Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

AS
ENVIRONMENTAL SCIENCE

Paper 1

Wednesday 16 May 2018 Morning Time allowed: 3 hours

Materials
For this paper you may use:
- a calculator.

Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 120.
- All questions should be answered in continuous prose.
- You will be assessed on your ability to:
  - use good English
  - organise information clearly
  - use specialist vocabulary where appropriate.

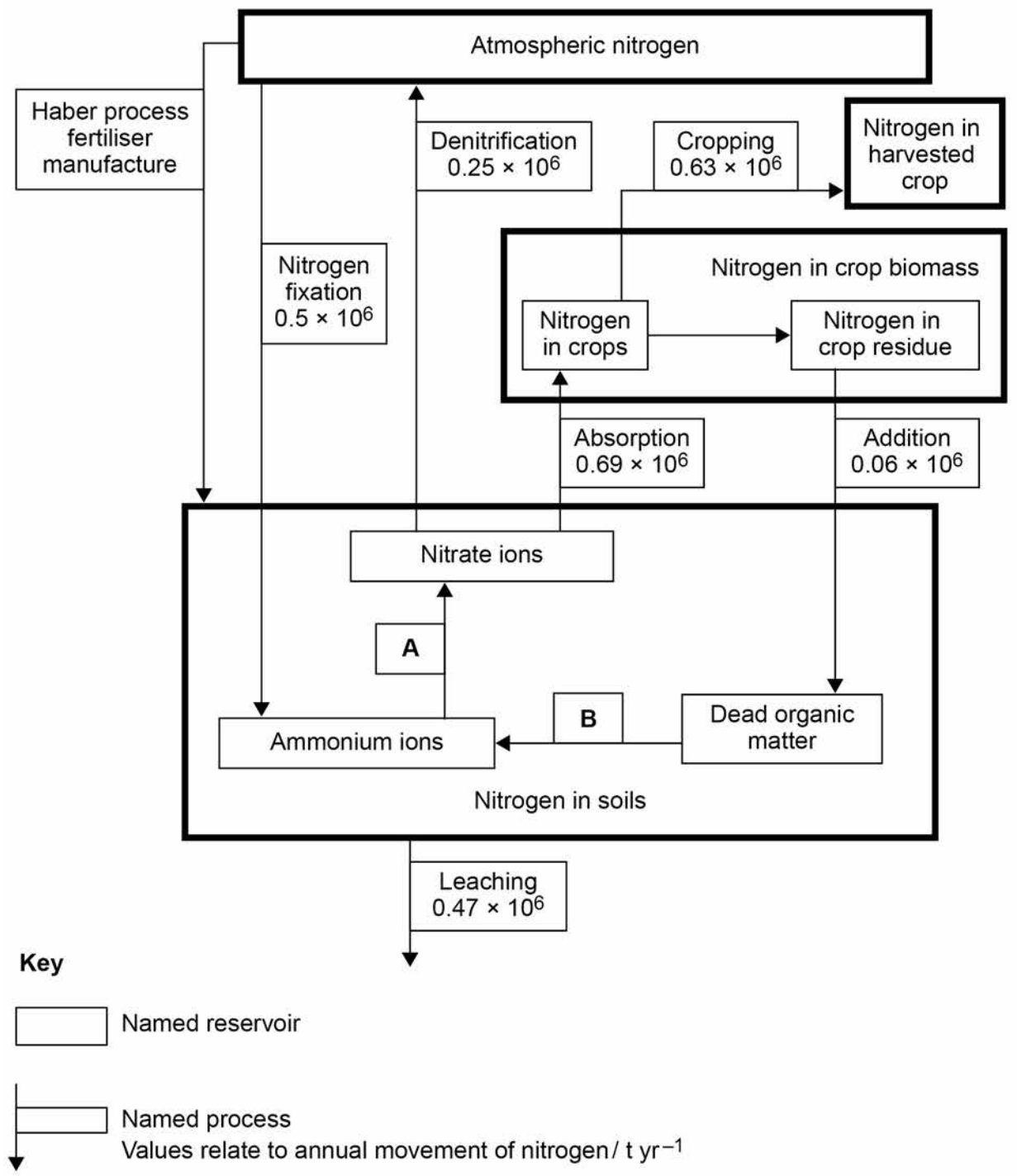
For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
TOTAL	

Do not write outside the box

Answer **all** questions in the spaces provided.

0 1 **Figure 1** shows some features of the nitrogen cycle in arable agriculture in the UK.

Figure 1



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0 1 . 1 State the names of the **two** missing transfer processes **A** and **B** in **Figure 1**.

[1 mark]

A _____

B _____

0 1 . 2 Calculate the amount of nitrogen, as artificial fertiliser, that needs to be added annually to maintain a state of dynamic equilibrium in the soil.

[1 mark]

_____ t yr^{-1}

0 1 . 3 Suggest how the crops to be grown may be chosen to maintain nitrogen levels in the soil.

[3 marks]

_____

_____

_____

_____

_____

_____

5

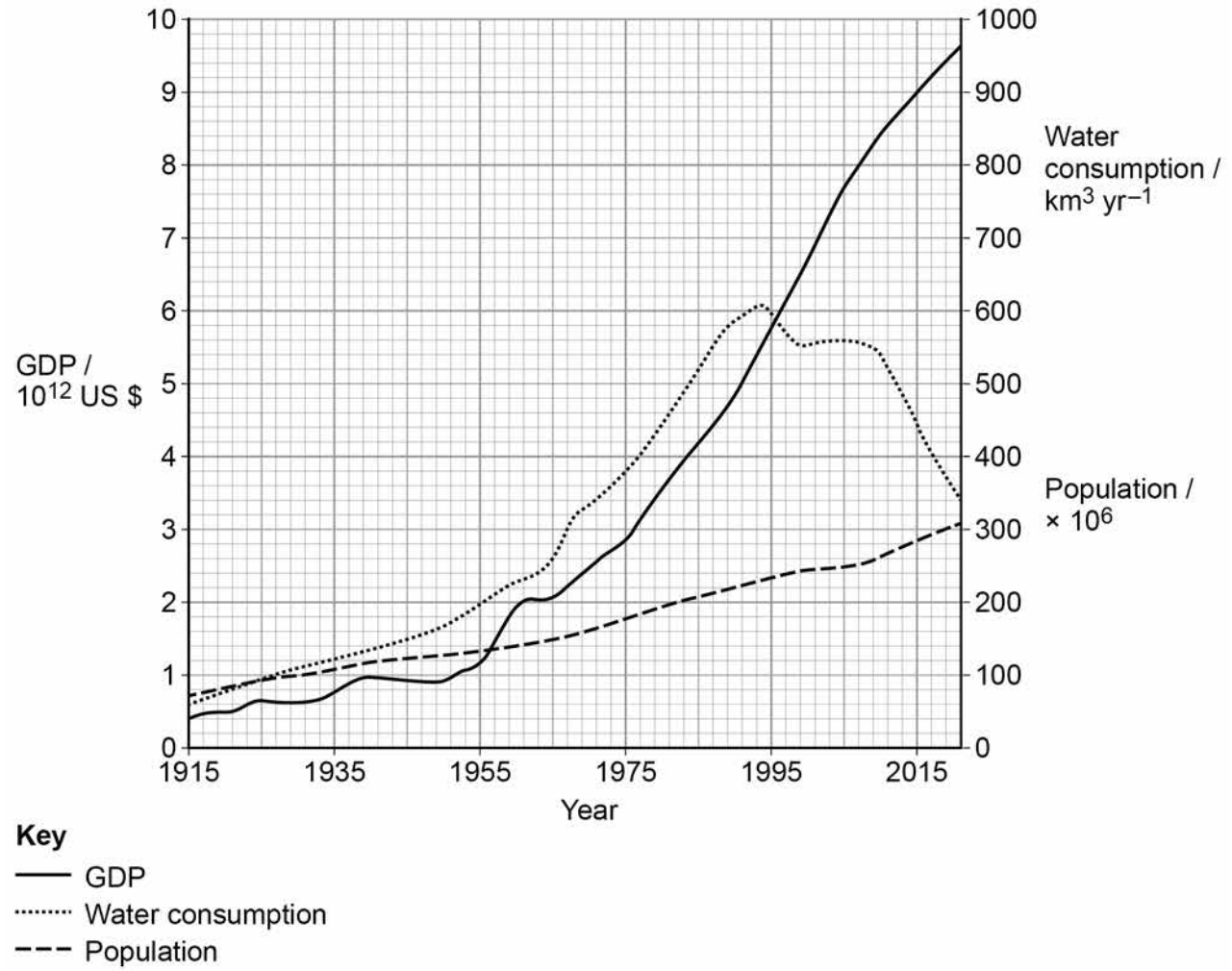
Turn over for the next question

Do not write outside the box

0 2 The understanding of trends in water use is an important part of planning sustainable water management.

Figure 2 shows the total annual water consumption, Gross Domestic Product (GDP) and population for the USA between 1915 and 2021.

Figure 2



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0 2 . 1 Use the information in **Figure 2** to complete **Table 1**.

[2 marks]

Table 1

	1955	**1975**	**1995**	**2015**
Per capita water consumption / **m^3 yr^{-1}**	1500	2100	2600	
Per capita GDP / **US $**	8900	16 000	25 000	

Show your working.

0 2 . 2 Suggest reasons for the decrease in per capita water consumption between 1995 and 2015.

[3 marks]

5

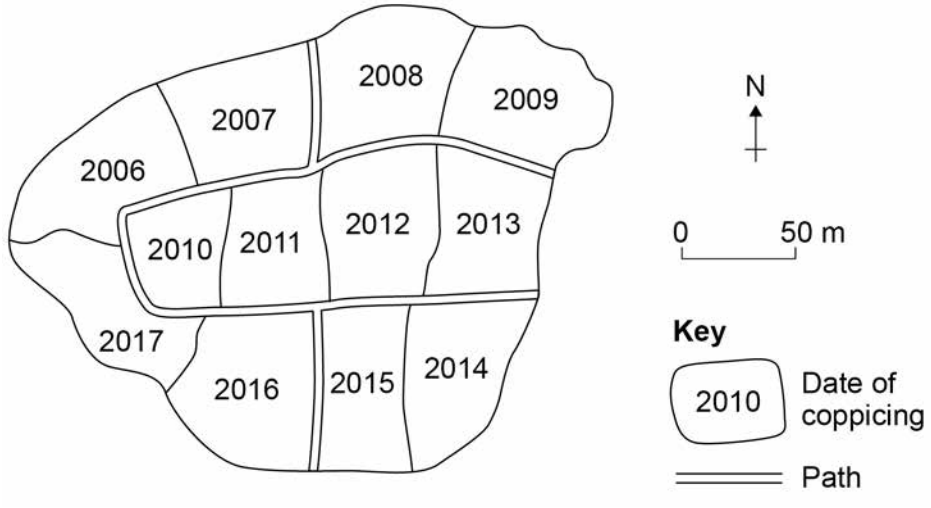
Turn over for the next question

Do not write outside the box

0 3 Coppice woodlands are habitats with high biodiversity as they provide a range of abiotic conditions suitable for many different species.

Figure 3 shows a woodland with areas that have been coppiced in different years.

Figure 3



0 3 . 1 Describe how a study of the woodland shown in **Figure 3** could be used to show the effect of coppicing on ground level light levels within the woodland.

[4 marks]

Do not write outside the box

0 3 . 2 Explain how changes in light intensity during the coppicing cycle affect the community of species in woodland habitats.

[4 marks]

Extra space

0 3 . 3 In the UK, the area of woodland managed by coppicing has decreased greatly since 1900. Some of the remaining sites have been designated as wildlife conservation areas.

Describe how designation as a wildlife conservation area by a government agency can ensure that wildlife on privately owned land is protected.

[2 marks]

10

Turn over for the next question

0 4 Madagascar is a large island off the east coast of Africa and is home to over 250 000 known species. Over 80% of these species are endemic to the island.
Tables 2 and 3 show information about the tropical rainforests of Madagascar.

Figure 4

Table 2
The forested area of Madagascar

Total land area /km^2	587 000
Tropical rainforest /% of total land	21
Rate of deforestation /km^2 yr^{-1}	2200

Table 3
The significance of Madagascan species

	Plant species	**Vertebrate species**
Number of known species in the world	349 710	68 045
Number of known species in Madagascar	14 883	1870
Ratio of endemic to non-endemic species in Madagascar	4:1	4:1
Known endemic Madagascan species dependent on the tropical rainforest /%	79	83

Do not write outside the box

Most of the original tropical rainforest habitat in Madagascar has been destroyed.

0 4 . 1 Calculate how much time it would take to lose all of the remaining tropical forest if deforestation were to continue at the same rate.

[2 marks]

Show your working.

_____ years

0 4 . 2 Calculate the percentage of the world's vertebrate species that would be made globally extinct if all of the tropical forests on Madagascar were lost.

[2 marks]

Show your working.

_____ %

Question 4 continues on the next page

Do not write outside the box

0 4 . 3 The International Union for Conservation of Nature (IUCN) is an important organisation for the conservation of global biodiversity. However, the IUCN prioritises the conservation of some species over others.

Explain how the IUCN selects species that should be prioritised for conservation.

[6 marks]

Extra space

10

Do not write outside the box

0 5 **Figure 5** shows the trend in global sea level from 1870 to 2000.

Graph of global sea levels cannot be reproduced here due to third-party copyright restrictions.

0 5 . 1 Use the information in **Figure 5** to calculate the difference between the annual rates of sea level change for the time periods 1880 to 1935 **and** 1940 to 2000.

Show your working.

[2 marks]

difference _____

Do not write outside the box

0 5 . 2 Suggest reasons why there is a difference between the annual rates of sea level change for the time periods 1880 to 1935 **and** 1940 to 2000, shown in **Figure 5**.

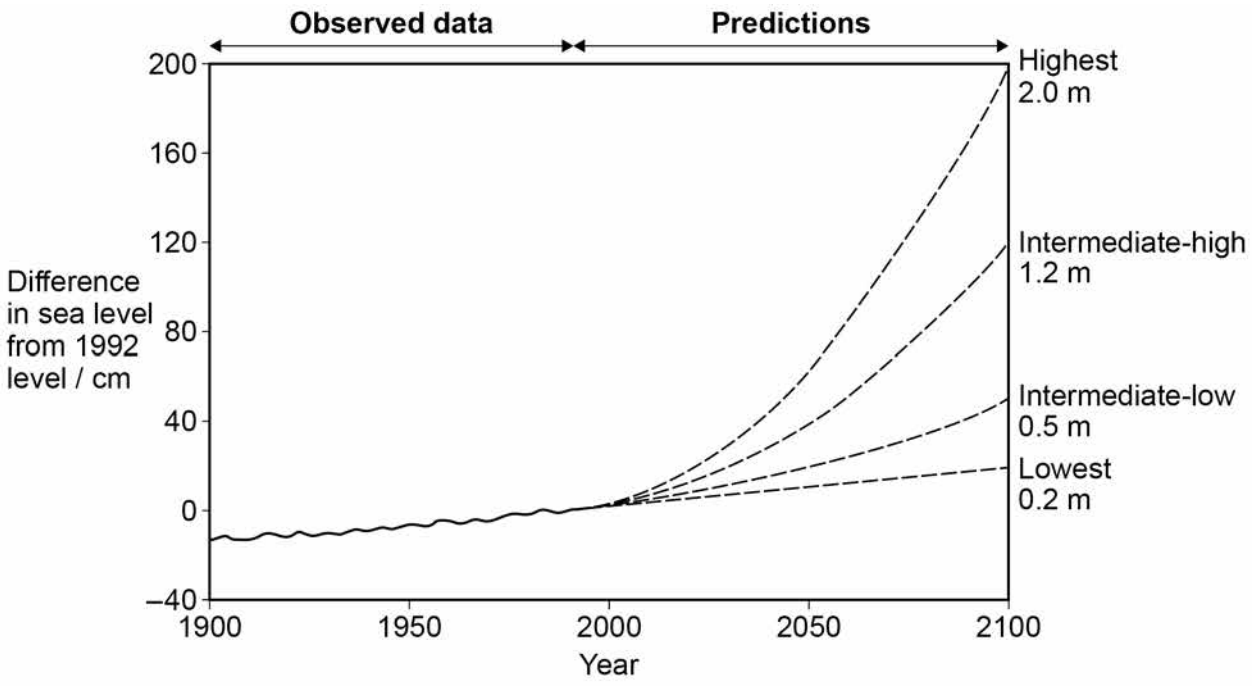
[3 marks]

0 5 . 3 Suggest how change in monitoring technologies has produced the reduction in standard deviation between 1870 and 2000.

[2 marks]

0 5 . 4 **Figure 6** shows graphs of predicted sea level rise produced by four computer models.

Figure 6



Explain why it is difficult to predict future global sea levels.

[3 marks]

10

Turn over for the next question

Do not write outside the box

0 6 Barn Owls, *Tyto alba,* are legally protected in the UK. Barn Owls hunt small mammals, favouring field voles, in the early morning and evening, over an area up to 1 km radius from their nest.

Figure 7

Ecologists wanted to determine the effect of grassland management on the feeding behaviour of Barn Owls.

Two areas of grassland were chosen in different owl territories. In the first area the grass was cut to a height of 8 cm and in the second area the grass was cut to a height of 40 cm.

The diversity of small mammals was assessed in each area by setting mammal traps that were checked each day. The results are shown in **Table 4**.

Table 4

Mammal	**Number of mammals trapped (n)**	
	Area cut to 8 cm	**Area cut to 40 cm**
Field Vole *Microtus agrestis*	7	21
Wood Mouse *Apodemus sylvaticus*	3	6
Common Shrew *Sorex araneus*	1	5
Pygmy Shrew *Sorex minutus*	0	3
Harvest Mouse *Micromys minutus*	0	2
Bank Vole *Myodes glareolus*	1	1
Water Shrew *Neomys fodiens*	0	1
Total number (N)	12	
Simpson's Index of Biodiversity	2.75	

Do not write outside the box

The Simpson's Index of Biodiversity was calculated for the mammal data collected in the grassland cut to 8 cm.

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

Where **D** = index of diversity
N = total number of all organisms of all species
n = total number of organisms of a particular species
$\sum$ = sum of

0 6 . 1 Complete **Table 4** by calculating the Simpson's Index of Biodiversity for the mammals in the area of grassland cut to 40 cm.

[2 marks]

Show your working.

0 6 . 2 Describe how this investigation may have been planned to make sure the results were representative and comparable.

[4 marks]

Over the next four weeks, owl pellets were collected from the area around each owl nest and the skeletons found within the pellets were identified.

The results are shown in **Table 5**.

Table 5 shows the proportion of each mammal species in the owl pellets expressed as a percentage of the total skeletal content collected from each of the different areas of grassland.

Table 5

	Area cut to 8 cm	**Area cut to 40 cm**
Number of pellets collected over 4 weeks	112	168
Mammal species	**Skeletons found in pellets / %**	
Field Vole *Microtus agrestis*	42	66
Wood Mouse *Apodemus sylvaticus*	27	19
Common Shrew *Sorex araneus*	20	13
Pygmy Shrew *Sorex minutus*	7	0
Harvest Mouse *Micromys minutus*	1	0
Bank Vole *Myodes glareolus*	2	2
Water Shrew *Neomys fodiens*	1	0

0 6 . 3 Use information in **Table 4** and **Table 5** to suggest **two** reasons for differences in the diet of the Barn Owls living in the two areas of different grass heights.

[2 marks]

Do not write outside the box

0 6 . 4 The use of owl pellets is an indirect method of monitoring species.

Suggest **two** other examples of indirect evidence which could have been used to identify the presence of a particular species.

[2 marks]

10

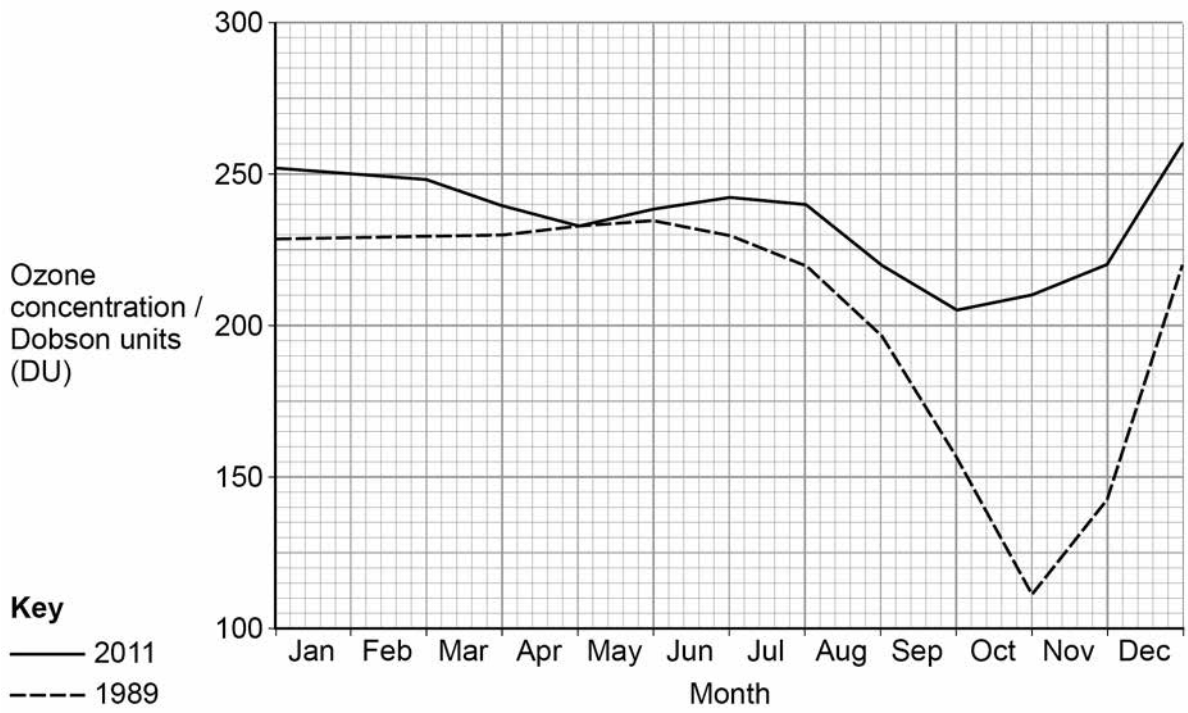
Turn over for Question 7

Do not write outside the box

0 7 Ozone (O_3) depletion, caused by anthropogenic releases of CFCs, is greatest over Antarctica.

Figure 8 shows the ozone concentration in the atmosphere over Antarctica for 1989 and 2011.

Figure 8



0 7 . 1 A hole in the ozone layer occurs when ozone levels fall below 220 DU.

Use the information in **Figure 8** to calculate the difference in the length of time that the ozone hole existed in 1989 and 2011.

[1 mark]

Show your working.

difference _____ months

Do not write outside the box

0 7 . 2 Calculate the difference, in Dobson units, between the maximum depletion in ozone concentrations in 1989 and in 2011.

[1 mark]

Show your working.

difference _____ DU

0 7 . 3 Explain why seasonal variations in ozone concentration are greater over Antarctica than over other areas of the world.

[5 marks]

Extra space _____

Question 7 continues on the next page

Do not write outside the box

0 7 . 4 **Figure 9** shows two methods that are used to estimate atmospheric ozone concentrations.

Figure 9

The UARS satellite carries a device for monitoring ozone.

A ground-based device monitors ozone concentrations in the atmosphere over Antarctica.

Outline the advantages of using satellite rather than ground-based surveys to collect data on atmospheric ozone concentrations.

[3 marks]

10

Do not write outside the box

0 8 . 1 Explain how **one** environmental problem caused by the drainage water from open cast mines may be reduced.

[3 marks]

Question 8 continues on the next page

Do not write outside the box

Bauxite is an aluminium ore and is surface mined on a large scale. Global reserves of bauxite in 2011 were 27 800 million tonnes.

Figure 10 shows the proportion of bauxite reserves by country in 2011.

Pie chart showing Bauxite reserves cannot be reproduced here due to third-party copyright restrictions.

0 8 . 2 Define the term 'reserves'.

[1 mark]

0 8 . 3 Use **Figure 10** to calculate how many years Jamaica's bauxite reserves in 2011 will last if the annual rate of bauxite production by Jamaica is 12 million tonnes.

[2 marks]

Show your working.

_____ years

Do not write outside the box

0 8 . 4 Explain why estimates of bauxite reserves will change in the future.

[9 marks]

Extra space

15

Do not write outside the box

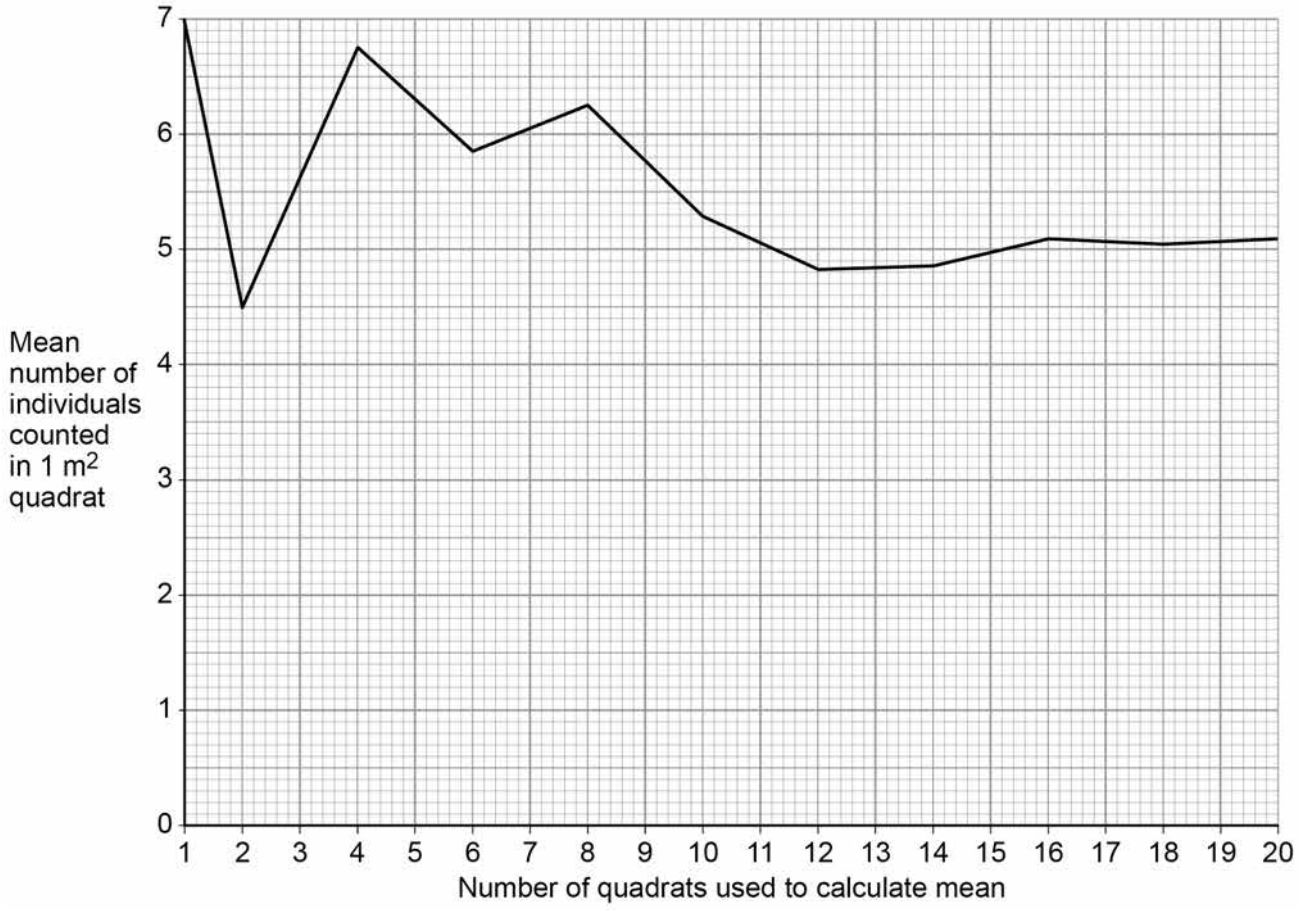
0 9 For five years, the effect of two different management practices on wild plants in a heathland community was investigated.

Study Area 1 was grazed with ponies and **Study Area 2** was grazed with cows.

After five years, both areas were sampled to compare the abundance of the heathland plant Pale Dog Violet, *Viola lacteal*.

Figure 11 shows the results of the preliminary study to determine the suitable number of 1 m^2 quadrat samples that would be required to ensure a representative amount of data was collected.

Figure 11 Mean number of Pale Dog Violets found from an increasing number of quadrats sampled



0 9 . 1 Use the information in **Figure 11** to explain how the data would **not** be representative if 10 or fewer quadrats were sampled.

[2 marks]

Do not write outside the box

Animals graze at different rates. **Table 6** shows some Livestock Unit equivalents for grazing, so that livestock densities can be compared.

Table 6

Animal	Livestock Unit (LU)
Pony	1.00
Cow	0.70
Goat	0.10
Sheep	0.08

Both study areas were 24 hectares in area and used the same livestock density of 0.5 LU ha^{-1}

Study Area 1 was stocked with ponies, **Study Area 2** was stocked with cows.

0 9 . 2 Calculate the number of animals that should have been stocked in each area to standardise the grazing rates at 0.5 LU ha^{-1}

[2 marks]

_____ ponies in Study Area 1

_____ cows in Study Area 2

0 9 . 3 The results of the investigation showed that the area grazed by cows had a greater abundance of Pale Dog Violet than the area grazed by ponies.

Suggest **two** reasons for these results.

[2 marks]

_____

_____

_____

_____

Question 9 continues on the next page

Do not write outside the box

0 9 . 4 Discuss the evidence that justifies the following statement:

'The conservation of biodiversity is of benefit to society now and in the future.'

[9 marks]

Extra space

15

Do not write outside the box

Only **one** answer per question is allowed.

For each answer completely fill in the circle alongside the appropriate answer.

CORRECT METHOD 

WRONG METHODS 

If you want to change your answer you must cross out your original answer as shown. 

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. 

1 0 **Table 7** shows some treatment processes that may be used to remove specific contaminants from water.

Table 7

Treatment process
Activated carbon filtration
Aeration
Distillation
Flocculation
Ion exchange
Membrane filtration
Ozonation
Reverse osmosis
Screening
Sedimentation
Ultraviolet light treatment

1 0 . 1 Use your own knowledge to identify which process is the most appropriate to remove salt.

[1 mark]

A Aeration ⬭

B Flocculation ⬭

C Reverse osmosis ⬭

D Sedimentation ⬭

Do not write outside the box

1 0 . 2 Use your own knowledge to identify which process is the most appropriate to remove suspended solids.

[1 mark]

A Activated carbon filtration ⬭

B Ion exchange ⬭

C Sedimentation ⬭

D Ultraviolet light treatment ⬭

1 0 . 3 Use your own knowledge to identify which process is the most appropriate to remove organic pollutants.

[1 mark]

A Activated carbon filtration ⬭

B Ion exchange ⬭

C Membrane filtration ⬭

D Ozonation ⬭

1 0 . 4 Use the information in **Table 7** and your own knowledge to outline how the following contaminants are removed from water.

[3 marks]

Pathogens _____

_____

Heavy metals _____

_____

Litter _____

_____

Do not write outside the box

1 0 . 5 Evaluate the environmental impacts of different methods of increasing water supplies.

[9 marks]

Extra space

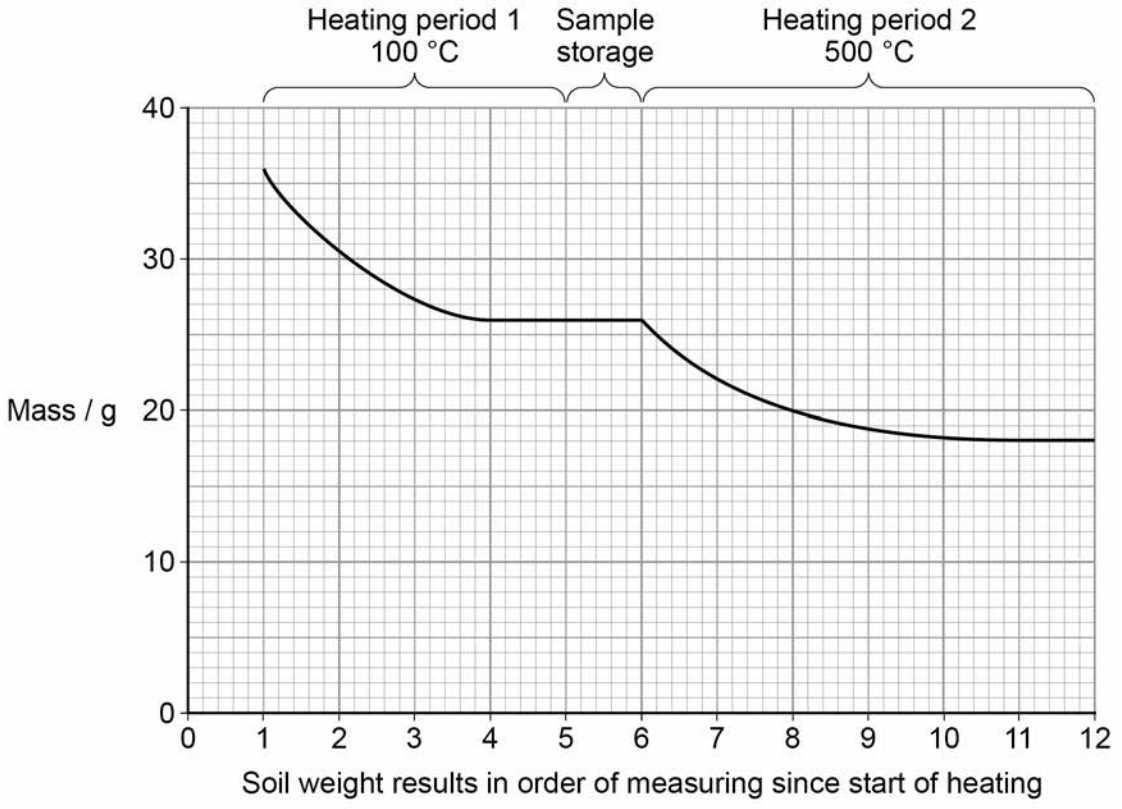
15

1 1 Soils were studied on three farms: Rosewood Farm, High Valley Farm and Fairview Farm.

20 samples of soil were taken from each farm and were analysed for organic matter content.

Figure 12 shows the results of one of the samples that was analysed.

Figure 12



1 1 . 1 Explain why it is necessary to record the results of heating period 1 when calculating the mass of the organic matter.

[1 mark]

Do not write outside the box

1 1 . 2 Calculate the percentage of organic matter in the dried soil sample shown in **Figure 12**.

[1 mark]

Show your working.

_____ %

The mean soil organic matter content and standard deviation of the 20 samples from each farm are shown in **Table 8**.

Table 8

Farm	Mean organic matter content %	Standard deviation
Rosewood	19.2	± 1.62
High Valley	31.1	± 1.48
Fairview	26.4	± 3.23

1 1 . 3 Use the data in **Table 8** to suggest whether there is a significant difference in the organic matter content of the soil from the three farms.

[2 marks]

_____

_____

_____

_____

Question 11 continues on the next page

Many factors affect the rate of soil erosion. The rate of soil erosion can be estimated using the **Universal Soil Loss Equation (USLE)**, measured in t ha^{-1} yr^{-1}.

Rate of soil erosion = **R × K × L × S × C × P**

Where:
R = Rainfall erosivity factor
K = Soil erodibility factor
L = Slope length factor
S = Slope gradient factor
C = Cropping management factor
P = Erosion prevention factor

Tables 9, **10**, **11**, **12** and **13** show USLE data for each of the three farms.

Table 9

Farm	R factor
Rosewood	110
High Valley	90
Fairview	120

Table 10

Farm	Texture	K Factor
Rosewood	Loamy sand	0.04
High Valley	Sandy clay loam	0.20
Fairview	Silty clay loam	0.32

Table 11

Farm	Slope	Slope %	L x S factor
Rosewood	125 m	10	2.7
High Valley	250 m	10	3.9
Fairview	1000 m	1	0.4

Table 12

Farm	Crop management	C factor
Rosewood	Permanent grassland	0.02
High Valley	Wheat	0.35
Fairview	Corn	0.40

Table 13

Farm	Erosion prevention	P factor
Rosewood	No ploughing	0.25
High Valley	Contour ploughing	0.50
Fairview	Ploughing up and down slope	1.00

Do not write outside the box

1 1 . 4 Fairview Farm has an erosion rate of 6.14 t ha^{-1} yr^{-1}. To try to reduce the erosion rate at Fairview Farm, the farmer decided to change cultivation from corn to wheat and from up and down ploughing to contour ploughing. Use data in **Table 12** and **Table 13** to calculate the new erosion rate.

[2 marks]

Show your working.

New soil erosion rate _____ t ha^{-1} yr^{-1}

1 1 . 5 Explain how farming methods can affect the rate of soil erosion.

[9 marks]

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END OF QUESTIONS

15

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