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**(Total for question = 5 marks)**

Q2.

The photograph shows a brown tree snake.



© staticflickr.com

The brown tree snake is found in areas of Indonesia.  
This snake eats small mammals, birds and reptiles.

In the 1940s, the brown tree snake was introduced to the Pacific Island of Guam.  
The population of this snake is now over two million.

Its introduction has had major effects on bird species in Guam.

The table shows the numbers of individuals of each bird species surveyed in the areas where this snake was present.

Species	1981	1982	1983	1984	1985	1986
Island collared-dove	0	0	3	19	1	0
White-throated ground-dove	1	3	5	5	0	0
Marian fruit-dove	11	19	3	0	0	0
Micronesian kingfisher	29	17	35	26	4	0
Marian crow	28	33	47	36	51	0
Guam flycatcher	6	23	11	0	0	0
Rufous fantail	74	55	43	0	0	0
Micronesian starling	148	159	135	71	7	0
Micronesian honeyeater	31	31	33	2	0	0
Bridled white-eye	108	98	2	0	0	0
<b>Index of diversity (D)</b>	4.6	4.7	4.1	3.5		0.0

(i) Calculate the index of diversity for 1985 using the formula

$$D = \frac{N(N - 1)}{\sum n(n - 1)}$$

(3)

Answer .....

(ii) Explain why using an index of diversity is a better measure of biodiversity than counting the number of species only.

(2)

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(iii) Comment on the effects of introducing the brown tree snake to Guam.

(4)

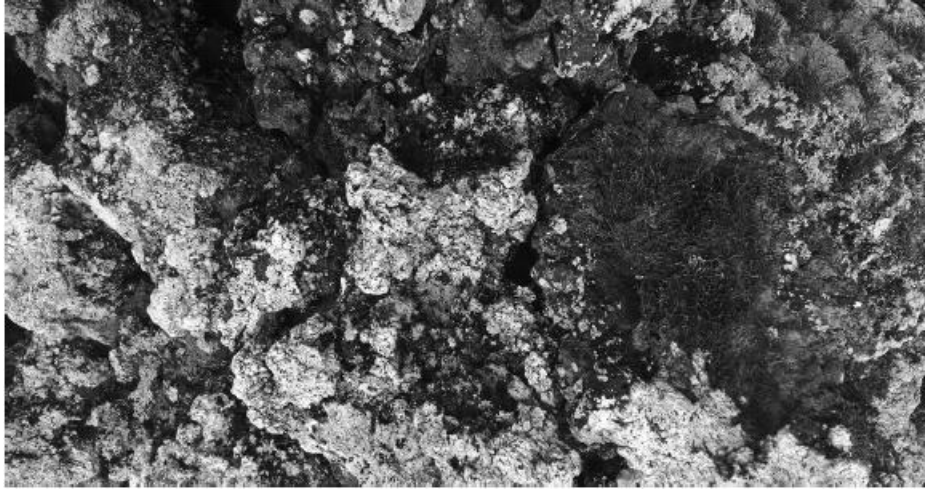
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**(Total for question = 9 marks)**

**Q3.**

Lanzarote is a volcanic island in the Atlantic Ocean. It lies near the coast of West Africa.

The photograph shows lichens growing on volcanic rock in Lanzarote.



Lichens are organisms composed of a fungus and algae living together.

Lichens colonise bare rock.

Explain how colonisation of bare rock by lichens can result in succession over long periods of time.

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**(Total for question = 4 marks)**

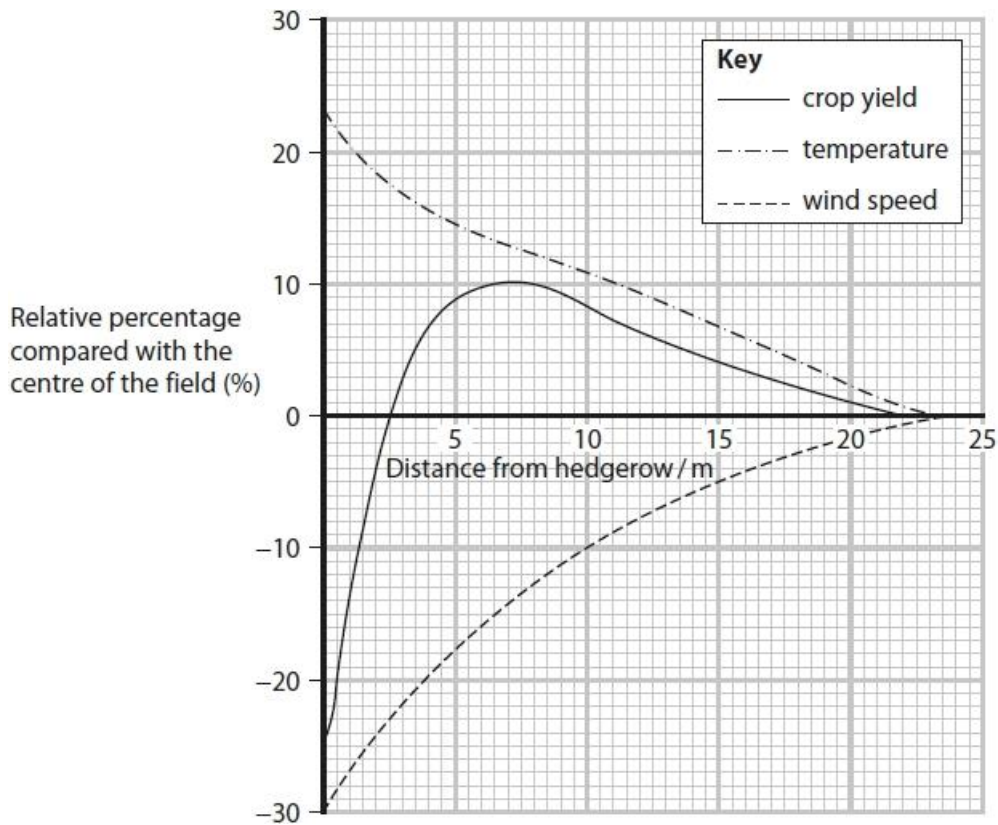
**Q4.**

\* For many years, hedgerows have been removed to increase field sizes to grow crop plants.

Hedgerows provide a habitat for many species of plants and animals.

Some animals that live in hedgerows eat pests of crops and some pollinate crop plants.

The crop yield, temperature and wind speed were measured across the field starting at the hedge. These factors and the crop yield are shown as a relative percentage compared with the centre of the field in the graph.



Analyse the information to comment on the value of conserving hedges around fields used for growing crops.

(6)

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**(Total for question = 6 marks)**

**Q5.**

A student measured the distribution of two plant species at the coast.

The distribution was measured from the high water line to 170 m inland.

The student measured the water content of the soil from the high water line to 170 m inland.

Describe how the student could have carried out these measurements.

**(3)**

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**(Total for question = 3 marks)**



Q6.

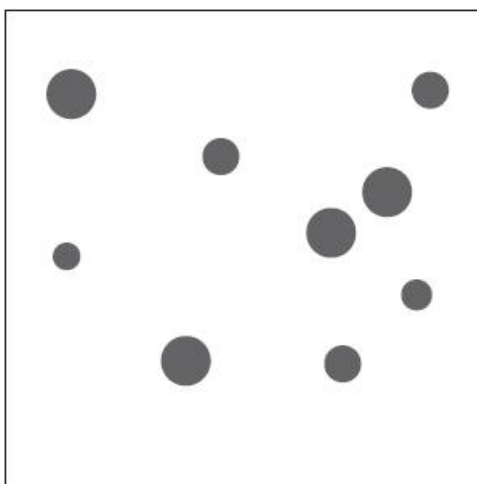
The drawing shows a plant called white clover, *Trifolium repens*.



A student used a 50 cm × 50 cm quadrat to compare the abundance of white clover in a trampled area of grassland and an untrampled area of grassland.

Each area measured 90 m × 45 m.

The diagram shows the distribution of white clover plants in one quadrat from the area of trampled grassland. Each circle represents one clover plant.



The student investigated the effect of one abiotic factor on the abundance of white clover plants.

(i) Name one abiotic factor, other than soil water content, that could affect the abundance of white clover plants in these areas.

(1)

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(ii) Describe how you would measure the abiotic factor named in part (i).

(2)

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(iii) The student obtained the following results for soil water content and the abundance of white clover plants in these two areas of grassland.

Area of grassland	Soil water content (%)	Abundance of white clover plants
Trampled	54.9	low
Untrampled	88.8	high

Explain the effect of trampling on the abundance of white clover plants.

(2)

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**(Total for question = 5 marks)**

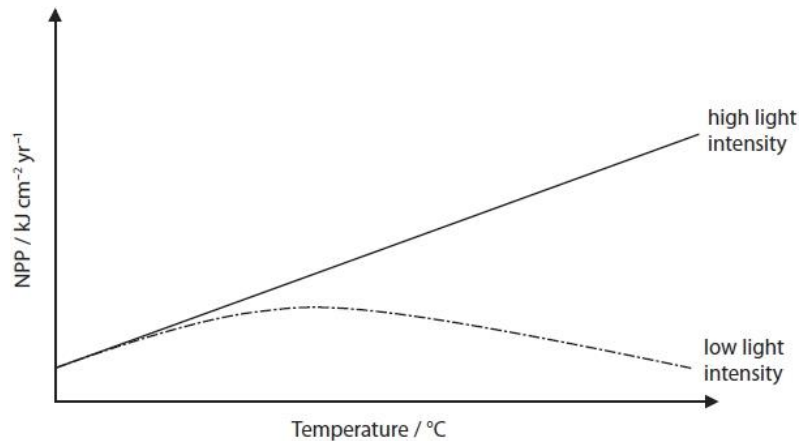
## Q7.

The effects of light intensity and temperature on the net primary productivity (NPP) of young willow trees were investigated.

Young willow trees were grown in two greenhouses: one with high light intensity and one with low light intensity.

In each greenhouse, groups of these willow trees were kept at different temperatures for six months.

The results are shown in the graph.



\* In a further investigation, succession was monitored for fifty years in an abandoned field.

The field was originally used to grow crops.

After fifty years, large numbers of coniferous trees were growing in the field.

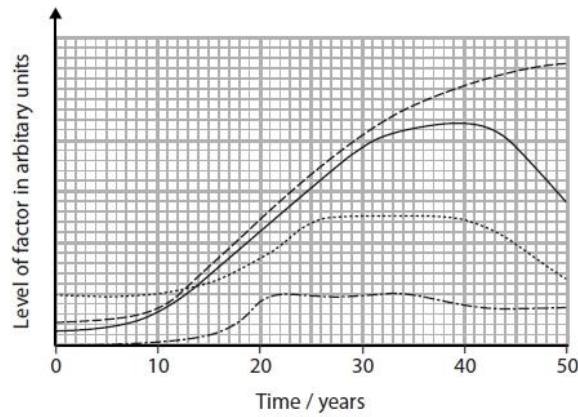
These coniferous trees do not shed many leaves.

When compared with younger trees, older coniferous trees have a much higher proportion of tree stem, branches and roots and a lower proportion of leaves.

The following factors were monitored:

- plant biomass
- NPP
- mineral ion content of soil
- index of diversity of animals

The line graphs show the trends that happened over fifty years for each of the factors.



Key	
—	plant biomass
.....	NPP
- - - -	mineral ion content of soil
- . - .	index of diversity of animals

Analyse the data to explain how succession is linked to the changes in this abandoned field.

(6)

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(Total for question = 6 marks)

**Q8.**

The island of Surtsey was formed by a volcanic eruption in the Atlantic Ocean in 1965.

The photographs show the formation of Surtsey in 1965 and part of the island in 2018.



volcanocafe.files.wordpress.com



vulkaner.no

Scientists have been studying the development of ecosystems on this island since its formation.

(i) State what is meant by the term ecosystem.

(1)

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(ii) Explain how ecosystems have developed on Surtsey since 1965.

(5)

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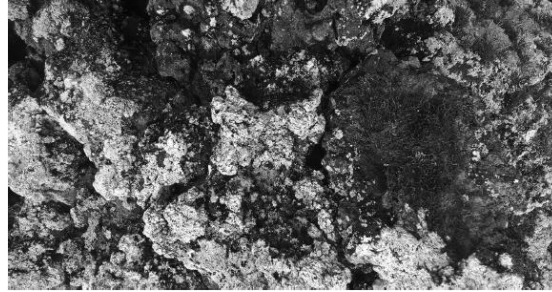
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**(Total for question = 6 marks)**

**Q9.**

Lanzarote is a volcanic island in the Atlantic Ocean. It lies near the coast of West Africa. The photograph shows lichens growing on volcanic rock in Lanzarote.



Lichens are organisms composed of a fungus and algae living together. Lichens colonise bare rock.

Devise an investigation to show how the lichen distribution is affected by a named abiotic factor.

(6)

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**(Total for question = 6 marks)**

**Q10.**

Last year, eight million Christmas trees were bought in the UK.

There are many Christmas tree farms that supply these trees.

The photograph shows young Christmas trees growing on a farm.



Christmas tree farmers remove the other plants (weeds) in order to increase tree growth.

A farmer investigated two methods of removing weeds:

- removing weeds by hand
- spraying herbicides that inhibit weed growth.

The table shows the mean height of Christmas trees using each method, over a five-year period.

Year	Mean height of trees / cm	
	Removing by hand	Using herbicide
0	20	20
1	50	60
2	70	100
3	90	130
4	110	160
5	130	200

(i) Calculate the difference between the mean rate of growth of these trees over the five years.

(2)

Answer .....

(ii) Analyse the data to explain the difference in the mean height of the trees at the end of the five-year period.

(2)

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(iii) Explain two biotic variables that need to be controlled to allow a valid comparison of the effect of each method on tree growth.

(2)

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**(Total for question = 6 marks)**



**Mark Scheme**

Q1.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to five of the following points:</p> <ul style="list-style-type: none"> <li>• {pioneer species / mosses / lichens arrive} (after glaciers melt and colonise bare rock) (1)</li> <li>• {decomposition /decay} increases the soil depth / humus content / minerals / nutrients (1)</li> <li>• therefore (larger) plants can grow (due to soil depth / minerals / nutrients) (1)</li> <li>• leaf litter increases after 40 / 100 years as more herbaceous plants / shrubs / trees are present (1)</li> <li>•</li> <li>• (steep) increase in nitrate after 40 / 100 years as more leaves / plants / animals / faeces (1)</li> <li>•</li> <li>• leaf litter falls (towards the end / from 150 – 250 years) as climax community has emerged (1)</li> </ul>	<p>Accept animals arrive / increased niches</p> <p>Accept larger plants</p> <p>Accept increase from 12.8 to 277 as equivalent to 40/100</p> <p>Accept increase from 5.3 to 21.8 as equivalent to 40 / 100</p> <p>Accept nitrate continues to increase due to presence of animals / faeces (as leaf litter falls)</p>	5 exp

Q2.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> <li>• correct calculation of <math>N(N-1)</math></li> <li>• correct calculation of <math>\sum n(n-1)</math></li> <li>• correct division of <math>N(N-1)</math> by <math>\sum n(n-1)</math></li> </ul> <p>1.5 (3)</p>	<p><u>Example of calculation</u></p> <p>= 3906 (1)</p> <p>= 2604 (1)</p> <p><math>3906 \div 2604 = 1.5</math></p> <p>Correct answer with no working gains full marks</p>	3

Question Number	Answer	Additional Guidance	Mark
(ii)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> <li>index accounts for population / numbers of organisms (1)</li> <li>because numbers of organisms in {each species vary} (1)</li> </ul>	<p><b>ACCEPT</b> converse for both Mps</p> <p><b>ACCEPT</b> population sizes can vary for two marks</p>	2

Question Number	Answer	Additional Guidance	Mark
(iii)	<p>An answer that makes reference to four of the following:</p> <p><b>THREE from:</b></p> <ul style="list-style-type: none"> <li>birds are now {extinct / dead / none left} (on Guam) (1)</li> <li>decrease in (bio)diversity (1)</li> <li>Marian crow population increased until 1985 / Island collared dove increased until 1984 / white throated ground dove increased until 1983 /1984 (1)</li> <li>bird species decline at different rates (1)</li> </ul> <p><b>TWO from:</b></p> <ul style="list-style-type: none"> <li>loss of some bird species allowed others to increase / loss of some bird species provided niches / food for others (1)</li> <li>snakes consumed some species before others (1)</li> </ul>	<p><b>ACCEPT</b> other correct dates</p> <p><b>ACCEPT</b> Species go extinct at different times</p> <p><b>ACCEPT</b> reduced competition between birds (allows some bird species to increase) / reduced interspecies competition (allows some bird species to increase)</p>	4

Q3.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to four of the following:</p> <ul style="list-style-type: none"> <li>• lichens are pioneer species (1)</li> <li>• they break down surface of rocks to create soil (1)</li> <li>• therefore other plants are able to {grow / be established}(1)</li> <li>• death and decay helps to {create humus / recycle minerals} (1)</li> <li>• therefore providing niches for either plants or animals (1)</li> </ul>	<p>Allow soil {becomes deeper / contains more minerals / more fertile}</p> <p>Allow wider variety of plants or animals can live there.</p> <p>Allow description of {trees / shrubs} growing</p> <p>Allow climax community develops</p>	<b>(4)</b>

Q4.

Question Number	Indicative content	
*	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p><b>Descriptions</b></p> <ul style="list-style-type: none"> <li>• crop yield is highest between 5 m and 10 m from hedgerow D</li> <li>• crop yield is lowest next to the hedgerow / crop yield is lower than the centre of the field upto 2.5 m</li> <li>• crop yield increases up to between 5 m and 10 m from the hedge and then decreases D</li> <li>• wind speed is lowest by the hedge D</li> <li>• wind speed increases with distance from the hedge D</li> <li>• temperature is higher by hedgerow / falls with distance D</li> <li>• hedgerows can increase crop yields, but fields need to be smaller D</li> <li>• hedgerows can take up land that could be used to grow crops D</li> </ul> <p><b>Abiotic Explanations</b></p> <ul style="list-style-type: none"> <li>• humidity is higher by the hedgerow A</li> <li>• reduced wind speed (by the hedge) increases the temperature A</li> <li>• transpiration / water loss / evaporation will be lower around hedgerow A</li> <li>• hedgerow acts as a wind break A</li> <li>• less than 2m from hedgerow productivity is lower due to competition / shading reducing photosynthesis A</li> <li>• between 5m and 15 m, higher temperature will increase</li> </ul>	6

		<p>photosynthesis rate A</p> <ul style="list-style-type: none"> <li>• higher temperature is closer to optimal enzyme temperatures A</li> <li>• wind can affect crops pollinated by wind A</li> </ul> <p><b>Biotic Explanations</b></p> <ul style="list-style-type: none"> <li>• pollinating species and predators increase productivity B</li> <li>• predators consume herbivores / pests B</li> <li>• pollinators are essential for seeded crops / example B</li> <li>• hedgerow may compete for nutrients / water / light B</li> <li>• less need for pesticides to be used when predator species live in hedgerows B</li> </ul>	
<b>Level</b>	<b>Marks</b>		
<b>Level 0</b>	Marks	No awardable content	
<b>Level 1</b>	1-2	<p>Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified.</p> <p>A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.</p> <p><b>Descriptions of factors</b>  <b>one mark: any two from D</b>  <b>two marks: three from D</b></p>	
<b>Level 2</b>	3-4	<p>A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified.</p> <p>A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.</p> <p><b>Descriptions and explanations</b>  <b>three marks: any four points from D, A or B</b>  <b>four marks: any five points from D, A or B and</b></p>	
<b>Level 3</b>	5-6	<p>A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information.</p> <p>A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.</p> <p><b>Detailed explanation of all factors and how use of hedges can be beneficial</b></p> <p><b>Descriptions and explanations</b>  <b>five marks: any six points from D, A and B</b>  <b>six marks: any seven points from D, A and B</b></p>	

Q5.

Question Number	Answer	Additional Guidance	Mark
	<p>A description that makes reference to the following:</p> <ul style="list-style-type: none"> <li>• sample at intervals along transect / sample from same place in quadrat (1)</li> <li>• weighing, drying and reweighing (1)</li> <li>• constant mass (1)</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• sample at intervals along transect / sample from same place in quadrat (1)</li> <li>• insert probe into the soil (1)</li> <li>• at same {depth / length of time}</li> </ul>	<b>DO NOT ACCEPT</b> burning	(3)

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> <li>• named abiotic factor</li> </ul>	e.g. light / temperature / pH / named mineral / salinity / wind	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	<p>A description that makes reference to the following:</p> <ul style="list-style-type: none"> <li>• apparatus (1)</li> <li>• measure {by clover plants / in each quadrat / in same place / at same time of day} (1)</li> </ul>		(2)



Question Number	Answer	Additional Guidance	Mark
(iii)	<p>An explanation that makes reference to two of the following:</p> <ul style="list-style-type: none"> <li>trampled soil has less {water / air / oxygen} (1)</li> <li>therefore {photosynthesis / respiration / absorption of mineral ions} affected (1)</li> <li>physical damage to plants / competition from other plants (adapted to compact soil) (1)</li> </ul>		(2)

Q7.

Question Number	Indicative content
*	<p>Answers will be credited according to candidates' deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p><u>Succession (S):</u></p> <ul style="list-style-type: none"> <li>succession begins with seeds / roots (from previous crops etc), followed by herbaceous plants, shrubs and trees</li> <li>increased plant diversity increases number of niches for animals, resulting in an increase in index of diversity</li> <li>steep increase in diversity at approximately 20 years with herbaceous plants / shrubs providing high numbers of niches</li> <li>index of diversity stabilises and then decreases as trees shade area</li> <li>shade reduces herbaceous / shrub plant species reducing niche number and index of diversity</li> </ul> <p><u>NPP (N):</u></p> <ul style="list-style-type: none"> <li>NPP increases as more herbaceous plants and shrubs with higher leaf areas grow</li> <li>NPP reduces as the community ages due to increase in proportion of non-photosynthetic tissue (wood / roots) reducing photosynthesis rate compared to respiration rate</li> <li>reduced mineral ion content due to lack of decay of leaves may reduce NPP</li> </ul> <p><u>Mineral ions (M):</u></p> <ul style="list-style-type: none"> <li>starting mineral ions are low due to farming</li> <li>mineral ions in soil increase with time due to humus / dead organic material from plants and animals</li> <li>organic material is decomposed by microbes to release minerals</li> <li>mineral ion content decreases in climax community as few leaves are dropped from pine trees so there is less decay</li> </ul>

Level	Marks	Descriptor
0	0	No awardable content
1	1-2	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made. <b>Level 1: Description of succession (S) with little / no reference to graph</b>
2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made. <b>Level 2: Explanation of succession (S) as shown in the graph linked to either N or M with some errors.</b>
3	5-6	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made. <b>Level 3: Detailed explanation of succession (S) as shown in the graph over 50 years using N and M with only minor errors.</b>

Q8.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following: <ul style="list-style-type: none"> <li>(interactions) of {organisms / biotic factors / communities / living} and {environment / abiotic factors / non-living factors} (1)</li> </ul>	IGNORE habitat / area	1



Question Number	Answer	Additional Guidance	Mark
(ii)	<p>An explanation that makes reference to five of the following:</p> <ul style="list-style-type: none"> <li>colonisation (of bare rock) by pioneer species / extremophiles / by organisms that withstand {low water / dry / low soil} (1)</li> <li>(primary) succession occurs (1)</li> <li>soil / humus produced (1)</li> <li>therefore provides {water / minerals / nutrients / anchorage} for plants to grow (1)</li> <li>provides niches / food / habitats for animals (1)</li> <li>herbaceous plants / shrubs / trees become established / climax community emerging (1)</li> </ul>	ACCEPT founder	5

## Q9.

Question Number	Acceptable Answers	Additional Guidance	Mark
	<p>An answer that makes reference to six of the following:</p> <ul style="list-style-type: none"> <li>relevant abiotic factor named (1)</li> <li>select {sample sites with environmental differences / one site with environmental gradient} (1)</li> <li>{quadrats / point frame} used {at random / in a transect} (1)</li> <li>to measure presence or absence of lichens (1)</li> <li>method used to measure abiotic factor described (1)</li> <li>t test carried out to measure significant difference (1)</li> <li>other named variable controlled or measured (1)</li> </ul>	<p>eg light intensity, temperature, distance from sea, altitude</p> <p>Allow calculation of percentage cover described</p> <p>Allow correlation test carried out to measure correlation if appropriate Allow standard deviations compared.</p>	(6)

Q10.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> <li>calculate rate of growth for both treatments (1)</li> <li>subtraction (1)</li> </ul>	rate for weeds $11 \div 5 = 22$ rate for herbicide $180 \div 5 = 36$  $36 - 22 = 14$ (cm year <sup>-1</sup> )  Correct answer gains full marks, with no working shown	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: <ul style="list-style-type: none"> <li>herbicide is more effective at removing weeds (1)</li> <li>therefore there is less competition for {light / carbon dioxide / mineral ions / water} (1)</li> </ul>	<b>ACCEPT</b> converse e.g. herbicide kills all the weeds but removing by hand lets them grow again  <b>DO NOT ACCEPT</b> nutrients	(2)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to two the following: <ul style="list-style-type: none"> <li>same species of tree because trees grow at different rates (1)</li> <li>{animals / pests / disease / herbivores / insects} as they {affect growth / feed on trees} (1)</li> <li>same {number / spacing} of trees to control (intraspecific) competition (1)</li> </ul>	<b>ACCEPT</b> trees get same light / mineral ions / water	(2)