



Surname _____

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Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

A-level

ENVIRONMENTAL SCIENCE

Paper 2

7447/2

Friday 7 June 2024 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]



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

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





0 4

Answer ALL questions in the spaces provided.

0	1
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EDGE (Evolutionarily Distinct and Globally Endangered) species are identified by combining their unique evolutionary history (ED scores) with their IUCN Red List status (GE).

TABLE 1 shows the EDGE data of four species of amphibian.

TABLE 1

SPECIES	SPECIES NAME	EVOLUTIONARILY DISTINCT SCORE (ED) / MILLION YEARS	IUCN RED LIST STATUS (GE)
A	Rattray's forest frog	42.6	Vulnerable
B	Chinese giant salamander	61.2	Critically Endangered
C	Archey's frog	62.8	Critically Endangered
D	Mistbelt chirping frog	42.6	Endangered

[Turn over]

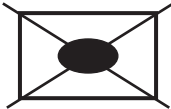


Only ONE answer per question is allowed.

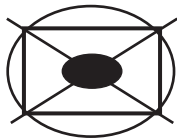
For each answer completely fill in the circle alongside the appropriate answer.

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	1	.	1
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Use the information in TABLE 1, on page 5, to order the species from the HIGHEST priority for conservation to the LOWEST priority.

Shade ONE box only. [1 mark]

A Species A, D, B, C

B Species B, C, D, A

C Species C, B, D, A

D Species D, A, C, B

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

Explain why the conservation of evolutionarily distinct species may be important for future genetic resource use. [2 marks]

[Turn over]



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

Explain ONE reason why a species' EDGE score may change over time. [2 marks]

5



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[Turn over]



0 2

The Sumatran rhinoceros, ‘*Dicerorhinus sumatrensis*’, is a critically endangered species native to Indonesia.

Habitat protection and management are in place to help increase the total population.

However, some small populations may NOT survive in the wild.

0 2 . 1

Suggest why some small populations of Sumatran rhinoceros may NOT survive in the wild, despite their habitat being protected and managed. [3 marks]



Captive breeding programmes are used in the conservation of the Sumatran rhinoceros.

0 2 . 2

Suggest TWO reasons why it may be difficult to keep Sumatran rhinoceros in captivity. [2 marks]

1 _____

2 _____

[Turn over]



Research suggests that a similar species, the Indian rhinoceros, ‘*Rhinoceros unicornis*’, could be used to help increase the success of captive breeding of the Sumatran rhinoceros.

0 2 . 3

Identify ONE method using the Indian rhinoceros which could increase the success of captive breeding of the Sumatran rhinoceros.

Describe how this method would work. [3 marks]

Method _____

Description _____



0	2	.	4
---	---	---	---

In the wild, Sumatran rhinoceros are monitored using radio collars.

Suggest ONE way that data from the radio collars can be used to help with the conservation of the Sumatran rhinoceros. [2 marks]

10

[Turn over]



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

Explain how Antarctica helps to regulate the global temperature of Earth. [1 mark]

The International Association of Antarctica Tour Operators looks at trends in tourism to help develop strategies to protect the wildlife of Antarctica.

TABLE 2 shows the number of tourists visiting Antarctica each year from 2015 to 2018.

TABLE 2

NUMBER OF TOURISTS VISITING ANTARCTICA			
2015	2016	2017	2018
38 478	44 202	51 842	55 489



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

Use TABLE 2 to predict the number of tourists that visited Antarctica in 2019.

Show your working. [2 marks]

Predicted number of tourists in 2019 _____

[Turn over]



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

An increase in the number of people visiting Antarctica is one reason that the risk of non-indigenous species colonising Antarctica may increase in the future.

Suggest TWO OTHER reasons why the risk of non-indigenous species colonising Antarctica may increase in the future. [2 marks]

1 _____

2 _____

0	3	.	4
---	---	---	---

Identify ONE international agreement that protects Antarctica. [1 mark]



0 3 . 5

Identify TWO atmospheric threats that are monitored in Antarctica.

Describe how they are monitored. [4 marks]

1 _____

2 _____

10

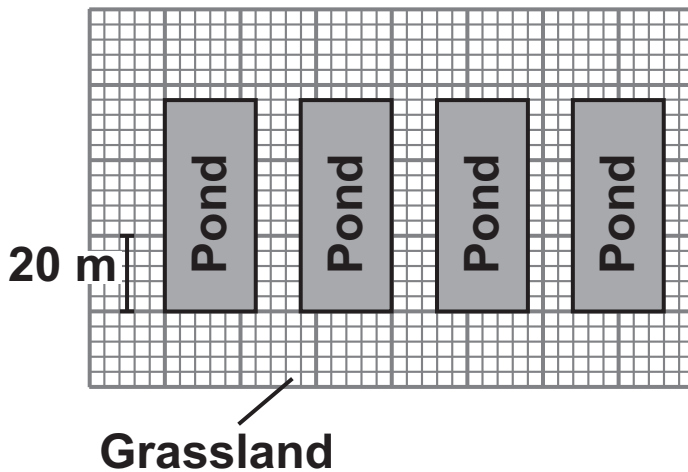
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0 4

FIGURE 1 shows a scale drawing of a habitat in a nature reserve for birds.

FIGURE 1



0 4 . 1

Using FIGURE 1, calculate the area : perimeter ratio of the ponds.

Show your working. [3 marks]

Area : perimeter ratio = _____ : 1



0	4	.	2
---	---	---	---

State TWO reasons why a smaller area : perimeter ratio may result in a greater biodiversity of birds. [2 marks]

1 _____

2 _____

[Turn over]



0	4	.	3
---	---	---	---

The species of birds in the nature reserve were investigated using auditory monitoring.

State TWO advantages of using auditory monitoring to investigate the species of birds present. [2 marks]

1 _____

2 _____



The number of birds of each species present was also investigated.

TABLE 3 shows the results of the investigation.

TABLE 3

BIRD SPECIES	NUMBER OF BIRDS (n)	n(n – 1)
Starling	74	
Tundra bean goose	27	702
Snipe	20	380
Eider	17	272
Cattle egret	12	132
Saker falcon	2	2

$$\text{Simpson's Index of Diversity } D = \frac{N(N-1)}{\sum n(n-1)}$$

KEY

D = index of diversity

N = total number of organisms of all species

n = number of individuals of a species

Σ = sum of

[Turn over]



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

Complete TABLE 3, on page 21, and calculate Simpson's Index of Diversity.

Give your answer to TWO decimal places.

Show your working. [3 marks]

10



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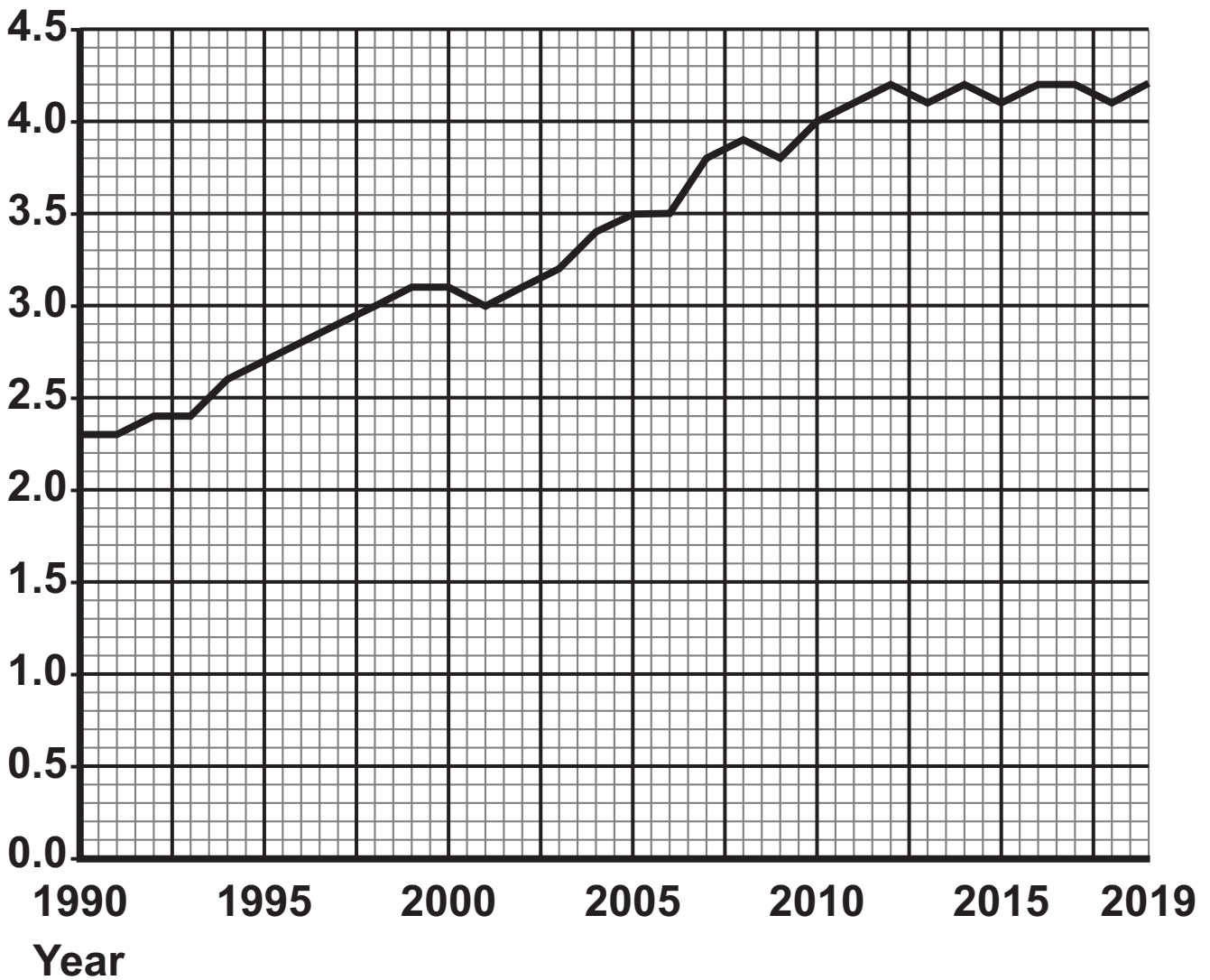


0 5

FIGURE 2 shows the worldwide use of pesticides in agriculture from 1990 to 2019.

FIGURE 2

Pesticide use
/ million tonnes



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

Use **FIGURE 2** to calculate the percentage increase in the worldwide use of pesticides from 1990 to 2019.

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

Show your working. [2 marks]

%

[Turn over]



0 5 . 2

Insecticides with different solubilities can have different impacts on the environment.

Identify ONE water-soluble insecticide group and ONE lipid-soluble insecticide group.

Describe how their solubilities lead to different environmental impacts. [4 marks]

Water-soluble insecticide _____

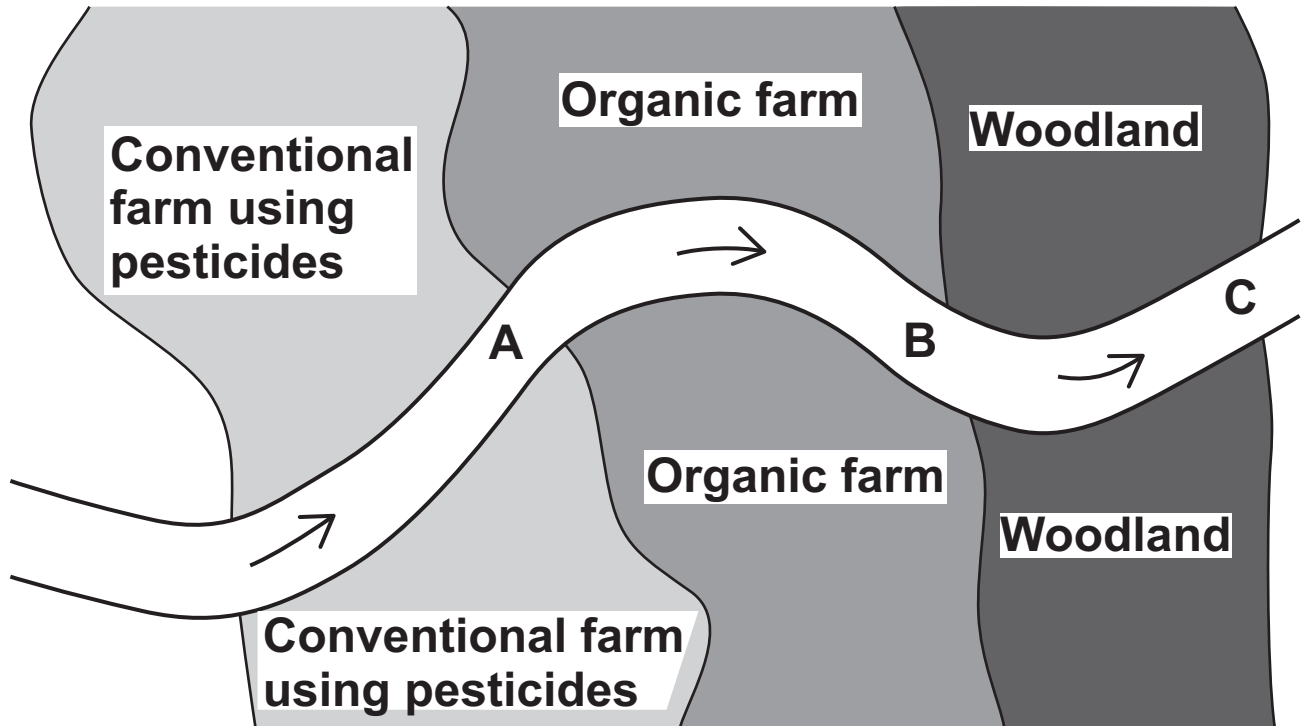
Lipid-soluble insecticide _____

[Turn over]



FIGURE 3 shows a river running through two types of farmland and a natural woodland.

FIGURE 3



KEY

→ Flow

A B C = Monitoring sites

Students want to investigate the impacts of the different farms on the invertebrates in the river.

They hypothesise that there will be fewer invertebrates in the river at the conventional farm compared to the organic farm.

The students sampled invertebrates at points A, B and C on the same day.



0 5 . 3

Identify a technique that could be used to sample invertebrates in the river.

State TWO ways this technique can be standardised, other than when the samples are taken. [3 marks]

Technique _____

1 _____

2 _____

0 5 . 4

Explain why sample location B in FIGURE 3 may not provide reliable results in showing the impact of the organic farm. [1 mark]

10

[Turn over]



0 6 . 1

Describe how ONE ethical factor can influence agricultural production. [2 marks]

0 6 . 2

Describe how quotas affect agricultural production. [1 mark]



0 6 . 3

Describe how ONE political factor can influence agricultural production.

Do NOT use quotas in your answer. [2 marks]

5

[Turn over]



0	7
---	---

Wild Atlantic salmon, ‘Salmo salar’, are fish that migrate from the ocean to lay their eggs in the gravel of upland rivers.

The populations of wild salmon in Scottish rivers are monitored.

Each year, the percentage chance of producing the minimum number of eggs required for sustainable exploitation for each river is calculated. The five-year mean of these percentages is used to determine a grade for each river.

The grade determines the level of management needed to support sustainable exploitation.



TABLE 4 gives information about the grades given to Scottish rivers.

TABLE 4

FIVE-YEAR MEAN PERCENTAGE CHANCE OF PRODUCING THE SUSTAINABLE EGG REQUIREMENT / %	GRADE	MANAGEMENT
> 80	1	Exploitation is sustainable, no management is required.
60–80	2	Exploitation is only sustainable with management.
< 60	3	Exploitation is unsustainable, no catch is allowed.

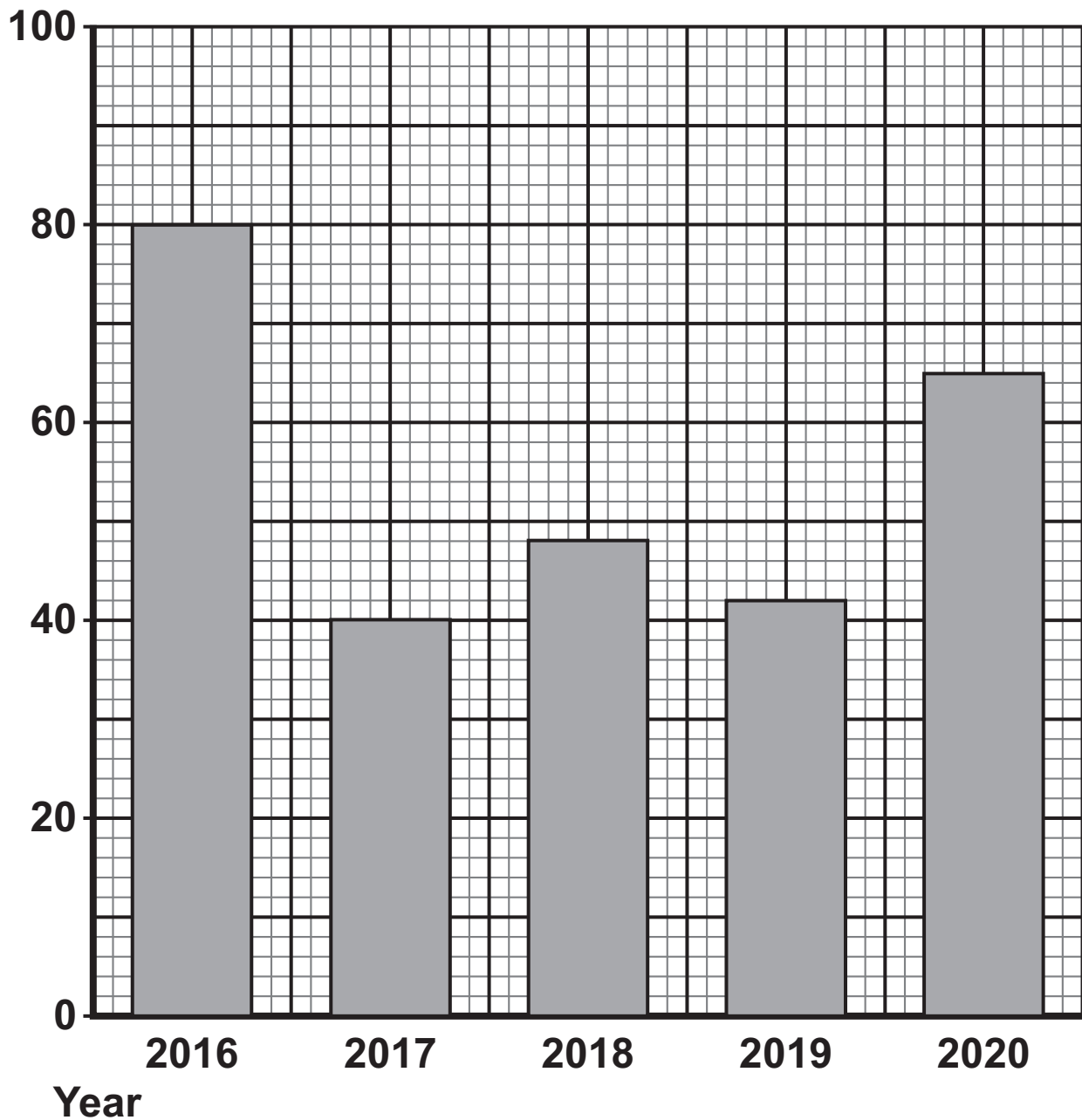
[Turn over]



FIGURE 4 shows the annual percentage chance of a population of wild salmon producing the sustainable egg requirement in a river in Scotland over five years.

FIGURE 4

Percentage chance of producing sustainable egg requirement / %



0	7	.	1
---	---	---	---

Calculate the five-year mean percentage chance of producing the sustainable egg requirement.

Use your answer to determine the grade that should be given to the river.

Use information from FIGURE 4 and TABLE 4 on page 33.

Show your working. [2 marks]

Five-year mean percentage chance _____

Grade _____

[Turn over]



07.2

Suggest ONE method that could be used to manage wild salmon in Grade 2 rivers.

Describe how this method works. [2 marks]

Method _____

Description _____

The population of wild salmon in a river can be estimated.

In some rivers, the number of wild salmon on a given day is recorded using a laser counter, which counts wild salmon as they swim upstream.

The number of wild salmon caught by people fishing that day is also recorded.

The relationship between the data can then be used to estimate the number of wild salmon on rivers without laser counters.

0 7 . 3

Suggest TWO ways that this method of estimating wild salmon populations can be made reliable. [2 marks]

1 _____

2 _____

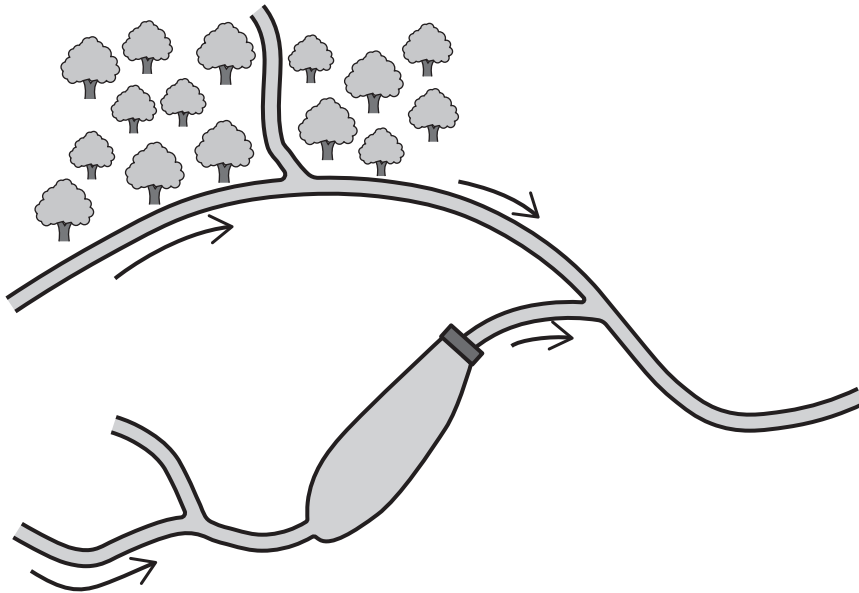
[Turn over]



FIGURE 5 shows a river where wild salmon breed.

FIGURE 5

Not to scale



KEY

→ Flow

  Forest plantation

 Dam

 Reservoir

0 7 . 4

Explain ONE way the forest plantation in FIGURE 5 may impact the reproductive success of wild salmon.

[2 marks]



0 7 . 5

Explain ONE way the dam in FIGURE 5 may impact the reproductive success of wild salmon. [2 marks]

10

[Turn over]



0	8
---	---

Productivity in aquaculture can be increased by the control of disease.

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

Explain how THREE different methods control disease in aquaculture. [3 marks]

1 _____

2 _____

3 _____



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

Other than disease control, explain **THREE** reasons why **INTENSIVE** aquaculture has high productivity. [3 marks]

1 _____

2 _____

3 _____

[Turn over]



0	9
---	---

Scientists investigated whether different species of 'Eucalyptus' tree have different rates of carbon (C) sequestration.

Two species of 'Eucalyptus' were grown in monoculture plantations.

After 20 years the carbon sequestered by the trees was estimated and the mean calculated for each species.



0 9 . 1

Trees were sampled at the same time of year and at similar locations within each plantation.

Suggest why this helps to ensure that the results are comparable. [2 marks]

Same time of year _____

Similar locations _____

[Turn over]



A Student's t-test was used to analyse the results of the investigation.

0 9 . 2

State the null hypothesis that would be used to analyse the results. [1 mark]

TABLE 5 shows some of the results of the investigation.

TABLE 5

SAMPLE	1	2
TREE SPECIES	'Eucalyptus nitens'	'Eucalyptus globulus'
MEAN C / t ha ⁻¹	784.1	520.3
SAMPLE SIZE (n)	258	258
$\Sigma(x - \bar{x})^2$	1 165 027	325 711
STANDARD DEVIATION (s)	s ₁ :	s ₂ : 35.6



Standard deviation

KEY:

s = standard deviation

x = individual measurement

\bar{x} = mean

n = total number of samples

Σ = the sum of

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

Student's t-test

KEY:

t = t value

\bar{x}_1 = mean of sample 1

\bar{x}_2 = mean of sample 2

s₁ = standard deviation of sample 1

s₂ = standard deviation of sample 2

n₁ = size of sample 1

n₂ = size of sample 2

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

[Turn over]



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

Complete TABLE 5, on page 48, by calculating the standard deviation of the 'Eucalyptus nitens' data.

Use your answer to calculate the t value for this investigation.

Give your answer to TWO decimal places.

Show your working. [3 marks]

t value _____



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[Turn over]



Only ONE answer per question is allowed.

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

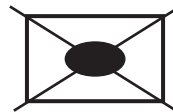
CORRECT METHOD



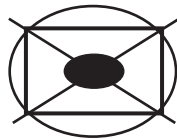
WRONG METHODS



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.



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

The t value was greater than the critical value at $p = 0.05$

Select the conclusion the scientists must use.

Shade ONE box only. [1 mark]

- A Accept the null hypothesis because there is < 5% probability the difference is due to chance.
- B Accept the null hypothesis because there is > 5% probability the difference is due to chance.
- C Reject the null hypothesis because there is < 5% probability the difference is due to chance.
- D Reject the null hypothesis because there is > 5% probability the difference is due to chance.

[Turn over]



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[Turn over]



1	0
---	---

To become more sustainable, countries are developing systems based on a circular economy. One part of this is to increase recycling.

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

Explain how ONE natural process has influenced a system in human society where waste products are recycled. [2 marks]



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

Some recycling systems in human society may NOT be an example of a circular economy.

Explain why. [2 marks]

[Turn over]



1 0 . 3

Describe TWO ways that the design of products may make them more recyclable. [2 marks]

1 _____

2 _____

1 0 . 4

Explain how recycling reduces NAMED greenhouse gas emissions. [4 marks]



10

[Turn over]



Write an essay on ONE of the following topics.

1 1 . 1

Discuss how legislation, protocols and international agreements may help to manage the rate of decline in biodiversity. [25 marks]

OR

1 1 . 2

Discuss how agriculture may be managed to adapt to the impacts of climate change as well as reduce future climate change. [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



25

END OF QUESTIONS



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

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