Questions

Q1.

Organic farming does not use artificial insecticides, herbicides or fertilisers, all of which are used in conventional farming.

Students investigated the effect of organic farming on the species diversity of butterflies.

They compared fields used for growing crops on an organic farm and on a conventional farm.

Some conventional farms have converted to organic farming.

A further experiment was carried out to investigate the effect on species diversity of how long the farms have used organic methods.

(i)   Butterflies and plant species were sampled from a range of farms that had used organic farming methods for different lengths of time.

The number of plant species and the number of butterfly species were recorded.
The results are shown in the table.

Years of organic farming	Number of plant species	Number of butterfly species
0	17	4
1 to 5	38	12
6 to 15	42	14
16 to 25	39	12

Explain how the number of years of organic farming affects the biodiversity of butterfly species.

(3)

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(ii) Creeping thistle is considered to be a weed.

Creeping thistle has a deep root system and takes many years to be completely removed by organic farming methods.
The moth population and the number of creeping thistle plants were counted.
The results are shown in the table.

Years of organic farming	Number of moth species	Number of creeping thistle plants
0	15	10
1 to 5	27	235
6 to 15	20	74
16 to 25	10	14

Explain the changes in the number of moth species.

(2)

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(Total for question = 5 marks)

Q2.

A survey was carried out to compare the biodiversity in different areas of a village.

The photograph shows a children's playing field in this village.

Honeybees are important pollinators of flowers.

Surveys have suggested that butterflies, ladybirds, beetles, flies and dragonflies are also important pollinators of flowers.

A recent report has suggested that a large increase in honeybees kept in towns and cities could affect biodiversity.

Explain how the increase in honeybees in towns and cities could affect biodiversity.

(2)

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(Total for question = 2 marks)

Q3.

Explain the difference between biodiversity within a habitat and biodiversity within a species.

(2)

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(Total for question = 2 marks)

Q4.

A survey was carried out to compare the biodiversity in different areas of a village.

The photograph shows a children's playing field in this village.

Quadrats placed in the playing field showed predominantly grass with a few dandelion species, ribbed plantains, yarrow and clover. No animal species were observed.

The biodiversity of this playing field was low.

(i) Explain the reasons why the biodiversity of this playing field was low.

(3)

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(ii) The photograph shows a path in a woodland nature reserve near the playing field in this village.

After surveying the playing field, a survey of the woodland reserve was carried out using the following method:

- quadrats were placed at various intervals either side of the path
- plant species were counted in the quadrats
- animal species were counted at regular intervals along the path.

The table shows the results of this survey.

	Species	Number
Plant	Dock	10
	Thistle	10
	Hawthorn	6
	Wild cherry	2
	Hazel	5
	Yarrow	5
Animal	Meadow brown butterfly	2
	Shield bug	4
	Beetle	20
	Honeybee	20
	Dragonfly	4
	Spider	5

Calculate the biodiversity index for this woodland nature reserve.

Use the formula

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

(3)

Answer ....

(iii) It was suggested that the biodiversity index calculated from this survey was an underestimate.

Criticise the method used in the survey of the woodland nature reserve.

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(Total for question = 12 marks)

Q5.

The biodiversity of habitats can be measured by recording the species present.

Describe **two** reasons why biodiversity of habitats should be maintained.

(2)

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(Total for question = 2 marks)

Q6.

The biodiversity of habitats can be measured by recording the species present.

A student investigated the plant species growing in a sand dune habitat.

Plants were identified and counted in two regions, A and B, of the sand dune.

The results for region A are shown in Table 1.

Species	Number of individual plants
sea holly	8
sand couch	10
sea bindweed	2
sand dropwort	3
prickly parsnip	7

Table 1

The index of diversity (D) was calculated from the data.

This gave a value of 4.44.

The results for region B are shown in Table 2.

Species	Number of individual plants
sea holly	6
sand couch	7
sea bindweed	5
sand dropwort	8
prickly parsnip	4

Table 2

(i) Calculate the index of diversity (D) for region B using the formula

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

(3)

Answer ....

(ii) Comment on the diversity of each region.

(3)

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(Total for question = 6 marks)

Q7.

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
Index of diversity (D)	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)

Q8.

The World Wide Fund For Nature (WWF) is the largest conservation organisation in the world.

The WWF recently claimed that 'some 46 000 to 58 000 square miles of forest are lost each year. This is equivalent to 36 football fields every minute'.

This level of deforestation affects biodiversity.

Scientists studied the relationship between protecting land from deforestation and the percentage of species conserved.

The graph shows the results of the study.
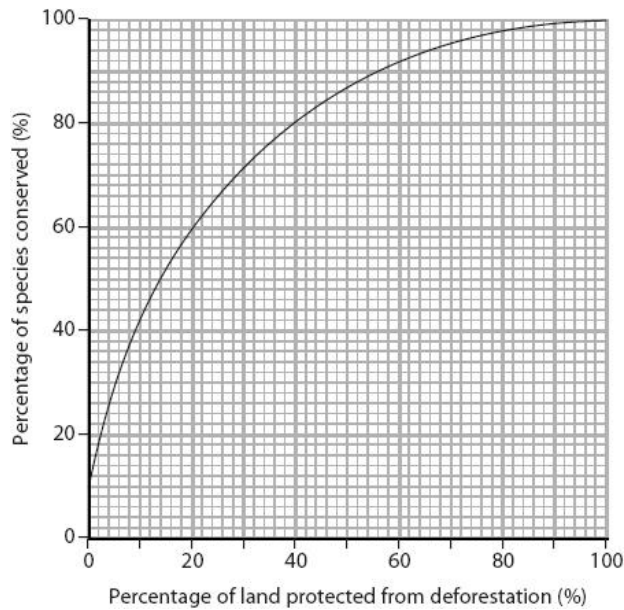
The number of species in a forest is one factor that affects biodiversity.

Some scientists use the following formula to calculate biodiversity.

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

Describe how scientists could collect the data needed for this formula in order to calculate biodiversity.

(3)

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(Total for question = 3 marks)

Q9.

Organic farming does not use artificial insecticides, herbicides or fertilisers, all of which are used in conventional farming.

Students investigated the effect of organic farming on the species diversity of butterflies.

They compared fields used for growing crops on an organic farm and on a conventional farm.

Butterflies were sampled three times on both farms during July. They were collected by walking around the fields using a sweep net. On each sampling exercise, the butterflies were collected until no more butterflies were seen.

Sampling was only carried out when the temperature exceeded 25°C and the wind speed was low.

The results are shown in the table.

Species of butterfly	Number of butterflies	
	Organic farm	Conventional
Cabbage white	22	44
Common blue	12	0
Large skipper	4	0
Monarch	3	0
Painted lady	11	0
Peacock	14	5
Red admiral	35	6
Small copper	2	0
Swallowtail	14	4

(i)   The index of diversity for the conventional farm is 1.54

    Use the formula to calculate the index of diversity for the organic farm.

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

N = total number of organisms of all species
n = total number of organisms of a particular species

(2)

Answer ....

(ii) Explain why the organic farm has a higher index of diversity than the conventional farm.

(3)

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(iii) Criticise the method used by the students to obtain these results.

(4)

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(Total for question = 9 marks)

Q10.

The Northern elephant seal is a mammal found in the Eastern Pacific Ocean.
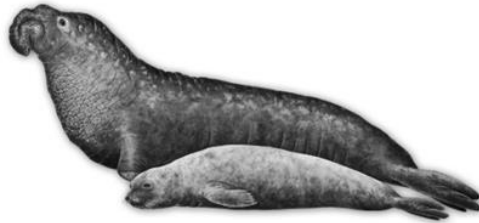
In the nineteenth century, Northern elephant seals were hunted and this reduced the population to about 20 seals.

The seals were listed as an Appendix II species when CITES was established in the 1970s.

The population has now recovered to over 100 000 individuals.

The seals in this population have developed health problems, including a high mortality rate for newborn pups, deformities and weak immune systems.

(i) Describe the role of treaties such as CITES in maintaining global biodiversity.

(2)

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(ii) Explain why, although the population of seals has recovered, many of the seals have health problems.

(2)

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(Total for question = 4 marks)

Q11.

* The photograph shows a tawny owl. These owls live in areas close to the Arctic Circle.

(Source: © LINDA WRIGHT/SCIENCE PHOTO LIBRARY)

Scientists investigated the feather colours of a population of tawny owls. Feather colours of the owls were scored on a scale of 1 to 11, according to how grey or brown they were.

Grey feathered owls were given a score between 6 and 1, with 1 being the most grey.

Brown feathered owls were given a score between 7 and 11, with 11 being the most brown.

The graph shows the percentages of owls in the population with each of the colour scores.
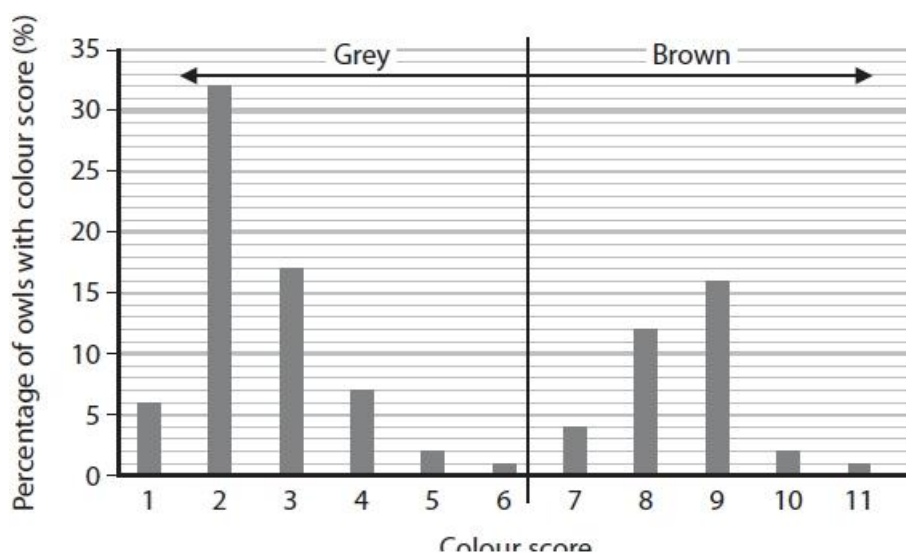
The scientists investigated the effect of climate change on the frequencies of these two alleles for feather colour in populations of tawny owls.

The percentage survival rates of both colours of owl were measured when there were different depths of snow.

The mean depth of snow was recorded each year between 1980 and 2007.

The percentage of owls that were coloured brown between 1960 and 2007 was also recorded.

The graphs show the results.

The scientists concluded that increased greenhouse gases from human activity are resulting in an increase in the frequency of the brown allele.

Analyse the data to evaluate this conclusion.

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(Total for question = 6 marks)

Q12.

Seed banks store seeds for future use. Seeds can be stored for a long time if the seeds are kept dry with a moisture content of less than 8%.

The seeds are stored in closed containers. The percentage germination of the seeds is measured to test their viability during storage.

At the Millennium Seed Bank, the seeds are stored in closed glass containers at 15% relative humidity at a temperature of –20°C.

The graph shows the percentage germination of seeds kept in three different closed containers: metal, cellophane and paper. They were kept for 72 months at a temperature of –20°C.

(a) Analyse the data to explain why seeds are stored in glass containers in the Millennium Seed Bank.

(4)

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(b) Each time the seeds are tested for viability, 50 seeds are used.

State why 50 seeds are used.

(1)

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(c) Calculate the rate of change in viability of the seeds stored in a cellophane container for the first two years.

(2)

Answer ....

(d) Seeds from other parts of the world are stored in seed banks.

(i) Explain how the viability test would be different for these seeds from other parts of the world.

(3)

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(ii) Explain why plants grown from these germinating seeds may not flower at the same time of year as they would have done in their country of origin.

(2)

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**(Total for question = 12 marks)**

Q13.

The World Wide Fund For Nature (WWF) is the largest conservation organisation in the world.

The WWF recently claimed that 'some 46 000 to 58 000 square miles of forest are lost each year. This is equivalent to 36 football fields every minute'.

This level of deforestation affects biodiversity.

Scientists studied the relationship between protecting land from deforestation and the percentage of species conserved.

The graph shows the results of the study.
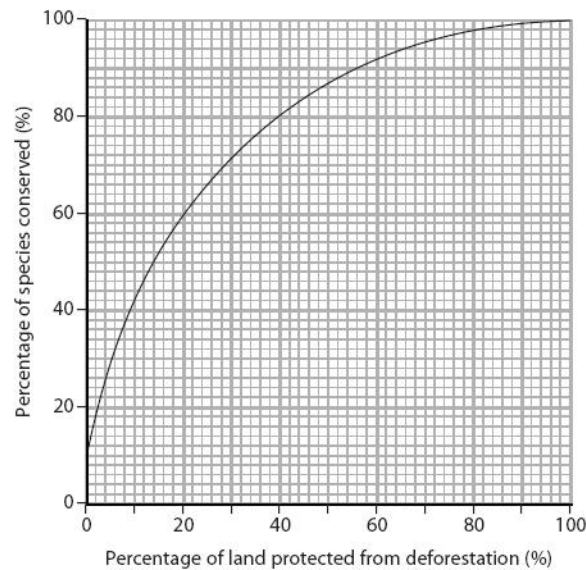
Analyse the data in the graph to explain how protection of land affects the percentage of species conserved.

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(Total for question = 4 marks)

Q14.

In Kenya, an in-situ conservation project has been set up to make paper from elephant dung.

This project aims to help conserve elephant populations, conserve biodiversity and help local communities.

Elephant conservation often involves the setting up of protected areas to stop poaching. Local people are banned from entering these areas.

This method of elephant conservation sometimes causes conflict with local people, as elephants can trample and eat crops in nearby farmland. Farmers sometimes burn areas of grassland and forest to stop elephants destroying their farmland.

The new paper conservation project encourages local people to make paper from elephant dung they collect from the conservation area. The paper they make is sold at a high price.

Conservationists measured the effect of the new paper project on the index of diversity of the area over two years. They also measured the effect of a protected conservation area where local people were banned from entering on the index of diversity. The results are shown in the table.

Area	Index of diversity	
	At start of project	After two years
Conservation area with paper project	2.8	3.6
Conservation area where local people are banned from entering	2.4	2.2

(i) State why calculating an index of diversity is a better measure of biodiversity than counting the number of different species.

(1)

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(ii) Give two advantages of in-situ conservation of elephants compared with ex-situ conservation of elephants.

(2)

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(iii) Explain the effect of the new paper project on biodiversity compared with the protected area where local people were banned.

(4)

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(Total for question = 7 marks)

Q15.

*A student stated that 'zoos are successful at protecting endangered species from extinction'.

Evaluate the validity of this statement.

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(Total for question = 6 marks)

Q16.

The biodiversity of plant species on Guam has decreased.

(i) Give two reasons why changes in the number of bird species have led to this decrease in biodiversity of plant species.

(2)

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(ii) Scientists are using seed banks to conserve the biodiversity of plants.
Describe how seed banks are used as a method of conservation.

(4)

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(Total for question = 6 marks)

Q17.

Biodiversity is monitored by conservationists.

Biodiversity can be calculated using the formula

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

Give the symbol in this formula that represents the total number of organisms of all species.

(1)

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(Total for question = 1 mark)

Q18.

The Eurasian lynx is the largest native European cat species.

It was once widespread across Europe but is now restricted to small areas of national parks.

Ex-situ and *in-situ* conservation measures were used in the 1970s to increase biodiversity.

- Lynx were bred in zoos and 10 were reintroduced into an area of protected forest where the lynx had become extinct.
- Existing wild lynx were protected in an area of forest where they had not become extinct.

In 2016 scientists estimated the population sizes and genetic biodiversity of the lynx in these two areas of forest.

They found that the population and genetic biodiversity of the lynx in the area where they had been reintroduced were much lower than in the protected area.

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

(1)

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(ii) Explain why, in 2016, the genetic biodiversity of the lynx population in the area where they had been reintroduced was much lower than in the protected area.

(2)

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(Total for question = 3 marks)

Q19.

*Discuss the use of *in-situ* and *ex-situ* methods in the conservation of endangered species.

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(Total for question = 6 marks)

Q20.

Biodiversity can be measured by calculating an index of diversity.

The following data were collected from a freshwater pond in England.

Species	Number of individuals (n)
Mayfly nymph	80
Freshwater shrimp	23
Freshwater hoglouse	14
Beetle larvae	9

(i) Calculate the index of diversity (D) for this pond.
Use the formula

(3)

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

Answer ....

(ii) A pond in a different area had a lower index of diversity.

Explain how the composition of this second community could have resulted
in this lower index of diversity.

(2)

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(Total for question = 5 marks)

Q21.

The Eurasian lynx is the largest native European cat species.

It was once widespread across Europe but is now restricted to small areas of national parks.

Ex-situ and *in-situ* conservation measures were used in the 1970s to increase biodiversity.

• Lynx were bred in zoos and 10 were reintroduced into an area of protected forest where the lynx had become extinct.
• Existing wild lynx were protected in an area of forest where they had not become extinct.

In 2016 scientists estimated the population sizes and genetic biodiversity of the lynx in these two areas of forest.

They found that the population and genetic biodiversity of the lynx in the area where they had been reintroduced were much lower than in the protected area.

Explain the principles and issues associated with *ex-situ* conservation methods.

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(Total for question = 4 marks)

Q22.

The World Wide Fund For Nature (WWF) is the largest conservation organisation in the world.

The WWF recently claimed that 'some 46 000 to 58 000 square miles of forest are lost each year. This is equivalent to 36 football fields every minute'.

This level of deforestation affects biodiversity.

Scientists studied the relationship between protecting land from deforestation and the percentage of species conserved.

The graph shows the results of the study.
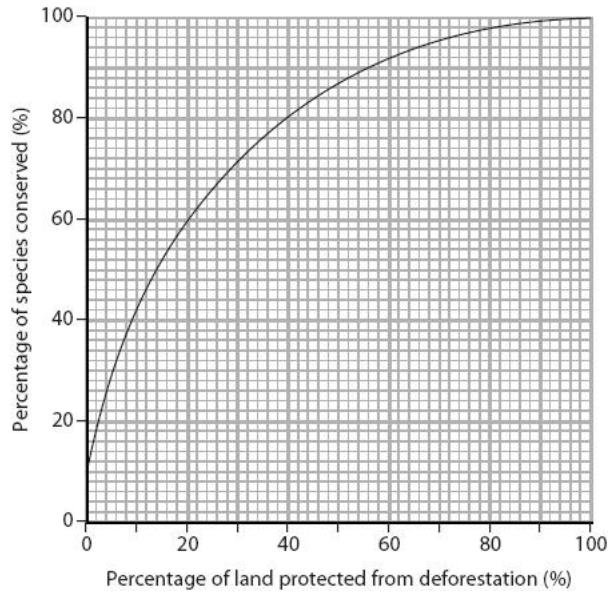
* Some scientists state that 'all forests should be protected from deforestation'.

Evaluate this statement.

(6)

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(Total for question = 6 marks)

Q23.

The graph shows the total number of endangered species and the number of new species listed as endangered from 1985 to 2015.
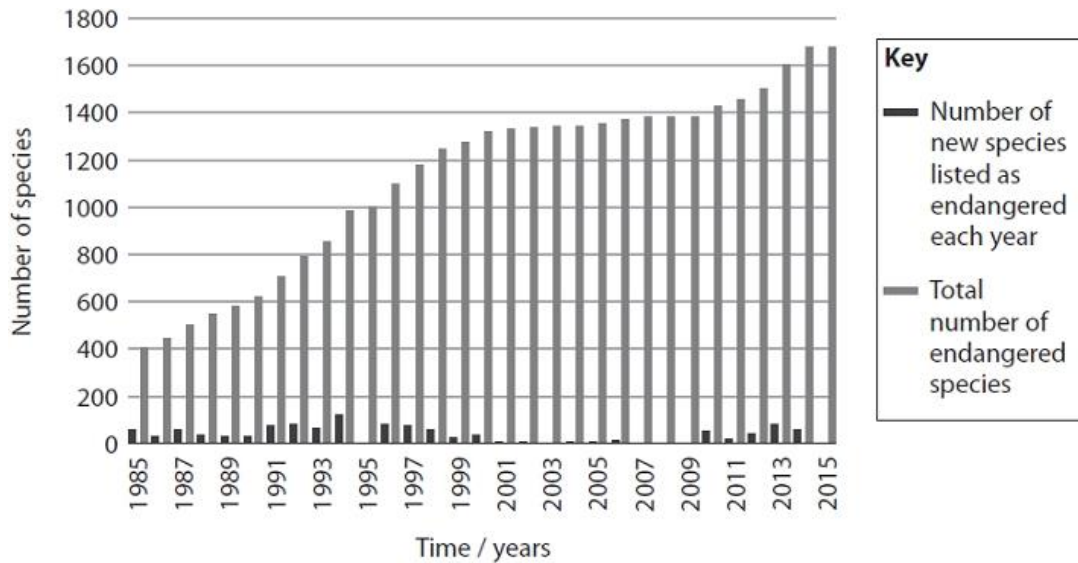
(i) Calculate the rate of change in the total number of endangered species between 1985 and 2015.

(2)

Answer ....

(ii) Explain how the total number of endangered species and the total number of

new species listed as endangered each year have both changed.

(4)

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(Total for question = 6 marks)

Q24.

The photograph shows a hedge.

(Source: © 1000 Words/Shutterstock)

Many fields in the UK are separated by hedges.

Conservationists investigated biodiversity in hedges of different ages.

Hedges of different ages were sampled at random and the number of species of woody plants was counted.

The graph shows the results of this investigation.
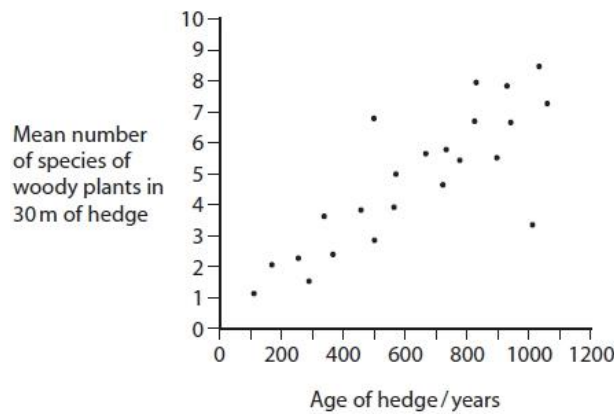
Analyse the data to explain why conservationists object to the destruction of hedgerows to increase the size of fields.

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(Total for question = 4 marks)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: • number of butterfly {species / diversity} increases then {levels off / decreases} (1) • because there are more plant {species / diversity} / positive correlation between number of butterfly species and plant species (1) • providing more {niches / food sources / nesting sites} / decrease due to competition from other organisms (1)		(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • number of moths is highest when creeping thistle is highest (1) • because creeping thistle is a {food source / habitat / niche / used for reproduction} (1)	ACCEPT converse statement	(2)

Q2.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • biodiversity decreases (1) • one relevant reason given (1)	Allow • because honeybees will compete with natural pollinators (for pollen /nectar / food) (1) • because populations of wild pollinators decrease (1) • because many wild pollinators will also provide food for other species (so they decline due to lack of food)(1)	(2)

Q3.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • number of different {species} within a habitat / richness / relative number of each one {species} / {species} evenness (1) • genetic variation (within a species) / heterozygosity / degree of inbreeding (1)	not just numbers of organisms	(2)

Q4.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to three of the following: • (biodiversity is low) because there are few species (1) • because there is a lot of trampling (1) • because animals are disturbed (by noise) (1) • because grass is mown (makes it difficult for other species to establish themselves) (1)		(3)
(ii)	An answer that makes reference to the following: • calculation of N(N-1) (1) • calculation of sum of n(n-1) (1) • calculation of D (1)	Example calculation 8556 1058 8.1 / 8.09 / 8.087 Correct answer with no working gains full marks	(3)

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to six of the following: • quadrats not placed at random (1) • {size / number} of quadrats not mentioned (1) • plants sampled at various intervals, animals at regular intervals (1) • {animals observed / no mention of how animals are counted} (1) • animals may {hide / move away / be counted twice} (1) • {only path sampled / inner area of woodland not sampled} (1) • not all animals identified to species level (1) • survey done at only one {time of year / time of day} (1)	Allow size of sample area not mentioned Allow description of pitfall traps, sweepnets, mark release recapture etc. couldbe used	(6)

Q5.

Question Number	Answer	Additional guidance	Mark
	A description that makes reference to the following: • ethical reasons for maintaining biodiversity (1) • economic reasons for maintaining biodiversity (1)	example of ethical reason such as denying future generations the opportunity to use renewable resources/ genetic resources / aesthetic / maintain gene pool example of ecosystem services: provisioning services such as food clothing , fuel , medicines , building materials / regulating services / removal of toxins supporting services / soil formaton / nutrient recycling / cultural services tourism / allow maintain healthy ecosystem / prevent extinction (accept two ethical or two economic reason)	**Exp (2)**

Q6.

Question Number	Answer	Additional guidance	Mark
(i)	An answer that includes • calculation of numerator • calculation of denominator • correct calculation of D	Example of calculation $30 \times 29 = 870$ **870 scores 1 mark** $(30 + 42 + 20 + 56 + 12) = 160$ $870 \div 160$ **÷ 160 scores one mark** D = 5.44 D = 5.4375 Correct answer with no working gains full marks	Exp (3)

Question Number	Answer		Mark
(ii)	An answer that makes reference to three of the following points: • same number of different species in region A and B (1) • more species evenness / similar relative species abundance in region B (1) • as numbers of each species almost equal (1) • (shown by) D value higher in region B / B more diverse (1)	allow species richness same allow converse for mp 2 3 4	EXP (3)

Q7.

Question Number	Answer	Additional Guidance	Mark
(i)	• correct calculation of N(N-1) • correct calculation of ∑n(n-1) • correct division of N(N-1) by ∑n(n-1) 1.5 (3)	Example of calculation = 3906 (1) = 2604 (1) 3906 ÷ 2604 = 1.5 Correct answer with no working gains full marks	3

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • index accounts for population / numbers of organisms (1) • because numbers of organisms in {each species vary} (1)	ACCEPT converse for both Mps ACCEPT population sizes can vary for two marks	2

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

Q8.

Question Number	Answer	Additional guidance	Mark
	A description that makes reference to the following: • use of a stated sampling method (1) • (count N = total) number of organisms of all species (1) • (count n = total) number of organisms of {a particular species / each species} (1)	Eg. quadrat / sweep net / tree beating / light trap Ignore species richness / evenness / abundance	**(3)**

Q9.

Question Number	Answer		Additional Guidance	Mark
(i)	• correct numerator (13572) or denominator (2278)	(1)	Example of Calculation	
			$N(N-1)\Sigma n(n-1)$	
	• correct calculation of D	(1)	$= 5.96$	
			Correct answer with no working gains full marks	(2)

Question Number	Answer		Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following:		ACCEPT converse statements	
	• more species of butterfly / higher species richness / more varieties of butterfly / 9 species compared to 4 species	(1)		
	• because there are more plant species	(1)		
	• therefore more niches / food sources / breeding areas / hibernation	(1)		
	• because species are unaffected by herbicide / insecticide / fertiliser	(1)		(3)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to four of the following: • (A) stated abiotic factor not controlled (1)	e.g. temperature / wind speed / humidity / rain / previous weather/ sunlight	
	• (S) sweep method not standardised (1)	e.g. number of sweeps / size of nets / may not catch all species / some not caught / sampling was not random / subjective / relies on judgement when all are collected / bias / should grid areas / some not seen / some may fly away	
	• (T) time not standardised / date of sampling differs / length of time spent sampling is different (1)	e.g. some butterflies not present at different times / hatch at different times / migrate at different times / should look at other months	
	• (R) sampling area / number of fields vary (1)	e.g. lots of fields needed / may be other differences between fields / sizes of fields / may differ / needs more repeats over more years IGNORE ethical issues	(4)

Q10.

Question Number	Answer	Additional Guidance	Mark
(i)	A description that makes reference to two of the following: • CITES prevents {exploitation / hunting / sale / trade / poaching} (1) • by countries that sign up to the treaty (1) • by {protecting / conserving} endangered species (1)		(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to two of the following: • (genetic / population) bottleneck (1) • causing reduced {genetic diversity / gene pool / number of different alleles} (in populations) (1) • therefore the chance of inheriting two harmful recessive alleles increases (1)	**Accept** small / restricted gene pool	(2)

Q11.

Question Number	Indicative content

*	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.
	
	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.
	
	    • with increasing snow depth, there is higher survival of grey owls / fewer brown owls survive / more grey owls D
	    • snow depth has decreased over time D
	    • the percentage of brown owls has increased over time / percentage of grey owls has decreased D
	
	For
	    • with less snow, more ground is visible / uncovered / more twigs and trees visible E
	    • with less snow, grey owls more obvious (to predators / prey) / less camouflaged E
	    • with less snow, natural selection would favour brown owls / more brown (advantageous) alleles passed on / fewer grey alleles passed on / brown owls outcompete grey owls E
	    • enhanced greenhouse effect due to carbon dioxide emissions reflecting radiation back / absorbing radiation (causing melting) E
	
	Against
	    • no direct measure of greenhouse gas / temperature / fossil fuel emissions A
	    • graphs show correlations not causal links A
	
	    • data for owl survival with snow depth is scattered / gaps in data / weak correlation A
	    • data for mean snow depth has many outliers / anomalies / not all points are around line / data is scattered A
	    • other factors (named factors) could be affecting the owl population A
	    • reduced snow may not be due to greenhouse gas release A

		• data for owl survival with snow depth is scattered / gaps in data / weak correlation A
		• data for mean snow depth has many outliers / anomalies / not all points are around line / data is scattered A
		• other factors (named factors) could be affecting the owl population A
		• reduced snow may not be due to greenhouse gas release A

Level 0	Marks	No awardable content
Level 1	1-2 (1-3)	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 1 mark : any 1 from D, E, A 2 marks : any 2 from D, E, A
Level 2	3-4 (4-6)	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. D and, E OR A 3 marks : at least 3 points. Any combination of D, plus E, or A 4 marks : at least 4 points. Any combination of D, plus E, or A
Level 3	5-6 (7-9)	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. D, E, AND A 5 marks : at least 5 points. Must have combination of D, E, and A 6 marks : at least 6 points. Must have combination of D, E, and A

Q12.

Question Number	Answer	Additional Guidance	Mark
(a)	An explanation that makes reference to four of the following: • {seed viability / germination} high in metal containers (1) • glass containers have similar properties to metal containers (1) • because {metal / glass} containers keep {air / moisture} out (1) • therefore seed water content is kept below 8% (1) • can see through glass without removing lid (1)	**Accept** converse for paper / cellophane	(4)

Question Number	Answer	Additional Guidance	Mark
(b)	• to produce valid (measure of seed viability / results / data)	**Accept** allows identification of anomalous result **Do not accept** if in list	**(1)**

Question Number	Answer	Additional Guidance	Mark
(c)	• difference calculated • how many times better calculated with units	Example of calculation: $90 - 16 = 74$ $74 \div 2 = 37$ % year^{-1} or $74 \div 24 = 3.08$ % month^{-1} / 3.1 % month^{-1} / 3 % month^{-1}	**(2)**

Question Number	Answer	Additional Guidance	Mark
(d)(i)	An explanation that makes reference to the following: • {viability test / germination} requires similar conditions as the country (1) • because germination is affected by {temperature / pH / light intensity / wavelength / humidity / vernalisation} (1) • if correct conditions not used seeds would not germinate even if viable (1)	**Accept** other relevant abiotic factor	**(3)**

Question Number	Answer	Additional Guidance	Mark
(d)(ii)	An explanation that makes reference to the following: • because flowering is affected by {day length / photoperiod / light and dark period} (1) • because flowering involves {phytochrome / P_R / P_{FR}} (1)	**Accept** florigen	**(2)**

Q13.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to the following: • increase in land protection increases species conserved (1) • because (trees) provide {niches / habitat / food / shelter} (1) • when no land protected (10 to 12%) species still exist (1) • because these species {live in soil / not in trees} (1)		(4)

Q14.

Question Number	Answer	Additional Guidance	Mark
(i)	• (index of diversity) takes into account populations (of each species) (1)	Accept considers abundance / number of each species Accept because an area could have many different species but different populations	1 exp

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to two from the following points: • other species are also conserved (in the ecosystem) (1) • animals are not humanised / behaviours are natural / no change to behaviour (1) • less inbreeding occurs (1)	Accept converse for *in situ* Accept other species are protected / food webs are maintained / maintains biodiversity / maintains links in ecosystem Accept more space for animals Accept no need to transport animals Accept less inbreeding depression / maintain gene pool	2 grad

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference the following points: • biodiversity has increased (in the paper project area) **more** (than the protected area) (1)	**Accept** biodiversity has increased but {did not increase / went down} in area where people are banned	
	• as less / no grassland is burnt / less poaching (1)	**Accept** grassland burning / poaching still occurs in unprotected area **Accept** converse for protected area	
	• (more) niches are available / habitats are not destroyed / elephants transfer plant seeds (1)	**Accept** converse for protected area	
	• local people make money from the paper project / if the elephants are not present, local people lose a source of income (1)	**Accept** people have a vested interest in the elephants / make a profit	4 exp

Q15.

Question Number	Indicative content
*	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. Reasons for keeping zoos: • education about endangered animals / public awareness / research • save endangered species / protect endangered species / safe environment / protect from poachers, habitat loss, starvation, predators / vaccinated / protected from disease • breeding programs • reintroduce animals into the wild • minimise inbreeding / exchange semen / exchange animals • money used for conservation Reasons against zoos: • animals suffer stress, boredom, confinement, change behaviour / habitat differs ☐ certain species favoured • captive breeding programs may not successfully release animals back into the wild • removing individuals from the wild will further endanger the wild population • people can observe wildlife in the wild or visit a sanctuary • conservation more successful in situ / in a reserve

Level	Mark	Descriptor
	0	No awardable content
1	1-2	The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context. *Explains one reason for OR one reason against = 1* *Explains one reason for AND explains one reasons against OR two reasons for / two reasons against = 2*
2	3-4	An explanation 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. *Explains two reasons for and one against = 3 Explains one reason for and two against = 3* *Explains two reasons for and two against = 4*
3	5-6	An explanation 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. *Explains two reasons for and three against or Explains three reasons for and two against = 5* *Offers an opinion / summary / conclusion = 6*

Q16.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to two of the following: • less distribution of seeds (1) • fewer {mineral / ions / fertiliser / nutrients} from faeces / excretion (1) • less predation / eating of insects (1) • less pollination / birds are pollinators (1)	**ACCEPT** less nutrient recycling **ACCEPT** not fertilised by faeces	2

Question Number	Answer	Additional Guidance	Mark
(ii)	A description that makes reference to four of the following: • variety of seeds from each {species / type} are kept / seeds from many {species / types / varieties} are kept / seeds with high genetic diversity are kept (1) • kept at {low / cold / frozen} temperature (1) • kept in {low humidity / low moisture / dry} (1) • kept in {airtight / sealed / low oxygen} containers (1) • seeds tested for viability / X-ray seeds to detect embryos / sterilise (1)	**ACCEPT** cryogenics	4

Q17.

Question Number	Answer	Additional Guidance	Mark
	N		(1)

Q18.

Question Number	Answer	Additional Guidance	Mark
(i)	different {alleles} in a gene pool / species / population OR different {species} in an {area / habitat / environment / ecosystem / community}	**ACCEPT** genetic variation within a species	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • only small number / 10 introduced / {founder effect / genetic bottleneck} has occurred / (1) • (resulting in a) limited gene pool / few different alleles / inbreeding in zoos / no other lynx present to provide new alleles (1)	**ACCEPT** converse for lynx in protected area **ACCEPT** converse for lynx in protected area **DO NOT ACCEPT** diversity of alleles	(2)

Q19.

Question Number	Indicative content
*	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. benefits of in-situ It doesn't involve removing species from their natural ecosystems. It doesn't lead to behavioral change stereotypy It is not as disruptive as ex situ conservation, i.e. ecological integrity is maintained. It involves protection of larger populations and conservation of organisms and their habitat as a whole. The organisms/species get the opportunity to evolve. Allows and facilitates scientific studies of the area. Encourages Ecotourism risks of in-situ It requires larger areas Animals are always under threat of several diseases or any natural disasters. Risk of increased inbreeding and thus reduced fitness which is known as homozygosity. The animal species could be less productive and thus expensive to be monitored and maintained. Poachers and ecological tourists may find these thriving habitats as an opportunity and may cause harm.

benefits of ex situ

It involves protection of species from external threats like predation and poaching.
Selective breeding processes are put in place.
Can keep breeding logs / studbooks etc
It involves reintroduction of several organisms that have left their natural habitat
Improvised quality of off-springs can be obtained
Many seeds can be stored in seed banks take up little room

risks of ex-situ

It can be considered only for a few kinds of species.
Due to human interference, rare species remain under threat.
Inbreeding small population size
Hybridization
Captive species show divergent genetics/ subject to different selective pressure allele
frequencies change.
Poor germination rate.
Costly method of conservation.
Harm to seeds by pests

Level	Mark	Descriptor
	0	No awardable content
1	1-2	The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context. explains what in-situ and ex-situ are **Explains one benefit or risk for one method =1** **Explains two benefits or risks for one method or one benefit or risk for each method = 2**
2	3-4	An explanation 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. **Explains two benefits and one risk for each method = 3** **Explains two benefits and two risks for each method = 4**
3	5-6	An explanation 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.

		Explains two benefits and two risks for each method with some evidence of detail = 5 **Offers an opinion / summary / conclusion of which reflects evidence presented = 6**

Q20.

Question Number	Answer	Additional Guidance	Mark
(i)	• calculation of N (N-1) (1) • calculate $\sum n(n-1)$ (1) • calculation of D (1)	N = 126 N (N-1) = 15750 6320+506+182+72=7080 15750 ÷ 7080 = 2.2 allow 2.23 or 2.225 or 2.2246 allow 1 mark for 6320+506+182+72 and allow 1 mark for 1570	**(3)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • smaller number of different species within this pond / low species richness so that N is lower (1) • few of some species whilst others are very {abundant / low species evenness} so that n is higher (1)	 must refer to some species high numbers **and** other species low numbers	**(2)**

Q21.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to four of the following:		
	any **two** from	e.g safari park	
	• {use of zoos / seed banks / captivity} to {prevent extinction / protect endangered species} (1)		
	• {education about /raising money for / raise awareness}importance of conservation (1)		
	• {breeding programmes / controlled feeding / removing predation / protect from poaching / veterinary care} to increase {numbers / population} (1)	**ACCEPT** any correct method	
	and any **two** from		
	• need to avoid inbreeding by use of stud books / frozen sperm (1)	**e.g.** cannot hunt / domesticated / reliant on humans	
	• **ethical** issues (1)		
	• loss of normal behaviours (1)		**(4)**

Q22.

Question Number	Indicative content
*	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.

Reasons against deforestation:

- conservation of biodiversity is important for medicines / wood products / sustainable products / prevent extinction / gene preservation
- forests provide livelihood / homes / food for indigenous people and recreational opportunities for non-indigenous people
- deforestation contributes to greenhouse effect / global warming / climate change / raised carbon dioxide
- deforestation results in soil erosion / landslides / flooding / desertification

Reasons for deforestation:

- deforestation has economic implications for employment / national income
- deforestation needed for wood products used in building of houses / fuel
- deforestation needed for cattle farming / crop growth
- deforestation results in habitat destruction / reduction of biodiversity / extinction

Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context. ***Explains one reason for AND one reason against deforestation =2*** ***Explains two reasons for = 2 OR explains two reasons against deforestation =2***
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure. ***Explains two reasons for and one against = 3 Explains one reason for and two against = 3*** ***Explains two reasons for and two against = 4***
Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. ***Explains two or three reasons for and two or three against with some evidence of detail = 5*** ***Offers an opinion / summary / conclusion of which reflects evidence presented = 6***

Q23.

Question Number	Answer	Additional Guidance	Mark
(i)	• figures read from graph and change calculated • rate calculated 41.67 to 43.33 (2)	Example of calculation 1685 - 400 = 1285 1285 ÷ 30 = 42.83 / 43 Correct answer with no working gains full marks **ACCEPT** one mark for ÷ 30 in working	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • total number (of endangered species) increases (1) • adding new species (each year) determines the total (1) • few species coming off total (1) • rapid increase in total from 1985 to 2000/1 / little change in total between 2000/1 and 2009 / few new species between 2000/1 and 2009 (1)	**ACCEPT** no new species listed means no change in total	(4)

Q24.

Question Number		Additional Guidance	Mark
	An explanation that makes reference to four of the following: • (because) there are more species of woody plants in the older hedges (1) • If hedges were destroyed {there would be a large loss of biodiversity / many species would be lost} (1) • older hedges provide more niches (1) • (so that) more species of {invertebrates / vertebrates / animals / plants} (are associated with older hedge) (1) • (Therefore) hedges provide {shelter / food / nesting sites} / allow safe movement of animals (for {interbreeding / genetic variation}) (1)	Accept there is a positive correlation Accept if hedges were destroyed it would take a long time {for biodiversity to recover / for species number to recover} / if hedges are destroyed there are less niches Accept some plants are found only in older hedges Accept biodiversity increases as age of hedge increases	
			(4)