5 Sarawak is an area of tropical rainforest in south-east Asia. Logging has been allowed in 60% of the forest.

A study was carried out into the effects of logging on the diversity of mammal species living in the forest. An area of rainforest was sampled before logging, immediately after logging and then again two years and four years after logging.

Before logging began, there were 29 mammal species and four years after logging there were 26 mammal species.

Table 5.1 shows the population densities of six groups of mammals before and after logging. Where numbers were too small to measure the density, the species was recorded as "present".

Table 5.1

mammal	mean number of animals per km^2			
	before logging	immediately after logging	two years after logging	four years after logging
marbled cat	present	0	0	0
oriental small-clawed otter	present	0	0	0
giant squirrel	5	1	4	1
small squirrel	16	24	104	19
tree shrew	10	5	10	38
barking deer	3	1	10	present

(a) Marbled cats and otters are carnivores, while squirrels, shrews and deer are herbivores.

Use the information provided to choose the best word(s) or terms to complete the following passage.

The rainforest ..... is a dynamic set of interactions between populations of organisms and the abiotic environment. Energy flows from ..... , such as trees, to ..... consumers, such as squirrels, and on to consumers such as cats and otters at higher ..... . The activities of decomposers contribute to the energy lost from the ..... component of the rainforest but decomposers allow ..... to be recycled. **[6]**

(b) (i) Table 5.1 shows that the number of small squirrels increases initially, but then decreases.

Explain, using your knowledge of factors affecting population growth, why the small squirrel population in this rainforest does **not** increase in size indefinitely.

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..... **[4]**

(ii) Describe, using the information provided, how species richness **and** species evenness change in the rainforest by comparing the situation before logging and four years after logging.

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..... **[2]**

(c) (i) Suggest why marbled cats and oriental small-clawed otters became extinct in this area but other mammals did not.

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..... **[1]**

(ii) Outline **three** reasons for conserving biological resources, such as the rainforest in Sarawak.

1 .....

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2 .....

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3 .....

..... **[3]**

(d) Timber is produced sustainably in the United Kingdom.

Describe **and** explain the benefits of **two** management practices used in sustainable timber production in a temperate country.

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..... **[4]**

[Total: 20]

7 Describe the differences between the following biological terms:

(a) a pioneer community and a climax community

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..... **[2]**

(b) decomposition and denitrification

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..... **[2]**

(c) conservation and preservation

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..... **[2]**

(d) nitrogen fixation and nitrification.

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..... **[2]**

[Total: 8]

END OF QUESTION PAPER

2 The elk, *Cervus canadensis*, is a large herbivore.

Fig. 2.1, **on page 2 of the Insert**, shows figures relating to the number of elk in Yellowstone National Park in the USA between 1965 and 2002.

The figures were obtained in two different ways:

- the white bars show estimated numbers of live elk obtained by ecological sampling
- the black bars show numbers of elk that were legally shot by hunters.

In some years no data for live elk were obtained.

(a) (i) Using Fig. 2.1, describe the pattern shown by the data for the estimated number of live elk from 1965 to 2002.

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..... **[3]**

(ii) The recorded number of elk legally shot by hunters provides accurate data.

Suggest why these data are accurate, but the method used to obtain these data is not a valid way of estimating the number of elk in the population.

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..... **[2]**

(b) The grey wolf, *Canis lupus*, is a large predator whose diet includes elk.

By 1926, grey wolves had been hunted to extinction in Yellowstone Park. However, this species could still be found in other parts of the world.

In 1995, a population of grey wolves was introduced to Yellowstone Park and their numbers increased.

(i) With reference to Fig. 2.1, discuss the factors that may have affected the size of the elk population:

- before 1995
- after 1995.

In your answer you should provide a balanced account referring to factors before and after 1995.

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.....[7]

(ii) Explain why the introduction of wolves to Yellowstone Park in 1995 is an example of conservation.

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..... [2]

[Total: 14]

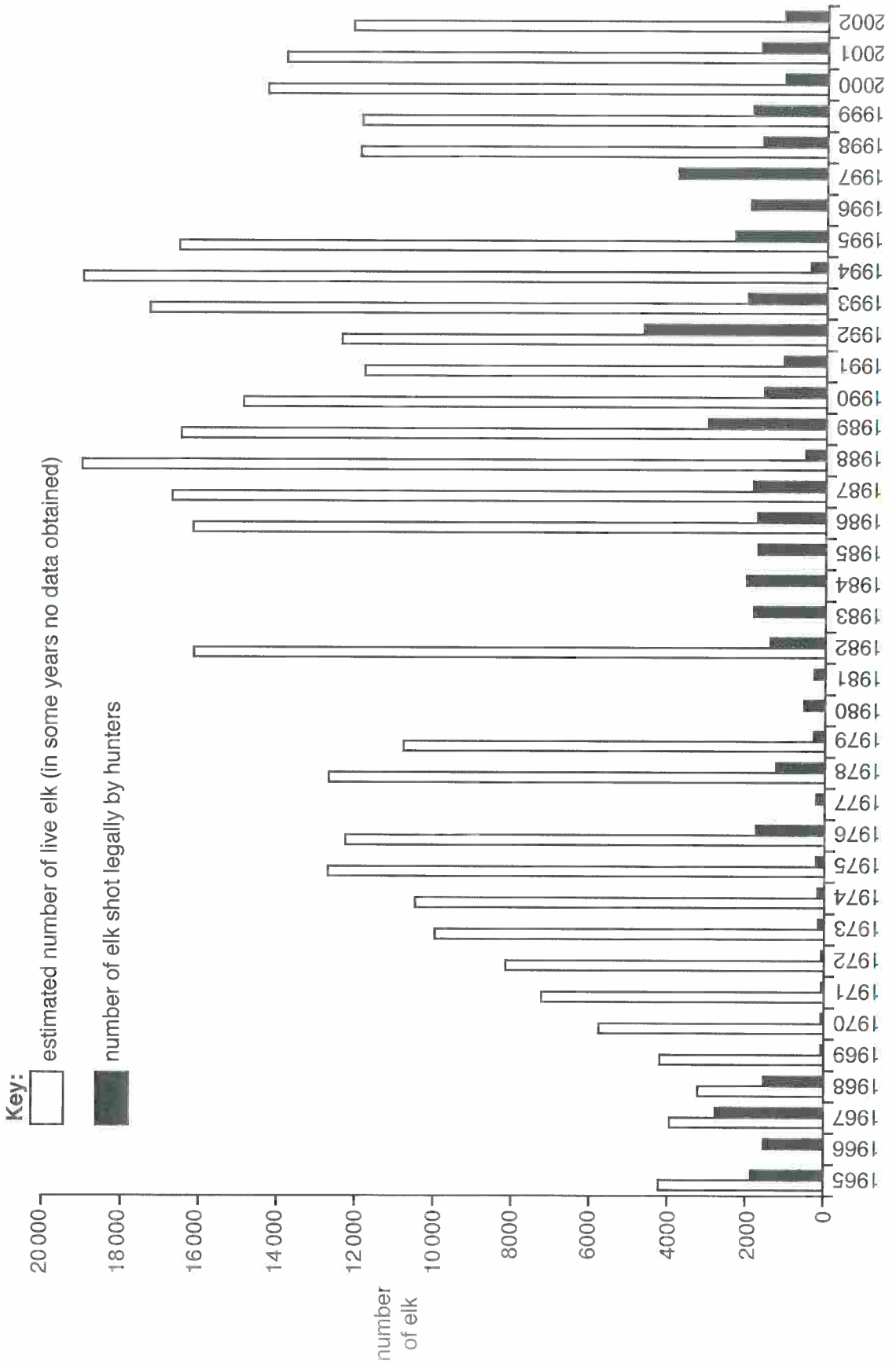
Key:
estimated number of live elk (in some years no data obtained)
number of elk shot legally by hunters
number of elk
20 000
18 000
16 000
14 000
12 000
10 000
8000
6000
4000
2000
0
year
1965
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Fig. 2.1

5 The efficiency of energy transfer between trophic levels limits the number of organisms in a particular ecosystem.

(a) Outline how the **percentage efficiency** of energy transfer between producers and herbivores can be estimated.

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..... **[4]**

(b) One way that humans try to maximise food production is to manipulate the transfer of energy through ecosystems.

A number of methods can be used to increase energy transfer through agricultural ecosystems and other food production systems.

These methods include:

A artificial selection

B recombinant DNA technology

C growing microorganisms in a fermenter

D use of immobilised enzymes

E control of plant physiology with synthetic plant hormones

F manipulation of the nitrogen cycle.

Using the letters **A – F**, select the **most suitable** method that could be used to achieve each of the aims shown in the table below.

You may select each letter more than once.

Aim	**Letter**
improving soil that is low in nutrients for the growing of wheat	
preventing the spoilage of fruits after picking	
reducing the impact of a fungal disease on yields from cucumber plants	
producing strawberry plants that grow quicker and fruit earlier	
making sugar syrup from waste starch	
producing large amounts of a fungus for food	

[6]

Question 5(c) begins on page 18

(c) Some animal pests compete with humans for food.

Some examples of pest behaviour are described below. These include examples of innate (instinctive) and learned behaviours.

Name each **specific** type of innate or learned behaviour described in the table below.

Description	Name of innate or learned behaviour
Sparrows initially fly away from fruit bushes on which shiny CDs are hung, particularly when the CDs move in the wind.	
After a few days the sparrows start visiting the fruit bushes again, and do not fly away even when the CDs move.	
Carrot flies move towards chemicals released by carrot plants.	
Raccoons learn to remove lids from containers of grain in a barn.	
A line of young chicks follow their mother into a cornfield.	

[5]

[Total: 15]

4 Fig. 4.1 shows some notes that a gardener pinned to his notice board to remind him of jobs to do.

Each is based upon a different biological principle.

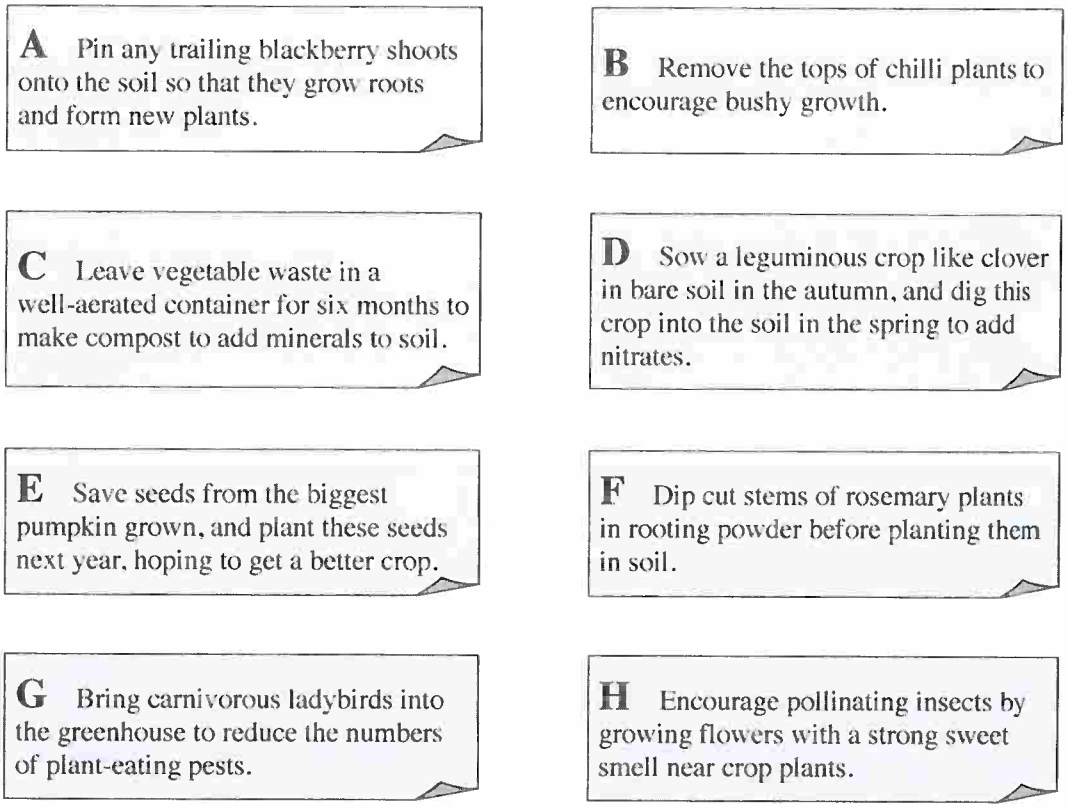

Fig. 4.1

(a) Match the notes, **A** to **H**, with the biological principles on which they are based.

Write the correct letter next to the description of each principle.

Biological principle	**Letter**
artificial selection	.....
predator-prey interaction	.....
apical dominance	.....
nitrogen fixation	.....
reproductive cloning	.....
positive chemotaxis	.....
decomposition	.....
use of plant hormones	.....

[8]

(b) Four **other** procedures associated with growing or storing crops are described in Table 4.1 below.

Name a biological process that is slowed down or stopped by each procedure.

Procedure	Biological process slowed down or stopped
storing apples at a low temperature of 5°C	
removing weeds from a vegetable garden	
placing seedlings so they are lit from all sides equally	
removing elm suckers and self-sown tree seedlings from farmland	

Table 4.1

[4]

(c) Suggest **three** ways that farmers can maximise the efficiency of the transfer of energy up food chains from **primary consumers** to humans.

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..... **[3]**

[Total: 15]

2 The Galapagos Islands are 600 miles away from the nearest land mass, South America. They consist of 15 main islands, 3 smaller islands, and 107 rocks and islets. This collection of islands is home to many endemic species of animals and plants. This means that these species are found nowhere else in the world.

(a) Explain, using scientific terms, why a collection of small islands remote from the mainland provides optimal conditions for speciation.

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..... **[2]**

(b) In 1978, the United Nations (UN) declared the Galapagos Islands a World Heritage Site. This led to a rise in the resident human population and the number of visitors to the Islands.

Table 2.1 shows how the number of people living on and visiting the Galapagos Islands changed between 1980 and 2005.

Year	Resident population	Number of visitors
1980	5500	16000
1985	7000	19000
1990	9500	42000
1995	12500	58000
2000	17500	68000
2005	27500	125000

Table 2.1

(i) Calculate the percentage increase in the number of visitors to the Galapagos Islands between 1980 and 2005.

Show your working. **Give your answer to the nearest whole number.**

Answer = ... % **[2]**

(ii) Outline the main ways in which increased human presence and activity have put endemic species on the Galapagos Islands, and in the sea around them, at risk of extinction.

In your answer you should link the ecological pressures imposed by human activity to examples of Galapagos Island species that have been affected.

[7]

(c) In 2007, the United Nations (UN) put the Galapagos Islands on its Red List of endangered sites. The Galapagos government's response to this action included making new laws and placing restrictions on human activity, issuing eviction orders and culling introduced species of animals.

Suggest **one** economic and **one** ethical problem that might have arisen from this 2007 UN decision.

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..... **[2]**

[Total: 13]

8 Earthworms are abundant in fertile soil where they play an important role in the transfer of energy in the ecosystem. An example of a food chain involving earthworms is shown in Fig. 8.1.

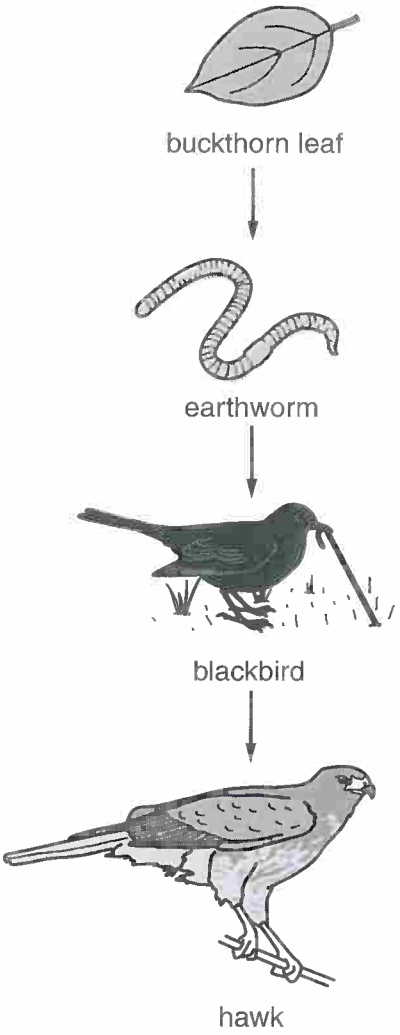

Fig. 8.1

(a) Define the following terms:

producer .....

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consumer .....

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trophic level .....

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[3]

(b) One way of measuring the abundance of earthworms is as follows:

- place quadrat frames of known area onto the ground
- pour a chemical solution onto the soil to cause the earthworms to come up to the surface
- wait and then count the earthworms.

Researchers used this technique in 2004 and 2006 to compare the abundance of earthworms in four areas of soil:

- soil underneath buckthorn plants
- soil underneath honeysuckle plants
- bare soil after the removal of buckthorn plants
- bare soil after the removal of honeysuckle plants.

The results are shown in Fig. 8.2.

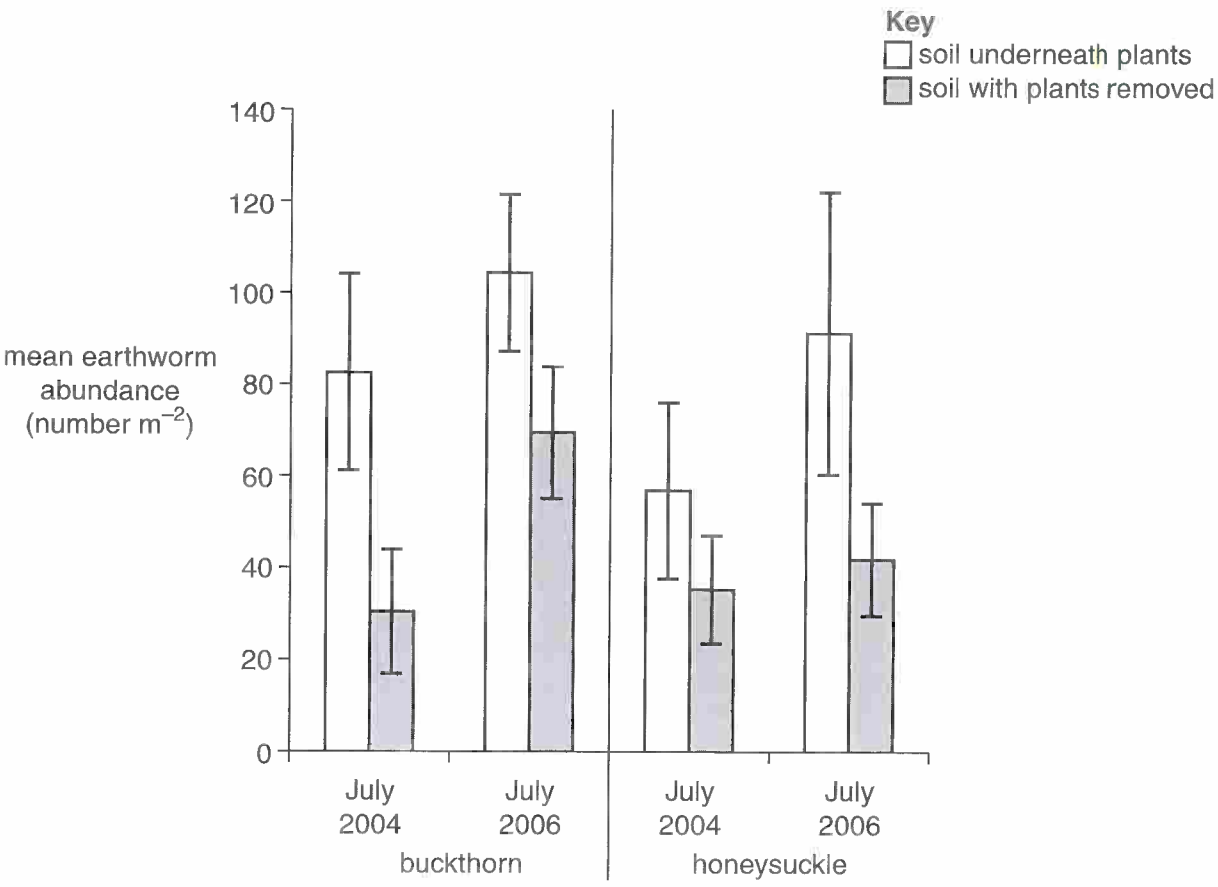

Fig. 8.2

(i) Suggest **two** variables which the researchers should have controlled in order to make the results comparable.

1 .....

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2 .....

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[2]

(ii) Evaluate, with reference to the error bars in Fig. 8.2, whether the data show a valid difference in the abundance of earthworms between the 'soil underneath honeysuckle' and 'soil with honeysuckle removed' sites for July 2004.

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..... **[2]**

(iii) Ecosystems can be described as dynamic.

State **two** pieces of evidence from Fig. 8.2 that show that the ecosystem is dynamic.

1 .....

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2 .....

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[2]

[Total: 9]

END OF QUESTION PAPER

5 Peat bogs are large areas of waterlogged land that support a specialised community of plants. Peat bogs take thousands of years to form.

Fig. 5.1 lists the main stages in the formation of a peat bog.

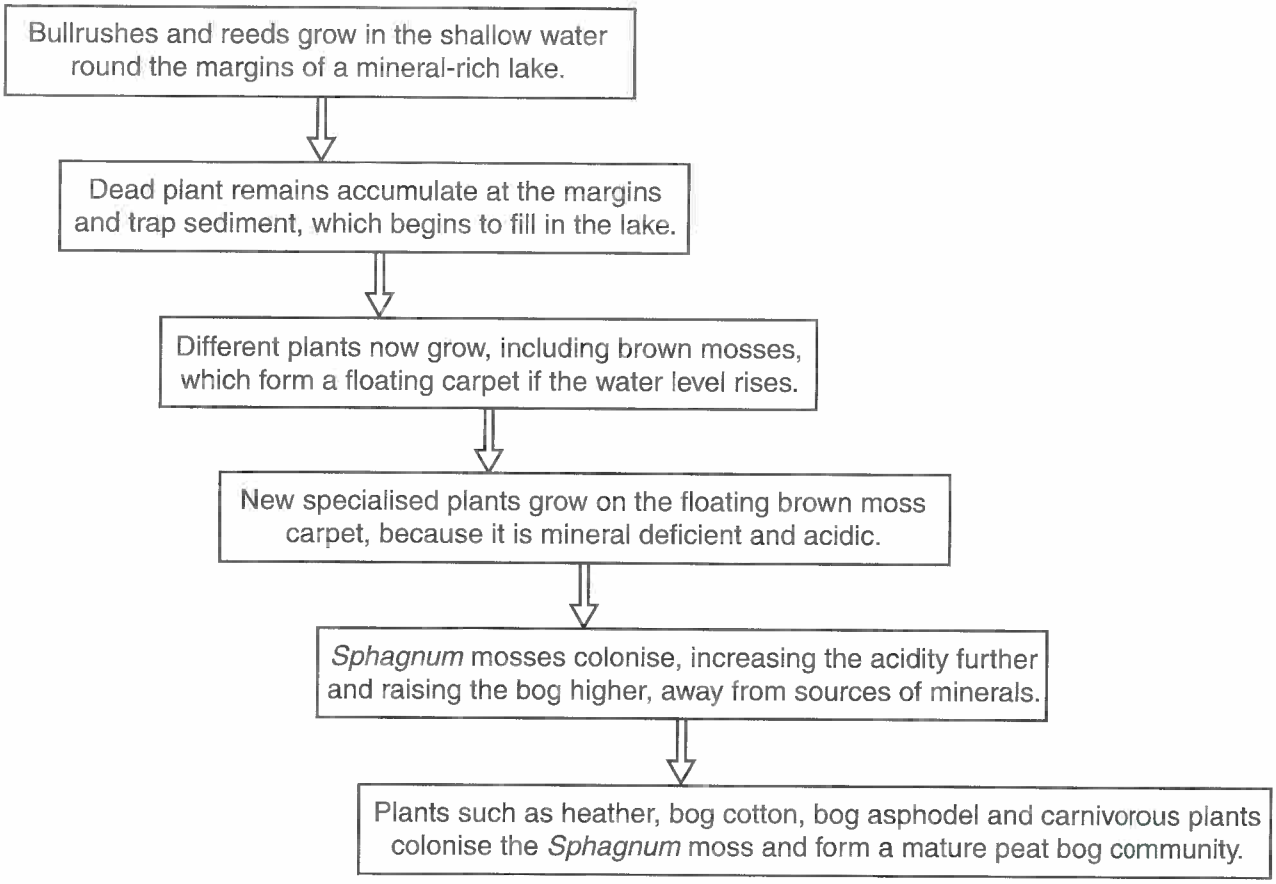

Fig. 5.1

(a) (i) Name the process summarised in Fig. 5.1 that changes a lake community into a peat bog community.

..... **[1]**

(ii) Using Fig. 5.1, list **two abiotic** factors that play a role in determining what species of plant can grow in an area.

1 .....

2 ..... **[2]**

(b) Most of the minerals in a peat bog are held within the living plants at all times, **not** in the soil.

- Plants like bog cotton and bog asphodel recycle the minerals they contain.
- The leaves of these plants turn orange as the chlorophyll within them is broken down.
- Minerals such as magnesium ions are transported from the leaves to the plants' roots for storage.

Describe **one** similarity and **two** differences in mineral recycling in a peat bog and in a **deciduous forest**.

similarity .....

.....

differences .....

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..... **[3]**

QUESTION 5(c) STARTS ON PAGE 16

(c) In Ireland in 2002, two well-preserved Iron Age human bodies were found in peat bogs. Despite having been dead for over two thousand years, the bodies had not decomposed. They still had skin, hair and muscle.

Suggest why these bodies had not decomposed.

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..... **[2]**

(d) Suggest **two** reasons why the large scale removal of peat from bogs for use in gardens is discouraged by conservation groups.

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..... **[2]**

[Total: 10]

6 **(a)** Great tits, *Parus major*, are birds that form male-female pairs. The male of each pair then establishes an area of territory, which he defends against other great tits by singing and threat displays.

The birds build a nest within the territory in which the eggs are laid and young chicks are reared. Weasels, *Mustela nivalis*, are predators which eat eggs and young chicks.

Fig. 6.1 shows how the territory size of great tits affects the risk of nest predation by weasels.

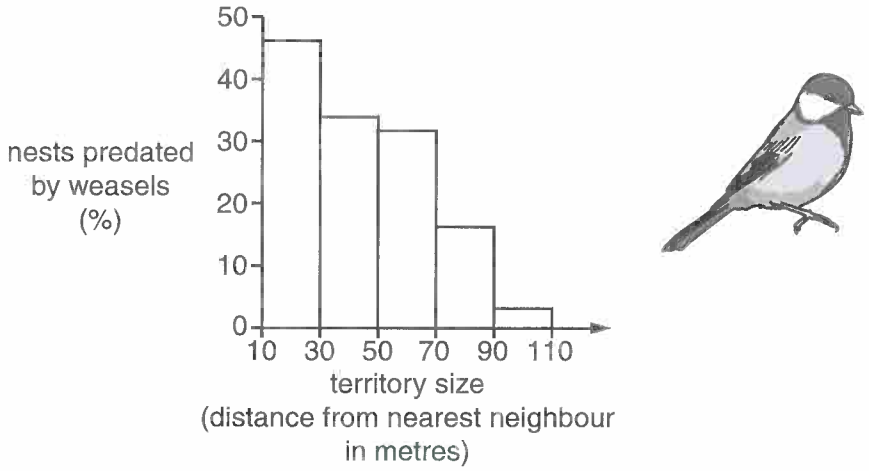

Fig. 6.1

(i) Describe the relationship shown in Fig. 6.1.

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..... [1]

(ii) Suggest and explain what effect weasels may have on the population size of the great tit.

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..... [2]

(b) The ochre starfish, *Pisaster ochraceus*, is a starfish that lives on rocky intertidal shores. It is the top predator in its habitat.

Fig. 6.2 shows part of the food web for this starfish.

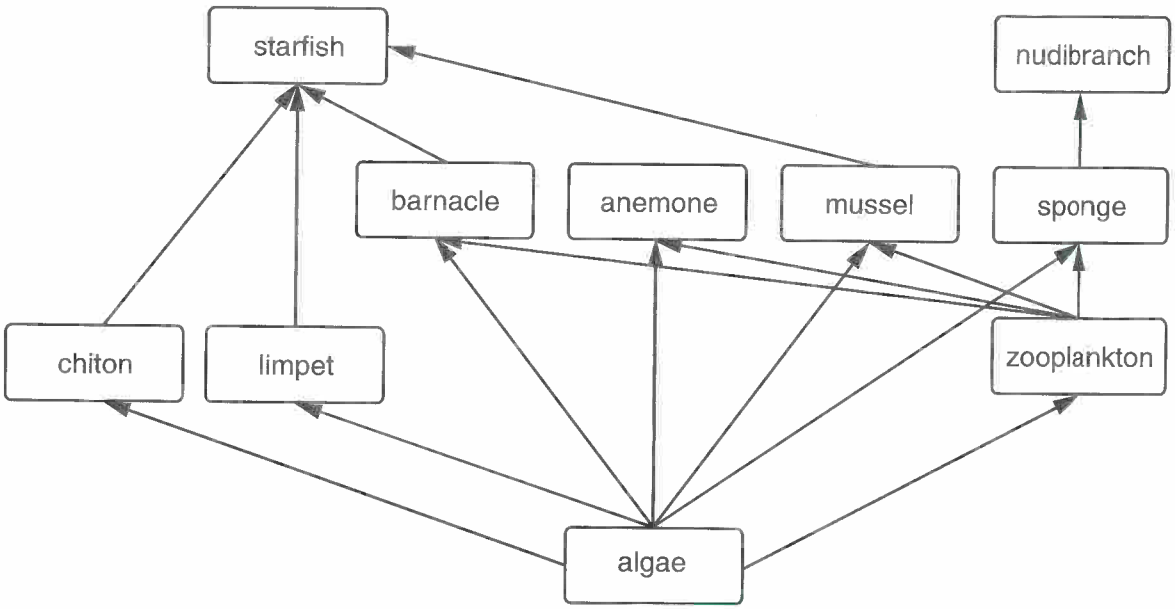

Fig. 6.2

An experiment was carried out in which all the starfish were removed from an 8 m × 2 m area of the shore. In an equivalent area of the same size, the starfish were not removed.

The population sizes of the other organisms in the food web were monitored at intervals. It was found that in the area in which starfish were removed:

- chitons and limpets disappeared
- anemones, sponges and nudibranchs decreased in abundance.

(i) Explain why two areas of the same size were monitored.

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..... **[2]**

(ii) Using Fig. 6.2, explain why the chitons and limpets disappeared in the area from which starfish were removed.

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..... **[2]**

(iii) Using Fig. 6.2, suggest the sequence of events that led to the decrease in abundance in nudibranchs in the area from which starfish were removed.

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..... **[2]**

[Total: 9]

3 **(a)** Organisms do not live in isolation, but interact with other organisms and with their physical environment.

State the word used to describe:

(i) the study of the interactions between organisms and their environment

..... **[1]**

(ii) the physical (non-living) factors in the environment

..... **[1]**

(iii) a physical area that includes all the organisms present **and** their interactions with each other **and** with the physical environment.

..... **[1]**

(b) State and describe **two types** of ecological interaction that can occur between different species in a habitat.

As part of each description, you should **name** the two species involved in your chosen example.

1 .....

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2 .....

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..... **[6]**

(c) Plants are able to respond to changes in their environment.

(i) Describe **two** ways in which hormones may alter a plant's growth in response to overcrowding by other plants.

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..... **[4]**

(ii) Suggest how hormones alter a plant's growth if the top of the plant shoot is eaten by an animal.

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..... **[3]**

(d) The distribution and abundance of plants in a habitat can show how a physical factor varies across the habitat.

Describe how you would measure the distribution and abundance of plants over a distance of 100 metres.

In your answer you should make clear the sequence of procedures you would follow.

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..... **[6]**

[Total: 22]

Answer **all** the questions.

1 Knowledge of the nitrogen cycle can be used to make decisions about management of farmland. A farmer uses her grass meadow to raise sheep. In a separate field she grows cabbages.

(a) Fig. 1.1 shows part of the nitrogen cycle. The four boxes on the bottom line of the diagram refer to substances in the soil.

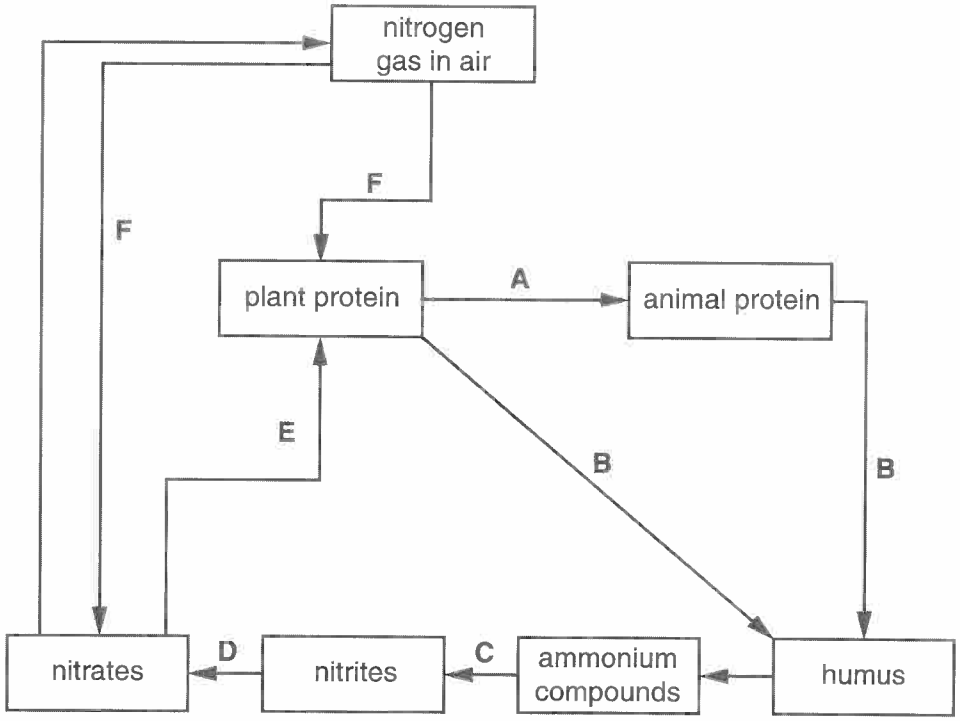

Fig. 1.1

(i) Briefly describe the steps that must occur for plant protein to be converted to animal protein in the farmer's sheep, as shown by arrow **A** on Fig. 1.1.

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..... **[3]**

(ii) List the processes which contribute to **B** in the meadow where sheep are raised.

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..... [2]

(iii) Name the bacteria that carry out processes **C** and **D, and** explain the significance of these bacteria for the growth of plants.

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..... [3]

(iv) Use the letters on Fig. 1.1 to explain why the soil nitrate concentration will decrease in the cabbage field if it is used to grow repeated crops of cabbages year after year.

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..... [3]

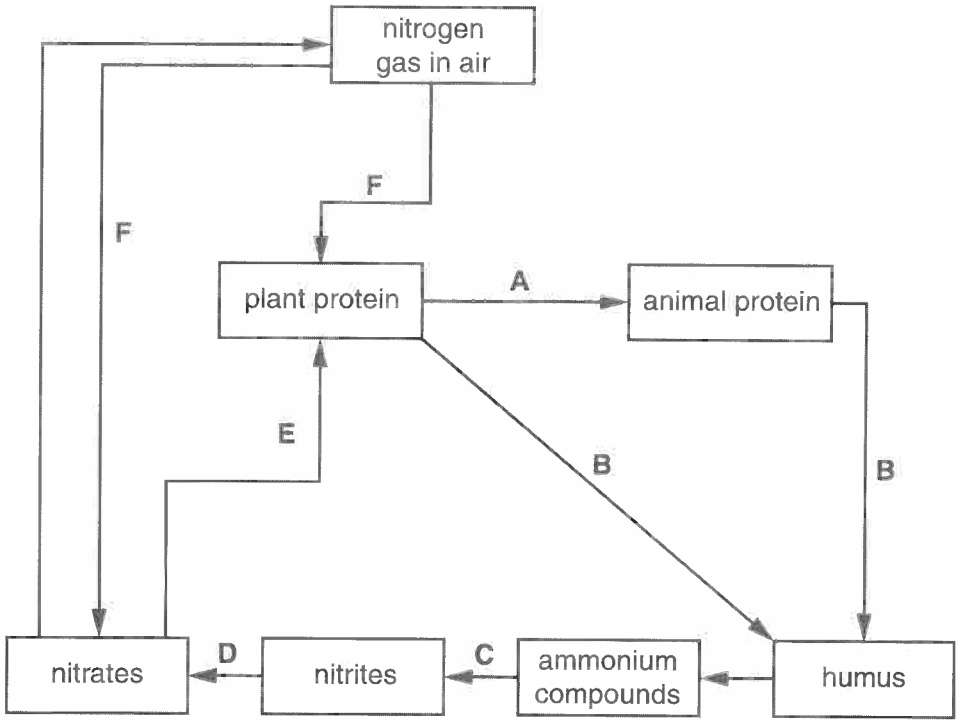

Fig. 1.1

(v) The farmer does not wish to use inorganic fertiliser to replace the nitrate in the soil of the cabbage field. She wishes to make use of process **F**.

Suggest a crop she could plant that would allow process **F** to occur **and** explain how this would add nitrate to the soil.

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..... **[3]**

(b) The sheep on this farm belong to a rare breed called Greyface Dartmoor. The Rare Breeds Survival Trust (RBST) gives advice on looking after these sheep and keep records to monitor the breeding of these sheep, in order to maintain a healthy population.

Why is the continued existence of rare breeds of farm animals desirable?

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..... **[2]**

(c) North Ronaldsay sheep are listed as 'endangered' by the Rare Breeds Survival Trust. These sheep were raised on a small Scottish Island where they were kept along the seashore for most of the year. The sheep developed an unusual metabolism that allowed them to survive by eating seaweed. They are, however, susceptible to copper poisoning when fed on grass.

(i) State the **two** essential steps that must have occurred for a breed to develop a distinctive metabolism, such as the ability to eat mainly seaweed.

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..... **[2]**

(ii) Suggest what particular problems make the North Ronaldsay breed one of the most endangered sheep breeds in the United Kingdom.

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..... **[2]**

[Total: 20]

4 Wading birds (waders) are birds that feed in shallow water. Table 4.1 shows changes in the population size of four species of wader in two areas of the Western Isles off the coast of Scotland.

- Area 1 is an area that has remained free of hedgehogs.
- Area 2 is an area where four hedgehogs were introduced from the mainland in 1974. Since then, they have established a large population.

Hedgehogs eat the eggs of ground-nesting birds like waders.

Table 4.1

	number of breeding pairs of wader birds			
	area 1 (hedgehogs absent)		area 2 (hedgehogs present)	
year / species of wader	1983	2000	1983	2000
lapwing	1104	1364	1869	1287
redshank	486	733	1288	760
dunlin	803	558	2016	884
snipe	172	154	655	280

(a) (i) Calculate the percentage decrease in the number of breeding pairs of **snipe** in **area 2** between 1983 and 2000.

Show your working.

Answer = ... % **[2]**

(ii) Use the data in Table 4.1 to describe **and** explain the effect of the introduction of hedgehogs on the number of breeding pairs of waders in **area 2**.

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..... **[6]**

(iii) Suggest **two** factors that might have allowed a large population of hedgehogs to increase from just four individuals in **area 2**.

Explain how each factor has led to an increase in the hedgehog population.

1 .....

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2 .....

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..... **[4]**

(b) Three suggested methods to reduce the effect of hedgehogs on the numbers of waders in area 2 were considered. These were:

- trapping and moving hedgehogs to the mainland
- trapping hedgehogs and keeping them in captivity indefinitely
- trapping of hedgehogs followed by humane killing.

The third method was judged to be the most effective and likely to succeed in reducing hedgehog numbers.

Comment on the ethical issues involved in making this decision.

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..... **[3]**

[Total: 15]

7 Two-spot ladybirds, *Adalia bipunctata*, show a colour polymorphism. They are normally red with two black spots. However, melanic individuals occur which are black with two red spots.

A student investigated the proportion of these colour forms in the ladybird population along a transect going up a hill near his school.

(a) (i) Suggest a suitable technique by which the student might have collected his samples of ladybirds along this transect.

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..... **[1]**

(ii) The student's teacher suggested he should make several transects up the hill rather than just one transect.

Explain why this is good experimental design.

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..... **[1]**

QUESTION 7(b) STARTS ON PAGE 20

(b) The student's results are shown in Table 7.1.

Table 7.1

height above sea level (m)	total number of red form of ladybird	total number of black form of ladybird
100	93	7
200	78	13
300	71	16
400	54	14

(i) Suggest a method of processing this data to make comparisons between the frequency of the red form and black form of ladybird at the different altitudes more valid.

Explain why your method is an improvement.

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..... **[2]**

(ii) Evaluate whether the student was correct to conclude as follows:

"My data showed a positive correlation between increasing altitude and the frequency of the black form of the ladybird. I therefore concluded that high altitude causes the black form to survive better."

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..... **[3]**

(c) The black, melanic, form of the ladybird is caused by an allele (**B**) that is dominant.

The red form of the ladybird is therefore homozygous recessive at this locus (**bb**).

(i) State what is meant by the term *recessive*.

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..... **[1]**

(ii) The data in Table 7.1 give the total number of the red form of ladybird found as 296, and the total number of the black form of ladybird as 50.

The Hardy-Weinberg principle states that:

$$p + q = 1$$

$$p^2 + 2pq + q^2 = 1$$

Use the Hardy-Weinberg principle and the figures given above to calculate the frequency of the dominant allele, p, and the recessive allele, q, in the two-spot ladybird population.

Show each step in your working. **Give your answers to 2 decimal places.**

p = ...

q = ... **[3]**

[Total: 11]

END OF QUESTION PAPER

3 Total plant growth within an ecosystem depends on the light intensity, temperature and the supply of water and inorganic minerals to the ecosystem.

Table 3.1 shows the net primary production by plants in four different ecosystems.

Table 3.1

ecosystem	net primary production ($kJ\,m^{-2}\,year^{-1}$)
temperate grassland	9240
temperate woodland	11340
tropical grassland	13440
tropical rainforest	36160

(a) Discuss possible reasons for the differences in net primary production in these ecosystems.

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..... [4]

QUESTION 3(b) STARTS ON PAGE 10

(b) To calculate the net primary production figures in Table 3.1 in $kJ\,m^{-2}\,year^{-1}$, it is necessary to measure the energy content of the primary producers.

Outline how the energy content, in kJ, of a primary producer such as grass can be measured in the laboratory.

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..... **[2]**

(c) The efficiency with which consumers convert the food they eat into their own biomass is generally low.

Table 3.2 compares the energy egested, absorbed and respired in four types of animal.

Table 3.2

animal	percentage of energy consumed that is:			
	egested	absorbed	respired	converted to biomass
grasshopper, a herbivorous insect	63	37	24	13
perch, a carnivorous fish	17	83	61	
cow, a herbivorous mammal	60	40	39	
bobcat, a carnivorous mammal	17	83	77	6

(i) **Complete Table 3.2** to show the percentage of energy consumed that is converted into biomass in the perch and the cow.

You may use the space below for your working.

[2]

(ii) Describe **and** explain, using the data from Table 3.2, how the trophic level of a **mammal** affects the percentage of its food energy that it is able to convert to biomass.

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(iii) Using the data from Table 3.2 and your knowledge of energy flow through food chains, suggest which of these four animals could be farmed to provide the maximum amount of food energy in $kJ\,m^{-2}\,year^{-1}$ for humans.

Explain the reasons for your choice.

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..... **[3]**

[Total: 14]

6 **(a)** State the term used to describe:

(i) a directional growth response of a plant

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(ii) a signalling molecule that enables **plants** to respond to environmental change

..... [1]

(iii) plants that lose their leaves seasonally

..... [1]

(iv) the process of managing an ecosystem sustainably to protect biodiversity

..... [1]

(v) organisms that return inorganic minerals from the bodies of dead organisms to the abiotic environment

..... [1]

(vi) the conversion of nitrogen gas to ammonium compounds in the soil.

..... [1]

(b) Describe briefly **one** example of each of the following types of **animal** behaviour:

(i) habituation

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..... [3]

For Examiner's Use

6 Fig. 6.1 shows primary succession on sand dunes.

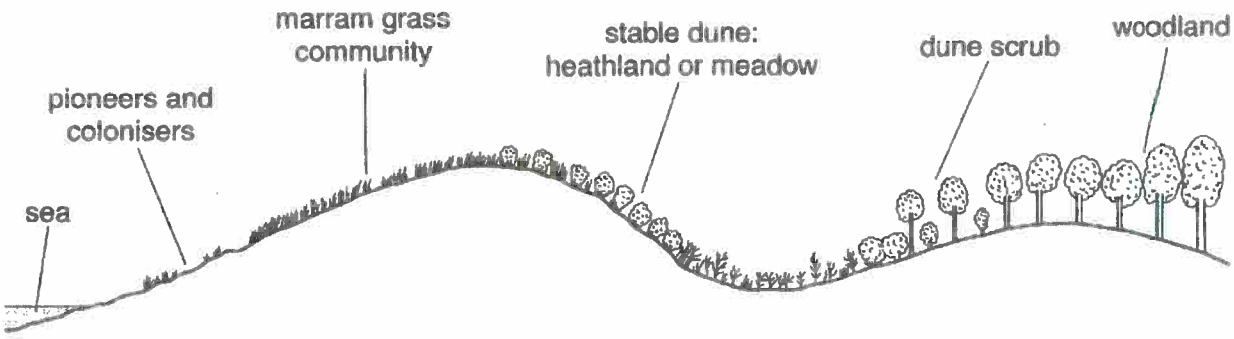

Fig. 6.1

(a) Explain *primary succession.*

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.....[2]

(b) In this question, one mark is available for the quality of written communication.

Describe the sampling techniques that biologists could use to show how the **distribution** and **abundance** of organisms change across a habitat such as the sand dunes shown in Fig. 6.1.

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For Examiner's Use

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Quality of Written Communication [1]

[Total: 10]

Turn over for Question 7