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Candidate number

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Candidate signature

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I declare this is my own work.

# A-level ENVIRONMENTAL SCIENCE

Paper 2

Friday 7 June 2024

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 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	
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<b>TOTAL</b>	



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

**0 1**

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**

<b>Species</b>	<b>Species name</b>	<b>Evolutionarily Distinct score (ED) / million years</b>	<b>IUCN Red List status (GE)</b>
<b>A</b>	Ratray's forest frog	42.6	Vulnerable
<b>B</b>	Chinese giant salamander	61.2	Critically Endangered
<b>C</b>	Archey's frog	62.8	Critically Endangered
<b>D</b>	Mistbelt chirping frog	42.6	Endangered



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 1 . 1

Use the information in **Table 1** 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]

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0 1 . 3

Explain **one** reason why a species' EDGE score may change over time.

[2 marks]

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**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]**

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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 \_\_\_\_\_

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2 \_\_\_\_\_

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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 for the next question

Turn over ►



0 3 . 1

Explain how Antarctica helps to regulate the global temperature of Earth.

[1 mark]

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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 \_\_\_\_\_



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 \_\_\_\_\_

\_\_\_\_\_

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\_\_\_\_\_

2 \_\_\_\_\_

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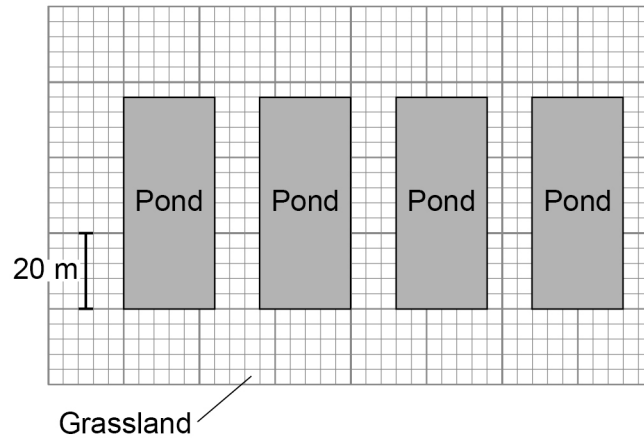
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**Turn over ►**

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 \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



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 \_\_\_\_\_

\_\_\_\_\_

**Question 4 continues on the next page**

**Turn over ►**



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

$\Sigma$  = sum of

**0 4 . 4** Complete **Table 3** and calculate Simpson's Index of Diversity.

Give your answer to **two** decimal places.

Show your working.

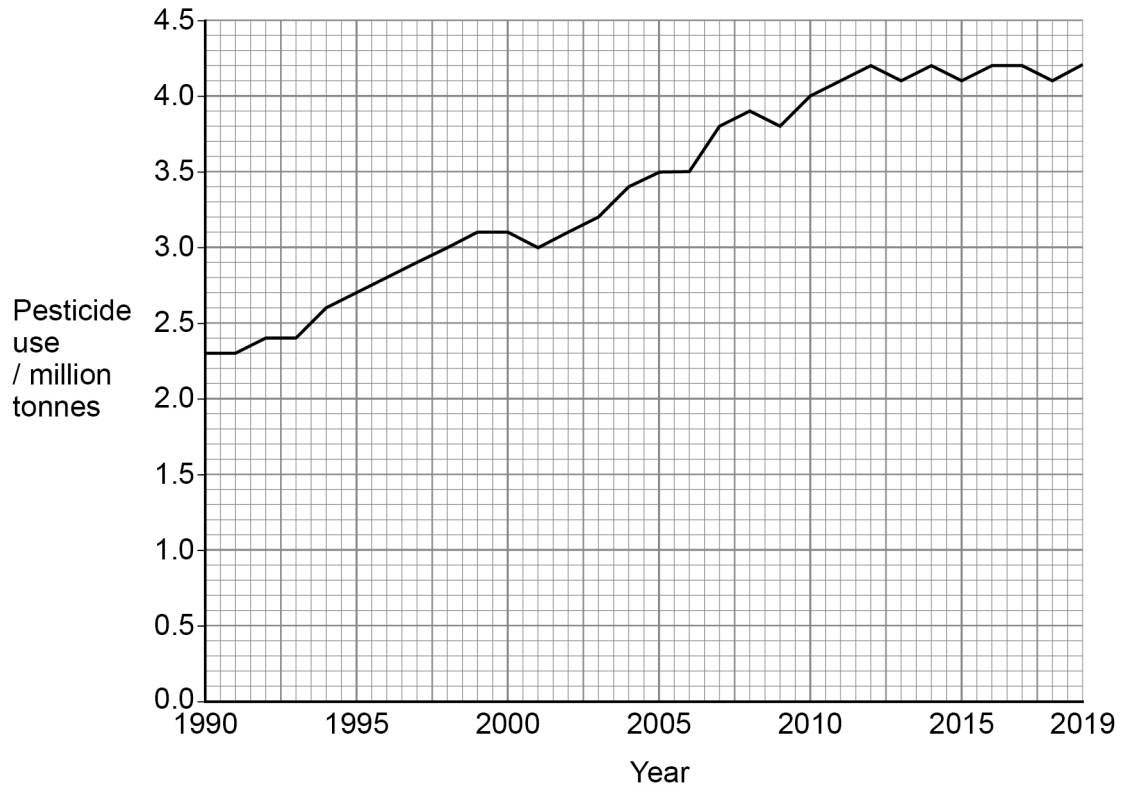
**[3 marks]**



0 5

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

Figure 2



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]

\_\_\_\_\_ %

Question 5 continues on the next page

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 \_\_\_\_\_

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Lipid-soluble insecticide \_\_\_\_\_

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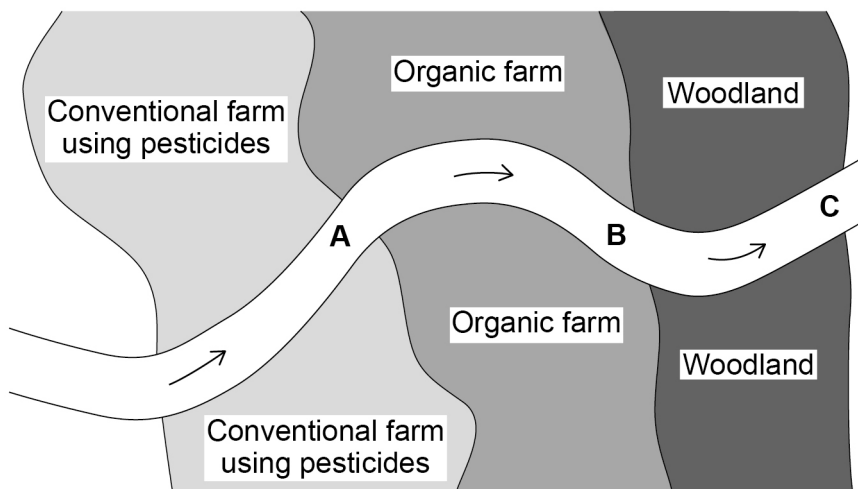
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Figure 3 shows a river running through two types of farmland and a natural woodland.

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]

\_\_\_\_\_

\_\_\_\_\_



0 6 . 1

Describe how **one** ethical factor can influence agricultural production.

[2 marks]

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0 6 . 2

Describe how quotas affect agricultural production.

[1 mark]

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0 6 . 3

Describe how **one** political factor can influence agricultural production.

Do **not** use quotas in your answer.

[2 marks]

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5



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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.

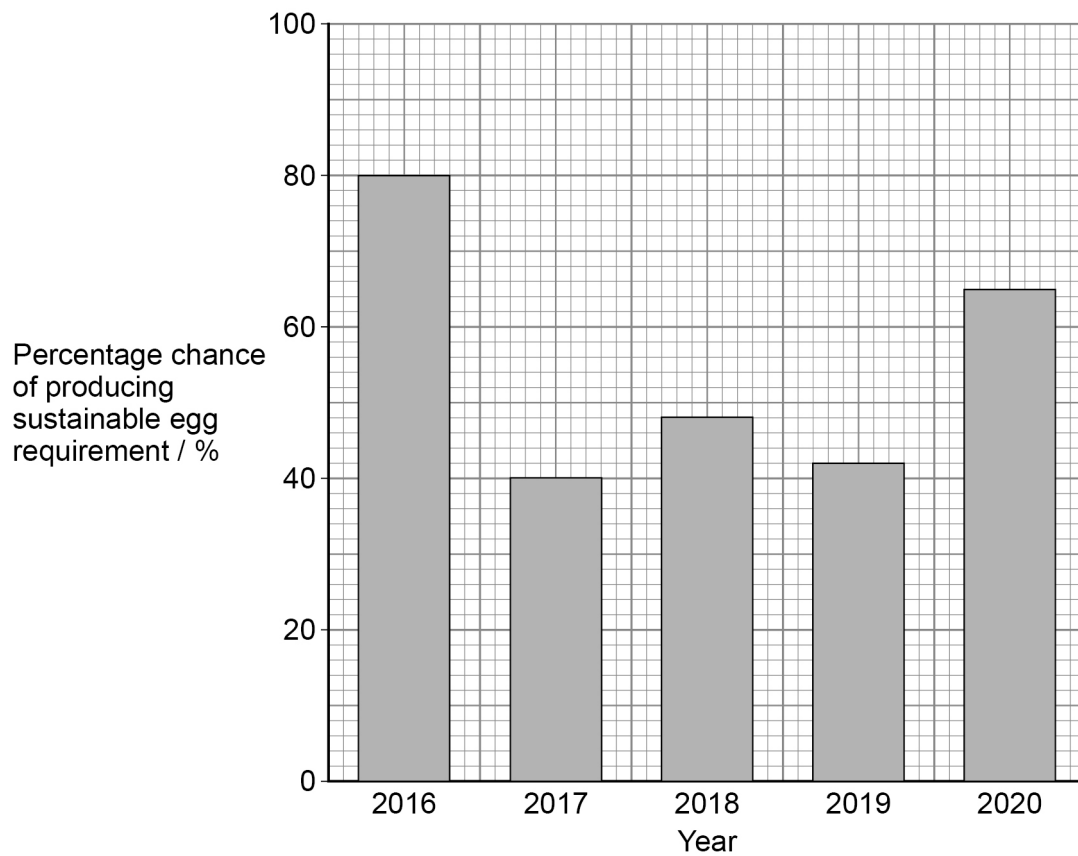
**Table 4**

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.



**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**



**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**.

Show your working.

**[2 marks]**

Five-year mean percentage chance \_\_\_\_\_

Grade \_\_\_\_\_

**Question 7 continues on the next page**

**Turn over ►**



**0 7 . 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 \_\_\_\_\_

\_\_\_\_\_

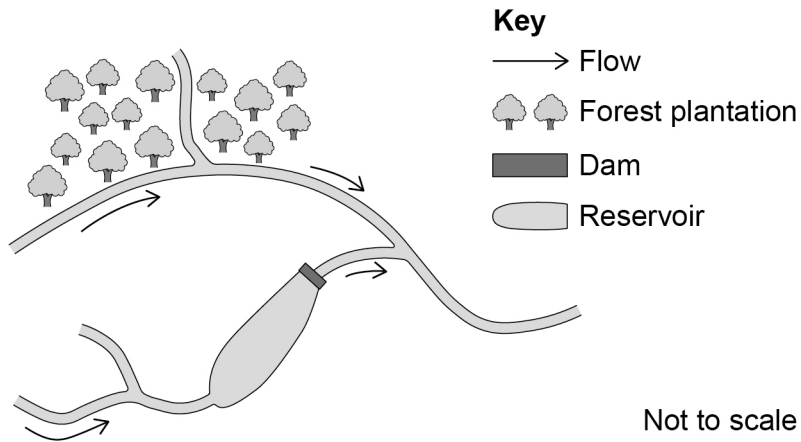
2 \_\_\_\_\_

\_\_\_\_\_



Figure 5 shows a river where wild salmon breed.

Figure 5



0 7 . 4

Explain **one** way the forest plantation in **Figure 5** may impact the reproductive success of wild salmon.

[2 marks]

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0 7 . 5

Explain **one** way the dam in **Figure 5** may impact the reproductive success of wild salmon.

[2 marks]

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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 \_\_\_\_\_







**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 \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Question 9 continues on the next page**

**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	Tree species	Mean C / t ha <sup>-1</sup>	Sample size (n)	$\Sigma(x - \bar{x})^2$	Standard deviation (s)
1	<i>Eucalyptus nitens</i>	784.1	258	1 165 027	s <sub>1</sub> :
2	<i>Eucalyptus globulus</i>	520.3	258	325 711	s <sub>2</sub> : 35.6

#### Standard deviation

Key:

s = standard deviation

x = individual measurement

$\bar{x}$  = mean

n = total number of samples

$\Sigma$  = the sum of

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

#### Student's t-test

Key:

t = t value

$\bar{x}_1$  = mean of sample 1

$\bar{x}_2$  = mean of sample 2

s<sub>1</sub> = standard deviation of sample 1

s<sub>2</sub> = standard deviation of sample 2

n<sub>1</sub> = size of sample 1

n<sub>2</sub> = size of sample 2

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



0 9 . 3

Complete **Table 5** 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 \_\_\_\_\_

**Question 9 continues on the next page**

**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.

0 9 . 5

Scientists suggest that coppicing trees may increase the carbon sequestered and increase biodiversity.

Describe how managing a woodland using coppicing may increase biodiversity.

[3 marks]

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**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]**

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**1 0 . 2**

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

Explain why.

**[2 marks]**

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**1 0 . 3**

Describe **two** ways that the design of products may make them more recyclable.

**[2 marks]**

1 \_\_\_\_\_

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2 \_\_\_\_\_

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1 0 . 4

Explain how recycling reduces **named** greenhouse gas emissions.

[4 marks]

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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




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