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National
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X826/76/02

Environmental Science Paper 2

WEDNESDAY, 28 MAY

10:15 AM – 12:45 PM



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

--

Scottish candidate number

--

Total marks — 100

Attempt ALL questions.

Questions 8 and 9 each contain 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. You should score through your rough work when you have written your final copy.

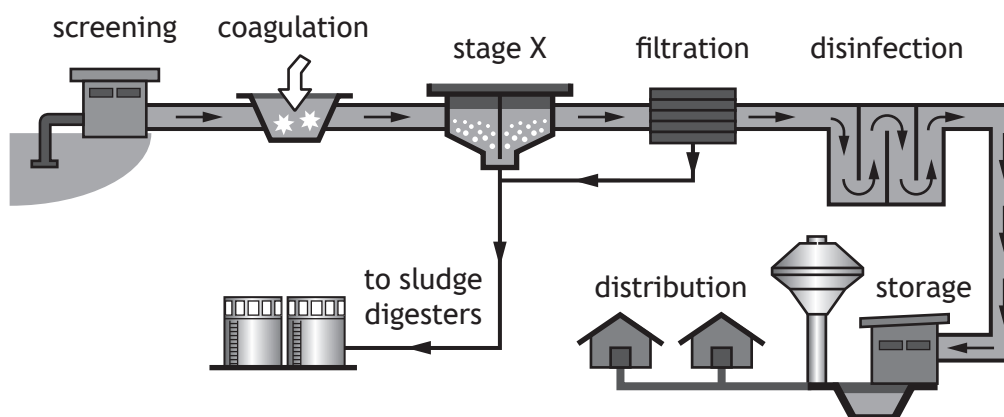
Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.



Total marks — 100 marks
Attempt ALL questions
Questions 8 and 9 each contain a choice

1. The diagram shows some of the stages of the water purification process used by a developed country.



- (a) Name stage X.

1

- (b) Complete the table to describe the role of coagulation and filtration in the water purification process.

2

Stage	Role
Coagulation	
Filtration	

1. (continued)

- (c) Describe one method used in the disinfection stage of water purification in a developed country.

1

- (d) The sludge collected during this process has very similar properties to sewage sludge. Both sludges can be used for the same purposes.

Describe how sewage sludge can be treated for a named end use.

2

[Turn over



* X 8 2 6 7 6 0 2 0 3 *

1. (continued)

- (e) The ecological quality of the surface water environment in the UK is assessed annually. The assessment looks at the biological and habitat conditions, and rates them from high to bad.
- (i) Surface water bodies include rivers, canals, lakes, estuaries, and coastal waters.

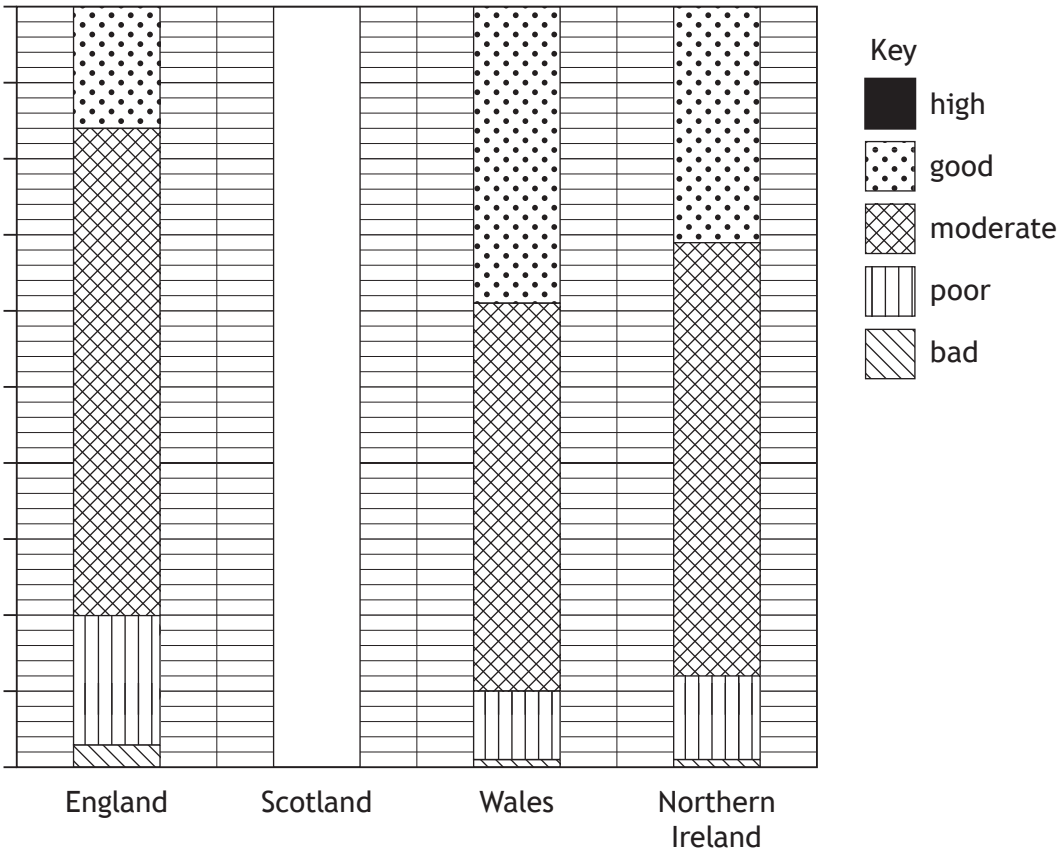
The table shows the percentage of surface water bodies in the UK awarded each quality rating in 2020.

Country	Surface water bodies achieving each rating (%)				
	High	Good	Moderate	Poor	Bad
England	0	16	64	17	3
Scotland	14	50	22	12	2
Wales	0	39	51	9	1
Northern Ireland	0	31	57	11	1

Complete the 100% stacked bar graph to show the % of surface water bodies in Scotland awarded each quality rating in 2020.

3

(An additional graph, if required, can be found on *page 28*.)



1. (e) (continued)

- (ii) Biological oxygen demand (BOD) is one of the measures used to assess water quality.

Describe what is meant by *biological oxygen demand (BOD)*.

1

- (iii) Explain why the evidence suggests that BOD measurements are likely to be lower overall in Scotland than in the other countries shown.

2

[Turn over



2. A drinks company recently announced plans to build an aluminium processing and recycling plant in the UK.

(a) As part of the plan, ore rich in aluminium oxide will be shipped to the UK from countries such as Australia, Brazil, and Vietnam.

(i) Name an ore rich in aluminium oxide.

1

(ii) State two factors associated with the formation of aluminium ore.

2

1:

2:

(b) State one possible environmental impact of mining aluminium ore.

1

(c) The drinks company claims that the construction of the plant will create a more sustainable aluminium supply chain.

(i) Sustainability involves the relationship or balance between three factors, one of which is environmental.

State **one** of the other two factors.

1

(ii) Explain **two** reasons why the processing of aluminium ore may not be considered sustainable.

2



2. (continued)

(d) The recycling of aluminium in the plant will contribute to the circular economy.

(i) Aluminium does not degrade and therefore can be recycled indefinitely.

Name this type of recycling model.

1

(ii) Determine the percentage of energy saved by recycling aluminium rather than processing it from its ore.

1

(iii) Other than reduced energy consumption, suggest one way the recycling of aluminium may contribute to a circular economy.

1

(e) The local planning authority will require full knowledge of all possible environmental effects associated with building the aluminium processing and recycling plant.

(i) State which type of environmental assessment would be required for an individual project such as this.

1

(ii) Explain the need for monitoring and mitigation in an environmental assessment.

(A) Monitoring:

1

(B) Mitigation:

1



3. Whisky is an important contributor to Scotland's economy, with exports worth £5.6 billion in 2023. More than 41 000 people are employed in this sector.

In 2021, the Scotch Whisky Association published a sustainability strategy that aims to achieve Net Zero by 2045. The focus of the strategy is on the key points shown in the table.

Key areas	Goals
Tackling climate change	Decarbonise distillery operations by 2040. Collaborate with supply chain partners and regulators.
Moving to a circular economy	Understand the environmental impact of different packaging decisions.
Using water responsibly	Develop a standardised approach to water stewardship for the whisky sector.
Caring for the land	Play an active role in the wider conservation and regeneration of Scotland's peatlands and arable agriculture.

- (a) Scotch Whisky is produced by fermenting cereals with yeast and water. The alcohol generated in the process is extracted by distillation.

The fermentation and distillation processes result in approximately 1.6 billion litres of liquid waste (pot ale syrup) and 500 000 tonnes of fermented grain waste (draff) each year.

- (i) Pot ale syrup can be fermented to generate biogas. The biogas is used to generate steam for electricity production.

State the process that generates biogas through decomposition of organic matter in an oxygen-free environment.

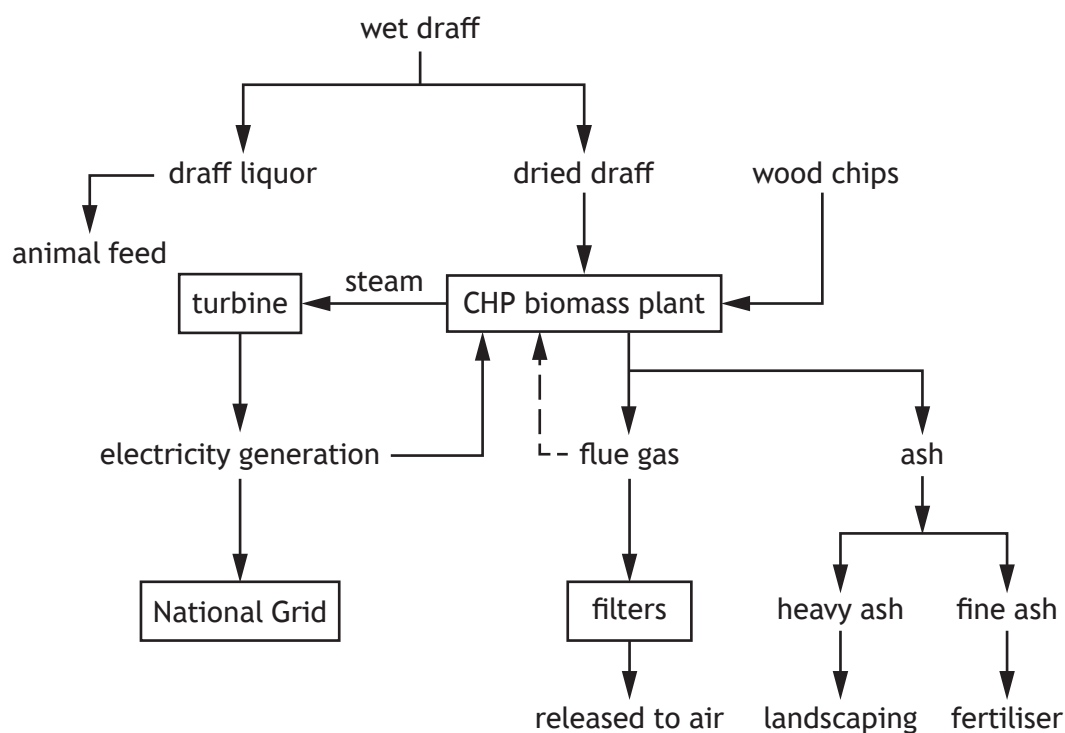
1

3. (a) (continued)

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- (ii) As part of the strategy to decarbonise distillery operations, several distilleries have modified their processes. This includes using the draff to fuel combined heat and power (CHP) plants.

The flow chart shows the re-purposing of draff in one distillery.



Key

infrastructure $\longrightarrow$ recirculation

Other than using the draff to fuel the CHP biomass plant, identify **two** examples of sustainable practice shown in the flow chart.

2

1:

2:

- (iii) Another distillery uses the draff and other by-products to produce biobutanol, which is a biofuel.

Name one other processed biofuel.

1



3. (continued)

- (b) Scotch Whisky companies are exploring ways to make glass bottles and packaging lighter, while still ensuring protection.

One company has re-designed its bottles, reducing the mass of an empty 750 ml bottle from 555 g to 420 g.

- (i) Calculate the percentage decrease in the mass of the new bottle.

1

Space for working

- (ii) The new glass bottle accounts for 85% of the packaging mass.
Determine the mass of packaging used to protect the new bottle.

2

Space for working

- (c) Around two-thirds of water used by the whisky industry is for production processes. The remainder is for general use within the distilleries.

- (i) Installation of water meters allows each distillery to monitor its water consumption.

Other than re-use of greywater or blackwater, state one other water conservation measure that could be used by the industry to reduce water consumption.

1

- (ii) Suggest why re-use of greywater or blackwater would not be an appropriate option for this industry.

1



3. (continued)

- (d) Scotch Whisky is a protected product name. It must have been distilled in Scotland and must mature in wooden casks for at least 3 years. The industry usually uses casks that have previously been used in other alcohol production outside of the UK.

Suggest one advantage and one disadvantage of re-using these casks.

- (i) Advantage:

1

- (ii) Disadvantage:

1

- (e) Scotch Whisky production relies on a sustainable supply of barley. Around 90% of the barley is sourced in Scotland. It is thought that long term supply could be impacted by climate change and by a lack of genetic diversity in the varieties available to Scottish farmers.

Suggest why climate change and a lack of genetic diversity could impact on the long-term supply of barley.

- (i) Climate change:

1

- (ii) Lack of genetic diversity:

1

[Turn over



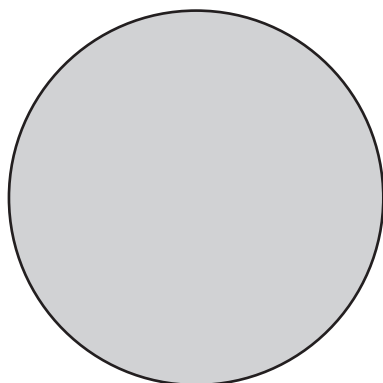
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4. The solar cycle is an 11-year change in the Sun's activity.

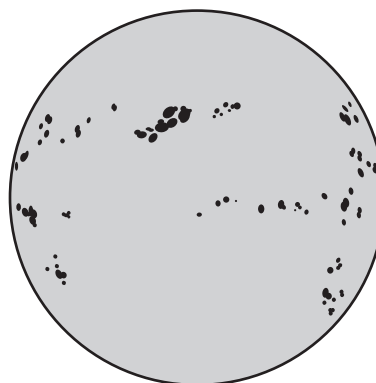
The activity is measured in terms of the number of sunspots observed on the Sun's surface.

The period with the lowest number of observed sunspots is known as the solar minimum. The period with the largest number of observed sunspots is known as the solar maximum.

solar minimum



solar maximum



- (a) (i) Describe what is meant by a *sunspot*.

1

- (ii) Describe a consequence of increased sunspot activity on Earth's climate.

1

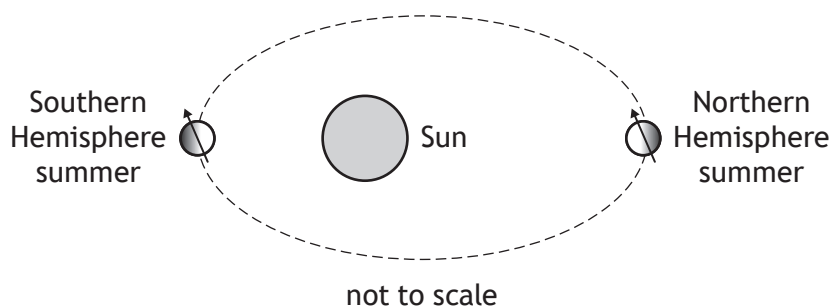


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4. (continued)

- (b) The shape of Earth's orbit around the Sun varies from elliptical to near circular over a 100 000-year cycle. This is known as eccentricity.

Currently, Earth travels around the Sun in a near elliptical orbit.



- (i) Using the information above, suggest why summers in the Southern Hemisphere may be hotter than summers in the Northern Hemisphere.

2

- (ii) Describe how long-term changes in the shape of Earth's orbit affect average **global** temperatures.

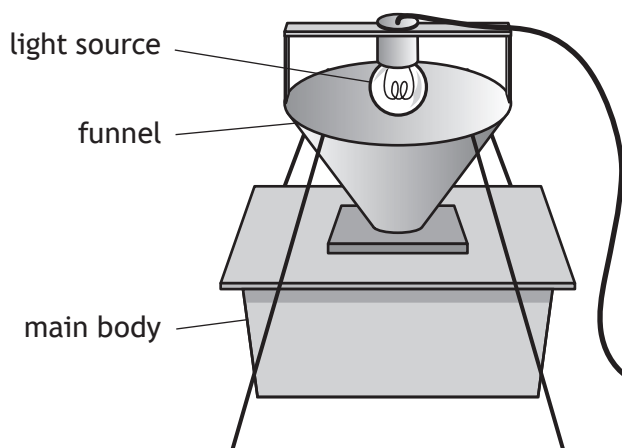
2

[Turn over

5. Moths account for approximately 3% of Scotland's species. As they can be found in many different habitats, they have the potential to be used as an indicator of environmental conditions.

A group of students carried out an investigation to compare the moth species found in three different areas of woodland.

- (a) The diagram shows a moth trap. Moth traps use a light source to attract flying moths at night, which are then caught in the main body of the trap.



State two variables that the students would have to keep constant to ensure that the sampling of the sites was valid.

2

1:

2:

- (b) The moths caught in the trap were identified and counted, before being released back into the wild.

The students used a paired statement key to ensure the moth species were identified accurately.

Explain why use of a paired statement key increases the validity of the design of the investigation.

1

[Turn over

5. (continued)

(c) The results of the survey are shown in the table.

Moth species	Number of moths in the sample		
	Sample site A	Sample site B	Sample site C
Amphipoea sp.	16	8	12
Antler moth	10	16	8
Autumnal rustic	0	3	2
Dark marbled carpet	1	0	13
Dotted clay	0	1	2
Golden-rod brindle	3	1	0
Large yellow underwing	1	0	3
Plain clay	5	1	4
Rosy rustic	0	6	4
Square-spot rustic	3	11	5
Simpson's Biodiversity Index (<i>D</i>)	0.24		0.14

Simpson's Biodiversity Index (*D*) is calculated using the formula

$$D = \frac{\sum n(n-1)}{N(N-1)}$$

where: *n* is the frequency of a given species

N is the total number of organisms of all species

Σ is 'the sum of'.

The higher the *D* value, the lower the diversity.



5. (c) (continued)

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- (i) Calculate Simpson's Biodiversity Index (D) for sample site B.
A partially completed table has been provided to help you.

3

Species	n	$n-1$	$n(n-1)$
Amphipoea sp.	8	7	56
Antler moth	16	15	
Autumnal rustic	3	2	
Dark marbled carpet	0	0	
Dotted clay	1	0	
Golden-rod brindle	1	0	
Large yellow underwing	0	0	
Plain clay	1	0	
Rosy rustic	6	5	
Square-spot rustic	11	10	
	$N = 47$		$\sum n(n-1) =$

Space for working

- (ii) Conclude which site has the highest biodiversity.
Justify your answer.

1

Site:

Justification:



5. (c) (continued)

- (iii) Suggest a benefit of using a biotic index when analysing the data collected from multiple sample sites.

1

- (d) Describe how the reliability of the investigation could be improved.

1

- (e) Simpson's Biodiversity Index is an example of a biotic index.

Describe the application of one other named biotic index.

3



6. Earth's internal heat can be harnessed for district heating schemes.

MARKS
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- (a) (i) State one source of Earth's internal heat.

1

- (ii) Describe what is meant by a *district heating scheme*.

1

- (iii) Suggest one advantage of using geothermal district heating schemes compared to conventional domestic heating systems.

1

- (iv) Suggest one disadvantage to an individual household of the use of district heating compared to conventional domestic heating systems.

1

- (b) Geothermal power plants also harness Earth's internal heat and convert this heat energy into electrical energy.

Water is injected into the ground where the crust is thin. The heat from below the Earth's surface heats the water, creating steam.

- (i) Explain why this process only takes place in areas where the crust is thin.

2

- (ii) Other than requiring a site where the crust is thin, describe a reason why a country may be unable to produce electricity from a geothermal source.

1



* X 8 2 6 7 6 0 2 1 9 *

7. Podzols and brown earths are two soils commonly found in Scotland.

- (a) (i) The table shows selected soil formation factors for a podzol and a brown earth.

Soil formation factor	Podzol	Brown earth
Vegetation type		
Associated macro-biota	none	
Parent material		various rocks, neither very acidic nor very alkaline

Complete the table to show comparative soil formation factors for a podzol and a brown earth.

3

- (ii) Climate has a major impact on soil formation.

Explain how precipitation influences the formation of **either** a podzol or a brown earth.

3

7. (continued)

(b) The formation of soil involves several processes.

- (i) Weathering refers to the exposure and breaking down of rocks *in situ* at the Earth's surface over time due to interaction with the atmosphere.

Describe one named form of weathering.

1

- (ii) Humification releases nutrients into the soil.

Describe what is meant by *humification*.

2

(c) State one commercial use of a podzol and a brown earth.

- (i) Podzol:

1

- (ii) Brown earth:

1

[Turn over

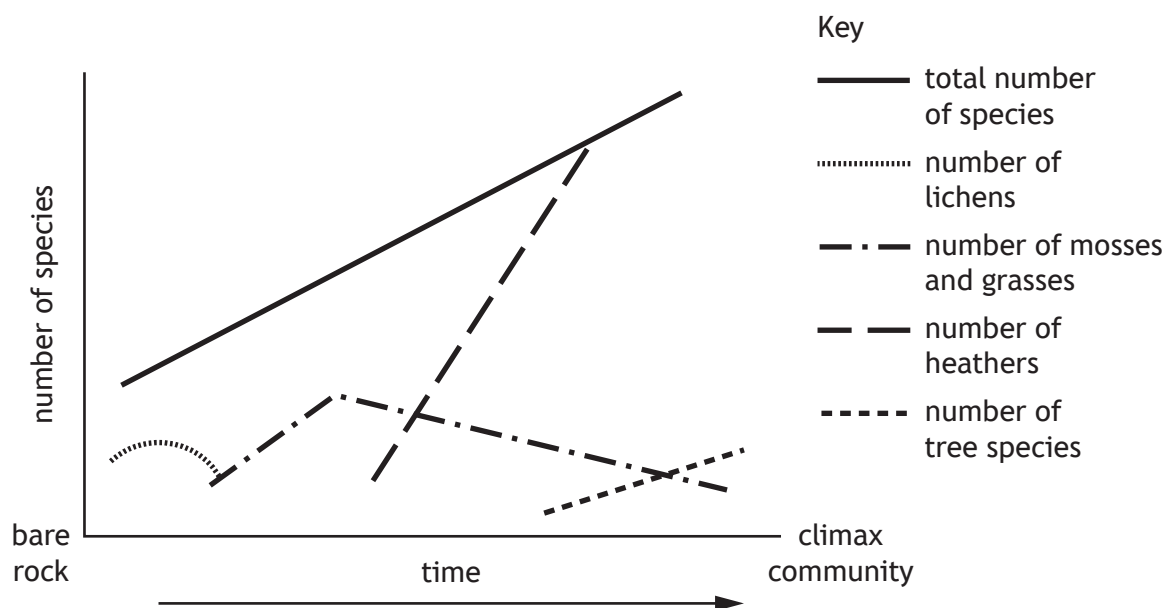


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Questions 8 and 9 each contain a choice

For each question, attempt either A or B. Write your answers to questions 8 and 9 on the following pages. You may use diagrams where appropriate.

8. A The diagram shows the sequence of plant communities inhabiting a moorland site over time. This is known as succession.



Discuss:

- (a) the sequence of succession shown in the diagram
(b) the characteristic features of a climax community.

10

OR

- B Human activities can have a significant influence on biodiversity.
Discuss species reduction and increase as a consequence of the following:

- (a) habitat fragmentation, habitat destruction, and rewilding
(b) conservation practices.

10



9. A The UK government is providing financial support to develop a world-leading hydrogen industry in the UK, to help achieve its Net Zero ambitions.
Discuss the advantages and disadvantages of using hydrogen as a fuel.

10

OR

- B Human activities can impact significantly on the quality of the natural environment.
Discuss human activities that may have a significant impact on the quality of air and water. The impacts may be positive or negative.

10

[Turn over



SPACE FOR ANSWERS



* X 8 2 6 7 6 0 2 2 4 *

SPACE FOR ANSWERS (continued)



SPACE FOR ANSWERS (continued)



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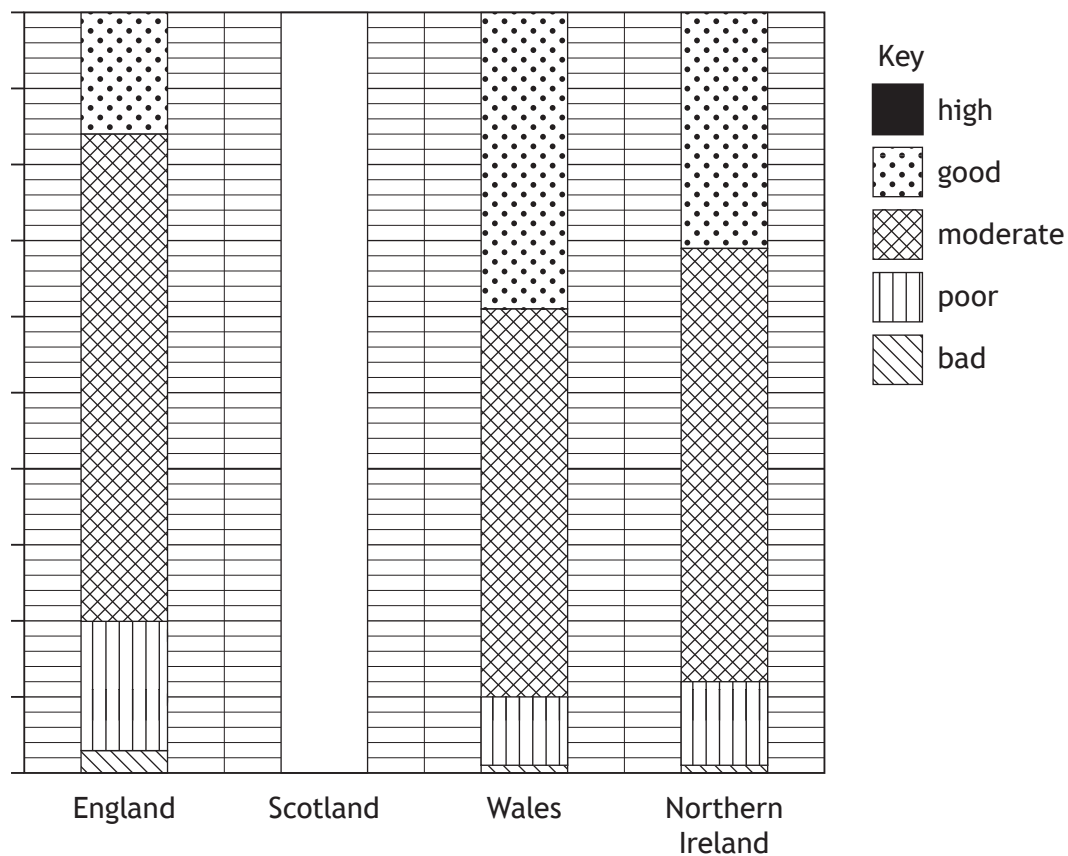
SPACE FOR ANSWERS (continued)

[END OF QUESTION PAPER]



ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph for question 1 (e) (i)



ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK



ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK



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