A

AQA

Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

A-level

ENVIRONMENTAL SCIENCE

Paper 2

7447/2

Friday 9 June 2023 Morning

Time allowed: 3 hours

At the top of the page, write your surname and forename(s), your centre number, your candidate number and add your signature.

[Turn over]

JUN237447201

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.**
- **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

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Answer ALL questions in the spaces provided.

0 1

TABLE 1 shows some ecological terms and definitions.

Complete TABLE 1. [5 marks]

TABLE 1

TERM	DEFINITION
	A group of organisms that resemble each other more than other organisms and interbreed to produce fertile offspring.
Biome	
	The populations of all the species living in a particular area.
Population	
Ecological niche	

5

0 2

Life developed on Earth billions of years ago. This early life began to change the conditions of the environment.

0 2 . 1

Describe how early life caused environmental changes that reduced the amount of ultraviolet radiation reaching the Earth's surface. [3 marks]

0 2 . 2

Explain TWO ways that atmospheric carbon dioxide has been important for the survival of living organisms on Earth. [4 marks]

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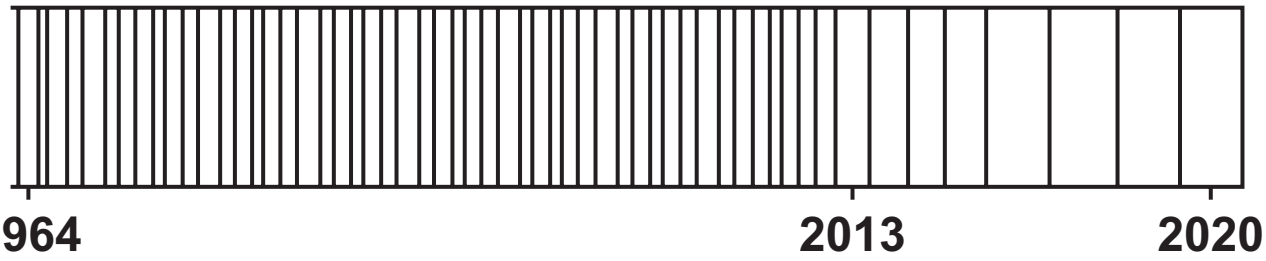
[Turn over]

Dendrochronology can be used to indicate how atmospheric temperature has changed over the last 10 000 years.

FIGURE 1 shows annual tree rings from a core sample taken from a tree in 2020.

FIGURE 1



0 2 . 3

Use FIGURE 1 to explain how the data suggests that the climate between 2013–2020 was different from the climate between 1964–2012. [2 marks]

0 2 . 4

State ONE limitation of dendrochronology as a method to indicate past climate change. [1 mark]

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[Turn over]

0 3

Bat detectors give information about the species richness of bats in an area.

0 3 . 1

Define the term 'species richness'. [1 mark]

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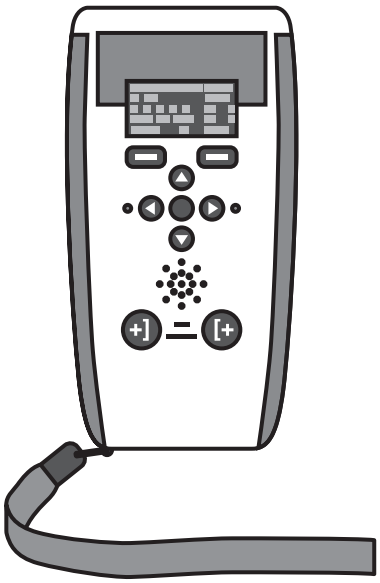
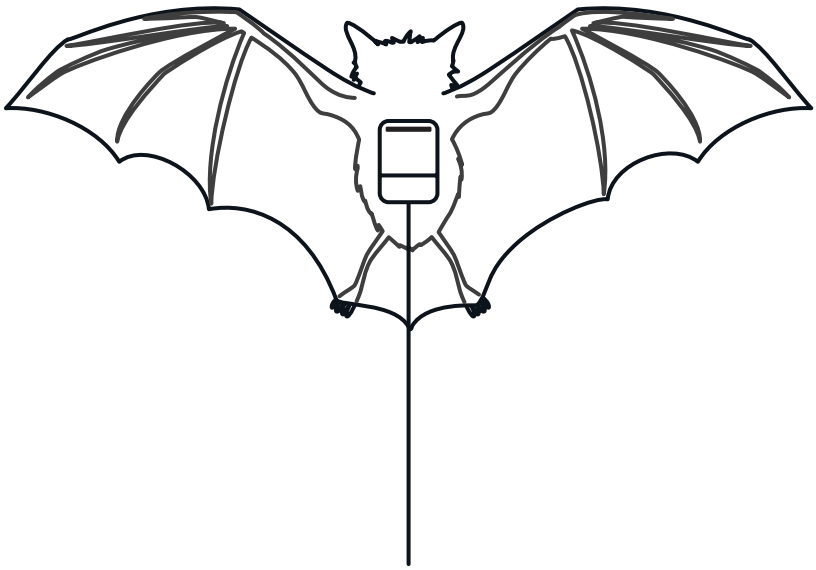
_____

FIGURE 2 shows two ways to monitor bats.

FIGURE 2



A bat detector



Attaching GPS transmitter to a bat

0 3 . 2

Describe how a bat detector gives information about the different species of bats in an area. [2 marks]

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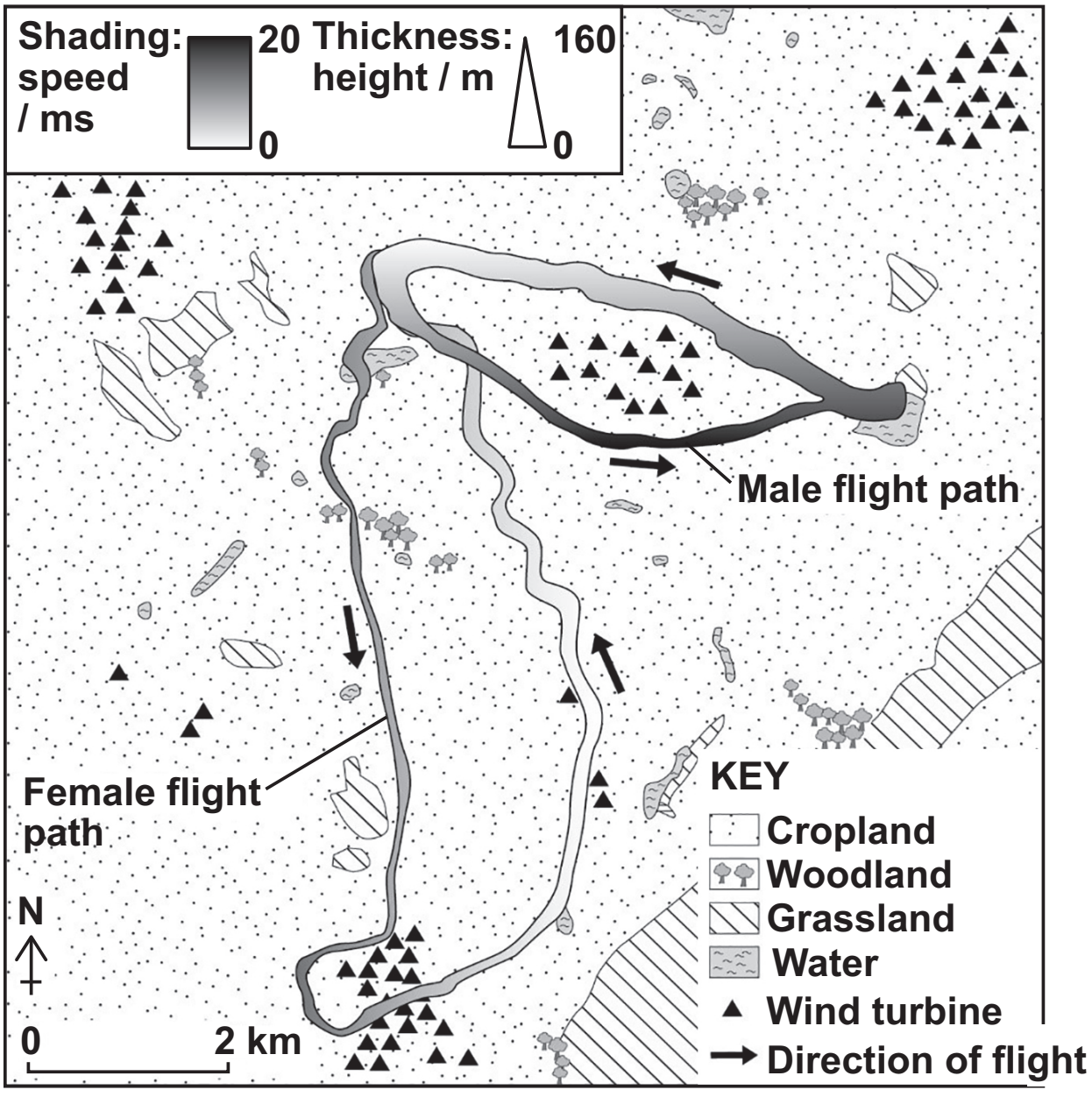
[Turn over]

FIGURE 3 shows a map with information from GPS transmitters attached to male and female bats of the same species.

FIGURE 3



0 3 . 3

Analyse the information in FIGURE 3.

State THREE differences in the flight behaviour of the male and female bats. [3 marks]

1 _____

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2 _____

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3 _____

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[Turn over]

0 3 . 4

Suggest THREE ways how information from GPS transmitters can be used to help conserve bats.
[3 marks]

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0 3 . 5

Suggest ONE limitation of using GPS transmitters for monitoring wildlife. [1 mark]

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[Turn over]

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0 4

Many glaciers are retreating and exposing bare rock to colonising pioneer species.

TABLE 2 shows the change in vegetation types through time in an environment with retreating glaciers.

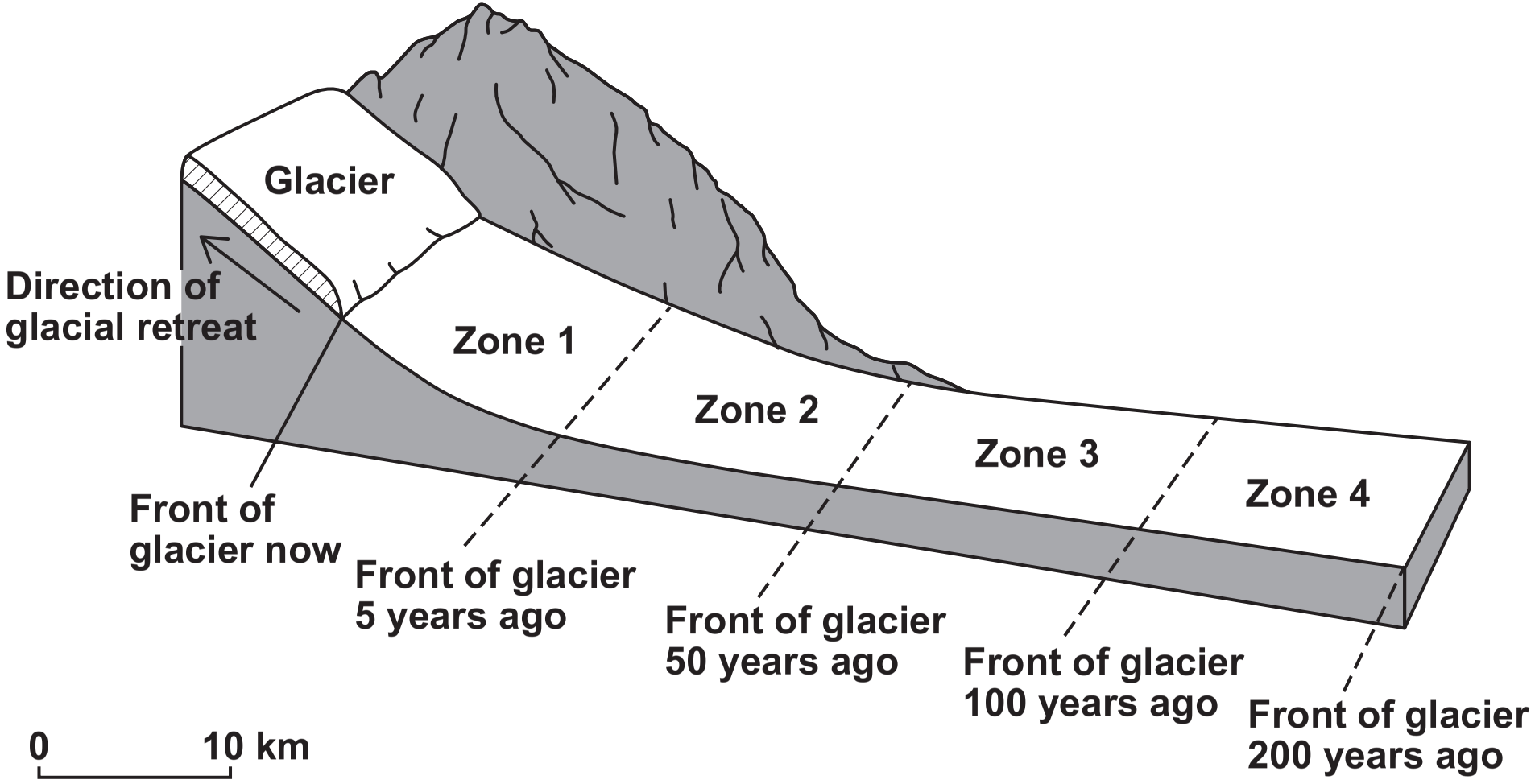
TABLE 2

Approximate time from retreat of glacier / years	Vegetation type
0–4	Lichens
5	Mosses and short grasses
25	Taller grasses and flowering plants
50	Shrubs
100	Shrubs with small trees
200	Conifer forest

[Turn over]

FIGURE 4 shows the area over which a glacier retreated for 200 years.

FIGURE 4



Research scientists wanted to find out the rate of ecological succession on the ground exposed by the retreating glacier.

The scientists used the following method:

- **a transect over 50 km long and 1 km wide was used**
- **the transect extended from the front of the glacier now to the end of Zone 4**
- **sites were sampled every 5 km along the transect**
- **30 quadrats were randomly placed across the 1 km width of the transect at each of the sample sites**
- **the percentage vegetation cover of each species was estimated in each quadrat**
- **the mean of the 30 quadrats at each site along the transect was calculated.**

[Turn over]

0 4 . 1

Justify the use of a transect and the use of random sampling described in the method above. [2 marks]

Transect _____

_____

_____

Random sampling _____

_____

_____

0 4 . 2

Use the information in TABLE 2, on page 17, and FIGURE 4, on pages 18 and 19, to identify a suitable size of quadrat that would be used to assess the vegetation cover in ZONE 2. [1 mark]

_____

_____

0 4 . 3

Other than size, suggest ONE feature of a quadrat that would make finding the percentage cover of the vegetation present easier in ZONE 1 and ZONE 2.

Explain your answer. [2 marks]

Feature _____

Explanation _____

_____

_____

_____

_____

[Turn over]

0 4 . 4

Explain how the scientists could use the distribution of vegetation types to estimate the rate of glacial retreat.
[2 marks]

0 4 . 5

Explain THREE ways how colonising species change the conditions of an area making it more suitable for other species to colonise. [3 marks]

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[Turn over]

0 5 . 1

Compare the threats to tropical coral reefs with the threats to deep-water coral reefs. [9 marks]

0 5 . 2

Give the name of a designation that may be used to protect a deep-water reef in the UK. [1 mark]

0 5 . 3

Suggest TWO reasons why the natural recovery of a deep-water coral reef takes much longer than the natural recovery of a tropical coral reef. [4 marks]

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2 _____

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[Turn over]

0 5 . 4

Tropical coral reef ecosystems are more biologically diverse than deep-water coral reef ecosystems.

Give ONE reason why tropical coral reefs are more likely to resist change than deep-water coral reefs. [1 mark]

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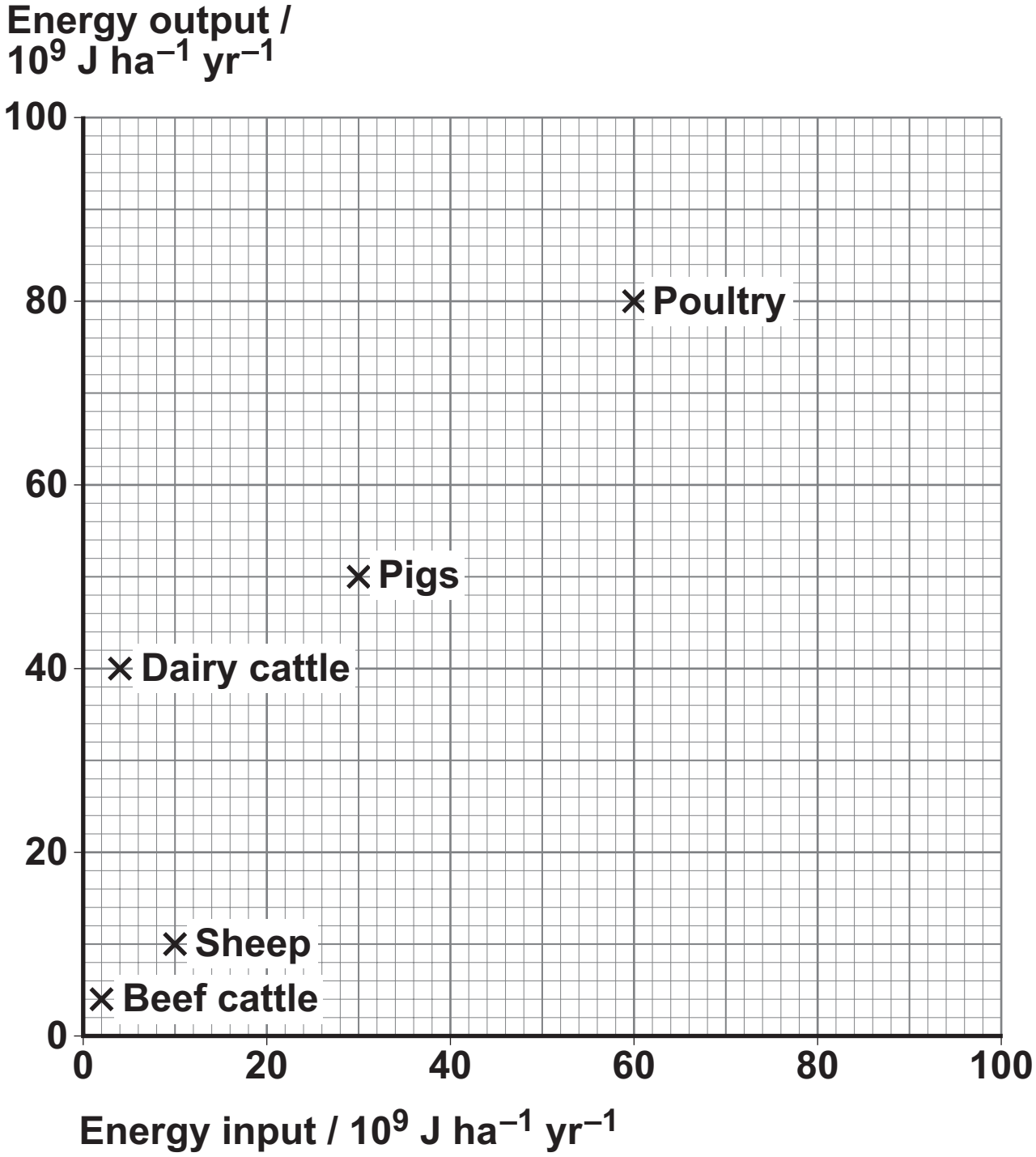
[Turn over]

0 6

FIGURE 5 shows the energy inputs and energy outputs for different livestock farming systems.

FIGURE 5



0 6 . 1

Use the data in FIGURE 5, opposite, to calculate the energy ratio for poultry farming.

Show your working. [2 marks]

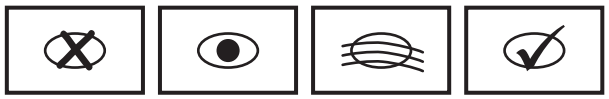
Answer _____

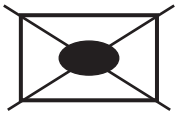
[Turn over]

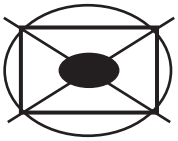
Only ONE answer per question is allowed.

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. 

0 6 . 2

Use the data in FIGURE 5, on page 32, to identify which livestock farming system is the most energy efficient.

Shade ONE box only. [1 mark]

- ⬭ **A Beef cattle**
- ⬭ **B Dairy cattle**
- ⬭ **C Pigs**
- ⬭ **D Poultry**
- ⬭ **E Sheep**

0 6 . 3

Suggest TWO reasons why poultry farming has a higher energy input than beef farming. [2 marks]

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2 _____

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0 7

Bt corn is a transgenic crop that has been genetically modified (GM) to contain a protein that is toxic to insect pests.

0 7 . 1

Define the term 'transgenics'. [1 mark]

_____

_____

_____

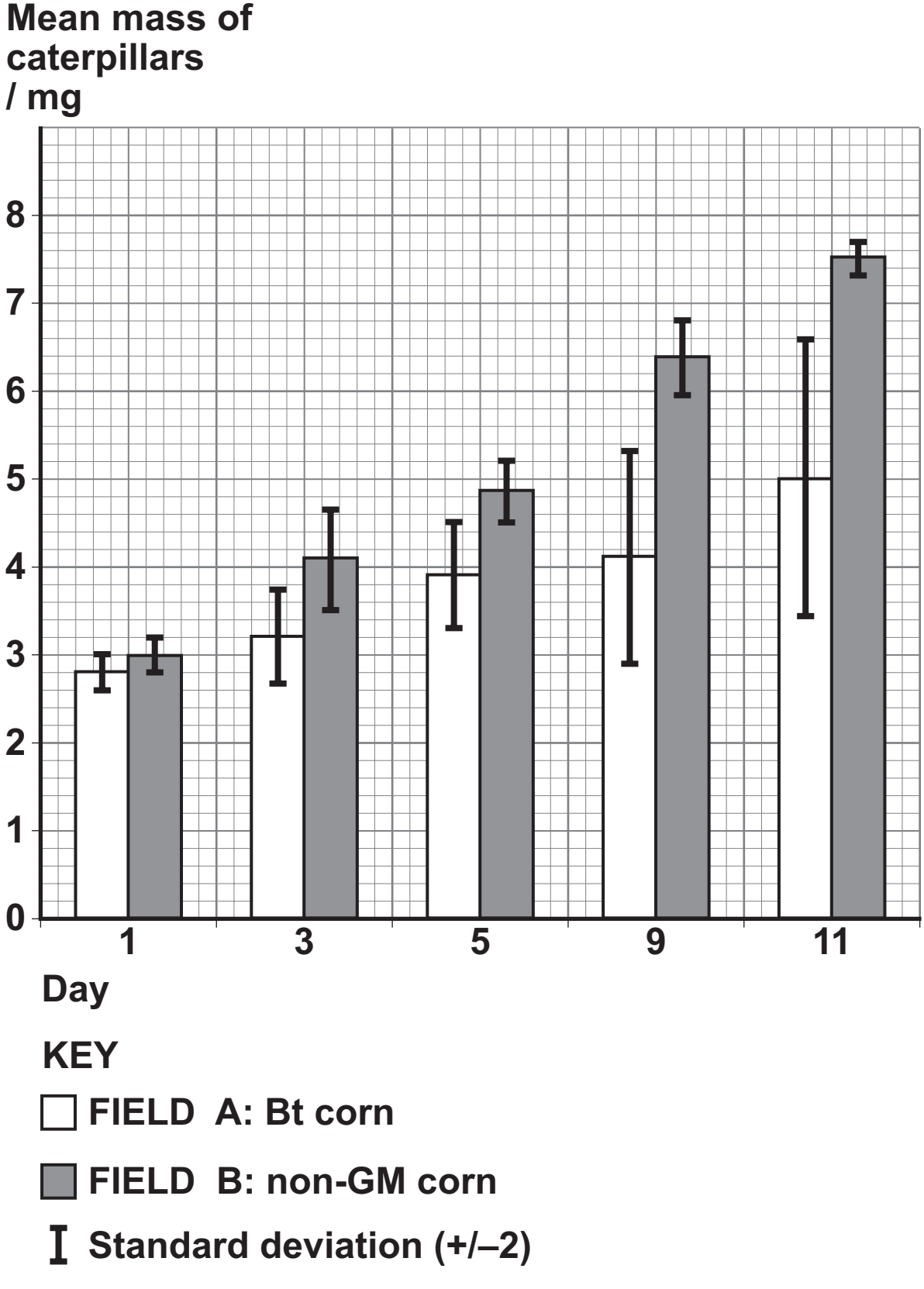
Scientists wanted to find out if pollen blown from Bt corn onto weeds growing at the edge of the field affected the growth of caterpillars feeding on the weeds.

Details of the method:

- **FIELD A: 1 ha of Bt corn**
- **FIELD B: 1 ha of non-GM corn**
- **80 caterpillars were hatched in a laboratory**
- **the mean mass of 40 caterpillars was found and they were then put onto the weeds around the edge of FIELD A on day 1**
- **the mean mass of the other 40 caterpillars was found and they were put onto the weeds around the edge of FIELD B on day 1**
- **on days 3, 5, 9 and 11 the mass of each caterpillar feeding on the weeds in each field was recorded and the mean mass for each field on each day was calculated.**

The results are shown in FIGURE 6.

FIGURE 6



0 7 . 2

Other than those included in the details of the method, describe FOUR ways this investigation should have been standardised to make sure the results were valid.
[4 marks]

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4 _____

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0 7 . 3

Analyse the results shown in FIGURE 6, on page 37.
[3 marks]

0 7 . 4

FIGURE 6 shows that the caterpillars eating the weeds around the edge of FIELD A had a high variability of mass.

Suggest why there is a high variability of mass.
[2 marks]

The study was repeated eight times. On the final day of each study, the percentage (%) survival of caterpillars was calculated.

The Mann–Whitney U test was used to find out if there was a significant difference in the percentage (%) survival between the caterpillars that fed on the weeds growing around FIELD A and FIELD B.

The U VALUES and SAMPLE SIZE (n) are shown in TABLE 3.

TABLE 3

CROP	U VALUE	n
Field A: Bt corn	23	8
Field B: Non-GM corn	26	8

0 7 . 5

State the null hypothesis for this investigation. [1 mark]

_____

_____

_____

[Turn over]

TABLE 4 shows the critical values for the Mann–Whitney U test at p = 0.05

TABLE 4

	Values of n_2											
	1	2	3	4	5	6	7	8	9	10	11	12
Values of n_1 1												
2								0	0	0	0	1
3					0	1	1	2	2	3	3	4
4				0	1	2	3	4	4	5	6	7
5			0	1	2	3	5	6	7	8	9	11
6			1	2	3	5	6	8	10	11	13	14
7			1	3	5	6	8	10	12	14	16	18
8		0	2	4	6	8	10	13	15	17	19	22
9		0	2	4	7	10	12	15	17	20	23	26
10		0	3	5	8	11	14	17	20	23	26	29
11		0	3	6	9	13	16	19	23	26	30	33
12		1	4	7	11	14	18	20	26	29	33	37

0 7 . 6

Use the data in TABLE 3, on page 41, to find the critical value from TABLE 4. [1 mark]

0 7 . 7

Use the data in TABLE 3 and TABLE 4 to explain if there is a significant difference between the percentage (%) survival of the two groups of caterpillars. [2 marks]

0 7 . 8

The critical values in TABLE 4 are at p = 0.05

What does p = 0.05 mean? [1 mark]

15

[Turn over]

0 8

In 2019, the income for a UK crop farm was £67 300

£16 100 of this income came from the sale of the crop and £1 900 came from other farm business.

The remaining income came from government subsidies.

0 8 . 1

Calculate the percentage (%) of income that came from government subsidies in 2019.

Give your answer to one decimal place. [1 mark]

Answer _____ %

0 8 . 2

Outline how economic subsidies from the UK government have affected the environmental impacts caused by agriculture. [4 marks]

5

0 9

Shrimp are farmed in tropical coastal regions.

TABLE 5 shows information about shrimp farming in different regions in India.

TABLE 5

The table is not reproduced here due to third party copyright restrictions

0 9 . 1

Use the data in TABLE 5, opposite, to calculate the productivity for the region of Karnataka.

Give your answer to the appropriate number of significant figures.

Show your working. [2 marks]

Answer _____ Mt ha $^{-1}$ yr $^{-1}$

[Turn over]

0 9 . 2

Use the data in TABLE 5 to explain TWO reasons why the Andhra Pradesh region may have the greatest environmental impacts from shrimp farming. [4 marks]

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0 9 . 3

Describe TWO ways that wastes from aquaculture may reduce local water quality. [4 marks]

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1 0

FIGURE 7 shows the percentage (%) of deforestation due to different causes in three regions of the world.

FIGURE 8 shows the rate of deforestation in these regions.

FIGURE 7

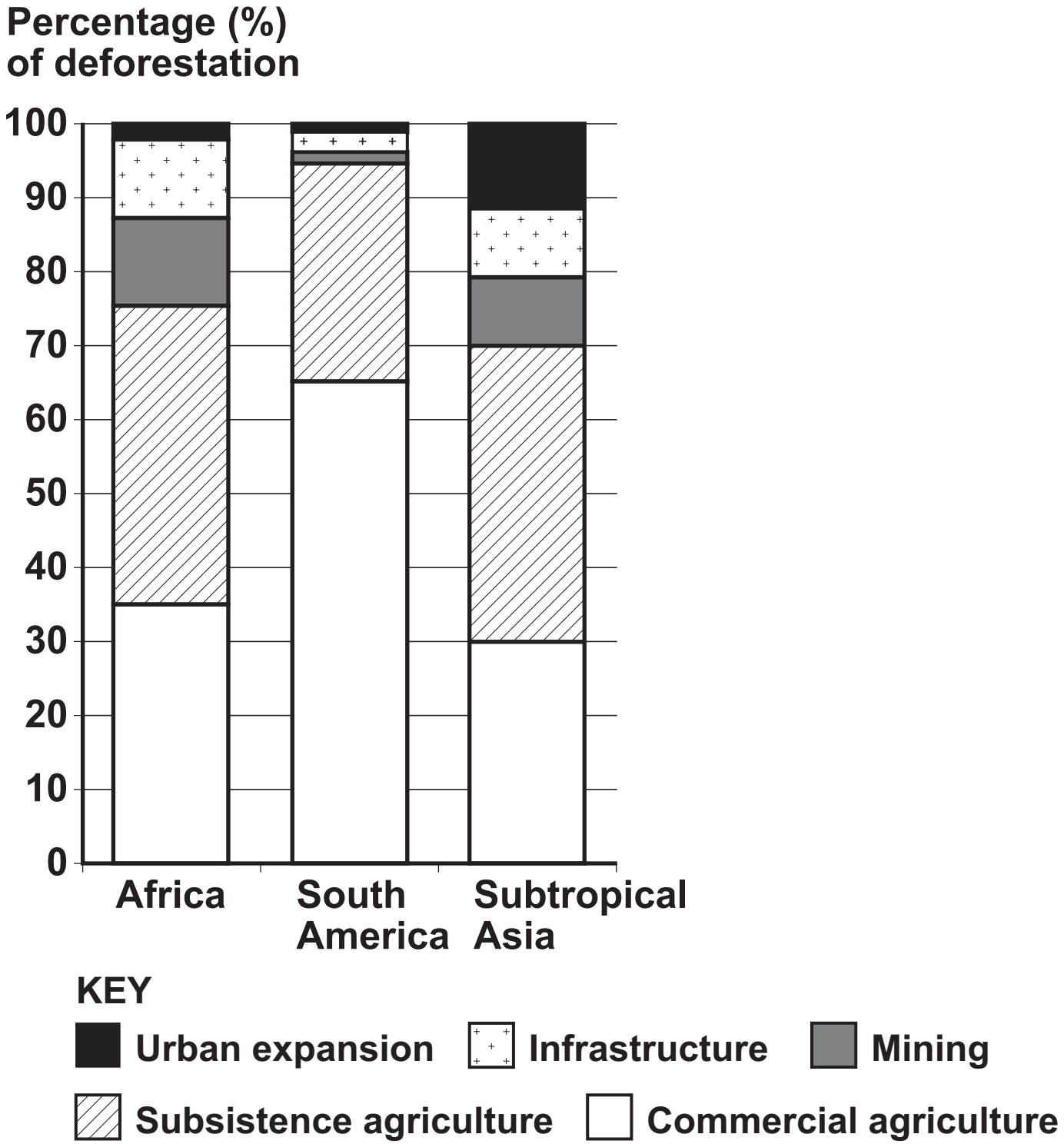
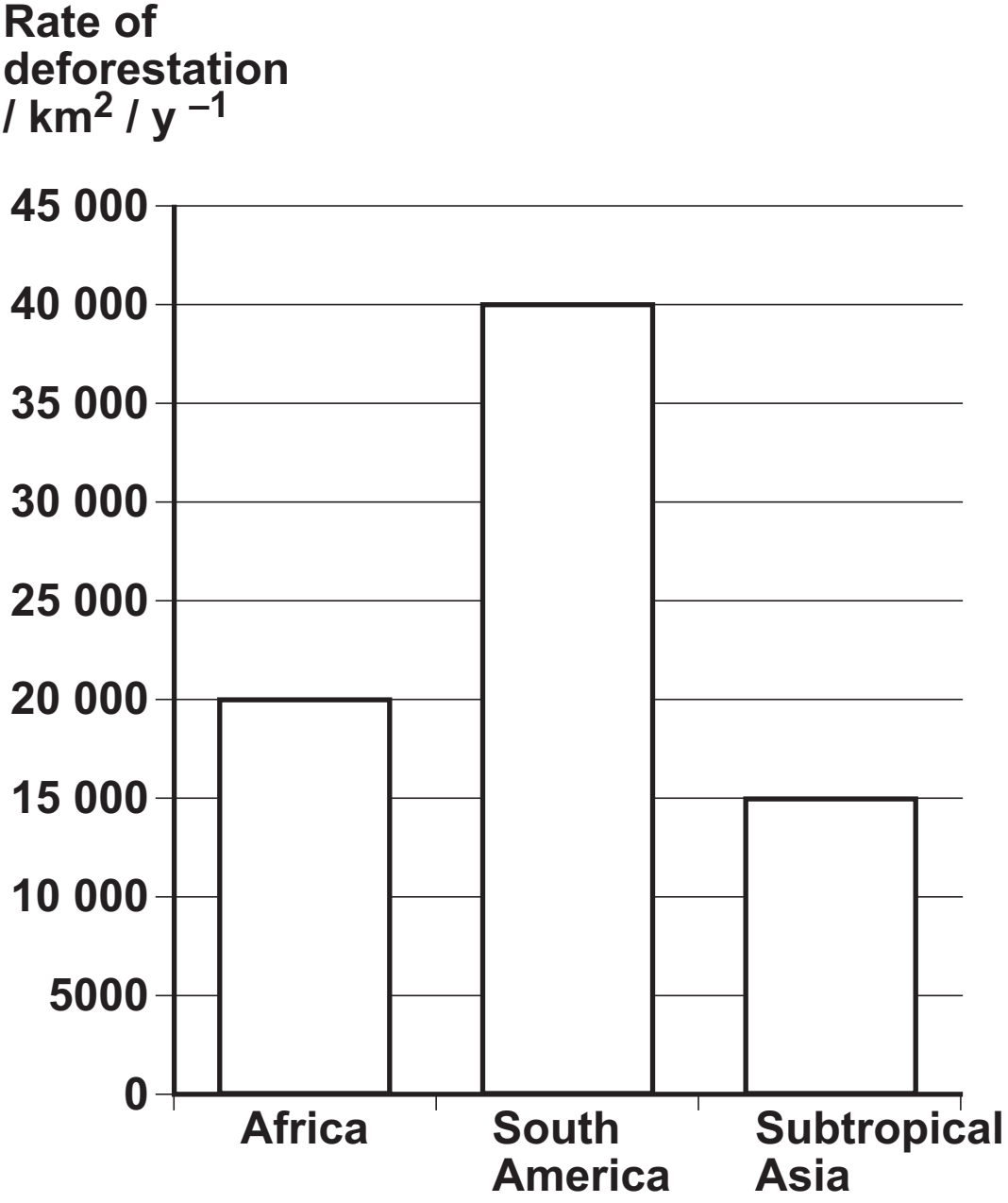


FIGURE 8


Rate of deforestation / km2 / y –1
45 000
40 000
35 000
30 000
25 000
20 000
15 000
10 000
5000
0
Africa
South America
Subtropical Asia

1 0 . 1

Use the data in FIGURE 7 and FIGURE 8, on pages 50 and 51, to find the region with the highest rate of deforestation caused by subsistence agriculture.

State the region and calculate its rate of deforestation.

Give your answer in standard form.

Show your working. [3 marks]

Region _____

Rate of deforestation _____ **$km^2\ yr^{-1}$**

1 0 . 2

Deforestation results in the loss of many ecosystem services.

Describe how the loss of forest ecosystem services can impact humans. [6 marks]

1 0 . 3

Name an organisation that encourages the sustainable exploitation of forests. [1 mark]

_____

_____

_____

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[Turn over]

Write an essay on ONE of the following topics.

1 1 . 1

Discuss the advantages and disadvantages of the methods used to reduce the environmental impacts of crop production. [25 marks]

OR

1 1 . 2

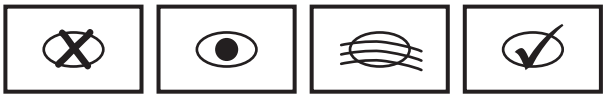
Discuss the advantages and disadvantages of the methods used to reduce the environmental impacts of fishing. [25 marks]

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

Question 1 1 . 1 ⬭

Question 1 1 . 2 ⬭

CORRECT METHOD ⬬

WRONG METHODS 


6 7

25

END OF QUESTIONS

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

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

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

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For Examiner's Use	
Question	Mark
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TOTAL	