21. Female silver-washed fritillary butterflies, *Argynnis paphia*, are usually an orange-brown colour. However, a deep olive-green colour can be seen in some females, largely in the south of England.

i. What is the term given to this type of biodiversity?

_____ **[1]**

ii. Give one possible benefit to the species of this type of biodiversity.

_____

_____ **[1]**

22(a). Beavers were hunted to extinction in the UK about 500 years ago. Recently a trial reintroduction in Scotland was hailed as a great success after researchers found that the animals had 'transformed the landscape'. After five years the beavers had:

- constructed dams – the largest of which was 18 m long and 1.6 m high
- felled trees
- created canals
- built lodges (large nests)
- successfully reproduced.

i. Beavers are considered to be a keystone species.

Explain why they are a keystone species in their native Canada.

_____

_____

_____

_____ **[2]**

ii. One benefit of the reintroduction of beavers in Scotland was an increase in habitat diversity.

Explain how the following activities could have contributed to increased habitat diversity.

Constructed dams_ _

_ _

Felled trees_ _

_ _

Built lodges_ _

_ _

[3]

iii. Suggest **one** other benefit of the reintroduction of beavers.

_____

_____ **[1]**

(b). Increasing habitat diversity may lead to an increase in species diversity and genetic diversity.

Explain why species diversity and genetic diversity may be increased as a result of the beavers' activity.

____

____

____

____

____ **[2]**

(c). Some land owners have expressed concern about the impact that beavers can have on rural businesses.

Suggest **two** arguments that may be used by local business leaders against the introduction of beavers. State whether these outweigh the arguments presented by the naturalists.

Argument 1 ____

____

____

____

Argument 2 ____

____

____

____

[4]

23. A study was carried out on butterflies in two different habitats in the north of England. The two habitats were farmland and mixed deciduous woodland.

- Surveys were completed in 1992 and then at four year intervals.
- Data were collected from butterfly transect sites in both habitats. Using this data, the total butterfly population in each habitat was estimated.
- In 2012, the general populations of butterflies in these two habitats reached historical lows as a result of the prolonged cold and wet weather.
- Between 1992 and 2012 the woodland had become overgrown due to lack of active management.
  In particular the number of open spaces in the woodland had decreased.

The data in Fig. 5 shows the total butterfly populations per square kilometre in both habitats between the years 1992 to 2012.

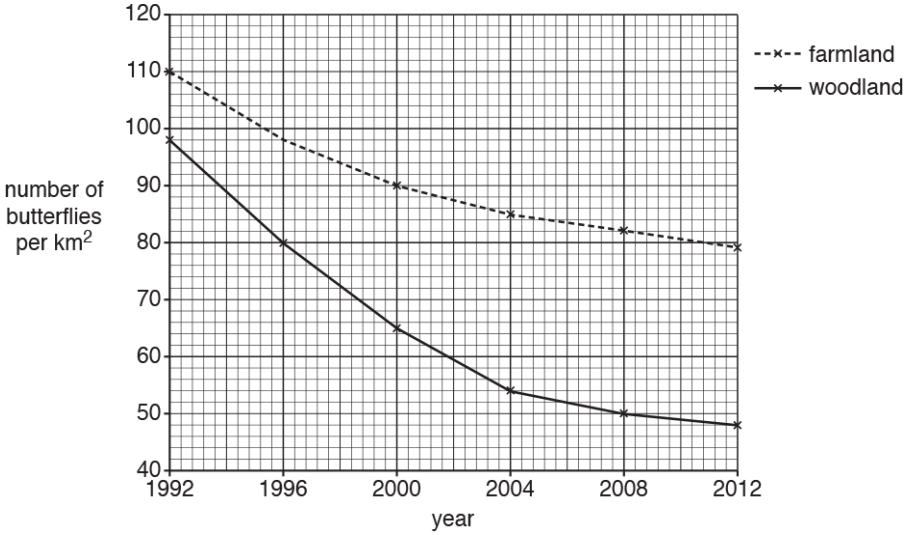


Fig. 5

i. Calculate the total percentage decrease in the number of butterflies on farmland between 1992 and 2012.

Show your working. Give your answer to the nearest whole number.

Answer……**[2]**

ii. Using the data given in **Fig. 5**, compare the changes in the number of butterflies on farmland and on woodland between 1992 and 2012.

_____

_____

_____

_____ **[2]**

iii. Both habitats experienced the same weather conditions.

Suggest a reason **for the difference** in the rates of decline in butterfly numbers in woodland and farmland.

_____

_____ **[1]**

iv. A student made the following statement:

'These data show that the change in butterfly numbers was caused by changes in weather conditions in England.'

Comment on the validity of this statement.

_____

_____

_____

_____ **[2]**

v. State **one** variable that scientists should control when carrying out surveys such as this.

_____

_____ **[1]**

24(a). A group of students were studying invertebrate biodiversity in **two** areas of local woodland, **Area A** and **Area B**. They used pitfall traps to sample the two areas.

i. Explain how a pitfall trap can be set up and used to sample invertebrate biodiversity.

_____

_____

_____

_____

_____

_____

_____

_____ **[3]**

ii. The results for **Area A** are shown in the table below.

Species	***n* = Number of organisms**	$\frac{n}{N}$	$\left(\frac{n}{N}\right)^2$
Common woodlouse	9		
Black sexton beetle	6		
Spotted wolf spider	2		
Woodlouse spider	4	0.190	0.036
	***N* =**		$\sum\left(\frac{n}{N}\right)^2 =$
			$1 - \sum\left(\frac{n}{N}\right)^2 =$

Complete the above table **and** calculate the Simpson's Index of Diversity (*D*) for **Area A**.

Use the formula: $D = 1 - \left(\sum\left(\frac{n}{N}\right)^2\right)$

Where: *n* = number of organisms of this species
N = total number of organisms

Give your answer to **2** significant figures.

***D* = ... [3]**

iii. The students found the Simpson's Index of Diversity for **Area B** to be 0.84.

Compare the stability of the community living in **Area B** with that of the community living in **Area A** based on their Simpson's Index of Diversity.

_____

_____ **[1]**

(b). A study was carried out on moorland vegetation in the North of England. A number of 10-metre interrupted belt transects were carried out in this area.

Here are some instructions for carrying out an interrupted belt transect:

1. Mark a line with a string.
2. Make an observation at varying points along the string.
3. Count how many different species of plants are found at each point.
4. Note down what you think the names of each of these species are.
5. Record your results as a table.

i. Suggest **two** improvements you could make to these instructions.

Improvement 1

_____

_____

_____

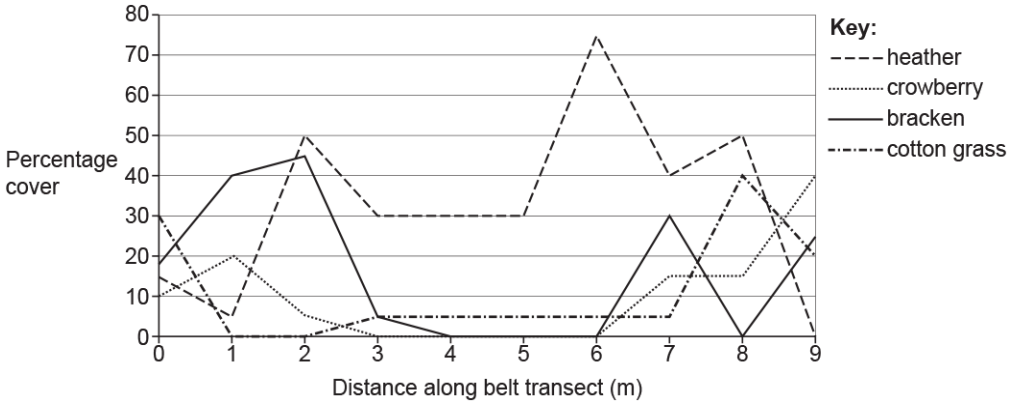
Improvement 2

_____

_____

_____ **[2]**

ii. Results of the four most abundant species from the study are shown in the graph below.



When presented with an aerial photograph of the moorland community being studied, a student stated that bracken and heather are not found growing in the same area.

Using the data in the graph, evaluate the student's statement.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ **[4]**

25. The invertebrate biodiversity of two different peat bog ecosystems was sampled. Values of Simpson's Diversity Index were calculated for both ecosystems. The results are shown in Table 4.1.

Species	**Ecosystem A**			**Ecosystem B**		
	n	*n/N*	$(n/N)^2$	*n*	*n/N*	$(n/N)^2$
G. cottonae	3	0.0361	0.0013	14	0.15	0.0227
G. servulus	1	0.0120	0.0001	12	0.13	0.0166
C. cocksi	4	0.0482	0.0023	20	0.22	0.0462
L. nigrifrons	24	0.2892	0.0836	25	0.27	0.0723
E. cryptarum	33	0.3976	0.1581	22	0.24	0.0560
T. limbata	5	0.0602	0.0036			
S. litorea						
T. rivularis	1	0.0120	0.0001			
S. argus	4	0.0482	0.0023			
Σ =			0.2607			0.2138
1 − Σ =			0.7393			0.7862

Table 4.1

i. Complete the missing row **in Table 4.1** by adding the correct values for *S. litorea*.

[3]

ii. What can you conclude about the species evenness and richness of **Ecosystem A** in comparison to **Ecosystem B**?

---**[2]**

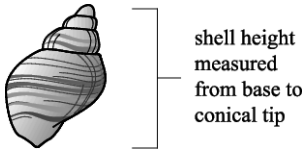
iii. Scientists planned to sample the biodiversity in another peat bog ecosystem. They identified three different areas within the ecosystem:

- an area of conifer trees (800 m^2)
- a marshy area with a high water table (2400 m^2)
- a heavily grazed area (3200 m^2)

Suggest the sampling strategy that the scientists should use and comment on the number of samples they should collect.

---**[3]**

26. The effect of wave action on the height of the shells of the dog whelk *(Nucella lapillus)* was investigated by comparing an exposed shore and a sheltered shore.



- A random sampling technique was used to collect 50 shells from an exposed shore.
- The shell height was measured from the base to the conical tip. The whelk was returned to its location.
- The process was repeated for the sheltered shore.
- All the results were recorded in **Table 3.1**.

Location	Height of shell (mm)										Range	Mean	SD
Sheltered shore	26	28	27	26	28	23	28	23	26	28			
	29	29	29	29	29	28	29	29	29	29			
	30	31	30	29	32	29	30	29	30	32			
	33	35	34	32	35	32	34	32	33	35			
	37	39	38	37	39	35	38	36	37	39	16	31.3	4.1
Exposed shore	15	17	16	15	23	15	23	16	13	15			
	17	24	18	17	17	14	17	18	16	17			
	19	19	20	24	18	20	19	20	18	20			
	23	14	24	14	21	20	23	17	21	23			
	25	25	28	26	25	27	25	28	25	27	15	20.0	4.2

Table 3.1

a. The t test can be used to determine the significance of the differences between shell height on the exposed shore and the sheltered shore.

b.

i. Calculate the *t* value for the data using the formula:

$$t = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$$

where, $|\bar{x}_1 - \bar{x}_2|$ is the difference in mean values of sample 1 and sample 2

s_1^2 and s_2^2 are the squares of the standard deviations of the samples

n_1 and n_2 are the sample sizes.

Give your answer to **two** decimal places.

Answer…… **[2]**

ii. The null hypothesis is that there is no difference between the means of the two shell populations.

The critical values at 98 degrees of freedom are shown in **Table 3.2**.

Degrees of freedom	$p = 0.10$	$p = 0.05$	$p = 0.01$	$p = 0.001$
98	1.67	2.00	2.64	3.41

Table 3.2

Using the table of critical values, explain whether the student would be able to accept or reject the null hypothesis as a result of the *t* value you calculated in part **(i)**.

_____.

_____.

_____ **[1]**

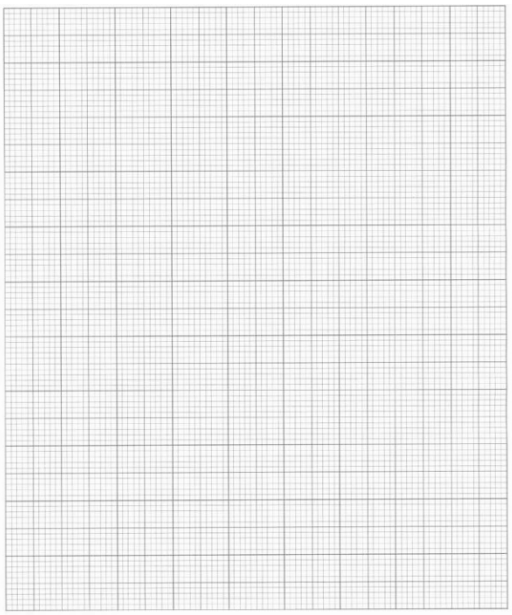
c. The students organised the data from **Table 3.1** into classes.

The organised data is shown in **Table 3.3**.

Sheltered shore			Exposed shore		
Height (mm)	**Tally**	**Total**	**Height (mm)**	**Tally**	**Total**
23–26	𝍸	5	11–14	𝍸	4
27–30	𝍸 𝍸 𝍸 II	22	15–18	𝍸 II	18
31–34	𝍸 𝍸 I	11	19–22	𝍸 𝍸 II	12
35–38	𝍸 IIII	9	23–26	𝍸 𝍸 II	12
39–42	III	3	27–30	IIII	4

Table 3.3

Plot the most suitable graph of the data given in **Table 3.3**.



[4]

d. Use the data and graph to discuss any correlation between the height of the whelk shell and the type of shore.

Suggest explanations for your findings.

[3]

e. Suggest a limitation of the procedure used to gather the data in this experiment and recommend how you could improve this.

[2]

f. How could the students improve the accuracy of their data?

[1]

g. Discuss the validity of the conclusions you have made during this experiment.

[3]

27. The Madidi National Park, in the South American rainforest, is home to a wide variety of species. The largest predator in the area is the jaguar. These large cats are well camouflaged and hunt mostly at night. A single individual can cover a very large area.

In 2007 the Wildlife Conservation Society (WCS) attempted to estimate the population of jaguars in the Madidi National Park.

- Digital camera traps were placed in areas that jaguars were likely to visit.
- If an infrared beam was broken by an animal, the camera was activated.
- The camera then took a photograph of the animal.

i. Suggest why it was **not** appropriate to estimate the number of jaguars using the capture-recapture technique.

_____

_____

_____

_____ **[2]**

ii. Most studies estimate the population density of jaguars in the South American rainforest to be 5 individuals per 100 km^2.
In the 2007 study:

- 100 camera traps were set up covering an area of 271 km^2.
- 28 images of 9 different jaguars were recorded.

How well do these results support a population estimate of 5 individuals per 100 km^2?

_____

_____

_____

_____

_____

_____

_____ **[4]**

iii. Other evidence used to estimate the jaguar population includes footprints and reports of sightings by local humans.

Suggest one disadvantage of each of these methods for estimating the size of the jaguar population.

human sightings

_____

_____

footprints

_____

_____

28.

i. Serial dilutions can be used to estimate the size of a bacterial population in a culture.

A scientist used 20 cm^3 of a bacterial culture that contained 1.0×10^6 bacterial cells.

- 5% of the 20 cm^3 culture was transferred to a new test tube and made up to 10 cm^3 with water.
- An additional ten-fold dilution was carried out, which produced a final 10 cm^3 solution.
- 0.1 cm^3 of the final 10 cm^3 solution was transferred to an agar plate.

Each colony that developed on the agar plate was assumed to represent a single bacterial cell in the bacterial culture.

Estimate the number of colonies that you would expect to develop on the agar plate.

number of colonies = ... [3]

ii. A student carried out a different serial dilution to estimate the size of another bacterial population.

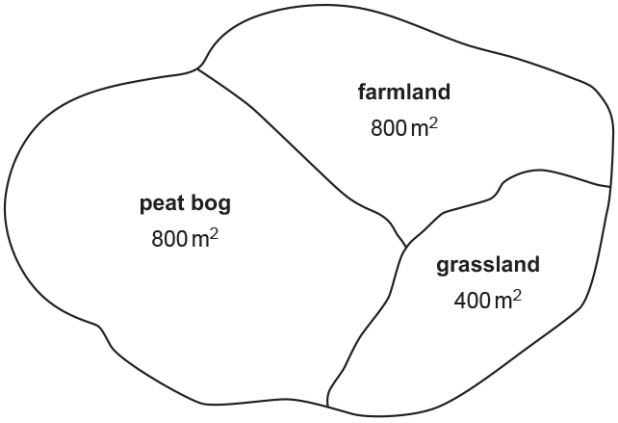
The serial dilution resulted in four colonies developing on an agar plate.

Explain why the student's estimation of this bacterial population is likely to be inaccurate.

---

[1]

29. Ecologists were studying an area that contained three different habitats. The area is shown in the diagram below.



The ecologists sampled the area to estimate insect biodiversity.

Describe how the ecologists should choose the number and locations of their samples to ensure that the sampling is representative.

Use a calculation to support your answer.

---

[3]

30. A group of students were studying a local field, Upper End Meadow. The students sampled plants from this field.

The students' results are given in Table 6.

Species	*n*
Meadow buttercup	6
Common daisy	7
Red clover	3
Ribwort plantain	8

Table 6

i. Calculate the Simpson−s Index of Diversity for Upper End Meadow.

Use the information in Table 6 and the formula:

$$D = 1 - \left(\sum\left(\frac{n}{N}\right)^2\right)$$

n = number of organisms of this species
N = total number of organisms

Show your working. Give your answer to **two significant figures**.

Answer ..... **[3]**

ii. Name a piece of equipment that you could use for the random sampling of the plants shown in Table 6.

_____ **[1]**

31(a). On a biology field trip, some students carried out a survey of butterfly species in two areas of heathland.

One part of the heathland was used regularly by walkers, while the other had been deliberately fenced off by the National Park Authority in an attempt to promote biodiversity.

Area 1 was the area accessible to walkers.
Area 2 was the fenced off area.

On two different mornings in June the students walked along a transect in each area 4 times, at 30 minute intervals, and recorded every butterfly sighting.

The aim of the survey was to compare the biodiversity of butterfly species in the two areas.

Suggest how the procedure could be improved so that a valid comparison could be made.

_____

_____

_____

_____ **[3]**

(b). The students' results are shown in Table 2.1.

	Area 1	Area 2		
Species of butterfly	**Number of individuals (*n*)**	**Number of individuals (*n*)**		
Grayling	2	5		
Large heath	16	10		
Gatekeeper	9	7		
Green hairstreak	3	5		
Silver-studded blue	0	2		
Small heath	8	11		
Simpsons Index	0.7131			

Table 2.1

i. Identify the area with the higher species **richness** and justify your answer.

Area……

Justification

---

[1]

ii. Identify the area with the higher species **evenness** and justify your answer.

Area……

Justification

---**[1]**

iii. Using the formula below, the students calculated Simpsons Index of Diversity in **Area 1** to be 0.7131.

$D = 1-(\Sigma(n/N)^2)$

Where *N* is the total number of individuals of all species.

Simpson's Index of Diversity in **Area 2** is greater than in **Area 1**.

Use the formula to show that this is the case.

You may use the blank spaces in Table 2.1 to assist in your calculations.

Answer..... **[4]**

(c). * The students concluded that “fencing off the area of heathland has increased the biodiversity of butterflies”.

Evaluate the validity of the students' conclusion using all of the information you have been given, including Table 2.1.

[6]

32. A group of students found 50 animals in a soil sample collected from Upper End Meadow and identified them as follows:

- 2 click beetles
- 24 leatherjackets
- 23 meadow ants
- 1 wireworm

What can you conclude about the species evenness shown in the soil sample? Justify your answer.

Conclusion_ _

Justification_ _

_ _

_ _

[1]

33. The Lake District is the largest National Park in England, covering an area of 2362 km^2.

It contains a wide variety of species, some of which are under threat or endangered. The resident human population is 41 000. In 2016 the Lake District received 18.4 million tourists.

The proportion of Lake District land used for different purposes is shown in Fig. 18.

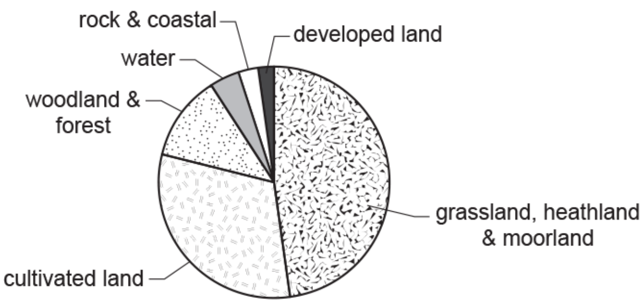


Fig. 18

Many schools visit the Lake District to undertake Biology fieldwork.

A group of students investigated the biodiversity of five herb plants they found in adjacent coppiced and mature areas of woodland in the spring of 2016.

Their results are shown in Table 18.

	Number of individuals (n)	
Species	**Coppiced**	**Mature**
Bluebell	35	46

Dog's mercury	2	12
Foxglove	5	1
Herb robert	20	4
Wood sorrel	8	4
Total	70	67

Table 18

i. The students calculated the Simpson's Index of Diversity (D) for the mature area to be 0.489.

Use the information in Table 18 to work out the Simpson's Index of Diversity (D) for the area of coppiced woodland.

Use the formula: $D = 1 - \left(\Sigma\left(\frac{n}{N}\right)^2\right)$

D = ... [3]

ii. Use the example of the students' fieldwork to explain how biodiversity can be considered at different levels.

_____

_____

_____

_____

_____

_____

_____

_____ **[3]**

34(a). The spruce pine plant is given the binomial name *Pinus glabra*.

A scientist sampled the species of trees present in two different habitats containing *Pinus glabra.*

The results of the sampling are shown in Table 5.

Species	Number of individuals in habitat A	Number of individuals in habitat B
P. glabra	45	60
M. grandiflora	23	10
F. grandiflora	55	20
L. styraciflua	0	10
L. tulipifera	0	0
S. shumardii	23	4

Table 5

Using Simpson's Index of Diversity, the scientist calculated the biodiversity (*D*) of Habitat A as 0.71.

Use the formula given to calculate the biodiversity of Habitat B.

Show your working.

State which habitat, A or B, has the greater biodiversity.

$$D = 1 - \left(\Sigma\left(\frac{n}{N}\right)^2\right)$$

D (Habitat A) = 0.71

D (Habitat B) = ...

Habitat with the greater biodiversity = ...

[2]

(b). Habitat B was situated beside a lake and showed evidence of ecological succession.

The scientist planned to investigate how the biodiversity changed from the edge of the lake to the other side of habitat B.

i. State the collective name of the animal and plant populations that are present at the end of primary succession.

_____ **[1]**

ii. Suggest how the scientist could achieve the following during their investigation:

Sample all stages of succession in the habitat
Minimise sampling bias
Sample insect biodiversity

[3]

iii. The scientist also measured primary production in both the woodland and lake habitats. Suggest the units the scientist should use to measure primary production in the two habitats.

Woodland

Lake

---

[1]

35. Two different fields, field **G** and **H**, were sampled for three common species of wildflower. The results are shown below.

	Number of individuals	
Species	**Field G**	**Field H**
Daisy	300	20
Dandelion	335	49
Buttercup	365	931
Total	1000	1000

Which of the options, **A** to **D**, is correct?

A. Field **G** will have a greater Simpson's diversity index.
B. Field **H** has greater species evenness.
C. Field **H** will have a greater Simpson's diversity index.
D. Field **G** has greater species richness.

Your answer ☐

[1]

36. The Sumatran rhinoceros, *Dicerorhinus sumatrensis*, is a rare member of the family Rhinocerotidae. These rhinoceros are now critically endangered, with only six substantial populations in the wild: four in Sumatra, one in Borneo, and one in the Malay Peninsula.

D. sumatrensis lives in rainforests. Their numbers are difficult to determine but they are estimated to number fewer than 100.

i. Suggest **two** reasons why this species is critically endangered in the wild.

_____

_____

_____

_____

_____

_____ **[2]**

ii. The remaining populations of *D. sumatrensis* are all small and are scattered in isolated areas. These are factors that might speed up the extinction of the species.

Suggest why.

_____

_____

_____

_____

_____

_____ **[2]**

iii. Captive breeding programmes with *D. sumatrensis* have been unsuccessful.

Suggest **one** other way in which zoos can contribute to the conservation of the Sumatran rhinoceros.

_____

_____

_____

_____ **[1]**

37. Individuals within populations vary. Much of this variation is under genetic control.

Two groups of scientists were studying genetic polymorphism in fruit flies.

They extracted DNA from two different species of fruit fly, A and B.

The first group of scientists studied 26 gene loci from species A. They calculated the genetic polymorphism of species A to be 0.35.

The second group of scientists studied 32 gene loci from species B. They found that 13 of the gene loci were polymorphic.

i. Calculate the proportion of genetic polymorphic gene loci of species B.

proportion = ... **[2]**

ii. Evaluate the conclusion that species B shows greater genetic polymorphism than species A.

_____

_____

_____

_____

_____

_____

_____ **[3]**

38. The genetic diversity of the moss *Polytrichum commune* was analysed in two peat bog ecosystems.

Scientists measured genetic diversity by studying three gene loci. For each gene locus, they calculated the proportion of heterozygotes in each population. These values were used as a measure of genetic diversity.

The scientists sampled 72 individuals from Population A and 48 individuals from Population B.

The results of the genetic analysis are shown in Table 4.2.

	Number of heterozygous individuals		
	Locus 1	Locus 2	Locus 3
Population A	65	69	60
Population B	42	41	40

Table 4.2

Using the data in Table 4.2, suggest which of the two populations of *P. commune* has the greater genetic diversity.

Explain your conclusion **and** show your working.

---

[2]

39. *Global biodiversity is in decline.

Human population growth, agriculture and climate change each have an effect upon biodiversity.

Explain how each of these factors contributes to the decline in biodiversity.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ **[6]**

40. Penguins are flightless birds that eat fish. Most species of penguin live near the coast of Antarctica or on the many islands that surround Antarctica.

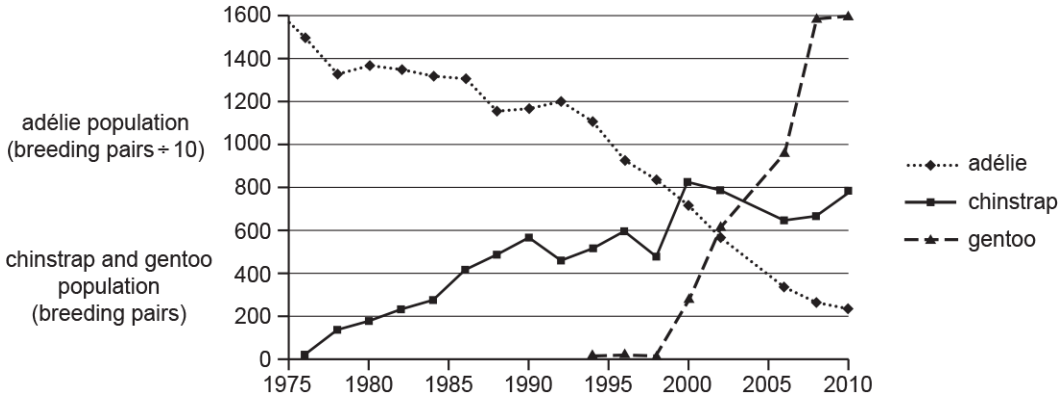


Fig. 17

Adélie penguins need a habitat that contains sea-ice. Gentoo and chinstrap penguins can survive without access to sea ice.

Scientists have claimed that the population changes in the three penguin species on the island suggests that the Antarctic temperature is increasing.

i. Discuss whether the information in Fig. 17 supports the scientists' claim.

You should refer to the data in Fig. 17 in your answer.

---

[3]

ii. Scientists working in the local area monitored water temperatures and populations of other water animals around the island between 1976 and 2010.

Suggest **two** further pieces of evidence that the scientists might have found to support their claim.

1 _____.

_____.

2 _____.

_____.

[2]

41. The Scottish wildcat and European wildcat are both classified in the same species, *Felis silvestris*. Researchers have suggested that both wildcats originated from the same population.

During the Ice Age, the British Isles were connected by ice to mainland Europe.

- After the Ice Age, sea levels rose and the British Isles became isolated from the rest of Europe.
- The isolated population of wildcats in the British Isles developed slightly different characteristics from the mainland population in Europe.
- A subspecies is a group of individuals that is geographically isolated from others of the same species and that is distinguishable from other populations of the same species.
- The Scottish wildcat is now classified as the subspecies *Felis silvestris grampia* and the European wildcat as the subspecies *Felis silvestris silvestris*.

By the 19th century, the wildcat population in the British Isles had decreased as it had been under threat from deforestation and hunting. The wildcat could only be found in Scotland.

i. Suggest one reason why the wildcat was hunted.

_____

_____ **[1]**

ii. * Current estimates of the Scottish wildcat population vary. Recent reports by the Scottish Wildcat Association indicate that fewer than 100 individuals, possibly as few as 35, remain in the wild. These individuals occur only in the most remote, uninhabited areas of the Scottish Highlands.

Biodiversity can be considered at several levels. A scientist concluded that the biodiversity of the

Scottish Highlands would continue to reduce because of the small population of Scottish wildcats.

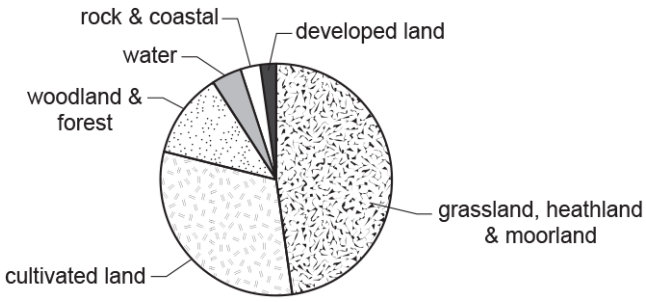
Evaluate the scientist's conclusion with reference to genetic biodiversity and species biodiversity.

[6]

42. The Lake District is the largest National Park in England, covering an area of 2362 km^2.

It contains a wide variety of species, some of which are under threat or endangered. The resident human population is 41 000. In 2016 the Lake District received 18.4 million tourists.

The proportion of Lake District land used for different purposes is shown in Fig. 18.



Explain **one** way in which tourists can lead to an increase in the biodiversity of an area.

_____

_____

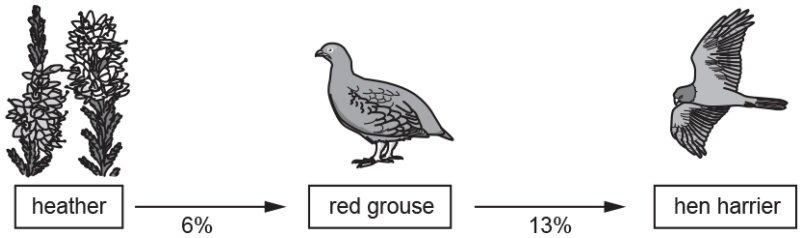
_____

_____ **[2]**

43. Heather is a plant with a woody stem that grows on upland areas of the UK such as the North York Moors. These areas are often described as heather moorland.

Heather moorland is a habitat that is relatively common in the UK but rare elsewhere in the world.

The diagram shows an example of biomass transfer in a heather moorland ecosystem.



The numbers below the arrows represent the percentage of biomass transferred to the species shown in the next trophic level.

The hen harrier is the top predator on heather moorland in the UK.

Scientists are concerned about a recent decrease in the population of hen harriers.

The current estimate of the hen harrier population in the UK is 545 pairs. This represents 71% of the estimated population in 2004.

i. Calculate the estimated population of UK hen harriers in 2004.

Estimated population = ... pairs **[2]**

ii. Since 2004, the population of red grouse in the UK has been relatively stable and it is not thought that the population has been affected by changes in climate.

Suggest an explanation for the decrease in hen harrier numbers since 2004.

---**[1]**

44. The cassowary is a large, flightless bird found in the rainforest in parts of Australia. It feeds mainly on fruit. The seeds of the fruit are deposited on the rainforest floor.

i. The cassowary is known as a *keystone species*. This means it is important for the survival of other species.

Suggest what role the cassowary plays in the survival of other species.

---**[1]**

ii. The cassowary needs to be conserved for ecological reasons.
State **two** other reasons for maintaining biodiversity.

1

2
---

[2]

45.

Termites such as the species that built the mound in **Fig. 5.1** on the insert can be classed as 'keystone species'.

Fig. 5.1

Use the information given to state one argument that supports this statement and one argument that does not.

---**[2]**

46. In 2019, scientists discovered a source of a new antibiotic in the roots of a wild bean plant, *Phaseolus vulgaris*, in Los Tuxtlas, Mexico.

The antibiotic, phazolicin, was extracted from the roots of the wild bean plant.

i. Suggest **one** feature of a bacterium the phazolicin might attack.

---**[1]**

ii. Explain the importance of maintaining biodiversity for the discovery of new antibiotics like phazolicin.

---**[2]**

47. The Scottish wildcat and European wildcat are both classified in the same species, *Felis silvestris*. Researchers have suggested that both wildcats originated from the same population.

During the Ice Age, the British Isles were connected by ice to mainland Europe.

- After the Ice Age, sea levels rose and the British Isles became isolated from the rest of Europe. The isolated population of wildcats in the British Isles developed slightly different characteristics from the mainland population in Europe.
- A subspecies is a group of individuals that is geographically isolated from others of the same species and that is distinguishable from other populations of the same species.
- The Scottish wildcat is now classified as the subspecies *Felis silvestris grampia* and the European wildcat as the subspecies *Felis silvestris silvestris*.

With Scottish wildcat numbers at their lowest ever, decisive action has been taken.

In the West Highlands of Scotland, remote land has been targeted to establish a wildcat haven. The land chosen is mostly surrounded by sea, far away from other populations.

Table 3 lists some details of the action that has already been taken and will be taken in the future to protect the Scottish wildcat.

A	The wildcat haven has been established in an area of land mostly surrounded by sea.
B	Over the past few years all domestic cats, wild cats and Scottish wildcats in the area have been neutered.
C	Over the past few years all domestic cats, wild cats and Scottish wildcats in the area have been checked for disease.
D	In the near future, Scottish Natural Heritage and Chester Zoo plan to establish a breeding and release project for pure-bred Scottish wildcats.

Table 3

Indicate which of the **letter or letters**, **A** to **D**, in Table 3 apply to each of the following statements.

i. An example of ex-situ conservation.

_____ **[1]**

ii. Helps to prevent the domestic and wild cats mixing freely with the Scottish wildcats in the haven.

_____ **[1]**

iii. Contributes to maintaining a healthy population in the wildcat haven.

_____ **[1]**

iv. Contributes to maintaining the genetic purity of the Scottish wildcat.

_____ **[1]**

48. Listed below are three approaches, A, B and C, that can be taken to maintain biodiversity:

A	*ex situ* conservation
B	*in situ* conservation
C	preservation

For each of the statements below, indicate whether it could be consistent with *in situ* conservation, *ex situ* conservation or preservation by inserting the correct **letter or letters** in the table.

	Approach
organisms are **not** removed from their natural habitat	
human intervention is happening	

[2]

49.

i. The biomass of large fish in the Southern Ocean is a food resource for humans. It is increasingly harvested by powerful, long-distance trawlers. If over-exploited, the Southern Ocean ecosystem may be permanently altered.
   - Suggest two measures that an international treaty might impose, to prevent fishing from causing permanent damage to the Southern Ocean.
   - Identify the practical difficulties that might prevent your two measures from being effective.

First measure_ _

_ _

Difficulty_ _

_ _

Second measure_ _

_ _

Difficulty_ _

_ _

[4]

ii. Krill can also be harvested as a human food source.
The fishing industry aims to harvest large fish.
Some environmentalists say that krill harvesting should be increased.

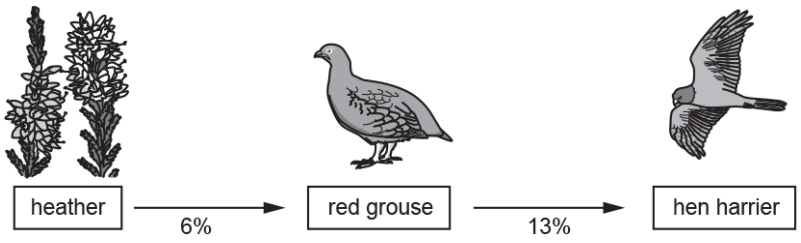
Use this information and **Table 21.1** to put forward arguments for and against harvesting krill instead of large fish as a human food source.

---**[2]**

50. Heather is a plant with a woody stem that grows on upland areas of the UK such as the North York Moors. These areas are often described as heather moorland.

Heather moorland is a habitat that is relatively common in the UK but rare elsewhere in the world.

The diagram shows an example of biomass transfer in a heather moorland ecosystem.



The numbers below the arrows represent the percentage of biomass transferred to the species shown in the next trophic level.

Heather moorland in the UK is managed in an attempt to conserve the habitat. One of the procedures carried out as part of this management is regular burning of the moorland. Small areas are burnt in the winter and new shoots begin to grow the following year. This helps to maintain a variety of heights of heather plants, and prevents the growth of other larger species of plant.

i. State why the management of heather moorland is known as *in situ* conservation.

---**[1]**

ii. Apart from regular burning, suggest another procedure that could be carried out to conserve the heather moorland habitat.

---**[1]**

51. The mountain gorilla is an endangered species with as few as 880 individuals surviving in the wild. Many of the animals have been 'habituated' to human contact. The health of these animals is monitored and medical assistance is given when necessary. Animals that are not habituated are rarely visited.

i. Suggest one advantage **and** one disadvantage of keeping some gorilla families that have not been habituated.

---**[2]**

ii. The gorilla population in one area, Virunga, has been regularly monitored (**Table 24.1**). The data have been collected by indirect methods such as collecting dung samples at nest sites. However, DNA analysis of another gorilla population suggests that estimates made by these indirect methods may be up to 6% inaccurate.

Year	Population in Virunga
1981	254
1989	320
2003	380
2010	480

Table 24.1

Calculate the mean annual percentage rate of growth of the gorilla population in Virunga between 1981 and 2010.

Show your working.

Answer …… % **[2]**

iii. In 1993 the Rio Convention on Biodiversity came into force. In 2010, one conservationist commented that the Rio Convention had had a real effect on the gorilla population.

Use the information above to evaluate the effect that the Rio Convention on Biodiversity has had on the gorillas in Virunga.

---**[3]**

52(a). Elephants are protected by the treaty known as the Convention on International Trade in Endangered Species (CITES).

Fig. 5 shows the approximate percentages of elephants that were killed illegally in three different regions of Africa.

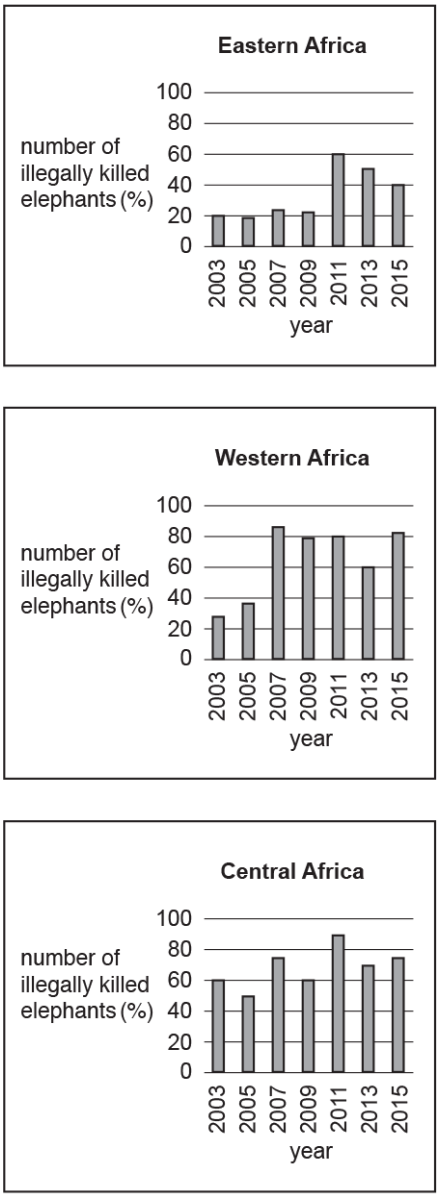


Fig 5

John Scanlon, the Secretary-General of CITES in 2015, made the following statement:

> "African elephant populations continue to face an immediate threat to their survival from unacceptably high-levels of poaching for their ivory, especially in Central and West Africa where high levels of poaching are still evident. There are some encouraging signs, including in certain parts of Eastern Africa... showing us all what is possible through a sustained and collective effort..."

Give two pieces of evidence to show how the data in Fig. 5 support the statement made by John Scanlon.

Evidence 1 ____

____

____

____

Evidence 2 ____

____

____

____

[2]

(b).

i. Give **one** aim of CITES.

____

____

____ **[1]**

ii. Between 1913 and 2013 the approximate worldwide population of living elephants dropped from 10 000 000 to 500 000.

Calculate how many orders of magnitude smaller the elephant population is likely to be in 2213 compared to 1913.

Assume that the elephant population continues to decline at the same rate each 100 years.

Show your working.

Answer .... **[2]**

53. Conservation agreements can be national (within a particular country) or international.

Three conservation agreements are listed in the table below.

Place ticks (✓) in the correct boxes to indicate which features are true for each of the three conservation agreements.

Name of agreement	International agreement	Farmers are offered payments for conservation
Environmental (Countryside) Stewardship Scheme		
Convention on International Trade in Endangered Species		
Rio Convention on Biological Diversity		

[2]