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National
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2024

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X826/76/01

**Environmental Science
Paper 1**

FRIDAY, 26 APRIL

9:00 AM – 9:45 AM



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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 — 20

Attempt ALL questions.

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.



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

Total marks — 20
Attempt ALL questions

Storm Arwen was a powerful storm that hit the UK in 2021. Extreme winds caused extensive damage, including the loss of around 16 million trees across 8000 hectares in Scotland. Most were coniferous species (known as softwood), but broadleaved species (hardwood) were also damaged.

A country park estate in Scotland was landscaped in the early 19th century, with over 2 million trees planted. Most were Scots pine (*Pinus sylvestris*) and European larch (*Larix decidua*), grown for construction work on the estate. Such softwood species are regularly harvested and replanted. A wide variety of other trees were also planted, including both native and non-native species.

The estate is now owned by a local authority and is open to the public. Parkland containing large, mature, ornamental trees is a key visitor attraction.

The estate managers estimate that over 100 000 trees were lost during Storm Arwen, with softwoods most affected. Currently, it is not financially viable to extract all fallen softwood or to replant all areas, and some damaged areas will be left to be reclaimed by nature.

The impacts of the storm have provided estate managers with an opportunity to increase the estate's biodiversity potential and minimise local climate change impacts.

The estate's recovery plan aims to restock larger areas once fallen and damaged trees have been removed. The plan for Area D is still under consideration.



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

1. Scottish Forestry is working with Forestry and Land Scotland to fully assess the impact of Storm Arwen on Scotland's forests and woodlands.

State one role of Scottish Forestry.

1

2. The table shows the contribution of two forestry-related sectors to Scotland's economy and employment in 2015.

	Forestry sector	
	Forestry and timber processing	Forest recreation and tourism
Economic contribution	£771 million	£183 million
Employees	19 555	6312

Identify which of these sectors makes the largest contribution to the Scottish economy per employee.

1

[Turn over



* X 8 2 6 7 6 0 1 0 3 *

3. Wind is a major cause of damage in forests, causing snapping of tree trunks (known as windbreak) or uprooting of trees (windthrow). Both forms of damage occurred on the estate.

Tree trunks bend in response to a gust of wind, and will sway for up to 30 seconds. During a sway, a tree is exposed to the arrival of another gust and is vulnerable to windbreak or windthrow.

The flexibility of a tree trunk changes with age, as shown in the tree flexibility diagram below.

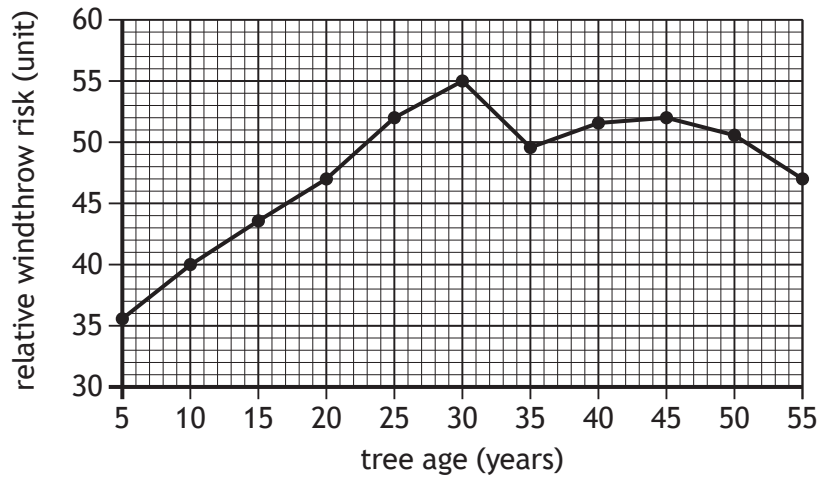
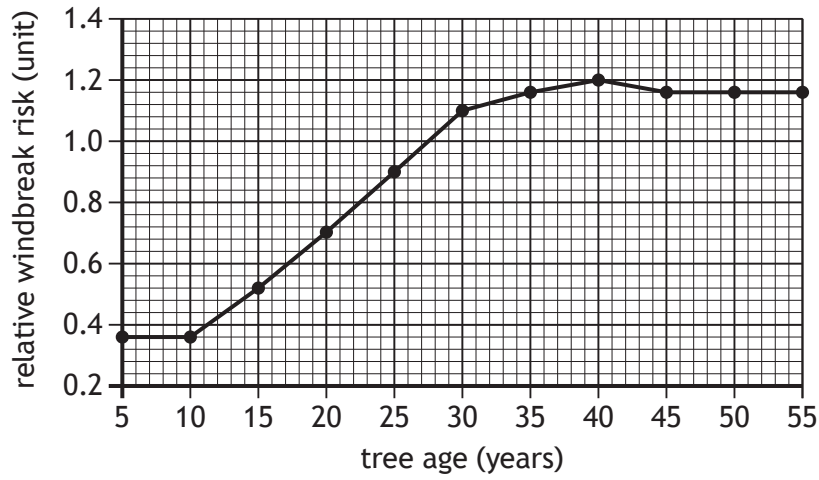
The black silhouettes represent trees at rest, while the grey silhouettes represent the degree of sway during a gust event relative to the tree's age.



3. (continued)

MARKS DO NOT WRITE IN THIS MARGIN

Computer modelling was used to simulate the risk of windbreak and windthrow in a growing softwood forest relative to tree age. The outcomes are shown in the graphs below.



(a) Using information provided in the tree flexibility diagram and the graphs, conclude why most softwoods are harvested around 40 years.

3



3. (continued)

- (b) Loss of trees through windbreak and windthrow is a natural disturbance process.

Explain why natural disturbance processes are important in terms of succession and subsequent changes in biodiversity in a forest.

- (i) Succession

1

- (ii) Biodiversity

1

- (c) (i) The estate's felling and restocking plan (**Source C**) shows that softwoods are to be planted at a density of 2500 stems per hectare and hardwoods at 1600 stems per hectare.

Suggest why softwoods are planted at a higher density than hardwoods.

2

- (ii) Suggest why trees planted at a higher density may be more vulnerable to wind damage.

2



4. Ramorum disease is caused by *Phytophthora ramorum*, a fungus-type organism that is damaging and killing a wide range of trees and shrubs around the UK.

Ramorum disease has periodically been detected in *Rhododendron ponticum*, an invasive non-native species that is present in many areas of the estate.

Suggest why removal of *Rhododendron ponticum* is part of the estate's annual maintenance programme.

1

[Turn over



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

5. Estate managers considered the potential impacts of climate change when preparing the long-term recovery plan.

Forests capture carbon dioxide from the atmosphere. The carbon is stored in the forest as living biomass, leaf litter, deadwood, and soil, in a process known as carbon sequestration.

The table shows the carbon sequestration rate and crop rotation period for Sitka spruce (softwood) and beech (hardwood).

	Sitka spruce	Beech
Carbon sequestration rate (tonnes CO ₂ ha ⁻¹ yr ⁻¹)	13.2	8.8
Crop rotation period (yr)	55	92

- (a) Using the formula provided, calculate the percentage difference in carbon sequestered over the crop rotation period of the two species.

$$\% \text{ difference} = \frac{(A - B)}{\left[\frac{(A + B)}{2} \right]} \times 100$$

where: A = carbon sequestration rate \times crop rotation period (Sitka spruce)

B = carbon sequestration rate \times crop rotation period (beech).

2

Space for working

- (b) State which of the two species will sequester most carbon over its crop rotation period.

Justify your response.

1



6. The estate managers have prepared a long-term plan for restocking most areas where trees were lost, but are still debating options for **Area D**. They must consider their aim to expand the estate's range of habitats and its biodiversity potential alongside the need for commercial income from woodland.

Using information from the sources and your knowledge of environmental science, decide which option they should adopt for **Area D**.

Justify your decision.

5

Restocking for habitats and biodiversity

Restocking for commercial income

[END OF QUESTION PAPER]



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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK



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