3 Conservation programmes are used to save endangered species.

The Scottish wildcat, shown in the photograph, is a subspecies of the European wildcat, *Felis silvestris silvestris*.

The Cairngorms Wildcat Project estimates that there are 150 breeding pairs left, but the Scottish Wildcat Association believes that only 35 cats remain.

A conservation group proposed that a captive breeding programme, and the relocation of Scottish wildcats, would be necessary to prevent extinction.

(a) (i) State why the Scottish wildcat has been described as **endemic**.

(1)

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(ii) The Scottish wildcat can interbreed successfully with domestic cats.

Explain the effect this could have on the genetic diversity of the Scottish wildcat.

(2)

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(b) Explain how molecular phylogeny could be used to determine the relationships between the Scottish wildcat and other subspecies of European wildcat.

(2)

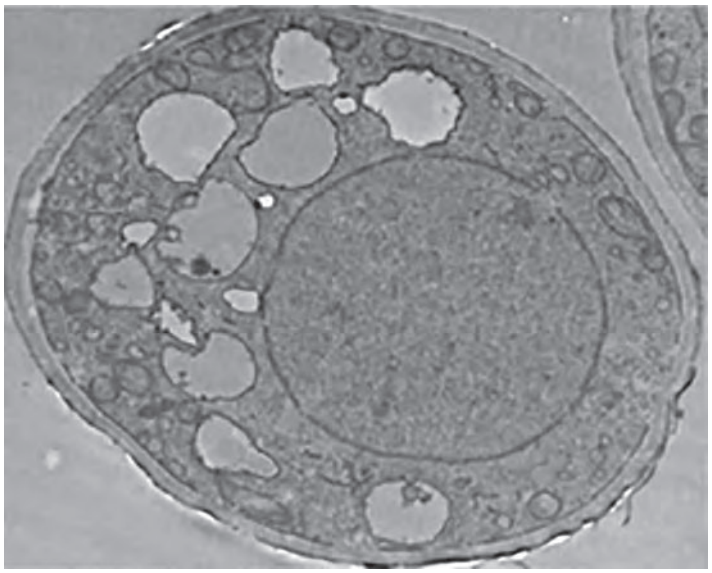
(c) Describe how the proposed conservation programme could prevent the Scottish wildcat from becoming extinct.

(4)

(Total for Question 3 = 9 marks)

7 *Hymenoscyphus fraxineus* (*H. fraxineus*) is the fungus that causes ash dieback. This disease usually kills all the ash trees that it infects.

(a) The electron micrograph shows a section through a fungal cell.



Magnification ×1000

To which group do fungi belong?

(1)

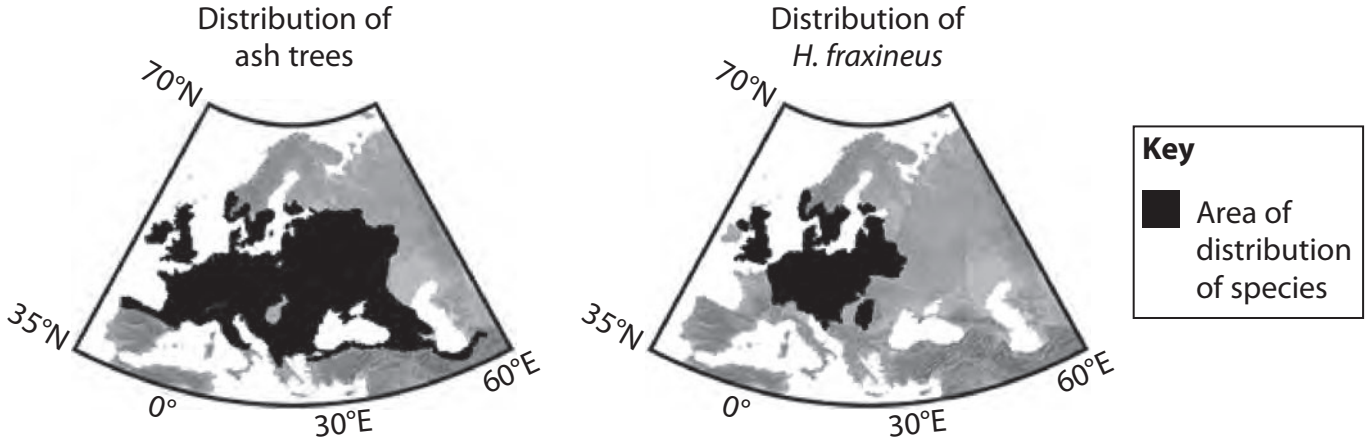
☒ **A** Archaea

☒ **B** Eukaryota

☒ **C** Prokaryota

☒ **D** Viruses

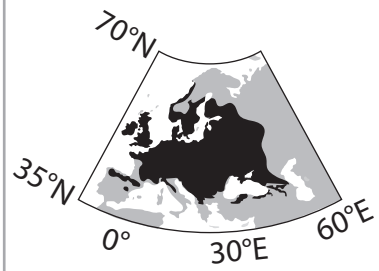
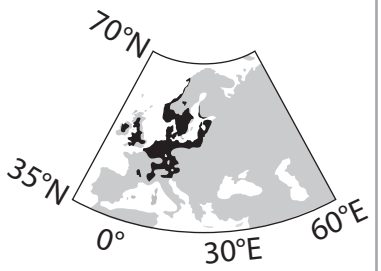
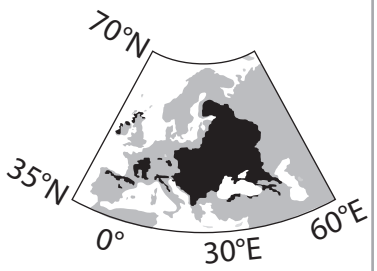
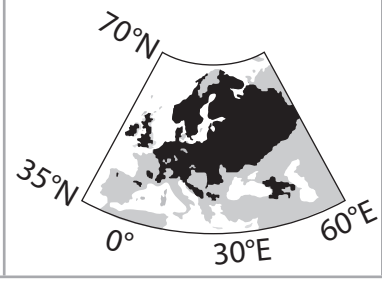
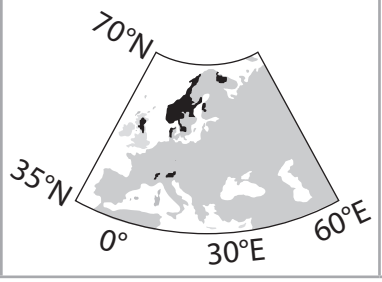
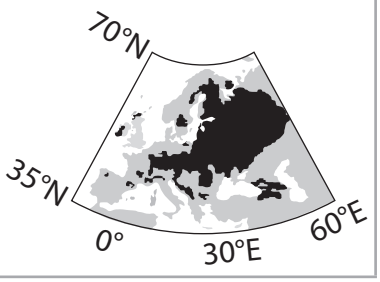
(b) The diagrams show the distribution of ash trees and *H. fraxineus* in 2007.



In 2007 the mean atmospheric carbon dioxide concentration was 398 ppm.

Models have been used to predict the effect of increasing atmospheric carbon dioxide concentration on the distribution of ash trees and *H. fraxineus*.

The table shows these predictions.

Concentration CO_2 / ppm	Predicted region suitable for ash trees	Predicted region suitable for *H. fraxineus*	Predicted distribution of ash trees
430			
1080			

(i) Which of the following is an abiotic factor that should be considered in the model?

(1)

- ☒ **A** ash tree resistance to *H. fraxineus*
- ☒ **B** *H. fraxineus* pathogens
- ☒ **C** humidity
- ☒ **D** ocean pH

(ii) Which of the following could be caused by an increase in atmospheric carbon dioxide from 398 ppm to 1080 ppm?

(1)

☒ **A** decreased photosynthesis

☒ **B** global warming

☒ **C** increased plant respiration

☒ **D** ozone depletion

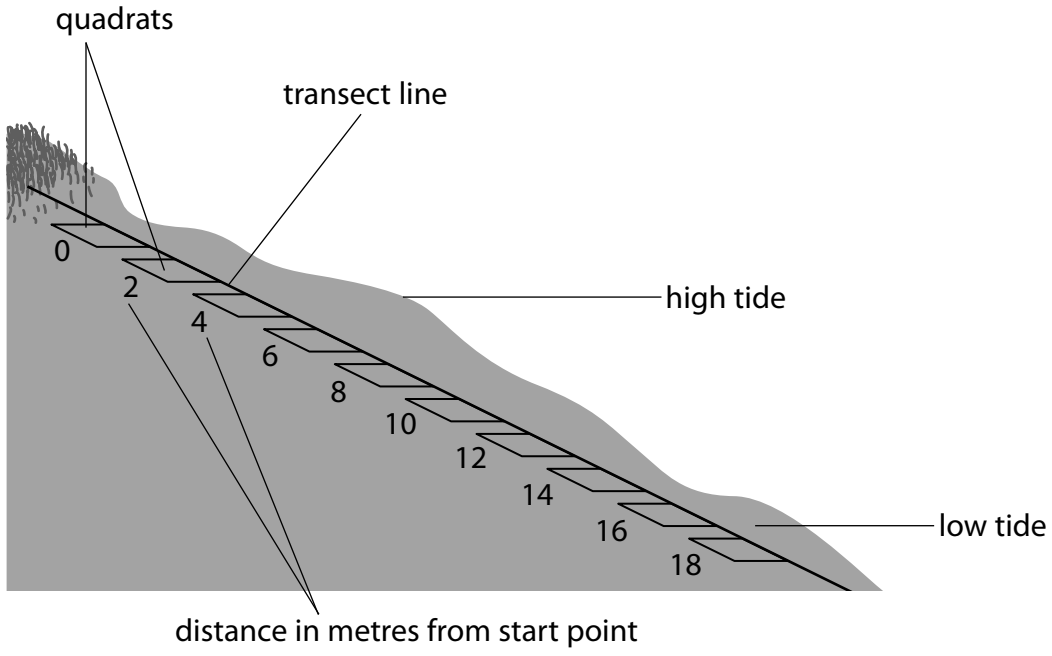
(iii) Analyse the data to explain the predicted effect of climate change on the distribution of ash trees.

(5)

(Total for Question 7 = 8 marks)

11 The distribution and abundance of species on a rocky shore were investigated using a systematic sampling technique.

(a) The diagram shows the placing of the transect and quadrats on a rocky shore.



Not to scale

(i) Give a reason why systematic sampling, rather than random sampling, was used in this investigation.

(1)

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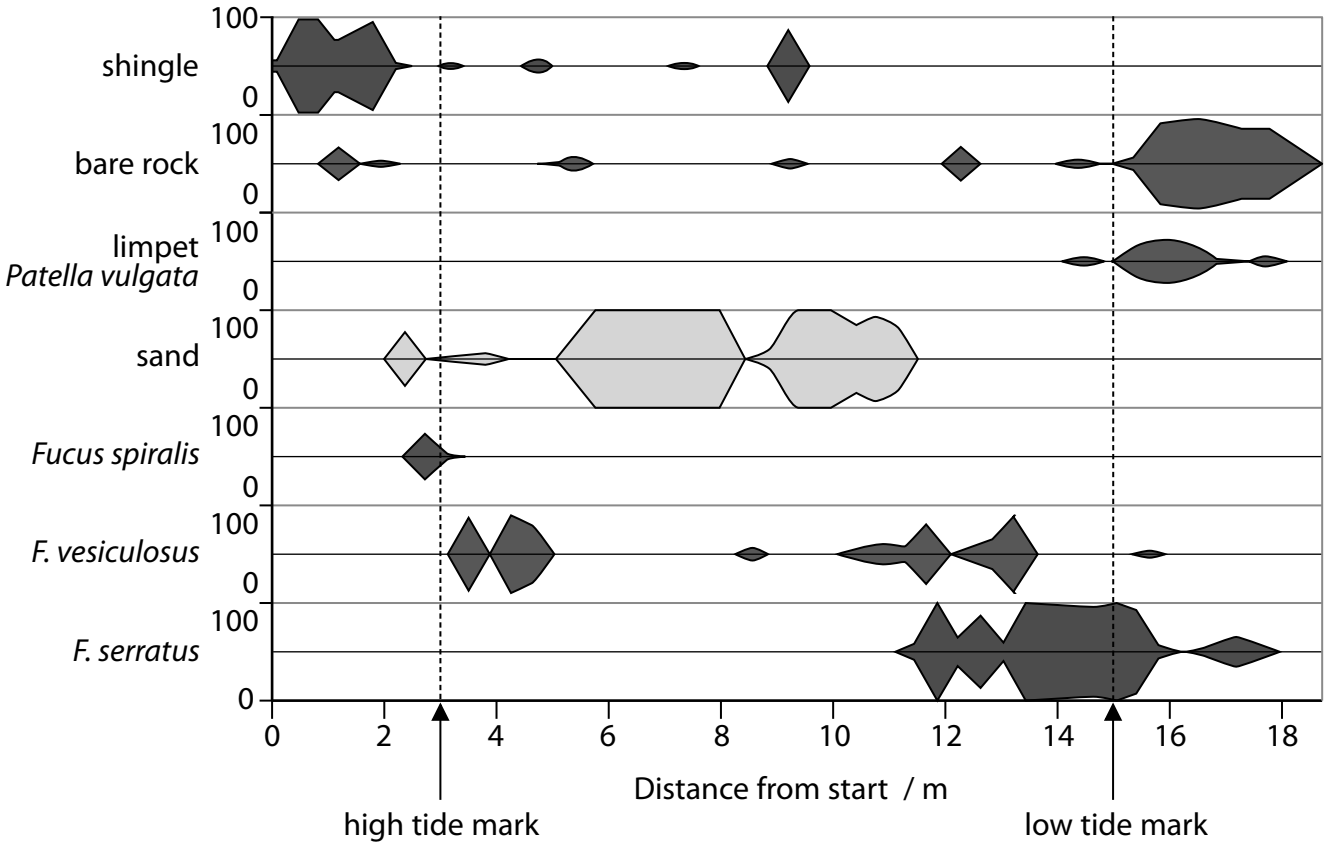
.....

*(ii) The diagram shows the distribution of some of the abiotic and biotic components of a sea shore. There are three species of seaweed (*Fucus*) and one species of limpet (*Patella vulgata*). Limpets feed on seaweed.



Analyse the data to explain how the distribution patterns of *Fucus spiralis, Fucus vesiculosus* and *Fucus serratus* are affected by abiotic and biotic factors.

(6)

(b) (i) Another study compared the diversity of species at different places on the shore. On the upper shore the following data were obtained.

Species	Number of individuals found
Pelvetia canaliculata	10
Enteromorpha sp.	3
Patella vulgata	3
Littorina littorea	15
Gibbula sp.	14
Lichens	15

Calculate an index of diversity (D) for this site using the formula below.

(3)

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

n = total number of organisms of a particular species

N = total number of organisms of all species

Answer .....

(ii) On the middle shore the index was found to be 7.74 with a total individual count of 37.

Comment on the relationship between diversity and the total number of individuals on these two parts of the shore.

(2)

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(Total for Question 11 = 12 marks)

9 The coffee husks, shown in the photograph, are a waste product of coffee plantations.

Composting has been suggested as an environmentally friendly way of decomposing these coffee husks.

The effect of adding cow dung to coffee husks, before they are composted, has been investigated.

The table shows the percentages of organic carbon and nitrogen in two compost heaps at the start of composting and after 90 days.

	Husks alone		**Husks with added cow dung**	
Days composting	0	90	0	90
Organic carbon (%)	54.50	41.70	48.10	35.40
Nitrogen (%)	1.84	2.31	2.76	3.19

(a) Comment on the effect of adding cow dung to composting coffee husks.

(3)

*(b) The changes in the compost heaps are due to the activity of decomposers and other organisms.

Devise an investigation to determine the effect of the carbon to nitrogen ratio on the succession of species in these compost heaps.

(6)

(Total for Question 9 = 9 marks)

6 The photograph shows heather, *Calluna vulgaris*, a plant that grows on moorland.

© C016/7131/Science Photo Library

In an investigation into the net primary productivity of heather, all the vegetation on an area of two different moorlands, A and B, was removed by burning. The dry biomass, in g m^{-2}, was then measured each year for a period of 20 years.

(a) Give an equation that shows the relationship between gross primary productivity, net primary productivity and respiration.

(1)

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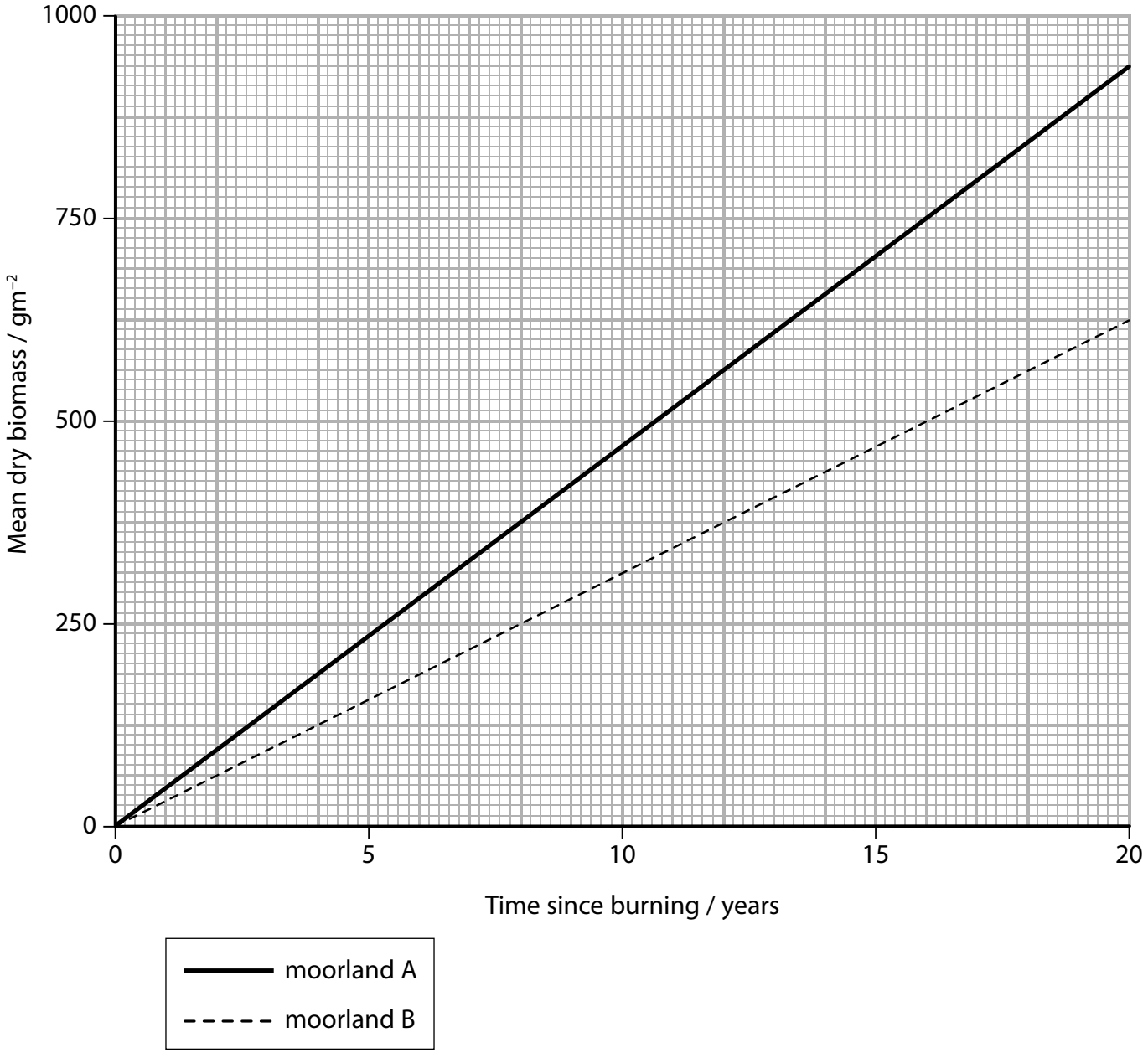
.....

(b) The graph shows the change in the mean dry biomass of the heather plants during the 20 year period.



(i) Describe a method that could be used to obtain the mean dry biomass of the heather plants in year 20.

(2)

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(ii) The total solar radiation reaching moorland A was 3 144 000 kJ m^{-2} yr^{-1}.
Each gram of dry heather contains 22.186 kJ.

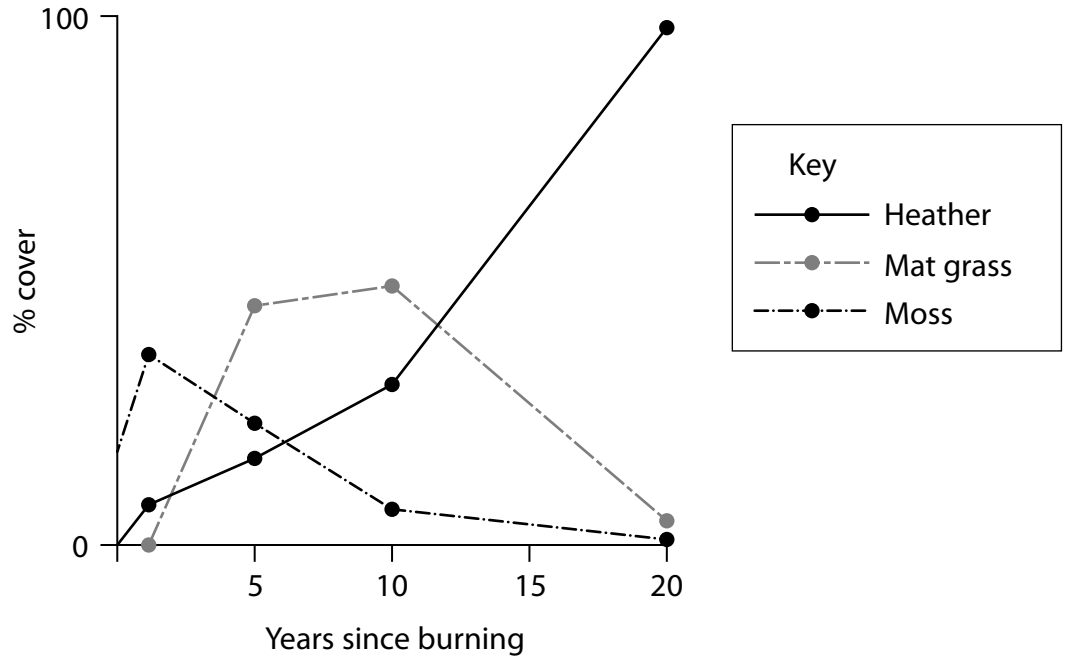
Calculate the percentage efficiency of heather plants from moorland **A** at converting solar radiation into dry biomass.

(2)

Answer.....

(iii) After the burning of the moorland, a process of succession occurred.

The following information shows some of the changes found over the 20 years.



Analyse the data to explain the changes shown.

(3)

(Total for Question 6 = 8 marks)

Question Number	Answer	Additional Guidance	Mark
3(a)(i)	An answer that makes reference to the following: • it is found {in one location / only in Scotland} **(1)**	DO NOT ALLOW habitat	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(a)(ii)	An explanation that makes reference to the following: • increases (genetic diversity)/increases size of gene pool **(1)** • because of introduction of {new/different} alleles (into the population) **(1)**	ALLOW increase variety of alleles ALLOW maintain genetic diversity	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(b)	An explanation that makes reference to the following: • (compare) sequences of {bases in DNA /amino acids in proteins} **(1)** • the more similarities in common the more closely-related the subspecies **(1)**	ALLOW nucleotides for bases ALLOW more recently evolved from a common ancestor ALLOW converse statements	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(c)	A description that makes reference to the following: • (relocating) isolates Scottish wildcats from domestic cats **(1)** • use of {studbooks/selection of mates} **(1)** • increase the number (of Scottish wildcats) **(1)** • prepared for reintroduction (to native habitat) **(1)**	ALLOW moves away instead of isolates ALLOW hacking out	**(4)**

Question Number	Answer	Mark
7(a)	**B** - Eukaryota *The only correct answer is **B*** ***A** is incorrect because the electron micrograph has a nucleus and other membrane bound organelles so must be a eukaryote* ***C** is incorrect because the electron micrograph has a nucleus and other membrane bound organelles so must be a eukaryote* ***D** is incorrect because the electron micrograph has a nucleus and other membrane bound organelles so must be a eukaryote*	**(1)**

Question Number	Answer	Mark
7(b)(i)	**C** – humidity *The only correct answer is **C*** ***A** is not correct because resistance to infection is a biotic factor* ***B** is not correct because pathogens are biotic factors* ***D** is not correct because ocean pH is an abiotic factor but not one relevant to plants and their pathogens*	**(1)**

Question Number	Answer	Mark
7(b)(ii)	**B** – global warming *The only correct answer is **B*** ***A** is not correct because increase CO_2 to 1080 ppm does not decrease photosynthesis* ***C** is not correct because increased CO_2 to 1080 ppm does not increase plant respiration* ***D** is not correct because increased CO_2 to 1080 ppm does not cause ozone depletion*	**(1)**

Question Number	Answer	Additional Guidance	Mark
7(b)(iii)	An explanation that makes reference to the following • carbon dioxide (is a greenhouse gas and) causes global warming (1) • a relevant description of a change in the distribution of ash trees (with increasing CO_2 concentrations) (1) • (because increased CO_2) would result in a change in the range for *H. fraxineus* (1) • and ash trees will be found in regions without *H. fraxineus* (1) • change in range of { *H. fraxineus* / ash trees } linked to a relevant aspect of climate change (1)	e.g. an increase to 430 ppm leads to more ash trees in the east or an increase to 1080 ppm leads to more ash trees in the north e.g. temperature increase, change in humidity, change in rainfall patterns	**(5)**

Question Number	Acceptable Answer	Additional guidance	Mark
11(a)(i)	because there is environmental gradient (1)		**(1)**

Question Number	Indicative content	
11(a)(ii)*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. 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. • reference to F. spir / F. ves at top and F. serr. at bottom / F. ves distributed from top to bottom / ranges of each of the three species quoted • reference to top of shore exposed to different levels of abiotic factors such as {water / temperature} than lower part of shore • reference to the F. spir / F. ves able to resist {dehydration / temperature fluctuations} more than F. serr. • reference to bare rock as an abiotic factor and that F. serr. {needs solid surface to {grow / attach} / not able to {grow / attach} in sand} • reference to competition between {Fucus species / other plants} for {space / light} on rocks in lower shore • reference to different distribution of {consumers / animals / limpets} that consume Fucus species /idea that different consumers live on rock than in sand	
Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one variable. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.

Question Number	Acceptable Answer	Additional guidance	Mark
11(a)(i)	because there is environmental gradient (1)		**(1)**

Question Number	Indicative content	
11(a)(ii)*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. 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. • reference to F. spir / F. ves at top and F. serr. at bottom / F. ves distributed from top to bottom / ranges of each of the three species quoted • reference to top of shore exposed to different levels of abiotic factors such as {water / temperature} than lower part of shore • reference to the F. spir / F. ves able to resist {dehydration / temperature fluctuations} more than F. serr. • reference to bare rock as an abiotic factor and that F. serr. {needs solid surface to {grow / attach} / not able to {grow / attach} in sand} • reference to competition between {Fucus species / other plants} for {space / light} on rocks in lower shore • reference to different distribution of {consumers / animals / limpets} that consume Fucus species /idea that different consumers live on rock than in sand	
Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one variable. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.

Level 2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both variables. The explanation shows some linkages and lines of scientific reasoning with some structure.
Level 3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.

Question Number	Acceptable Answer	Additional guidance	Mark
11(b)(i)	• N(N-1) = 3540 (1) • Σ n(n-1) = 704 (1) • = 3540 ÷ 704 = 5.028 / 5.03 (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
11(b)(ii)	An answer that makes reference to the following: • middle shore has higher diversity (1) • even though there are fewer individuals (1)	Allow converse argument.	**(2)**

(Total for Question 11 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
9(a)	An answer that makes reference to the following: • at the start of composting the percentage of organic carbon is less and the percentage of nitrogen is more when cow dung is added (1) • adding cow dung does not change the decrease in organic carbon (1) • adding cow dung causes {a slight / no change} to the increase in nitrogen (1) • adding cow dung has no significant effect on composting (of coffee husks) (1)	e.g. 12.8% and 12.7% e.g. 0.43% compared with 0.47%	**3**

Question Number	Answer
***9(b)**	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. 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. • standardisation of composition of compost heaps • identification of species • abundance of each species of organism in the sample • determination of C:N / set up compost heaps with different C:N ratios • time e.g. days / intervals / repetition of sampling • other factors to monitor or control e.g. water / gases / humidity / temperature / aeration / mass • sampling technique e.g. location of sample within compost heap / repetition of sampling

Level	Mark	Descriptor	
0	Marks	No awardable content	
Level 1	1-2	An explanation of how the investigation should be modified may be attempted but with limited analysis, interpretation and/or evaluation of the scientific information. Generalised comments made. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	Measure / set up compost heaps with different C:N ratios Observe species present over time
Level 2	3-4	An explanation of how the investigation should be modified will be given with occasional evidence of analysis, interpretation and/or evaluation of the scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	Recording species present / numbers of each species / measuring C:N ratio Monitoring changes over time Control of relevant factors
Level 3	5-6	An explanation of how the investigation should be modified is given which is supported throughout by evidence from the analysis, interpretation and/or evaluation of the scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear, coherent and logically structured.	Description of a suitable sampling technique Linking species present or species density to C:N measurements Use of a statistical test to compare changes of time / C:N ratio Use information on numbers of species and population sizes to demonstrate succession

Question Number	Acceptable Answer	Additional guidance	Mark
6(a)	NPP = GPP – R (1)		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(b)(i)	A description that makes reference to the following: • use of several quadrats of stated area placed at random (1) • heather placed in drying oven until constant mass (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(b)(ii)	• (gradient) 46.875 (g m^{-2} yr^{-1}) x 22.186 (kJ) = 1039.97 (g kJ m^{-2} yr^{-1}) (1) • (1037.97 ÷ 3 144 000) x 100 = 0.033% (1)	Example 750 g m^{-2} ÷ 16 years = 46.875 g m^{-2} yr^{-1}	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(b)(iii)	An explanation that makes reference to the following: • moss not all removed by burning so quickly re-grows (1) • mat grass colonises after 1 year and outcompetes moss for {light / minerals / water} so is the dominant plant after 5 years (1) • both decrease as heather colonises and becomes dominant as the heather outcompetes them both for {light / minerals / water} (1)		**(3)**

(Total for Question 6 = 8 marks)