



Surname _____

Other Names _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

**A-level
ENVIRONMENTAL SCIENCE**

Paper 2

7447/2

Time allowed: 3 hours

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]



J U N 2 2 7 4 4 7 2 0 1

MATERIALS

For this paper you must have:

- a calculator

INSTRUCTIONS

- **Use black ink or black ball-point pen. Pencil should only be used for drawing.**
- **Answer ALL questions 1 to 10 and ONE essay from question 11.**
- **You must answer the questions in the spaces provided. Do not write 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.**

**DO NOT TURN OVER UNTIL TOLD
TO DO SO**



Answer ALL questions in the spaces provided.

0	1
----------	----------

TABLE 1 contains terms and descriptions used in habitat conservation.

**Complete TABLE 1, on the opposite page.
[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	

[Turn over]



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

[Turn over]



0	2	.	3
---	---	---	---

Explain ONE way that the use of low energy density resources can reduce the human carbon footprint. [2 marks]

5



BLANK PAGE

[Turn over]



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 _____



BLANK PAGE

[Turn over]

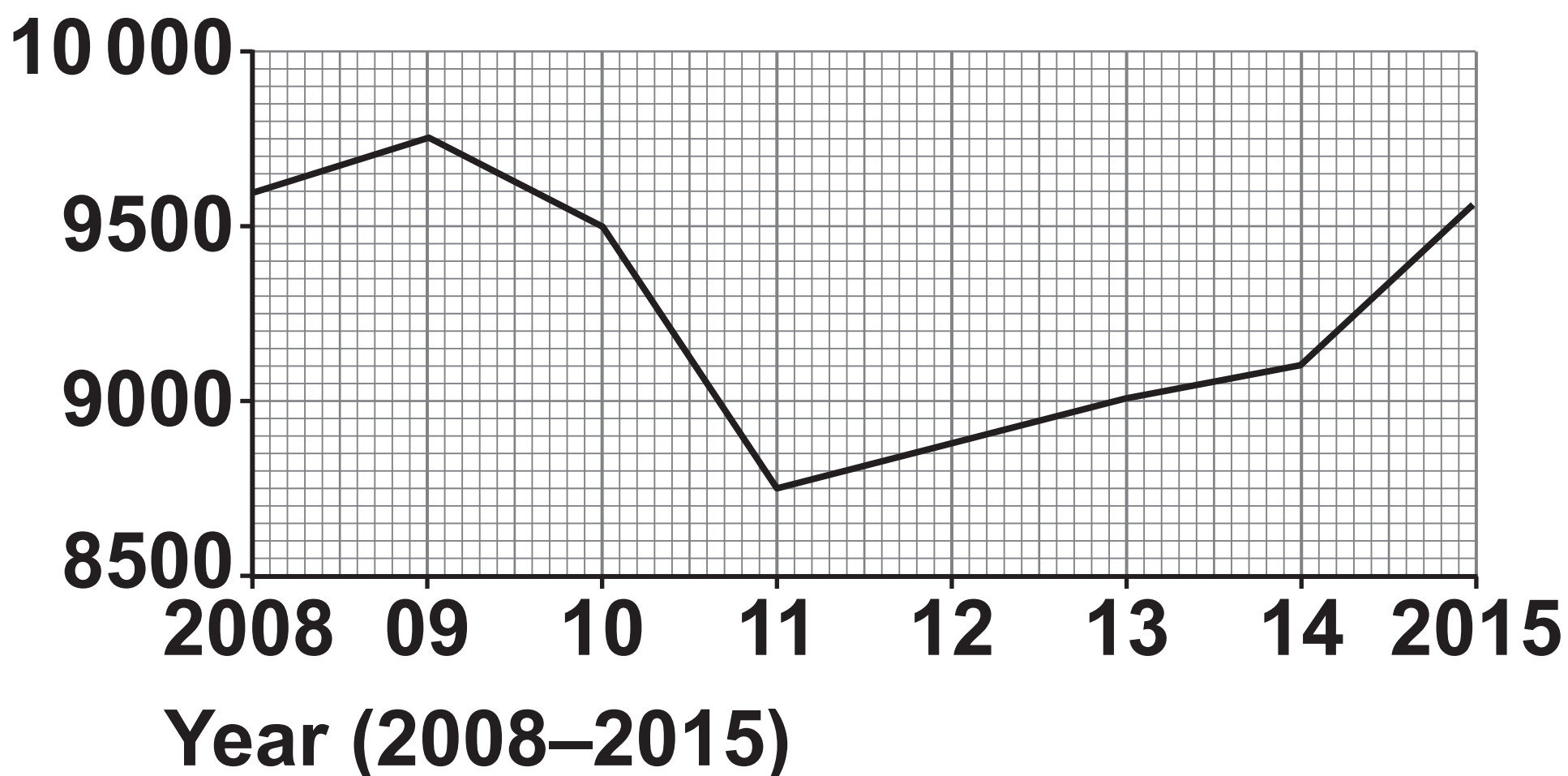


FIGURE 1 shows the red fox population in one area of France. Culling has been used in this area since 2009.

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

FIGURE 1

Red fox population



0 3 . 2

Use FIGURE 1, on the opposite page, 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: _____**

[Turn over]



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, on page 12. [2 marks]



BLANK PAGE

[Turn over]



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

[Turn over]



BLANK PAGE



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 _____

[Turn over]



04.2

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

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



Use the data in TABLE 2, on the opposite page, to evaluate if the new net design should be used for shrimp trawling.

In your answer include appropriate calculations.

Show your working. [4 marks]

[Turn over]



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 _____

[Turn over]



0	4	.	4
---	---	---	---

Describe TWO other environmental impacts of trawling. [2 marks]

1

2

10



BLANK PAGE

[Turn over]



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 m² from a total area of 255 000 m² was sampled.

TABLE 3, on the opposite page, shows the results taken in November 2020 and 2021.



TABLE 3

	November 2020	November 2021
Mean Adélie penguins per 1 000 m²	68.96	
Number of Adélie penguins counted	400	370
Estimated population	17 586	

[Turn over]



0	5	.	1
---	---	---	---

Complete TABLE 3, on page 27.

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]

[Turn over]



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]



BLANK PAGE

[Turn over]



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]**

[Turn over]



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]

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

[Turn over]



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

[Turn over]



0	7	.	3
---	---	---	---

State ONE method to measure the acidity of river water. [1 mark]

5



0	8	.	1
---	---	---	---

Describe TWO climatic features of temperate broadleaf forests. [2 marks]

1

2

[Turn over]



0	8	.	2
---	---	---	---

Explain how ONE named biotic factor affects the soil characteristics in a temperate broadleaf forest. [2 marks]



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

[Turn over]



0	8	.	4
---	---	---	---

State TWO variables, other than forest cover, which may affect the results.

[2 marks]

1

2

[Turn over]



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, on the opposite page, 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]

[Turn over]



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]



0	9	.	1
---	---	---	---

Explain how the magnetosphere helps create suitable conditions for life on Earth. [2 marks]



BLANK PAGE

[Turn over]



09.2

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

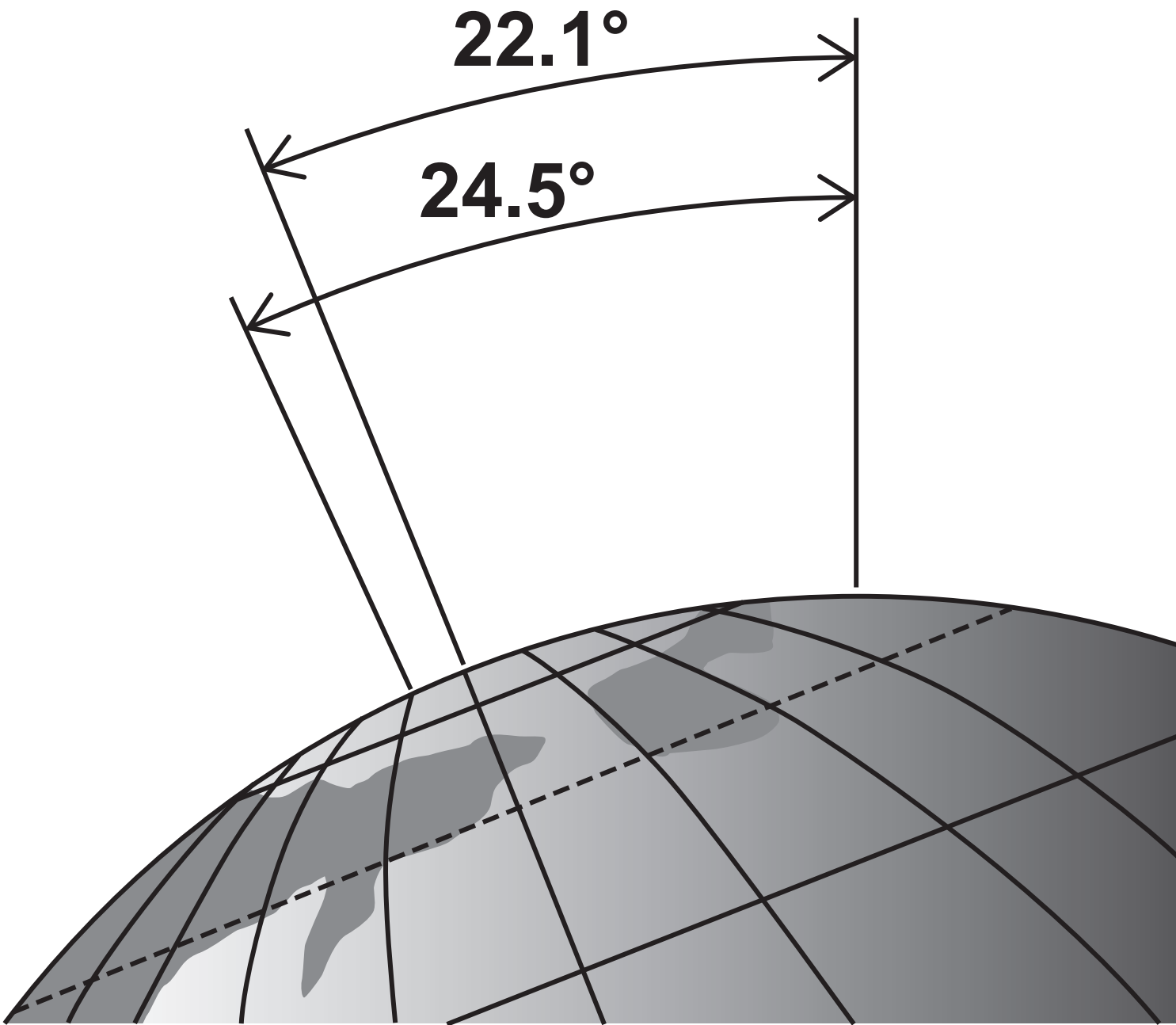
In 2020, the tilt was 23.4°

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, on the opposite page, shows the range in the Earth's tilt between 22.1° and 24.5°.



FIGURE 3



[Turn over]



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)	

Use the information in FIGURE 3, on page 55, and TABLE 6 to calculate the year the Earth will reach its minimum tilt (22.1°).

The Earth's tilt is currently declining.



57

Give your answer to TWO significant figures.

Show your working. [3 marks]

Year _____

[Turn over]



0	9	.	3
---	---	---	---

State how the Earth's temperature would be affected if the speed of its rotation was slower. [1 mark]

0	9	.	4
---	---	---	---

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



BLANK PAGE

[Turn over]



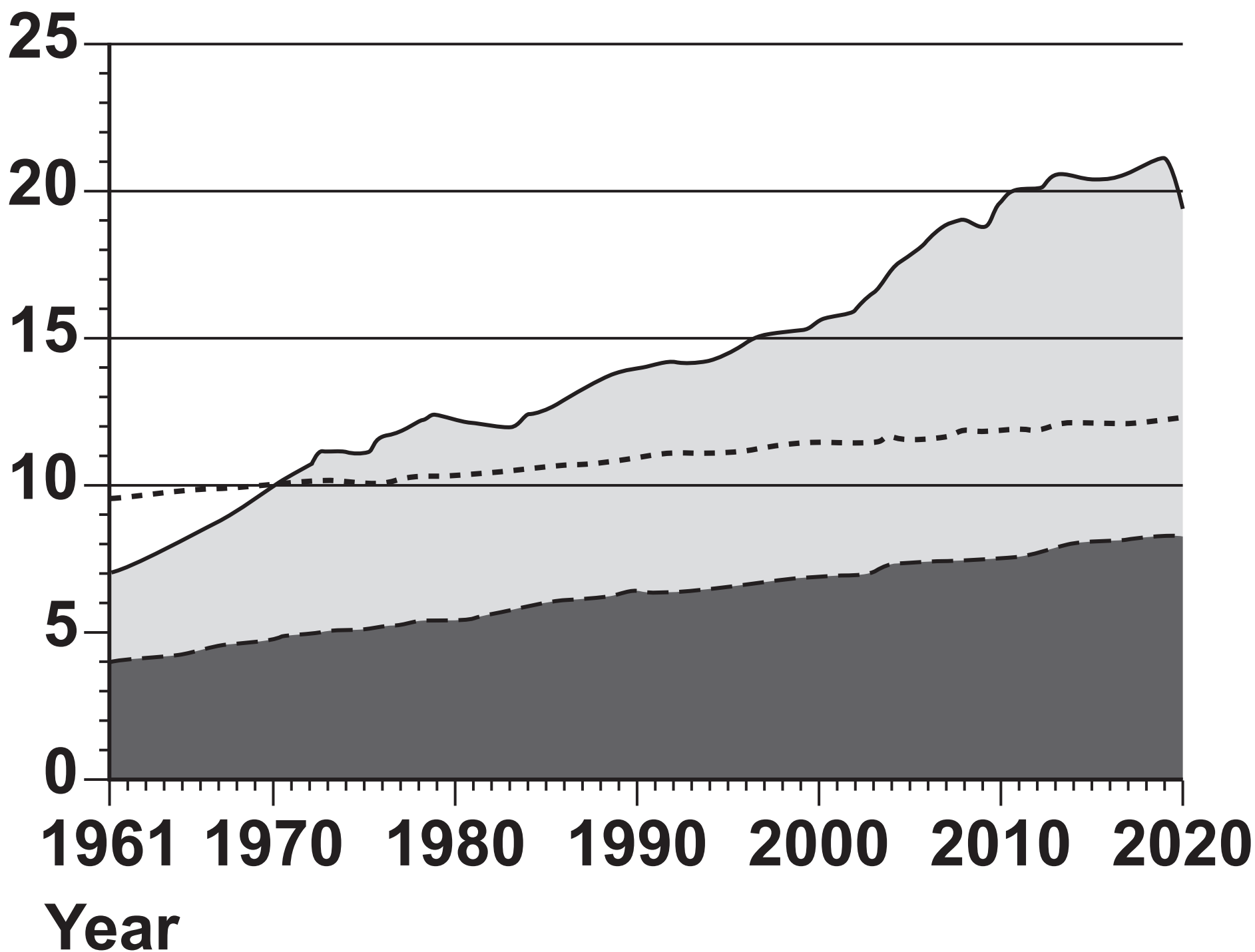
1	0
---	---

FIGURE 4, on the opposite page, shows the Earth's biocapacity compared to the total global ecological footprint from 1961 to 2020.

1	0	.	1
---	---	---	---

**Explain the change in the total global ecological footprint shown in FIGURE 4.
[2 marks]**



FIGURE 4**Footprints and biocapacity /
10⁶ global hectares****Key**

■ Carbon footprint

■ Other footprints

— Total global ecological footprint

..... World biocapacity

--- Total other footprints

[Turn over]



1	0	.	2
---	---	---	---

Use FIGURE 4, on page 63, to calculate the percentage (%) change in the global carbon footprint between 1970 and 2019.

Show your working. [2 marks]

%

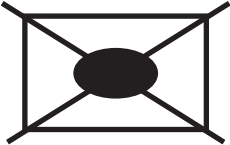


Only ONE answer per question is allowed.

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. 

[Turn over]



1	0	.	3
---	---	---	---

Use **FIGURE 4**, on page 63, to identify which year the global carbon footprint overtook biocapacity.

Shade **ONE** box only. [1 mark]

A 1970

B 1980

C 1990

D 2000

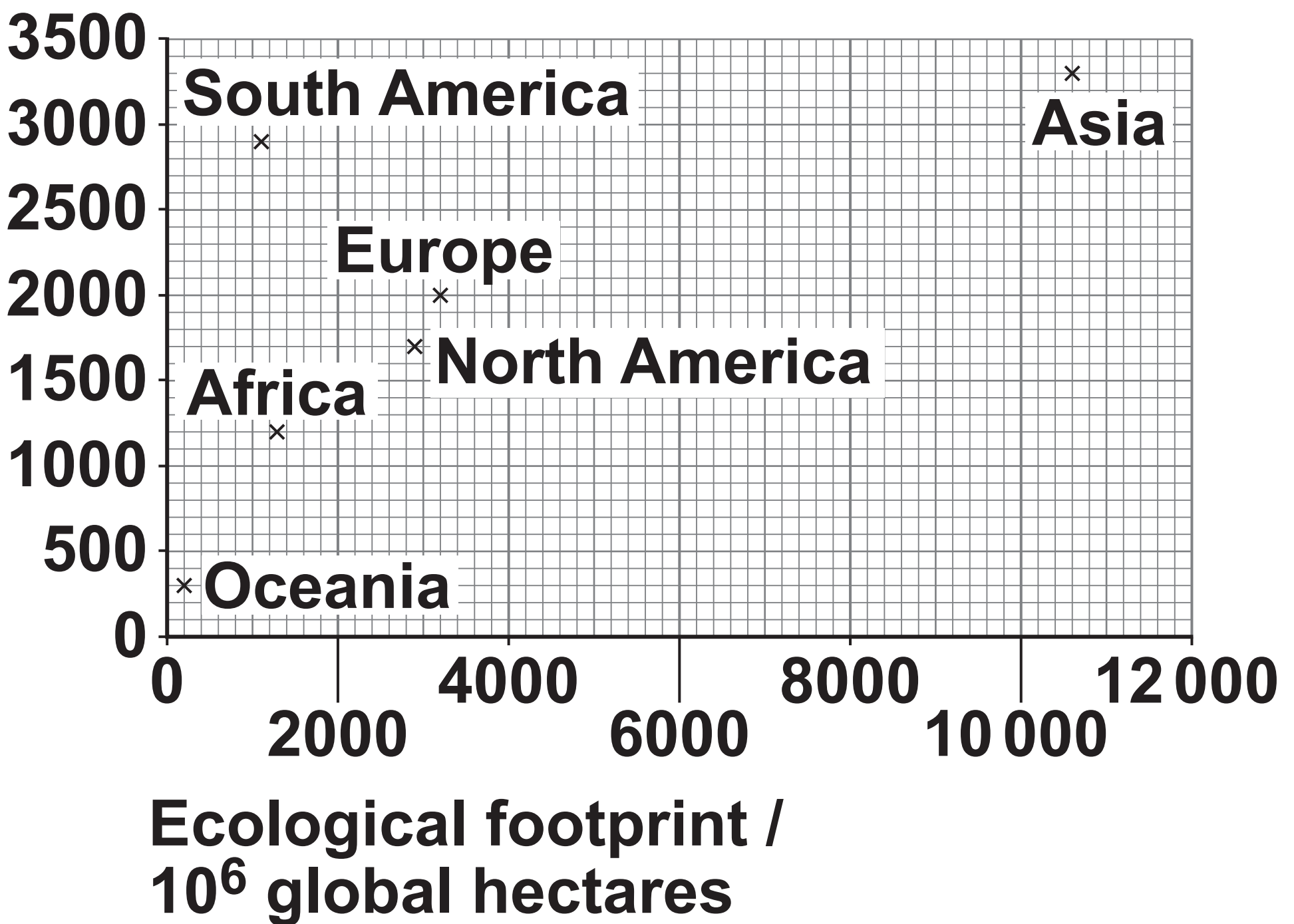
E 2010



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

FIGURE 5

Biocapacity / 10^6 global hectares



[Turn over]



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, on page 67.

Use the space below to show your working. [3 marks]



10.5

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]



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

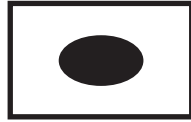
1 | 1 | . | 2

Discuss how an understanding of dynamic equilibria can help make human activities more sustainable. [25 marks]

Shade the lozenge opposite to indicate which optional question you have answered. [25 marks]



CORRECT METHOD



WRONG METHODS



Question

1	1	.	1	○
---	---	---	---	---

Question

1	1	.	2	○
---	---	---	---	---

[Turn over]



BLANK PAGE



BLANK PAGE

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

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.

Copyright © 2022 AQA and its licensors. All rights reserved.

G/LM/Jun22/7447/2/E4



8 8



2 2 6 G 7 4 4 7 / 2