

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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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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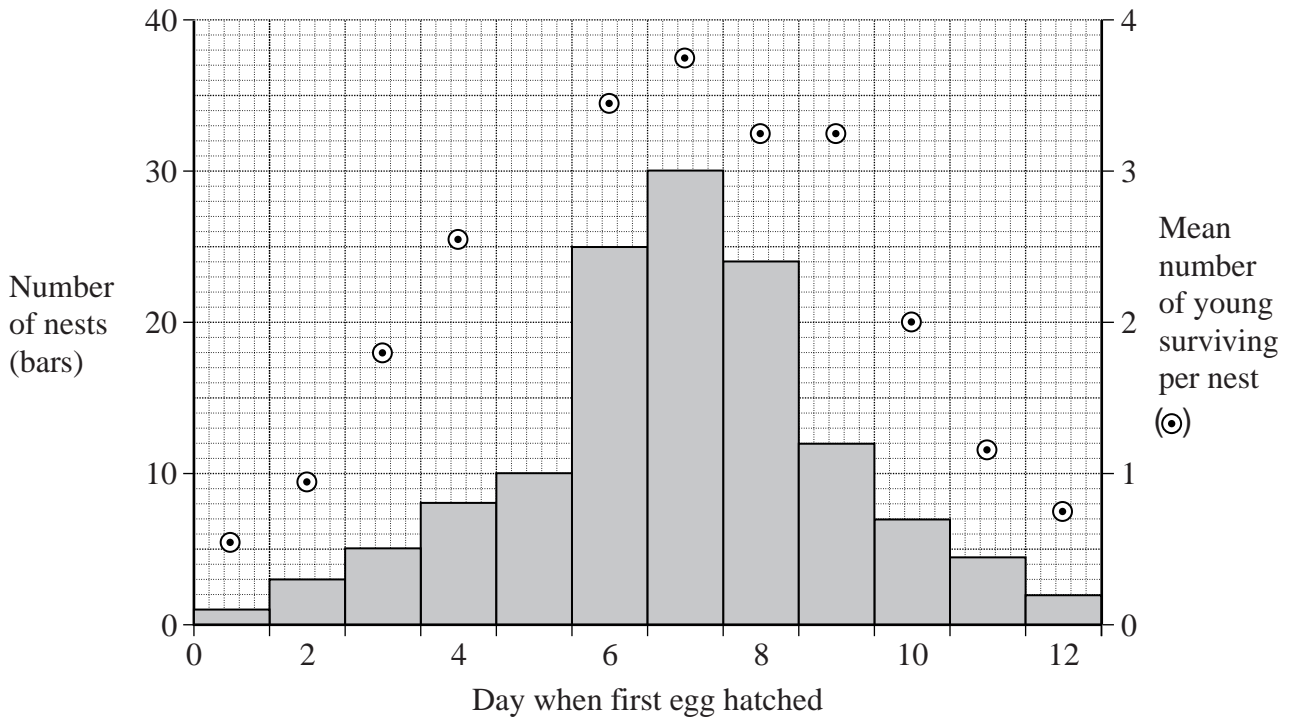
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(2 marks)

Question 1 continues on the next page

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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)

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

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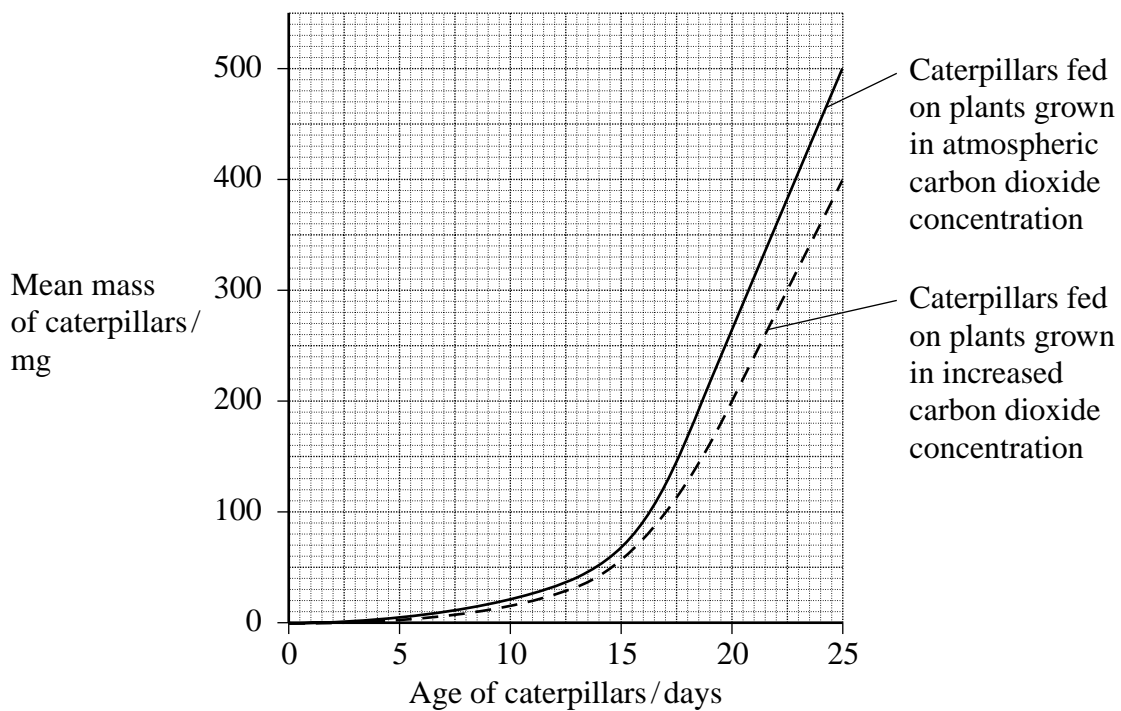
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Scientists grew groups of the same species of crop plant in a greenhouse in two different concentrations of carbon dioxide. They fed caterpillars on plants from each group and measured the growth of the caterpillars. The results of their investigation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

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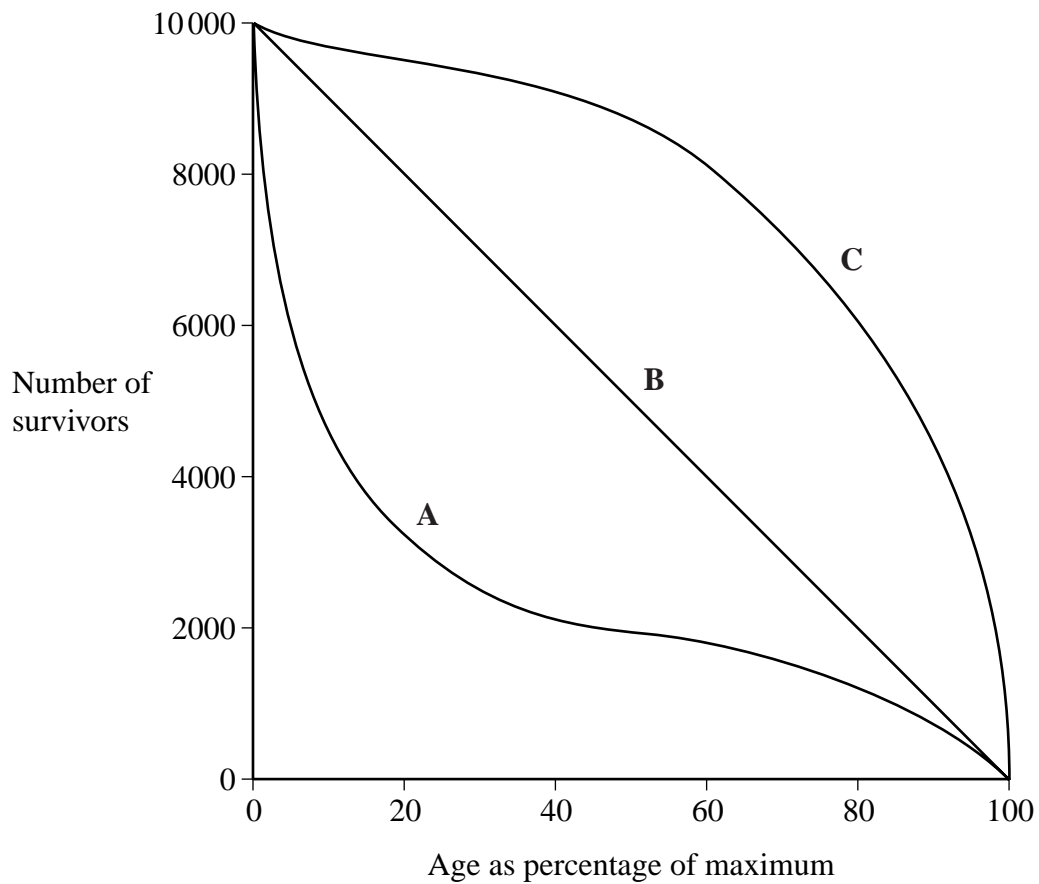
3 (a) Explain what is meant by the ecological term, population.

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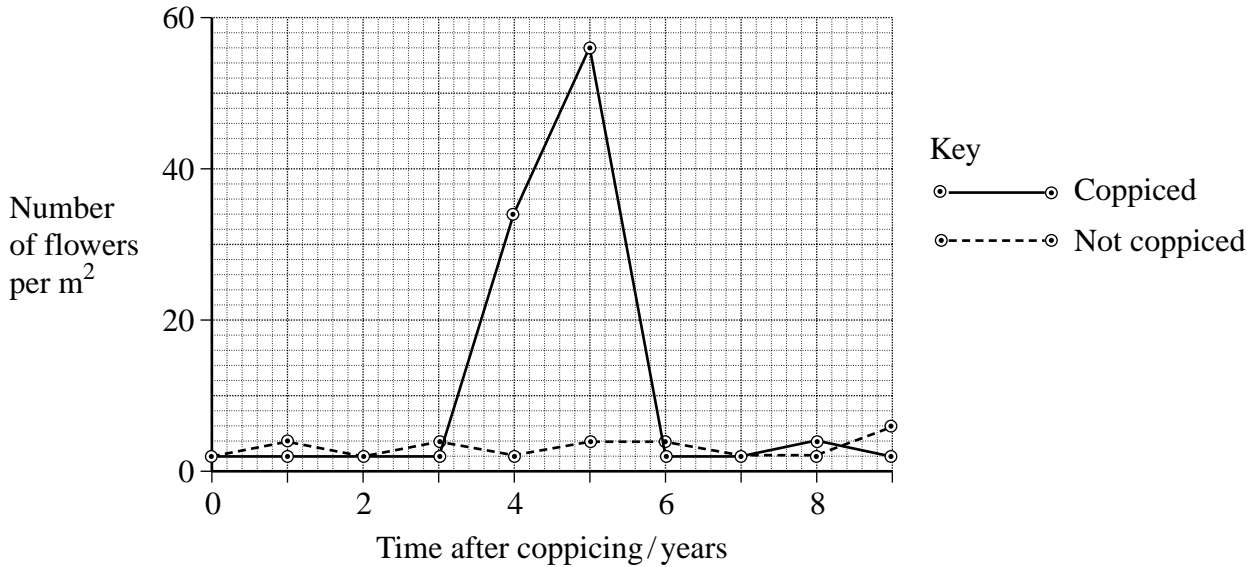
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4 Woods can be coppiced to provide a continuous supply of useful logs and poles. Coppicing involves cutting down some trees in a wood to leave stumps. New shoots grow from the stumps. After about 15 years, these trees can be coppiced again.

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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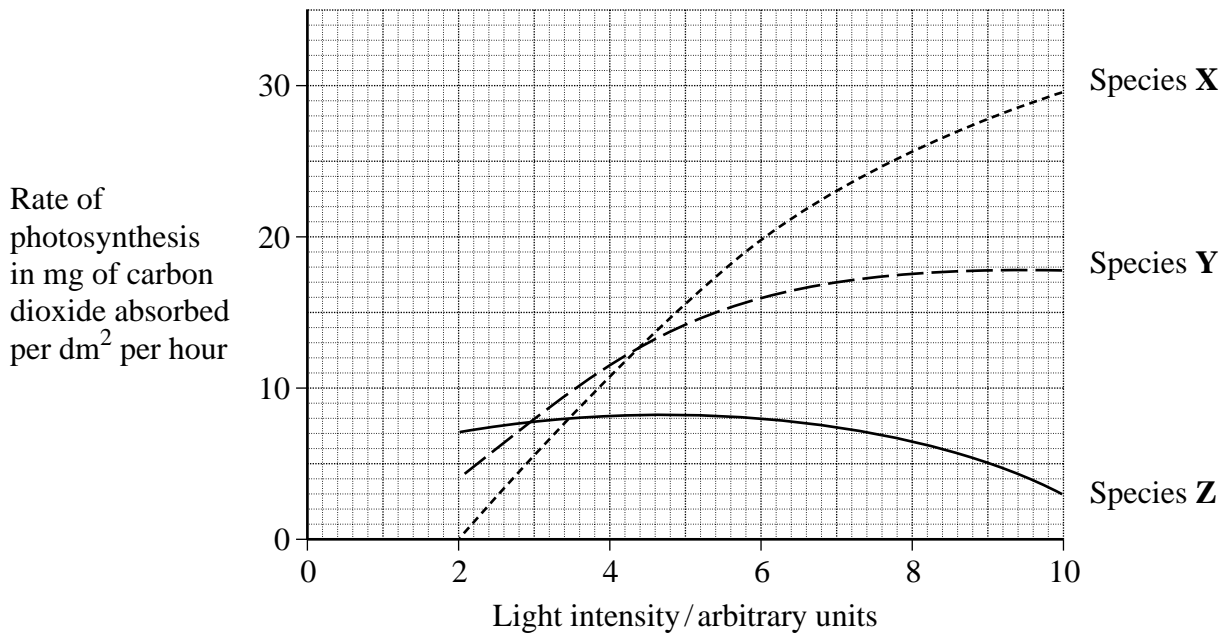
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Question 5: N/A

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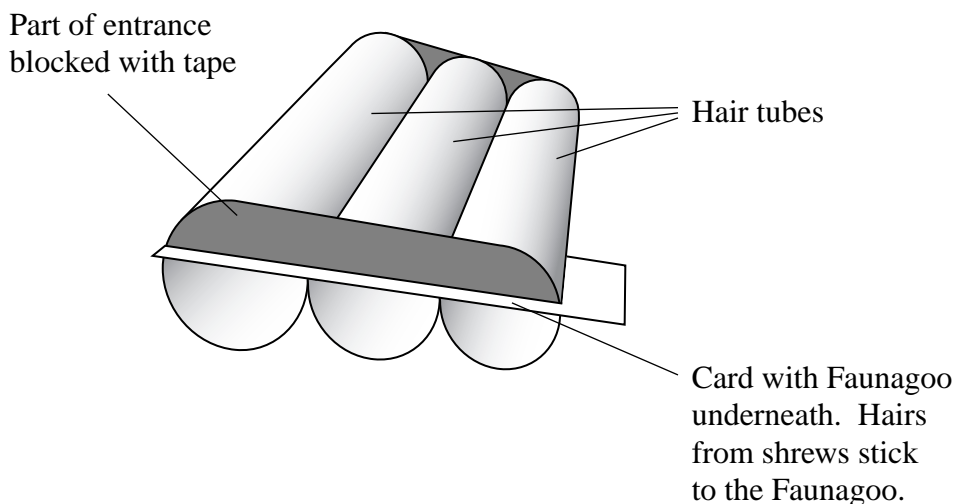
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7 Shrews are small mammals. Three species of shrew live in mainland Britain. The table shows some features of these shrews.

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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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)

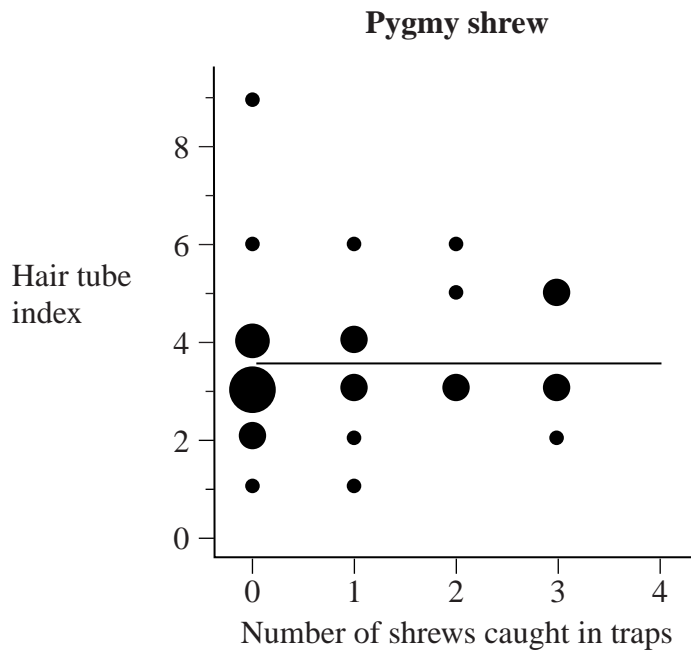
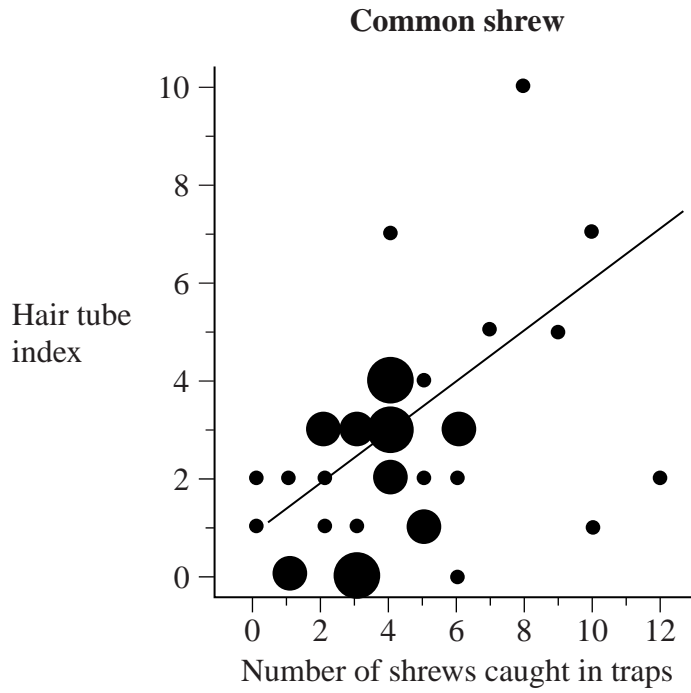
7 (d) (ii) The research team set the traps immediately after using the hair tubes. Explain why setting the traps immediately after using the hair tubes would make comparisons between the two methods more reliable.

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(2 marks)

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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.



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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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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(2 marks)

15

Turn over ►

8 SCID is a severe inherited disease. People who are affected have no immunity. Doctors carried out a trial using gene therapy to treat children with SCID. The doctors who carried out the trial obtained stem cells from each child's umbilical cord.

(a) Give **two** characteristic features of stem cells.

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(2 marks)

The doctors mixed the stem cells with viruses. The viruses had been genetically modified to contain alleles of a gene producing full immunity. The doctors then injected this mixture into the child's bone marrow.

The viruses that the doctors used had RNA as their genetic material. When these viruses infect cells, they pass their RNA and two viral enzymes into the host cells.

(b) One of the viral enzymes makes a DNA copy of the virus RNA. Name this enzyme.

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(1 mark)

8 The other viral enzyme is called integrase. Integrase inserts the DNA copy anywhere in the DNA of the host cell. It may even insert the DNA copy in one of the host cell's genes.

(c) (i) The insertion of the DNA copy in one of the host cell's genes may cause the cell to make a non-functional protein. Explain how.

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(c) (ii) Some of the children in the trial developed cancer. How might the insertion of the DNA have caused cancer?

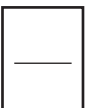
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(d) Five out of the 20 children in the trial developed cancer. Although the cancer was treated successfully, the doctors decided to stop the trial in its early stages. They then reviewed the situation and decided to continue. Do you agree with their decision to continue? Explain your answer.

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(2 marks)



9 There are wolves in many European countries. Scientists investigated the genetic diversity of these wolves. They collected samples of DNA from the mitochondria of wolves from different countries. For each sample they identified which haplotypes were present in the DNA. A haplotype is a particular sequence of bases on DNA. Mutations can produce new haplotypes.

The scientists wanted to find out whether one of the haplotypes in the Portuguese wolves was the same as one of those in the Spanish wolves. They used a restriction endonuclease, electrophoresis and a labelled DNA probe.

9 (a) For what purpose did they use

9 (a) (i) the restriction endonuclease

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 (1 mark)

9 (a) (ii) electrophoresis?

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 (1 mark)

9 (b) Explain why the labelled DNA probe could be used to find out whether the haplotypes were the same.

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 (2 marks)

9 (c) Two hundred years ago there were many wolves in Italy. By the 1970s there were fewer than 100 wolves left. Since 1980, wolves have increased in number and have spread to France.

9 (c) (i) Use this information to explain the number of haplotypes in the Italian wolves.

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(2 marks)

9 (c) (ii) Suggest an explanation for the number of haplotypes in the wolves that have spread to France.

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(1 mark)

9 (d) The scientists analysed the DNA on the Y chromosome and the DNA in the mitochondria of the Swedish wolves. They concluded that the Swedish wolf population descended from one male wolf from Finland and one female wolf from Russia.

9 (d) (i) Explain why DNA on the Y chromosome helped them to reach this conclusion.

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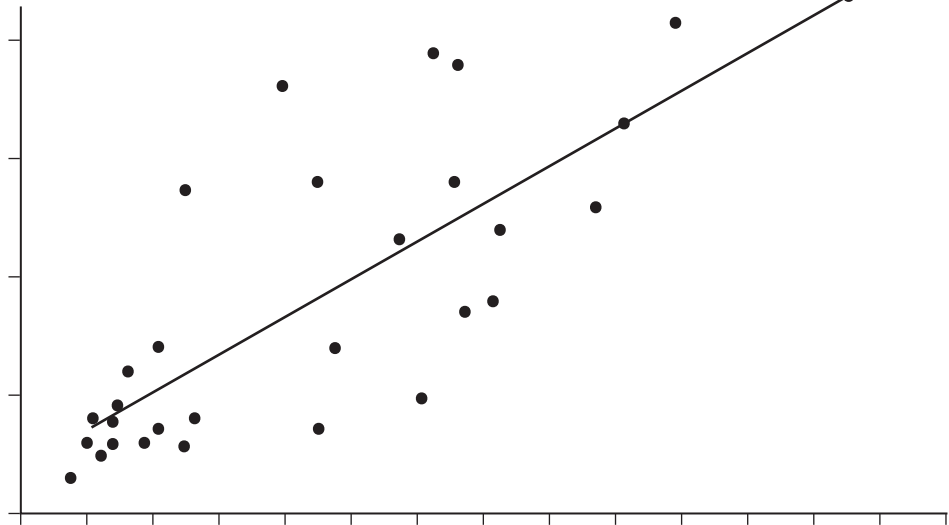
(1 mark)

9 (d) (ii) Suggest why DNA in the mitochondria helped them to reach this conclusion.

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(1 mark)

Wolves eat different mammals. An ecologist investigated factors that affect wolf numbers in North America. He collected data from different field studies carried out in different places. The graph shows his results.



9 (e) (i) The wolf numbers are given per unit area. Explain why.

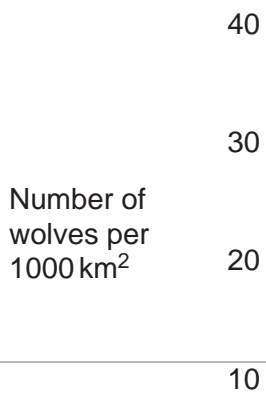
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9 (e) (ii) The ecologist calculated the total prey index for each of the places that had been studied. In order to do this, he gave each prey species a value based on how much food was available to wolves from the prey animal concerned. He called this value the prey index.

The ecologist considered that the prey index gave a better idea of the food available than the prey biomass in kg. Suggest why the prey index gives a better idea of food available.

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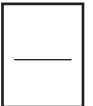
9 (f) The ecologist calculated the total prey index by combining the prey indices and the total number of animals of each species present in 1000 km². He plotted this information on the graph.

What does the graph suggest about the factors that determine wolf numbers in North America? Explain your answer.

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(2 marks)

Turn over for the next question



ESSAY

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy. It will also be marked for your selection of relevant material from different parts of the specification and from the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific content	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

10 Write an essay on **one** of the following topics.

EITHER

10 (a) Carbon dioxide may affect organisms directly or indirectly. Describe and explain these effects. (25 marks)

OR

10 (b) The causes of disease in humans. (25 marks)

If you want to make a plan write it here.

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