	km ³ yr ⁻¹	% of total	
Africa	111	82	6	4	18	14	135
Americas	180	38	237	49	63	13	480
Asia	2120	81	195	8	292	11	2607
Europe	82	29	124	44	74	27	280
Oceania	14	67	4	19	3	14	21

6. (b) (continued)

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- (i) Calculate, as a percentage of the total water withdrawal, the water withdrawn for use by the industrial sector around the world.

1

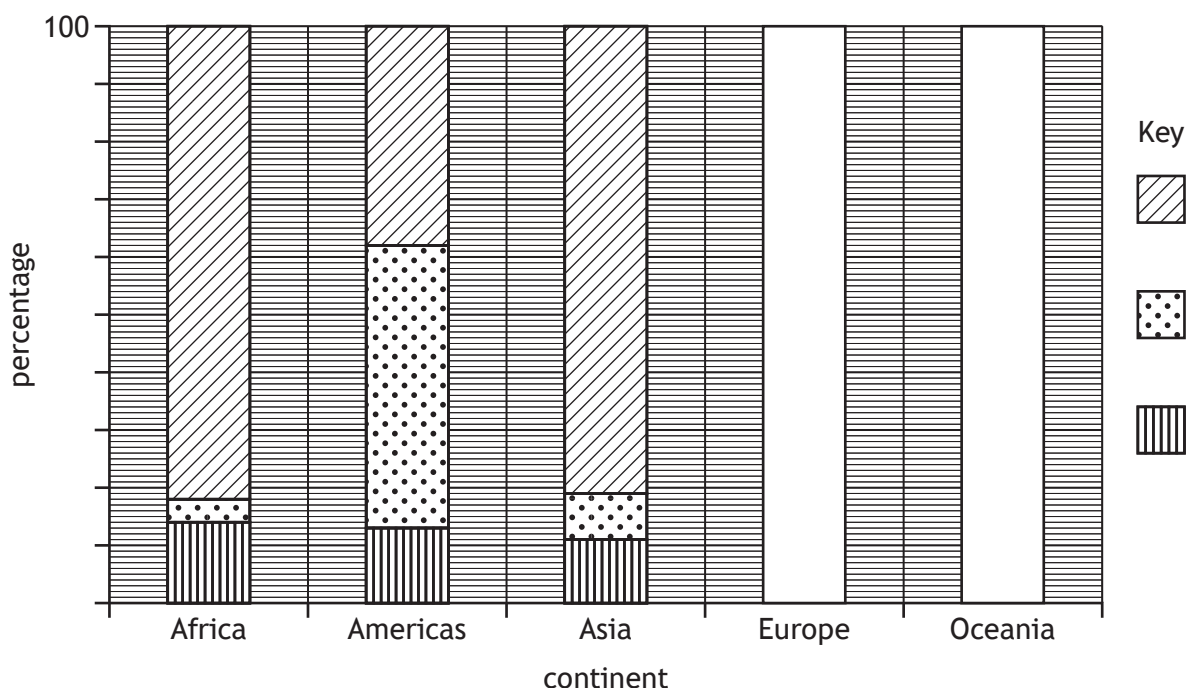
Space for working

- (ii) The 100% stacked bar chart shows the percentage of total water withdrawal by sector.

Use the information in the table to complete the bar chart and key.

2

(An additional graph, if required, can be found on *page 21*.)



- (iii) Suggest one reason why the agricultural sector in Asia has the largest water withdrawal value ($\text{km}^3 \text{yr}^{-1}$) in comparison to other continents.

1

- (c) State one water conservation method that could be adopted by the following sectors.

- (i) Agriculture

1

- (ii) Industry

1



* S 8 2 6 7 6 0 2 1 5 *

7. The Food and Agriculture Organisation (FAO) is a United Nations agency. It leads international efforts to tackle hunger.

- (a) (i) One of the FAO's goals is to achieve food security for all.

Define *food security*.

1

- (ii) State **two** reasons why demand for food has increased worldwide.

1:

2

2:

- (b) Explain one social, one economic, and one environmental impact of a named land-based strategy for increasing food production.

4

Land-based strategy:

Social impact:

Economic impact:

Environmental impact:



7. (continued)

- (c) Palm oil is a common ingredient in many processed foods.

The image shows oil palm plantations, which have replaced large areas of native forest in tropical regions.



A palm plantation is an example of monoculture, where one plant species is cultivated over a large area.

Suggest an impact of monoculture on the consumer, the producer, and biodiversity. The impacts may be positive or negative.

(i) (A) consumer 1

(B) producer 1

(C) biodiversity 1

- (ii) Palm oil plantations are predominantly located in tropical areas, where evapotranspiration is high.

Describe what is meant by *evapotranspiration*. 1



Question 8 contains a choice
Attempt one of the following questions

8. A A cross-section through soil horizons produces a characteristic soil profile that helps identify the soil type.

Discuss the distinctive horizons that help differentiate between the following soil types. You may wish to include an annotated diagram(s).

- (a) brown earth
- (b) podzol

10

OR

- B Some countries allow fracking. The Scottish Government has adopted a cautious approach to fracking, with a temporary suspension on unconventional oil and gas development until potential impacts are investigated.

Discuss extraction and use of shale gas under the following headings.

- (a) benefits
- (b) challenges

10



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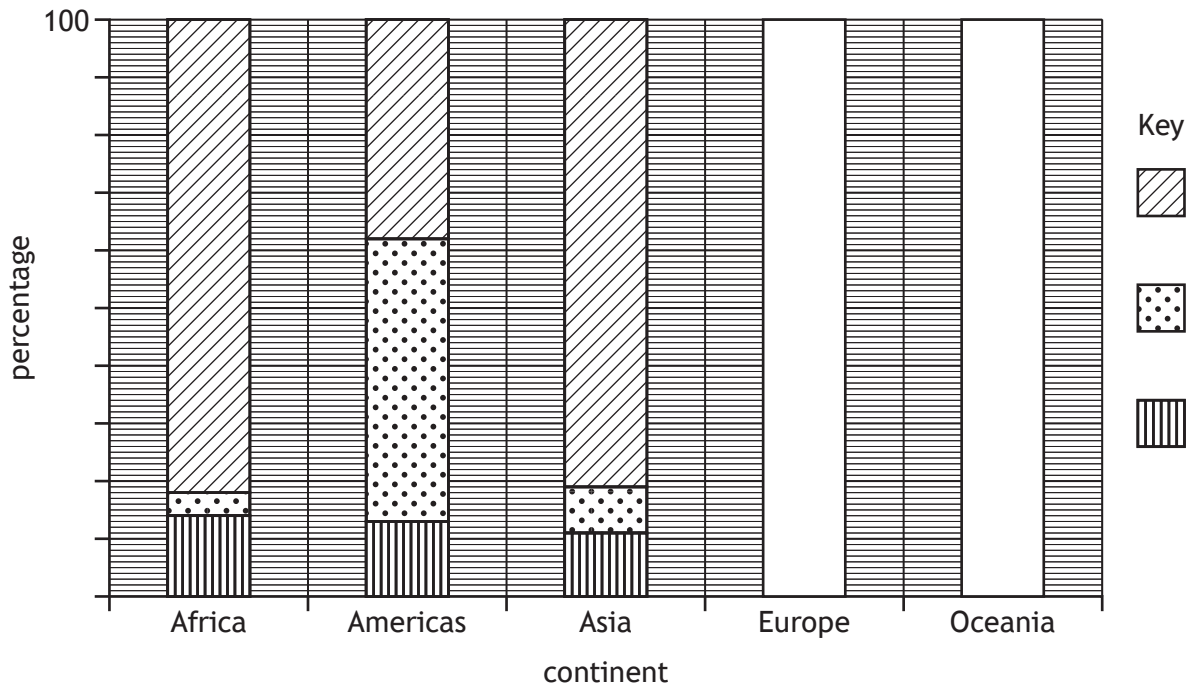
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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph for question 6 (b) (ii)



ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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**Environmental Science
Paper 2**

Marking Instructions

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General Marking Principles for Environmental Science Higher

Always apply these general principles. Use them in conjunction with the detailed marking instructions, which identify the key features required in candidates' responses.

- (a) Always use positive marking. This means candidates accumulate marks for the demonstration of relevant skills, knowledge and understanding; marks are not deducted for errors or omissions.
- (b) If a candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you should seek guidance from your team leader.
- (c) Where a candidate makes an error at an early stage in a multi-stage calculation, award marks for correct follow-on working in subsequent stages. Do not award marks if the error significantly reduces the complexity of the remaining stages. Apply the same principle in questions which require several stages of non-mathematical reasoning.
- (d) Award full marks for a correct final answer (including units if required) on its own, unless a numerical question specifically requires evidence of working to be shown.
- (e) Candidates may access larger mark allocations fully, whether they respond in continuous prose, linked statements or a series of discrete developed points.
- (f) In the detailed marking instructions, if a word is **underlined** then it is essential; if a word is **(bracketed)** then it is not essential.
- (g) In the detailed marking instructions, words separated by/are alternatives.
- (h) Do not award marks if a candidate gives two answers, where one is correct and the other is incorrect.
- (i) Where the candidate is instructed to choose one question to answer but instead answers both questions, mark both responses and award the better mark.
- (j) Award marks for a valid response, even if the response is not presented in the format expected. For example, award the mark if the response is correct but is not presented in the table as requested, or if it is circled rather than underlined as requested.
- (k) Candidates may use abbreviations (for example, BOD or GPP) or chemical formulae (for example, CO₂ or H₂O) as acceptable alternatives to naming, unless required by the question.
- (l) Award marks, up to the maximum mark allocation for the question, for content that is outwith the course specification but used appropriately at the correct level for Higher.
- (m) If candidates are required to give a numerical answer, and units are not given in the stem of the question or the answer space, they must supply the units to gain the mark. Do not penalise candidates repeatedly if units are required on more than one occasion.
- (n) If incorrect **spelling** is used:
 - and the term is recognisable, then award the mark;
 - and the term can easily be confused with another scientific term, then do not award the mark, for example bioaccumulation and biomagnification, or qualitative and quantitative;
 - and the term is a mixture of other terms, then do not award the mark.

(o) When presenting data:

- for marking purposes no distinction is made between bar charts (used to show discontinuous features, have descriptions on the x-axis and have separate columns) and histograms (used to show continuous features, have ranges of numbers on the x-axis and have contiguous columns)
- other than in the case of bar charts/histograms, if the question asks for a particular type of graph or chart and the wrong type is given, then do not give the mark(s) for this. Where provided, marks may still be awarded for correctly labelling the axes, plotting the points, joining the points either with straight lines or curves (best fit rarely used), etc.
- do not award the relevant mark if the graph uses less than 50% of the axes; if the x and y data are transposed; if 0 is plotted when no data for this is given (ie candidates should only plot the data given)

(p) Award marks only for a valid response to the question asked. For example, in response to questions that ask candidates to:

- **identify, name, give, or state**, they need only name or present in brief form;
- **define**, they should give a statement of the definition;
- **calculate**, they must determine a number from given facts, figures or information;
- **compare**, they must demonstrate knowledge and understanding of the similarities and/or differences between things;
- **describe**, they must provide a statement or structure of characteristics and/or features;
- **evaluate**, they must make a judgement based on criteria;
- **explain**, they must relate cause and effect and/or make relationships between things clear;
- **outline**, they must provide a brief sketch of content - more than naming but not a detailed description;
- **predict**, they must suggest what may happen based on available information;
suggest, they must apply their knowledge and understanding of Environmental Science to a new situation. A number of responses are acceptable: marks will be awarded for any suggestions that are supported by knowledge and understanding of Environmental Science.

Question			Expected response	Max mark	Additional guidance
1.	(a)	(i)	Identification of bat species from sound frequencies emitted.	1	Key point is production of a species list (qualitative), rather than an estimate of actual numbers (quantitative).
		(ii)	Reliability: Use of several detectors will increase the data/number of records. Validity: Use of two methods to identify the bats, confirming species identification. Or other valid response.	2	1 mark for each.
		(iii)	Bats would be stressed by being netted and handled/ethics of capturing live animals/a licence is required to handle bats/rabies shots are required before handling bats/other valid response.	1	Do not accept: bats are blind.
	(b)	(i)	Overall number of passes increases from year 1 to year 3. OR Extended range of activity from year 1 and year 3. OR More passes early and late in the year from year 1 to year 3.	2	1 mark for each. Must compare bat passes across the years.
		(ii)	3 : 4 : 2	1	120 : 160 : 80
		(iii)	Low temperature/high winds/heavy precipitation, (1 mark) could affect availability of prey, so bats are unlikely to expend energy seeking them. (1 mark) Or other valid response.	2	1 mark for valid abiotic factor. 1 mark for influence of the named abiotic factor on the number of bats recorded.

Question			Expected response	Max mark	Additional guidance
2.	(a)		An approach where resources, waste, emissions, and energy loss are minimised through use of (long-lasting) design, maintenance, repair, reuse, reprocessing, and recycling.	1	Must infer reduction in waste and pollution, and extension of product life. Accept: reference to a move from take-make-waste model to a more sustainable model
	(b)		Decomposing food waste releases methane, (which enhances the natural greenhouse effect). OR Transportation of food waste to landfill releases carbon dioxide, (which enhances the natural greenhouse effect). Or other valid response.	1	Must refer to release of a greenhouse gas.
	(c)		It encourages producers to think about sustainable product design/material recovery. Or other valid response.	1	
	(d)		183 (%)	1	$\frac{1863306 - 658506}{658506} \times 100$
	(e)		The waste hierarchy aims to reduce the environmental impact of waste. (1 mark) Decarbonising aims to reduce carbon emissions (from waste), which has an environmental impact. (1 mark) Or other valid response.	2	Must refer to the purposes of both the waste hierarchy and decarbonising.
	(f)		An EIA focuses on individual projects, while an SEA evaluates larger scale plans/programmes.	1	

Question			Expected response	Max mark	Additional guidance
3.	(a)	(i)	Hot desert	1	Do not accept: desert
		(ii)	Albedo of snow and ice/ seasonality (3 months of no solar input beyond 60° N or 60° S)/curvature of the Earth means incoming energy has greater surface area to heat/incoming energy in polar regions travels at an (oblique) angle due to curvature of the Earth (increasing the possibility of reflection/absorption).	2	Any two
		(iii)	1 mark for naming the three cells correctly. 1 mark for showing the direction of movement in the Hadley, Ferrel and Polar cells correctly. 1 mark for showing the latitudes (0°, 30°, 60°, 90°) correctly.	3	

Question			Expected response	Max mark	Additional guidance
3.	(b)	(i)	Shape: The shape of Earth's orbit around the Sun varies from elliptical to nearly circular. (1 mark) When the orbit is circular, the amount of insolation received annually is greater than when elliptical. (1 mark) (or converse) Tilt: Greater tilt results in more severe seasonal variation (or vice versa). (1 mark) The build up of ice and snow increases albedo and causes additional cooling. (1 mark) Orientation: Is driven by tidal changes influenced by the Sun and Moon, (1 mark) resulting in one polar hemisphere being closer to the Sun and receiving more insolation than the other hemisphere. (1 mark)	2	2 marks for a valid description of any one of the cycles.
		(ii)	Volcanic event/sunspot activity/other valid response.	1	
	(c)	(i)	The proportion of light that is reflected by a body or surface.	1	Must refer to light reflection or absorption.
		(ii)	Darker/low albedo surfaces (eg oceans, forests, urban areas) absorb rather than reflect solar energy. (1 mark) The energy absorption causes ice and snow to melt, and cloud cover to reduce, (1 mark) enhancing global warming, which accelerates climate change. (1 mark)	3	1 mark for low albedo = absorption. 1 mark for impact of absorption on snow/ice/cloud cover. 1 mark for contribution to global warming and climate change.

Question			Expected response	Max mark	Additional guidance
4.	(a)	(i)	Red grouse and black grouse	1	Both species required.
		(ii)	<pre> graph BT red_grouse[red grouse] --> hen_harrier[hen harrier] black_grouse[black grouse] --> hen_harrier golden_plover[golden plover] --> hen_harrier heather[heather] --> red_grouse heather --> black_grouse heather --> golden_plover </pre>	2	1 mark for 5 correct species. 1 mark for correct use of arrows.
		(iii)	Two of the hen harrier's prey species prefer small heather patches.	1	
	(b)	(i) (A)	Red grouse need different ages of heather for different functions.	1	
		(i) (B)	Provides an increased range of habitats/range of niches, suiting a greater range of species.	1	
		(ii)	The maximum population size of a species that the environment can sustain indefinitely.	1	
		(iii) (A)	Intra-specific competition	1	
		(iii) (B)	It prevents overpopulation by excluding birds that lack a territory. Or other valid response.	1	

Question			Expected response	Max mark	Additional guidance
5.	(a)	(i)	Constructive/divergent	1	
		(ii)	Is a destructive/convergent boundary. (1 mark) The Nazca Plate/oceanic crust subducts below the South American Plate/continental crust. (1 mark) Increased pressure/friction can cause earthquakes. (1 mark) Magma may rise to the surface through rock fractures and erupt as lava (1 mark) via volcanoes/offshore island arcs. (1 mark) Fold mountains may form in the crumple zone. (1 mark) Or other valid response.	3	An annotated diagram could be used as part of the response. Response must include tectonic activity and valid effect of that activity. Any three
	(b)	(i)	Pressure and friction at subduction zone generates heat/fractures rock. (1 mark) Magma rising through the rock fractures also carries super-heated water and suspended/dissolved metallic minerals. (1 mark) The water evaporates and leaves behind metallic deposits. (1 mark)	2	Any two

Question			Expected response	Max mark	Additional guidance
5.	(b)	(ii)	Landscape changes through removal of timber/vegetation/rock and soil. Ecosystem/biodiversity changes as a result of removing timber/vegetation/rock and soil. Erosion/runoff from the mine operations. Disturbance of movement/quality/distribution of water. Disposal of overburden/tailings/other waste. Dust/noise/emissions from mining operations and transport. Or other valid response.	2	Any two
	(c)	(i)	Water dissolves soluble minerals from rock surfaces, weakening and fragmenting the rock. OR (Precipitation falling as) snow contributes to physical weathering through the freeze-thaw process. Or other valid response.	1	
		(ii)	Physical weathering increases the exposed surface area, (1 mark) making it more susceptible to chemical weathering by air and water. (1 mark)	2	1 mark for increased surface area. 1 mark for air and water as agents of chemical weathering.

Question			Expected answer(s)	Max mark	Additional guidance
6.	(a)	(i)	Desalination	1	
		(ii)	Brine is a highly concentrated salt solution, so could affect soil/vegetation/watercourses/aquatic ecosystems if released.	1	
		(iii)	Positive: Can be purified for industrial use or human consumption. Negative: Cost of transporting brine/salt to a processing/disposal point. Or other valid response.	2	1 mark for positive impact. 1 mark for negative impact.
	(b)	(i)	16.1 (%)	1	Total industrial withdrawal = 566 Total water withdrawal = 3523 $\frac{566}{3523} \times 100$ Accept: 16, 16.07, 16.066
		(ii)	y-axis scale ranging from 0 to 100 AND key completed. (1 mark) Bars plotted correctly for Europe and Oceania. (1 mark)	2	
		(iii)	Asia has a very high population to feed, requiring large quantities of water for agriculture. OR The agricultural system in Asia is heavily water-dependent (eg rice production requires flooding of paddy fields). Or other valid response.	1	
	(c)	(i)	Drip irrigation/drought-resistant crops/mulching/water harvesting/conservation tillage/other valid response.	1	
		(ii)	Modification of processes/equipment replacement/reuse of blackwater/reuse of greywater/water auditing/water harvesting/employee training/other valid response.	1	

Question			Expected answer(s)	Max mark	Additional guidance
7.	(a)	(i)	When people, at all times, have (physical and economic) access to sufficient, (safe, and nutritious) food that meets their dietary needs and food preferences (for an active and healthy life).	1	Response should refer to access, quantity, and quality.
		(ii)	Increasing population/changes in consumer demand/changes brought about by development and climatic change/increased wealth/affordability/other valid response.	2	Any two
	(b)		Land-based strategies: • Intensive agriculture: Larger fields/crop rotation/drainage/hedgerow removal/cultivation of marginal land/conservation practices/diversification • Changes in technology: Mechanisation/agrochemicals (fertilisers, pesticides)/irrigation/selective breeding/high yield varieties/GM crops/hydroponics Example: pesticide use Social impact • Negative: health issues through bioaccumulation • Positive: increased food production/food security Economic impact • Negative: have to buy fertiliser/potential to be tied in to specific agrichemical company • Positive: profit from increased yield Environmental impact • Negative: impact on food chain/biodiversity of killing (pest and/or non-target species) • Positive: reduced disease transfer from pest species Or other valid response.	4	1 mark for named land-based strategy. 1 mark for each impact (one social, one economic, one environmental), which may be positive or negative. For full marks, all three impacts must be covered AND related to the named strategy.

Question			Expected answer(s)	Max mark	Additional guidance
7.	(c)	(i) (A)	Wider range of cheap(er) goods/increased food security/moral impact/increased food miles. Or other valid response.	1	
		(i) (B)	Higher yields/reduced costs/increased disease potential/vulnerability to natural disasters/pests/soil erosion. Or other valid response.	1	
		(i) (C)	Loss of habitat/potential extinction of some species/loss of potential biopharmaceuticals/soil erosion. Or other valid response.	1	
		(ii)	Water lost to the atmosphere through evaporation from the land surface and from plant leaves.	1	Must include reference to evaporation both from land and plants.

Question		Expected answer(s)	Max mark	Additional guidance
8. A	(a)	Brown earth: - Typically found under deciduous/broadleaved woodland or grassland (1 mark) - Rich humus layer/leaf litter decomposes quickly because of intense biological activity (1 mark) - Evidence of earthworm channels/animal burrows (1 mark) - Indistinct O-A horizon (or organic layer-topsoil) boundary, because of mixing action of soil biota (eg earthworms) (1 mark) - A-horizon/topsoil is sometimes red-brown because of iron oxidation (1 mark) - Depth of A-horizon/topsoil can be considerable because of significant organic input (eg decomposed leaf litter/humus) (1 mark) - Plant root system can be extensive because brown earth soil supports rich vegetation (1 mark) - B-horizon/subsoil is a distinctive brown colour, lightening with depth as humus/iron content decreases (1 mark) Or other valid response.	10	Candidates must comment on features that distinguish between the profiles. These could be: - typical ecosystem for each. - level of decomposition, or types of decomposer organisms. - characteristic horizons: deep A-horizon and/or indistinct O-A horizon boundary in brown earth soil; presence of an ashy layer and/or humic or iron pan in podzols. Give credit for annotated diagrams, but these should be accompanied by detailed comments. Max of 5 marks if only (annotated) diagrams have been provided but no further discussion. Max of 7 marks for each soil type.

Question			Expected answer(s)	Max mark	Additional guidance
8. A	(b)		Podzol: - Typically found under moorland/heathland/coarse grassland/coniferous woodland (1 mark) - Deep organic/O-horizon (1 mark) because poor soil biodiversity limits decomposition (1 mark) - Few earthworms OR Decomposers are typically fungi, (1 mark) because of acidic soil conditions (1 mark) - No mixing organisms, so horizons are distinct (1 mark) - A-horizon/topsoil likely to be ashy-grey/silica-rich, (1 mark) because iron/aluminium has eluviated/leached downwards (1 mark) - B-horizon/subsoil may be rusty red colour and very hard, (1 mark) from accumulation/illuviation of iron from the A-horizon, forming an iron pan (1 mark) Or could be very dark, because of washing down of humus, (1 mark) forming a humic pan (1 mark) Or other valid response.		

Question			Expected answer(s)	Max mark	Additional guidance
8. B	(a)		Benefits: Combustion of shale gas/natural gas/methane emits lower levels of greenhouse gases/carbon dioxide/nitrogen oxides/sulfur dioxides/particulates than coal or oil. (1 mark) Shale gas/natural gas/methane is a more efficient fuel source than other fossil fuels. (1 mark) Reduces dependence on traditional fossil fuels. (1 mark) Increased fuel security, so less need to import fuel, (1 mark) especially in times of energy crisis/conflict. (1 mark) Country could become a net exporter of gas, generating income. (1 mark) Development of a fracking industry offers employment opportunities. (1 mark) A secure home source of fuel could stimulate wider industry reliant on natural gas/methane. (1 mark) Or other valid response.	10	The focus should be on the benefits and challenges of fracking. No marks awarded for the physical fracking process unless linked to a benefit/challenge. Max of 7 marks for benefits. Max of 7 marks for challenges.

Question			Expected answer(s)	Max mark	Additional guidance
8. B	(b)		Challenges: Land will need to be cleared to set up drilling site, so could impact on biodiversity/vegetation cover. (1 mark) Shale gas is a fossil fuel so emits greenhouse gases (eg carbon dioxide, nitrogen oxides, sulfur dioxides), with potential to enhance global warming/climate change. (1 mark) Drilling can cause seismic activity (eg earth tremors, earthquakes), with potential to damage civic infrastructure. (1 mark) Requires huge quantities of water, which can reduce water availability to other users or impact on aquatic habitats/species. (1 mark) Potential for pollution of soil/water environment around the fracking site through wastewater ('flow water')/fracking fluids entering (subterranean or surface) water reservoirs. (1 mark) Wastewater/flow water can be disposed of via injection into deep wells, but can cause earthquakes. OR Requires transportation, with associated risks such as air pollution or spills. (1 mark) Disposal of wastewater/flow water/salt and metal precipitates/fracking waste requires special handling/cannot be treated at municipal waste disposal sites. (1 mark)		

Question			Expected answer(s)	Max mark	Additional guidance
8. B	(b)		Fracking fluids may be carcinogenic/radioactive/contain toxic levels of metals, potentially affecting human/wildlife health. (1 mark) Disruption from heightened noise levels during construction of facilities/fracking/transportation. (1 mark) Atmospheric pollution from leakage of methane from drill site. OR Emissions from fracking equipment/diesel engines. (1 mark) Visual/noise pollution from fracking can decrease local property prices. (1 mark) Volumes of shale gas (or shale oil) in UK/Scottish deposits are still unknown. (1 mark) Or other valid response.		

[END OF SPECIMEN MARKING INSTRUCTIONS]

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Change since last published:

The duration of the paper has been shortened and the number of marks reduced. Some questions have been removed from the previous specimen question paper, some have been edited or updated, and some have been replaced.