Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

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

General Certificate of Education
Advanced Level Examination
January 2010

Biology BIOL4

Unit 4 Populations and environment

Monday 25 January 2010 1.30 pm to 3.00pm

For this paper you must have:
- a ruler with millimetre measurements.
- a calculator.

Time allowed
- 1 hour 30 minutes

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. Answers written in margins or on blank pages will not be marked.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 75.
- The marks for questions are shown in brackets.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use accurate scientific terminology.

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

1 Snow geese fly north to the Arctic in the spring and form breeding colonies. Different colonies form at different latitudes. The greater the latitude, the further north is the colony. The further north a breeding colony forms, the colder the temperature and the greater the risk of snow.

1 (a) There is a positive correlation between the size of snow geese and how far north they breed. A large size results in snow geese being adapted for breeding in colder conditions. Explain how.

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(2 marks)

Snow geese are either white or blue in colour. The table shows the percentage of white snow geese in colonies at different latitudes at different times over a 40-year period. The blank cells in the table are years for which no figures are available.

Colony	Latitude in degrees north	Percentage of white snow geese each year			
		1930	1950	1960	1970
A	72	100		100	100
B	71		>99	>99	>99
C	66	95	85	76	
D	63	86	75	67	65
E	55		62		28

1 (b) (i) Describe how the percentage of white snow geese varies with distance north.

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(1 mark)

1 (b) (ii) The further north, the greater the risk of snow. Use this information to explain how natural selection might have accounted for the effect of latitude on the percentage of white snow geese.

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(3 marks)

(Extra space) .....

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1 (c) The percentage of white snow geese in these colonies changed over the period shown in the table. Use your knowledge of climate change to suggest an explanation.

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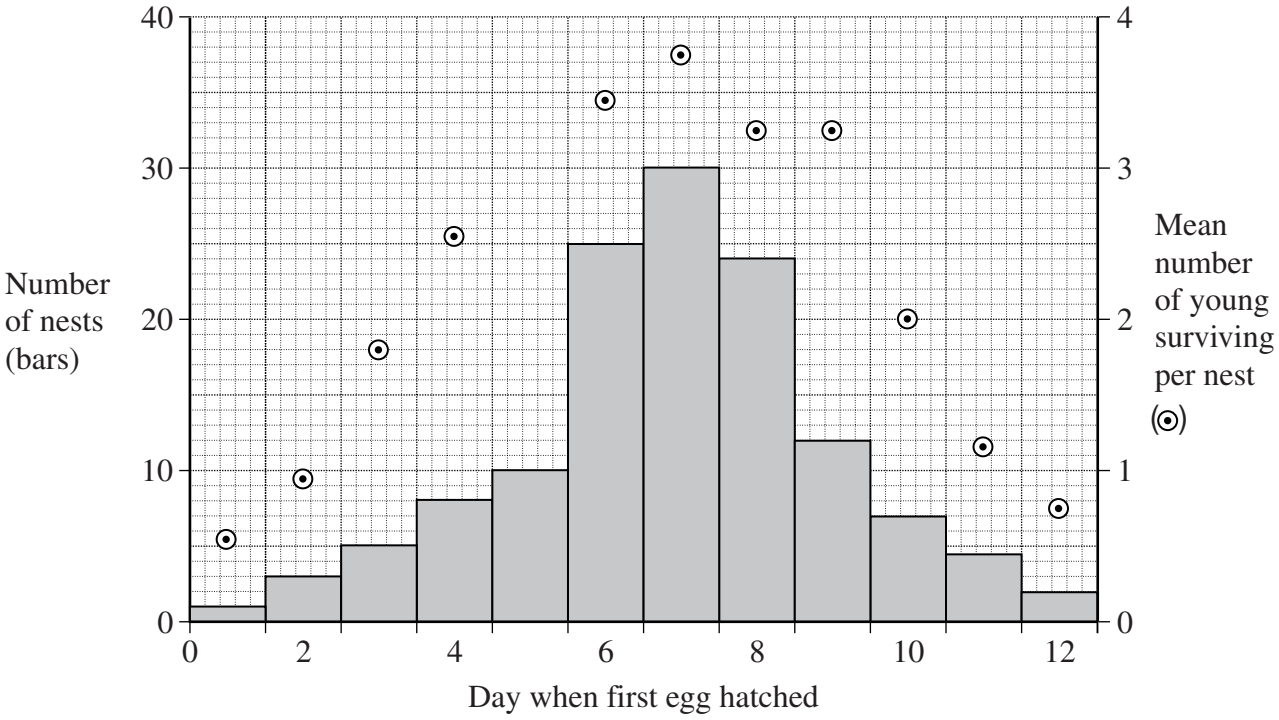
(2 marks)

Question 1 continues on the next page

1 (d) Snow geese breed in large colonies. Scientists studied the nests in one colony. For each nest, they recorded the day on which the first egg hatched. They also recorded the number of young that survived from the nest. They used the data to plot a graph.



1 (d) (i) What type of natural selection is shown in the graph?

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(1 mark)

1 (d) (ii) Describe the evidence for your answer.

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(1 mark)

10

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

2 (a) Dead leaves contain starch. Describe how microorganisms make carbon in starch available to plants.

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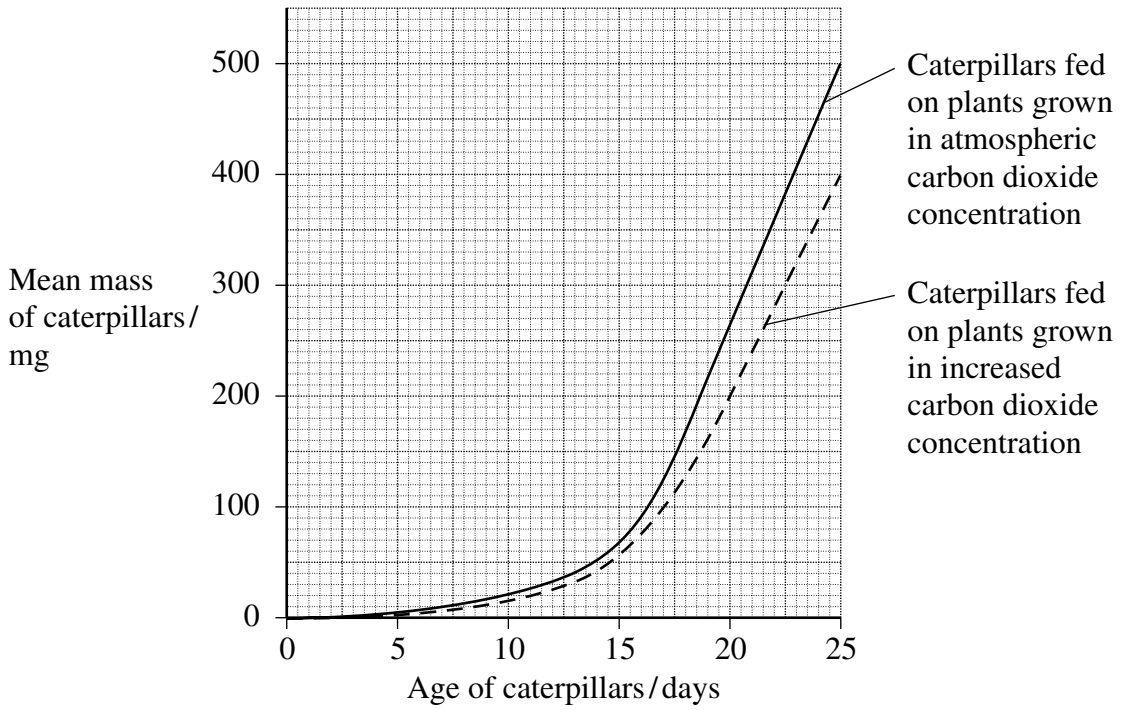
(2 marks)

Scientists grew groups of the same species of crop plant in a greenhouse in two different concentrations of carbon dioxide. They fed caterpillars on plants from each group and measured the growth of the caterpillars. The results of their investigation are shown in the graph.



2 (b) Calculate the maximum rate of growth of the caterpillars on the plants grown in the increased carbon dioxide concentration. Show your working.

Answer ..... mg day^{-1}

(2 marks)

2 (c) Other scientists showed that plants grown in an increased concentration of carbon dioxide have a higher carbon : nitrogen ratio than plants grown in atmospheric carbon dioxide concentration. What does this suggest about the protein concentration in the plants grown in the increased concentration of carbon dioxide? Explain your answer.

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(2 marks)

2 (d) It would not be valid to conclude from the investigations described in this question that an increase in carbon dioxide concentration would reduce crop losses due to caterpillars. Give **two** reasons why this conclusion might not be valid in field conditions.

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(2 marks)

8

Turn over for the next question

3 (a) Explain what is meant by the ecological term, population.

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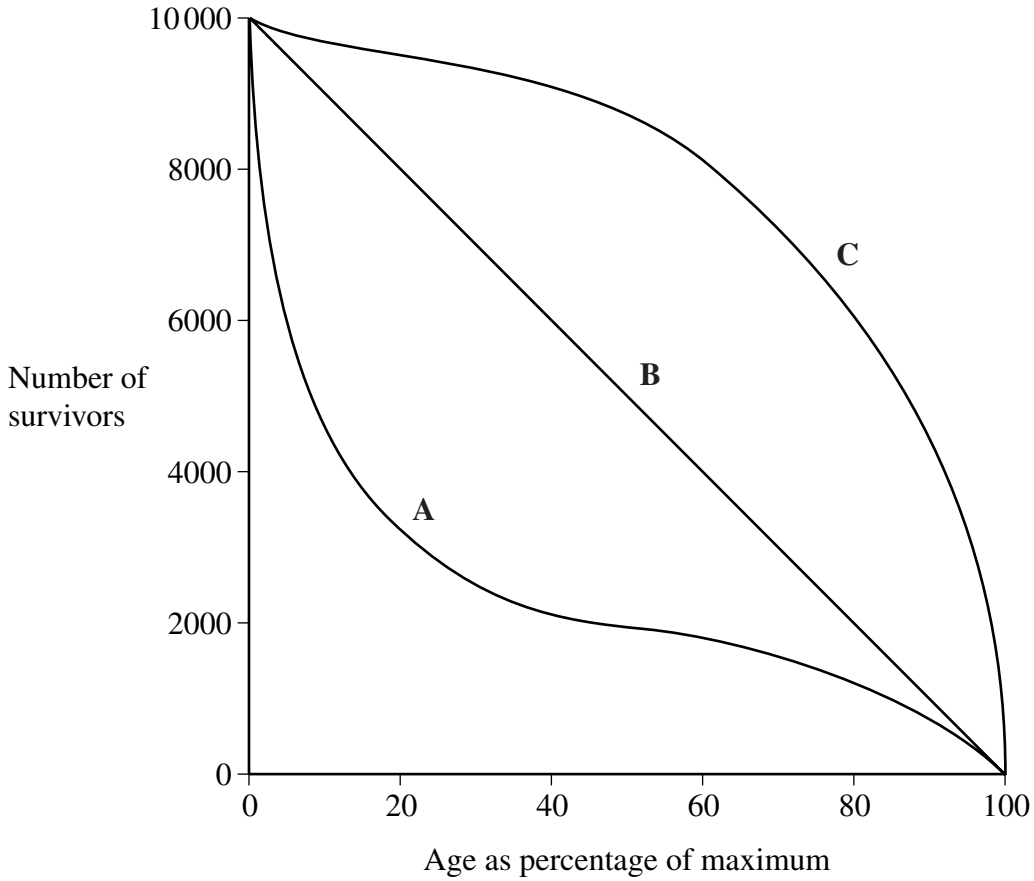
(1 mark)

3 (b) The diagram shows three survival curves, **A**, **B** and **C**.



3 (b) (i) Assume that the maximum age of a person living in a developed country is 95 years.

The diagram can be used to find the average life expectancy of people living in developed countries. Explain how.

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(3 marks)

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3 (b) (ii) Curve **A** is a survival curve for people living in the UK in 1750. Explain why the curve is this shape.

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(2 marks)

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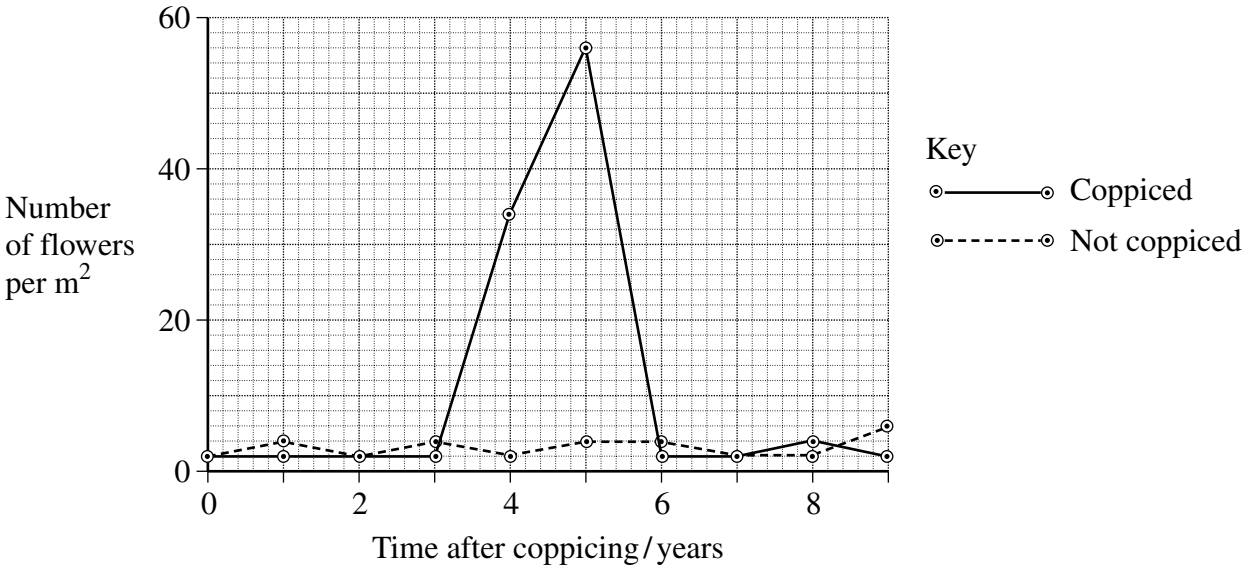
4 Woods can be coppiced to provide a continuous supply of useful logs and poles. Coppicing involves cutting down some trees in a wood to leave stumps. New shoots grow from the stumps. After about 15 years, these trees can be coppiced again.

Because coppicing produces a wood with patches of light and shade, the diversity of plants and animals in a coppiced wood is high.

Ecologists investigated the effect of coppicing on the flowering of wild daffodils growing in a wood in Cumbria. Some areas of the wood were coppiced and some areas were not. The graph shows some results from this investigation.



4 (a) You could collect data for the coppiced plots by using quadrats.

4 (a) (i) Describe how you would place the quadrats at random.

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(2 marks)

4 (a) (ii) Describe how you would decide the number of quadrats to use in order to collect representative data.

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(2 marks)

4 (b) Members of the public visit this wood to see wild daffodils in flower. Explain how the information in the graph could help the owners to manage the wood so that there were many wild daffodils in flower every year.

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(2 marks)

4 (c) The ecologists analysed the relationship between the number of daffodils in flower in the whole wood and data collected from a nearby weather station for the previous year. They used the Spearman rank correlation test. The table shows their results.

Month	Climatic factor	Correlation coefficient	Statistical significance
July	Total rainfall	+0.65	significant
August	Total rainfall	+0.74	significant
July	Monthly mean temperature	−0.78	significant
August	Monthly mean temperature	−0.65	significant

The ecologists concluded that a wet, cool summer produces good flowering the following spring. Do you support this conclusion? Use the data in the table to explain your answer.

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(2 marks)

8

5 (a) The biochemical pathway of aerobic respiration involves a number of different steps. Name **one** step in which carbon dioxide is produced.

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(1 mark)

In an investigation, scientists transferred slices of apple from air to anaerobic conditions in pure nitrogen gas. They measured the rate of carbon dioxide production.

5 (b) The scientists kept the temperature constant throughout the investigation. Explain how a decrease in temperature would affect the rate of carbon dioxide production.

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(2 marks)

5 (c) When the apple slices were transferred to nitrogen, the following biochemical pathway took place.

Pyruvic acid Ethanol

Use this pathway to explain the part played by reduced NAD when the apple slices were transferred to nitrogen.

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(2 marks)

5 (d) The rate of carbon dioxide production was higher when the apple slices were in nitrogen than when they were in the air. Explain why.

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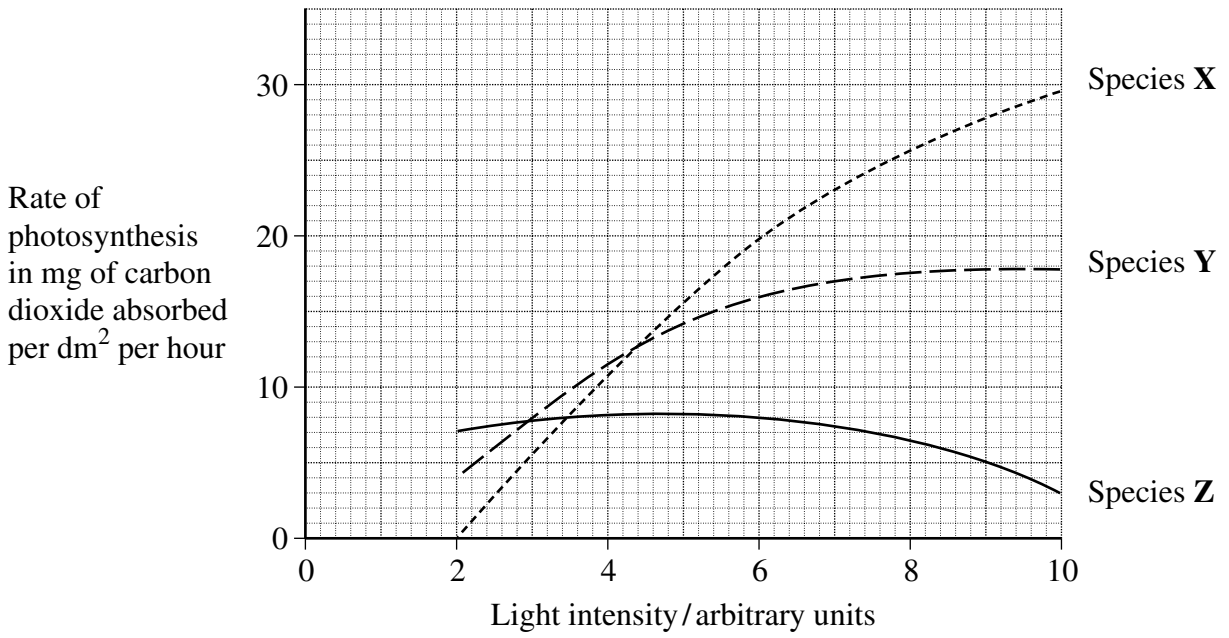
Turn over for the next question

6 The graph shows the effects of light intensity on the rate of photosynthesis of three species of tree, **X**, **Y** and **Z**. Each of these species occurs at a different stage in succession.



6 (a) Species **X** is the first tree to become established in the succession. Use the graph to explain why it is likely to become established earlier in the succession than **Y** or **Z**.

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(3 marks)

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6 (b) Species **X** may change the environment so that it becomes more suitable for species **Z**. Use the graph to explain why.

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(2 marks)

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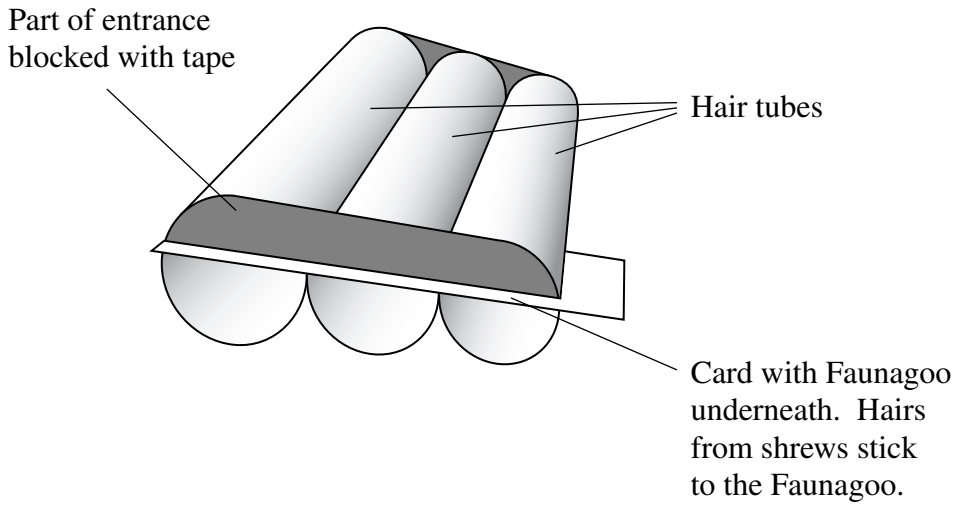
Turn over for the next question

7 Shrews are small mammals. Three species of shrew live in mainland Britain. The table shows some features of these shrews.

Species	Mean body mass / g	Mean length of head and body / mm	Food
Common shrew	10	79	Mainly insects and other small invertebrates
Pygmy shrew	5	58	
Water shrew	13	85	

A team of biologists investigated a method of estimating the abundance of shrews. They used plastic tubes, called hair tubes. Some of the hairs from a shrew that enters one of these tubes stick to glue in the tube. These hairs can be used to identify the species of shrew. The diagram shows a set of these hair tubes.



7 (a) (i) Faunagoo is a glue that remains sticky after wetting and drying. Explain the advantage of using Faunagoo in these hair tubes.

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(1 mark)

7 (a) (ii) The diagram shows that the biologists partly blocked the entrances to the tubes with tape. Suggest why they partly blocked the entrances.

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(1 mark)

7 (b) The biologists needed to find a way of distinguishing between the hairs of the three species of shrew. They collected hairs from shrews of each species. For each species, they selected hairs at random and made different measurements.

Explain why the biologists selected the hairs at random.

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(1 mark)

7 (c) Repeatable measurements are measurements of the same feature that are very similar. In this investigation, each measurement was made by two observers. This helped the team to check the repeatability of these measurements.

7 (c) (i) Explain why it was important to check the repeatability of the measurements.

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(2 marks)

7 (c) (ii) You could use a scatter diagram to check the repeatability of measurements made by two observers. Describe how.

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(2 marks)

Question 7 continues on page 19

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ANSWER IN THE SPACES PROVIDED

7 (d) The biologists used hair tubes to find the abundance of shrews along the edges of some fields. They also used traps that caught shrews without harming them. They selected areas where all three species of shrew were present.

- They put sets of hair tubes at 5 m intervals along the edges of the fields. They inspected the tubes one week later and recorded the number of sets of tubes that contained shrew hairs. They called this the hair tube index.
- At each site where they used hair tubes, they set traps immediately after using the hair tubes. They recorded the number of different shrews caught in these traps.

7 (d) (i) The research team found the hair tube index. Explain why they could not use the hair tubes to find the total number of shrews present.

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(1 mark)

7 (d) (ii) The research team set the traps immediately after using the hair tubes. Explain why setting the traps immediately after using the hair tubes would make comparisons between the two methods more reliable.

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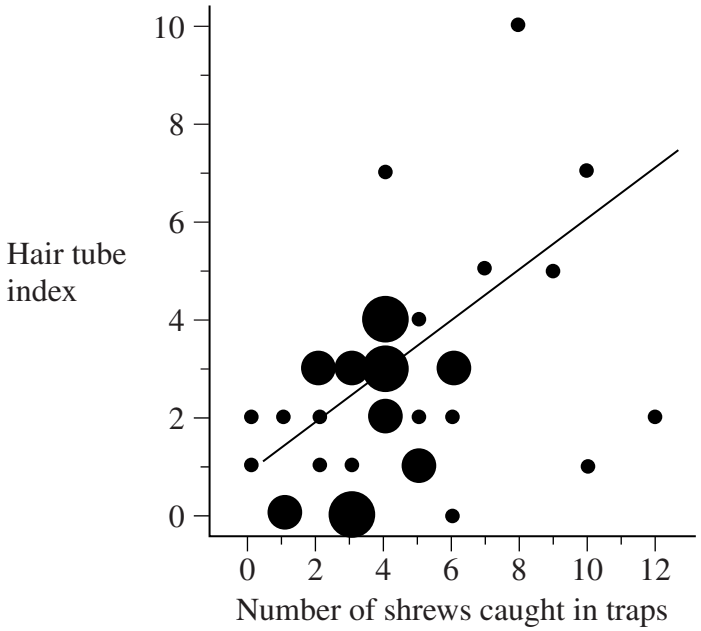
(2 marks)

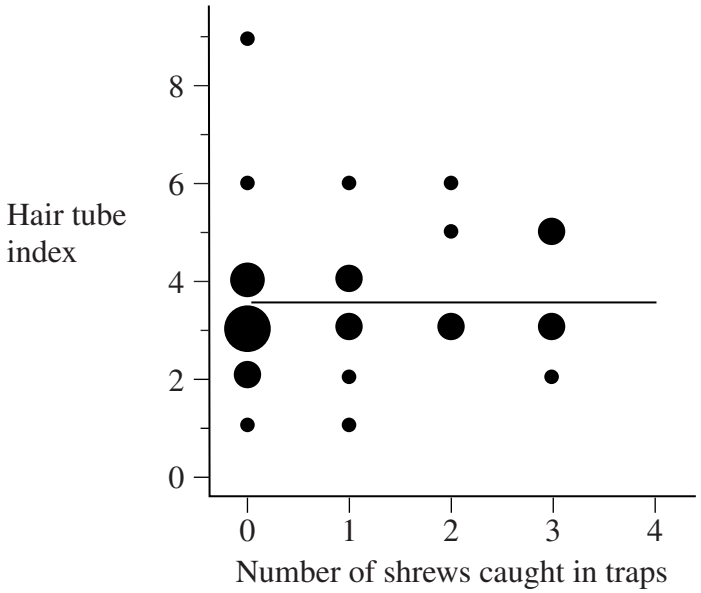
Question 7 continues on the next page

The graphs are types of scatter diagram called bubble plots. They show hair tube index plotted against the number of shrews caught in traps. The area of the bubble is proportional to the number of records plotted.

Common shrew



Pygmy shrew



7 (e) Explain why a statistical test was necessary in analysing the results for the common shrew. Use the terms chance and probability in your answer.

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(2 marks)

7 (f) (i) The biologists concluded that hair tubes were a reliable way of measuring the abundance of common shrews. Give evidence from the graph to support this conclusion.

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(1 mark)

7 (f) (ii) Use information in this question to evaluate the use of hair tubes as a way of measuring the abundance of pygmy shrews.

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15

8 (a) In the light-dependent reaction of photosynthesis, light energy generates ATP. Describe how.

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8 (b) Energy is transferred through an ecosystem.
Describe how and explain why the efficiency of energy transfer is different at different stages in the transfer.

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Question 8 continues on the next page

8 (c) Explain how the intensive rearing of domestic livestock increases net productivity.

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END OF QUESTIONS