AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

A-level
ENVIRONMENTAL SCIENCE

Paper 2

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 1 to 10 and **one** essay from question 11.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- 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	

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

Do not write outside the box

0 1 **Table 1** contains terms and descriptions used in habitat conservation.

Complete **Table 1**.

[5 marks]

Table 1

Term	Description
Rewilding	
	The role a species has in an ecosystem
	Habitat where human activity has prevented the ecosystem from developing further
	Habitat that connects populations by allowing individuals to move between different areas
Gene pool	

5

Do not write outside the box

0 2 Natural systems and processes are driven by low energy density resources.

0 2 . 1 Define the term 'energy density'.

[1 mark]

0 2 . 2 State **two** natural processes which operate with a low energy density.

[2 marks]

1 _____

2 _____

0 2 . 3 Explain **one** way that the use of low energy density resources can reduce the human carbon footprint.

[2 marks]

5

Turn over for the next question

Do not write outside the box

0 3 The culling of red foxes, *Vulpes vulpes*, was introduced in some areas of France between 2008 and 2015.

0 3 . 1 Suggest **three** reasons why animals are culled.

[3 marks]

1 _____

_____

2 _____

_____

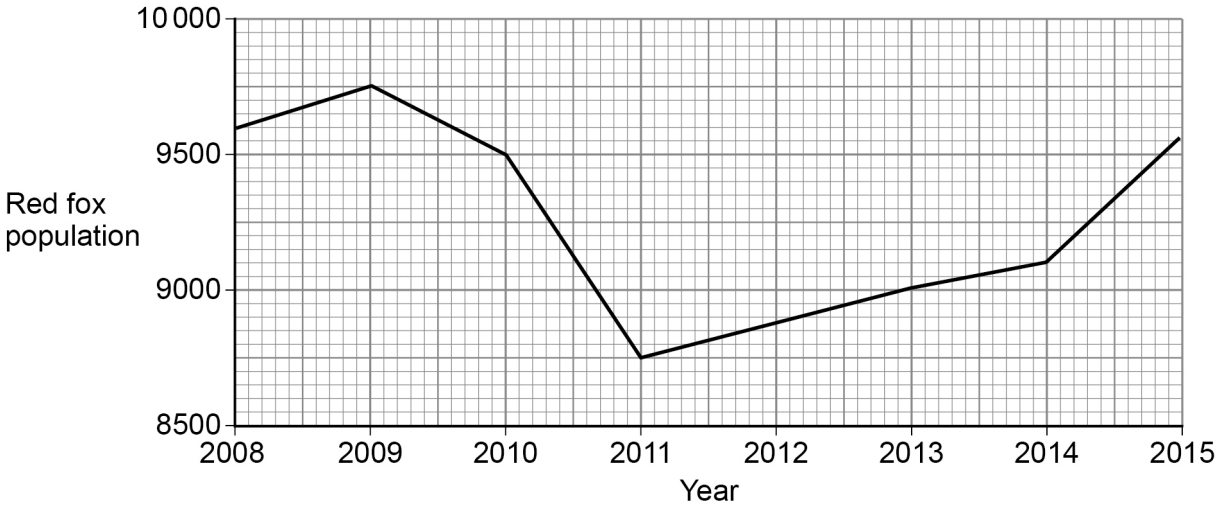
3 _____

_____

Figure 1 shows the red fox population in one area of France. Culling has been used in this area since 2009.

In 2010, scientists had estimated that the red fox population would decrease by 5% each year due to culling.

Figure 1



Do not write outside the box

0 3 . 2 Use **Figure 1** to calculate the expected population of red foxes in 2012 based on the scientists' estimations and the 2011 population.

Show your working.

[1 mark]

Expected population of red foxes in 2012: _____

0 3 . 3 It was suggested that the observed changes in the red fox population were due to red foxes being an r-selected species.

Explain how red foxes being an r-selected species may have led to the changes in population after 2011, shown in **Figure 1**.

[2 marks]

_____

_____

_____

_____

0 3 . 4 Explain **two other** reasons why the red fox population may **not** have decreased as expected.

[4 marks]

Reason 1 _____

Explanation _____

_____

_____

Reason 2 _____

Explanation _____

_____

_____

10

Do not write outside the box

0 4 . 1 Trawling often results in high by-catch.

Describe how **one** change in net design and **one** change in fishing method can reduce by-catch.

[2 marks]

Net design _____

_____

_____

Fishing method _____

_____

_____

0 4 . 2 **Table 2** shows the results from an investigation testing a new design of trawl net used to catch shrimp.

The net is designed to catch high yields of shrimp but limit the amount of by-catch.

Table 2

	Number of trawls	Total catch of shrimp / kg	Total by-catch / kg	Net size / litres
Traditional net	52	2139	14 498	450
New net	78	1599	11 588	200

Use the data in **Table 2** to evaluate if the new net design should be used for shrimp trawling.

In your answer include appropriate calculations.

Show your working.

[4 marks]

Do not write outside the box

0 4 . 3 Variables were controlled to ensure that the results were comparable.

State **one** variable that should have been controlled in the investigation and explain why.

[2 marks]

Variable _____

Explanation _____

0 4 . 4 Describe **two** other environmental impacts of trawling.

[2 marks]

1 _____

2 _____

10

Do not write outside the box

0 5 To estimate its population, scientists manually counted a sample of the Adélie penguin, *Pygoscelis adeliae*, colony at Halley Bay in Antarctica.

An area of 5800 m^2 from a total area of 255 000 m^2 was sampled.

Table 3 shows the results taken in November 2020 and 2021.

Table 3

	Mean Adélie penguins per 1 000 m^2	**Number of Adélie penguins counted**	**Estimated population**
November 2020	68.96	400	17 586
November 2021		370	

0 5 . 1 Complete **Table 3**.

Use the space below to show your working.

[2 marks]

0 5 . 2 Explain how named remote sensing techniques could increase the accuracy of the study.

[2 marks]

Do not write outside the box

0 5 . 3 Suggest **one** other way the scientists can increase the accuracy of their estimations.

[1 mark]

0 5 . 4 Describe how named methods of conservation protect Antarctica.

[5 marks]

10

Do not write outside the box

0 6 Micropropagation is a form of vegetative propagation that can be used to improve food production.

Figure 2 shows the steps used in micropropagation.

Figure 2

Figure 2 not reproduced here due to third-party copyright restrictions

0 6 . 1 Define the term 'vegetative propagation'.

[1 mark]

The effect of different nitrate concentrations on the growth of micropropagated potato plants was investigated.

Five different nitrate concentrations were used.

500 potato plants were grown in each nitrate concentration.

At the end of the investigation, the plants were transferred to a field.

0 6 . 2 State the null hypothesis for this investigation.

[1 mark]

Do not write outside the box

0 6 . 3 Outline a method to investigate the effects of the five different nitrate concentrations on the growth of micropropagated potato plants.

[4 marks]

0 6 . 4 At the end of the investigation, the plants were transferred to a field.

Explain how transferring the potato plants to the field as a monoculture may affect the yield.

[2 marks]

0 6 . 5 Explain how **one** method of gene manipulation is used to increase crop yields.

[2 marks]

10

Do not write outside the box

There are no questions on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 7 Acid mine drainage can reduce the pH of river water.

0 7 . 1 Suggest how acid mine drainage can affect **one** other aspect of river water quality.

[1 mark]

0 7 . 2 Suggest how a change in pH may make river water more suitable and less suitable for the survival of wildlife.

[3 marks]

More suitable

Less suitable

0 7 . 3 State **one** method to measure the acidity of river water.

[1 mark]

5

Do not write outside the box

0 8 . 1 Describe **two** climatic features of temperate broadleaf forests.

[2 marks]

1 _____

_____

2 _____

_____

0 8 . 2 Explain how **one** named biotic factor affects the soil characteristics in a temperate broadleaf forest.

[2 marks]

_____

_____

_____

_____

Do not write outside the box

Students investigated the relationship between canopy cover and air temperature in two sites of temperate forest.

They took measurements in the shrub layer to investigate the hypothesis:

'As canopy cover increases, air temperature in the shrub layer will increase.'

Table 4 shows the canopy cover at each site.

Table 4

Site	Canopy cover / percentage (%)
A	85
B	30

0 8 . 3 Describe a method to collect comparable data from the two sites.

[4 marks]

0 8 . 4 State **two** variables, other than forest cover, which may affect the results.

[2 marks]

1 _____

2 _____

Question 8 continues on the next page

Students also conducted a study to investigate the infiltration rates at sites **A** and **B**.

They used the Mann–Whitney U test to find out if there was a significant difference in the infiltration rates between sites **A** and **B**.

Table 5 shows the ranks of the readings taken from sites **A** and **B**.

Table 5

Site A – Infiltration rate / cm min^{-1}	**Rank**	**Site B – Infiltration rate / cm min^{-1}**	**Rank**
0.5	12	0.2	3
0.7		0.1	
0.4	8.5	0.4	8.5
0.4	8.5	0.4	8.5
0.6	14.5	0.3	5.5
0.5	12	0.5	12
0.6	14.5	0.2	3
0.3	5.5	0.2	3
Sum	91.5	Sum	

0 8 . 5 Complete **Table 5**.

[1 mark]

Do not write outside the box

0 8 . 6 The results of the Mann–Whitney U test produced the following U values:

U_1: 55.5
U_2: 8.5

The critical value at p = 0.05 was 13

Explain what the U values and the critical value suggest about the infiltration rates at sites **A** and **B**.

[2 marks]

0 8 . 7 Suggest **two** ways that deforestation may modify local hydrology.

[2 marks]

1

2

15

Turn over for the next question

Do not write outside the box

0 9 . 1 Explain how the magnetosphere helps create suitable conditions for life on Earth.

[2 marks]

0 9 . 2 The Earth's climate is affected by the tilt of the Earth on its axis.

In 2020, the tilt was 23.4°

The degree of tilt varies between a minimum of 22.1° and a maximum of 24.5° on a cycle of approximately 40 000 years.

Figure 3 shows the range in the Earth's tilt between 22.1° and 24.5°.

Figure 3

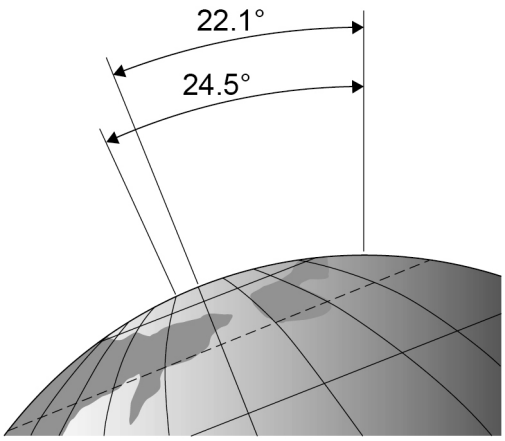


Table 6 shows dates for movements in the Earth's tilt.

The rate of change in the Earth's tilt is linear.

The convention for dating Before Present (BP) starts in 1950.

Table 6

Tilt of the Earth / degrees (°)	Time / year
23.4	2020
24.5 (maximum)	10 900 BP
22.1 (minimum)	

Do not write outside the box

Use the information in **Figure 3** and **Table 6** to calculate the year the Earth will reach its minimum tilt (22.1°).

The Earth's tilt is currently declining.

Give your answer to **two** significant figures.

Show your working.

[3 marks]

Year _____

0 9 . 3 State how the Earth's temperature would be affected if the speed of its rotation was slower.

[1 mark]

_____

Question 9 continues on the next page

Do not write outside the box

0 9 . 4 Discuss how changes in research methods over time have improved our understanding of conditions for life on the Earth.

[9 marks]

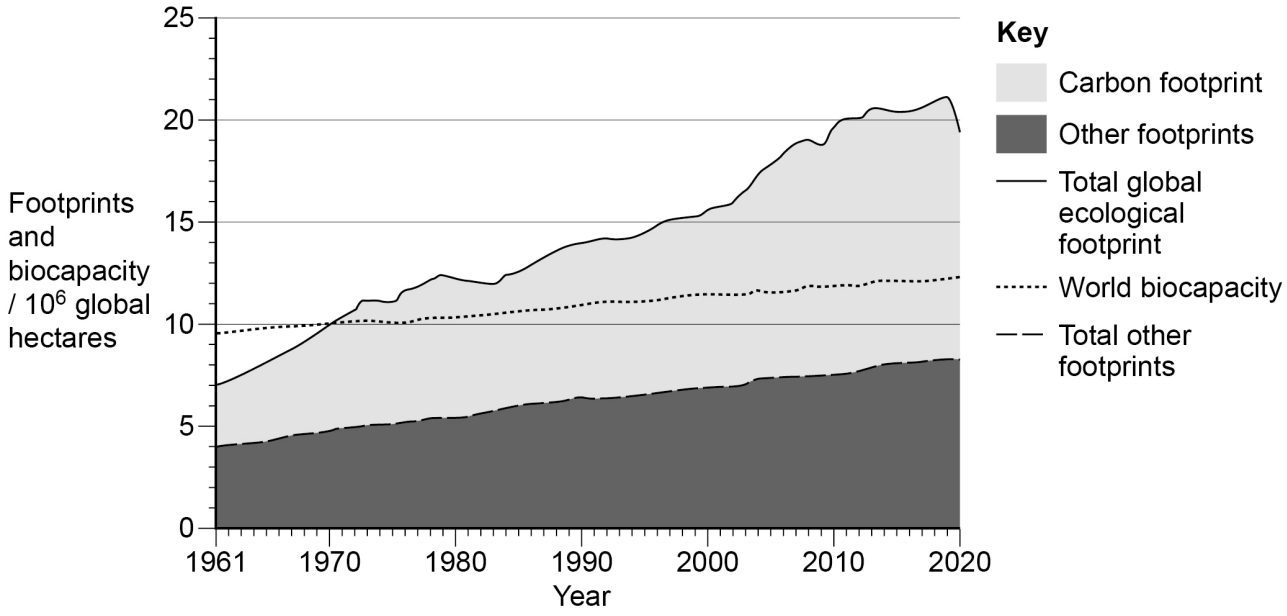
Extra space

15

Do not write outside the box

1 0 **Figure 4** shows the Earth's biocapacity compared to the total global ecological footprint from 1961 to 2020.

Figure 4



1 0 . 1 Explain the change in the total global ecological footprint shown in **Figure 4**.

[2 marks]

1 0 . 2 Use **Figure 4** to calculate the percentage (%) change in the global carbon footprint between 1970 and 2019.

Show your working.

[2 marks]

_____ %

Question 10 continues on the next page

Do not write outside the box

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

For each question 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 . 3 Use **Figure 4** to identify which year the global carbon footprint overtook biocapacity.

Shade **one** box only.

[1 mark]

A 1970

B 1980

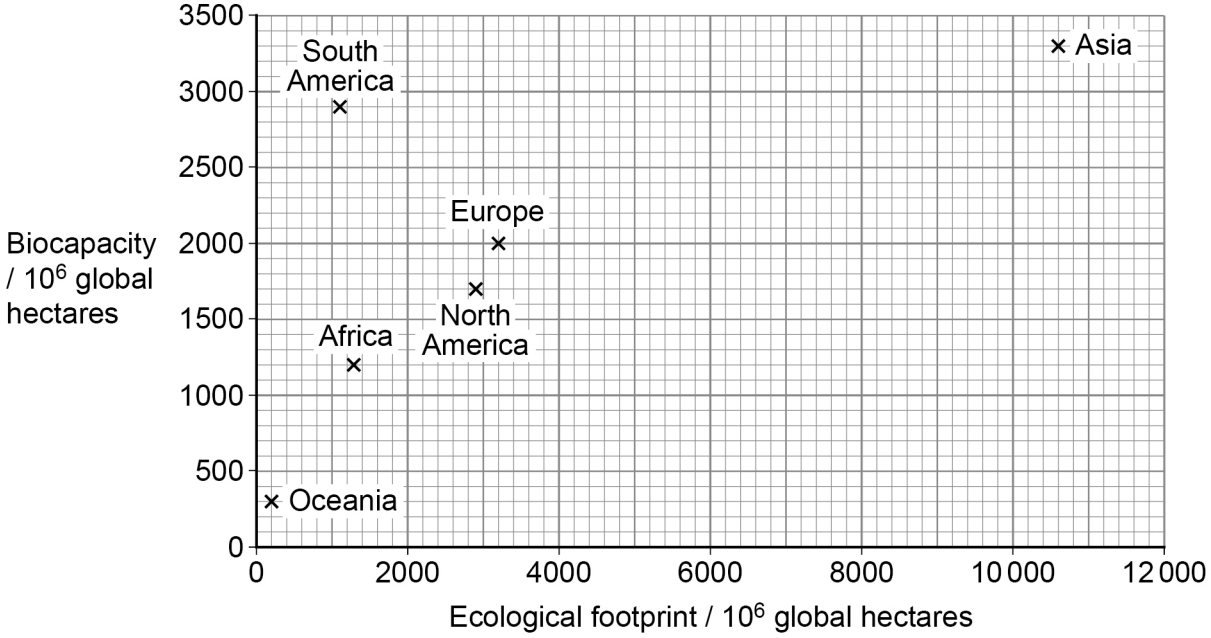
C 1990

D 2000

E 2010

Figure 5 shows the biocapacity and ecological footprint of each continent in 2016.

Figure 5



Do not write outside the box

1 0 . 4 It is estimated that the mean continental ecological footprint needs to be cut by at least 58% of the 2016 value to be sustainable.

Calculate what this ecological footprint would be and plot your answer on **Figure 5**.

Use the space below to show your working.

[3 marks]

1 0 . 5 In 2016, Oceania (Australasia) had the lowest biocapacity, but the highest biocapacity per capita.

Suggest **two** reasons why Oceania has the largest biocapacity per capita although it has the smallest land mass.

[2 marks]

1 _____

_____

2 _____

_____

10

Turn over for the next question

Do not write outside the box

Write an essay on **one** of the following topics.

1 1 . 1 Discuss how an understanding of ecological processes can help make conservation activities more effective.

[25 marks]

OR

1 1 . 2 Discuss how an understanding of dynamic equilibria can help make human activities more sustainable.

[25 marks]

Shade the lozenge below to indicate which optional question you have answered.

Question **1 1 . 1** ⬭ Question **1 1 . 2** ⬭

CORRECT METHOD ⬬ WRONG METHODS ⊗ ⦿ ≋ ∅

Do not write outside the box

Turn over ►

Do not write outside the box

Do not write outside the box

Extra space

Do not write outside the box

END OF QUESTIONS

25

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

Do not write outside the box

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

Do not write outside the box

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**
	Copyright information For confidentiality purposes, all acknowledgements of third-party copyright material are published in a separate booklet. This booklet is published after each live examination series and is available for free download from www.aqa.org.uk Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright-holders may have been unsuccessful and AQA will be happy to rectify any omissions of acknowledgements. If you have any queries please contact the Copyright Team.