OXFORD
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I declare this is my own work.

INTERNATIONAL A-LEVEL
BIOLOGY (9610)

Unit 3 Populations and Genes

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 In the Arctic, some animals hibernate. Hibernation is a dormant state. The animals hibernate during the cold winter months when food is limited. One example of a hibernating animal is the Arctic ground squirrel.

Before beginning to hibernate, the Arctic ground squirrel builds up energy stores in its body.

Scientists calculate the respiratory quotients (RQ) of Arctic ground squirrels hibernating at different environmental temperatures.

0 1 . 1 Tick (✓) one box to indicate how the scientists calculate the RQ values.

[1 mark]

$$RQ = \frac{\text{carbon dioxide given out}}{\text{oxygen taken in}}$$ ☐

RQ = (carbon dioxide given out) x (oxygen taken in) ☐

RQ = (oxygen taken in) – (carbon dioxide given out) ☐

$$RQ = \frac{\text{oxygen taken in}}{\text{carbon dioxide given out}}$$ ☐

Table 1 shows the calculated mean RQ values, plus or minus standard error, at different environmental temperatures.

Table 1

Environmental temperature / °C	Respiratory quotient (RQ)
– 16	0.86 ± 0.02
– 8	0.79 ± 0.01
– 4	0.77 ± 0.01
0	0.74 ± 0.02
4	0.70 ± 0.02
8	0.70 ± 0.02

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0 1 . 2 Describe the trend in the data in **Table 1**.

[1 mark]

0 1 . 3 **Table 2** shows typical RQ values for three different respiratory substrates.

Table 2

Respiratory substrate	**Typical respiratory quotient (RQ)**
Fats	0.7
Proteins	0.8–0.9
Carbohydrates	1.0

Scientists think that as the environmental temperature decreases, the length of time Arctic ground squirrels can hibernate will also decrease.

Suggest why.

Use information from **Table 1** and **Table 2**.

[3 marks]

Question 1 continues on the next page

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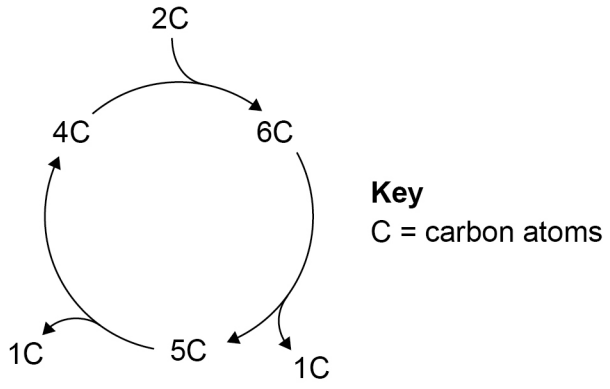
Different respiratory substrates enter the process of aerobic respiration at different points, but all respiratory substrates are involved in the reactions shown in **Figure 1**.

Figure 1



0 1 . 4 Name the stage of aerobic respiration shown in **Figure 1**.

[1 mark]

_____

0 1 . 5 Name the 1C and the 2C compounds shown in **Figure 1**.

[1 mark]

Name of the 1C compound _____

Name of the 2C compound _____

Do not write outside the box

0 1 . 6 The stage of aerobic respiration shown in **Figure 1** produces ATP and reduced NAD.

Complete **Table 3** stating the use of these molecules.

[1 mark]

Table 3

Molecule	**Use of this molecule**
ATP	
Reduced NAD	

8

Turn over for the next question

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0 2 When plants are harvested, nutrients are removed from the soil.

Growing bean plants can help to replace the nutrient levels in the soil.

Bean plants have nodules on their roots. The nodules contain nitrogen-fixing bacteria.

0 2 . 1 State what nitrogen-fixing means.

[1 mark]

_____

_____

_____

Heavy metals are pollutants that can contaminate soil and kill nitrogen-fixing bacteria. Scientists grow bean plants in pots of soil with different concentrations of a heavy metal.

The scientists measure the plants in each pot, recording:

- dry mass
- number of root nodules
- nitrogen content of the plants.

The data are shown in **Table 4.**

Table 4

Heavy metal concentration in soil / mmol kg^{-1}	Per pot of soil		
	Dry mass of plants / g	Number of nodules	Nitrogen content of plants / mg
0.00	14.8	129	59
0.02	12.3	120	47
0.12	11.0	99	40
0.24	8.8	78	30
0.48	4.9	54	15
1.20	2.5	24	8

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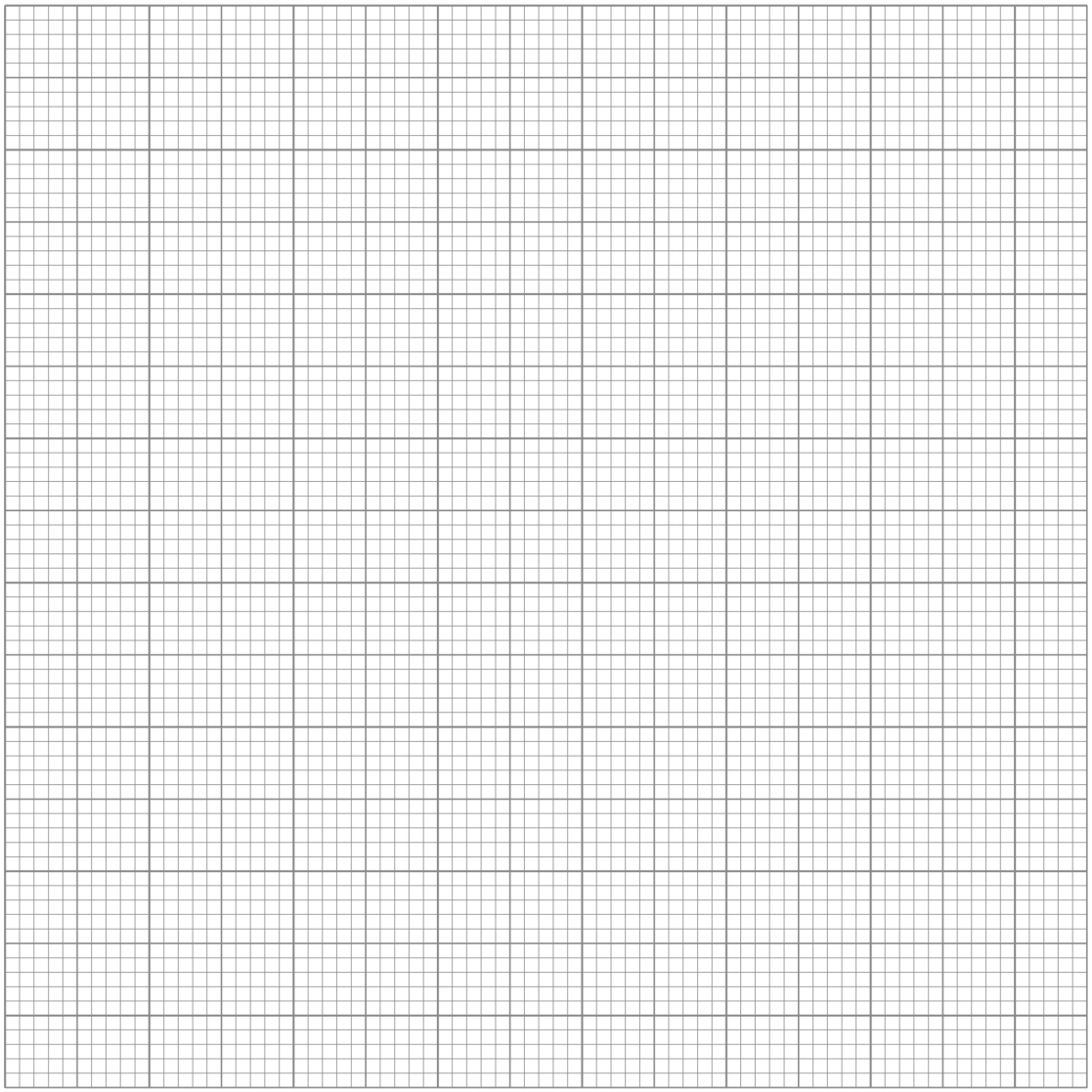
0 2 . 2 Draw a graph to show how heavy metal concentration in soil affects the dry mass of the bean plants.

[4 marks]



Question 2 continues on the next page

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0 2 . 3 Suggest an explanation for the relationship between the concentration of heavy metal in the soil, the number of nodules and the dry mass of the bean plants.

[3 marks]

0 2 . 4 Lost nutrients could be replaced using natural or artificial fertilisers.

Some farmers prefer to use natural fertilisers.

Suggest **one** reason why.

[1 mark]

9

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0 3 Dogs and humans can become overweight.

In humans, some cases of being overweight have been linked to a mutation in the pro-opiomelanocortin (POMC) gene.

Labradors are a common breed of dog. Scientists want to know if Labradors with the same mutation in the POMC gene are also overweight.

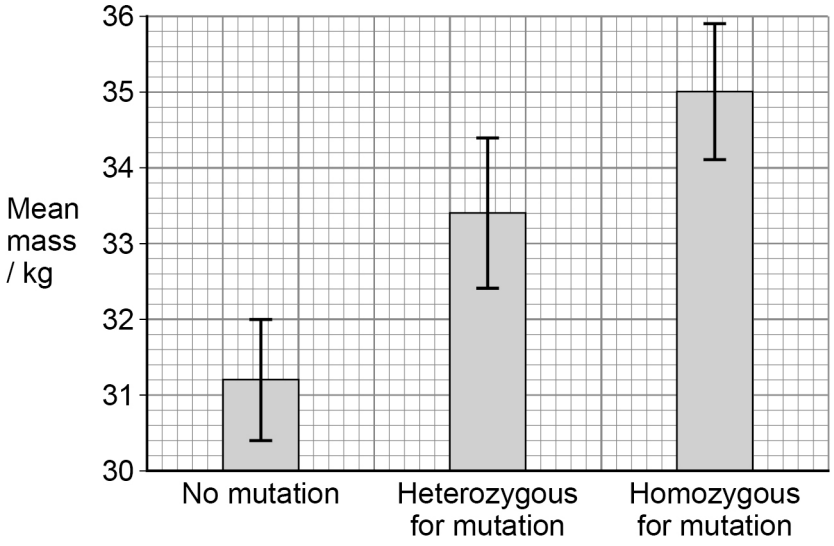
The scientists:

- weigh 310 Labradors
- take a DNA sample from each dog
- analyse the DNA samples for the mutation in the POMC gene.

Healthy adult Labradors weigh between 27 and 32 kg. Males usually weigh more than females.

Figure 2 shows the mean mass of the Labradors split into three groups based on their genotypes. The bars represent standard deviation.

Figure 2



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0 3 . 1 The scientists suggested that Labradors with the POMC mutation are overweight. Give evidence from **Figure 2** to support the scientists' suggestion.

[3 marks]

Question 3 continues on the next page

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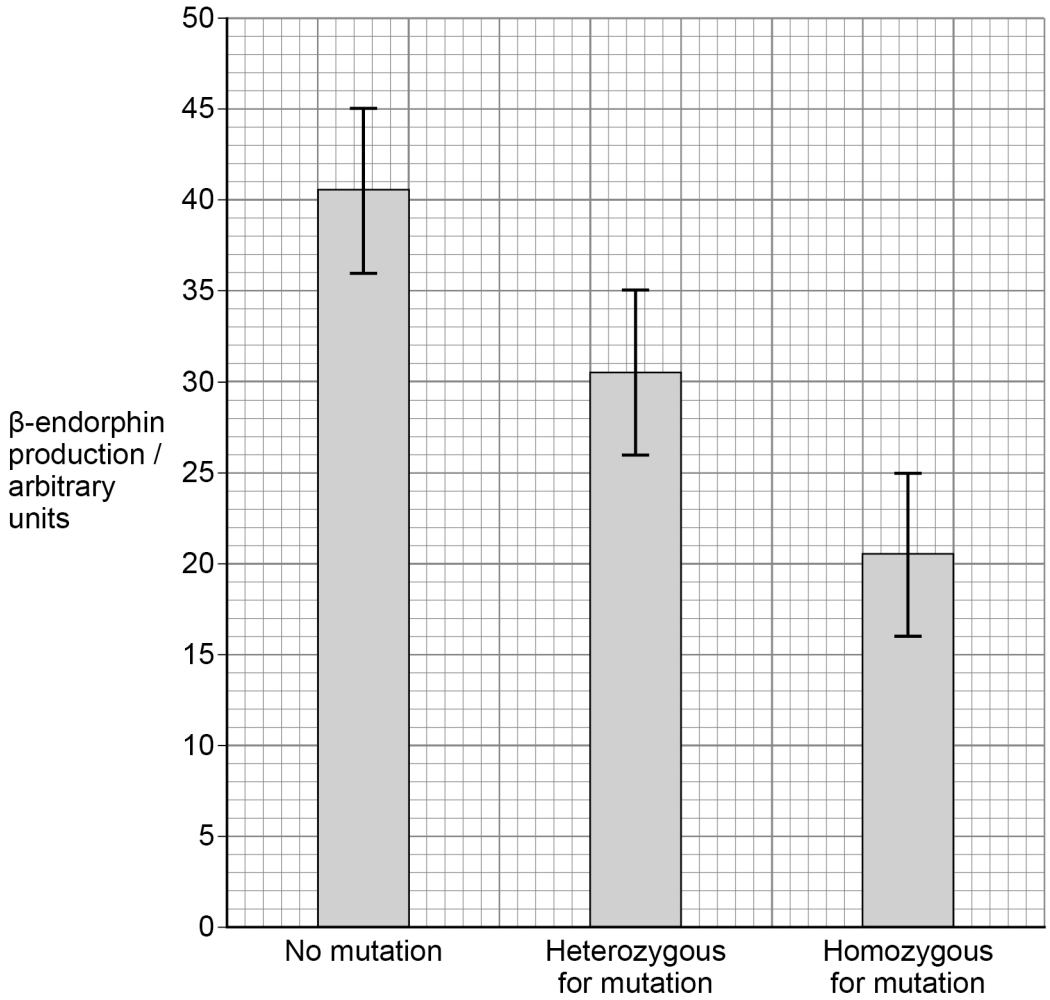
The POMC gene codes for the hormone β-endorphin.

High levels of β-endorphin cause an animal to no longer feel hungry and stop the animal eating any more.

The scientists measure the amount of β-endorphin produced when the Labradors in **Figure 2** (on page 10) are eating.

The results are shown in **Figure 3**. The bars represent standard deviation.

Figure 3



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0 3 . 2 The scientists state that the information in **Figure 3** shows why Labradors with the mutation are heavier than normal.

Explain how the information shows this.

[3 marks]

Question 3 continues on the next page

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0 3 . 3 Labradors can be trained as assistance dogs to help people with disabilities.

Assistance dogs are selected for training when they are 8 weeks old. A common form of training is to offer food rewards for desired behaviour. Young Labradors suitable for training show a lot of interest in food.

Some of the dogs selected for training will be used to breed the next generation of assistance dogs.

Overweight dogs may develop joint problems.

Evaluate the Labradors' interest in food as a method of selection for training and breeding.

[5 marks]

11

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0 4 Plant scientists want to produce plants with more flowers and larger flowers.
The plants are grown indoors using artificial lights. The scientists think that increasing carbon dioxide concentration could increase flower growth.

0 4 . 1 Describe how carbon dioxide is fixed and organic substances are produced during the light-independent reaction of photosynthesis.

[4 marks]

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The scientists investigate if increasing the carbon dioxide concentration results in a higher number of larger flowers.

The scientists grow plants in pots in two separate rooms for 1 month.

- Room 1 has the normal atmospheric concentration of carbon dioxide (380 ppm).
- Room 2 has double the normal atmospheric concentration of carbon dioxide (760 ppm).

The scientists need to control other variables to make sure that only the difference in carbon dioxide concentration causes any differences in flower growth.

0 4 . 2 Give **two** variables the scientists need to control.

[2 marks]

1 _____

2 _____

At the end of the month, the scientists take a random sample of plants from each room and:

- count the number of flowers on each plant
- measure the diameter of the flowers
- measure the total leaf area of each plant.

The sample must be random. The scientists do this by numbering the plant pots and using a computer to identify which pots to sample.

0 4 . 3 State why the scientists need the sample to be random.

[1 mark]

_____

_____

_____

Question 4 continues on the next page

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The results for flower number, flower diameter and leaf area are shown in **Table 5**.

Table 5

	Normal carbon dioxide concentration / 380 ppm	**Double carbon dioxide concentration / 760 ppm**	**Percentage increase**	**P value**
Mean flower number per plant	4.83	8.33	72.46	<0.010
Mean flower diameter / cm	6.62	6.66	0.60	0.130
Mean leaf area / cm^2	9.02	9.86		<0.001

0 4 . 4 Calculate the percentage increase in mean leaf area when the carbon dioxide concentration is doubled.

[1 mark]

Percentage increase = _____ %

0 4 . 5 Increasing the carbon dioxide concentration increased the number of flowers and the diameter of the flowers produced.

Comment on whether these changes are significant.

Use data from **Table 5.**

[1 mark]

_____

_____

_____

_____

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0 4 . 6 Name a statistical test that could be used to determine if there is a relationship between the leaf area and the number of flowers per plant.

[1 mark]

0 4 . 7 Explain the relationship shown in **Table 5** between leaf area and the number of flowers per plant.

[3 marks]

0 4 . 8 At the end of the experiment, a scientist sees that the leaves on the plants grown with increased carbon dioxide are changing to a yellow colour.

Suggest a cause for this yellow leaf colour.

[1 mark]

14

Turn over for the next question

Do not write outside the box

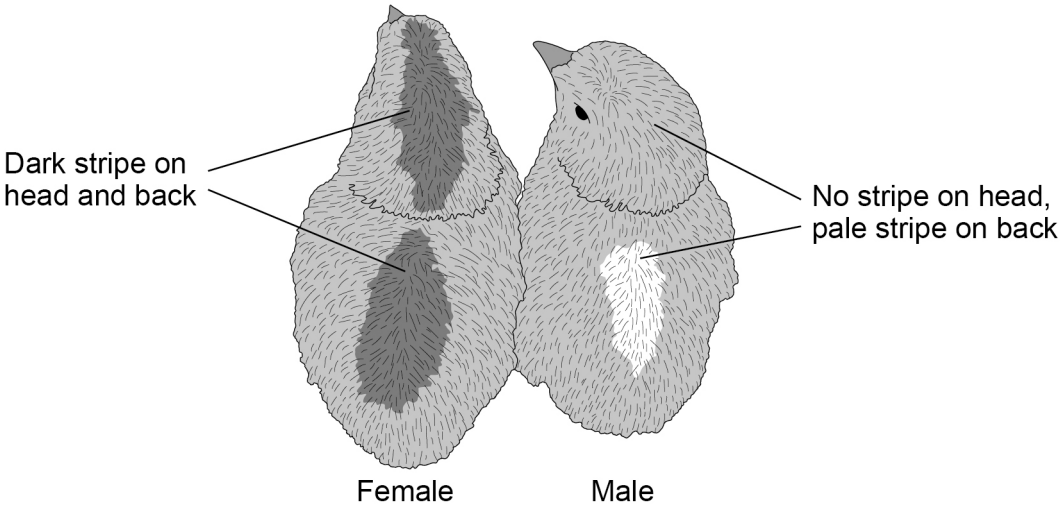
0 5 A farmer only wants to keep female chickens to produce eggs, but identifying the sex of young chicks is difficult.

However, in the 'Cream Legbar' breed of chickens, the male and female chicks look different from each another when only 1 day old.

The farmer plans to start with a small number of Cream Legbar chickens and then increase the number.

Figure 4 shows 1-day-old female and male Cream Legbar chicks.

Figure 4



The stripe characteristic is controlled by a sex-linked gene.

Dark stripes are caused by inheriting one copy of the allele **B**. Inheriting **B**-alleles from both parents causes the stripe to be paler.

Sex of chickens is controlled by the chromosomes **Z** and **W**.

Males are **ZZ** and females are **ZW**.

In chickens, sex-linked genes are only carried on the **Z** chromosome.

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0 5 . 1 The chicks shown in **Figure 4** develop into adults.

Complete the genetic diagram to show how a cross between these adults can produce chicks that are easy to identify as male or female at 1 day old.

Use the following symbols:

W for the **W** chromosome
Z^B for the **Z** chromosome with the **B**-allele.

[4 marks]

	Female parent	**x**	**Male parent**
Genotypes of parents			
Gametes			
Genotypes of offspring			
Phenotype and sex of offspring			

The farmer wants to increase the net production of the chickens.
Chickens are consumers.

0 5 . 2 State the equation to calculate the net production of a consumer.

[1 mark]

_____

_____

Question 5 continues on the next page

Do not write outside the box

Table 6 shows the mass of food required per week to feed 100 chickens and the cost of each kilogram of food.

Table 6

	Mean mass of food per 100 chickens per week / kg	Cost per kg / USD
Food	60	1.32

0 5 . 3 The farmer starts with 15 female chickens.

Calculate the cost of keeping these 15 chickens until they start laying eggs at 18 weeks of age.

[2 marks]

Answer = _____ USD

0 5 . 4 Identifying and keeping mostly female chickens allows the farmer to reduce costs.

Explain **one** other way that the farmer could increase the efficiency of egg production.

[2 marks]

_____

_____

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9

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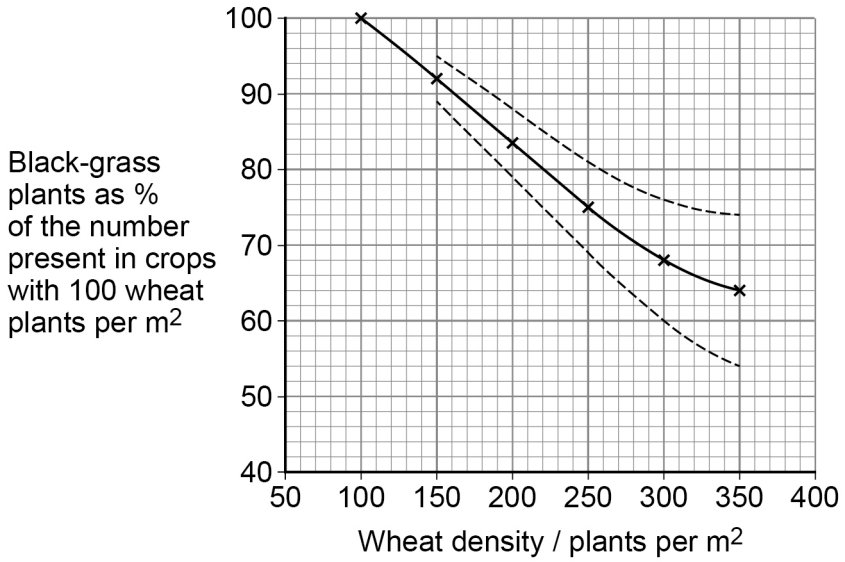
0 6 Weeds compete with crop plants for resources. Black-grass is a common weed found in fields of a crop plant called wheat.

Figure 5 shows the effect of wheat density on the growth of black-grass.
The dotted lines indicate the 95% confidence limits.

Figure 5



0 6 . 1 Wheat plants are often planted at a density of 100 plants per square metre.

A farmer studies the data in **Figure 5** and decides to increase the density of wheat plants to 300 plants per square metre.

Evaluate the farmer's decision. Use information from **Figure 5**.

[3 marks]

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0 6 . 2 Wild oats are another common weed found in fields of wheat.

Students want to investigate the effect of competition with wild oats on the growth of wheat seedlings.

The students are given:

- wild oat seeds
- wheat seeds
- plant pots filled with moist soil
- rulers.

Describe how the students should set up the materials in their investigation and the measurements they should take.

[4 marks]

Do not write outside the box

0 6 . 3 A teacher advises the students to measure the dry mass of the seedlings.

Suggest **two** reasons why.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

9

Turn over for the next question

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0 7 . 1 State the difference between the terms **population** and **community**.

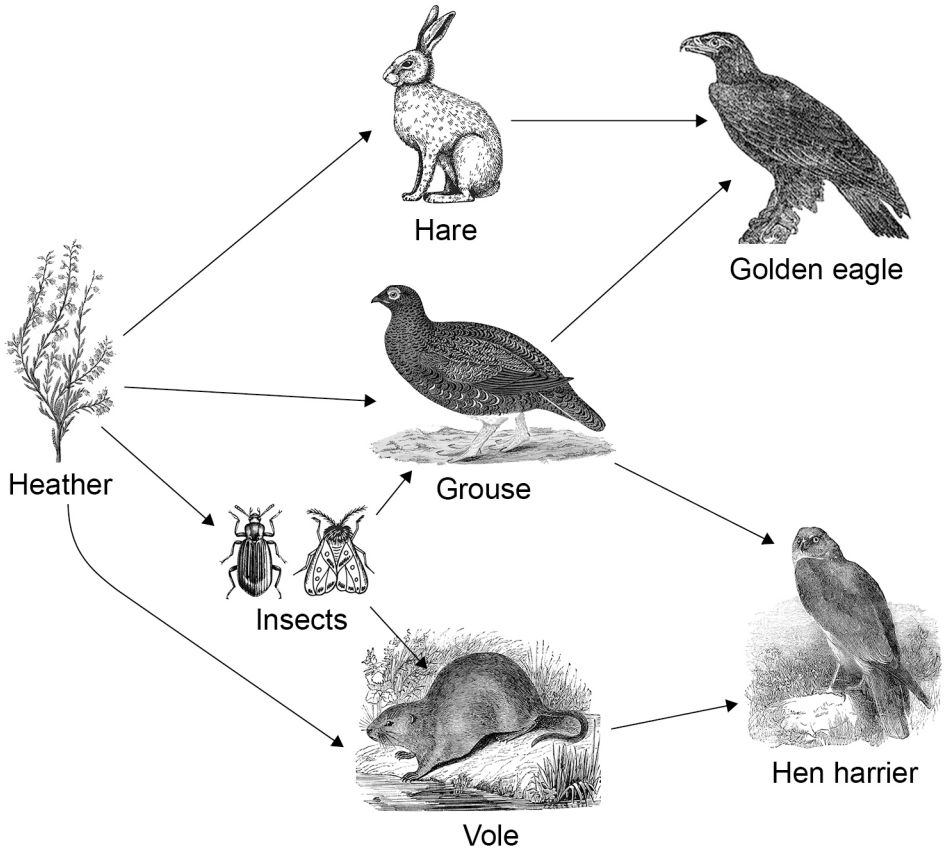
[1 mark]

Grouse are wild birds that are hunted and eaten as food.

Grouse live in open areas with low vegetation, such as heather moorland.

Figure 6 shows a simplified food web involving the grouse.

Figure 6



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0 7 . 2 Large numbers of hen harriers have been killed to protect the grouse.

Suggest the effect that killing the hen harriers would have on the numbers of grouse and voles in the food web.

[4 marks]

Question 7 continues on the next page

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0 7 . 3 The numbers of hen harriers have become dangerously low.

Captive breeding programmes have been set up to conserve the hen harrier species.

Some people are worried that captive breeding could result in a genetic bottleneck.

Suggest why a genetic bottleneck could be a problem for the hen harrier.

[4 marks]

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0 7 . 4 For grouse numbers to remain high, the heather moorland ecosystem must be managed to maintain the open areas with low vegetation.

The moorland ecosystem can be managed by controlled burning of the land. After burning, the moorland plants grow back.

This is an example of secondary succession.

Describe similarities and differences between secondary succession and primary succession.

[6 marks]

15

END OF QUESTIONS

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