AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.7.4 POPULATIONS IN ECOSYSTEMS

SCORE	PERCENTAGE
/696	%

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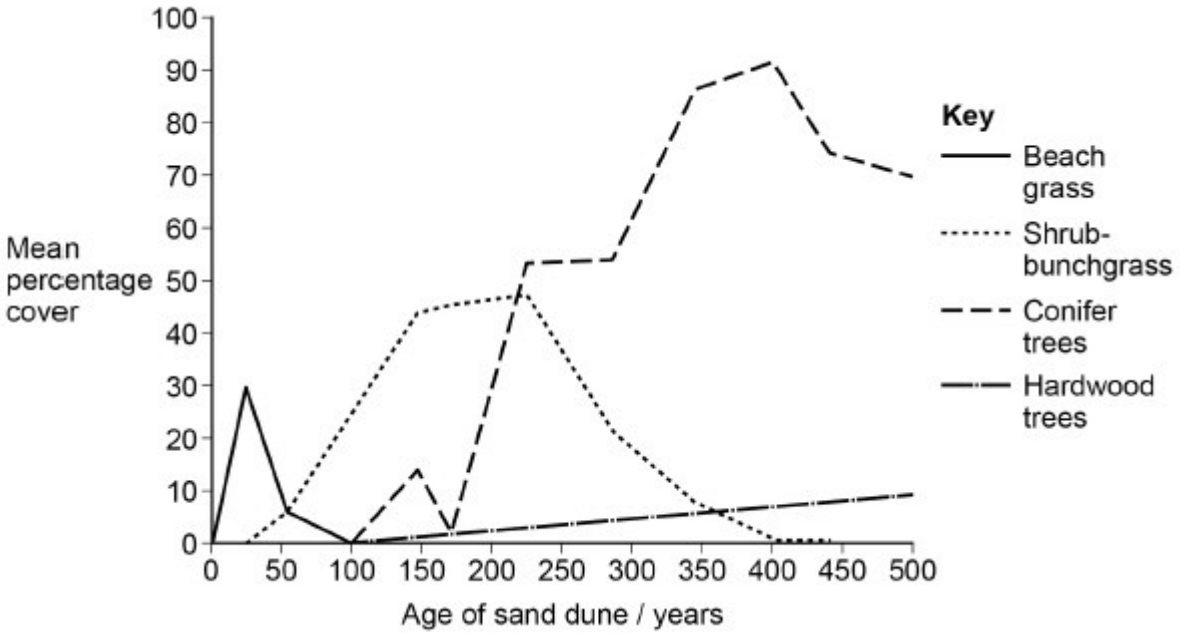
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Q1.

Scientists investigated the process of succession on sand dunes. They measured the percentage cover of different species of plants on sand dunes of different ages. Some of the results the scientists obtained are shown in **Figure 1**.

Figure 1



(a) Describe how you would determine the mean percentage cover for beach grass on a sand dune.

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(3)

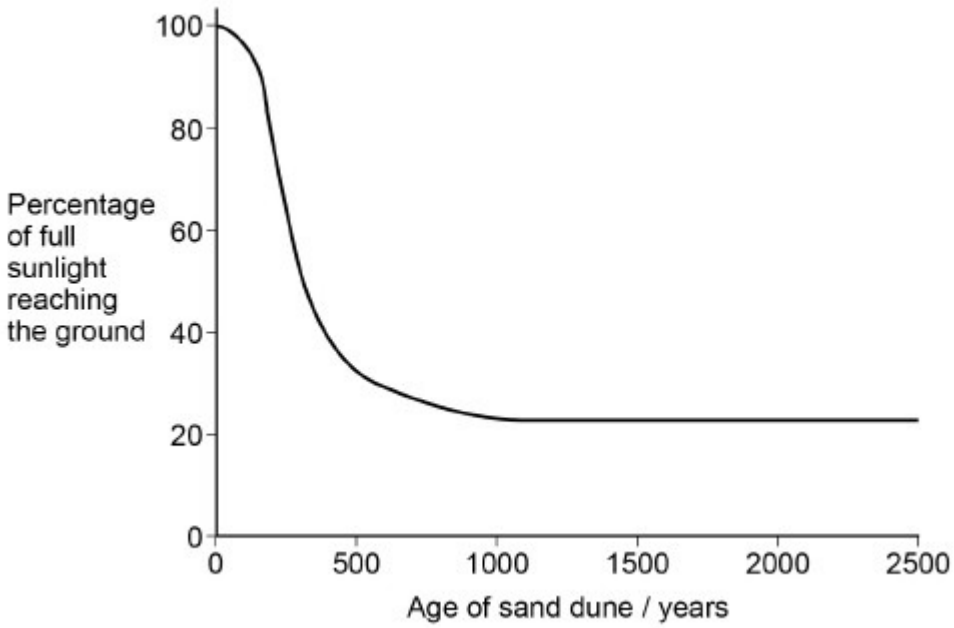
(b) The scientists concluded that the results shown in **Figure 1** were due to succession taking place.

Use **Figure 1** to explain why the scientists reached this conclusion.

(4)

The scientists also investigated how the proportion of sunlight reaching the ground changed during succession. Some of the results the scientists obtained are shown in **Figure 2**.

Figure 2



(c) Use **Figure 1** to explain the results in **Figure 2**.

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(1)

(d) Using evidence from **Figure 2**, what can you conclude about the net primary productivity (NPP) in the sand dunes that are older than 1000 years?

Explain your answer.

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(2)

(Total 10 marks)

Q2.

Dengue is a serious disease that is caused by a virus. The virus is carried from one person to another by a mosquito, *Aedes aegypti*. One method used to try to reduce transmission of this disease is the Sterile Insect Technique (SIT). This involves releasing large numbers of sterile (infertile) male *A. aegypti* into the habitat. These males have been made infertile by using radiation.

(a) Explain how using the SIT could reduce transmission of dengue.

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(2)

(b) Describe how the mark-release-recapture method could be used to determine the population of *A. aegypti* at the start of the investigation.

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(3)

(c) The release of radiation-sterilised *A. aegypti* has not been very successful in controlling the transmission of dengue.

Suggest **one** reason why.

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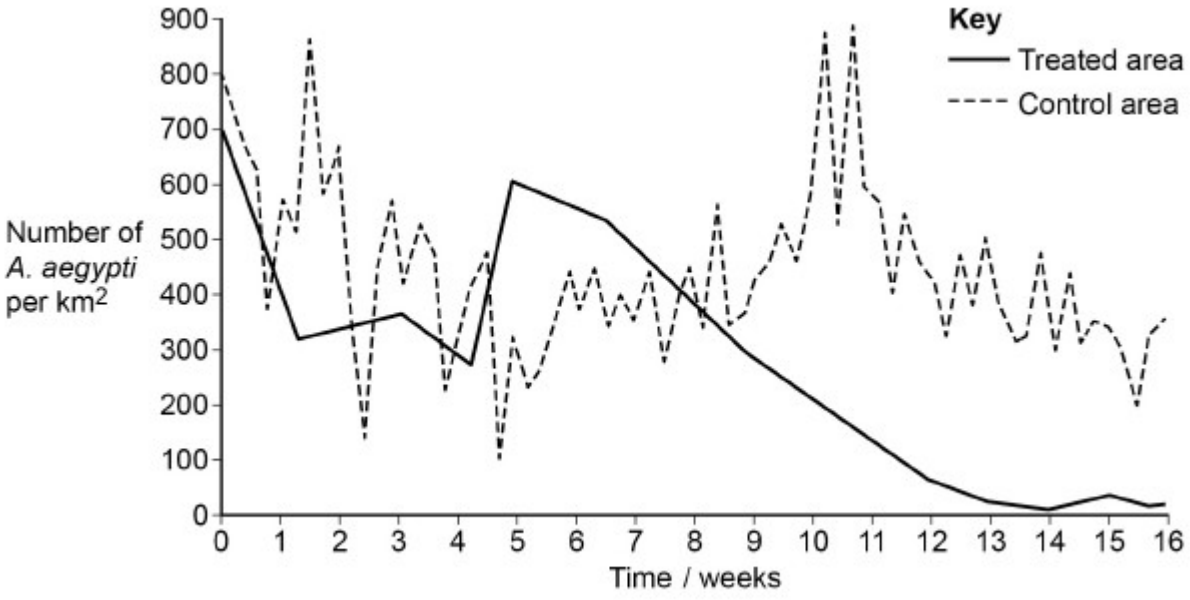
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(1)

(d) Recently a new method was developed to control *A. aegypti*. Scientists produced transgenic males carrying a 'lethal gene' which kills their offspring before they can reproduce.

The scientists released transgenic males every week in one area of a city in Brazil. At regular intervals they determined the number of *A. aegypti* per km^2 in the area where transgenic males were released and in a control area where no transgenic males were released.

The graph shows their results.



Suggest why the scientists released more transgenic males every week.

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(1)

(e) The release of transgenic males proved successful in reducing the number of *A. aegypti*.

Describe how the results in the diagram above support this conclusion.

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(2)

(Total 9 marks)

Q3.

Alzheimer's disease (AD) is a non-reversible brain disorder that develops over a number of years. At the start of 2014 the number of Americans with AD was estimated to be 5.4 million. Every 30 seconds another person in America develops AD.

5 In the brain of a person with AD there is a lower concentration of acetylcholine.

This affects communication between nerve cells and initially results in memory loss and confusion. Some of the symptoms of AD that are associated with communication between nerve cells are reduced by taking the drug donepezil. Donepezil inhibits the enzyme acetylcholinesterase.

A gene mutation called E280A found on chromosome 14 causes early-onset AD at a mean age of 49 years. The age at which the E280A mutation is expressed to cause AD varies.
Yaramul is a town in a historically isolated region of the Andes Mountains. The population of this town has the highest frequency of the E280A mutation in the world. The origin of the E280A mutation in this population has been traced back to a common ancestor in the 17th century. Natural selection has not reduced the frequency of the E280A mutation in the population.

This autosomal dominant mutation involves a change in triplet 280 from GAA to GCA. Scientists analysed chromosome 14 from 102 individuals from Yaramul. They recorded a sample size of 204 and detected 75 E280A mutations but only 74 potential AD cases. The scientists identified individuals with the mutation by whole genome sequencing. They had decided that a DNA probe would not be a suitable method to detect the E280A mutation.

(a) Assuming no one with AD died in 2014, calculate the annual percentage increase in AD cases in America for 2014 (lines 2–4).

Answer = _____ %

(2)

(b) Explain how donepezil could improve communication between nerve cells (lines 7–9).

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(3)

(c) Suggest and explain **two** reasons why there is a high frequency of the E280A mutation in Yaramul (lines 13–15).

1. _____

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2. _____

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(2)

(d) Explain why natural selection has **not** reduced the frequency of the E280A mutation in the population (lines 16–17).

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(2)

(e) The age at which the E280A mutation is expressed to cause AD can vary (lines 11–12).

Suggest and explain **one** reason for this.

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(2)

(f) One scientific study which analysed chromosome 14 involved 102 individuals. The scientists recorded a sample size of 204. In this sample they detected 75 E280A mutations but only 74 potential AD cases (lines 19–21).

Suggest explanations for the figures the scientists recorded.

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(2)

(g) Suggest why a DNA probe for the mutated triplet was **not** considered a suitable method for detection of the E280A mutation (lines 22–23).

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(2)

(Total 15 marks)

Q4.

Ecologists investigated changes in grassland communities on large islands off the coast of Scotland between 1975 and 2010. On each island, they used data from a number of sites to determine the change in mean species richness and the change in mean index of diversity.

(a) **Table 1** shows plant species recorded at one site, on one island, in 1975.

Table 1

Species	Number of individuals
Hydrocotyle vulgaris	3
Plantago maritima	19
Ranunculus acris	3
Hieracium pilosella	3
Calliergon cuspidatum	10
Prunella vulgaris	16
Pseudoscleropodium purum	6

Calculate the index of diversity for this site using the formula:

$$d = \frac{N(N-1)}{\Sigma n(n-1)}$$

d = _____

(2)

(b) Outline a method the ecologists could have used to determine the plant species richness at one site.

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(3)

(c) Some of the ecologists' results are shown in **Table 2**. They carried out a statistical test to find out whether any differences between the 1975 and 2010 means were significant. The values for P that they obtained are also shown in **Table 2**.

Table 2

Island	Change in mean species richness between 1975 and 2010	Value of P	Change in mean index of diversity between 1975 and 2010	Value of P
Islay	+8.89	≤0.001	+0.22	>0.05
Colonsay	+14.70	≤0.001	+2.68	≤0.01
Harris	−5.13	≤0.001	−2.44	≤0.01

Do these data show that there were any significant changes in the grassland communities on these islands? Give reasons for your answer.

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(3)

(Total 8 marks)

Q5.

Ecologists studied a stream community before and after a flood. The flood reduced animal populations in the stream by 98%.

The table shows how the populations of six animal species found in the stream changed following the flooding.

Animal species	Number of days after flooding						
	1	5	13	22	35	49	63
	Mean number of organisms / thousands m^{-3}						
Baetis quilleri	0.03	0.85	2.6	9.3	6.4	0.9	0.3
Leptohyphes packeri	0.0	0.0	0.25	2.5	17.3	18.0	29.5
Helicopsyche mexicana	0.0	0.02	0.2	0.1	0.07	0.03	0.01
Cryptolabis paradoxa	0.0	13.3	21.3	55.8	62.9	168.7	182.6
Pentaneurini guttipennis	0.1	0.5	0.6	1.8	1.0	0.6	0.25
Micropsectra klinki	0.0	0.0	0.0	0.0	0.0	0.2	5.6

(a) Explain how the data in the table provides evidence of succession.

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(5)

(b) The populations of *Cryptolabis paradoxa* and *Leptohyphes packeri* both increased between days 13 and 63.

Calculate how many times the population growth per day of *Cryptolabis paradoxa* is greater than that of *Leptohyphes packeri* between these days.

Answer = _____

(2)

(c) The stream eventually recovered to reach a climax community.

Give **two** features of a climax community.

1. _____

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2. _____

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(2)

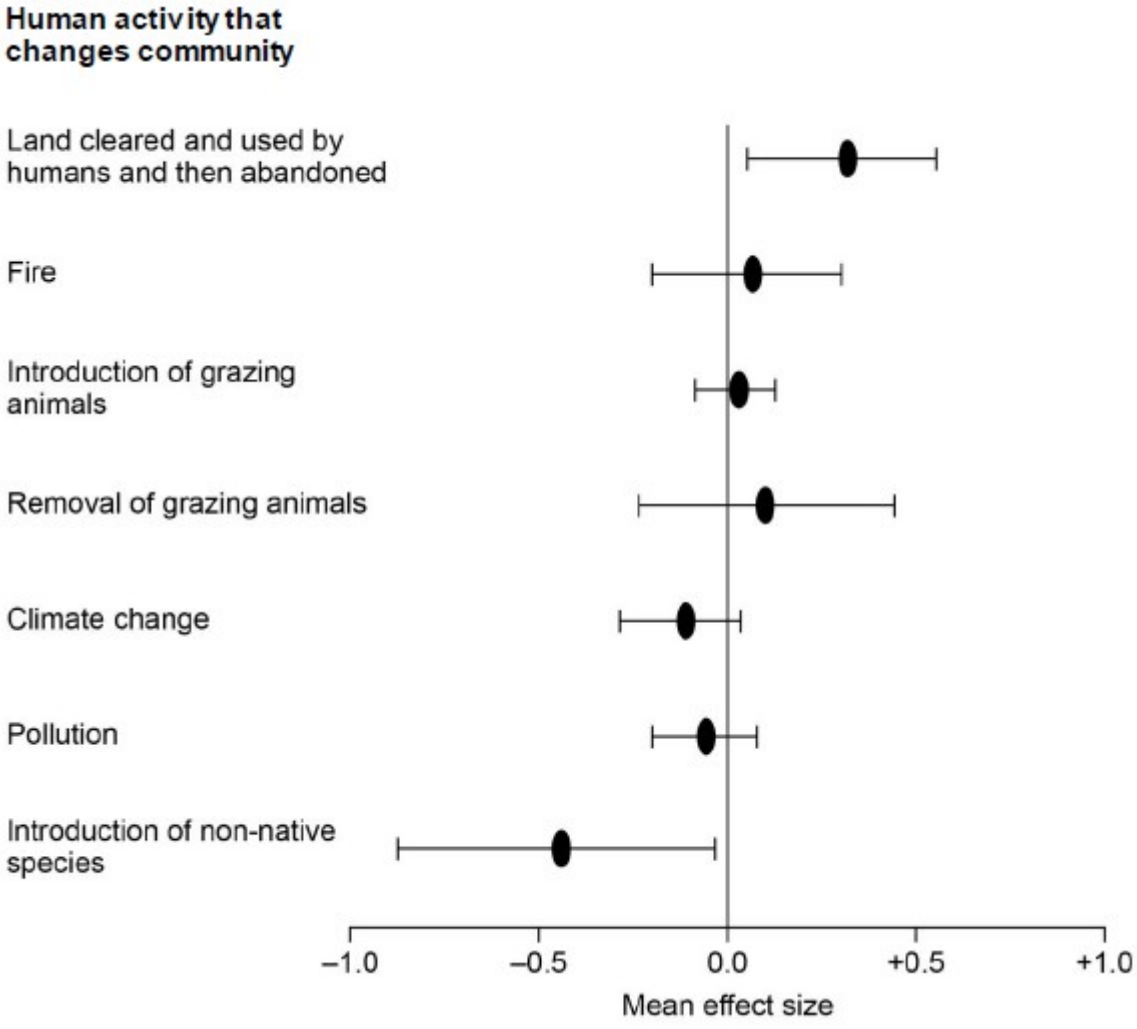
(Total 9 marks)

Q6.

Scientists investigated changes in plant biodiversity in different communities after changes caused by humans. They collected data from many published investigations that recorded changes in species richness of plants over a large number of years.

The scientists used data from each investigation to calculate the effect size.
The effect size is a measure of change in species diversity with time. A positive value shows an increase in species richness with time.

The graph below shows the scientists results in the form in which they were published.
The horizontal bars represent ±2 standard deviations, which includes 95.4% of the data.



(a) What can you conclude from these data about the effects of human activities on biodiversity?

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(3)

(b) Suggest an explanation for the effect size when non-native species were introduced to communities.

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(2)

(c) Describe how you would investigate the effect of an invasion by a non-native species of plant (a biotic environmental factor) over many years on the abundance of a native species of plant in a community.

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(3)

(d) Effect size is calculated in the following way.

1. Divide the species richness in the last year of an investigation (SR2) by species richness in the first year of the investigation (SR1).
2. Find the natural log ($\log_e$) of the result.
3. Divide this by the time (T) between the first and last year in decades (1 decade = 10 years).

In one community:

- species richness in year 2 (SR2) was 15.3
- species richness in year 1 (SR1) was 18.2
- and the investigation lasted for 29 years.

Use $\log_e$, SR2, SR1 and T to write an equation for 'effect size' and calculate its value for this investigation. On a calculator, the key for $\log_e$ is shown as ln, or $\log_e$.

Effect size = _____

(2)

(Total 10 marks)

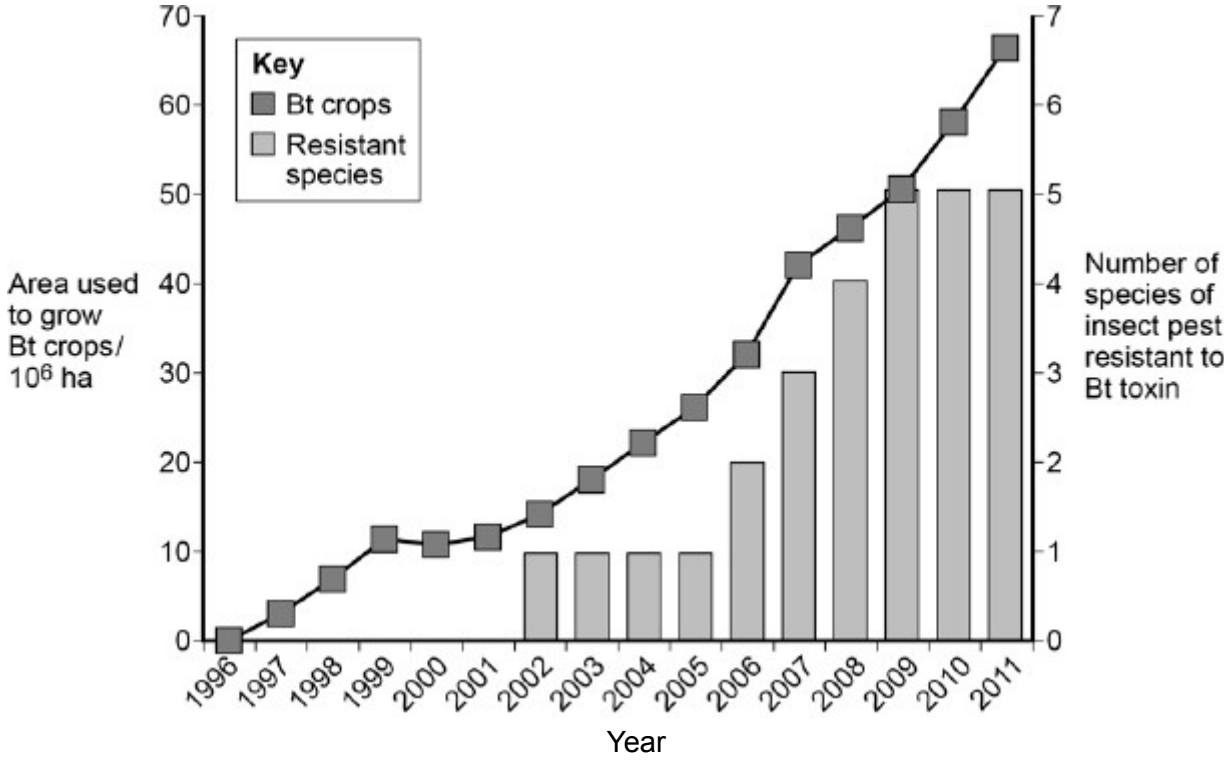
Q7.

To reduce the damage caused by insect pests, some farmers spray their fields of crop plants with pesticide. Many of these pesticides have been shown to cause environmental damage.

Bt plants have been genetically modified to produce a toxin that kills insect pests. The use of Bt crop plants has led to a reduction in the use of pesticides.

Scientists have found that some species of insect pest have become resistant to the toxin produced by the Bt crop plants.

The figure below shows information about the use of Bt crops and the number of species of insect pest resistant to the Bt toxin in one country.



(a) Can you conclude that the insect pest resistant to Bt toxin found in the years 2002 to 2005 was the same insect species? Explain your answer.

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(1)

(b) One farmer stated that the increase in the use of Bt crop plants had caused a mutation in one of the insect species and that this mutation had spread to other species of insect. Was he correct? Explain your answer.

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(4)

(c) There was a time lag between the introduction of Bt crops and the appearance of the first insect species that was resistant to the Bt toxin.
Explain why there was a time lag.

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(3)

(Total 8 marks)

Q8.

(a) What term is used to describe populations of different species living in the same habitat?

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(1)

(b) Different species occupy different ecological niches.

Explain the advantage of species occupying different niches.

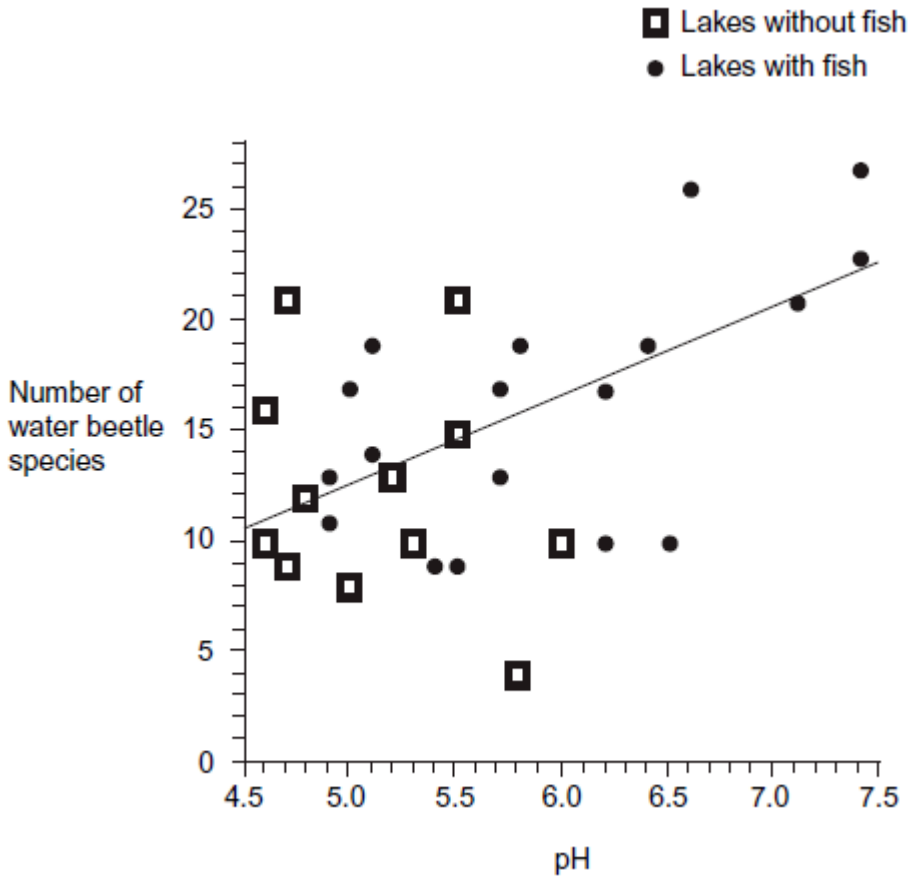
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(1)

Scientists recorded the number of water beetle species in 30 lakes. In each lake, they measured the pH of the water and recorded whether there were any fish present.

The graph shows their results.



(c) A student concluded that a decrease in acidity caused an increase in the number of water beetle species.

Evaluate this conclusion.

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(3)

(d) Explain how the presence of fish in a lake could cause an increase in the number of water beetle species.

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(1)

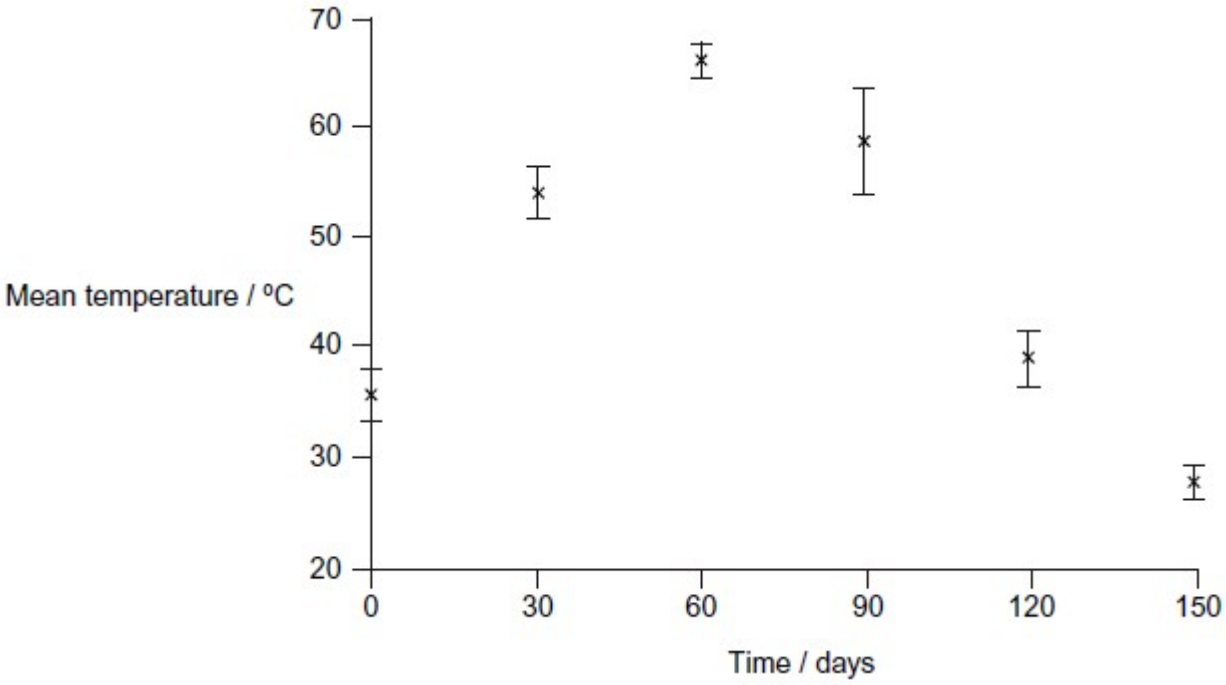
(Total 6 marks)

Q9.

The organic material in household waste can be used to make compost for use as a fertiliser. Scientists investigated changes during one process used to make this compost. The method involved placing the waste in large containers for 150 days. At regular intervals the containers were rotated. The scientists measured the temperature of samples of waste during the investigation.

Figure 1 shows the results they obtained. The vertical bars show standard deviations.

Figure 1



(a) Explain how microorganisms contributed to the increase in temperature during processing of organic waste.

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(2)

(b) Explain the advantage of showing the data using standard deviations rather than ranges.

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(2)

(c) Suggest **two** advantages of rotating the containers during the process.

1. _____

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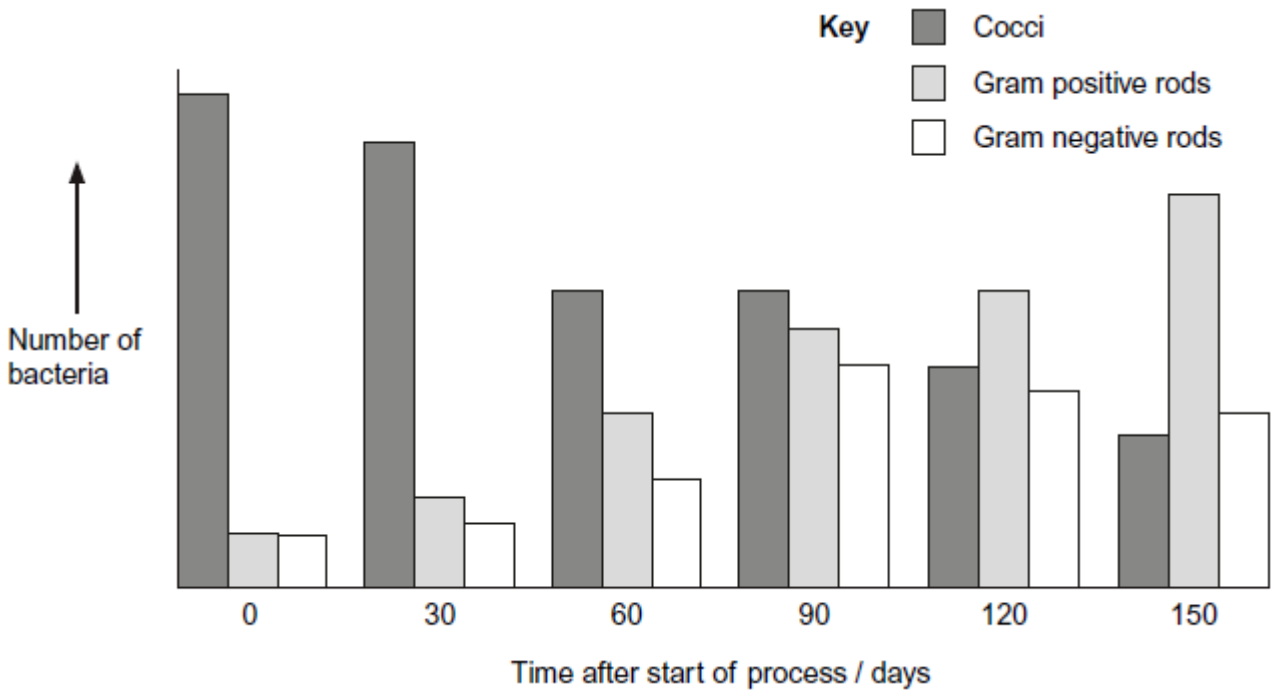
2. _____

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(2)

(d) The scientists took a sample of the waste at the start of the process. They then took samples every 30 days. In each sample, they determined the numbers of particular types of bacteria.
Figure 2 shows the changes in the number of three types of bacteria during the process.

Figure 2



The scientists concluded that the results in **Figure 1** and **Figure 2** are evidence for a form of succession during the process.

Use the information to suggest how they reached this conclusion.

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(3)

(Total 9 marks)

Q10.

Algae are photosynthesising organisms. Some grow on rocky shores. Scientists investigated the abundance of different species of algae at two sites, **A** and **B**, on a rocky shore. Site **A** was on the upper shore and site **B** was on the lower shore. The diagram shows the location of sites **A** and **B** on the rocky shore.

Table 1 shows some of the results the scientists obtained.

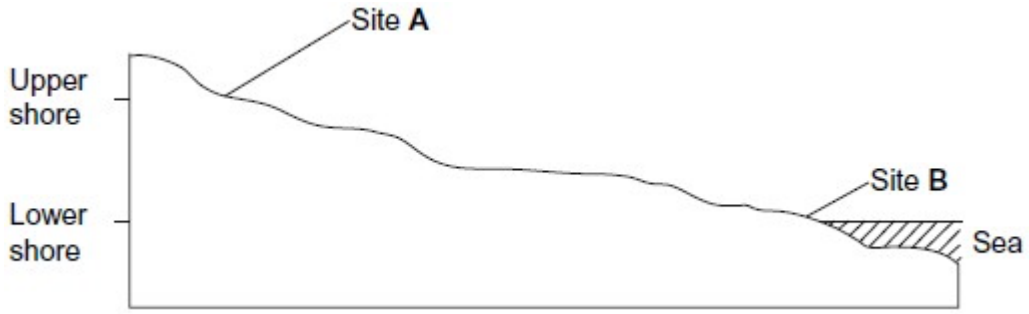


Table 1

	Site A **Upper shore**	**Site B** **Lower shore**
Species of algae with percentage cover more than 1%	*Gigartina leptorhynchos* *Gigartina canaliculata* *Gelidium coulteri* *Rhodoglossum affine*	*Gigartina spinosa* *Rhodoglossum affine* *Laurencia pacifica* *Gastroclonium coulteri* *Centroceros clavulatum* *Gigartina canaliculata* *Corallina vancouveriensis*

(a) The scientists recorded data from 40 large rocks at each site.

Describe **one** method that the scientists could have used to ensure that the large rocks were chosen without bias.

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(2)

(b) The scientists used percentage cover rather than frequency to record the abundance of algae present

Suggest why.

_____

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(1)

(c) Apart from availability of water, describe and explain how **two** abiotic factors may have caused differences in the species of algae growing at sites **A** and **B**.

Factor 1 _____

Explanation _____

_____

Factor 2 _____

Explanation _____

_____

(2)

(d) Use the information provided in **Table 1** to explain why the diversity of consumers will be greater at site **B**.

_____

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(2)

(e) The scientists also investigated the algae eaten by two consumers found on the rocky shore, the sea slug and the shore crab. The scientists carried out their investigation in a laboratory.

- They put each consumer into a separate tank through which aerated seawater flowed slowly.
- Each tank contained 5 grams of one species of alga.
- After 50 hours, they measured the mass of the alga remaining in each tank.
- They repeated this procedure several times using a different sea slug and a different shore crab each time.

The scientists then calculated the mean mass of each species of alga eaten by the consumers. They used a statistical test to determine the P value.

Table 2 shows some of the results they obtained.

Table 2

Species of alga	Mean mass eaten / g		P value
	Sea slug	Shore crab	
Laurencia pacifica	4.42	0.22	<0.01
Egregia leavigata	0.12	0.08	>0.05
Microcystis pyrifera	0.19	0.14	>0.05
Cystoseira osmondacea	0.17	0.04	<0.05

(i) The consumers were starved for 5 days before the investigation.

Explain why.

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(2)

(ii) The data in **Table 2** for the mean mass of alga eaten were adjusted for loss of mass by the alga due to respiration.

Suggest how the scientists were able to determine the loss of mass due to respiration of a sample of alga.

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(3)

(iii) Suggest what conclusions the scientists could have made from this investigation when using the probability values in **Table 2**.

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(3)

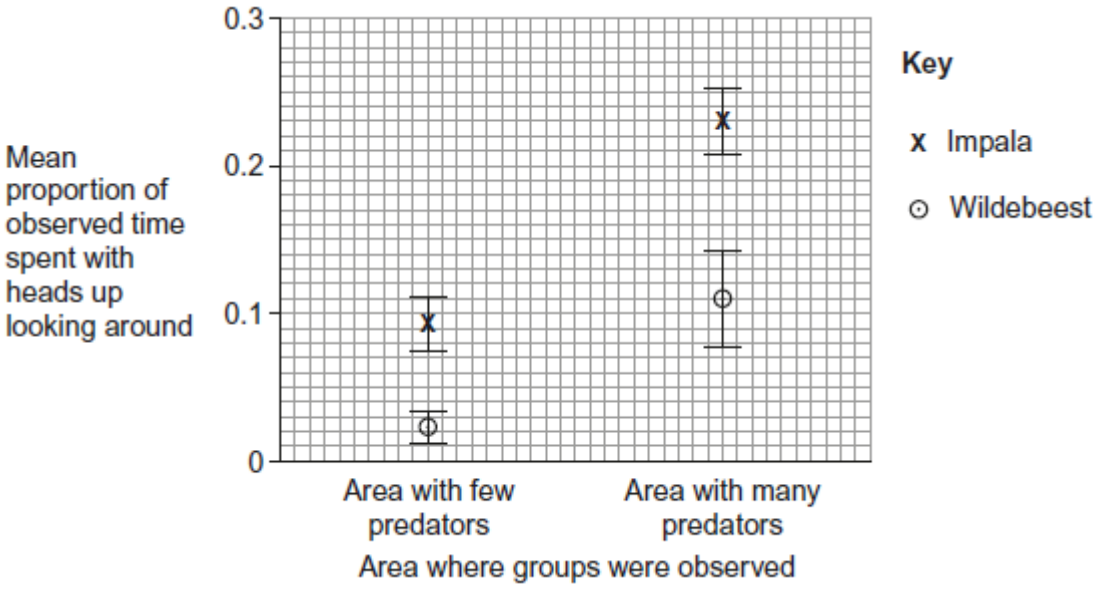
(Total 15 marks)

Q11.

Impala and wildebeest are species of herbivore that live in large groups. They spend most of their time feeding with their heads near the ground.

Scientists investigated the relationship between the number of predators in an area and the mean proportion of time these herbivores spent with their heads up, looking around rather than feeding. They obtained data from groups of impala and wildebeest in two areas. In one area there were few predators and in the other area there were many predators.

The graph shows their results. The bars show standard deviations.



(a) The scientists observed both groups of animals for 75 hours.

Use data from the graph to calculate the difference in the mean number of hours spent by each species looking around in the area where there were **many** predators.

Show your working.

Difference _____ hours

(2)

(b) The scientists concluded that these herbivores spend more time looking for predators in areas where there are many predators.

Do these data support this conclusion? Give reasons for your answer.

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(4)

(c) The behaviour of the herbivores in having their heads up has a benefit but it also has costs. The benefit is being able to see, and escape from, predators.

Suggest and explain **one** cost to the herbivores of this behaviour.

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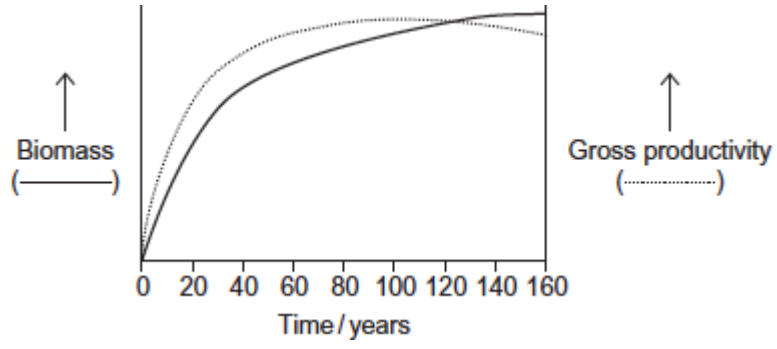
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(2)

(Total 8 marks)

Q12.

The graph shows how gross productivity and biomass in an area changed with time in the succession from bare soil to mature woodland.



(a) (i) Suggest appropriate units for gross productivity.

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(1)

(ii) Explain the decrease in gross productivity as the woodland matures.

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(2)

(b) Use your knowledge of succession to explain the increase in biomass during the first 20 years.

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(3)

(c) Use the information in the graph and your knowledge of net productivity to explain why biomass shows little increase after 100 years.

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(2)

(d) Suggest **one** reason for conserving woodlands.

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(1)

(Total 9 marks)

Q13.

(a) On islands in the Caribbean, there are almost 150 species of lizards belonging to the genus *Anolis*. Scientists believe that these species evolved from two species found on mainland USA. Explain how the Caribbean species could have evolved.

(6)

(b) *Anolis sagrei* is a species of lizard that is found on some of the smallest Caribbean islands. Describe how you could use the mark-release-recapture method to estimate the number of *Anolis sagrei* on one of these islands.

(4)

(c) Large areas of tropical forest are still found on some Caribbean islands. The concentration of carbon dioxide in the air of these forests changes over a period of 24 hours and at different heights above ground.

Use your knowledge of photosynthesis and respiration to describe and explain how the concentration of carbon dioxide in the air changes:

- over a period of 24 hours
- at different heights above ground.

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(5)

(Total 15 marks)

Q14.

Hydrilla (*Hydrilla verticillata*) is an aquatic plant which has become a major pest of waterways in parts of the USA. Hydrilla is not a native species of the USA. It was introduced into natural habitats from aquariums. In many freshwater habitats it has rapidly become the dominant plant species.

(a) In many freshwater habitats Hydrilla has rapidly become the dominant plant species. Suggest **two** reasons why.

1. _____

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2. _____

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(2)

(b) The spread of Hydrilla has had economic consequences for commercial activities and for the government's environmental agency.
Suggest **two** economic consequences of the spread of Hydrilla.

1. _____

_____

2. _____

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(2)

(c) Scientists investigated the effect of the chemical fluridone as a method of controlling Hydrilla. The study was carried out using samples of Hydrilla grown under controlled laboratory conditions. Several samples of the plant were grown at different concentrations of fluridone. The results are shown in the following table.

	Days of treatment			
	0	20	40	60
Concentration of fluridone / µg dm^{-3}	**Mean biomass of Hydrilla / g**			
0.0	5.0	16.4	20.4	33.4
0.5	5.0	14.1	18.2	31.3
1.0	5.0	9.7	8.9	7.4
5.0	5.0	4.6	2.8	1.3
25.0	5.0	3.2	1.6	0.4

(i) The scientists obtained the biomass of each sample by heating it at 75 °C for 2 hours.
They then weighed the sample, reheated it for 15 minutes and weighed it again. They continued this cycle of reheating and weighing until they found the sample had a constant mass.

Explain how this method helped to provide a reliable measurement of the biomass.

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(2)

(ii) A scientist reviewed the results of this investigation. He suggested that fluridone should be used in the habitat at a concentration of 5.0 µg dm^{-3} rather than at the other concentrations tested. Use the information provided and your knowledge of chemical control to explain why he made this suggestion.

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(4)

(d) Scientists have also investigated the use of an integrated system to control Hydrilla. This involved using fluridone and a fungus as a biological control agent. They set up four different experiments.

- Experiment **1** – Hydrilla left untreated
- Experiment **2** – Hydrilla treated with the fungus
- Experiment **3** – Hydrilla treated with fluridone
- Experiment **4** – Hydrilla treated with both fluridone and the fungus.

The scientists determined the biomass of Hydrilla at the end of each experiment.

(i) Experiment **1** acted as a control. Explain why the scientists carried out experiment **1**.

_____

_____

(1)

(ii) The scientists isolated the fungus from the tissue of Hydrilla growing in its country of origin. Suggest **two** possible advantages of using this fungus as the biological control agent.

1. _____

_____

2. _____

_____

(2)

(iii) The treatment in experiment **4** was the most effective. Use your knowledge of integrated pest control systems to suggest why the treatment in experiment **4** was the most effective.

_____

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(2)

(Total 15 marks)

Q15.

Ecologists used a method called proportional sampling to estimate the population size of an animal species. This method is based on assumptions. Two of the assumptions are given below.

1. They know the size of the area, **A**, where the animal population lives.
2. The animals are uniformly distributed in this area.

To carry out the method, the ecologists:

- chose a region of known size, **R**, inside area **A**
- counted the number of animals in region **R**. They called this number **S**
- assumed that the number, **S**, would be in proportion to the size of the total population, **P**, in area **A**.

(a) Proportional sampling can be used to estimate the population size of a species that is uniformly distributed.

(i) What is a **species**?

_____

_____

_____

(1)

(ii) What is meant by **uniformly distributed**?

_____

_____

_____

(1)

(b) Use the letters **A**, **R** and **S** to write an equation showing how proportional sampling is used to estimate the total size of a population, **P**. Show your working.

P = _____

(2)

(c) Population size can be estimated using proportional sampling or mark-release-recapture.

(i) How do the assumptions made in proportional sampling differ from those made in mark-release-recapture?

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(2)

(ii) Give **one** assumption about the animals caught that is made in both methods.

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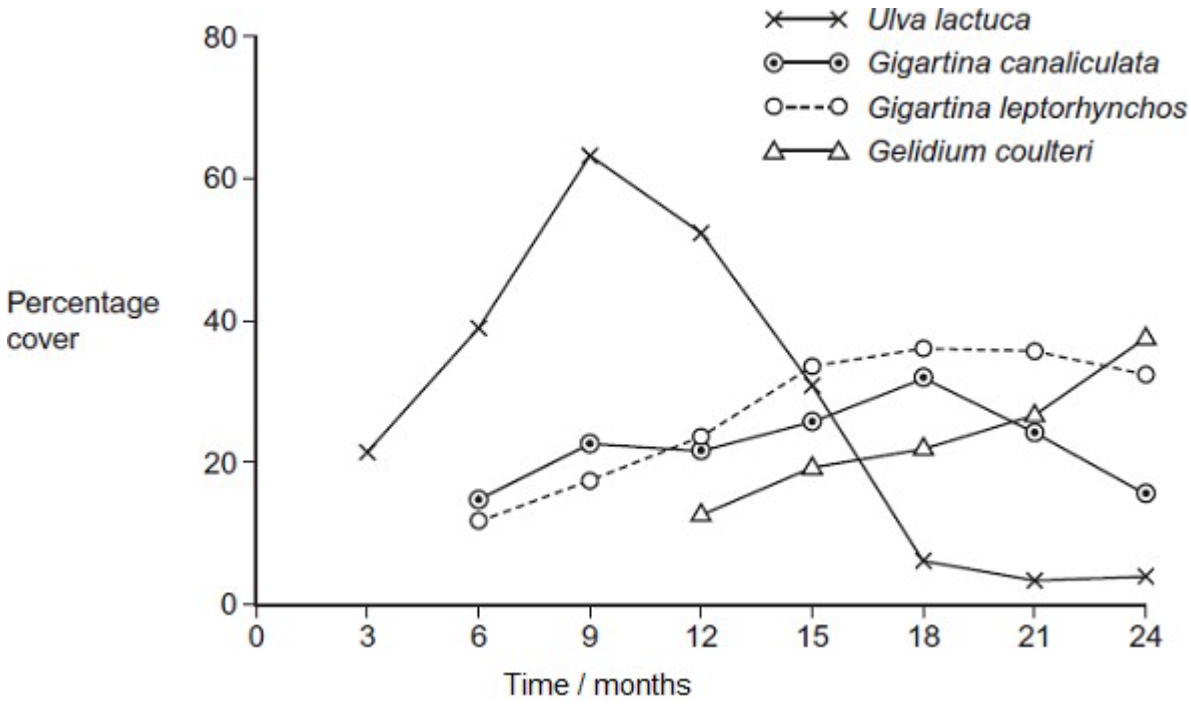
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(1)

(Total 7 marks)

Q16.

Algae are photosynthesising organisms. Some algae grow on rocky shores. A scientist investigated succession involving different species of algae. He placed concrete blocks on a rocky shore. At regular intervals over 2 years, he recorded the percentage cover of algal species on the blocks. His results are shown in the graph.



(a) Name the pioneer species.

_____

(1)

(b) (i) The scientist used percentage cover rather than frequency to record the abundance of algae present. Suggest why.

_____

_____

_____

(1)

(ii) Some scientists reviewing this investigation were concerned about the validity of the results because of the use of concrete blocks.
Suggest **one** reason why these scientists were concerned about using concrete blocks for the growth of algae.

_____

_____

_____

(1)

(c) Use the results of this investigation to describe and explain the process of succession.

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(4)

(Total 7 marks)

Q17.

Write an essay on the many different types of relationships and interactions between organisms.

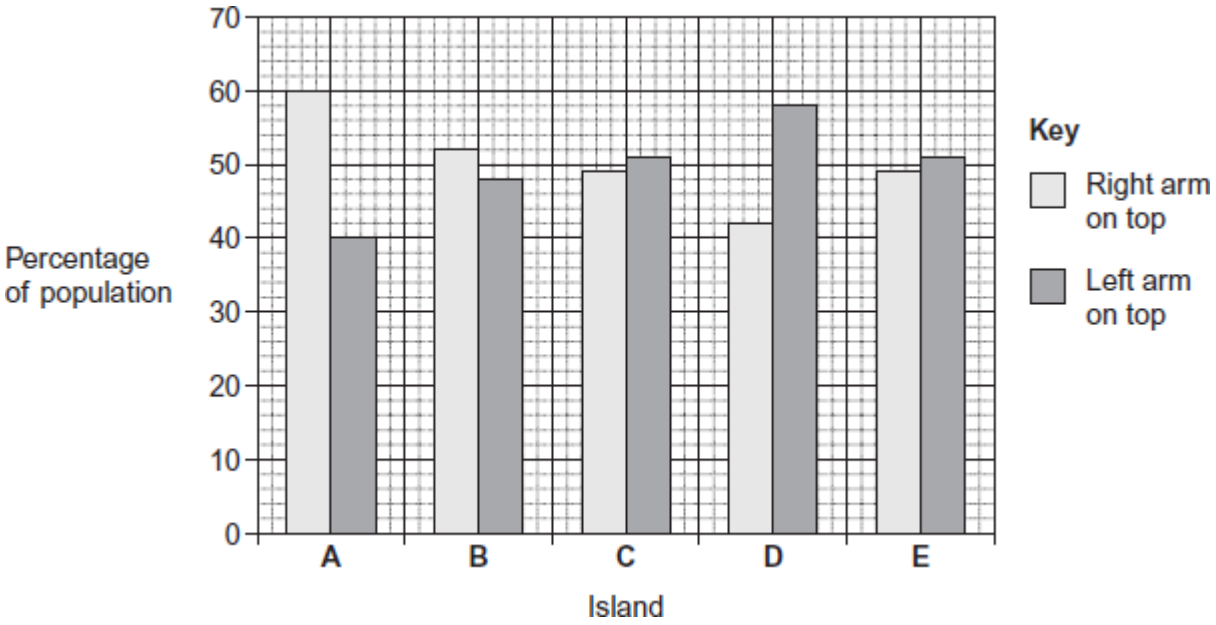
(Total 25 marks)

Q18.

When most people fold their arms, they either always have their left arm on top, **L**, or always have their right arm on top, **R**. A geneticist investigated this characteristic on five small islands, **A, B, C, D** and **E**.

Her results are shown in **Figure 1**.

Figure 1



On one of the islands she recorded the arm-folding characteristics of parents and their children.

These results are shown in **Figure 2**.

Figure 2

Arm-folding of parents	Arm-folding of the children / %	
	Right arm on top, R	Left arm on top, L
R and **R**	41	59
R and **L**	45	55
L and **L**	44	56

The geneticist concluded that arm-folding is not determined by a single gene with a dominant allele and a recessive allele.

(a) The geneticist investigated arm-folding on five small islands.

(i) Use information from **Figure 1** to describe the results she obtained.

_____

_____

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_____

_____

(2)

(ii) Suggest advantages of using island populations in this investigation.

_____

_____

_____

_____

_____

(2)

(b) The geneticist concluded that arm-folding is **not** determined by a single gene with a dominant allele and a recessive allele.

Use information from **Figure 2** to explain why she reached this conclusion.

_____

_____

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(3)

(c) In another study, the geneticist investigated arm-folding in genetically identical twins. Data from this study supported her conclusion from the island study.

Suggest the evidence she found that supported her conclusion.

_____

_____

_____

(1)

(Total 8 marks)

Q19.

A student investigated an area of moorland where succession was occurring. She used quadrats to measure the percentage cover of plant species, bare ground and surface water every 10 metres along a transect. She also recorded the depth of soil at each quadrat. Her results are shown in the table.

	Percentage cover in each quadrat A to E				
	A	**B**	**C**	**D**	**E**
Bog moss	55	40	10	–	–
Bell heather	–	–	–	15	10

Sundew	10	5	–	–	–
Ling	–	–	–	15	20
Bilberry	–	–	–	15	25
Heath grass	–	–	30	10	5
Soft rush	–	30	20	5	5
Sheep's fescue	–	–	25	35	30
Bare ground	20	15	10	5	5
Surface water	15	10	5	–	–
Soil depth / cm	3.2	4.7	8.2	11.5	14.8

– Indicates zero percentage cover.

(a) Explain how these data suggest that succession has occurred from points **A** to **E** along the transect.

_____

_____

_____

_____

_____

_____

(3)

(b) The diversity of animal species is higher at **E** than **A**. Explain why.

_____

_____

_____

_____

_____

(2)

(c) The student used the mark-release-recapture technique to estimate the size of the population of sand lizards on an area of moorland. She collected 17 lizards and marked them before releasing them back into the same area. Later, she collected 20 lizards, 10 of which were marked.

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

1. _____

_____

2. _____

_____

(2)

(ii) Calculate the number of sand lizards on this area of moorland. Show your working.

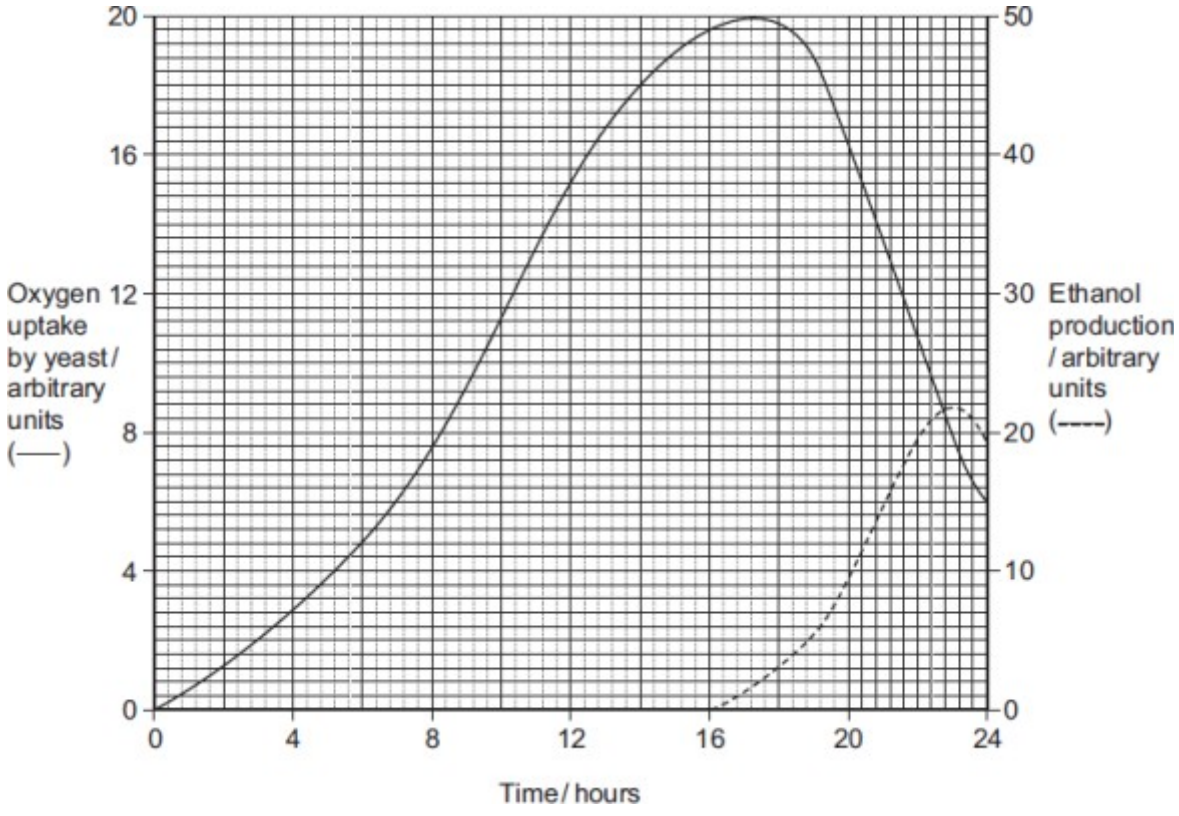
Answer = _____

(2)

(Total 9 marks)

Q20.

Yeast is a single-celled organism. A student investigated respiration in a population of yeast growing in a sealed container. His results are shown in the graph.



(a) Calculate the rate of oxygen uptake in arbitrary units per hour between 2 and 4 hours.

Answer _____ arbitrary units per hour

(1)

(b) (i) Use the information provided to explain the changes in oxygen uptake during this investigation.

_____

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_____

(3)

(ii) Use the information provided to explain the changes in production of ethanol during this investigation.

_____

_____

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(2)

(c) Sodium azide is a substance that inhibits the electron transport chain in respiration.The student repeated the investigation but added sodium azide after 4 hours. Suggest and explain how the addition of sodium azide would affect oxygen uptake and the production of ethanol.

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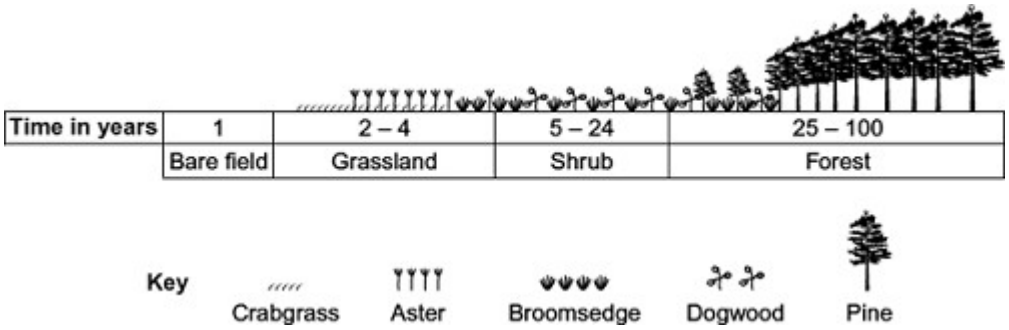
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(3)

(Total 9 marks)

Q21.

The diagram shows the dominant plants in communities formed during a succession from bare soil to pine forest.



(a) Name the pioneer species shown in the diagram.

_____

(1)

(b) The species that are present change during succession. Explain why.

_____

_____

_____

_____

_____

(2)

(c) The pine trees in the forest have leaves all year. Explain how this results in a low species diversity of plants in the forest.

_____

_____

_____

(1)

(Total 4 marks)

Q22.

(a) Explain what is meant by the ecological term community

_____

_____

_____

_____

(1)

(b) Scientists investigated the distribution of three species of fish in a lake. They recorded the range of depths where each species was found. The table shows their results.

Species of fish	Range of depths /m
White bass	0 to 8.4
Walleye	6.8 to 10.0
Sauger	7.2 to 14.6

(i) Use information from the table to give the range of depths at which all three species of fish may be found living together.

Answer _____ m

(1)

(ii) Suggest and explain **one** advantage to the fish of occupying different depths in the lake.

_____

_____

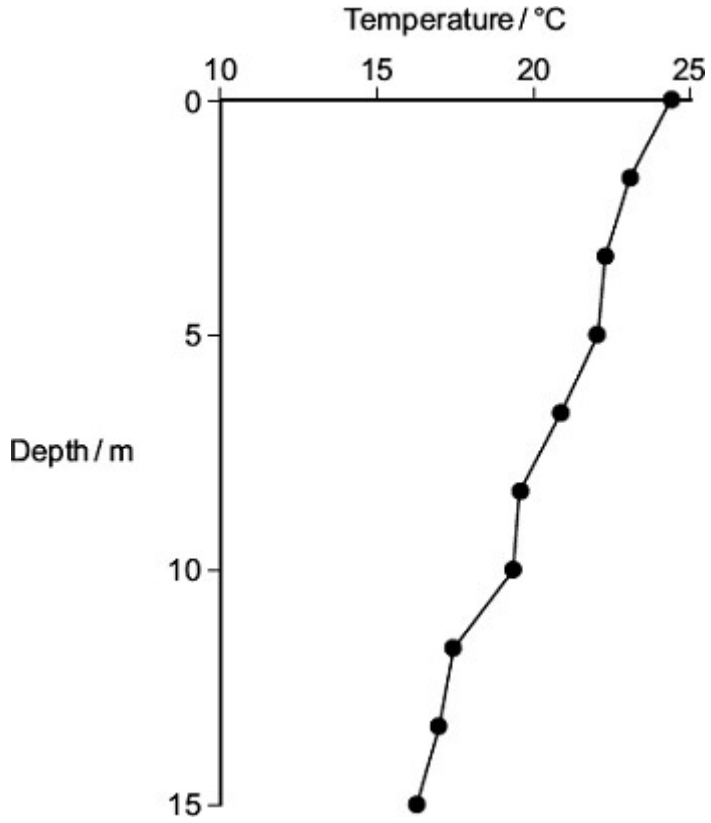
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(2)

(c) The graph shows the relationship between the depth and the temperature of the water in the lake.



A student concluded that the temperature of the water in the lake determined the depth at which the species of fish were found. Use the table and the graph to evaluate this conclusion.

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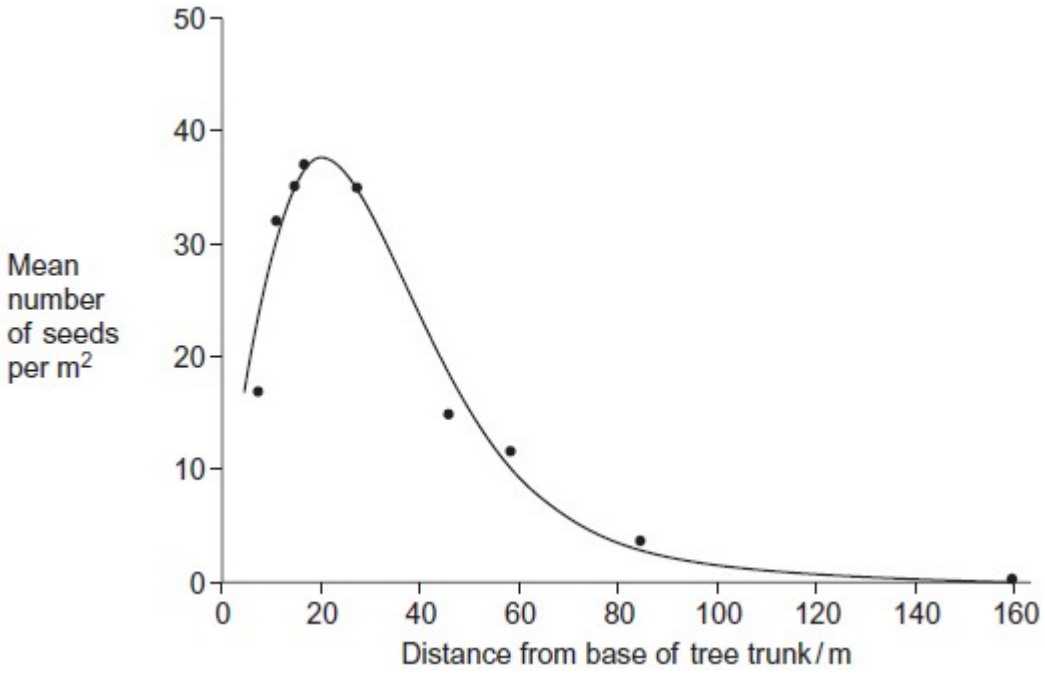
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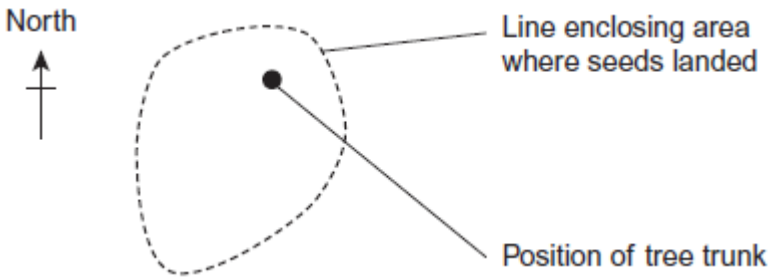
(Total 7 marks)

Q23.

A 75 m tall tree released very large numbers of small seeds. Ecologists used quadrats along a transect to measure the number of these seeds at different distances from the tree. Their results are shown on the graph.



The seeds of this tree are dispersed by wind. The diagram shows the pattern of seed dispersal from this tree.



(a) Describe how the ecologists could have used quadrats and a transect to obtain the data from which the graph was drawn.

_____

_____

_____

_____

_____

(2)

(b) Look at the diagram showing the pattern of seed dispersal from this tree.

(i) Suggest an explanation for the shape of the line enclosing the area where the seeds landed.

_____

_____

_____

_____

(2)

(ii) The line enclosing the area where the seeds landed would be different for trees of this species that were of a different height. Suggest why.

_____

_____

_____

_____

(2)

(c) In an ecological succession, trees that are pioneer species often have smaller seeds than those that are part of a climax community.

(i) The species of tree in this investigation is adapted to colonising areas that have been cleared of vegetation. Use information given above to explain how.

_____

_____

_____

_____

(2)

(ii) The seeds produced by this species of tree did **not** grow successfully in a climax community. Suggest why.

_____

_____

_____

_____

_____

(2)

(Total 10 marks)

Q24.

Agricultural scientists divided a field into a number of different plots. They planted soya bean seeds in these plots at different sowing densities. The diagram shows how these plots were arranged. The numbers show the sowing densities in seeds per m^2. The plots containing seeds sown at a density of 250 seeds per m^2 have been shaded.

250	500	1000	15	25	50	100
15	25	50	100	250	500	1000

25	50	100	250	500	1000	15
50	100	250	500	1000	15	25
1000	15	25	50	100	250	500
500	1000	15	25	50	100	250
100	250	500	1000	15	25	50

The scientists recorded the number of soya bean plants growing in each plot at different times after the start of the investigation. Their results are shown in the table.

Number of seeds planted per m^2	**Mean number of plants surviving per m^2 after**			
	22 days	**39 days**	**61 days**	**93 days**
15	15	15	15	15
25	24	24	24	23
50	47	46	46	41
100	98	96	96	87
250	246	242	204	196
500	492	486	313	124
1000	987	788	276	95

(a) (i) In terms of rows and columns, describe how the plots containing seeds sown at a density of 250 m^2 were arranged.

_____

_____

(1)

(ii) Explain the advantage of arranging the plots in this way.

_____

_____

_____

_____

(2)

(b) The scientists would have treated the plots in the same way. Suggest **two** ways in which the scientists would have treated the plots to ensure that confounding variables would **not** affect the results.

1. _____

_____

2. _____

_____

(2)

(c) (i) Describe the results of this investigation.

_____

_____

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_____

(3)

(ii) Explain the results when 1000 seeds were planted per m^2.

_____

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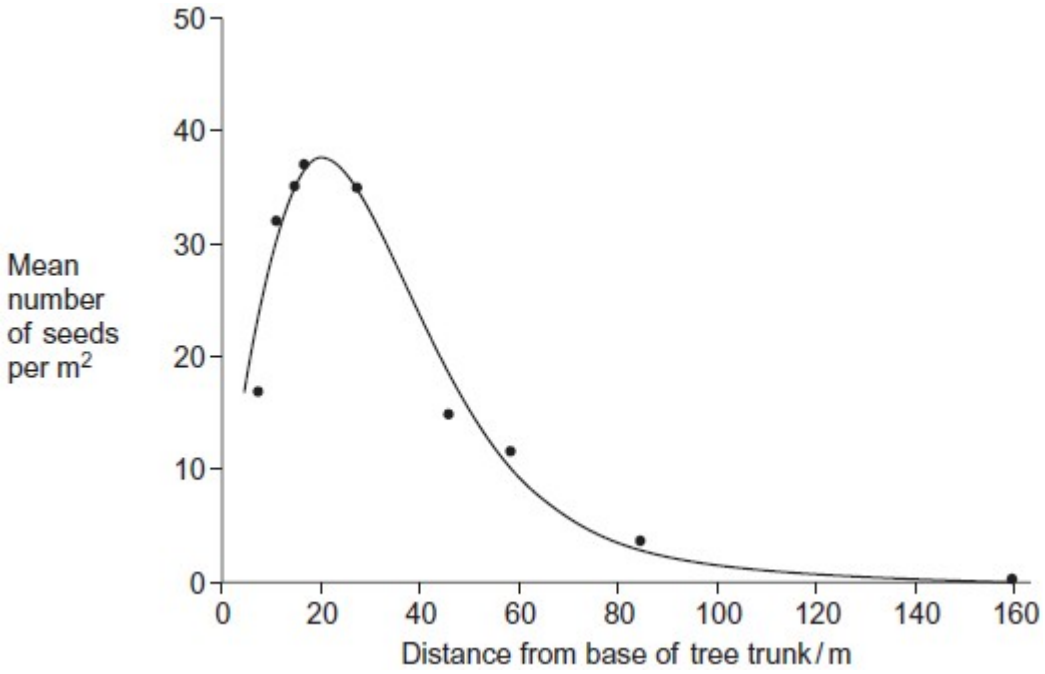
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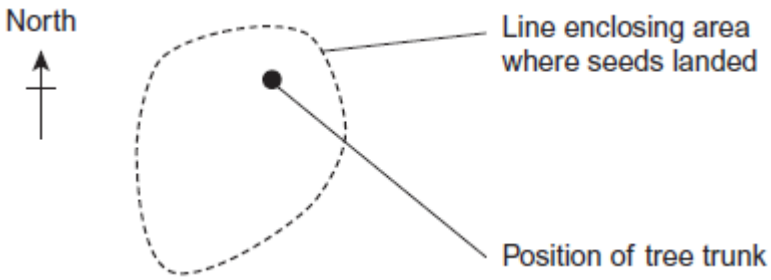
(Total 10 marks)

Q25.

A 75 m tall tree released very large numbers of small seeds. Ecologists used quadrats along a transect to measure the number of these seeds at different distances from the tree. Their results are shown on the graph.



The seeds of this tree are dispersed by wind. The diagram shows the pattern of seed dispersal from this tree.



Agricultural scientists divided a field into a number of different plots. They planted soya bean seeds in these plots at different sowing densities. The diagram shows how these plots were arranged. The numbers show the sowing densities in seeds per m^2. The plots containing seeds sown at a density of 250 seeds per m^2 have been shaded.

250	500	1000	15	25	50	100
15	25	50	100	250	500	1000
25	50	100	250	500	1000	15
50	100	250	500	1000	15	25
1000	15	25	50	100	250	500
500	1000	15	25	50	100	250

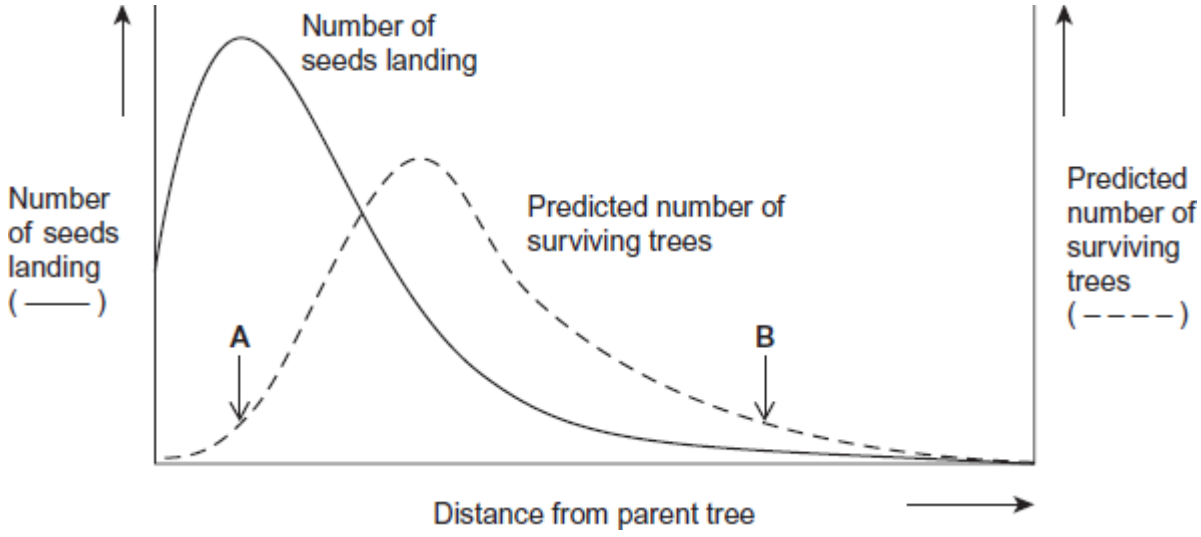
100	250	500	1000	15	25	50

The scientists recorded the number of soya bean plants growing in each plot at different times after the start of the investigation. Their results are shown in the table.

Number of seeds planted per m^2	Mean number of plants surviving per m^2 after			
	22 days	39 days	61 days	93 days
15	15	15	15	15
25	24	24	24	23
50	47	46	46	41
100	98	96	96	87
250	246	242	204	196
500	492	486	313	124
1000	987	788	276	95

(a) A scientist measured the number of seeds landing at different distances from a parent tree. He then produced a theoretical model. He used this model to predict how the number of new trees that grew from the seeds and survived varied with distance from the parent tree. The scales used for the two vertical axes are different.

The predictions from this model are summarised in the graph.



(i) Explain why the model predicts a low number of surviving trees at point **A**

_____

_____

_____

_____

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_____

(3)

(ii) Explain why the model predicts a low number of surviving trees at point **B**.

_____

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(2)

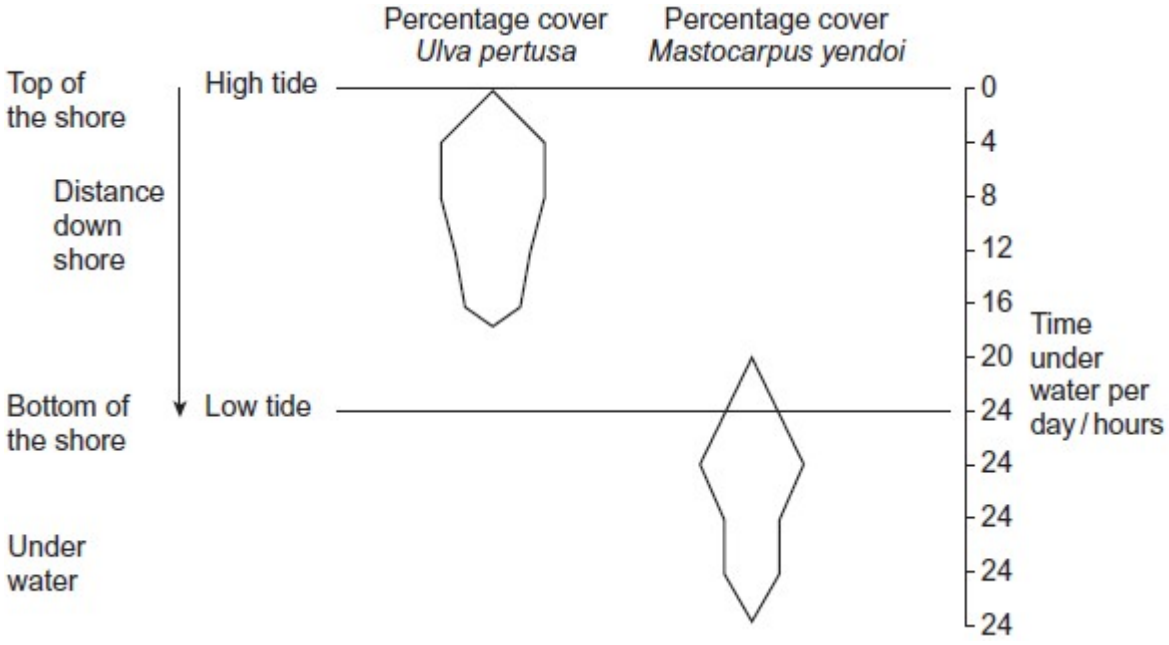
(Total 5 marks)

Q26.

Rocky shores are covered and uncovered by sea water as the tide moves in and out during the day.

An ecologist visited a rocky shore during low tide (when the shore was not covered by sea water).
He investigated the distribution of the two species of seaweed.

The ecologist estimated the percentage cover of each of the seaweeds at various positions on the seashore. He also recorded the mean length of time during the day for which each sampled area was covered by sea water caused by the rising tide. He used the kite diagram below to show his results. The width of each kite at any point is proportional to the percentage cover of a seaweed.



(a) Describe how the ecologist would have collected the data to draw the kite diagram for *U. pertusa* in the figure.

_____

_____

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(3)

(b) *U. pertusa* has thicker cell walls than *M. yendoi*. Use this information, in addition to the information from the diagram above, to suggest reasons for the difference in distribution of the two species of seaweed.

_____

_____

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_____

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(3)

(Total 6 marks)

Q27.

Ecologists studied a community of fish in a lake.

(a) Explain what is meant by a community.

_____

_____

_____

(1)

(b) (i) The ecologists could have used the mark-release-recapture method to estimate the number of one species of fish in the lake. Describe how.

_____

_____

_____

_____

_____

_____

(3)

(ii) This species of fish breeds at a certain time of the year. During this fish-breeding season, the mark-release-recapture technique might **not** give a reliable estimate.
Suggest **one** reason why.

_____

_____

_____

(1)

(c) The ecologists found that each species of fish had adaptations to its niche. One of these adaptations was the shape of its mouth.

Suggest how the shape of mouth is an adaptation to its niche.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q28.

The photograph shows marram grass growing on a sand dune.



Marram grass on sand dune by Nigel Chadwick [CC-BY-SA], via Wikimedia Commons

(a) Describe how you would investigate the distribution of marram grass from one side of the dune to the other.

_____

_____

_____

_____

_____

_____

(3)

(b) Marram grass is a pioneer species that grows on sand dunes. It has long roots and a vertically growing stem that grows up through the sand.
Sand dunes are easily damaged by visitors and are blown by the wind. Planting marram grass is useful in helping sand dune ecosystems to recover from damage.

Use your knowledge of succession to explain how.

_____

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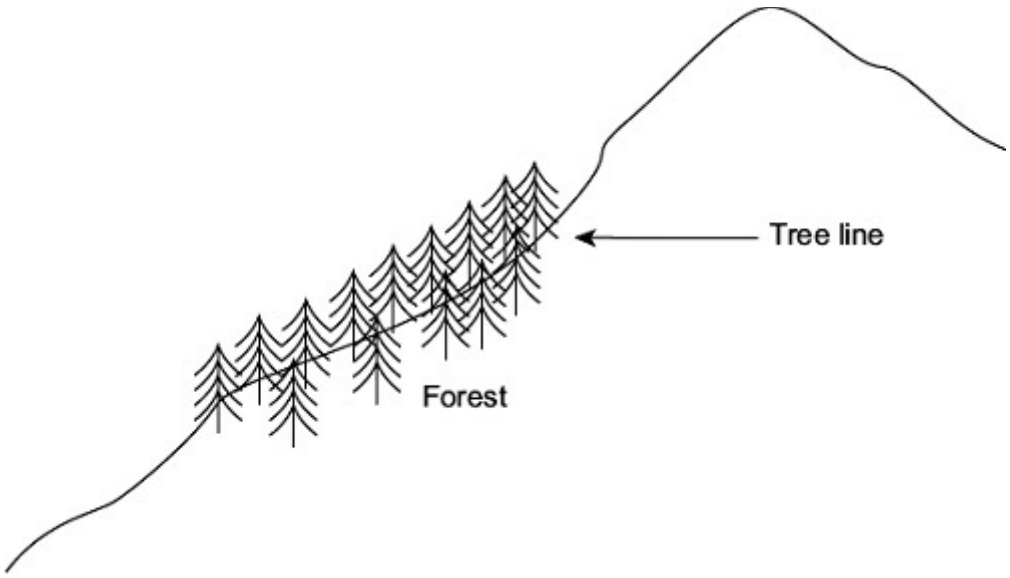
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(2)

(Total 5 marks)

Q29.

Mountains are harsh environments. The higher up the mountain, the lower the temperature becomes. The diagram shows a forest growing on the side of a mountain. The upper boundary of the forest is called the tree line. Trees do not grow above the tree line.



(a) (i) The position of the tree line is determined by abiotic factors.
What is meant by an abiotic factor?

_____

_____

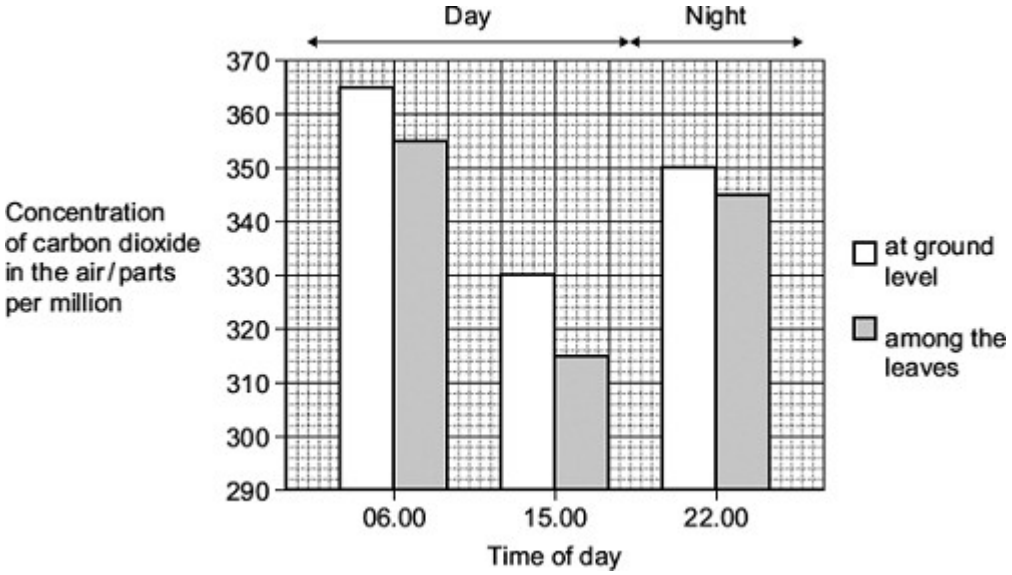
(1)

(ii) Other than temperature, suggest **one** abiotic factor that is likely to affect the position of the tree line on the mountain.

_____

(1)

(b) Scientists measured the concentration of carbon dioxide in the air in one part of the forest. They took measurements at different times of day and at two different heights above the ground. Their results are shown in the bar chart.



Use your knowledge of photosynthesis and respiration to explain the data in the bar chart.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) The population of trees in the forest evolved adaptations to the mountain

environment.
Use your knowledge of selection to explain how.

_____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

Q30.

Parasites are organisms that live on or in host organisms. The populations of many organisms may be reduced by the effects of parasites.

Feather mites are small parasites found on the wing feathers of many birds. The mites feed on the oil that the birds produce. This oil keeps the feathers in good condition. Birds unable to oil their feathers properly use more energy in maintaining their body temperature. This results in less energy being available for other processes.

Scientists investigated the relationship between the numbers of feather mites and the breeding success of one species of bird, the great tit.

(a) Use the information above to suggest how feather mites could affect breeding in great tits.

_____

_____

_____

_____

_____

(2)

(b) The scientists located a large number of great tit nests. They sampled these at random.

For each nest they recorded

- the total number of eggs laid
- the number of chicks that hatched from the eggs
- the number of chicks that survived to leave the nest
- the total number of feather mites on the two parent birds.

(i) Explain why the scientists sampled the nests at random.

_____

_____

_____

_____

_____

(2)

(ii) The scientists calculated the percentage of each pair's eggs from which chicks survived to leave the nest. They called this 'breeding success per pair'.

The table shows some of the data that the scientists obtained.

Total number of feather mites on both parent birds	Breeding success per pair
0	86
2	100
5	64
10	82
14	70
15	85
170	42

Do these data support the hypothesis that the presence of feather mites reduces the ability of great tits to reproduce successfully? Give reasons for your answer.

_____

_____

_____

_____

_____

_____

(3)

(c) The scientists calculated a correlation coefficient for these data.

(i) State a null hypothesis that would be appropriate for this investigation.

_____

_____

(1)

(ii) The correlation coefficient that they obtained had a negative value. What does a negative value indicate about these data?

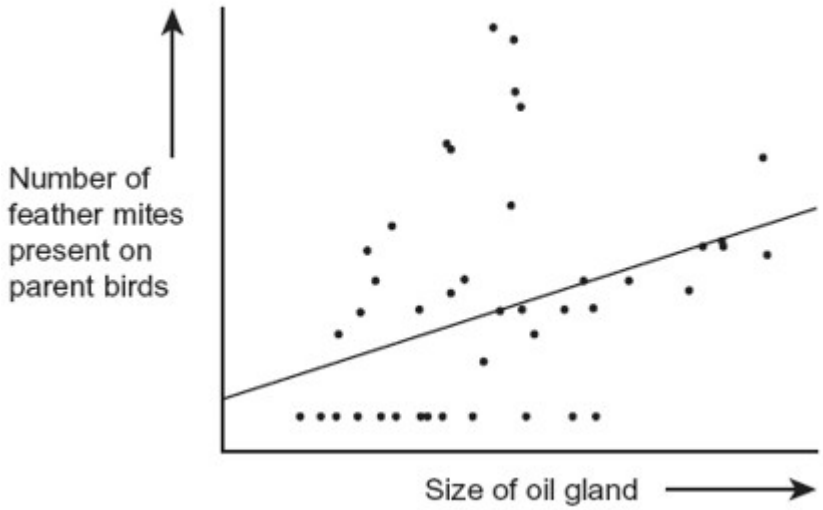
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(1)

(d) The oil that a great tit puts on its feathers is made in an oil gland at the base of the tail. The bird uses its beak to spread the oil over its feathers. This is called preening. Preening takes place in early morning and evening and empties the oil gland each time. After preening, the oil gland is considerably smaller.

At the same time that the scientists recorded the number of feather mites on each great tit, they also measured the size of the oil gland. The graph shows their results and includes the scientist's line of best fit.



(i) Describe the relationship between the number of feather mites present on each great tit and the size of the oil gland.

_____

_____

_____

_____

_____

(2)

(ii) Explain how measuring the oil gland at the same time as counting the feather mites may have affected the reliability of the data.

_____

_____

_____

_____

_____

(2)

(e) Feather mites eat pathogenic bacteria and fungi as well as oil. Explain how this may affect the breeding success of the birds.

_____

_____

_____

_____

_____

(2)

(Total 15 marks)

Q31.

The Harvest Index is the percentage of dry biomass that is harvested and used.

Barley is a cereal. It is grown for its grain. Researchers collected data to calculate the Harvest Index of barley growing in a small field. They obtained their measurements from quadrats at different places in the field. Their results are shown in the following table.

Quadrat number	Dry biomass of barley plants / g m^{-2}	Dry biomass of barley grain harvested / g m^{-2}
1	80	42
2	75	37
3	82	41
4	93	39

(a) Use the data for quadrat number **4** in the table to calculate the Harvest Index for barley. Show your working.

Harvest Index = _____

(2)

(b) Plant breeders are trying to produce barley plants with shorter stems.
Explain how this would increase the Harvest Index.

_____

_____

(1)

(c) The values for the biomass of the barley plants are different in each quadrat.
Suggest an explanation for this difference.

_____

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(2)

(d) The researchers measured the dry biomass of the barley plants and the barley grain.
What is the advantage of using dry biomass for these measurements?

_____

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(2)

(Total 7 marks)

Q32.

Herbicides are substances that kill weeds. Three farmers wanted to know which herbicide to use to control weeds in fields of barley. They chose eleven fields of barley and used a different herbicide in each field. Four weeks later they collected, counted and weighed the weeds in each field. Their results are shown in **Figure 1** and **Figure 2**.

Figure 1

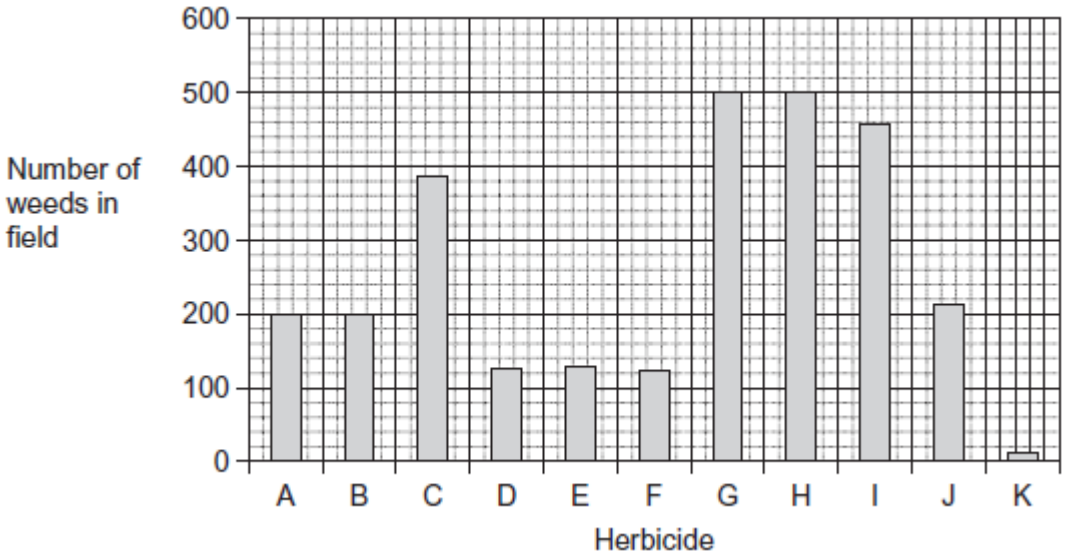
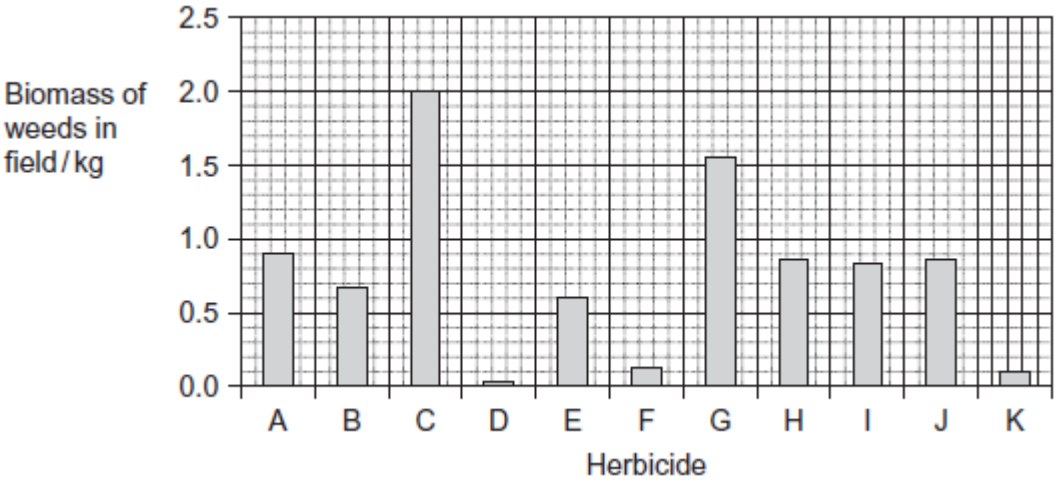


Figure 2



(a) Describe the difference in biomass of **each** of the weed plants in fields treated with herbicides **G** and **H**. Explain how you arrived at your answer.

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_____

(2)

(b) The farmers decided that **K** would be the best herbicide to use.
Explain why herbicide **K** would give a higher crop yield.

_____

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(2)

(c) The farmers carried out their investigation during the summer.
Suggest **one** advantage and **one** disadvantage of carrying out this investigation during the summer.

Advantage _____

_____

Disadvantage_____

_____

(2)

(d) One of the farmers told a local newspaper reporter of their findings. The newspaper published an article with the following headline: “Local farmers show scientists the way to bigger crop yields.” Was this headline justified? Explain your answer.

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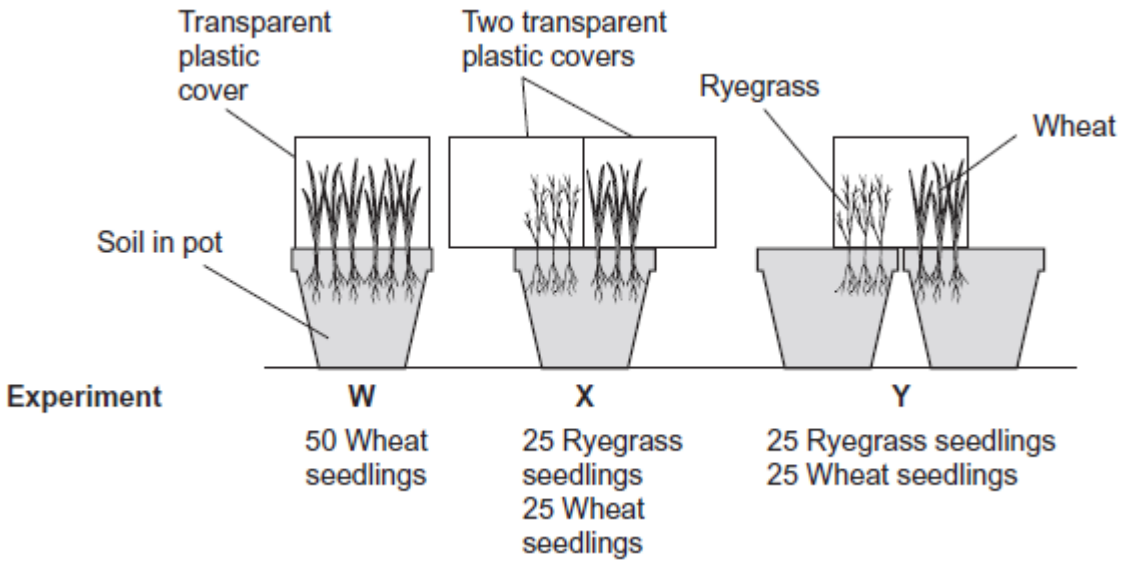
(5)

(Total 11 marks)

Q33.

Wheat is an important cereal crop. Ryegrass is a weed in wheat fields. Wheat and ryegrass belong to the grass family.

Scientists investigated competition between wheat and ryegrass seedlings. They set up three experiments **W, X**, and **Y** as shown in the diagram.



The table shows the mean dry mass of the wheat seedlings as a percentage of their dry mass when grown alone.

	Experiment		
	W	**X**	**Y**
Mean dry mass of wheat seedlings as a percentage of their dry mass when grown alone	100	76	46

(a) Experiment **W** was a control experiment. Explain the purpose of the control experiment in this investigation.

_____

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(2)

(b) What can you conclude from this investigation about competition between wheat and ryegrass? Use the data in the table to support your answer.

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(4)

(c) Explain how a decrease in temperature could affect the outcome of this investigation.

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(2)

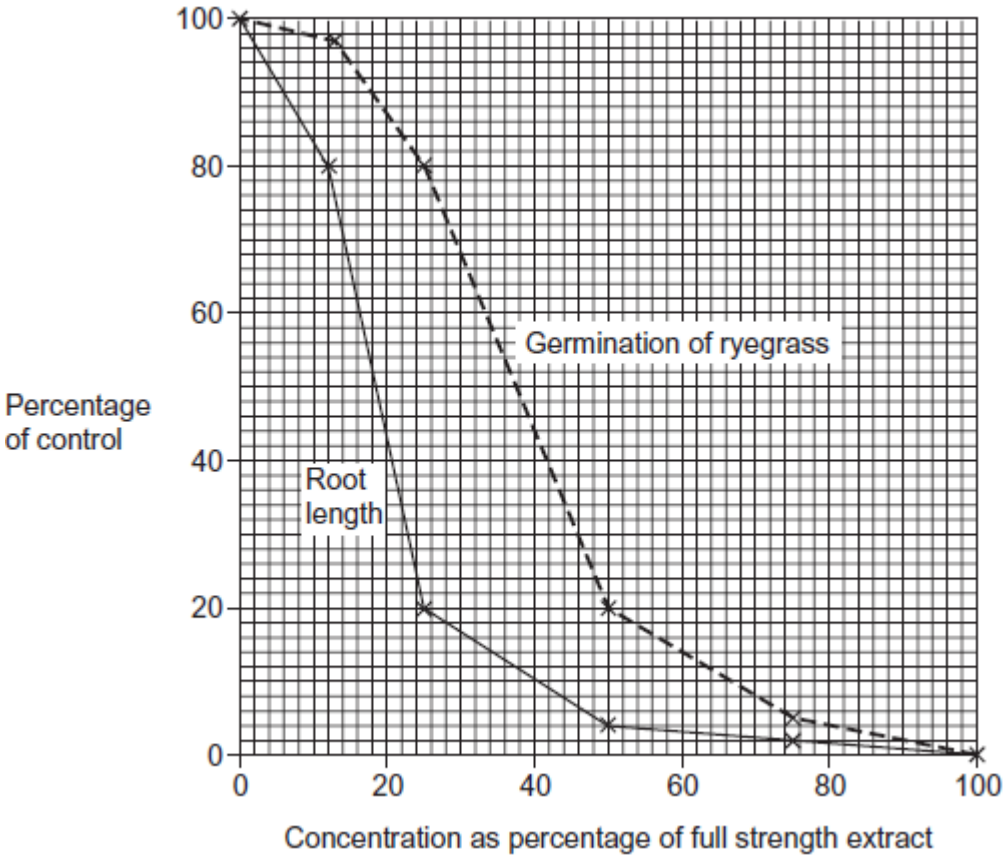
(Total 8 marks)

Q34.

Australian scientists investigated one aspect of competition between wheat and ryegrass.

- They crushed up some wheat plants and mixed the crushed plants with distilled water.
- Water-soluble substances in the crushed plants dissolved in the distilled water. The scientists called this solution the *full-strength* extract.
- The scientists then made a series of dilutions of the full-strength extract.
- They put ryegrass seeds into each dilution and recorded how many seeds germinated (started to grow). If the seeds germinated, they measured the lengths of the roots of the seedlings.
- They presented their results as percentages of a control experiment.

The graph shows the effects of different concentrations of the extract on the germination of ryegrass and on the length of the roots of the seedlings that grew from them.



(a) Describe the control that the scientists set up in this investigation.

_____

_____

(1)

(b) The scientists found a positive correlation between the inhibition of germination and the concentration of the extract.

(i) Describe how they could find out whether this correlation was significant.

_____

_____

_____

_____

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(2)

(ii) Explain why a correlation does **not** mean that the extract caused inhibition of germination.

_____

_____

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(1)

(c) The scientists concluded that wheat plants produce substances that help them to compete with ryegrass.

(i) Give evidence from the investigation to support this conclusion.

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(2)

(ii) Why might their conclusion **not** be valid?

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(3)

(Total 9 marks)

Q35.

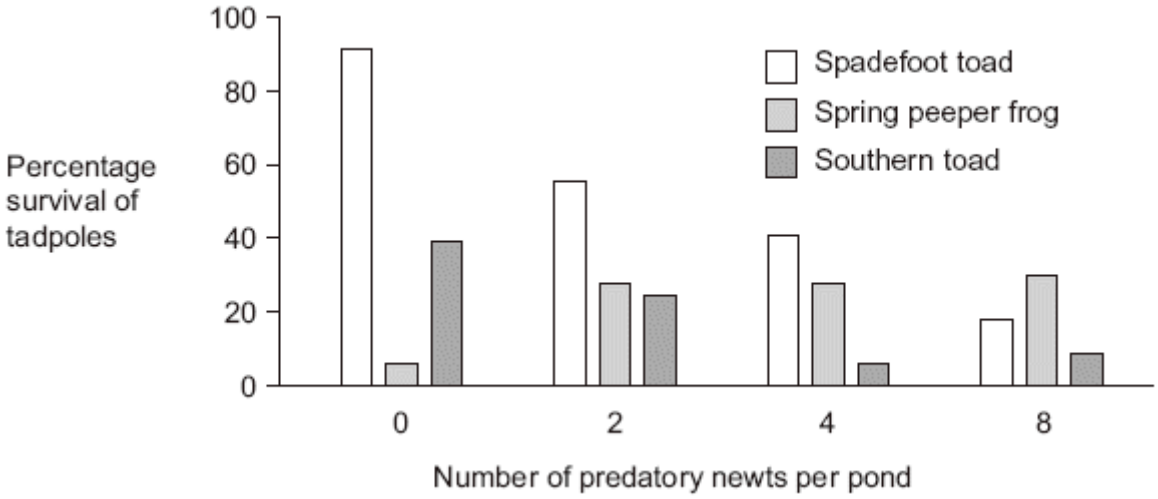
The young of frogs and toads are called tadpoles. Ecologists investigated the effect of predation on three species of tadpole. They set up four artificial pond communities.

Each community contained

- 200 spadefoot toad tadpoles
- 300 spring peeper frog tadpoles
- 300 southern toad tadpoles.

The ecologists then added a different number of newts to each pond. Newts are predators. **Figure 1** shows the effect of increasing the number of newts on the percentage survival of the tadpoles of each species.

Figure 1



(a) (i) Describe the effect of an increase in the number of newts on the percentage survival of the tadpoles of each of the **toad** species.

_____

_____

_____

_____

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(2)

(ii) Suggest an explanation for the effect of an increase in the number of newts on the percentage survival of the tadpoles of spring peeper frogs.

_____

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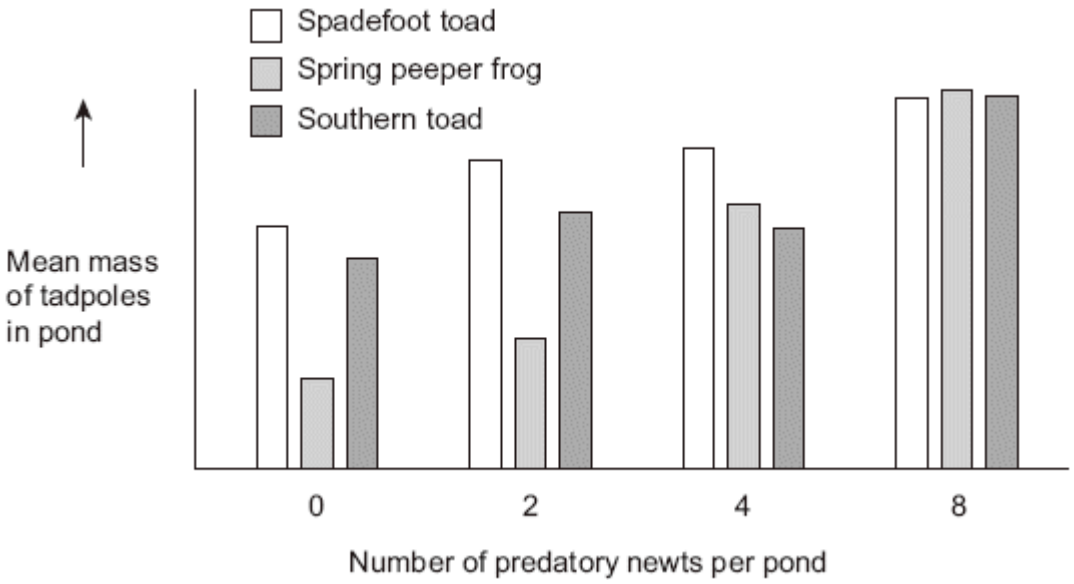
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(2)

Figure 2 shows how the masses of the tadpoles were affected in each pond during the investigation.

Figure 2



(b) Using the information provided in **Figure 1** explain the results obtained in **Figure 2**.

_____

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_____

(2)

(Total 6 marks)

Q36.

(a) Succession occurs in natural ecosystems. Describe and explain how succession occurs.

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(5)

(b) Changes in ecosystems can lead to speciation. In Southern California 10 000 years ago a number of interconnecting lakes contained a single species of pupfish.

Increasing temperatures caused evaporation and the formation of separate, smaller lakes and streams. This led to the formation of a number of different species of pupfish. Explain how these different species evolved.

_____

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(5)

(Total 10 marks)

Q37.

(a) Blue tits are small birds that live in woods. An ecologist estimated the size of the blue tit population visiting gardens near a wood in November.

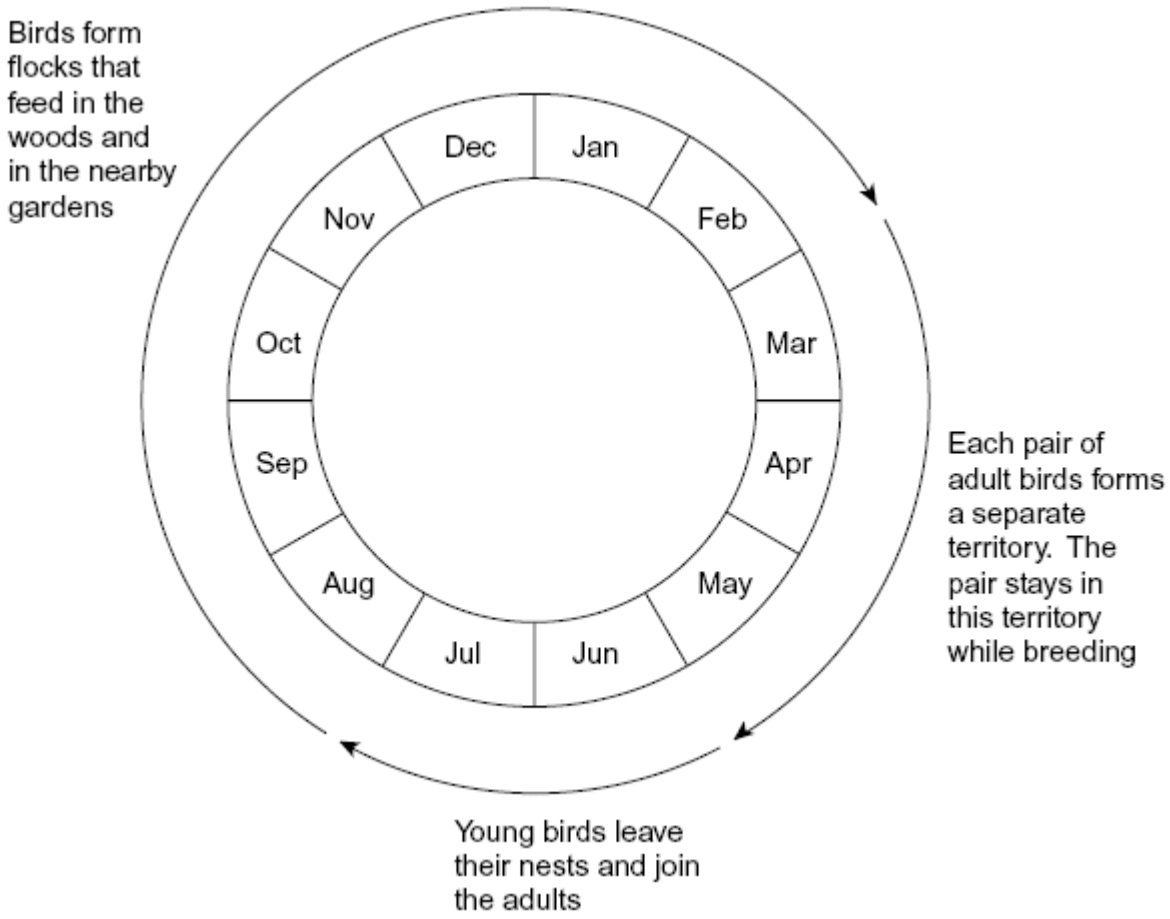
- She trapped 28 blue tits. She marked all of these birds with small metal rings on their legs.
- Two weeks later, she trapped another sample of blue tits. Of these birds, 18 were marked and 20 were not marked.

Use the data to estimate the size of the blue tit population. Show your working.

Size of population _____

(2)

(b) The diagram shows some features of blue tit behaviour at different times of the year.



(i) Using mark-release-recapture to estimate the size of a blue tit population in June would **not** give reliable results. Explain why.

_____

_____

_____

_____

_____

(2)

(ii) Using mark-release-recapture to estimate the size of a blue tit population in March would **not** give reliable results. Explain why.

_____

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(2)

(c) Whales spend most of their time deep in the sea but they come to the surface to

breathe. When they are at the surface, scientists obtain small samples of their skin. The scientists find the base sequence in some of the DNA from these samples. The base sequence is different in each whale.

You could use the information about the base sequence to estimate the size of the whale population by using mark-release-recapture. Explain why.

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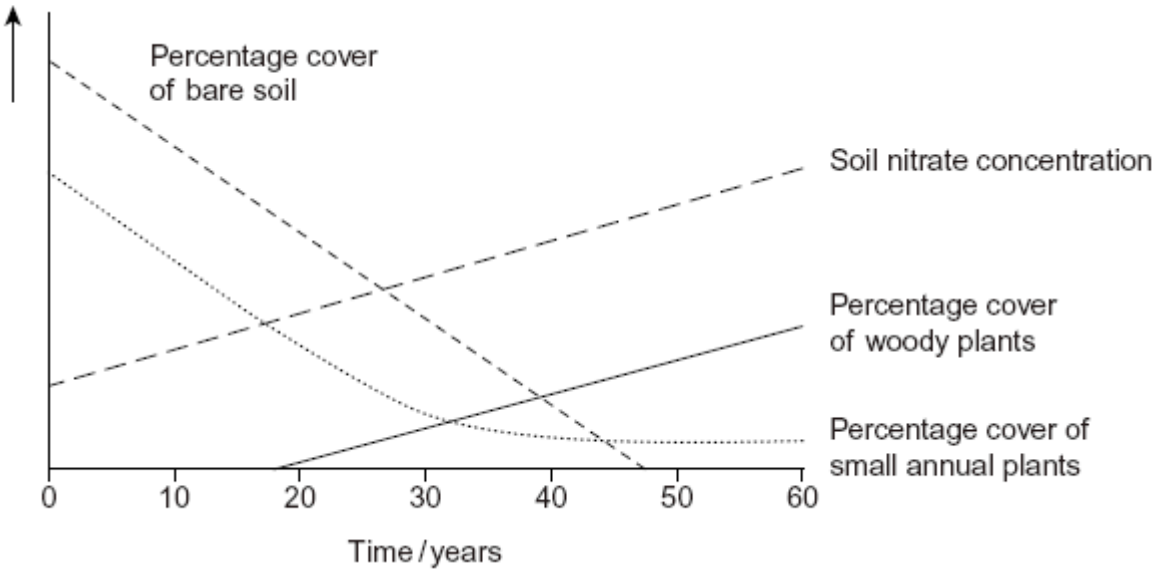
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(2)

(Total 8 marks)

Q38.

Ecologists investigated succession in some abandoned crop fields. The data that they collected are shown in the graph. The curves show the trends that occurred over a period of 60 years.



(a) Explain the change in soil nitrate concentration shown on the graph.

_____

_____

_____

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_____

(2)

(b) The pioneer plants had different characteristics from the plants that colonised the

fields after 50 years.

(i) The pioneer plants had seeds that germinate better when the temperature fluctuates.

Explain the advantage of this to these pioneer plants.

_____

_____

_____

_____

_____

(2)

(ii) Explain the advantage to a plant that colonises after 50 years of having a high rate of photosynthesis at low light intensities.

_____

_____

(1)

(c) Conservation of grassland habitats involves management of succession. Use the data in the graph to explain why.

_____

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(2)

(Total 7 marks)

Q39.

A Sri Lankan scientist investigated the effect of human disturbance on the organisms living on a rocky seashore. He chose three areas for the study. These areas had different amounts of human disturbance.

The scientist measured human disturbance by walking from one end of the beach to the other. He recorded the number of people he encountered. **Figure 1** shows his results.

Figure 1

	Site **R**	Site **G**	Site **U**
Mean number of people encountered per hour (± standard deviation)	2.2 (± 2.1)	17.6 (± 9.6)	34.6 (± 11.6)

(a) (i) What conclusions can you draw about the number of people visiting Site **R** compared with the number of people visiting the other two sites? Give evidence from **Figure 1** to support your answer.

_____

_____

_____

_____

_____

(2)

(ii) The scientist reported that the difference between the number of people visiting Site **R** and the number visiting the other two sites differed significantly ($p < 0.05$).

Use the words probability and chance to explain the meaning of *differed significantly ($p < 0.05$).*

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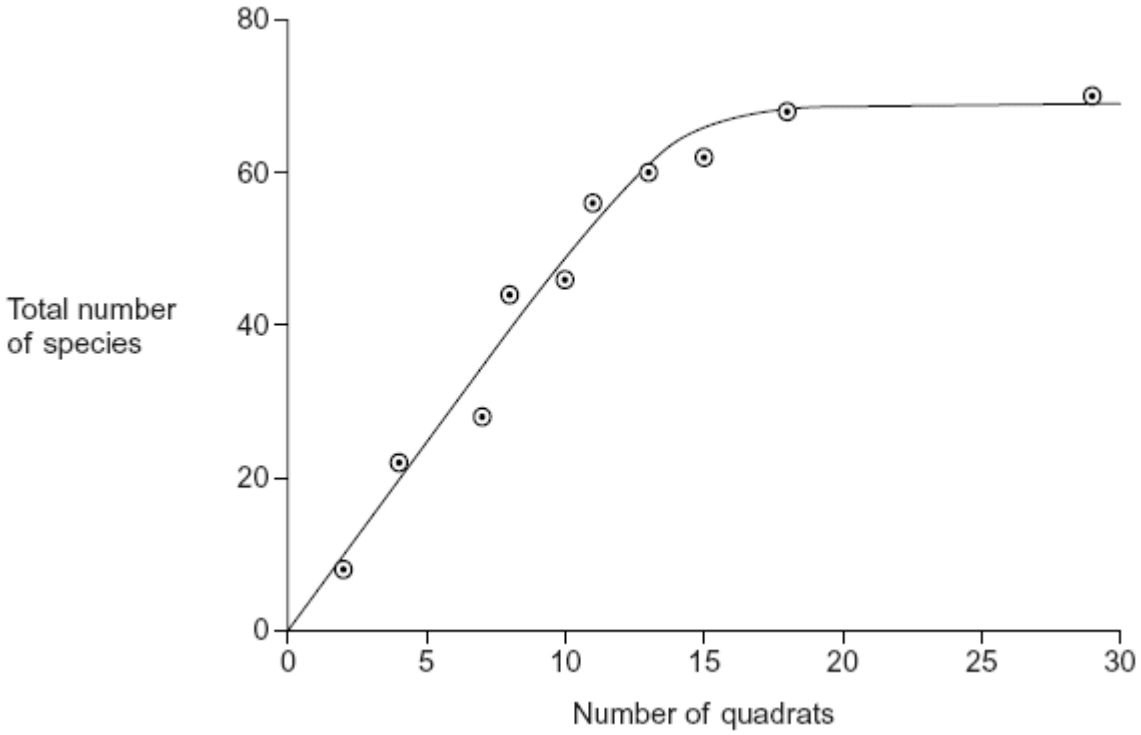
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(2)

(b) The scientist used quadrats to find the number of species at each of the three sites. He carried out a preliminary investigation and recorded the total number of species in an increasing number of quadrats. **Figure 2** shows the results.

Figure 2



(i) Use **Figure 2** to explain why 10 would **not** be an appropriate number of quadrats to use.

_____

_____

_____

(1)

(ii) Use **Figure 2** to explain why 25 would **not** be an appropriate number of quadrats to use.

_____

_____

_____

(1)

The scientist measured the dry biomass of seaweeds at each of sites **R**, **G** and **U**. He collected all the organisms of a particular species in a quadrat and incubated them in an oven at a temperature of 80 °C.

(c) The scientist incubated the seaweeds at 80 °C. Suggest why incubating them at a higher temperature would **not** produce valid results.

_____

_____

_____

(1)

As well as measuring the dry biomass of the seaweeds, the scientist measured the dry mass of the animals present. He also measured the abundance of each species. **Figure 3** shows the data he collected.

Figure 3

	Site **R**	Site **G**	Site **U**
Mean number of people per hour	2.2	17.6	34.6
Mean number of species of seaweed per quadrat	4.2	2.1	1.3
Ratio of dry biomass of animals to dry biomass of seaweeds	0.15	0.06	0.03
Ratio of dry biomass of animals to abundance of animals	0.20	0.10	0.09
Ratio of dry biomass of seaweeds to abundance of seaweeds	0.79	1.57	3.24

(d) The ratio of the dry biomass of animals to the dry biomass of seaweeds is always a lot less than one. Explain why.

_____

_____

_____

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_____

(2)

(e) (i) Conservation officers were working on the beaches used in this investigation. They noticed that there were fewer larger seaweeds on beaches used by a large number of people than on beaches visited by only a few people. Explain how the data in **Figure 3** support this.

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(2)

(ii) What conclusions can you draw from the data in **Figure 3** about the effect of human disturbance on the animals living on the seashore? Explain your answer.

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(4)

(Total 15 marks)

Q40.

Lettuce is classified in the same family as dandelions. Dandelions commonly grow on roadside verges and may accidentally be sprayed with salt when salt is added to the road in winter.

Describe how you could use a transect to investigate whether the distribution of dandelions changed with increased distance from the road.

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(Total 4 marks)

Q41.

Resource A

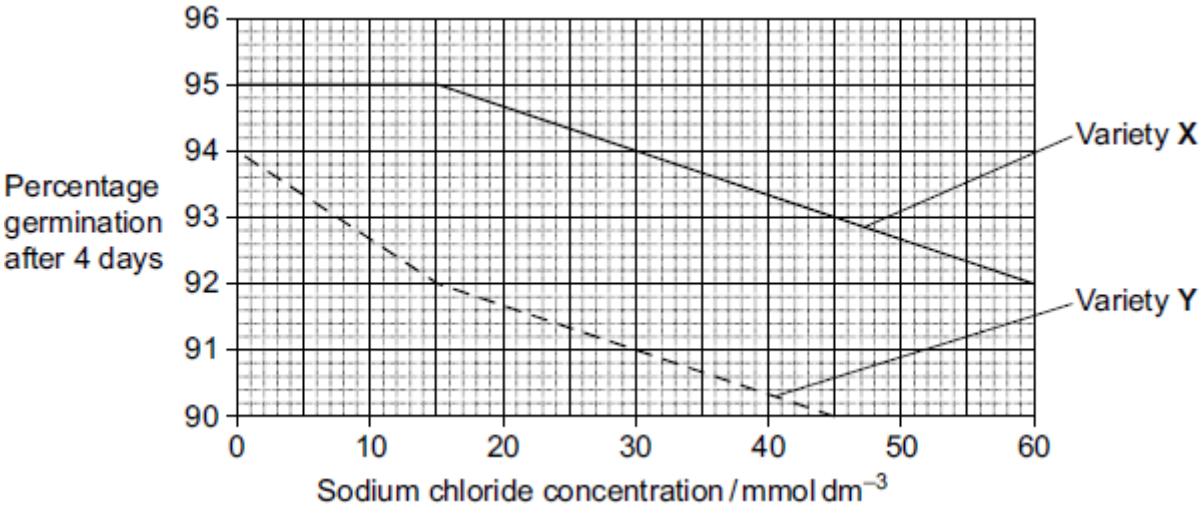
Lettuce growers investigated the best conditions for germinating lettuce seeds. They soaked lettuce seeds for 8 hours in distilled water at different temperatures. They then germinated some of the seeds at 20 °C and some at 35 °C. The table shows their results.

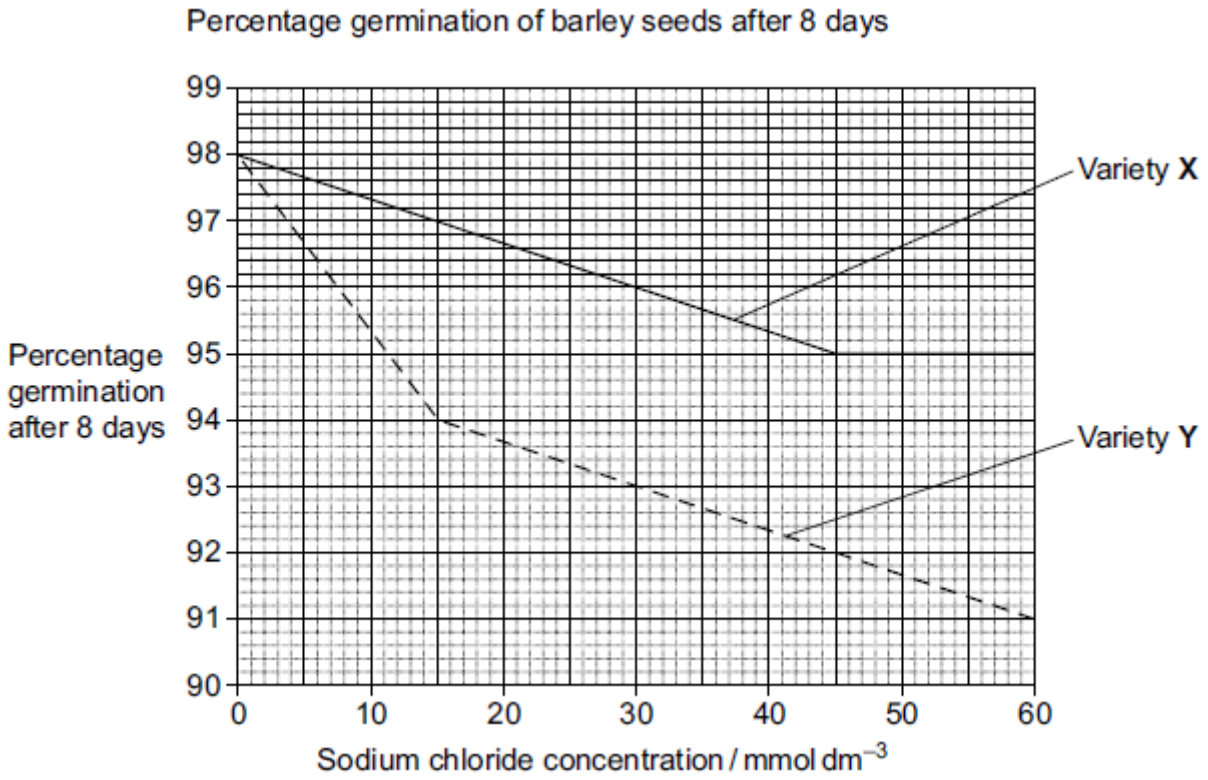
Temperature at which seeds were soaked / °C	Percentage of seeds which germinated	
	at 20 °C	at 35 °C

20	100	89
25	100	43
30	41	1
35	21	0

Resource B

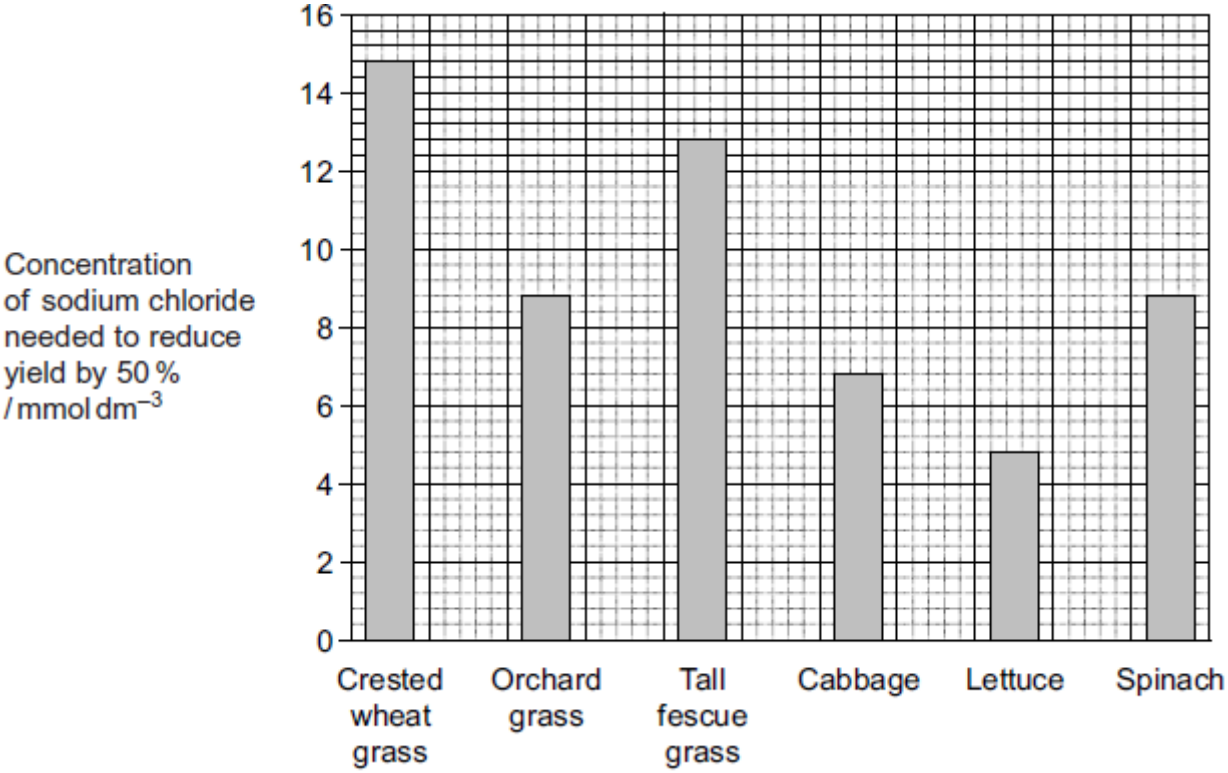
Scientists investigated the effects of different concentrations of sodium chloride on the germination of the seeds of two varieties of barley. The seeds were soaked for one hour in different concentrations of sodium chloride solutions and then germinated in distilled water at 25 °C. The scientists found the percentage of germinated seeds after 4 days and again after 8 days.





Resource C

The Food and Agriculture Organisation is investigating the effect of salt on plant growth. In some countries the water used to irrigate crops contains sodium chloride. The graph shows the effect of sodium chloride on the growth of some grasses and crop plants.



Resource D

Salt is used frequently on the roads in Canada during the winter months. The Highways

Agency wants to plant salt-tolerant trees on roadside verges. They surveyed a range of roadside trees to determine how salt-tolerant they were. In the survey each tree was growing in soil with a similar salt concentration.

Tree Species	Number of trees surveyed	Percentage of trees in each class			Mean concentration of chloride ions in the tissues of roadside trees / arbitrary units
		Healthy	Slightly injured	Moderately to severely injured	
Red oak	108	100	0	0	0.02
Paper birch	3	100	0	0	1.15
Black cherry	36	92	8	0	0.09
Basswood	54	57	41	2	0.90
Red maple	282	63	11	26	1.01
Red pine	140	9	15	76	1.08

(a) The scientists concluded that red oak and paper birch are salt-tolerant but that the other species of tree are not. Use the data in **Resource D** to evaluate their conclusion.

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(4)

(b) Farmers have suggested that using salt on the roads in winter is damaging the yield from their land. Do the data in the resources above support this claim?

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(4)

(Total 8 marks)

Q42.

Tomato plants were grown in two glasshouses, each with an area of 2000 m^2. The table shows the mean number of hours of sunshine per month during fruit production.

	1995 – 1997 (no extra carbon dioxide	**1998 – 2000 (extra carbon dioxide)**
Mean number of hours of sunshine per month	148.91	147.00

- The scientists used heating to maintain the temperature inside the glasshouses above 18 °C. They opened the windows to keep the temperature below 30 °C.
- From 1998 to 2000 they maintained the carbon dioxide concentration between 0.06 % and 0.08 % when the windows were closed and between 0.04 % and 0.05 % when the windows were open.
- The carbon dioxide concentration in the air outside the glasshouse was 0.04 %.

(a) The scientists monitored the number of hours of sunshine per month. Explain why they monitored the number of hours of sunshine.

_____

_____

_____

_____

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_____

(2)

(b) The temperature, the use of fertiliser and the number of insect pests were controlled during this investigation. Name one other factor which should have been controlled during the investigation. Explain why variation in this factor would affect yield.

Factor _____

Explanation _____

(2)

(Total 4 marks)

Q43.

During the last 50 years, there have been changes in the climate of the UK. One of the main changes is temperature. The data in the following resources all relate to southern England.

Figure 1 shows the mean temperatures for January and February combined.

Figure 1

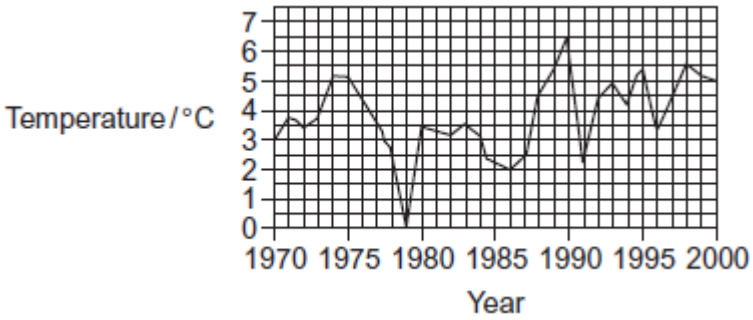
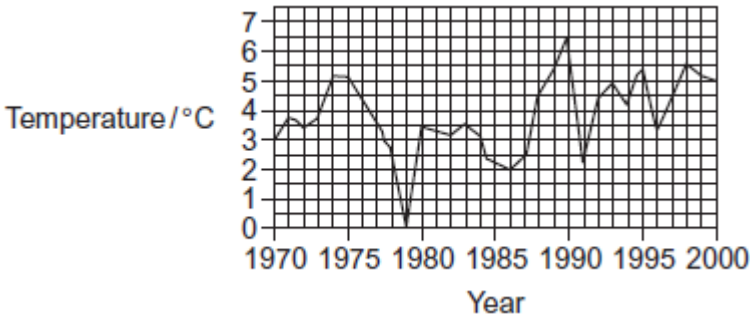


Figure 2 shows the mean temperatures for March.

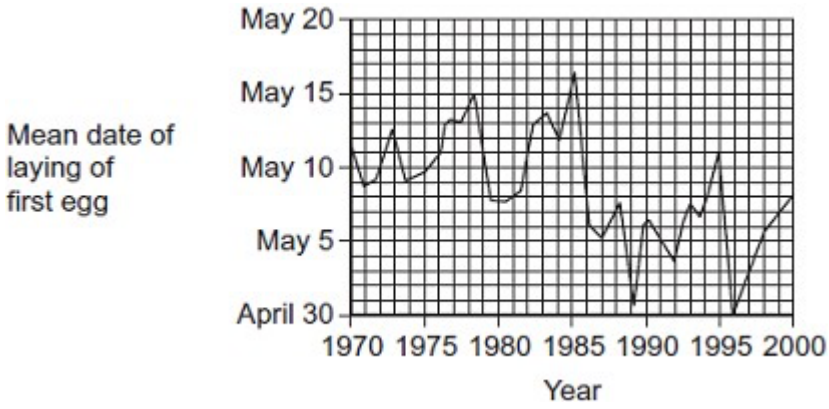
Figure 2



Birds, such as chaffinches, have been recorded as breeding earlier. Chaffinches build nests. When the nest is complete, the female lays eggs until she has produced a full clutch of 4 to 6 eggs. After the eggs hatch, the parent birds feed the young on insects.

Figure 3 shows the mean date on which chaffinches laid their first egg.

Figure 3



The data from which this graph was drawn were collected by volunteers. They used standard record cards. The volunteers used one record card for each nest they found. Each card was used to record

- the geographical location
- the habitat in which the nest site was situated
- the date of each visit to the nest by the volunteer
- the number of eggs present in the nest at each visit.

Visits were made to the nests at least once every 5 days.

(a) Do the data in **Figure 1** and **Figure 2** support the idea that there has been a rise in the mean temperatures in southern England between 1970 and 2000? Explain your answer.

_____

_____

_____

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_____

(2)

(b) Describe briefly how you would use a statistical test to find whether there is a significant correlation between mean March temperature and the date when chaffinches laid their first egg.

_____

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_____

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(3)

(c) In chaffinches, the date of laying the first egg is determined by a number of factors. These include day length and temperature. What is the advantage to the bird of

egglaying being determined by

(i) daylength

_____

_____

_____

_____

_____

(2)

(ii) temperature?

_____

_____

_____

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(2)

(d) Scientists found that there was a correlation between mean annual temperature and the date when chaffinches laid the first egg. Can you conclude that higher temperatures cause earlier laying of the first egg?
Explain your answer.

_____

_____

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_____

(2)

(e) How does the way in which the data were collected affect the conclusions which can be drawn from **Figure 3**?

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(2)

(Total 13 marks)

Q44.

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

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

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(2)

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

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

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

_____

_____

_____

(1)

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

_____

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(3)

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

_____

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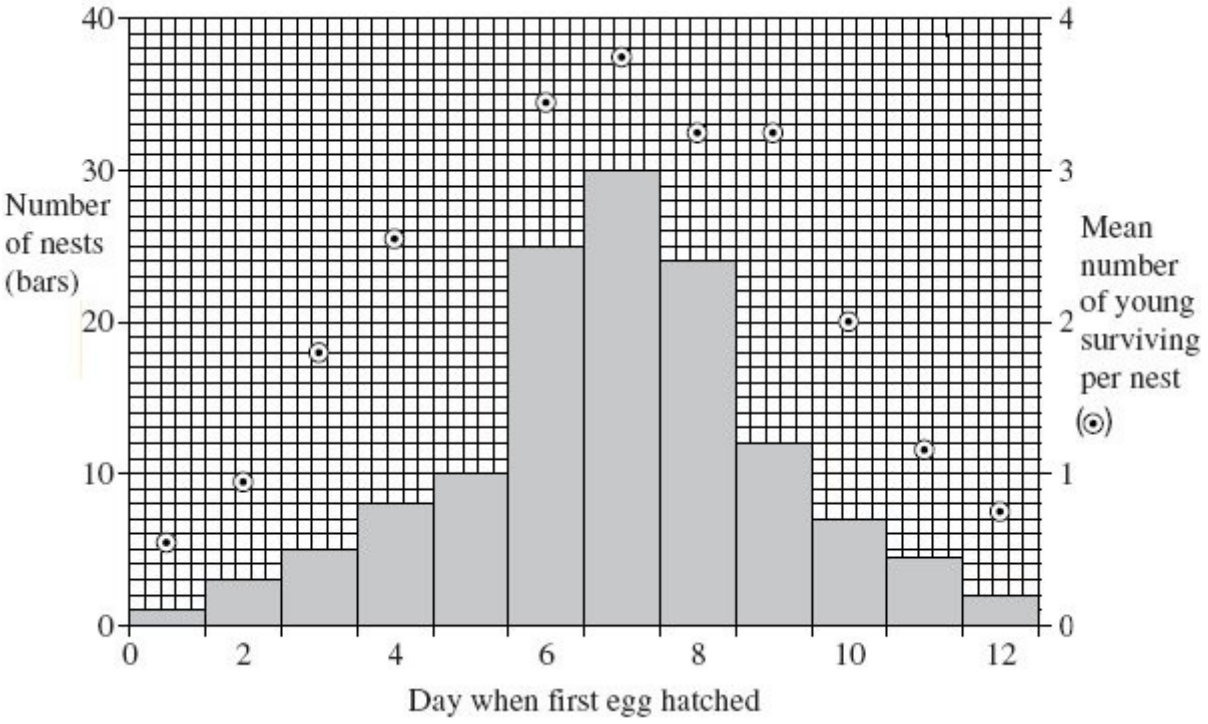
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(2)

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



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

_____

(1)

(ii) Describe the evidence for your answer.

_____

_____

(1)

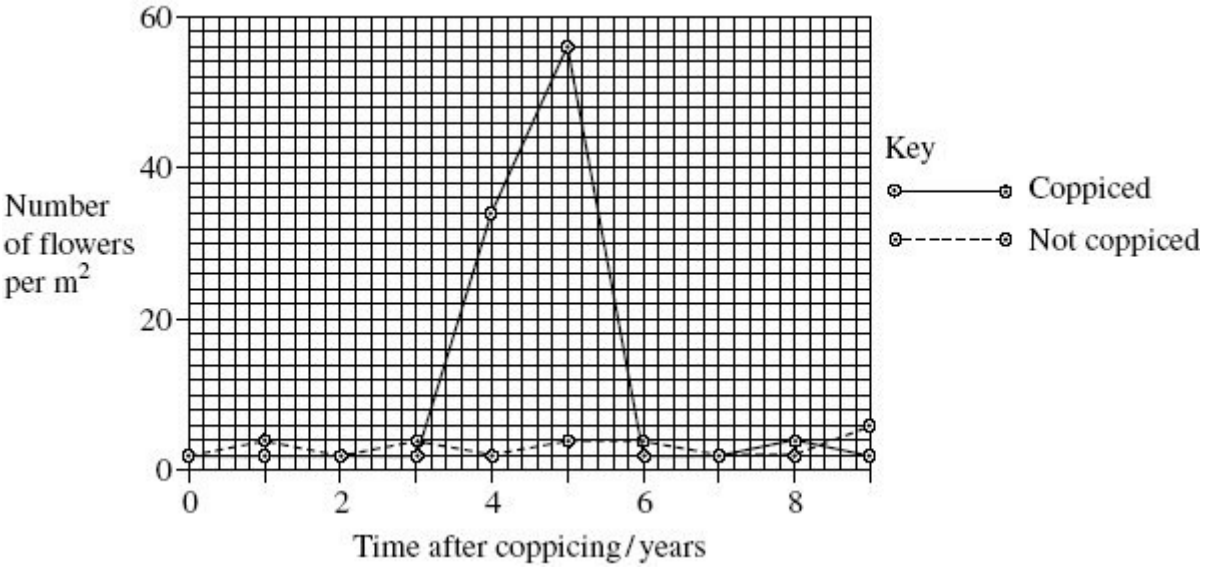
(Total 10 marks)

Q45.

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.

_____

_____

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_____

(2)

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

_____

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(2)

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

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(2)

(c) The ecologists analysed the relationship between the number of daffodils in flower in the whole wood and data collected from a nearby weather station for the previous year.

They used the Spearman rank correlation test. The table shows their results.

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

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

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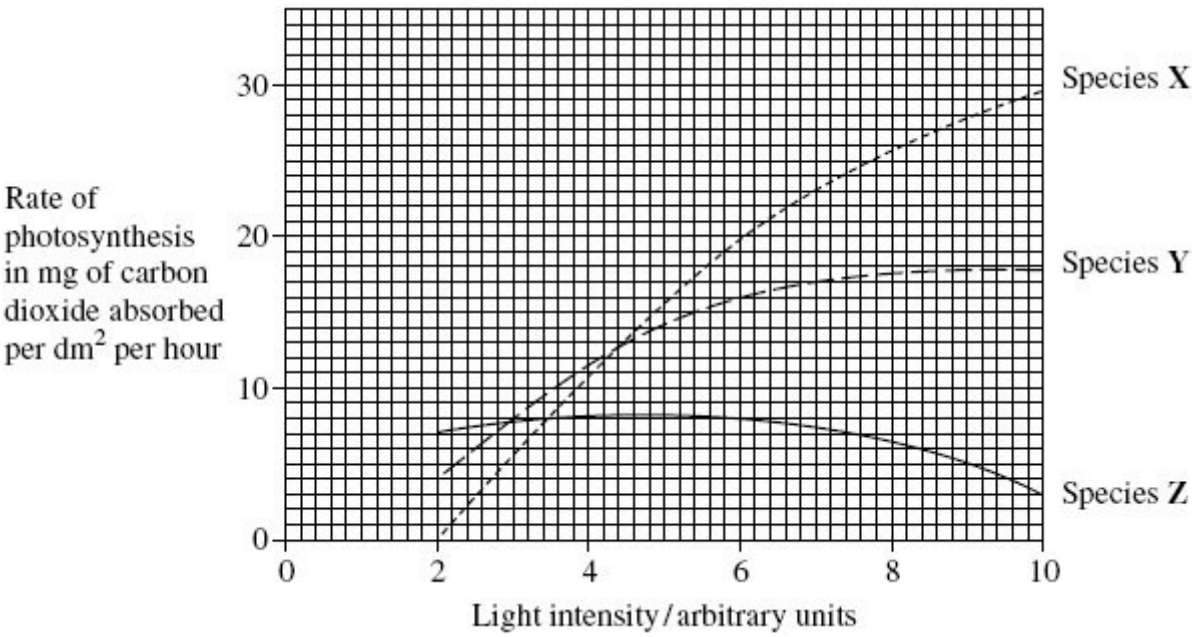
(2)

(Total 8 marks)

Q46.

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**.

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(3)

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

Use the graph to explain why.

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(2)

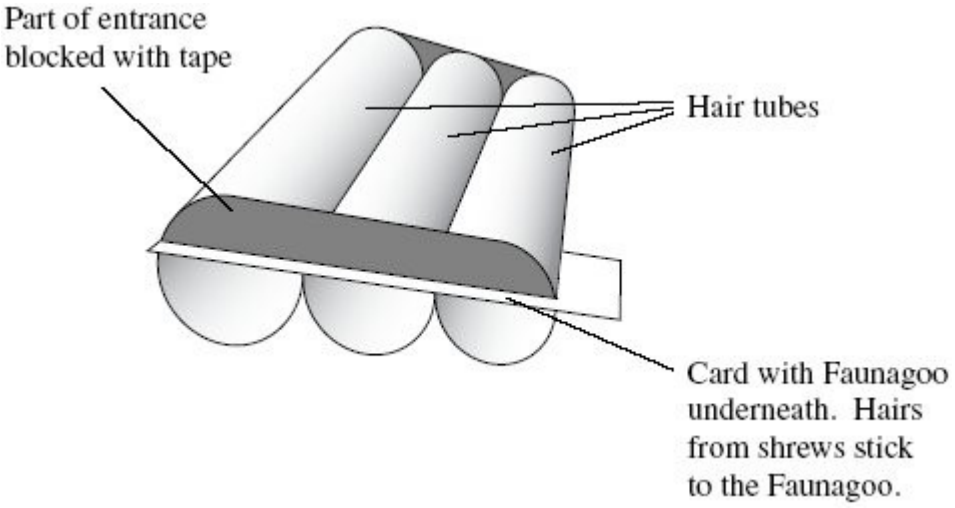
(Total 5 marks)

Q47.

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 the advantage 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 species of shrew. They collected hairs from shrews of each species. For each species, they selected hairs at random and made different measurements.

Explain why the biologists selected the hairs at random.

_____

_____

(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.

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_____

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(2)

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

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(2)

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

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

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

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_____

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(1)

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

_____

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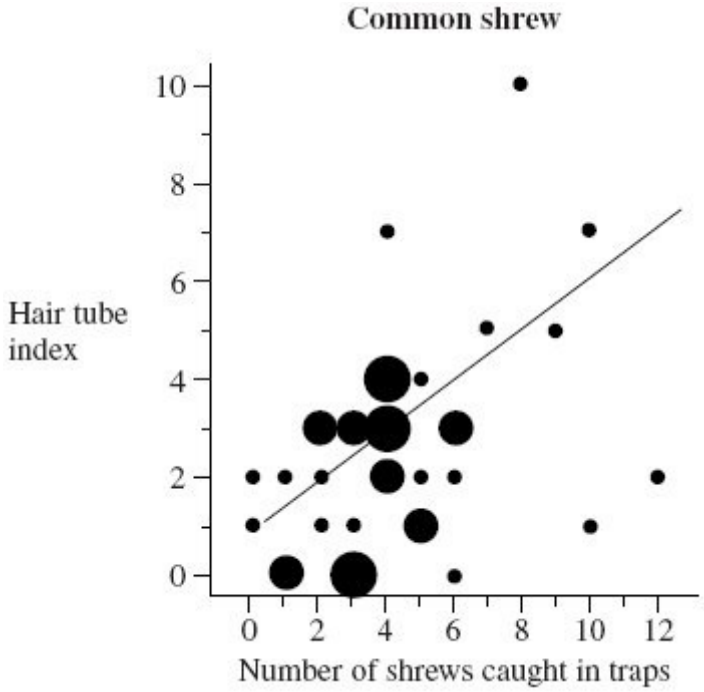
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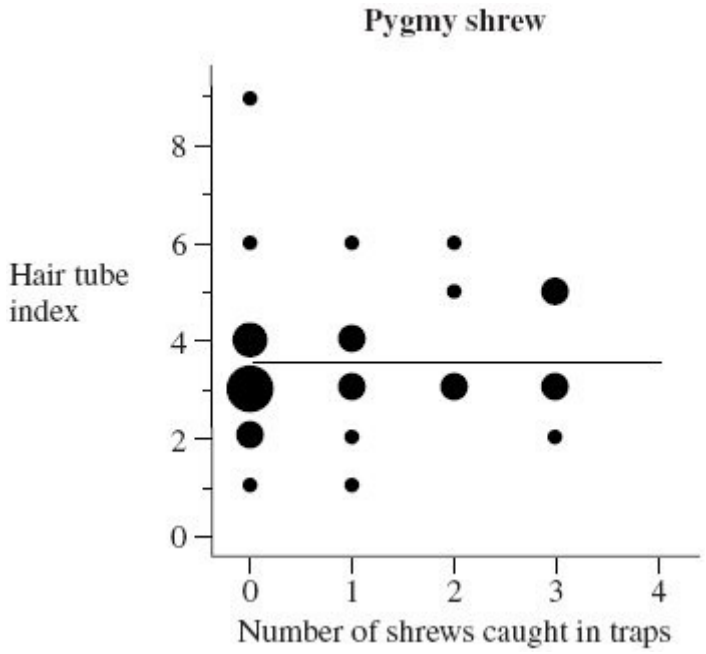
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(2)

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.

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(2)

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

_____

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(1)

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

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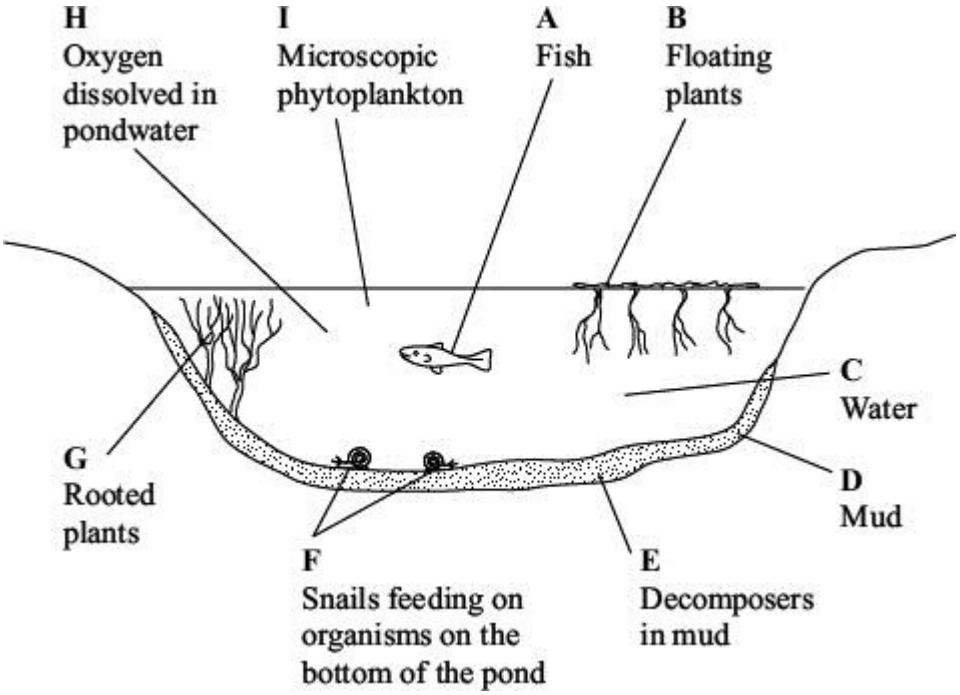
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(2)

(Total 15 marks)

Q48.

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 to some 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.

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(3)

(Total 5 marks)

Q49.

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.

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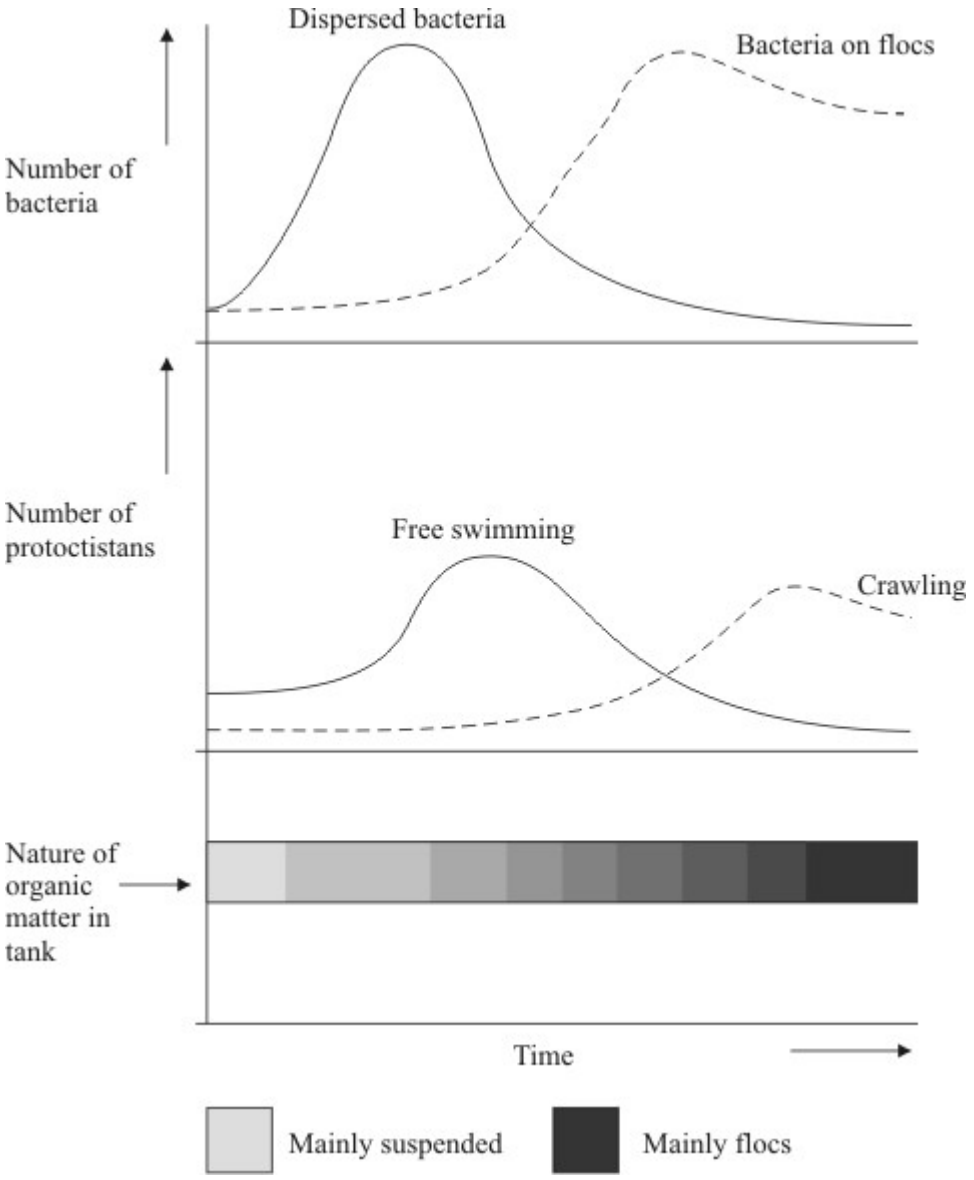
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(2)

(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 of free-swimming protoctistans.

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_____

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(3)

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

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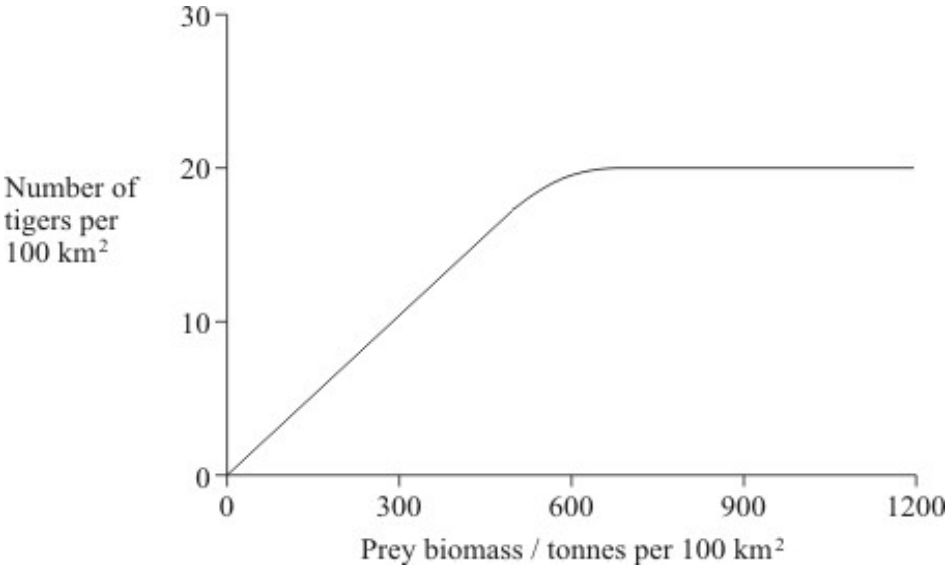
(4)

(Total 12 marks)

Q50.

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 tigers in an area.

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(3)

(Total 4 marks)

Q51.

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 the increase in the index of diversity?

_____

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(2)

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

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(3)

(Total 5 marks)

Q52.

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 a random 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

$$\text{area} = \text{length} \times \text{maximum width} \times 0.5$$

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)

Q53.

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 the numbers of insects.

_____

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(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 statistically significant?

_____

(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 total amount of plant biomass formed per year by photosynthesis.

_____

_____

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(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.

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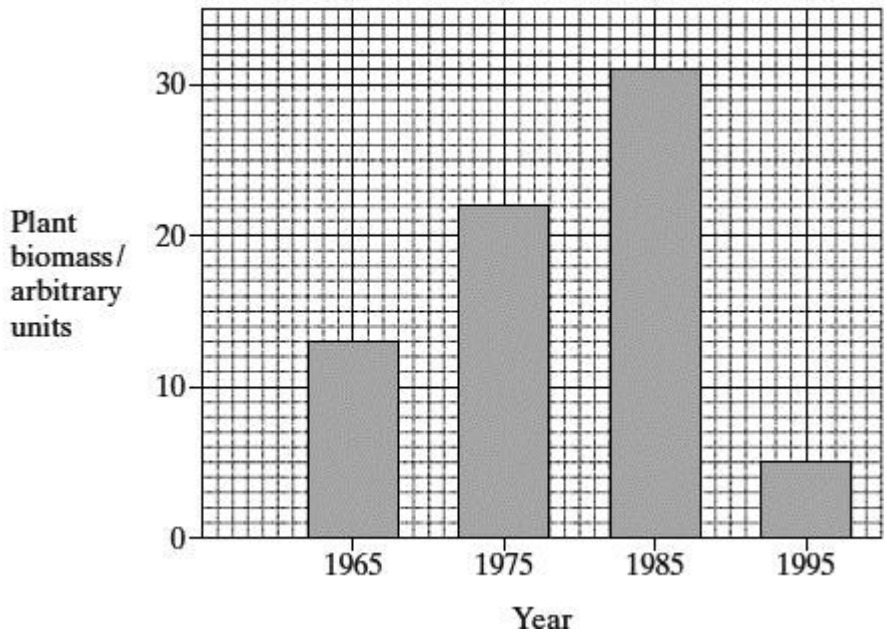
(1)

(Total 11 marks)

Q54.

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 your working.

Answer _____

(2)

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

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_____

_____

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(2)

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

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(6)

(Total 11 marks)

Q55.

(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 a population 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 field measuring 100 m by 150 m.

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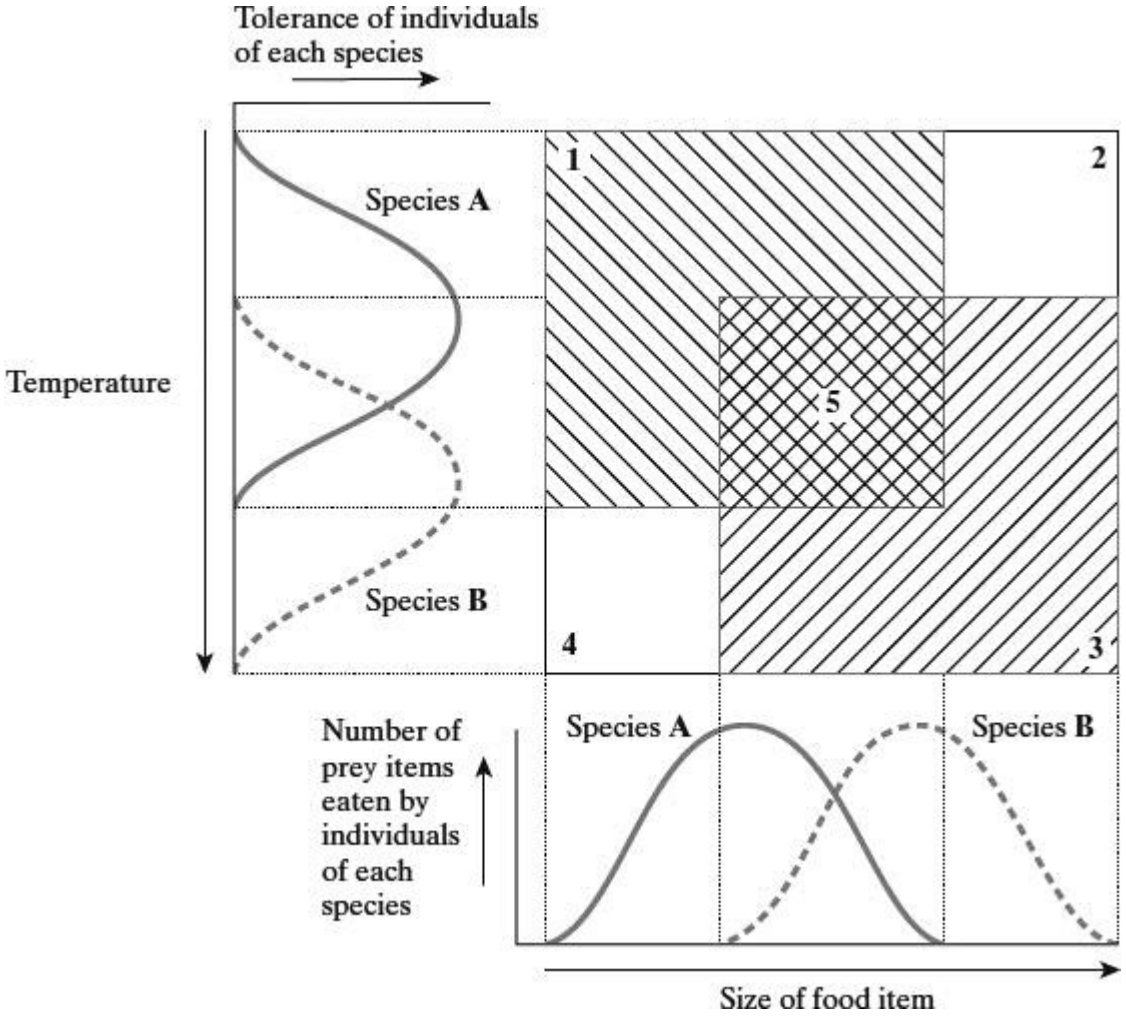
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(3)

(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)

Q56.

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

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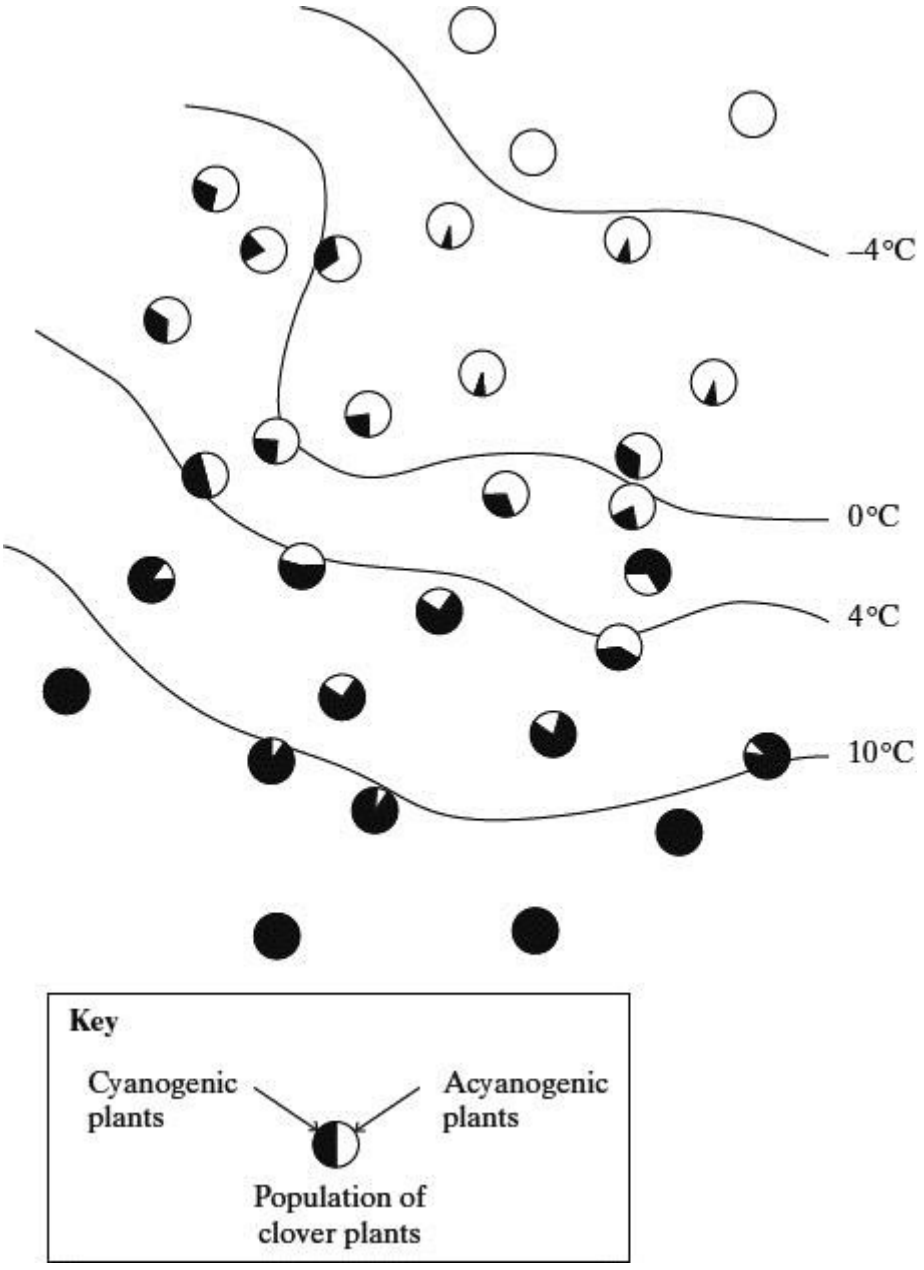
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(5)

(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)

Q57.

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 (× 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 the soil 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.

_____

_____

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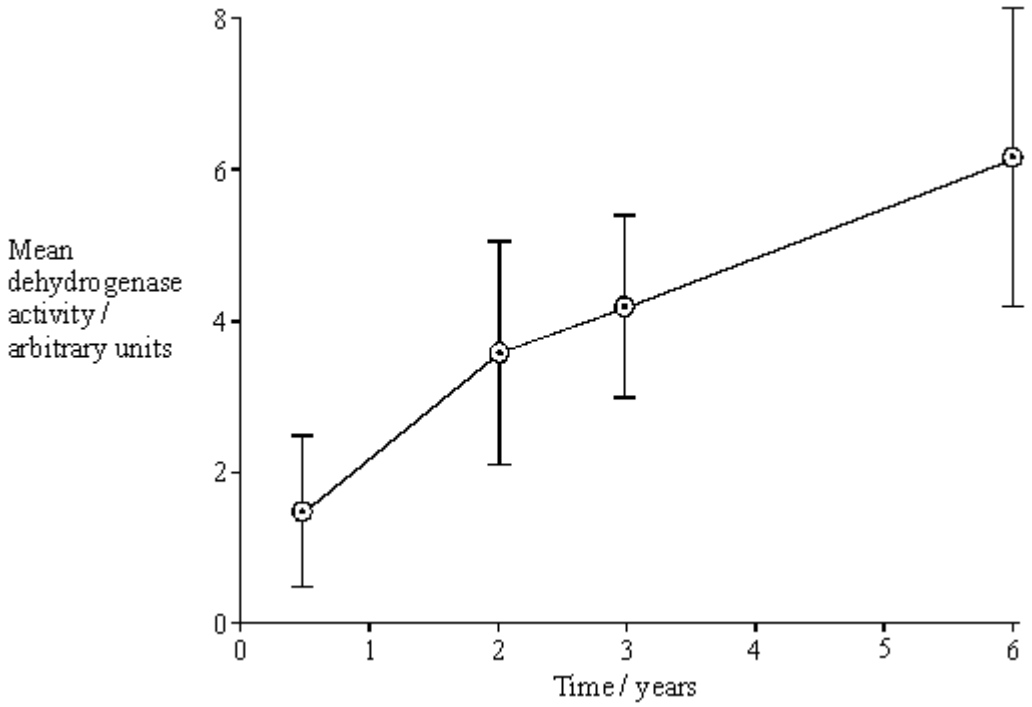
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(3)

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 been taken? 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 dehydrogenase activity 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.

_____

_____

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(3)

(Total 20 marks)

Q58.

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 pair of 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 the genotype $\mathbf{C^M\ C^M}$, 150 had the genotype $\mathbf{C^M\ CN}$ and 50 had the genotype $\mathbf{C^N\ C^N}$. Calculate the actual frequency of the allele $\mathbf{C^N}$ by using these figures. Show your working.

Answer _____

(2)

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

Answer _____

(3)

(Total 10 marks)

Q59.

(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.

_____

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(2)

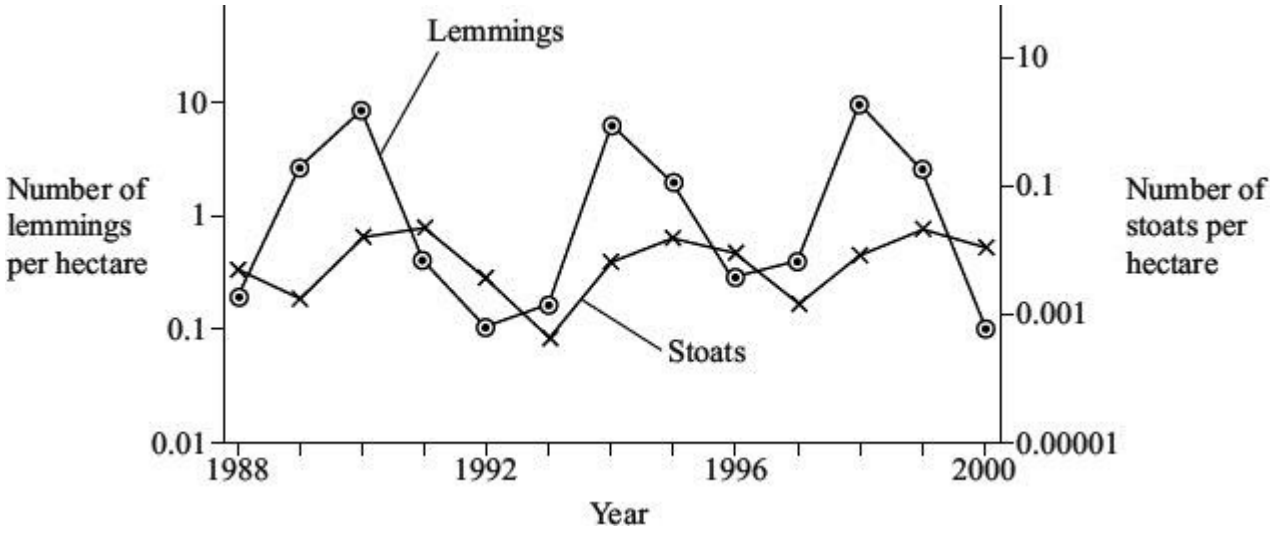
(c) The rate at which a heather plant produced new biomass was measured in g per kg of heather plant per year. This rate decreased as the plant aged. Use the information in the table to explain why.

(3)

(Total 8 marks)

Q60.

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)

(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)

(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.

_____

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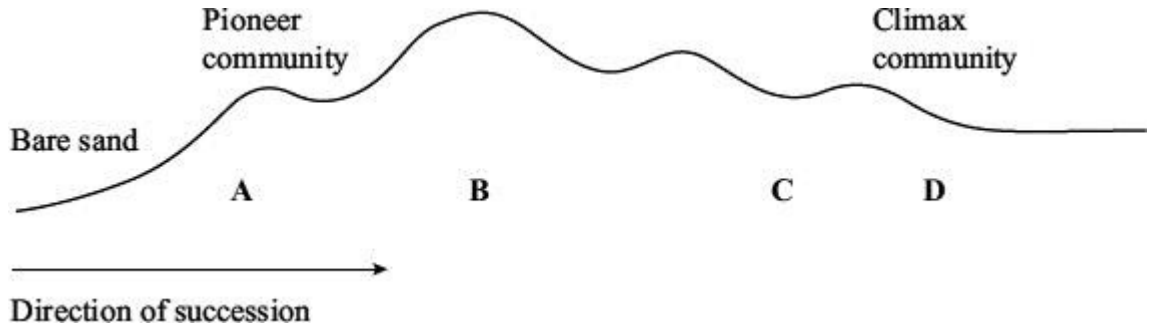
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(4)

(Total 12 marks)

Q61.

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.

_____

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(2)

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

_____

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(3)

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

_____

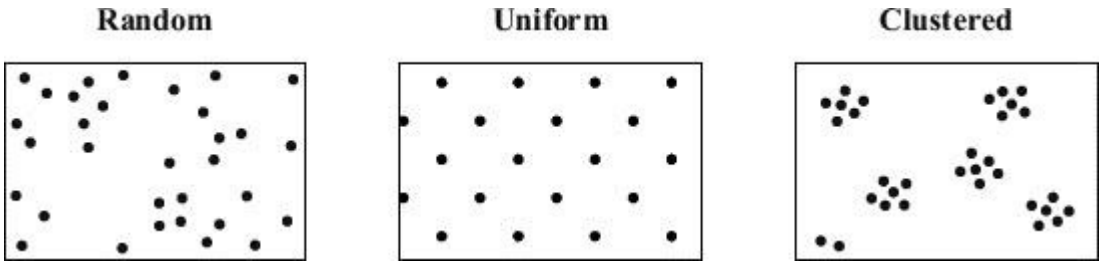
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(1)

(Total 9 marks)

Q62.

The diagrams show three types of plant distribution.



(a) Describe how you would use quadrats to determine whether a particular plant species has a 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.

_____

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_____

(2)

(Total 5 marks)

Q63.

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.

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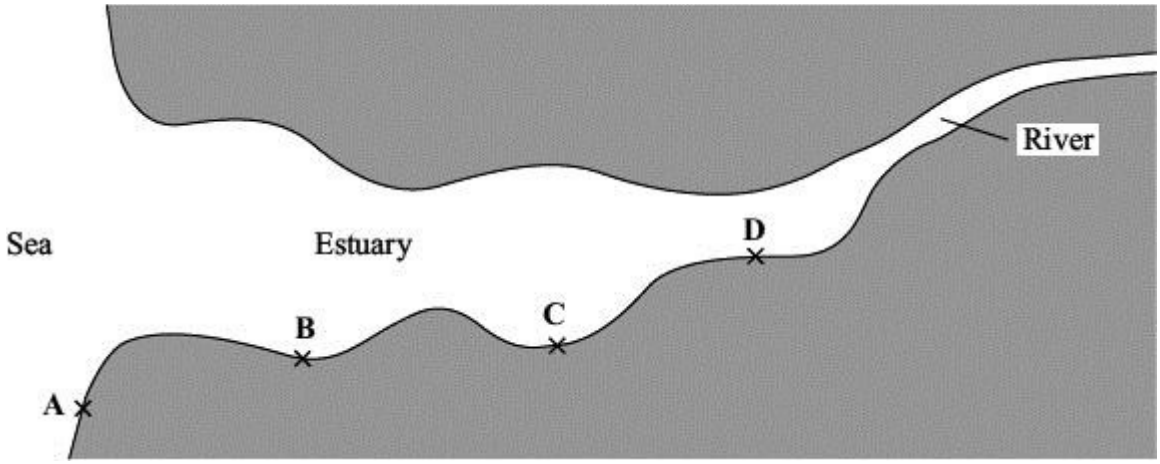
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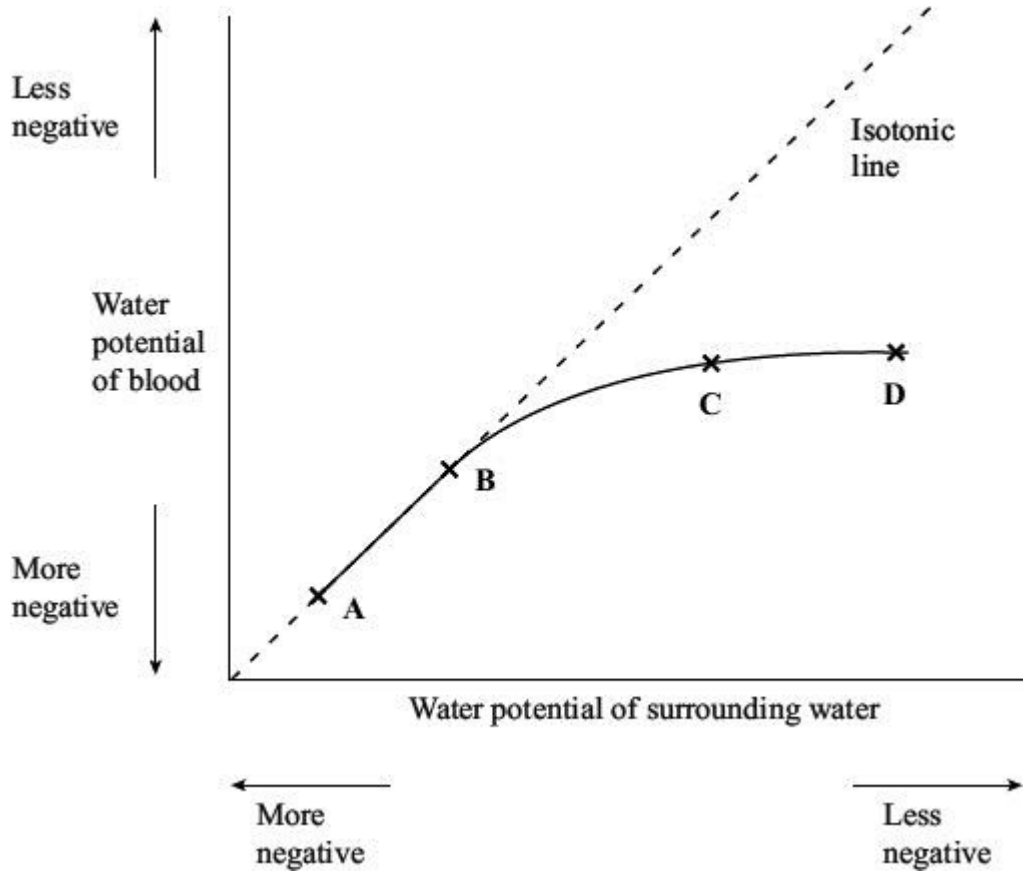
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(5)

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)

(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)

(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 water temperature falls, crab populations at sites **C** and **D** migrate towards the sea. Suggest the advantage of this behaviour.

_____

_____

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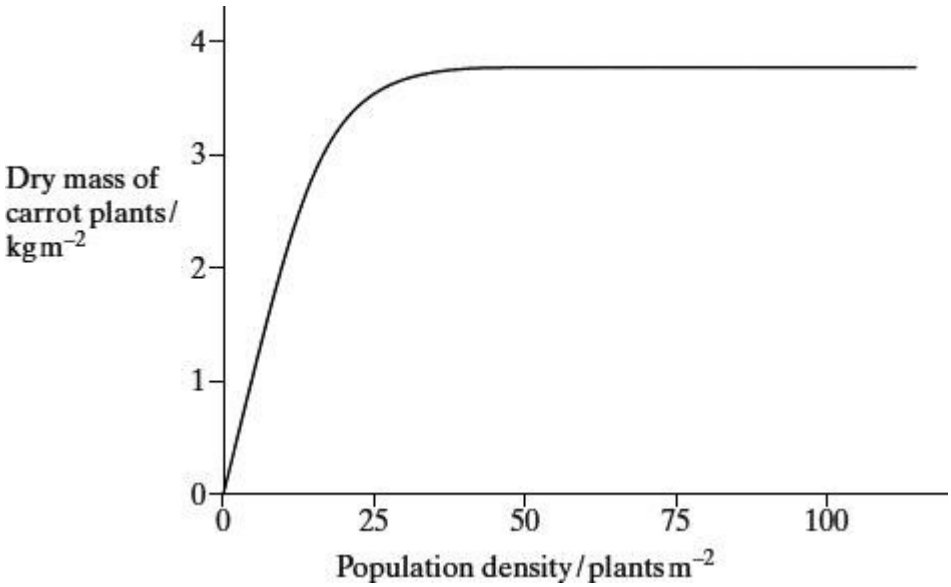
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(3)

(Total 12 marks)

Q64.

(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.



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

_____

(1)

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

_____

(1)

(iii) Explain the shape of the curve.

_____

_____

_____

_____

(2)

(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)

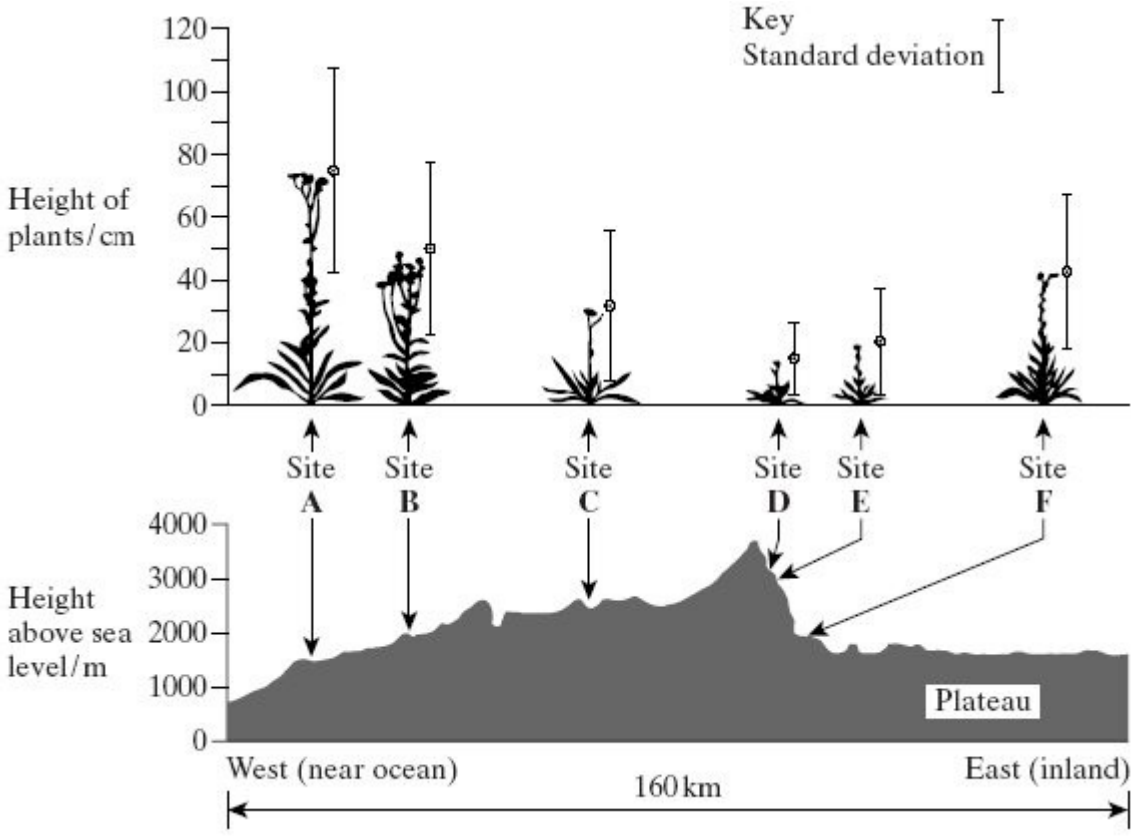
Q65.

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)

(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)

Q66.

(a) What is meant by a community?

_____

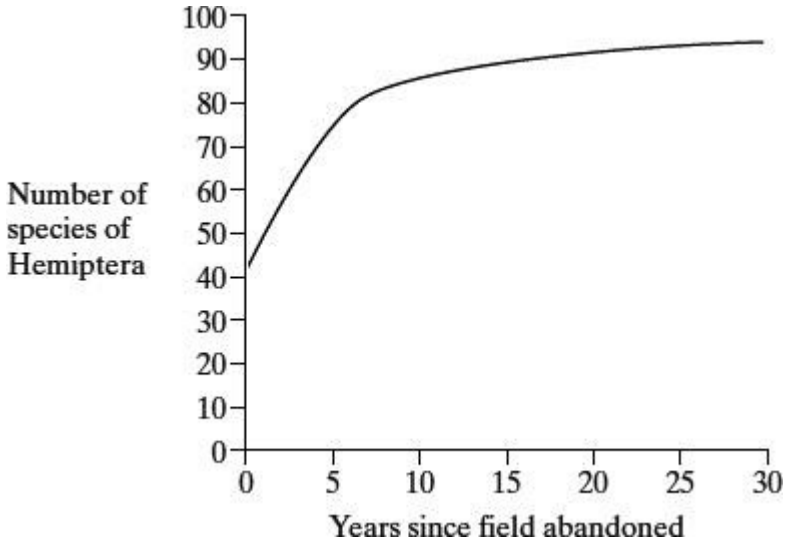
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(2)

(b) A farmer stopped using a field for growing crops. Scientists studied succession in the field over 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.

_____

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(3)

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

_____

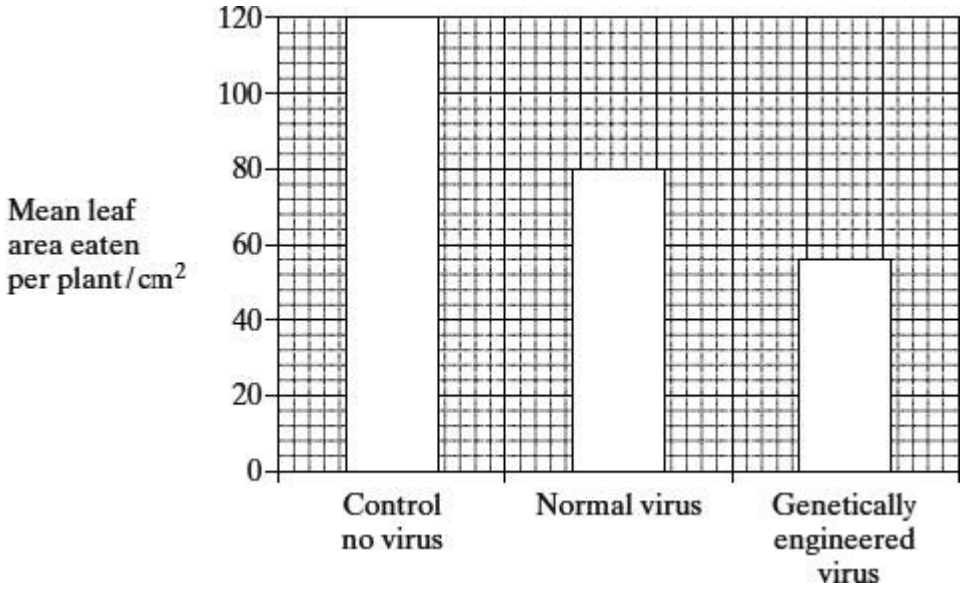
(1)

(Total 6 marks)

Q67.

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? Show your working.

Answer _____

(2)

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

_____

_____

_____

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(2)

(Total 4 marks)

Q68.

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.

_____

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(3)

(e) Algae are green protoctists. Lichens consist of a fungus and an alga living together in a relationship 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.

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(2)

(Total 8 marks)

Q69.

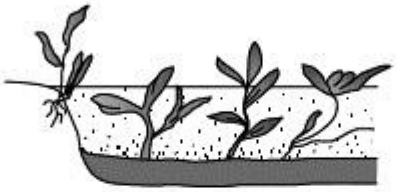
(a) The diagram shows a number of stages in an ecological succession in a lake.



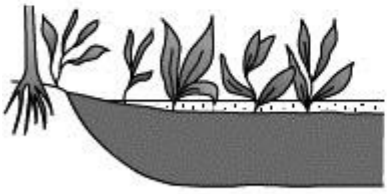
Stage 1
Microscopic plants and animals



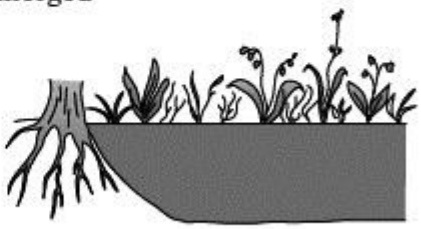
Stage 2
Layer of mud and organic matter settles on the bottom. Submerged plants appear.



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)

(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.

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(5)

(Total 13 marks)

Q70.

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)

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

_____

(1)

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

_____

_____

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(3)

(Total 5 marks)

Q71.

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.

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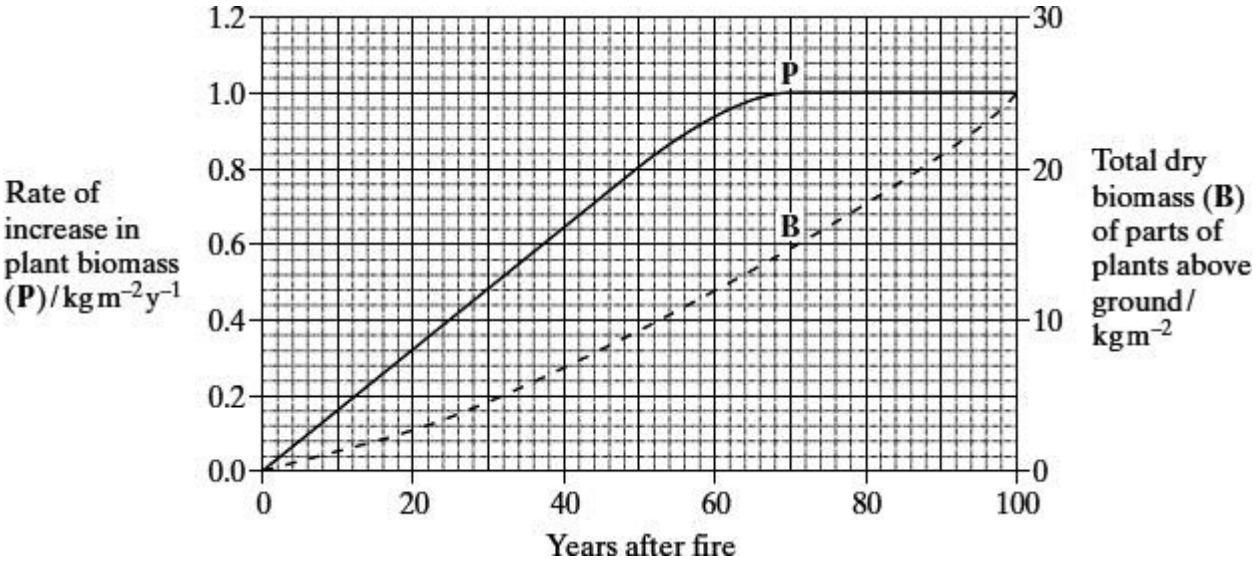
(Total 2 marks)

Q72.

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 herbaceous plants 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 total biomass (**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)

Q73.

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.

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(4)

(b) In areas of poor drainage the soil is waterlogged. In these areas the climax community is bog 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 waterlogged soils.

_____

_____

_____

_____

(2)

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

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(3)

(Total 10 marks)

Q74.

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

_____

_____

(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.

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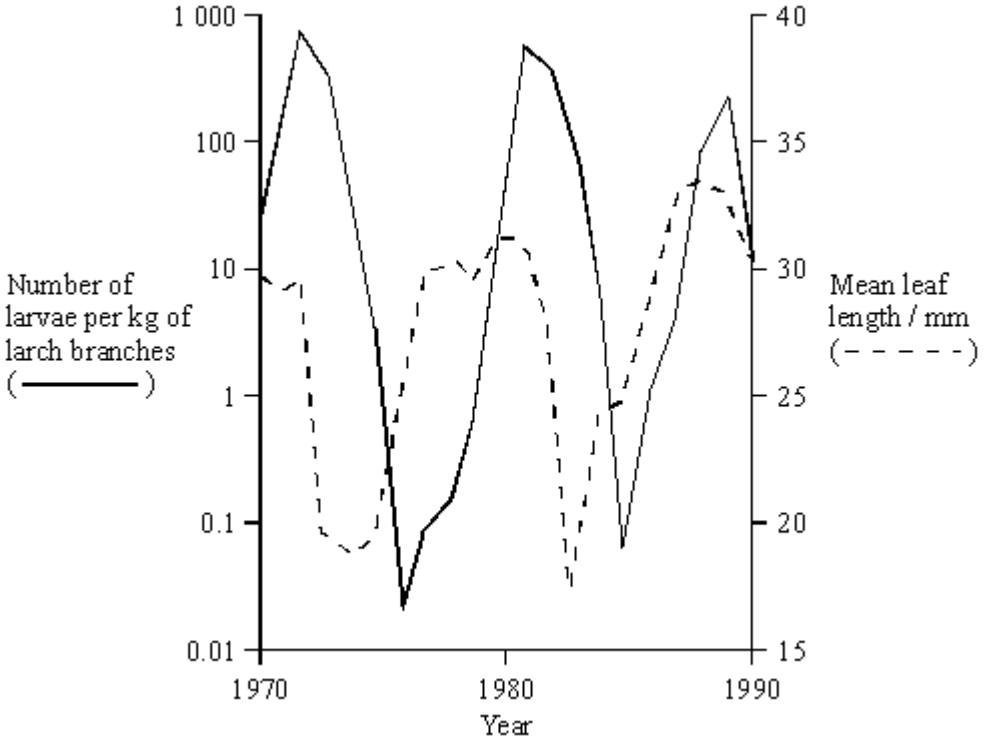
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(3)

(Total 5 marks)

Q75.

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)

(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.

_____

_____

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(2)

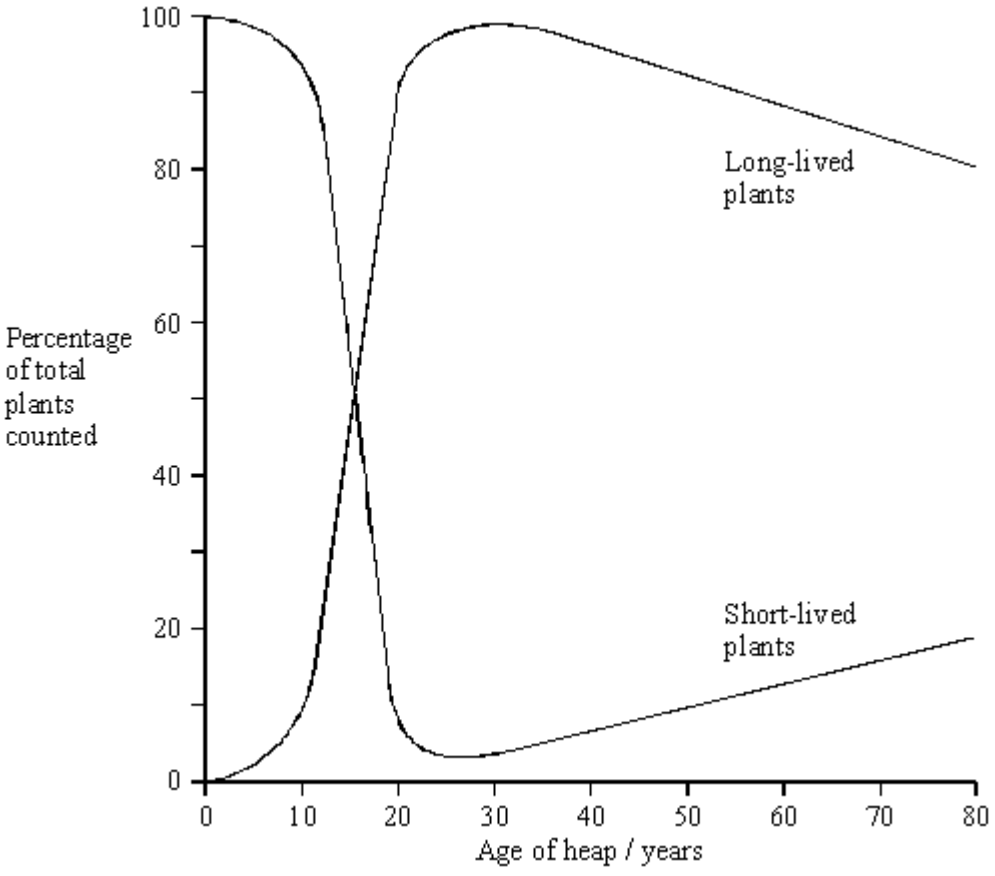
(Total 4 marks)

Q76.

Answers should be written in continuous prose, where appropriate.

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)

(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)

Q77.

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)

(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)

Q78.

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)

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

_____

_____

_____

_____

_____

_____

(3)

(Total 4 marks)