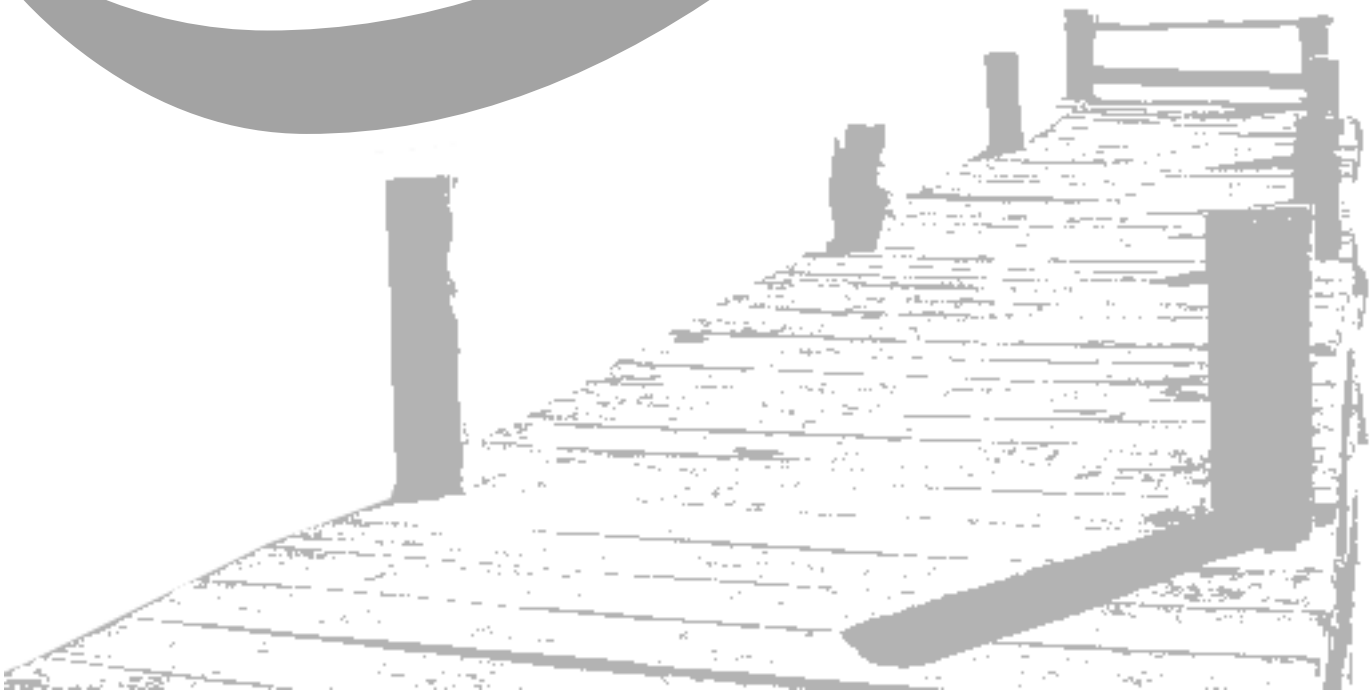
GCE
AS and A Level

Biology

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 4:
Specimen Question Paper

Version 1.1



Version 1.1 0309

Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

For Examiner's Use

General Certificate of Education
Advanced Level Examination

BIOLOGY
Populations and environment **BIOL4**

Specimen Paper

In addition to this paper you will require
- a ruler with millimetre measurements
- a calculator.

Time allowed: 1 hour 30 minutes

Instructions
- Use black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked

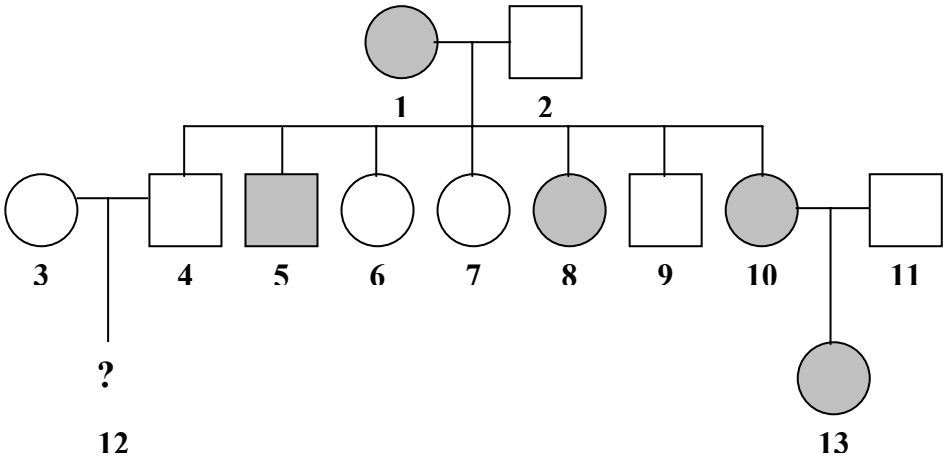
Information
- The maximum mark for this paper is 75.
- The marks for questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.
- Use accurate scientific terminology in all answers.

For Examiner's Use			
Question	Mark	Question	Mark
1			
2			
3			
4			
5			
6			
7			
8			
Total (Column 1)			
Total Column 2)			
TOTAL			
Examiner's Initials			

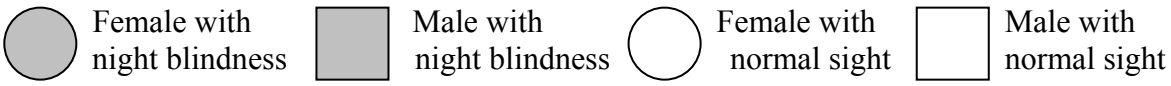
Answer **all** questions in the space provided.

1 People with night blindness have difficulty seeing in dim light. The allele for night blindness, **N**, is dominant to the allele for normal vision, **n**. These alleles are *not* carried on the sex chromosomes.

The diagram shows part of a family tree showing the inheritance of night blindness



Key



(a) Individual **12** is a boy. What is his phenotype?

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(1 mark)

(b) What is the genotype of individual **1**? Explain the evidence for your answer.

Genotype .....

Evidence.....

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(2 marks)

(c) What is the probability that the next child born to individuals **10** and **11** will be a girl with night blindness? Show your working.

Answer.....

(2 marks)

5

Turn over for the next question

2 The table shows the effect of carbon dioxide concentration on the rate of photosynthesis of wheat.

Carbon dioxide concentration/parts per million	**Rate of photosynthesis as net uptake of carbon dioxide per hour/mgdm^{-3}**
100	18
200	33
300	45
400	53
500	60
600	68
700	70
800	71

(a) (i) The rate of photosynthesis is given as the net uptake of carbon dioxide. The true rate of photosynthesis is greater than this. Explain why.

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(1 mark)

(ii) Describe and explain the trend shown by the data in the table above a carbon dioxide concentration of 500 parts per million.

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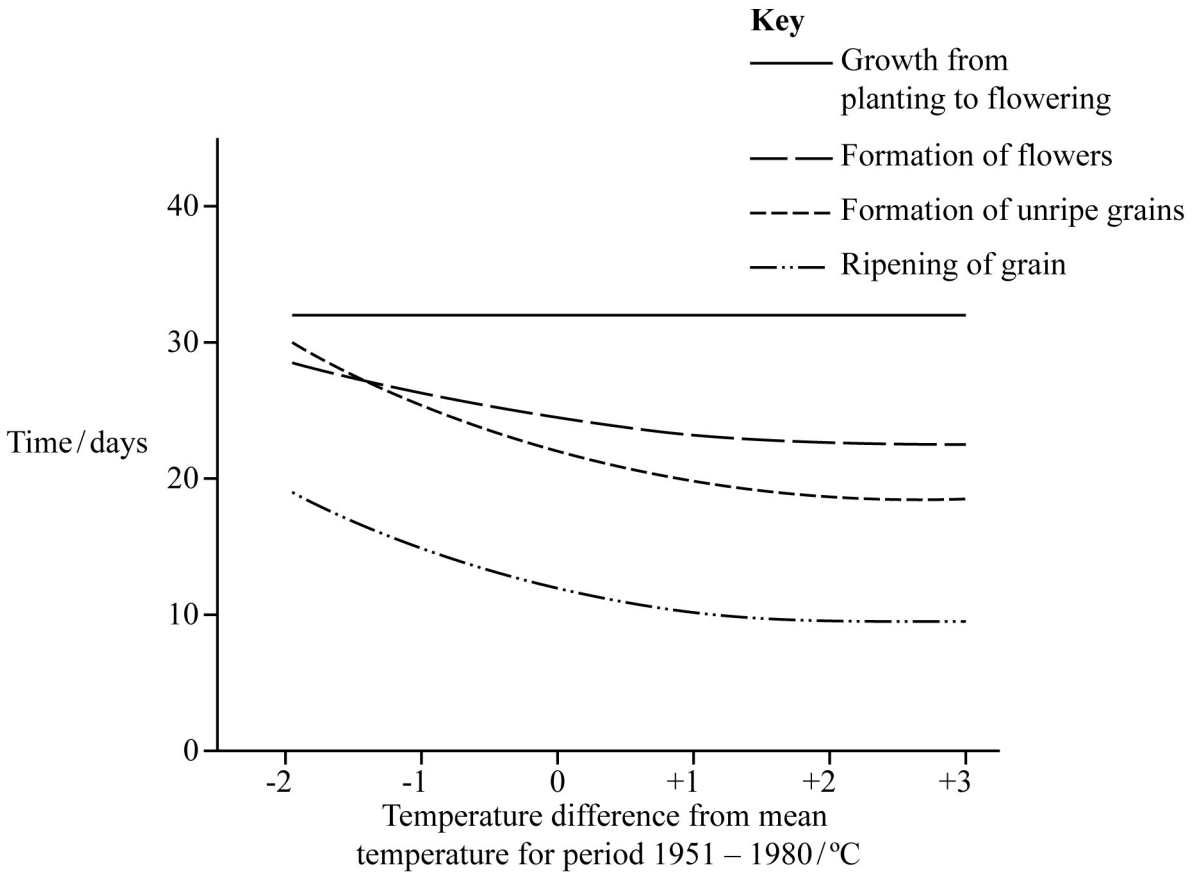
(2 marks)

(b) Scientists investigated the effect of temperature on the development of wheat plants. They calculated the mean temperature for the period 1951 – 1980 and grew wheat plants over a range of 5°C around this temperature. The results of the investigation are shown in the graph.



A rise in carbon dioxide concentration in the atmosphere could influence the yield and timing of the wheat harvest. Use the information from both the table and the graph to explain how.

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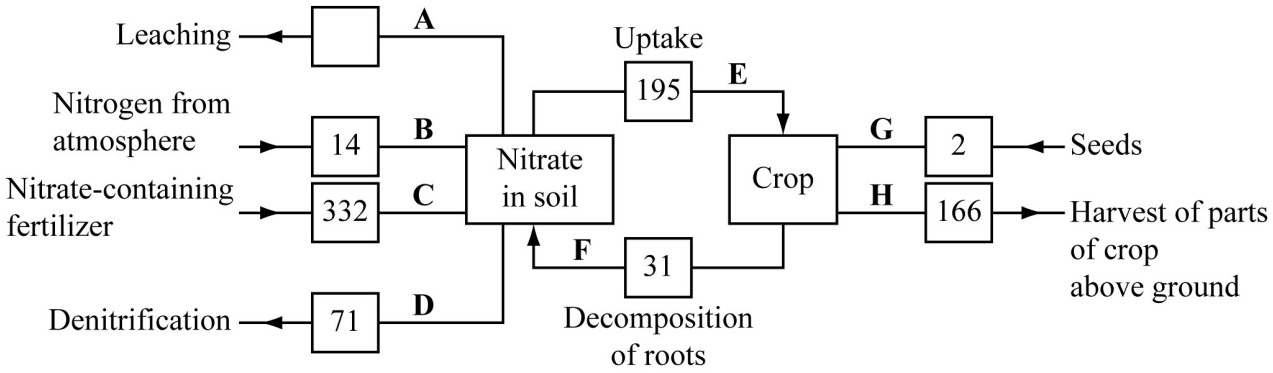
(4 marks)

7

3 A wheat crop was grown in a field on a Dutch farm. When the wheat was harvested, all parts of the crop growing above ground were removed. The diagram shows the nitrogen cycle for this field. The figures are in kg of nitrogen per hectare per year.



(a) Give the letter of **one** pathway involving

(i) nitrifying bacteria

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(1 mark)

(ii) nitrogen-fixing bacteria.

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(1 mark)

(b) (i) Describe the part played by bacteria in pathway **D.**

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(2 marks)

(ii) This wheat crop was growing on clay soil. Clay is easily waterlogged. The figure for pathway **D** would be lower on a farm with sandy soil that does not become waterlogged. Explain why.

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(2 marks)

(c) (i) Calculate the maximum amount of nitrogen that could be leached from the soil where this crop was growing in a year.

Answer.....kg ha^{-1}

(1 mark)

(ii) The information in the diagram could be useful to the farmer in reducing leaching. Explain **one** way in which it could be useful.

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(1 mark)

8

There are no questions printed on this page

4 Each of the following statements refers to a process that occurs either during photosynthesis or during respiration. A 6C compound refers to a compound whose molecules contain six carbon atoms, 5C refers to a compound with five carbon atoms, and so on.

For each statement, give as precisely as possible the stage of photosynthesis or respiration and the names of the compounds.

(a) A 6C compound is broken down into two 3C compounds.

Stage.....

6C compound .....

3C compound .....

(2 marks)

(b) A 5C compound is combined with a 1C compound.

Stage.....

5C compound .....

1C compound .....

(2 marks)

(c) 3C compounds are combined to form a 6C compound.

Stage.....

3C compound .....

6C compound .....

(2 marks)

6

5 Fur seals live in Antarctic seas. They feed on fish and shrimp-like animals called krill. During the summer the fur seals come ashore to breed. The table shows the number of fur seals breeding on an Antarctic island from 1956 to 1986.

Year	Number of adult fur seals
1956	100
1964	100
1970	200
1975	100
1976	1600
1981	2900
1983	3100
1986	11700

(a) (i) Calculate the mean annual growth rate of this fur seal population over the period 1981 – 1986. Show your working.

Answer.....

(2 marks)

(ii) Scientists suggested that the increase in the fur seal population was due to an increase in commercial whaling. Many species of whale living in Antarctic seas feed on krill. Explain how an increase in whaling might have resulted in an increase in the seal population.

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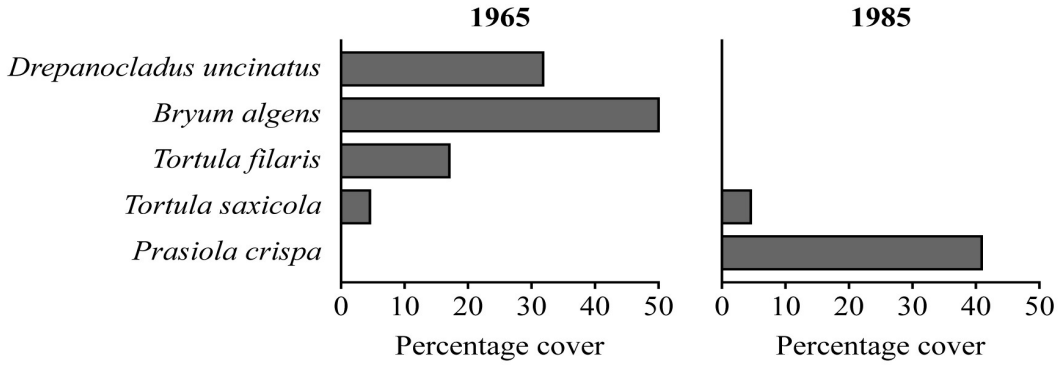
(2 marks)

Research workers set up permanent quadrats to investigate the effect of the seals on the island vegetation. The diagram shows the percentage cover of the plants in one of the permanent quadrats in 1965 and again in 1985.



(b) Give **two** advantages of collecting quantative data about plant distribution as percentage cover.

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(2 marks)

(c) The seals affected the vegetation in the quadrat over the time period. Describe how.

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(3 marks)

(d) *Prasiola crispa* colonises soil with a high concentration of nitrogen-containing ions. Explain the increase in *P. crispa* in this quadrat.

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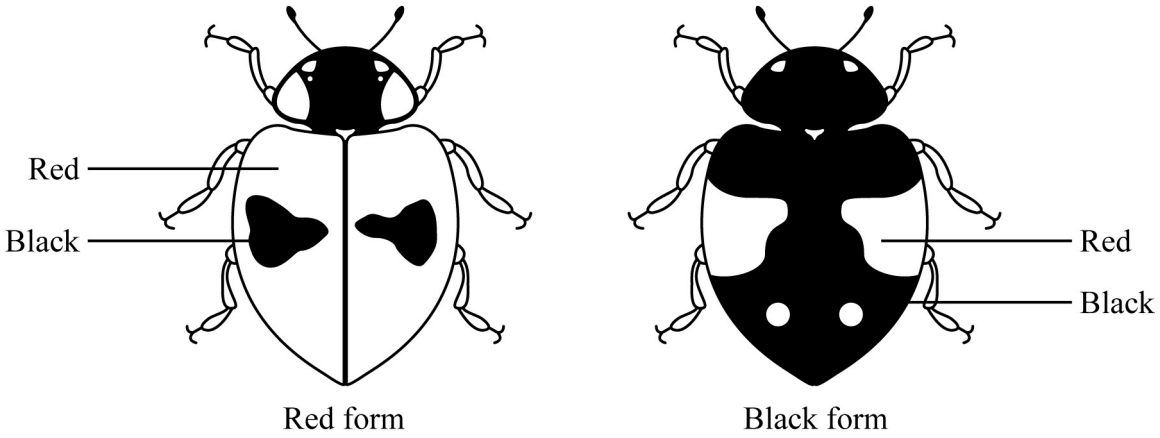
(2 marks)

11

6 The two-spot ladybird is a small beetle. It has a red form and a black form. These two forms are shown in the diagram.



Colour is controlled by a single gene with two alleles. The allele for black, **B**, is dominant to the allele for red, **b**.

Scientists working in Germany compared the number of red and black ladybirds over a ten-year period. They collected random samples of ladybirds from birch trees.

(a) (i) It was important that ladybirds in the samples were collected at random. Explain why.

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(1 mark)

(ii) Suggest **one** method by which the scientists could collect a random sample of ladybirds from the trees.

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(1 mark)

Some of the results from the investigation are shown in the table.

Year	Season	Frequency of b allele
1933	Autumn	0.70
1934	Spring	0.82
1934	Autumn	0.59
1935	Spring	0.76
1935	Autumn	0.57
1936	Spring	0.78

(b) Use the Hardy-Weinberg expression to estimate the percentages of red ladybirds and black lady birds in the Autumn 1933 ladybird population.
Show your working.

Answer ..... red ladybirds

..... black ladybirds
(2 marks)

(c) (i) The evidence from the table shows that the black ladybirds were at a disadvantage and survived less well over winter. Explain this evidence.

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(2 marks)

(ii) The scientists found that black ladybirds heated up more quickly and became active at lower temperatures than red ladybirds. How might this explain the poorer survival of black ladybirds over winter?

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(2 marks)

8

7 The polecat, shown in the drawing, is a wild British mammal. At one time it was very rare. It is now more common and its range is increasing. Scientists carried out a survey of the distribution and status of polecats in Britain during the 1990s.

The first problem that the scientists had was that they needed to distinguish between wild polecats and escaped ferrets. Ferrets are domesticated polecats. They investigated skulls from polecats and ferrets.

They used dial callipers to take skull measurements. They took each measurement six times on six different skulls. They used their measurements to calculate a percentage measurement error using the formula:

$$\text{Percentage measurement error} = \frac{100\,(1 + 0.25n)\,\sigma}{\text{x}}$$

where n = number of measurements
σ = standard deviation
x = mean

(a) (i) Use the information from this question to explain the difference between accuracy and reliability.

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(2 marks)

(ii) Unreliable measurements will produce a large percentage measurement error. Use the formula to explain why.

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(2 marks)

Table 1 shows some of the skull measurements obtained by the scientists.

Table 1

Animal	Sex	Number of skulls measured	Mean skull breadth/mm		Cranial volume/cm^3	
			mean	standard deviation	mean	standard deviation
Polecat	Male	90	16.38	1.34	10.15	0.92
Ferret	Male	114	15.56	0.84	8.96	0.93
Polecat	Female	44	15.52	1.04	8.34	0.68
Ferret	Female	47	14.42	0.78	7.03	0.55

(b) (i) Describe **one** way in which you could show whether there was a correlation between mean skull breadth and mean cranial volume.

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(2 marks)

(ii) The scientists found that there was an advantage in taking measurements of skull breadth rather than cranial volume when measuring skull size. Suggest this advantage.

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(1 mark)

Question 7 continues on the next page

(iii) Is skull breadth a reliable way of determining whether a particular skull came from a polecat of from a ferret? Explain the evidence from **Table 1** that supports your answer.

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(3 marks)

(c) In the report that the scientists wrote, they referred to an earlier scientific paper about "Some characteristics of the skulls and skins of the European polecat, the Asiatic polecat and the domestic ferret"
Describe **two** ways in which this earlier paper might have helped the scientists to carry out their work and produce a reliable report.

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(2 marks)

In this survey, the scientists collected the bodies of the dead polecats from roads where they had been killed by passing vehicles. They analysed the stomachs to see what the polecats had eaten. **Table 2** shows the results.

Table 2

Prey	Total number of polecats examined = 83			
	Mass/g	**Mass as percentage of all prey**	**Number of stomachs in which prey item found**	**Percentage of all stomachs in which prey item found**
Rabbit	1063.80	85.4	60	72.3
Rat	22.18	1.8	2	2.4
Other mammals	43.54	3.5	9	10.8
Pigeons	29.45	2.4	3	3.6
Other birds	7.68	0.6	5	5.6
Frogs and toads	56.98	4.6	7	8.4
Fish	0.12	0.01	1	1.2
Earthworms	21.97	1.8	2	2.4
Total	**1245.72**		**89**	

(d) The table shows that a total of 83 stomachs were analysed. Explain why the total for the number of stomachs in which the prey item was found was more than 83.

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(1 mark)

(e) Some farmers regard polecats as pests and claim that they kill poultry and game birds. Use the data to suggest how you would explain to these farmers that they should tolerate polecats on their land.

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(2 marks)

15

8 Roundabouts are common at road junctions in towns and cities. Ecologists investigated the species of plants and animals found on roundabouts in a small town.

(a) Ground beetles are large black insects. The mark-release-recapture method can be used to estimate the ground beetle population on a roundabout. Describe how.

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(5 marks)

(b) The grass on the roundabouts was mown at different time intervals. The table shows the mean number of plant species found on the roundabouts.

Approximate interval between mowing/days	**Mean number of plant species**
7	15.8
14	21.2
40	30.6
365+	32.0

Mowing was also found to affect the number of insect species found on a roundabout. Use your knowledge of succession to explain how.

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(5 marks)

(c) The carbon dioxide concentration was monitored at ground level in the centre of a small roundabout. The measurements were made on a summer day. Describe and explain how you would expect the concentration of carbon dioxide to fluctuate over the period of 24 hours.

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(5 marks)

END OF QUESTIONS

15

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