EXAM PAPERS PRACTICE

Populations in Ecosystems Pack 2

These practice questions can be used by students and teachers and is

Suitable for AQA A Level 7402 Biology Topic Question

Level: AQA A LEVEL 7402

Subject: Biology

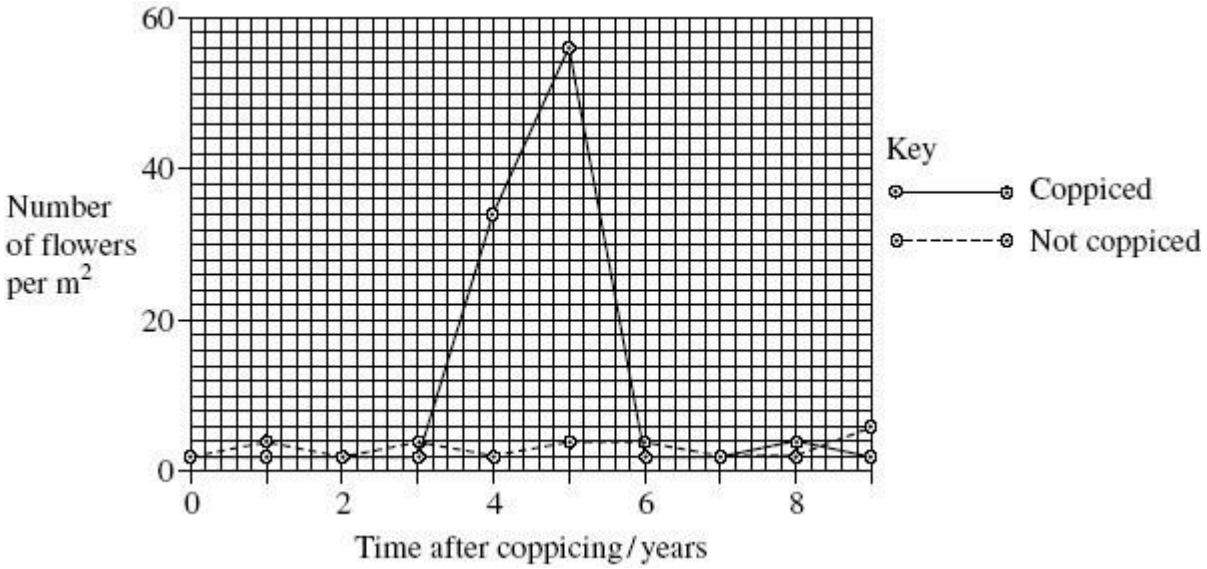
Exam Board: AQA A Level 7402

Topic: Populations in Ecosystems Pack 2

1 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.



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

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

_____

_____

_____

_____

(2)

(ii) Describe how you would decide the number of quadrats to use in order to collectrepresentative data.

_____

_____

_____

_____

(2)

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

_____

_____

_____

_____

_____

(2)

(c) The ecologists analysed the relationship between the number of daffodils in flower in thewhole 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

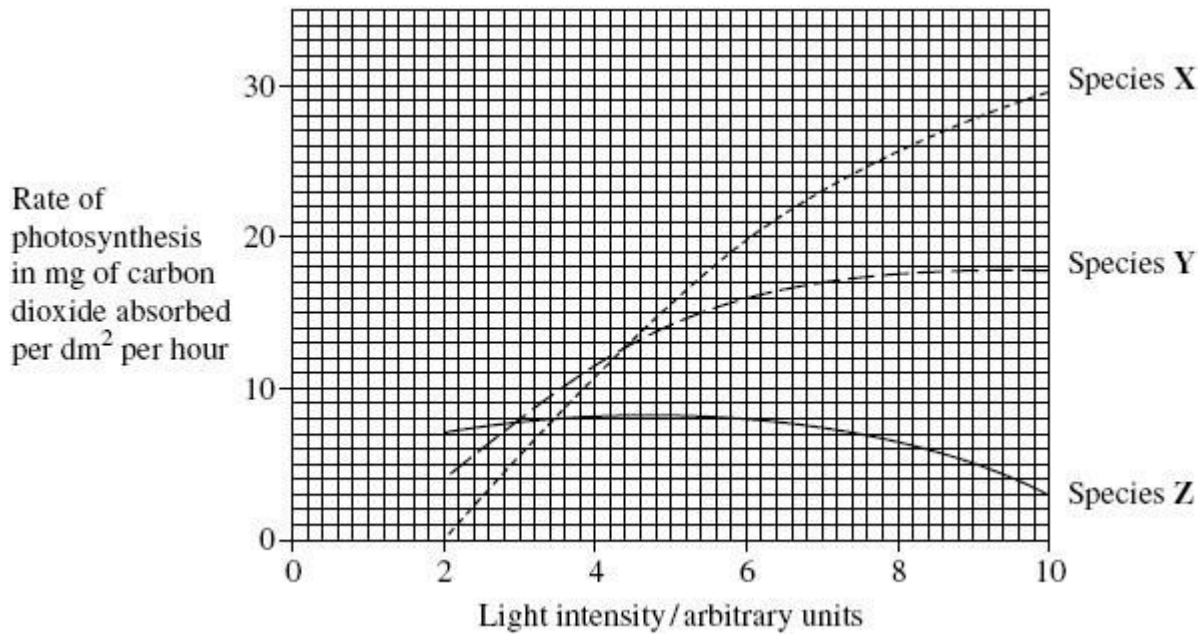
The ecologists concluded that a wet, cool summer produces good flowering the following spring.
Do you support this conclusion? Use the data in the table to explain your answer.

_____

(2)

(Total 8 marks)

2 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.



(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**.

_____

(3)

(b) Species **X** may change the environment so that it becomes more suitable for species **Z**.

Use the graph to explain why.

_____

_____

_____

_____

_____

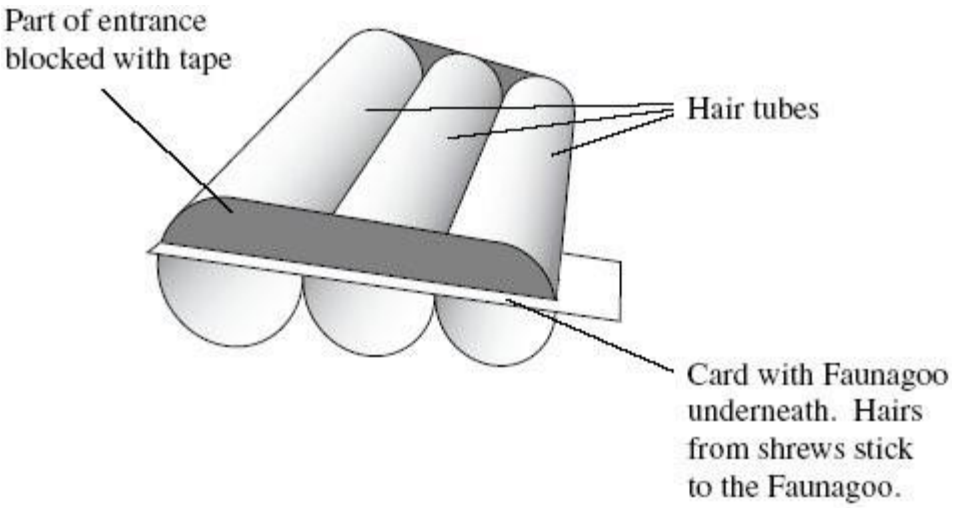
(2)

(Total 5 marks)

3 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.



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

_____

_____

(1)

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

_____

_____

(1)

(b) The biologists needed to find a way of distinguishing between the hairs of the three speciesof 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.

_____

_____

(1)

(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.

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

_____

_____

_____

_____

_____

(2)

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

_____

_____

_____

_____

_____

(2)

(d) The biologists used hair tubes to find the abundance of shrews along the edges of somefields. 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. Theyinspected 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 thehair tubes. They recorded the number of different shrews caught in these traps.

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

_____

_____

_____

(1)

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

_____

_____

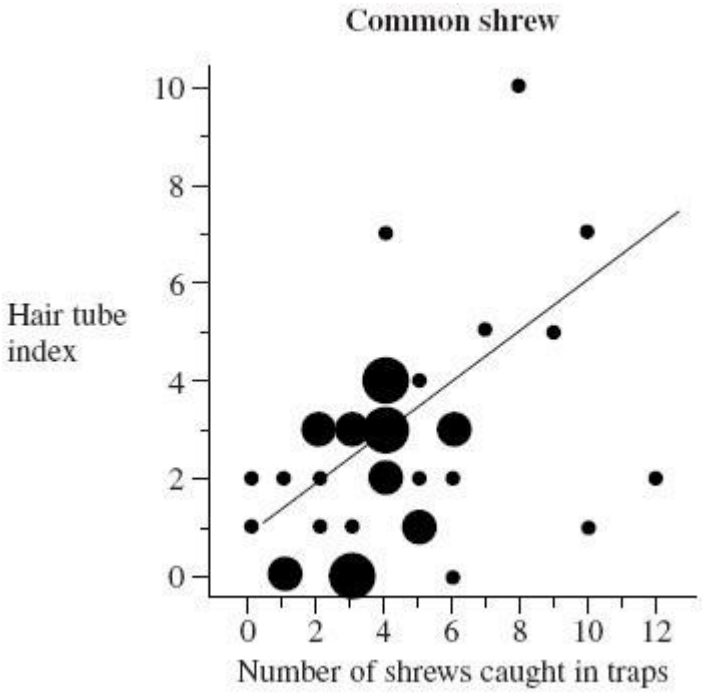
_____

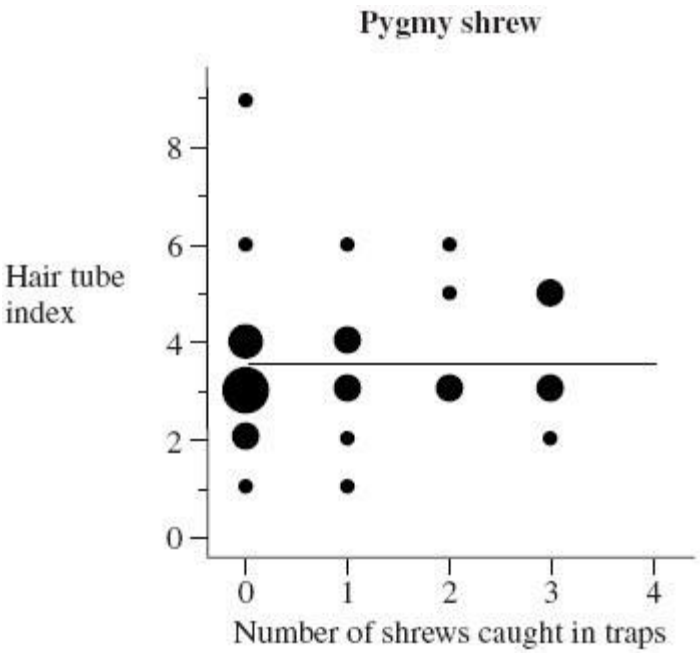
_____

_____

(2)

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.





(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.

(2)

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

(1)

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

(2)

(Total 15 marks)

4 In the activated sludge method of sewage treatment, organic matter in untreated sewage supplies nutrients to bacteria in the treatment tank. These bacteria include decomposers and nitrifying bacteria. The bacteria are eaten by ciliated protoctistans, which are, in turn, eaten by carnivorous protoctistans.

(a) (i) Explain the roles of the decomposers and the nitrifying bacteria in converting nitrogen in organic compounds in the sewage into a soluble, inorganic form.

(3)

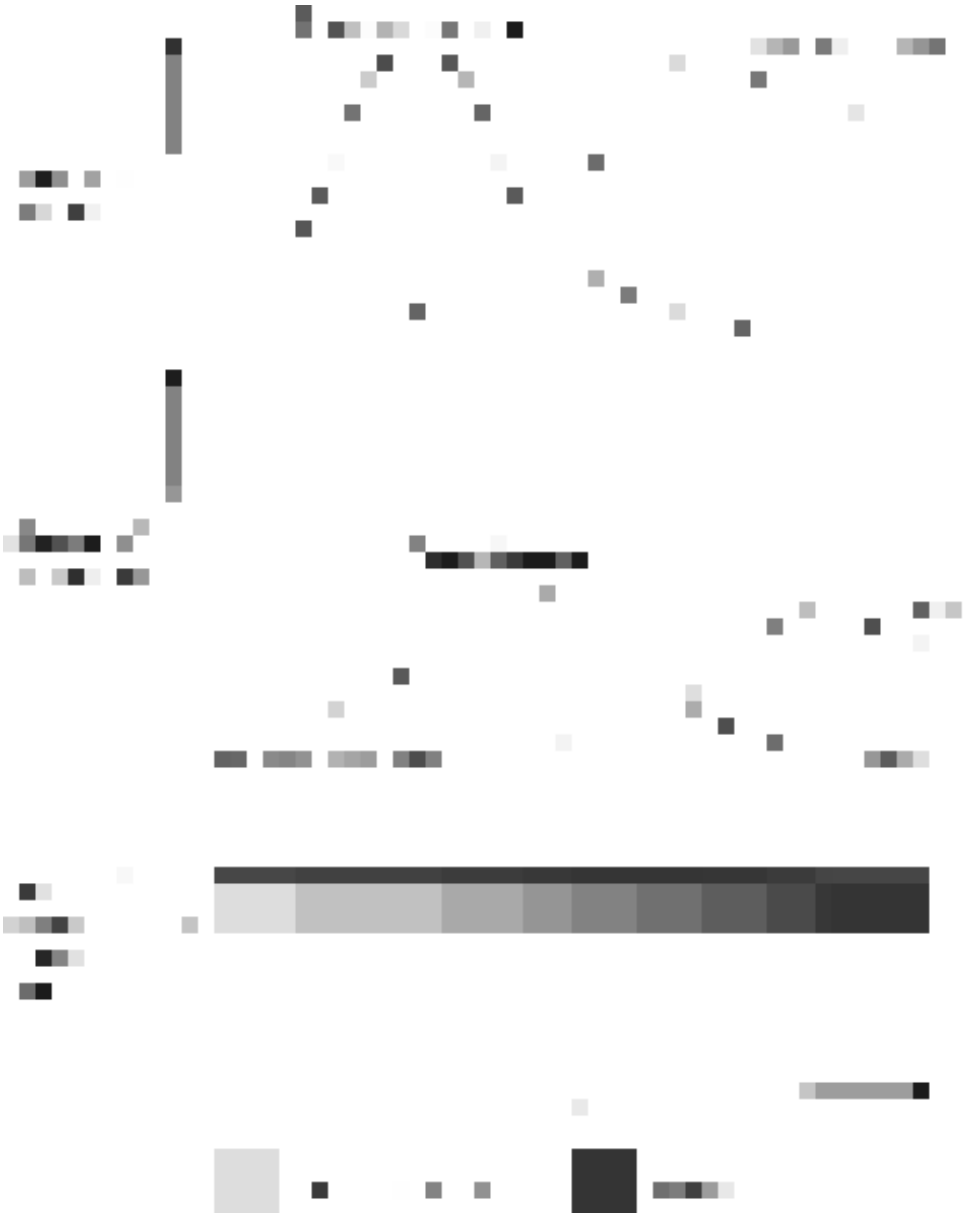
(ii) Nitrifying bacteria are one kind of bacteria that are important in the nitrogen cycle; nitrogen-fixing bacteria are another kind. Describe the part played by nitrogen-fixing bacteria in the nitrogen cycle.

(2)

(b) The organic matter in untreated sewage consists of small particles, which are suspended in water. Activated sludge consists of solid lumps (flocs) of organic matter and bacteria. When the two are mixed in the treatment tank, bacteria from the flocs become dispersed in the water and feed on the suspended organic matter, converting it to flocs. Different types of ciliated protoctistans feed on the bacteria.

- Free-swimming protoctistans are able to move throughout the tank.
- Crawling protoctistans can only move over the surface of the flocs.

The diagram shows the change in the nature of the organic matter in the treatment tank and the changes in the numbers of the different types of organisms present.



(i) Explain the changes in the numbers of dispersed bacteria and the numbers offree-swimming protoctistans.

_____

(3)

(ii) Explain how the changes that occur in the treatment tank illustrate the process ofsuccession.

_____

_____

_____

_____

_____

_____

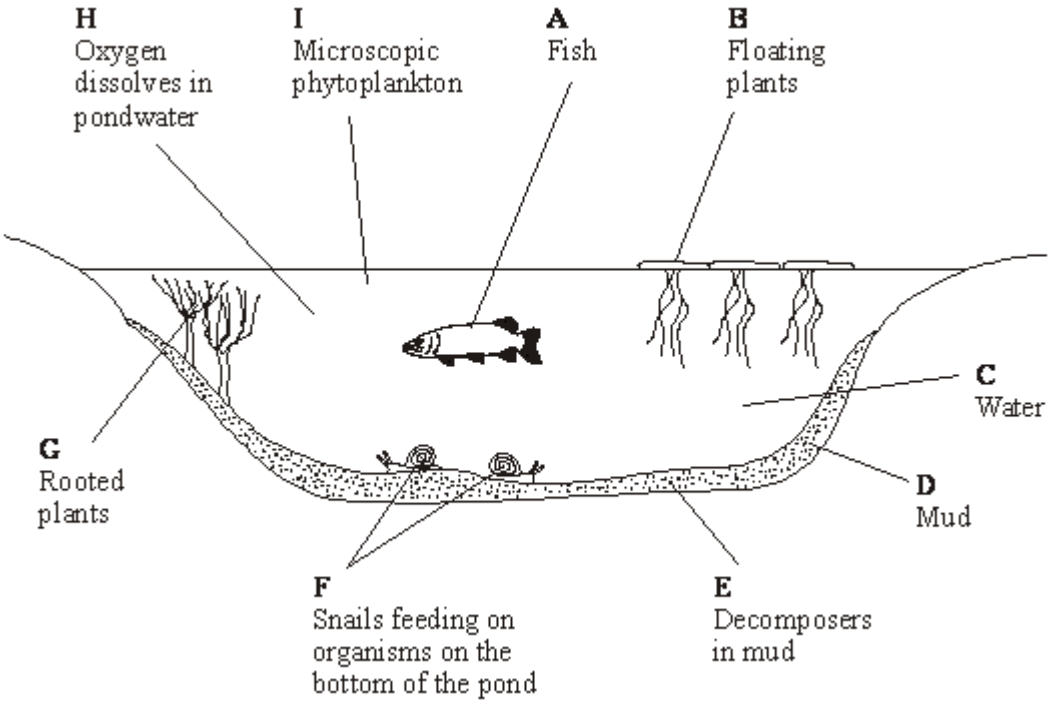
_____

_____

(4)

(Total 12 marks)

5 The diagram shows some of the components of a pond ecosystem.



(a) (i) What is an ecosystem?

_____

_____

(1)

(ii) List the letters that represent those components that are part of the pond community.

_____

(1)

(b) New Zealand pygmy weed has been introduced into many garden ponds and has spread tosome natural ponds. Here, it competes with naturally occurring plants. Suggest how the introduction of pygmy weed may lead to a reduction in the diversity of the community in a natural pond.

_____

_____

_____

_____

_____

_____

(3)

(Total 5 marks)

6 Biologists studied the process of succession in an area of wasteland over a period of ten years.

They calculated the index of diversity of the area every year. After three years, the index of diversity was 1.6. After ten years, it had risen to 4.3.

(a) What information concerning the organisms present in the area is suggested by theincrease in the index of diversity?

_____

_____

_____

_____

(2)

(b) The increase in the index of diversity is one indication that a biological succession is takingplace in the area. Describe those features of a succession that would bring about an increase in the index of diversity.

_____

_____

_____

_____

_____

_____

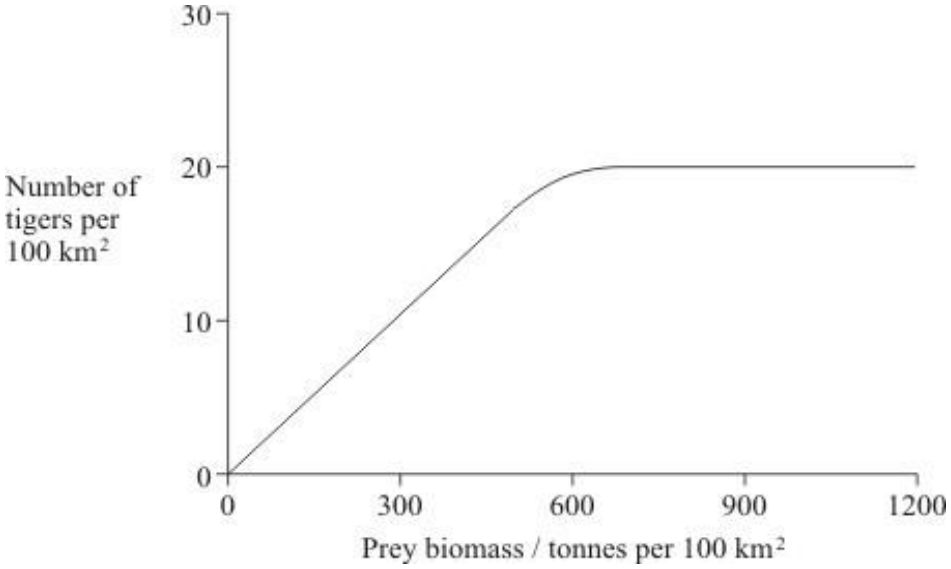
_____

(3)

(Total 5 marks)

7 Tigers inhabit forests where they feed mainly on large prey animals. Over the past fifty years, there has been extensive deforestation in many areas where tigers are found.

The graph shows the relationship between the prey biomass of an area and the tiger population that the area can support.



(i) What is meant by the ecological term *population*?

_____

_____

(1)

(ii) Use the graph to explain how deforestation might cause a reduction in the number of tigersin an area.

_____

_____

_____

_____

_____

_____

(3)

(Total 4 marks)

8

Some students investigated the effect of light intensity in the environment on the size of leaves of nettles. They measured leaves on sixty plants in each of two sites. The results are summarised in the table.

Dimensions of leaves / mm	Site with high light intensity	Site with low light intensity

Length of longest leaf	113	116
Length of shortest leaf	41	42
Mean length	86	92
Mean maximum width	68	74

Standard deviation of lengths	11	16
Standard deviation of maximum widths	7	11

(a) Each leaf to be measured was selected in the following way.

- The top left hand corner of a quadrat frame was placed at coordinates given by arandom number table; the nettle plant nearest the centre of the quadrat was selected,
- The sixth leaf from the tip of the plant was selected.

Explain the importance of

(i) the method of selecting the nettle plant;

_____

_____

_____

_____

(2)

(ii) measuring the sixth leaf.

_____

_____

_____

_____

(2)

(b) Use the data about the length of leaves in the two sites to explain why standard deviation is more useful than range as a measure of variation within a population.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) The area of a nettle leaf can be estimated using the formula

area = length × maximum width × 0.5

Calculate the ratio of the mean area of the leaves from the site with low intensity to the mean area of the leaves from the site with high light intensity. Show your working.

Answer _____

(2)

(Total 10 marks)

9 Detritivorous insects feed on the dead remains of plants. Some students estimated the numbers of detritivorous insects at two different sites in an ecosystem. They also obtained data about the net primary production of the sites to see if this influenced the numbers of insects present. Net primary production is a measure of plant biomass formed per year. The results are shown in the table.

Site	**Number of insects per m^2**	**Net primary production / g m^{-2} y^{-1}**

A	316	1440
B	90	550

(a) Explain how the students could use the mark-release-recapture technique to estimate thenumbers of insects.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) The students used the chi-squared (χ^2) test to test the hypothesis that there was no significant difference between the numbers of insects per square metre at sites **A** and **B**. The value they obtained was 125.8. They checked this value in χ^2 tables.

(i) How many degrees of freedom should they check against?

_____

(1)

(ii) What level of probability is normally used to judge whether a difference is statisticallysignificant?

_____

(1)

(iii) The value of χ^2 for the 0.001 level of probability for this number of degrees of freedom is 10.8. What does the value obtained by the students suggest about the difference in numbers of the insects per square metre between the two sites?

Explain your answer.

_____

_____

_____

_____

(2)

(c) (i) Explain why the net primary production of an area does not represent the totalamount of plant biomass formed per year by photosynthesis.

_____

_____

_____

_____

(2)

(ii) Suggest how the difference in net primary production of sites **A** and **B** might explain the difference in the number of insects between the sites.

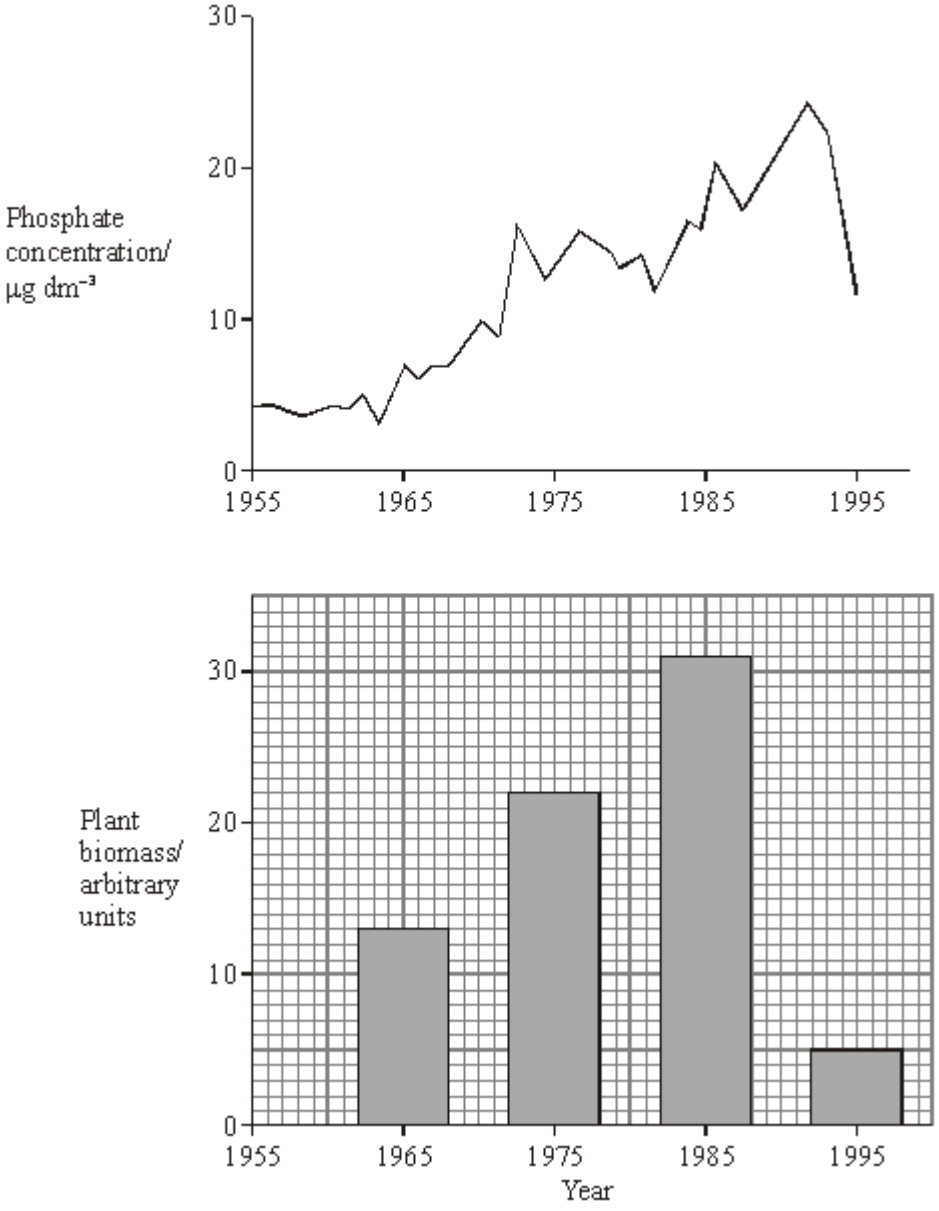
_____

_____

(1)

(Total 11 marks)

10 Since 1965 there has been a steady rise in the phosphate concentration in the water of Lake Windermere. Scientists have monitored the phosphate concentration and plant biomass over a period of time. The results are shown in the graphs.



(a) Suggest **one** source of the phosphate in the lake.

_____

_____

(1)

(b) Calculate the percentage decrease in plant biomass between 1985 and 1995. Show yourworking.

Answer _____

(2)

(c) From these graphs, a student concluded that changes in phosphate concentration causedchanges in plant biomass. Explain why this conclusion may not be valid.

_____

_____

_____

_____

(2)

(d) Between 1982 and 1992 the number of fish in the lake decreased. Explain how the changein phosphate concentration may have resulted in this decrease in the fish population.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total 11 marks)

11 (a) Explain the meaning of these ecological terms.

Population _____

_____

Community _____

_____

(2)

(b) Some students used the mark-release-recapture technique to estimate the size of apopulation of woodlice. They collected 77 woodlice and marked them before releasing them back into the same area. Later they collected 96 woodlice, 11 of which were marked.

(i) Give **two** conditions necessary for results from mark-release-recapture investigations to be valid.

1. _____

_____

2. _____

_____

(2)

(ii) Calculate the number of woodlice in the area under investigation. Show your working.

Answer _____

(2)

(c) Explain how you would use a quadrat to estimate the number of dandelion plants in a fieldmeasuring 100 m by 150 m.

_____

_____

_____

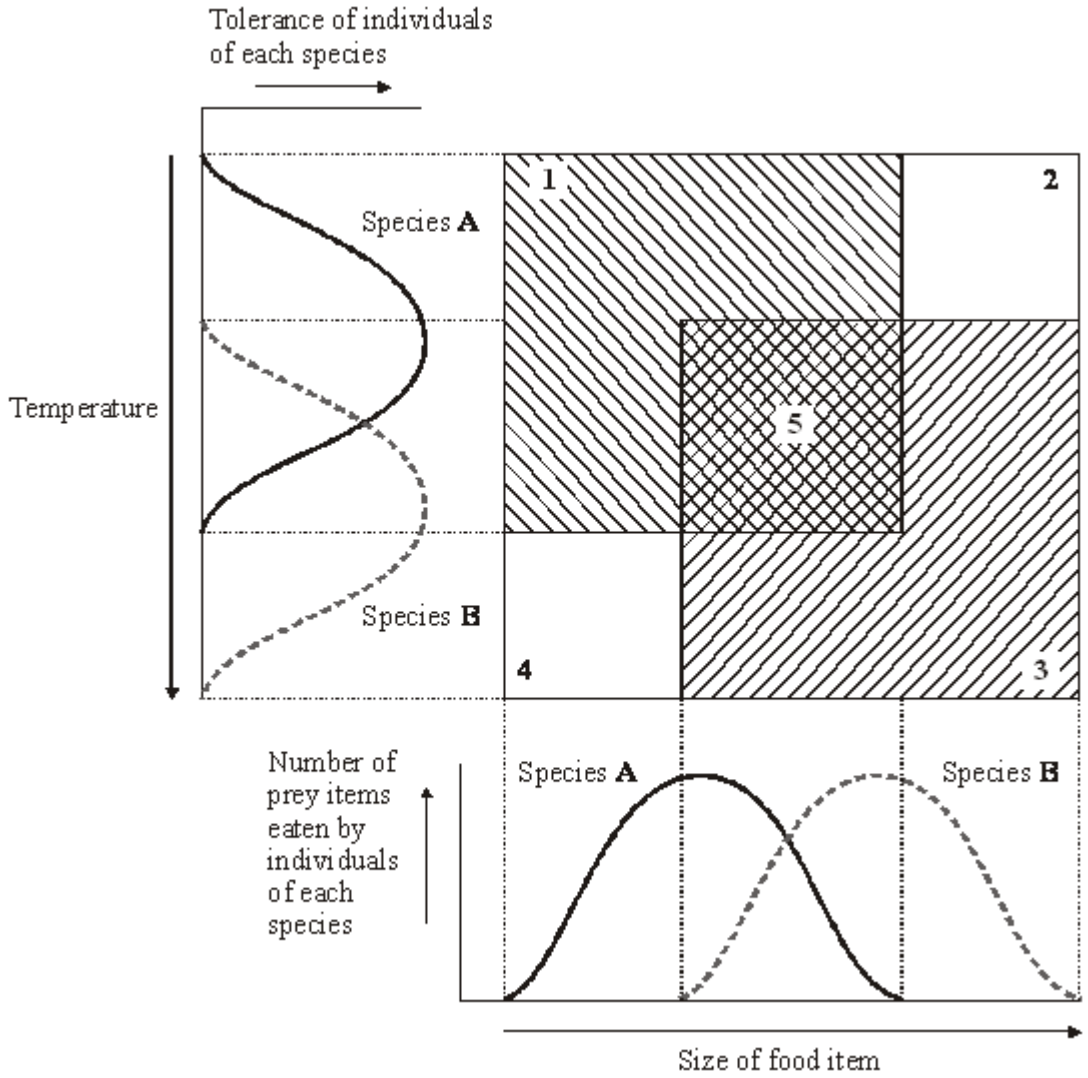
_____

_____

_____

(3)

(d) Two similar species of birds (species **A** and species **B**) feed on slightly different sized insects and have slightly different temperature preferences. The diagram represents the response of each species to these factors.



(i) Which of the numbered boxes describes conditions which represent

the niche of species **A**; _____ the

niche of species **B**; _____

insects too small for species **B** and temperature too warm for species **A**; _____

insects too large for species **A** and temperature too cool for species **B**? _____

(2)

(ii) These two species are thought to have evolved as a result of sympatric speciation.Suggest how this might have occurred.

(4)

(Total 15 marks)

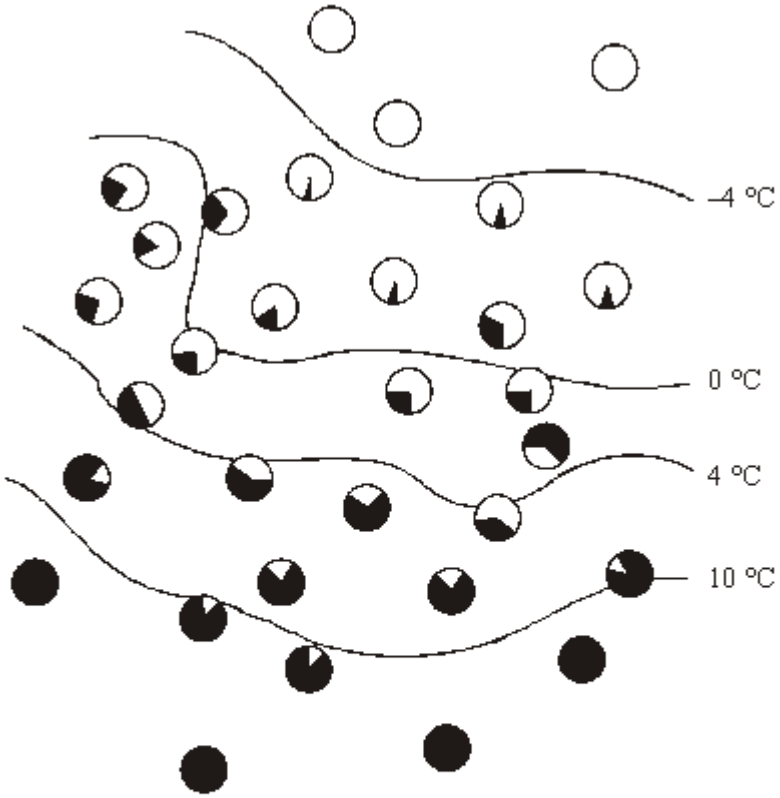
12 (a) Explain what is meant by stabilising selection and describe the circumstances under which it takes place.

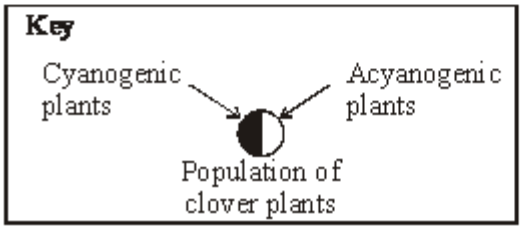
(5)

(b) Some European clover plants can produce cyanide. Those plants that can produce cyanide are called cyanogenic; those that cannot produce cyanide are called acyanogenic. Cyanide is toxic to the cells of animals and plants.

When the leaves of cyanogenic plants are damaged by slugs, or exposed to low temperatures, membranes within the cells are broken. This causes the release of the enzymes that control the reactions which produce cyanide.

The proportions of cyanogenic and acyanogenic plants in clover populations were determined in different parts of Europe. These are shown in the diagram below, together with the mean minimum winter temperatures. Slugs are not usually active at temperatures below 0 °C.





Explain the proportions of cyanogenic and acyanogenic plants in clover populations growing in the area where the mean minimum winter temperature is below –4°C and in the area where it is above 10 °C.

(5)

(Total 10 marks)

13 When coal is mined by open-cast mining, the top layer of soil is first scraped off and stored in a large heap. Once mining has finished, the area can be reclaimed. Soil from this store is then spread back over the surface.

Some of the bacteria living in the soil store respire aerobically and some respire anaerobically. **Table 1** shows the numbers of aerobic and anaerobic bacteria found at different depths in a soil store.

Depth / cm	Mean number of bacteria per gram of soil ($\times 10^7$)			
	Aerobic bacteria		Anaerobic bacteria	
	after 1 month	after 6 months	after 1 month	after 6 months
0	12.0	12.1	0.6	0.8
50	10.4	8.6	0.8	1.3
100	10.1	6.1	0.7	4.1
150	10.0	3.2	0.7	7.9
200	11.6	0.8	0.7	8.4
250	11.9	0.7	0.8	8.8
300	11.0	0.8	0.6	9.1

Table 1

(a) Some of the soil used to determine bacterial numbers was collected from the surface of thesoil store. Describe how you would ensure that this soil was collected at random.

_____

_____

_____

_____

(2)

(b) (i) Describe how the numbers of aerobic bacteria after 6 months change with depth.

_____

_____

_____

_____

(2)

(ii) Explain the difference in the numbers of aerobic bacteria at a depth of 300 cm between 1 and 6 months.

_____

_____

_____

_____

(2)

(c) Explain how the changes in bacterial numbers which take place at 150 cm illustrate the process of succession.

_____

_____

_____

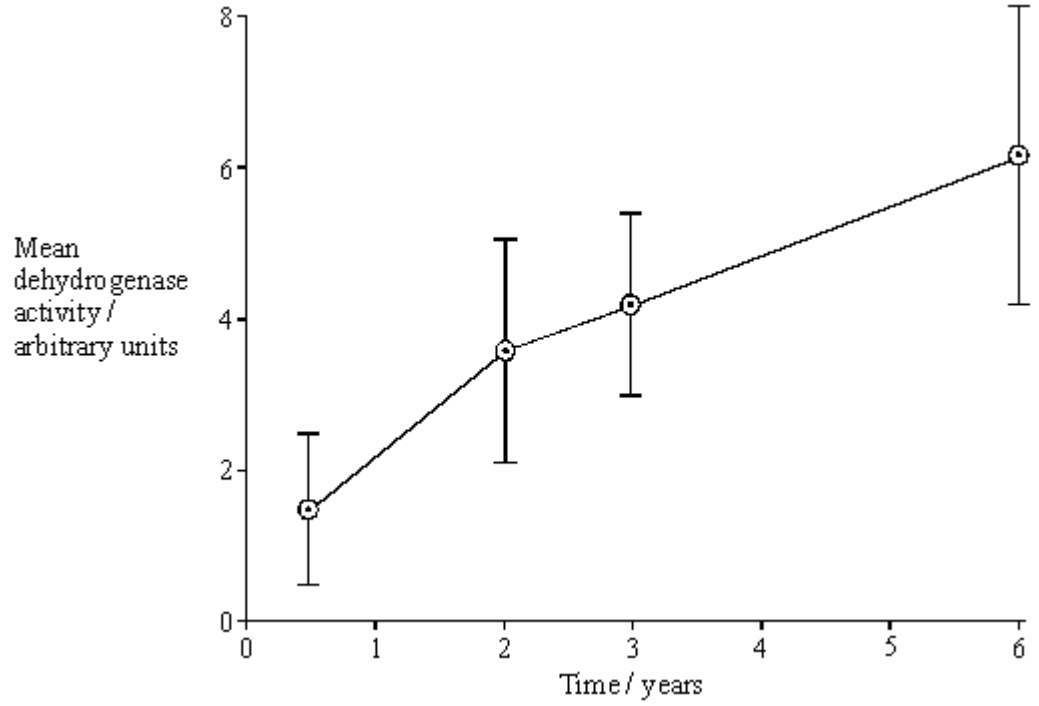
_____

_____

_____

(3)

Dehydrogenase is an enzyme involved in aerobic respiration. Dehydrogenase activity in a soil sample can be used as a measure of the activity of aerobic bacteria. The graph shows the mean dehydrogenase activity of soil samples taken from the same depth in a soil store at different times. The bars on the graph represent two standard errors above and below the mean.



(d) (i) From what depth in the soil store would you expect these soil samples to have beentaken? Use information from **Table 1** to explain your answer.

_____

_____

_____

_____

(2)

(ii) How would you expect dehydrogenase activity to vary with depth after 6 months?

Use information from **Table 1** to explain your answer.

_____

_____

_____

_____

_____

_____

(3)

(e) What do the error bars tell you about the difference between the mean dehydrogenaseactivity at 6 months and 3 years? Explain your answer in terms of probability and chance.

(3)

(f) **Table 2** shows the dehydrogenase activity and the number of aerobic bacteria present in some soil samples.

Dehydrogenase activity / arbitrary units	Number of aerobic bacteria per gram of soil ($\times 10^7$)
13.1	12.0
9.2	8.7
5.5	6.5
3.0	4.6
2.2	2.7
0.4	0.6

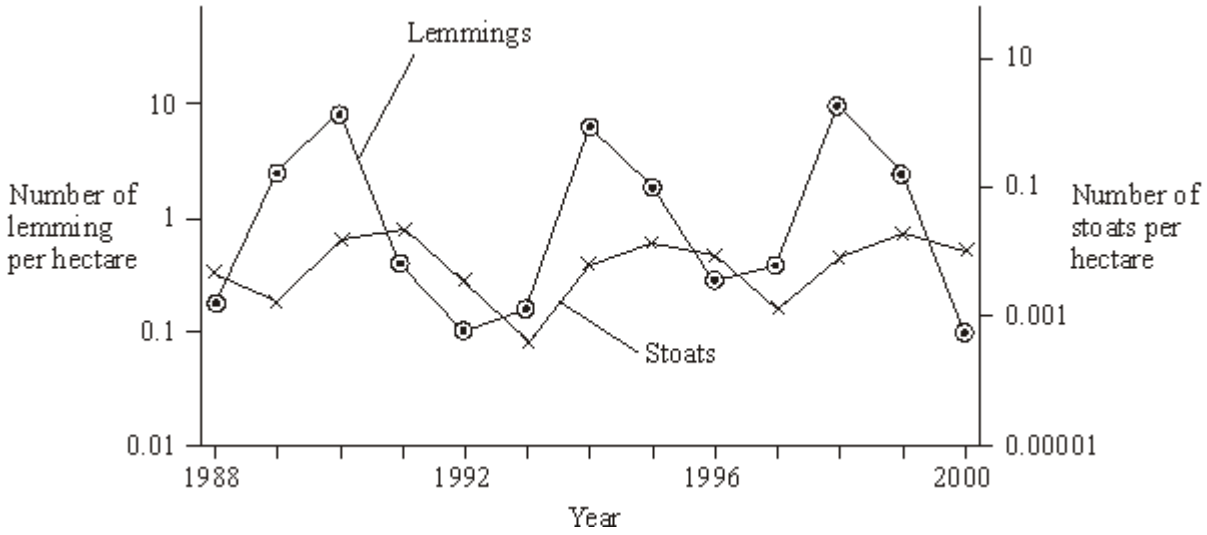
Table 2

A sample of soil was found to have dehydrogenase activity of 8.7 arbitrary units. Explain how you would use the data in **Table 2** to predict the likely number of aerobic bacteria in 1 g of this soil sample.

(3)

(Total 20 marks)

14 Lemmings are small mammals which live in the Arctic. Their main predator is the stoat, a small carnivorous mammal, which feeds almost entirely on lemmings. The graph shows the changes in the numbers of lemmings and stoats from 1988 to 2000.



(a) Describe and explain the changes which occur in the lemming and stoat populations.

(6)

S (b) Lemmings often live in isolated populations. From time to time some lemmings move and join other populations. Explain how this movement is important in maintaining genetic variability in lemming populations which have large fluctuations in size.

_____

_____

_____

_____

(2)

S (c) James Bay is a large ocean bay in northern Canada. It was formed by the melting of glaciers. One species of lemming inhabits the eastern side of James Bay and another species of lemming inhabits the western side. Before the glaciers melted there was only one species of lemming present. Explain how two species of lemming evolved from the original species.

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 12 marks)

15 (a) Explain what is meant by

(i) succession;

_____

_____

_____

_____

(2)

(ii) a climax community.

_____

_____

(1)

Heather plants are small shrubs. Heather plants are the dominant species in the climax community of some moorlands. The structure and shape of a heather plant changes as it ages. This results in changes in the species composition of the community. A large area of moorland was burnt leaving bare ground. The table shows four stages of succession in this area.

Time after burning / years	Appearance of heather plant	Mean percentage cover of heather	Other plant species present
4		10	Many
12		90	Few
19		75	Several
24		30	Many

(b) Explain why the number of other plant species decreases between 4 and 12 years after burning.

_____

_____

_____

_____

(2)

S (c) The rate at which a heather plant produced new biomass was measured in g per kg of heather plant per year. This rate decreased as the plant aged. Use the information in the table to explain why.

_____

_____

_____

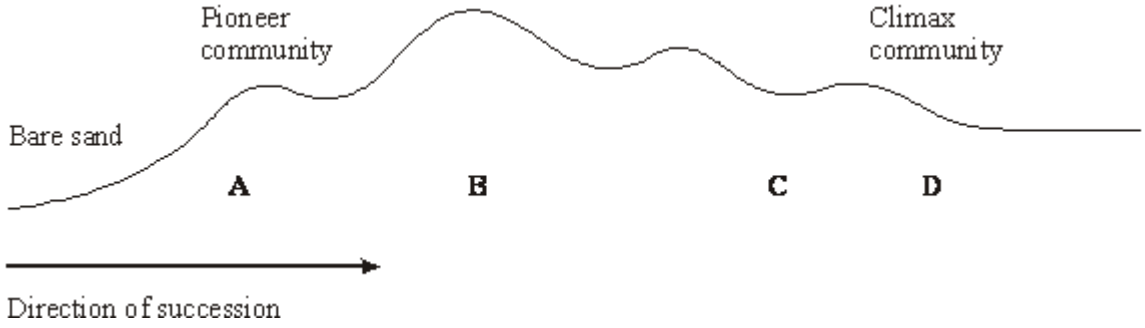
_____

_____

(3)

(Total 8 marks)

16 In a sand dune succession the pioneer community (**A**) colonises bare sand. This community is replaced over time by other communities (**B** and **C**) until a climax community of woodland (**D**) is formed.



(a) The communities **A** to **D** are composed of different species. Explain how the change in species composition occurs in a succession.

_____

_____

_____

_____

(3)

(b) Which community, **A** to **D**, is the most stable? Explain what makes this the most stable community.

_____

_____

_____

_____

(2)

S (c) Many species in the pioneer community are xerophytes. Suggest and explain how having sunken stomata is an advantage to these plants.

_____

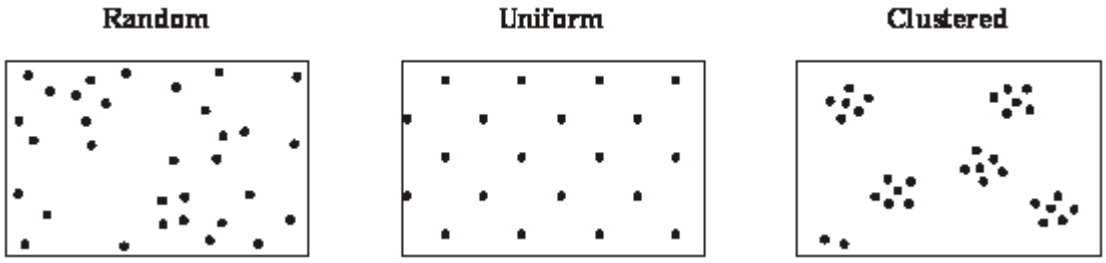
(3)

(d) Explain why it would be more appropriate to use a transect rather than random quadrats when investigating this succession.

(1)

(Total 9 marks)

17 The diagrams show three types of plant distribution.



(a) Describe how you would use quadrats to determine whether a particular plant species hasa clustered or a random distribution.

(3)

(b) Some plants in a dry, hot desert have a uniform distribution and are widely spaced.Suggest how this type of distribution is an advantage to the plants.

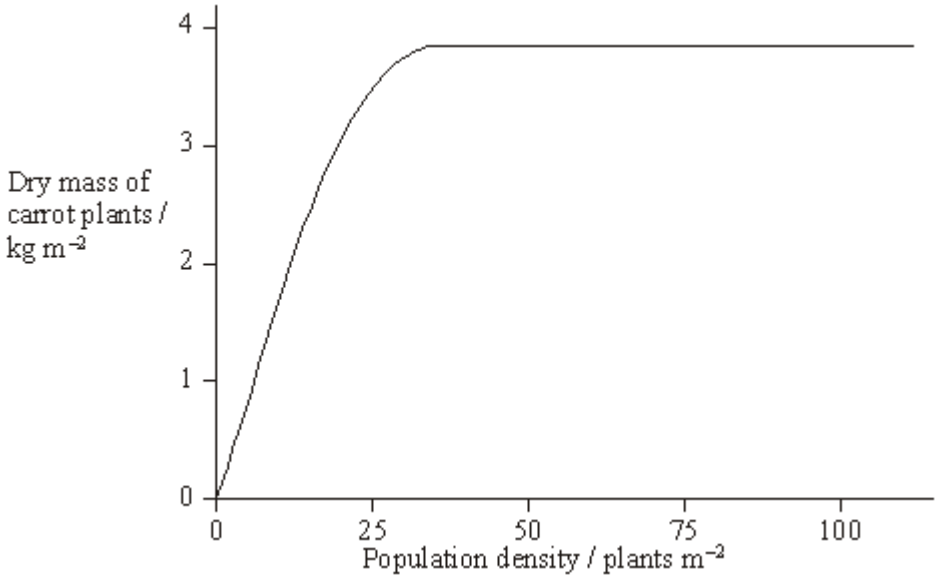
_____

_____

(2)

(Total 5 marks)

18 (a) In an investigation, carrot seeds were planted at different densities. After 120 days, the dry mass of the carrot plants was measured. The results are shown in the graph. 4



(i) What is the advantage of measuring the dry mass rather than the total mass of thecarrot plants?

_____

(1)

(ii) What type of competition is shown in this investigation?

_____

(1)

(iii) Explain the shape of the curve.

_____

_____

_____

_____

(2)

S (b) Commercial growers want all the carrots to be the same size when harvested. Suggest **two** ways in which they can try to ensure this.

1. _____

_____

2. _____

_____

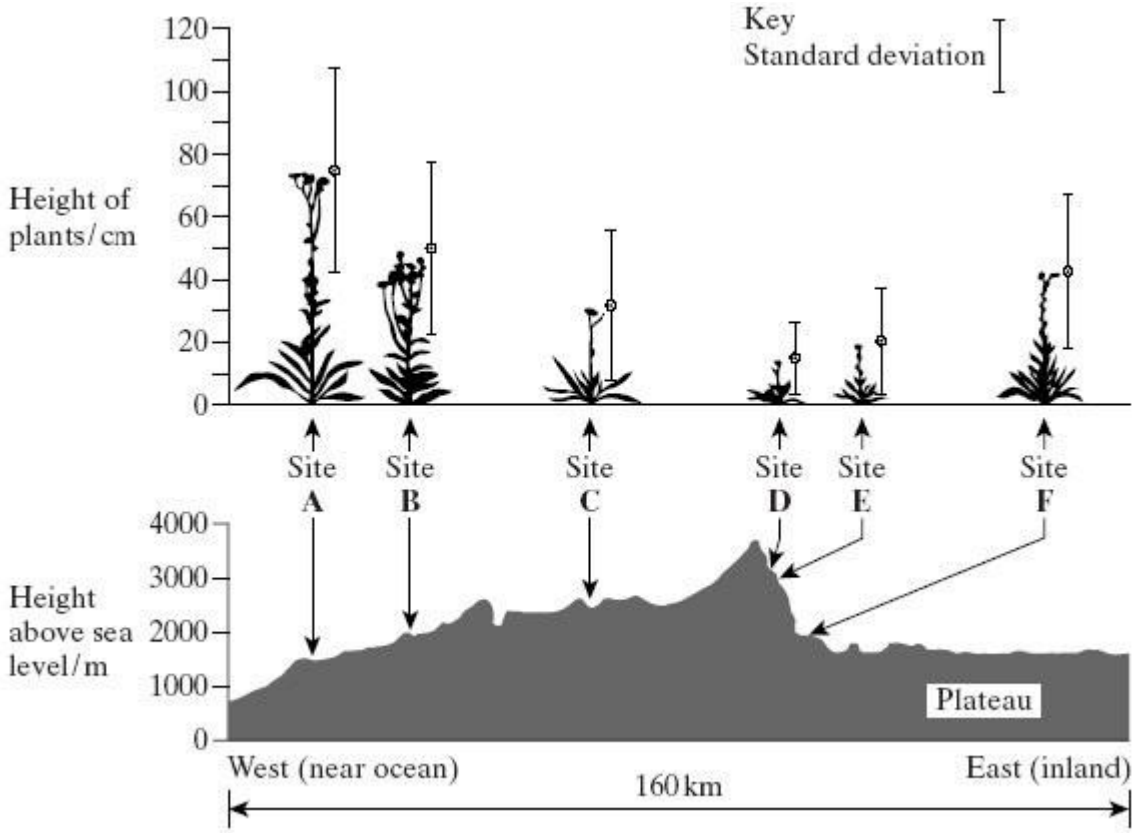
(2)

(Total 6 marks)

19 Climatic factors, such as temperature and rainfall, vary greatly over short distances across mountain ranges. In an investigation, populations of the plant, *Achillea lanulosa*, were sampled from several sites on a transect across a mountain range. At each sampling site, seeds were collected at random. Each batch of seeds was germinated and grown to maturity under the same experimental conditions.

The diagram shows

- a profile indicating the position and altitude of the sampling sites
- the mean height of mature plants grown from each sample of seeds
- the standard deviation of heights of the mature plants grown from each sample of seeds.



(a) (i) Give **one** limitation of using a line transect to collect these data.

_____

_____

(1)

(ii) Suggest how plants should be chosen at each sampling site to avoid bias and to be representative.

_____

_____

_____

_____

(2)

(b) (i) What information does the bar representing standard deviation give about the plants in a sample?

_____

_____

(1)

(ii) Describe what the results show about the variation of the height of the plants in relation to altitude.

_____

_____

_____

_____

(2)

S (iii) There was a significant difference between the mean heights of the plants grown from seeds taken from sites **A** and **D**. Describe the evidence from the information given which shows that this is likely to be due to genetic differences between the two populations.

_____

_____

(1)

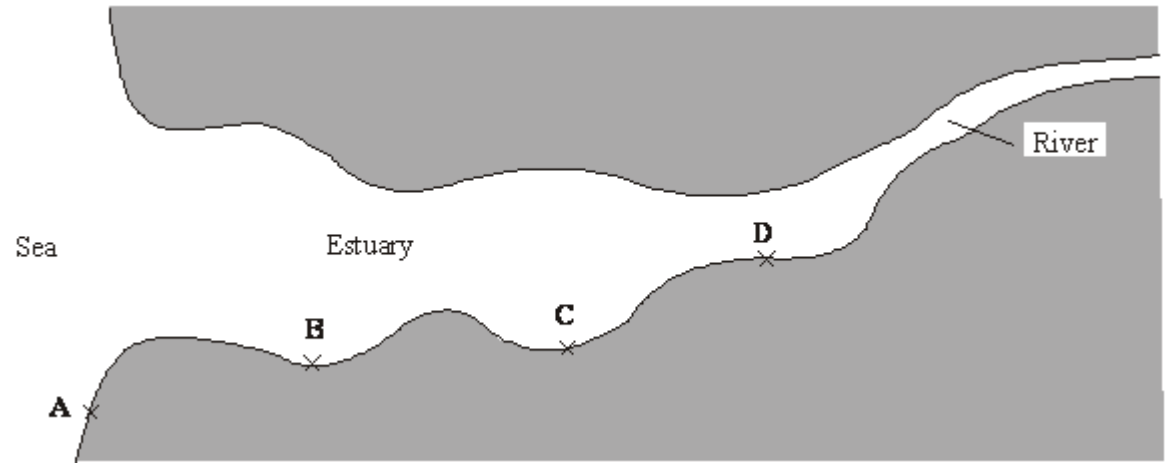
(Total 7 marks)

20 The shore crab is common in Britain. It lives both in the sea and in river estuaries, where it feeds on a wide variety of species.

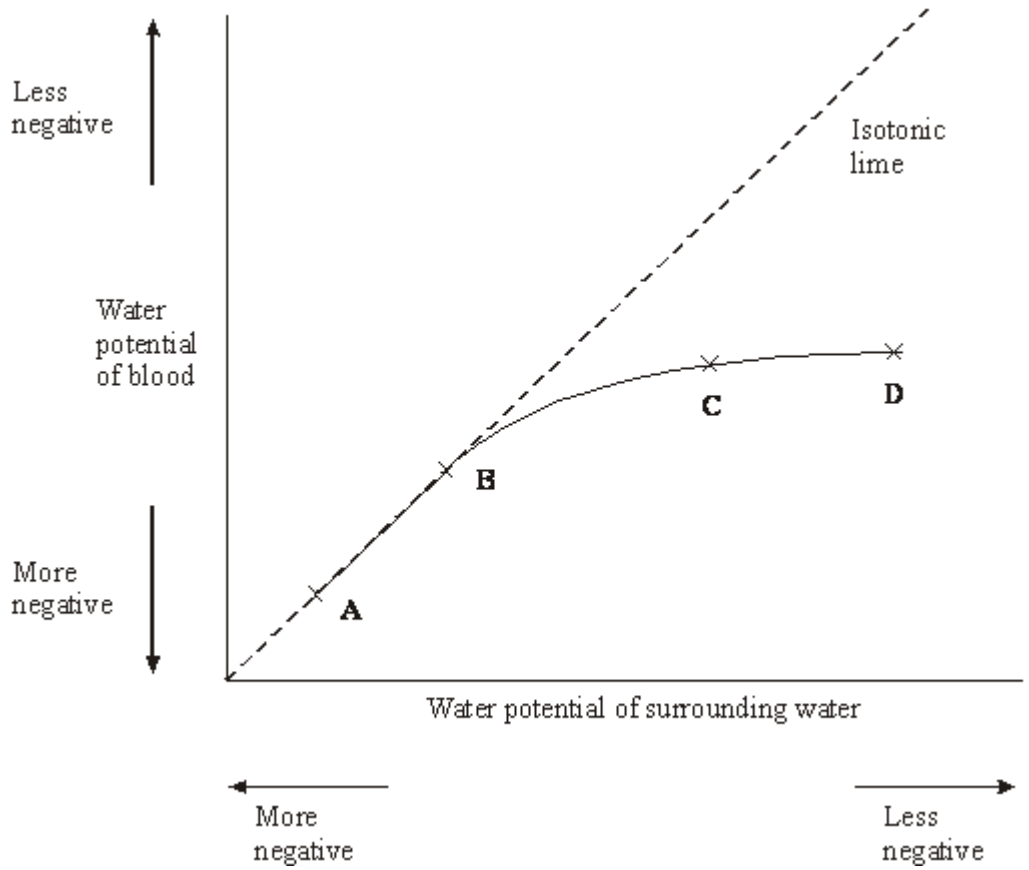
(a) The shore crab has recently spread to, and has established large populations in, the coastal waters of the USA, where it is not a native species. Explain how the shore crab has been able to establish large populations and why this is causing concern to ecologists in the USA.

(5)

In Britain, crabs living in an estuary and along the neighbouring coast were studied. Crabs were collected from four different sites, **A** to **D**, as shown in the map.



The graph shows the mean water potential of the blood of samples of crabs from the four sites in relation to the water potential of the environment at the same sites. The isotonic line shows values at which the water potential of the blood and surrounding water would be the same.



(b) Describe the relationship between the mean water potential of the blood of the crabs and the water potential of the surrounding water.

_____

_____

(1)

S (c) Is there any net movement of water in or out of the blood of the crabs at sites **A** and **B**? Explain your answer.

_____

_____

(1)

S (d) Crabs living at sites **C** and **D** actively transport salts into their blood through their gills.

(i) Explain how this enables crabs to survive at these sites.

_____

_____

_____

(2)

(ii) Crabs are unable to control their body temperature. In winter, when the watertemperature falls, crab populations at sites **C** and **D** migrate towards the sea. Suggest the advantage of this behaviour.

_____

_____

_____

_____

(3)

(Total 12 marks)

21 The inheritance of body colour in fruit flies was investigated. Two fruit flies with grey bodies were crossed. Of the offspring, 152 had grey bodies and 48 had black bodies.

(a) Using suitable symbols, give the genotypes of the parents. Explain your answer.

Genotypes _____

Explanation _____

_____

_____

_____

(2)

(b) Explain why a statistical test should be applied to the data obtained in this investigation.

_____

_____

_____

_____

(2)

(c) A species of insect, only found on a remote island, has a characteristic controlled by a pairof codominant alleles, $\mathbf{C^M}$ and $\mathbf{C^N}$.

(i) What is meant by *codominant*?

_____

_____

(1)

(ii) There were 500 insects in the total population. In this population, 300 insects had thegenotype $C^M C^M$, 150 had the genotype $C^M CN$ and 50 had the genotype $C^N C^N$.

Calculate the actual frequency of the allele C^N by using these figures. Show your working.

Answer _____

(2)

(iii) Use your answer to (ii) and the Hardy-Weinberg equation to calculate the number ofinsects that would be **expected** to have the genotype $C^N C^N$.

Answer _____

(3)

(Total 10 marks)

S 22 (a) What is meant by a community?

_____

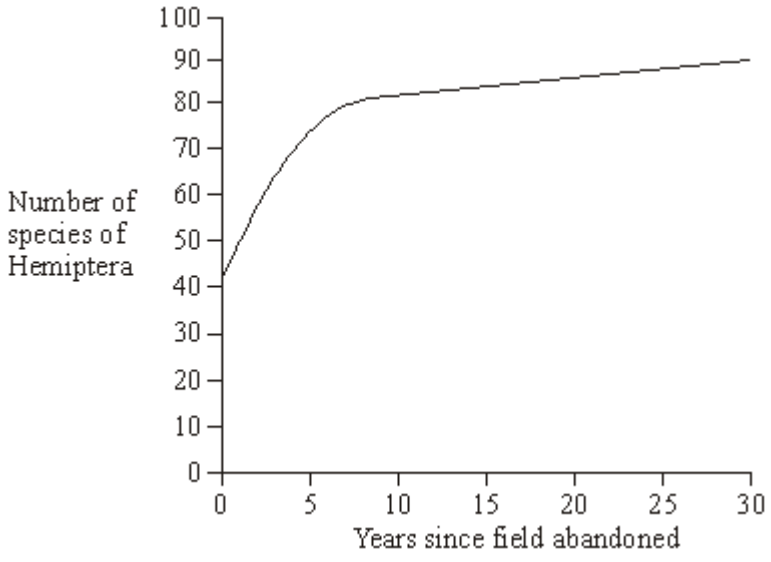
_____

_____

_____

(2)

(b) A farmer stopped using a field for growing crops. Scientists studied succession in the fieldover the next 30 years. The graph shows the number of species of Hemiptera (an order of insects) present during that period.



Explain the increase in the number of species of Hemiptera.

_____

_____

_____

_____

_____

_____

(3)

(c) To calculate a diversity index at a given time, it is necessary to know the number ofinsects in each population. Name **one** method that could be used to estimate the total number of insects in a population.

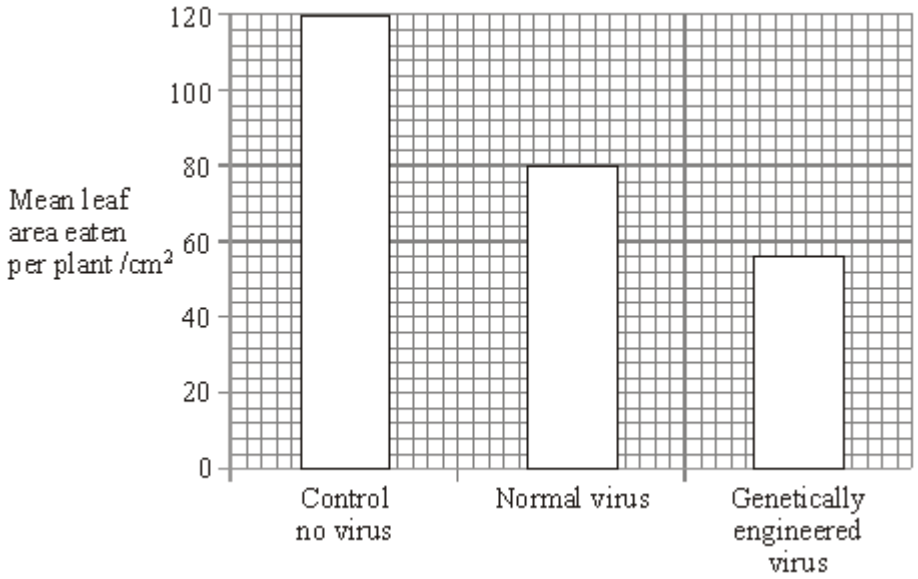
_____

(1)

(Total 6 marks)

23 Caterpillars damage crop plants by eating the leaves. There is a virus which kills caterpillars within a few days of infecting them. A genetically engineered form of the virus has been produced which contains a gene from a scorpion. This gene codes for production of a toxin specific to insects.

In an investigation, sample areas of crop were treated with either the normal or the genetically engineered virus. The bar chart shows the damage caused by caterpillars to the leaves of the crop plants.



(i) How much more effective is the genetically engineered virus than the normal virus? Showyour working.

Answer _____

(2)

(ii) Explain why the area of leaf eaten is less when caterpillars are infected with the geneticallyengineered virus rather than with the normal virus.

_____

_____

_____

_____

(2)

(Total 4 marks)

24 A student investigated whether the abundance of the orange star lichen on the walls of a building was influenced by the direction the wall faced. The student recorded the number of colonies within a 50 cm^2 quadrat, placed one metre above the ground on each of three walls.
A χ^2 test was applied to the results.

(a) Give a null hypothesis for this investigation.

_____

_____

(1)

(b) Complete the following table.

	Number of colonies on a wall facing		
	North	**South**	**West**
Observed	21	33	54
Expected			

(1)

(c) How many degrees of freedom were in this χ^2 test?

_____

(1)

(d) A χ^2 value of 15.5 was calculated from these results. This χ^2 value has a probability of less than 0.001. Explain what this means when applied to this investigation.

(3)

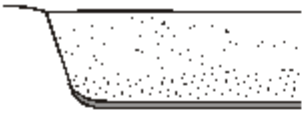
(e) Algae are green protoctists. Lichens consist of a fungus and an alga living together in arelationship where both organisms benefit. Suggest how the relationship between the alga and the fungus allows the lichen to survive on an inorganic surface such as a wall.

(2)

(Total 8 marks)

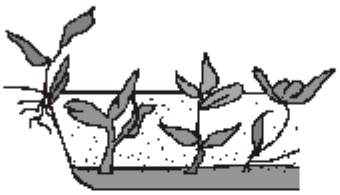
(a) The diagram shows a number of stages in an ecological succession in a lake.

25



Stage 1
Microscopic plants and animals

Stage 2
Layers of mud and organic matter settles on the bottom. Submerged plants appear.



Stage 3
Plants growing on surface and edges of pond. Submerged plants die out.

Stage 4
Build up of mud and organic matter forms a marsh.

Stage 5
Community of land plants

Explain how the diagrams illustrate the features of an ecological succession.

(6)

(b) Several small rivers flow into this lake. These rivers flow through forested areas. Explain how deforestation might affect the process of succession in the lake.

(2)

S (c) **Stage 5** illustrates the final stage of succession which is known as the climax community. During this stage the number of different species in the habitat and the size of each population remain fairly constant. Explain what limits the size of populations in a climax community.

(5)

(Total 13 marks)

26 The mesquite tree grows in dry areas which have soils with low concentrations of ions.

Its roots grow down to 25 metres and contain nitrogen-fixing bacteria. It is considered a pest in areas where farm animals graze because it out-competes grass. In some areas, young mesquite trees are cut down and then ploughed into the ground. This is expensive but makes the soil slightly more fertile for a few years.

(a) Using the information given, explain **one** way in which mesquite trees are adapted for survival.

_____

_____

(1)

S (b) Name the type of competition occurring between mesquite and grass.

_____

(1)

S (c) Explain how ploughing the mesquite into the soil makes it more fertile.

_____

_____

_____

_____

_____

_____

(3)

(Total 5 marks)

27 A hormone has been shown to switch on a gene in fish, leading to the increased production of an enzyme. Experiments were carried out to investigate the effects of heavy metal ions on the production of this enzyme, with and without the hormone. The table shows the results.

	Amount of enzyme produced / percentage of maximum	
Heavy metal ion present	**Without hormone**	**With hormone**
None	16	100
Cadmium	15	55
Zinc	17	94
Copper	16	100

Explain how the results suggest that cadmium affects the action of the hormone.

_____

_____

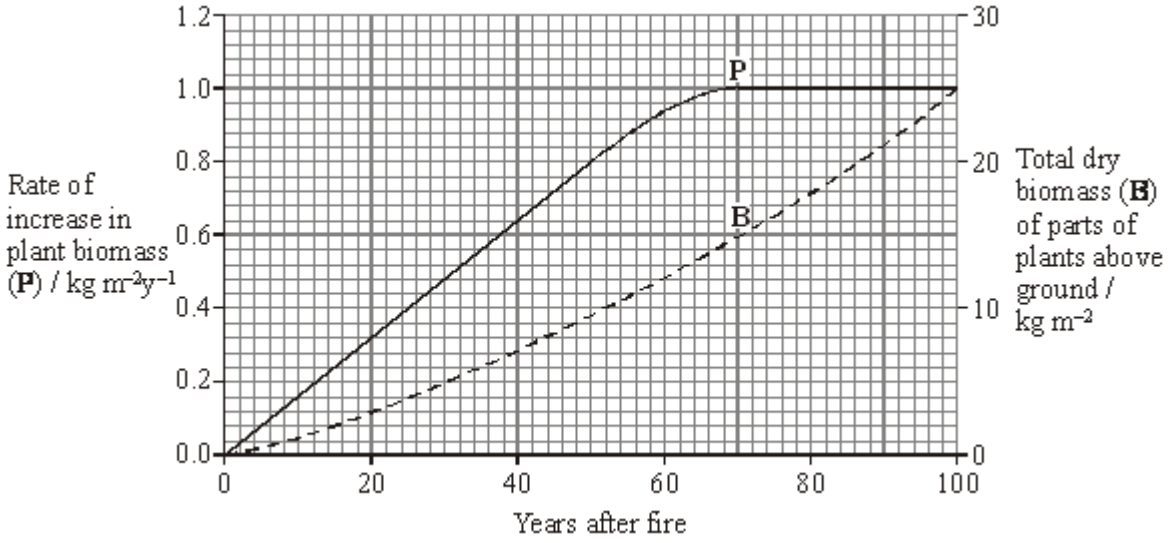
_____

_____

(Total 2 marks)

28 **S** A fire destroyed a large area of forest in North America. The process of succession was studied until the forest was re-established. The rate of increase in plant biomass, **P**, was determined at regular intervals. Also, the total biomass of the parts of plants above ground, **B**, was measured in sample areas.

The graph shows the results for the first 100 years after the fire.



(a) Ten years after the fire most of the area was covered with herbaceous plants.

(i) Describe how you could measure the dry biomass of the parts of the herbaceousplants above ground in a sample area of 1 m^2.

_____

_____

_____

_____

_____

_____

(3)

(ii) How could the researchers make sure that they obtained reliable data for the totalbiomass (**B**)?

_____

_____

_____

_____

(2)

(iii) Suggest **two** limitations involved in measuring the rate of increase in plant biomass (**P**) which would affect the accuracy of the data.

1. _____

_____

2. _____

_____

(2)

(b) The ratio of **P** to **B** after 10 years was 1 : 10.

(i) Calculate the ratio of **P** to **B** after 100 years.

Ratio _____

(1)

(ii) Explain the change in the ratio between 10 years and 100 years.

_____

_____

_____

_____

(2)

(Total 10 marks)

(a) (i) What is meant by an *abiotic* factor?

29

_____

_____

(1)

(ii) Do abiotic factors exert a density-dependent or a density-independent effect on a population? Using an example, explain your answer.

Effect _____

Explanation _____

_____

(1)

(b) Describe how you would collect the necessary data to estimate the size of a population by the mark-release-recapture technique.

_____

_____

_____

_____

_____

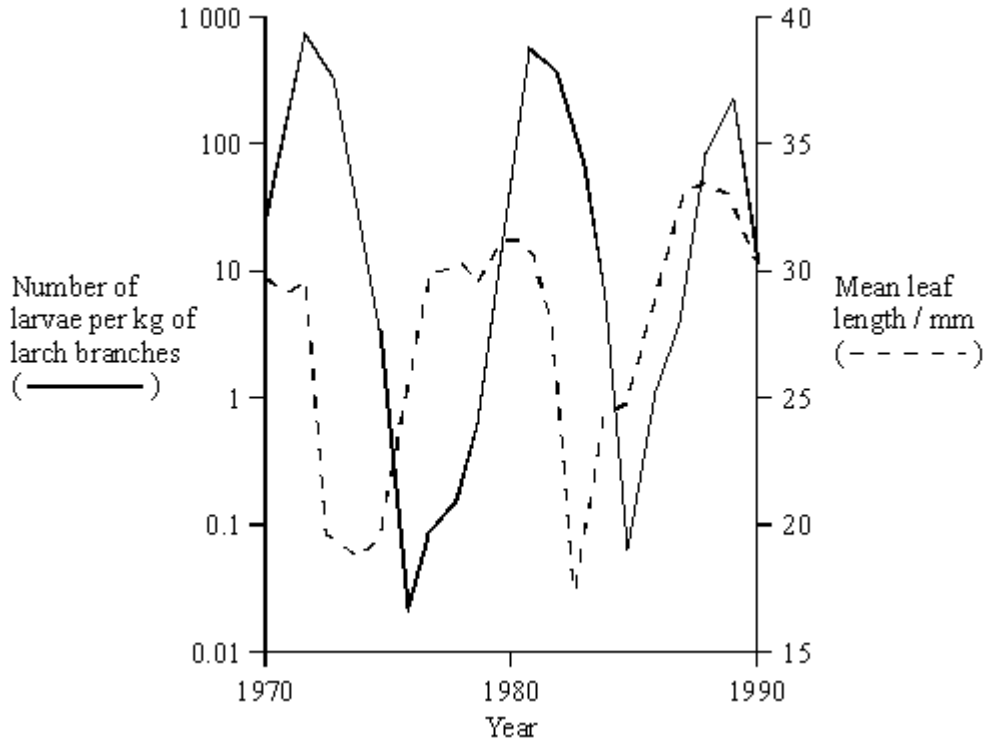
_____

(3)

(Total 5 marks)

30

A species of moth occurs in forests in Switzerland. The moth larvae feed on the needle-shaped leaves of larch trees that grow in the forests. The graph shows the numbers of larvae and the mean length of leaves over a period of 20 years.



(i) Describe how the population size of a species of bird that fed mainly on the moth larvae would be likely to change between 1970 and 1980.

(2)

S (ii) Larch trees lose their leaves in autumn. When numbers of larvae are large in one year, the leaves in the following year are shorter. Suggest an explanation for this.

(2)

(Total 4 marks)

31 Glaciers are masses of moving ice. When glaciers shrink, the thick covering of ice gradually disappears to leave behind bare land. Land exposed by a shrinking glacier in Alaska became covered by dense forest in 150 years.

(a) Explain how succession resulted in the formation of the forest.

(4)

(b) In areas of poor drainage the soil is waterlogged. In these areas the climax community isbog dominated by the moss, *Sphagnum*. Explain why bog is described as the climax community.

(1)

(c) Waterlogged soils lack oxygen. Suggest why trees are unable to survive in waterloggedsoils.

(2)

(d) The water and soil in *Sphagnum* bogs are usually acidic. Suggest why *Sphagnum* is not fully decomposed after it dies.

(3)

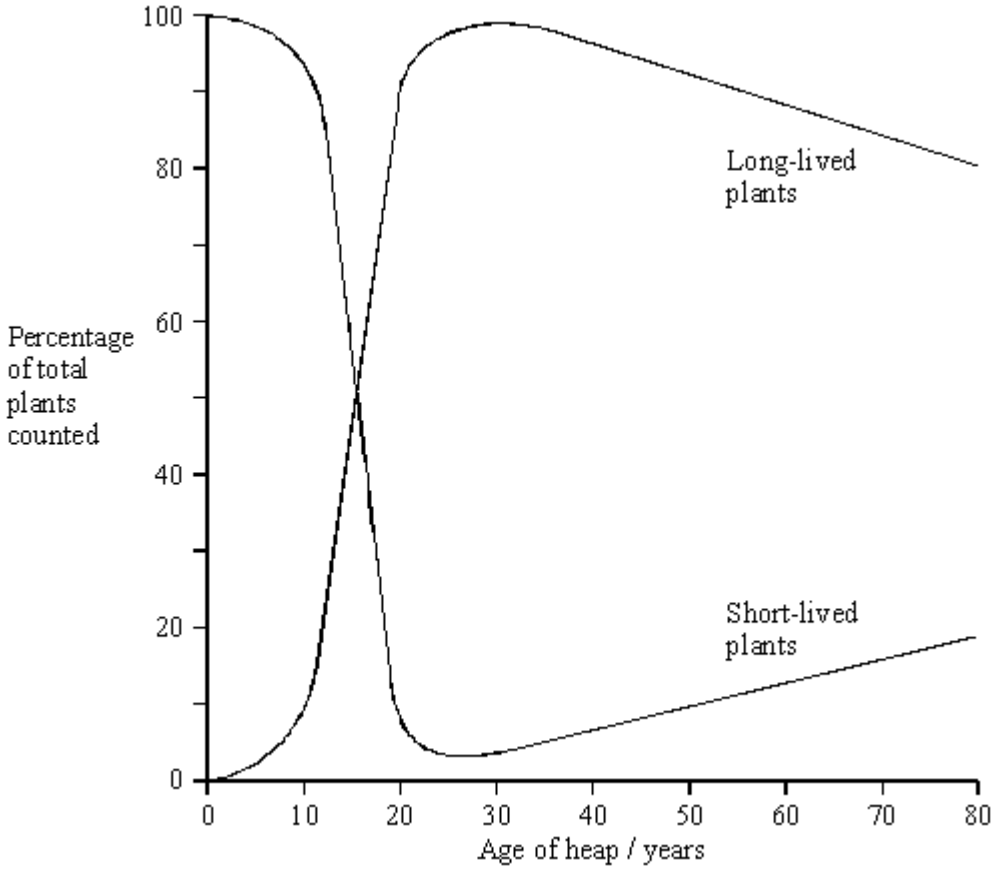
(Total 10 marks)

Answers should be written in continuous prose, where appropriate.

32

Quality of Written Communication will be assessed in these answers.

The waste material from coal mines is deposited in pit heaps. A particular mine closed and the colonisation of an area of its pit heap was studied for a period of 80 years. Species of plants that were found growing on the pit heap were recorded in two categories, short-lived plants that grow for one or two years before dying and long-lived plants that continue to grow for several years. The graph shows the percentages of short-lived and long-lived plants on the pit heap.



(a) Using your knowledge of succession, suggest explanations for the changes in the percentages of short-lived and long-lived plants

(i) over the first 20 years;

(ii) between 30 and 80 years.

(6)

S (b) Mine waste often contains metal ions at concentrations that are toxic to plants. Populations of two species of grass, red fescue and common bent, have been found on pit heaps contaminated with zinc ions.

Describe an experiment you would carry out in order to determine which of the two species has the greater tolerance to zinc ions in the soil.

(3)

(Total 9 marks)

33 The Solomon Islands are situated in the Pacific Ocean. The nearest large land mass is Australia, which is about 1500 km away. The biggest islands are mountainous, with large areas of tropical forest and a wide range of habitats. Some islands have a very high species diversity, and many species are endemic, that is they occur only in the Solomon Islands.

The table shows the total number of species on the islands in four vertebrate classes and the percentage which are endemic.

Vertebrate class	Total number of species	Endemic species / %
Mammals	53	36
Birds	223	20
Reptiles	61	16
Amphibians	17	53

(a) How many reptile species are endemic?

_____

(1)

S (b) Suggest an explanation for the high proportion of endemic species on the Solomon Islands.

_____

_____

_____

_____

_____

_____

(3)

(Total 4 marks)

34 (a) An ecosystem supports a certain size of population of a species.

Predation is one biotic factor that can cause the size of this population to change.

Give **one** other biotic factor that can cause the size of a population to change.

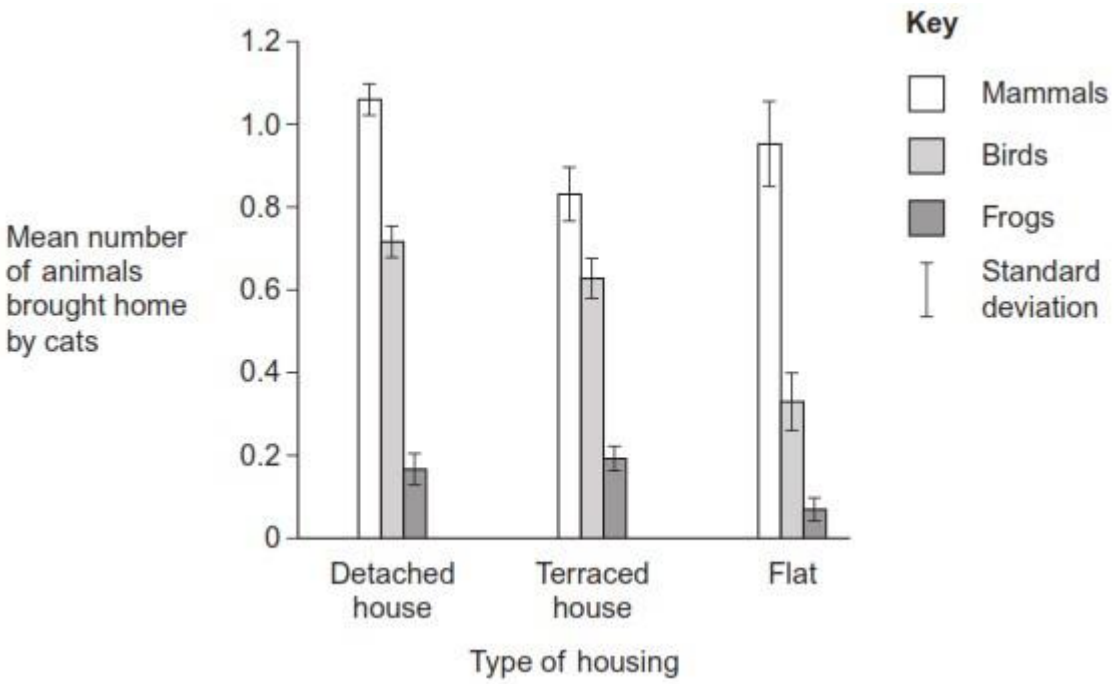
_____

_____

(1)

(b) Ecologists investigated predation by 555 domestic cats whose owners lived in differenttypes of housing. They asked cat owners to record the number of mammals, birds and frogs that their cats brought home over a five-month period.

The graph shows their results.



(i) What do these data suggest about predation by domestic cats?

_____

_____

_____

_____

(2)

(ii) Some scientists thought that the results of this investigation were **not** very reliable.

Suggest **one** reason why they might have thought that the results were **not** reliable.

_____

_____

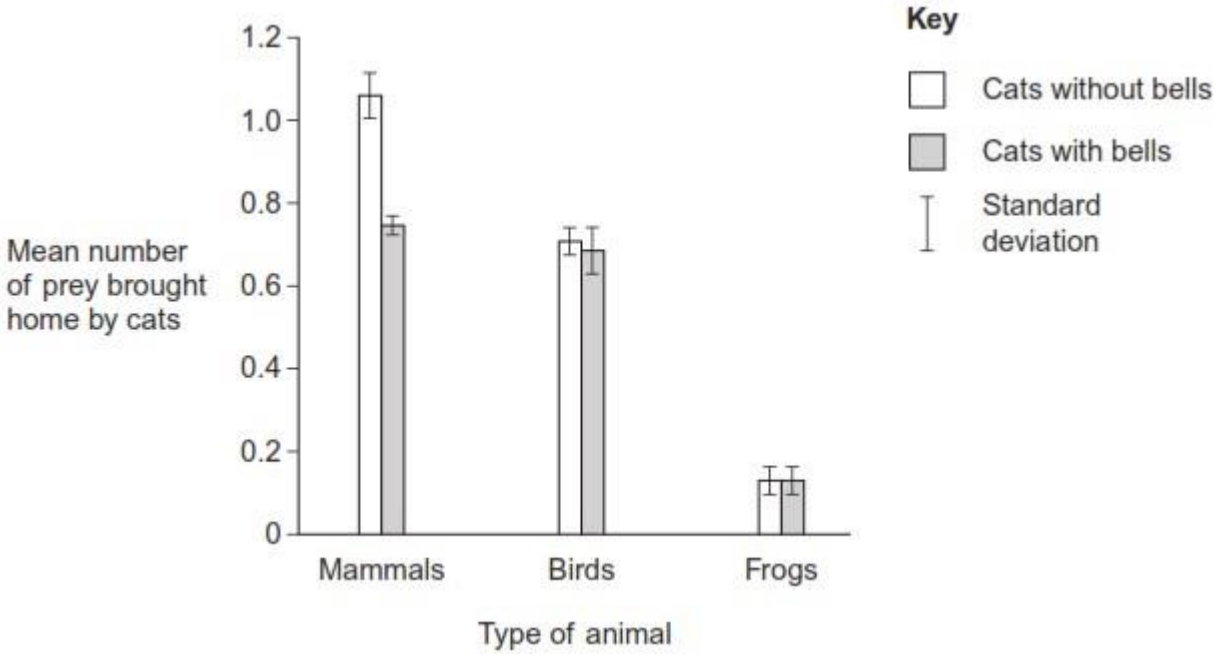
_____

_____

(2)

(c) The ecologists investigated the effect of putting a bell on a cat's collar on its probability ofcatching prey. As in the first investigation, they asked cat owners to record the prey brought home by their cats. Half of the cats in this study had bells on their collars.

The graph shows the results.



(i) What was the hypothesis that the ecologists were investigating?

_____

_____

(1)

(ii) What do these data suggest about the effect of putting a bell on a cat's collar?

_____

_____

_____

_____

(2)

(Total 8 marks)

35 The vegetation on a large heap of waste from an old mine was investigated. The table shows the results of the measurements of certain factors in $1m^2$ frame quadrats placed on the south-facing slope.

Quadrat	Angle of slope / °	Vegetation cover / %	Moisture content of soil / %	pH of soil
1	45	60	17.2	5.6
2	30	70	14.6	4.2
3	25	68	20.3	5.2
4	12	100	23.5	7.1
5	7	85	21.0	5.4
6	1	100	21.2	6.8

(a) Which of the factors measured are abiotic?

_____

(1)

(b) Describe how the investigators could obtain the value for vegetation cover in each quadrat.

_____

_____

_____

_____

(2)

(c) The correlation between vegetation cover and soil moisture content was tested statistically.These two factors were found to be positively correlated, and $p < 0.05$. Explain what this result means.

_____

_____

_____

_____

(2)

S (d) At first the waste heap had no plants growing on it. Some of the first plants to colonise it were small herbaceous plants. Explain **one** way in which colonisation by herbaceous plants could change the physical environment.

_____

_____

_____

_____

(2)

(Total 7 marks)

Mark schemes

(a) (i) Method of positioning quadrats,

1

E.g. Find direction and distance from specified point / find coordinates on a grid / split area into squares;

Method of generating random numbers;

E.g. From calculator / telephone directory / numbers drawn from a hat;

Last point represents minimum answer

Q *Do not credit any method that relies on throwing a quadrat*

2

(ii) Calculate running mean / description of running mean;

When enough quadrats, this shows little change / levels out (if plotted as a graph);

Enough to carry out a statistical test;

A large number to make sure results are reliable;

Ignore terms that are not incorrect
Regards large numbers as 10 / 10% +

Need to make sure work can be carried out in the time available;

2 max

(b) Coppice different parts of the wood at different times;

As data show many daffodils flowering 4 / 5 years after coppicing;

Q *Second point needs specific reference to the graph, numbers and time after coppicing. Accept any correct answer that does this.*

2

(c) Positive correlation between rainfall and flowering / the higher the rainfall, the more daffodil flowers;

Negative correlation / the higher the temperature the fewer daffodils in flower;

All statistically significant so not likely to be / not due to chance;

2 max

[8] (a) Vegetation consists mainly of low growing species / herbs / annuals / no / few trees;

2

Species **X** has high rate of photosynthesis at high light intensity;

*Do not credit Species **X** is first tree*

Species **X** grow fastest at high rate of photosynthesis / at high light intensities and will outcompete other species **Y** / **Z**;

3

(b) Produces shade / reduces light intensity;

Species **Z** grows best / photosynthesis best / in low light intensity /
Species **Z** does not grow well / low rate of photosynthesis in high light intensity;

Accept answers in terms of CO_2 absorption

2

[5

] (a) (i) Will work in all weather conditions / hairs will stick to it even if shrew / animal is wet /

3 withstand rain;

1

(ii) So shrews come into contact with glue;

1

(b) Avoids bias / allows statistical tests to be carried out;

Allow description

1

(c) (i) Increases the reliability of the measurements;

If measurements are repeatable, differences less likely to be due to measurement / personal error / anomalies unlikely;

Accept advantages of repeatable results. E.g. identifying anomalies / remove errors

2

(ii) Plot graph / scatter diagram of one set of results against the other;

***Q** To gain first marking point, candidates must say what has been plotted.*

Expect to see points lying close to line / Line should slope upwards / show positive correlation;

If what is being plotted is not clear, second point cannot be awarded.

OR

Plot measurement against hair number;

Look for overlying / corresponding points;

2

(d) (i) One mark for a valid explanation based on individual shrews entering morethan one hair tube / many hairs from same shrew / shrews enter without leaving hair;

1

(ii) Rules out differences due to changes in population / changes in environmentalconditions;

That could be produced by births / deaths / migration / specific example of environmental conditions affects results;

2

(e) (A statistical test) determines the probability of results being due to chance;

Enables null hypothesis / description of null hypothesis to be accepted / rejected / determines whether correlation / result is significant;

2

(f) (i) (Curve / line of best fit shows) positive correlation / description of positivecorrelation;

1

(ii) Curve / line of best fit (almost) parallel to x-axis / horizontal / level / nocorrelation / index is independent of number of shrews;

Hair tubes with positive results when no shrews trapped;

Small size of shrews means shrews may not trigger traps;

2 max

[15]

(a) (i) decomposers convert (nitrogen in organic compounds) into ammonia / ammonium;

4 suitable example of "organic nitrogen" - protein / urea / amino acid etc. (e.g. linked to process); nitrifying bacteria / correctly named convert ammonium to nitrate; via nitrite;

3

(ii) convert nitrogen (gas) into ammonium / ammonia / amino acids;
add usable / available nitrogen to an ecosystem / eq.;

2

(b) (i) 1. numbers of dispersed bacteria increase as they <u>feed</u> on organic matter;

2. numbers of free-swimming protoctistans increase because number ofbacteria increase;

3. dispersed bacteria decrease as amount of dispersed organic matterdecreases / due to lack of food / as organic matter is converted to flocs / are preyed on by free-swimming protoctistans;

3

(ii) 1. (in a succession) organisms (enter an area and) change the environment /conditions creating new niches / habitats;

2. allows different species / different types of organisms to enter / besuccessful;

3. dispersed bacteria change dispersed organic matter to flocs;

4. presence of flocs allows crawling protoctistans to enter / to increase / tobe successful;

4

[12]

5 (a) (i) ecosystem is (self-supporting) system in which all organisms / community interact with physical environment / community + environment / biotic + abiotic;

1

(ii) A + B + E + F + G + I;

1

(b) pygmy weed competes for CO_2 / light / nutrients; reduction in numbers of original plants; some of original plant <u>species</u> lost; loss of habitats / niches / shelter / food sources; consumers die / some migrate;

3 max

[5]

6 (a) Increase in number of species;

Increase in numbers of some species;

2

(b) Initial environment hostile / few organisms adapted;

These organisms change the environment / suitable example;

More niches / more habitats;

Allowing other organisms to become established;

max. 3

[5]

7 (i) Population is the total number of organisms / individuals of a species / tigers in an area (at a given time);

1

(ii) (Deforestation involves) habitat destruction / destruction of niches;

Some prey animals move out or die / fewer suitable prey for tiger / less food for tiger; Reduces tiger population if prey biomass falls below 600 (tonnes per km^2);

3 [4]

8 (a) (i) *Selecting the nettle plant*:

Random number table avoids bias in placing of quadrat;
'Nearest centre' avoids bias in choosing plant to measure;

1 mark for "method avoids bias"

2

(ii) *Measuring the sixth leaf:*
To allow valid comparison / so as not to introduce another variable;
Reduces / avoids influence of growth / age / light / shading;

2

(b) Definition of range + SD / effect of outliers on range + SD;
Ranges are similar in both areas;
Suggests that variation within populations is similar;
SD smaller in area of high light intensity;
Shows that area of high light intensity is a more uniform population;

4

(c) 1.164 / 1.16 / 1.2 , however derived = 2 marks
0.83 – 0.86 / 1.1, however derived = 1 mark

Evidence of correct use of both sets of figures, but inappropriate answer = 1 mark

2

[10]

9 (a) collect a sample (of insects in each area) and mark unobtrusively / in a way not harmful to insects; release and allow time <u>to re-integrate</u> with rest of population / eq.; collect second sample and count number marked; number in population estimated by:

$$\frac{S1 \quad \times \quad S2}{\text{Number marked in } 2^{nd} \text{ sample}} \;/\;/$$

$$\frac{\text{Total marked}}{\text{Number marked in } 2^{nd} \text{ sample}} = \frac{\text{Population}}{\text{second sample}};$$

4

(b) (i) 1;

1

(ii) (p =) 0.05 / 5%;
(ignore 95%)

1

(iii) value for χ^2 <u>exceeds</u> critical value / 125.8 > 10.8 ;
Results unlikely to be due to chance / have a biological cause;
P < 0.1% / < 5% ;

2 max

(c) (i) biomass respired / GPP – respiration = NPP;
biomass lost as CO_2;

2

(ii) more food for insects;

1

[11] (a) Fertilisers / detergents / slurry / manure / sewage / faeces;

10 **1**

(b) (31 – 5) / 31 x 100% / single error in otherwise correct method;83.87 / 83.9 / 84%;

2

(c) Have continuous data for phosphate but not for biomass;
Effect of named factor explained;

2

(d) 1. Increased phosphate causes increase in plant growth / algal bloom;
2. Plants (cover surface and) block out light so plants (under surface) die;
3. Increase in (aerobic) bacteria / decomposers (which break down plants);
4. Bacteria / decomposers use up oxygen / reduce oxygen conc. in water;5. In respiration;
6. Plants unable to photosynthesise so less oxygen produced;

max 6

[11] (a) Population – organisms of one species in an ecosystem / habitat / area;

11

Community – organisms of all species / all populations in an ecosystem / habitat / area;

2

(b) (i) No immigration / migration (Ignore references to emigration);
No reproduction *(Ignore references to death)*;
Idea of mixing;
Marking does not influence behaviour / increase vulnerability to predation;
Sample / population large enough;

max 2

(ii) $\frac{96 \times 77}{11}$; 672;
Correct answer (however derived) scores 2 marks
Incorrect answer with evidence of correct method scores 1 mark.

2

(c) Principle of randomly placed quadrats and method of producing randomquadrats;
(Reject 'throwing')
Valid method of obtaining no. dandelions in given area (mean per quadrat / total no. in many quadrats);
Multiply to give estimate for total field area;

3

(d) (i) Niche of A – 1;
Niche of B – 3;
Too small for B / too hot for A – 4;
Too large for A / too cold for B – 2;
All four correct = 2 marks; any 2 correct = 1 mark

2

(ii) Original population living in one area / 2 species evolved in the area;
Idea of genetic variability;
Concept of reproductive isolation;
Possible mechanism;
Gene pools become increasingly different;
Until interbreeding does not produce fertile offspring;

max 4

[15] (a) 1. Occurs in an unchanging environment;

12

1

+

2. Selection against extremes / selection for the mean / mean / median / modeunaltered
3. Range / S.D is reduced
4. Increasing proportion of populations becomes well adapted to environment;

4

(b) 1. All plants are acyanogenic below –4 °C and (most) cyanogenic above +10 °C;
2. Cyanogenic plants' cells freeze below –4°;
3. Releasing cyanide (into their own tissues) / damaging / killing plants / disruptingmetabolism;
4. Selective advantage not to produce cyanide at –4 °C;
5. Slugs present at higher temperatures / not usually present / inactive at lowertemperatures and cyanide production kills / deters slugs;

5

[10] (a) Tapes / string / axes laid out at right angles / grid area;

13

Method of obtaining random co-ordinates;
Do not allow "Use random number generator"

2

(b) (i) Decrease then remain constant;
From 200 cm / over 150 cm;

2

(ii) Oxygen decreasing because soil becomes more compacted / notreplaced;
Decrease in oxygen leads to fewer aerobes surviving;

2

(c) Anaerobic bacteria replace aerobic as oxygen decreased by aerobic bacteria;
Remove competition;
Aerobic bacteria no longer able to survive in these conditions;

3

(d) (i) Near the surface / in top 50 cm;
Table shows decrease with time at greater depths;

2

(ii) Decrease;
Fewer aerobic bacteria with depth;
Oxygen concentration decreases / less oxygen at depth;

3

(e) Probability greater than 95% / 0.95;
Results are not due to chance / results are significant;
Because bars do not overlap;

3

(f) Plot as graph;
Draw line of best fit;
Read off appropriate value;

3

[20] (a) 1 4 year cycles;

14

2 predator / stoat peaks after prey / lemming;
3 lemmings increase due to low numbers of stoats / available food;
4 more food for stoats so numbers increase;
5 increased predation reduces number of lemmings;
6 number of stoats decreases due to lack of food / starvation;

6

(b) smaller populations have fewer different alleles / more homozygosity / lessheterozygosity / smaller gene pool / lower genetic variability; migrants bring in new alleles / increase gene pool;

2

(c) geographical isolation of populations;variation present in population(s);
different environmental conditions / different selection pressures /
different phenotypes selected;
change in genetic constitution of populations / gene pools / allele frequency;

4

[12] (a) (i) change in community over time;

15

either due to change environmental / abiotic factors / change is due to species present;

2

(ii) stable community / no further succession / final community;

1

(b) (increased) <u>interspecific</u> competition; for light / nutrients / named nutrient / water;

2

(c) fewer leaves / lower surface area / shading of leaves so less photosynthesis to producenew biomass / glucose / growth;
competition with other species for nitrates / named nutrients so

reduced synthesis of protein or named compound; ratio of leaves to woody parts and roots decreases so higher respiration relative to photosynthesis;

3

[8] (a) species present change the habitat / named change;

16

other species able to colonise;
new species better competitors;

3

(b) D - as more species present;more complex food webs; or

change in one species will have little effect on others;
as alternative food sources;

2 max

(c) sand drains easily / low water retention;(sunken stomata) reduce transpiration; as pocket pf saturated air trapped near stomatal pore; this reduces diffusion / water potential gradient;

3 max

(d) series of changes over a distance / gradient of environmentalfactor / named environmental factor / cline present / ensures sampling of each community;

1

[9] (a) use of random numbers to place quadrats;

17

number of individuals counted in large number of quadrats;
little variation random, large variation - clustered;

3

(b) less competition;
for water /
nutrients;

2

[5] (a) (i) true indication of growth / water mass may vary;

18

1

(ii) intraspecific;

1

(iii) the denser the planting the greater the yield;above a planting density of approx 30 competition for named resource / named limiting factor / population density not limiting;

(accept nutrients / space reject food)

2

(b) use genetically identical plants / clones / asexual reproduction / tissue culture; maintain identical environmental conditions / named condition; reference to density of planting;

2 max

[6

] (a) (i) transect line may not go through representative areas / may avoid certain areas;

19

1

(ii) large sample; how random coordinates are generated / how random places chosen;

2

(b) (i) spread of values around the mean height of the plant;

1

(ii) smaller plants at higher altitude;greater the altitude the lower the standard deviation ; reference to figures to make a comparison;

2 max

(iii) the plants measured were grown under uniform conditions;

1

[7] (a) 1 shore crab rapidly colonises / rapid growth;

20

2 ability to live different environments / no natural predators / will have similar /overlapping niche with native species / valid example / shore crab may be carrier of disease;
3 shore crab better competitor / more aggressive;
4 decreased population of prey species;
5 ecosystem less stable;

5

(b) between A and B water potential of blood rises as water potential of blood rises aswater potential of surrounding water rises, after B rise in water potential less rapid / at C no further change occurs;

1

(c) No – as blood is isotonic with surrounding water / blood and surroundingwater have same water potential;

1

(d) (i) water potential of blood maintained;so (blood) cells not destroyed (by osmosis);

OR

replaces ions / salts lost diffusion;

ions / salts required for named metabolic process;

2

(ii) rate of respiration decreases; less ATP made; insufficient to maintain water potential of blood when in estuary; isotonic in sea so no need to transport salts;

OR

sea temperature higher than river; higher metabolic rate / higher enzyme activity;
advantage of this crab e.g. still able to escape from predators;

3 max

[12] (a) Gg / suitable equivalent;

21

Grey : black about 3: 1;

[Note: Can be in table / diagram]

2

(b) To determine the probability;

[Accept: Likelihood]

Of the results being due to chance;

[Accept: Coincidence]

2

(c) (i) both alleles will be expressed (in the phenotype);

1

(ii) 0.25 / 25%; = 2 marks
C^N = 250 / 1000; = 1 mark

2

(iii) P^2 = $(0.25)^2$ / 0.0625 / square of calculated figure for C^N; = 2 marks $p^2 + 2pq +$ q^2 = 1.0; = 1 mark
= 31.25 / 31;

[Accept: Derived from either p^2 or q^2]

3

[10] (a) populations of different species;

22

living in the same environment / habitat;
(often) named after dominant plant / example;

(one mark for principle:all the species living in the same place)

2 max

(b) more species / diversity (in the field);more niches / habitats;
more feeding opportunities (range of types available);

3

(c) one method named, e.g.:
mark, release, recapture;
sweep netting / kick sample; pitfall traps; light trap;

1 max

[6]

23 (i) normal virus reduces area eaten by 40cm^2

genetically engineered reduces by 64 cm^2

64 – 40 = 24

$\frac{24}{40} \times 100$

= 60% more effective

1 mark for principle of calculation;

60% more effective = 2 marks; or

$\frac{64}{40}$

= 1.6 times more effective

1 mark for principle of calculation;
1.6 times more effective = 2 marks;

(if only difference in area eaten given, 1 mark)

2

(ii) toxin kills the caterpillars faster than just the virus; so less time for leaves to be eaten / energy for eating;

2

[4]

24 (a) there is no difference between the number of lichens growing on the walls (facing different directions);

1

(b) 36, 36, 36;

1

(c) 2;

1

(d) p less than 0.05 so reject the null hypothesis;the difference is not due to chance / significant difference;
the direction the wall faces does have an effect on the population of lichens;

3 max

(e) algae photosynthesise / produce organic molecules / named;fungus anchors the lichen / absorbs water which is available to the algae / prevents dehydration of alga / absorbs mineral ions / phosphates / nitrates;

2

[8]

25

(a) 1. colonisation / pioneering;

2. microscopic plants at start;
3. death / decomposition;
4. named change in environment e.g. increase in organic matter / stabilisation;
5. new species colonise once there is a change;
6. increase in number of species / diversity / increase in total amount of livingmaterial / biomass / more niches / increase in nutrient availability / change from more extreme conditions / more stability;

6

(b) marking principles:
one mark – direct result of removing forest cover;
e.g. soil erosion / leaching one mark – specific effect on organisms in lake;
e.g. more sediment / nutrients (for plants to grow)

2

(c) 1. named nutrient availability;
2. numbers of <u>producers</u> providing <u>energy</u> (for a food chain) / <u>light</u> intensity affecting the rate of <u>photosynthesis</u>;
3. <u>disease killing</u> (weaker) members of species / predation described;
4. space for nest building / niches;
5. competition for a named limited resource / (intra and interspecific) competitionexplained;

5

[13]

26

(a) very long / deep roots, to reach water deep in the soil / nitrogen-fixing bacteria, to provide a source of nitrogen for growth in poor soil;

1

interspecific;

1

(b) (mesquite) proteins / amino acids (ploughed) into soil / nodules ploughed in and
(decomposers) bacteria / fungi feed on these;
excrete ammonia;
nitrifying bacteria convert these to nitrites / nitrates; absorbed by roots of grasses and increase their growth; *accept increases recycling of other ions / phosphate / potassium;*

3

(c) control organism a parasite / predator;specific to pest; population varies with population of pest; controls size of pest population but does not kill all;

keeps pest population low enough to prevent significant (economic) damage;

3 max

[8]

27

With hormone (third column) cadmium produces large / significant / 45% fall in enzyme production; without hormone (second column) no significant effect on enzyme production with cadmium;.

2 max

[2]

28

(a) (i) (collect and) dry all above ground plant material; *(reject collect one / small sample / whole plants)* in an oven at or just below 100 °C; weigh and repeat until constant mass; other precaution, e.g. cooling in desiccator;

3 max

(ii) large number of sample areas / repeats;randomly selected;

2

(iii) drying destroys plants, so different samples needed;large area, so difficult to get representative samples; difficult to measure biomass of trees; variability in growing conditions; variability of abiotic conditions in different areas of forest;

2 max

(b) (i) 1:25

1

(ii) most of the plants are trees / large with high proportion of dead / non-photosynthesising biomass; herbs grow rapidly / small so large percentage increase / herbs have higher productivity, so ratio lower at 10 years;

2

[10]

29

(a) (i) the non-living / physical part (of an ecosystem / environment);

1

(ii) density-independent, with named abiotic factor and a specific effect;

1

(b) capture, count and release; carefully mark to avoid detection; recapture, count marked and unmarked;

(information from an equation is valid)

3

[5]

(i) idea of rise and fall;

30

peak and trough later than those of larvae / idea of time lag;
(*allow correct line drawn on the graph*)

2

(ii) reduction in leaf area / size decreases photosynthesis;
less food reserves available for production of new needles;
OR
feeding larvae damage more growing points;
takes time for tree to recover / less growing time for needles;

2

[4]

31

(a) pioneers / suitable example colonise land;

example of change in environment;
enables change in species;
<u>conditions change further / example</u> to favour trees;

4

(b) stable community / no further succession / final community;

1

(c) <u>roots</u> unable to respire (aerobically); active transport of minerals / other metabolic effect stops;

2

(d) action of bacteria / decomposers inhibited / fewer bacteria / decomposers;acid conditions <u>inhibits</u> enzymes / enzymes denatured / changes active site;
H^+ ions affect active site;
anaerobic conditions;

3 max

[10] (a) (i) tips colonised by short-lived plants / short lived plants are pioneers;

32

short-lived plants fast growing / spreading / distribute seeds quickly; short-lived plants change the environment e.g. make conditions more favourable for long-lived plants; valid reference to competition;

(ii) long-lived plants compete with each other; death of some long-lived plants; more niches / leaving spaces / areas for growth of short-lived plants; short-lived plants recolonise;

6 max

(b) control of named variable e.g. light, water-content, nutrients; large numbers of both species / 10+ individuals; range of different concentrations of zinc; valid measurement of growth, height / leaf area / root growth / numbers / mass / % germination;
statistical analysis / correlation between the two sets of data;
OR
large number of samples taken (in the field);
principle of determining zinc concentration of soil;
valid measurement of growth, height / leaf area / root growth / numbers / mass / % germination;
statistical analysis / correlation between the two sets of data;

3 max

[9] (a) 10

33

(reject: 9.76)

1

(b) isolation (on islands); variety of habitats / conditions different from origin / other islands; differing pathways of natural selection; leading to organisms too different to interbreed.

3 max

[4] (a) Competition described / named biotic factor (that they might compete for);

34

Reject ref. to predation or abiotic factors

1

(b) (i) Not many animals brought home during this period;
Overall, detached bring in most animals;
Mostly mammals, (fewer birds) and fewest frogs;
Idea of 'preference', not just restating data

Cats prefer mammals to birds / find mammals easier to catch;
Idea of 'preference'/'availability', not just restating data

Cats do not prefer frogs / have fewer frogs to catch;
Cats in flats take very few birds or frogs;
Suitable use of standard deviations;

2 max

(ii) Suggestion; with explanation;
Note that sample size is large – reject ref. to small / sample sizes.

Examples,

Method underestimates prey;
(Because) cats don't bring some prey home/eat it before seen;

Cats may kill other animals;
But don't bring them home/eat them;

Don't know how many cats in each type of housing;
So comparisons difficult;

Overlap of SDs (in some cases);
So no significant differences between means / named examples where this is so;

Don't know details of housing;
May have different amounts of prey / types of prey around;

Number of prey not large;
So, possible large variability in results;

2 max

(c) (i) Wearing a bell reduces/affects/changes a cat's probability of catching prey;

Accept statements of – Null hypothesis that wearing a bell makes no difference to probability of catching prey

1

(ii) No (significant) difference for birds and frogs;
(Significant) fall in mammals caught;
Suitable ref. to standard deviations;

Reject mammals and birds fall

2 max

[8]

35 (a) angle, moisture and pH

(all required)

1

(b) system for subdividing quadrat into, e.g. many squares;method of estimating cover in small squares, e.g. counting those where cover over 50%, or cover at points (of intersection);

(not just 'count squares with vegetation' unless very small)

2

(c) increasing vegetation cover is related to increasing moisture content

(allow 'affects' moisture content or vice versa, not 'causes);

correlation is significant / not due to chance / can reject null hypothesis / only 1 in 20 / 5% probability that the correlation is due to chance;

2

(d) factor; and linked effect e.g.
wind-blown particles trapped;
accumulation of soil;
OR

accumulation of organic / dead / decomposed matter / humus;
increase in mineral ions / improved water retention / improved soil structure;
OR
nitrogen fixation;
increased nitrate concentration / improved soil fertility;

2 max

[7]