OXFORD AQA
INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____
I declare this is my own work.

INTERNATIONAL A-LEVEL
BIOLOGY (9610)

Unit 3 Populations and Genes

Monday 20 May 2024 07:00 GMT Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- 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).
- All working must be shown.
- 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 75.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

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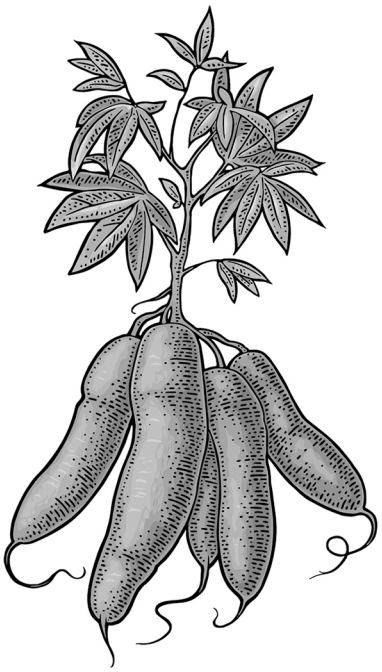
Answer **all** questions in the spaces provided.

0 1 Cassava is a plant originally found in South America.

It was imported to Africa and Asia where it has become an important food crop.

Figure 1 shows a drawing of a cassava plant.

Figure 1



0 1 . 1 Cassava mealybugs are insect pests that feed on cassava plants.

The mealybugs were originally found in South America but have spread much more quickly through cassava crops in Africa and Asia.

Suggest why.

[1 mark]

_____

_____

_____

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0 1 . 2 A parasitic wasp from South America is used for controlling mealybugs.

The female wasps only lay their eggs in cassava mealybugs. The eggs hatch and the wasp larvae feed on the mealybugs.

The wasp is no threat to humans, or to other insects.

Describe the advantages and disadvantages of using parasitic wasps to control mealybugs instead of using chemical pesticides.

[4 marks]

Advantages _____

_____

_____

_____

_____

_____

Disadvantages _____

_____

_____

_____

_____

_____

5

Turn over for the next question

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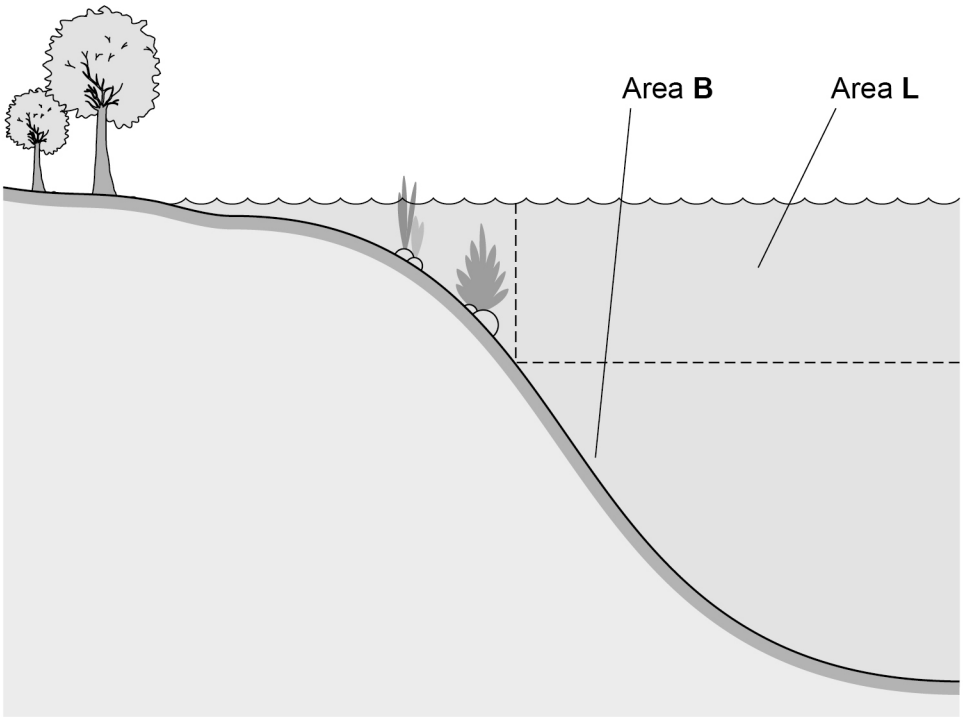
0 2 Sticklebacks are a type of fish.

There are two populations of sticklebacks in Paxton Lake in Canada. The two populations live in different areas of the lake:

- benthic area (**B**)
- limnetic area (**L**).

Figure 2 shows areas **B** and **L** of the lake.

Figure 2



Benthic sticklebacks live in area **B** and limnetic sticklebacks live in area **L**.

0 2 . 1 Suggest why living in different areas of the lake is an advantage to both stickleback populations.

[1 mark]

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The body length of sticklebacks ranges from 40 mm to 64 mm with a mean body length of 50 mm

Table 1 shows the ranges of body lengths for the populations of sticklebacks in Paxton Lake.

Table 1

Stickleback population	Body length / mm
Benthic	53–64
Limnetic	40–48

0 2 . 2 Sticklebacks select their mates by body length.

Name the type of selection that may have produced the two different populations of sticklebacks.

Give the reason for your choice.

[1 mark]

Type of selection _____

Reason for choice _____

_____

The two populations of sticklebacks may develop into two separate species through sympatric speciation.

0 2 . 3 Define **sympatric speciation**.

[2 marks]

_____

_____

_____

_____

_____

_____

Question 2 continues on the next page

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0 2 . 4 Describe how the benthic and limnetic stickleback populations could develop into two separate species through sympatric speciation.

[4 marks]

8

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Turn over for the next question

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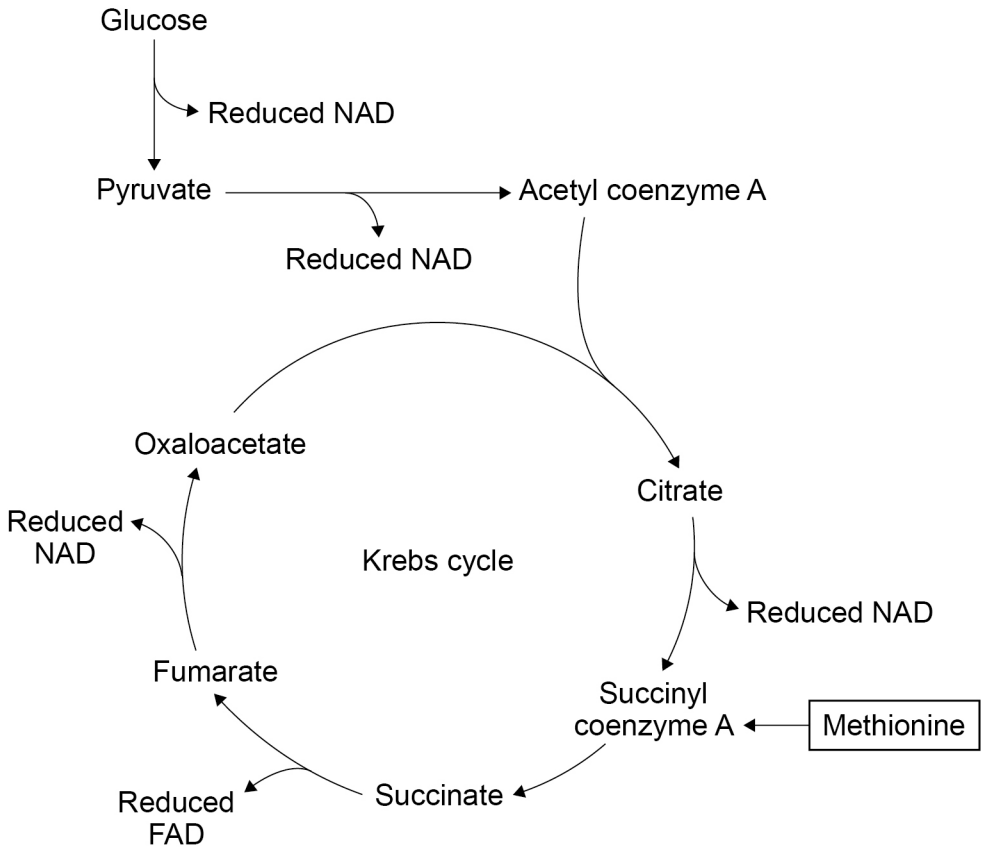
0 3 Amino acids can be used as respiratory substrates.

Figure 3 shows where the amino acid methionine can enter the Krebs cycle.

Figure 3



0 3 . 1 If methionine is used as a respiratory substrate, the amount of ATP produced will be less than when glucose is the respiratory substrate.

Suggest why.

Use information from **Figure 3**.

[3 marks]

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0 3 . 2 The brain needs glucose as a respiratory substrate.

If there is no glucose in the diet, glucose is synthesised from oxaloacetate, a molecule found in the Krebs cycle.

Use **Figure 3** to explain why this leads to a build-up of acetyl coenzyme A.

[3 marks]

0 3 . 3 Succinate and fumarate are molecules found in the Krebs cycle.

Succinate dehydrogenase is an enzyme that catalyses the conversion of succinate to fumarate.

Explain why an inhibitor of succinate dehydrogenase would reduce the rate of oxygen uptake in mitochondria.

Use information from **Figure 3**.

[3 marks]

9

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0 4 *Drosophila* is a genus of fly that can be used to investigate genetic crosses.

Female *Drosophila* sex chromosomes are **XX** and male *Drosophila* sex chromosomes are **XY**.

One characteristic of *Drosophila* is eye colour. The allele for red eyes is **dominant** and the allele for white eyes is **recessive**.

In a genetic cross between a female with red eyes and a male with red eyes, a large number of offspring are produced.

Table 2 shows the results of the genetic cross.

Table 2

Phenotype of the offspring	**Number of *Drosophila* with the phenotype**
Female with red eyes	76
Female with white eyes	0
Male with red eyes	38
Male with white eyes	41

Do not write outside the box

0 4 . 1 Explain the results of the genetic cross in **Table 2** using a genetic diagram.

Use the symbols:

X^R for an X chromosome with allele for red eyes
X^r for an X chromosome with allele for white eyes
Y for a Y chromosome.

[2 marks]

Parental phenotypes	Female with red eyes	Male with red eyes
Parental genotypes	_____	_____
Gametes	_____ _____	_____ _____

Offspring genotypes _____

Offspring phenotypes _____

_____

Question 4 continues on the next page

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0 4 . 2 Some female *Drosophila* have white eyes.

Explain why female *Drosophila* are less likely than males to have white eyes.

[2 marks]

Body colour and wing length are characteristics of *Drosophila*.

The gene for body colour has two alleles:

G for grey body is **dominant**
g for black body is **recessive**

The gene for wing length has two alleles:

N for normal wings is **dominant**
n for short wings is **recessive**

The genes for body colour and wing length are **not** on the sex chromosomes.

Female *Drosophila* with the genotype **GgNn** are crossed with male *Drosophila* with the genotype **ggnn**.

A student expects the cross between flies of genotype **GgNn** and **ggnn** to produce the following offspring in approximately equal numbers:

- black body and normal wings
- black body and short wings
- grey body and normal wings
- grey body and short wings.

Do not write outside the box

0 4 . 3 Draw a genetic diagram to explain why the student expects a 1 : 1 : 1 : 1 ratio of offspring phenotypes.

[2 marks]

Parental genotypes GgNn ggnn

Gametes

Offspring genotypes _____

Offspring phenotypes _____

_____

Question 4 continues on the next page

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The actual numbers of offspring phenotypes are shown in **Table 3**.

Table 3

Phenotypes	Number of offspring with phenotype
Black body, normal wings	18
Black body, short wings	944
Grey body, normal wings	965
Grey body, short wings	21

0 4 . 4 Explain why the **actual** ratio of offspring phenotypes in **Table 3** is different from the expected ratio given in Question **04.3**.

[3 marks]

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0 4 . 5 The student calculates a value of $\chi^2 = 1795.59$ using the actual and expected results.

Table 4 gives the values for χ^2 at different levels of probability and for different numbers of degrees of freedom.

Table 4

Degrees of freedom	**Probability**				
	0.1	**0.05**	**0.01**	**0.005**	**0.001**
1	2.71	3.84	6.64	7.88	10.83
2	4.61	5.99	9.21	10.60	13.82
3	6.25	7.82	11.35	12.84	16.27
4	7.78	9.49	13.28	14.86	18.47
5	9.24	11.07	15.09	16.75	20.52

Explain what the calculated value of χ^2 shows about the results of the genetic cross.

Use **Table 4**.

[3 marks]

12

Turn over for the next question

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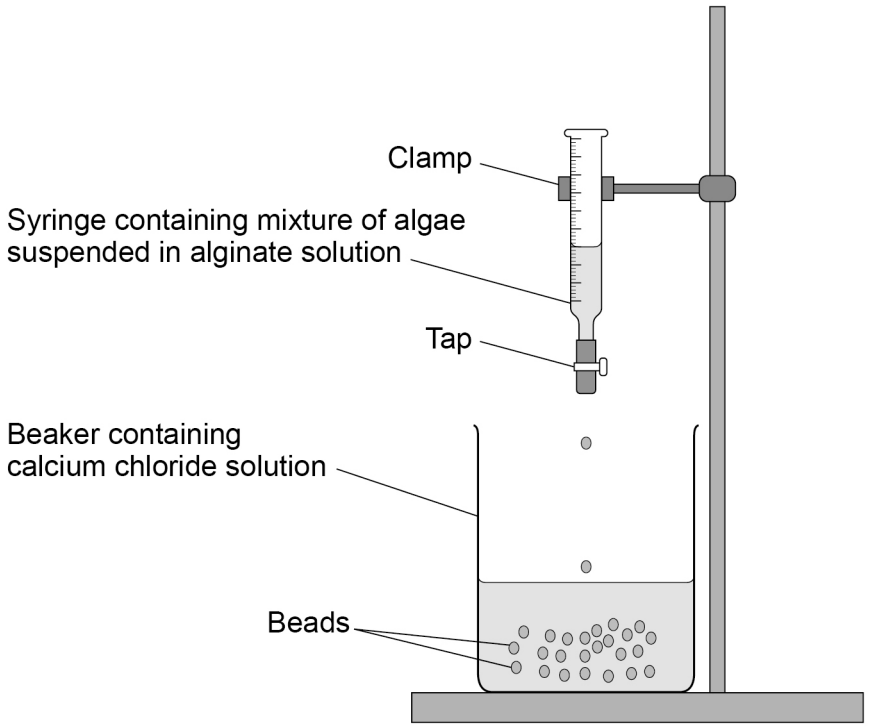
0 5 A student uses algae to investigate a factor affecting the rate of photosynthesis.

Algae are cells containing chlorophyll.

The student prepares beads of alginate jelly containing algae using the equipment shown in **Figure 4**.

Figure 4



0 5 . 1 Suggest **two** limitations of the student's method.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

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The student investigates the effect of light intensity on the rate of photosynthesis in the algae using an indicator solution.

This is the method the student uses.

1. Use a pipette to transfer 5 cm^3 of indicator solution to a bottle.
2. Add 20 beads containing algae to the bottle and immediately put the lid on the bottle.
3. Put the bottle at a measured distance from the lamp.
4. Measure the light intensity next to the bottle using a light meter.
5. Use a pipette to remove solution from the bottle after 45 minutes.
6. Use a colorimeter to measure the absorbance of the solution (how much light the solution absorbs).
7. Repeat steps 1–6 at different distances from the lamp.

0 5 . 2 The indicator solution changes colour when the pH changes. As the algae take up carbon dioxide, the pH of the solution increases.

Give the reason why a change in pH only gives an approximate measurement of the rate of photosynthesis.

[1 mark]

0 5 . 3 Suggest why all equipment must be clean and dry.

[2 marks]

Question 5 continues on the next page

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Table 5 shows the student's results.

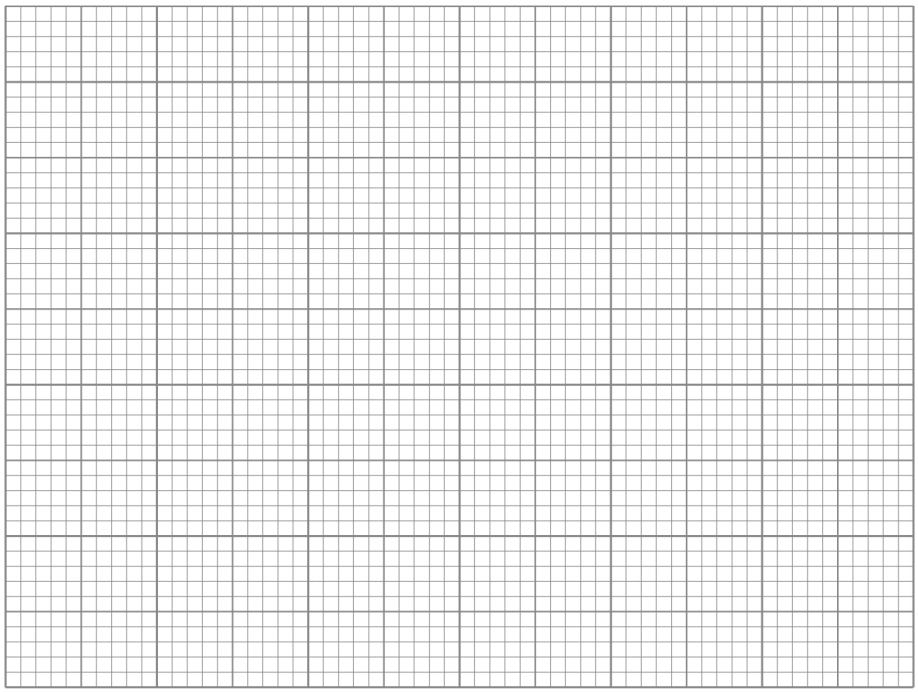
Table 5

Light intensity / lux	Absorbance / arbitrary units
1 000	0.11
2 000	0.25
5 000	0.45
10 000	0.59
20 000	0.68
40 000	0.57
55 000	0.71

0 5 . 4 Plot a graph of the student's results using the data from **Table 5**.

Draw a line of best fit.

[3 marks]



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0 5 . 5 The student suggests that one of the results is anomalous.

Identify the anomalous result and give the reason for your choice.

[1 mark]

Anomalous result _____

Reason for choice _____

_____

0 5 . 6 Suggest a reason why the student may have obtained this anomalous result.

[1 mark]

_____

_____

_____

Question 5 continues on the next page

Do not write outside the box

Scientists investigate a factor affecting the rate of photosynthesis in plants.

The scientists investigate the effect of increasing the concentration of carbon dioxide on the biomass of radish plants.

The scientists:

- grow a large number of radish plants for 15 days
- remove 20 plants and measure their dry mass by drying them at 100 °C
- put the remaining plants in a growth chamber
- control humidity, light duration and intensity, and temperature
- provide a normal concentration of carbon dioxide
- remove 20 plants from the growth chamber each day from days 16–21 and measure their dry mass
- repeat the investigation using a high concentration of carbon dioxide in the growth chamber.

0 5 . 7 The scientists controlled the temperature in this investigation.

Explain how a change in temperature could alter the rate of biomass production.

[2 marks]

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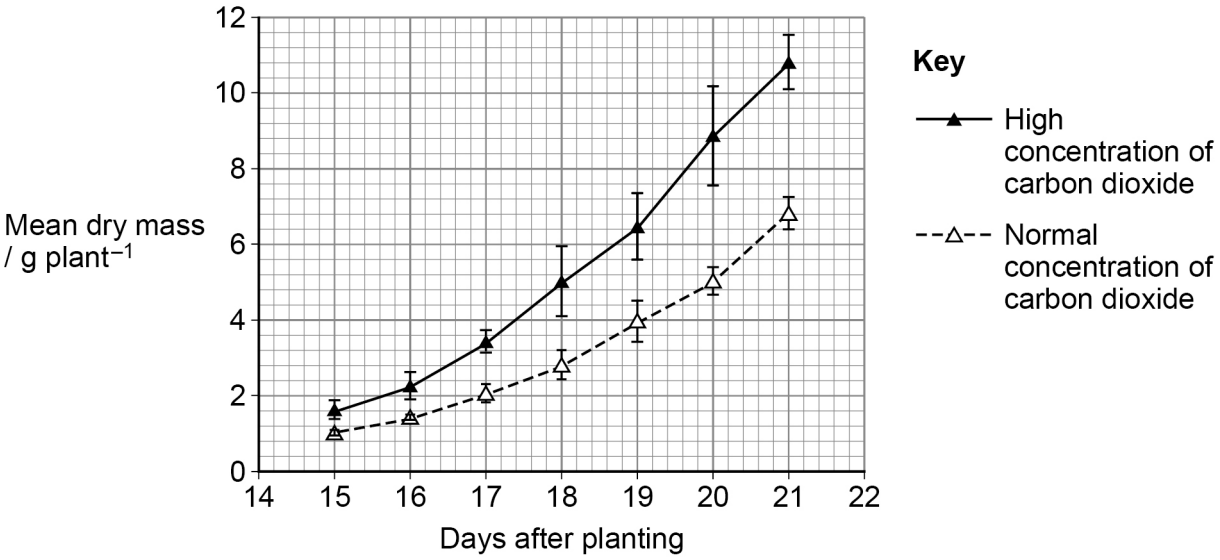
Figure 5 shows the scientists' results.

The error bars show ± standard error.

Figure 5



0 5 . 8 One conclusion from this investigation is that high concentrations of carbon dioxide increase the rate of photosynthesis in plants.

Evaluate this conclusion using information from the scientists' method and the results in **Figure 5**.

[4 marks]

16

Turn over ►

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0 6 Conservation of habitats frequently involves management to slow down the rate of succession.

0 6 . 1 Give **one** management technique that could be used for slowing down the rate of succession.

[1 mark]

0 6 . 2 Explain how the management of succession helps to conserve habitats.

[2 marks]

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Primary succession can happen when mud is deposited where a river meets the sea. Mud can build up over time and a saltmarsh habitat is formed.

Figure 6 shows a saltmarsh.

Figure 6

0 6 . 3 Clams are animals that occupy a niche in saltmarshes.

What would happen if another species occupied the same niche as clams?

[1 mark]

_____

_____

_____

Question 6 continues on the next page

Do not write outside the box

The common redshank is a bird that breeds in saltmarshes.

Figure 7 shows a common redshank.

Figure 7

Scientists investigate the effect of conservation management strategies on the population of common redshanks in England.

The scientists:

- count the number of breeding pairs of common redshanks at all saltmarsh sites in England in 1996 and 15 years later in 2011
- measure the area of saltmarsh in England.

Table 6 shows the scientists' results.

Table 6

Year	Number of breeding pairs
1996	14 338
2011	10 086

The total area of saltmarsh in England is 438 km^2. The scientists find no evidence that the area changes significantly during the investigation.

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0 6 . 4 Calculate the rate of change in the number of breeding pairs of common redshanks in England from 1996 to 2011.

Give your answer in breeding pairs km^{-2} $year^{-1}$

[2 marks]

Rate of change _____ breeding pairs km^{-2} $year^{-1}$

Question 6 continues on the next page

Do not write outside the box

The scientists measure the change in the number of breeding pairs of common redshanks from 1996 to 2011 in two different regions of England:

- North West
- South.

The scientists determined the significance of the changes by using 95% confidence limits and comparing the means for each region with the mean for England.

Table 7 shows the scientists' results.

Table 7

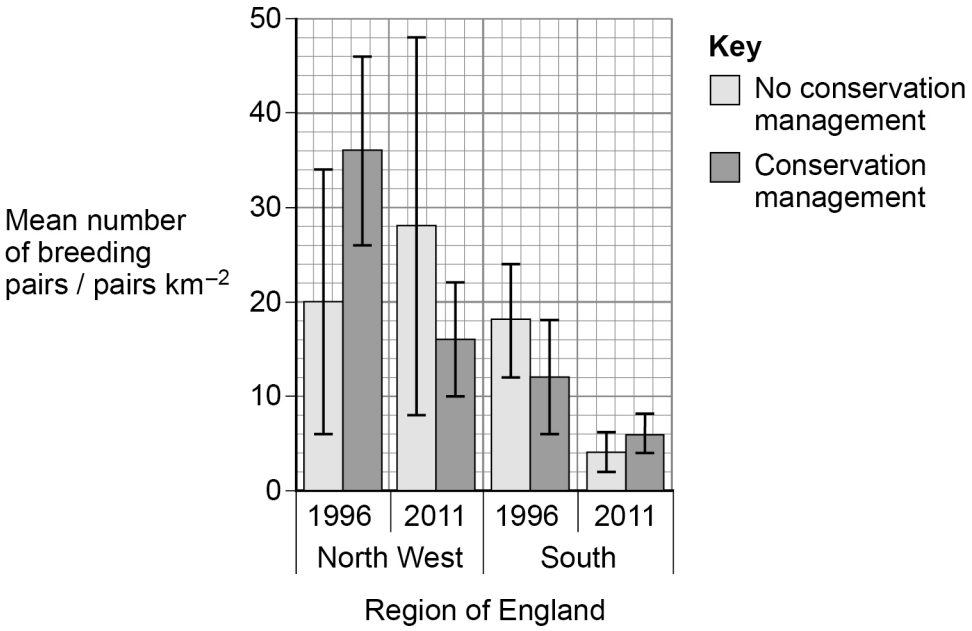
Region of England	Change in number of breeding pairs from 1996 to 2011 / pairs km^{-2}	Rate of change in number of breeding pairs per year / pairs km^{-2} $year^{-1}$	Significance
North West	–13.31	–0.89	$P > 0.05$
South	–26.61	–1.77	$P < 0.001$

The scientists also compared the number of breeding pairs in the two regions where there was conservation management and no conservation management.

Figure 8 shows the scientists' results.

The error bars show ± standard error.

Figure 8



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0 6 . 5 One conclusion from the scientists' results is that conservation management schemes in England are **not** preventing the decline in common redshank populations.

Evaluate this conclusion using data from **Table 7** and **Figure 8**.

[4 marks]

10

Turn over for the next question

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0 7 The Earth's atmosphere is made of gases including nitrogen and carbon dioxide.

The activity of living organisms can change the concentration of different gases in the atmosphere.

0 7 . 1 Describe the role of bacteria in changing the concentration of nitrogen gas in the atmosphere.

Your answer should include the conditions the bacteria need.

[6 marks]

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0 7 . 2 Describe how the concentration of carbon dioxide in the atmosphere changes due to green plants.

[4 marks]

Question 7 continues on the next page

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0 7 . 3 Some human activities are changing the concentration of carbon dioxide and other gases in the atmosphere. This is affecting the global climate.

Describe how human activities can bring about climate change.

[5 marks]

15

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