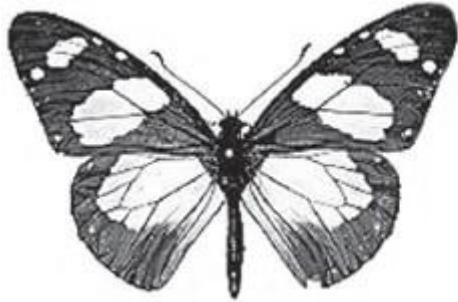


1 The drawings show two different species of butterfly.



Amauris



Hypolimnas

- Both species can be eaten by most birds.
- *Amauris* has an unpleasant taste which birds do **not** like, so birds have learned **not** to prey on it.
- *Hypolimnas* does **not** have an unpleasant taste but most birds do **not** prey on it.

(a) Suggest why most birds do **not** prey on *Hypolimnas*.

(2)

(b) Suggest an explanation, in terms of natural selection, for the markings on the wings of *Hypolimnas*.

(3)

(Total 5 marks)

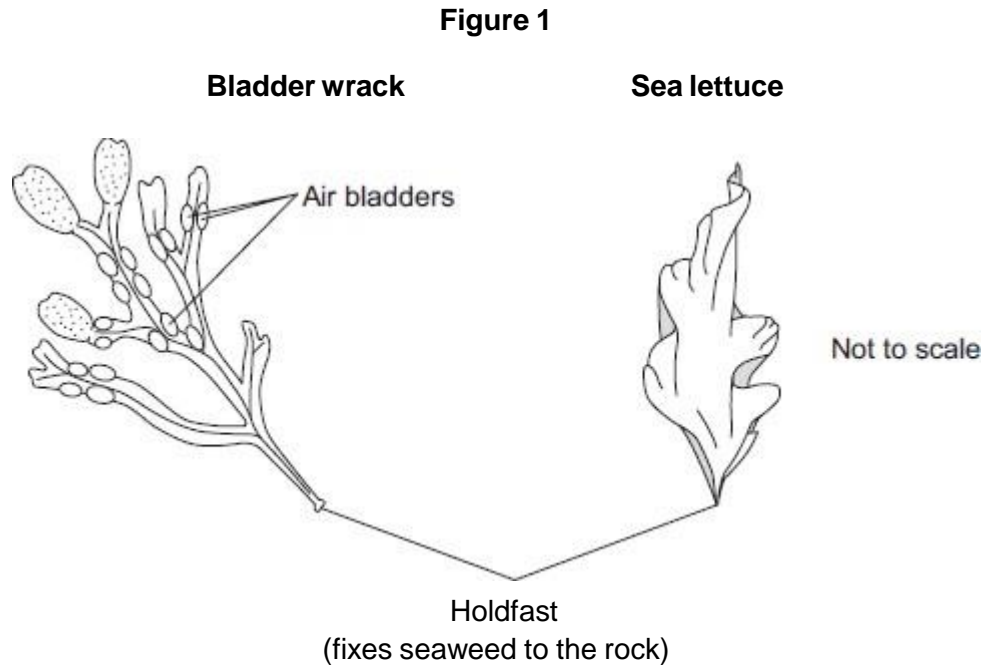
2

At the seashore, the tide comes in and goes out twice each day.

Some students investigated whether two different species of seaweed could live only at certain positions on a rocky shore.

Seaweeds are plant-like organisms that make their food by photosynthesis.

Figure 1 shows the two species of seaweed that the students investigated.



(a) The students:

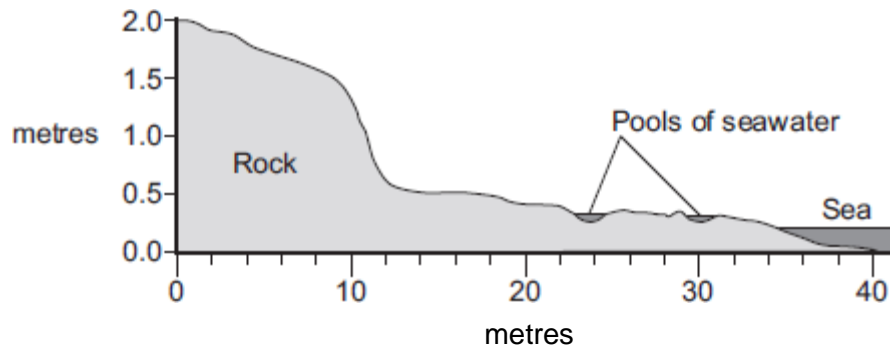
- 1 placed a 50-metre tape measure on the rocks at right angles to the sea
- 2 placed a quadrat next to the tape measure
- 3 recorded whether each species was present or not.

The students repeated steps 2 and 3 every metre down the shore.

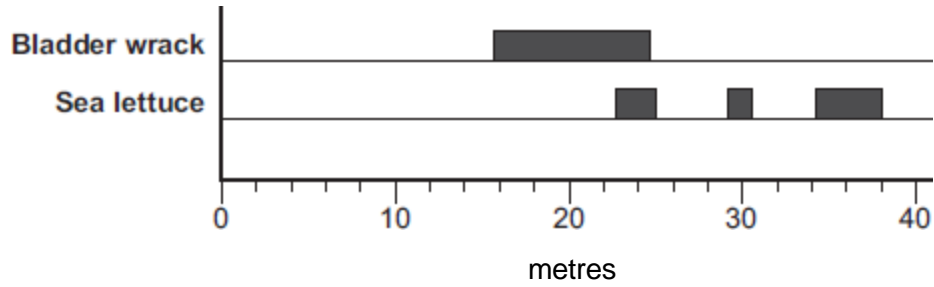
Figure 2 shows a section of the seashore and the students' results.

Figure 2

Section of the seashore



Students' results



- (i) The students placed the quadrat at regular intervals along a transect line rather than placing the quadrat at random positions anywhere on the rocky shore.

Explain why.

(2)

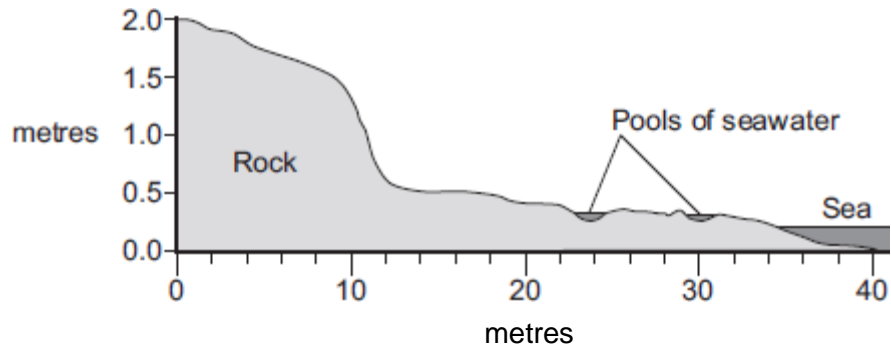
- (ii) How could the students have improved their investigation to ensure that they produced valid data?

(2)

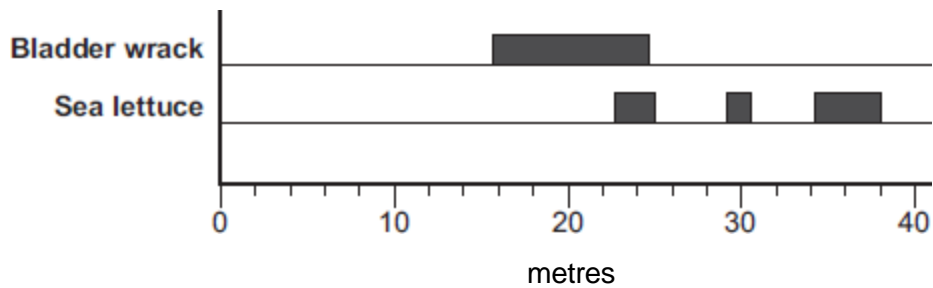
(iii) **Figure 2** is repeated here to help you answer this question.

Figure 2

Section of the seashore



Students' results



The students concluded that bladder wrack is better adapted than sea lettuce to survive in dry conditions.

What is the evidence for this conclusion?

Use information from **Figure 2**.

(2)

- (b) The bladder wrack has many air bladders.
The air bladders help the bladder wrack to float upwards when the sea covers it.

Suggest how this helps the bladder wrack to survive.

(2)
(Total 8 marks)

3 Squirrels live in woodland.

Table 1 shows:

- the total area of England, Scotland and Wales
- the area of different types of woodland in these countries.

Table 1

Country	Total area of country in thousands of km ²	Area of woodland in thousands of km ²		
		Coniferous woodland	Broadleaf woodland	Total
England	130	3.6	7.8	11.4
Scotland	79	10.4	3.0	13.4
Wales	21	1.9	0.9	2.8

- (a) Look at the data for the three countries. Estimate which country has the greatest proportion of its area suitable as a habitat for squirrels.

Support your answer with relevant figures.

(2)

- (b) The maps show the distribution of grey squirrels and red squirrels in England, Scotland and Wales.

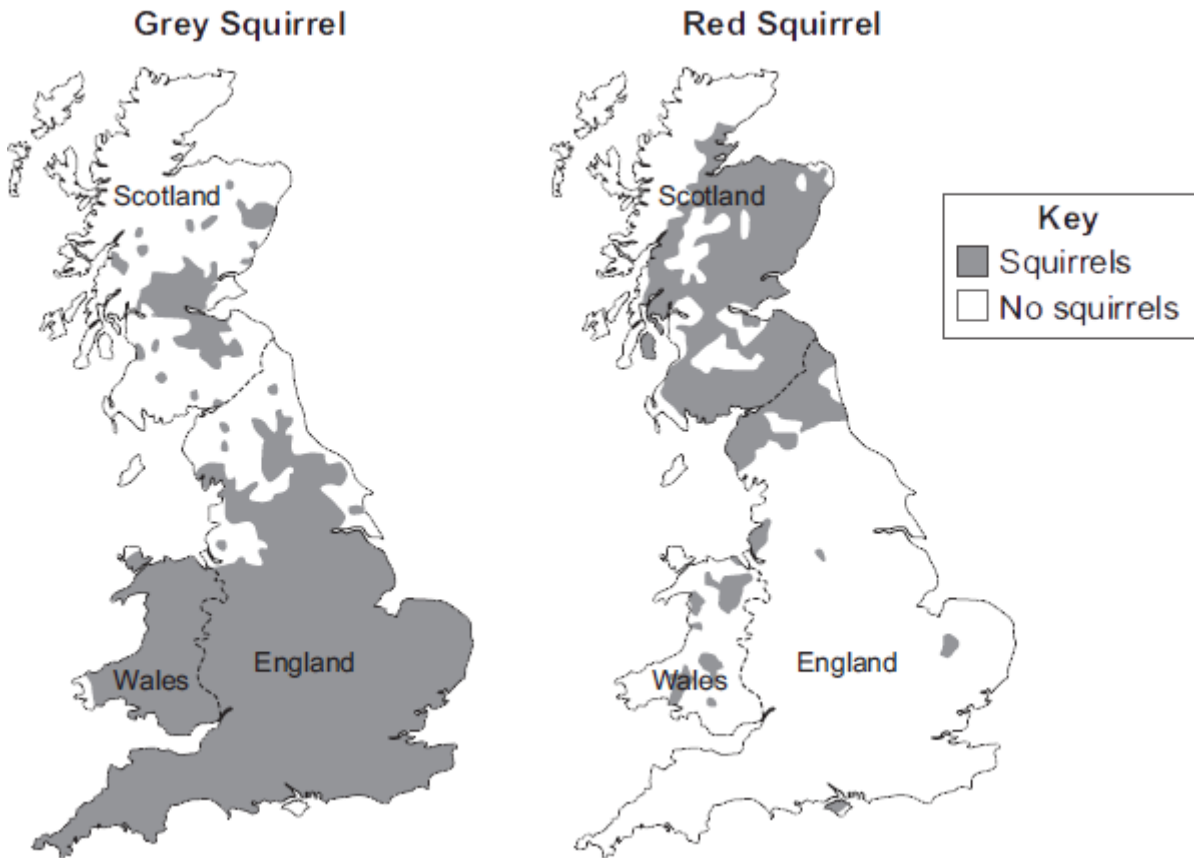


Image under Crown Copyright and courtesy of Pepper & Patterson, 2001.
Contains public sector information licensed under the Open Government Licence v1.0

Scientists suggested that the distribution of grey squirrels and red squirrels is linked to the type of trees in woodlands.

- (i) The information for England and Scotland supports this suggestion.

How?

(1)

- (ii) Give **one** piece of evidence that contradicts this suggestion.

(1)

- (c) Red squirrels are native to the UK.
Grey squirrels were introduced to the UK from the USA over 100 years ago.

Table 2 gives information about the two types of squirrel.

Table 2

	Grey squirrel	Red squirrel
Population in UK	2.5 million	140 000
Main food types	Seeds, nuts, tree bark, birds' eggs, young birds	Cones from coniferous trees, nuts, tree bark, berries
Health	Can become immune to parapox virus	Cannot become immune to parapox virus
Reproduction	Up to 9 young, twice a year	Up to 6 young, twice a year
Survival rate of young in mixed populations	41 %	14 %
Length of life	2 – 4 years	Up to 7 years

In most parts of the UK the population of grey squirrels is increasing, but the population of red squirrels is decreasing.

Suggest why.

Use information from **Table 2**.

(3)
(Total 7 marks)

4 Human activities affect the environment.

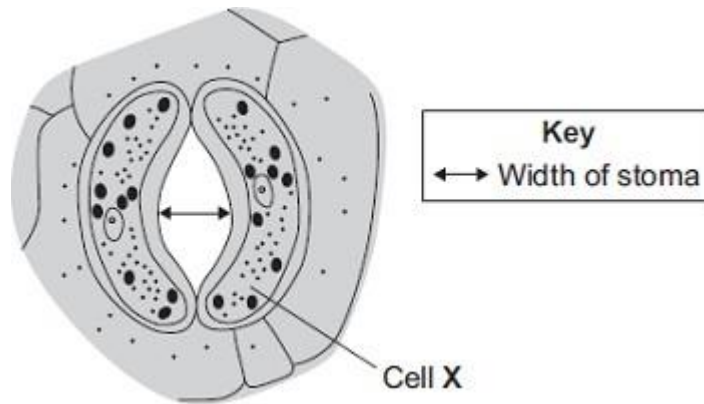
(a) Deforestation results in an increase in carbon dioxide levels in the atmosphere.

Give **two** reasons why.

(2)

5

Plant leaves have many stomata.
The diagram shows a stoma.



(a) Name cell X _____

(1)

(b) The table shows the mean widths of the stomata at different times of the day for two different species of plant.
Species **A** grows in hot, dry deserts.
Species **B** grows in the UK.

	Time of day in hours	Mean width of stomata as a percentage of their maximum width	
		Species A	Species B
Dark	0	95	5
	2	86	5
	4	52	6
Light	6	6	40
	8	4	92
	10	2	98
	12	1	100
	14	0	100
	16	1	96
	18	5	54
Dark	20	86	6
	22	93	5
	24	95	5

The data in the table show that species **A** is better adapted than species **B** to living in hot, dry deserts.

Explain how.

(4)

(Total 5 marks)

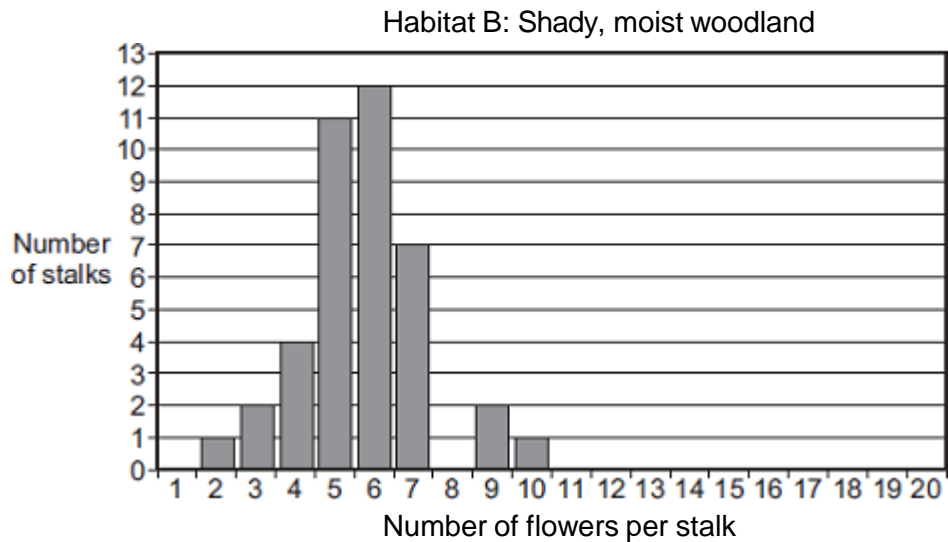
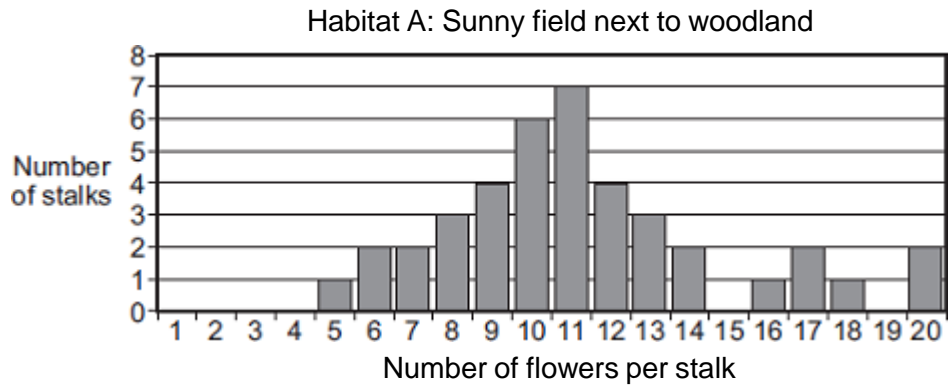
6 Some students studied bluebell plants growing in two different habitats.

Habitat A was a sunny field next to woodland.

Habitat B was a shady, moist woodland.

A bluebell plant can have several flowers on one flower stalk. The students counted the number of flowers on each of 40 bluebell flower stalks growing in each habitat.

The bar charts show the results.



- (a) The students wanted to collect valid data.
Describe how the students should have sampled the bluebell plants at each habitat to collect valid data.

(2)

- (b) (i) The students used the bar charts to find the mode for the number of flowers per stalk in the two habitats.

The mode for the number of flowers per stalk in habitat **A** was 11.

What was the mode for the number of flowers per stalk in habitat **B**?

Mode = _____

(1)

- (ii) The students suggested the following hypothesis:

'The difference in the modes is due to the plants receiving different amounts of sunlight.'

Suggest why.

(2)

- (iii) Suggest how the students could test their hypothesis for the two habitats.

(2)

- (c) Suggest how receiving more sunlight could result in the plants producing more flowers per stalk.

(2)

(Total 9 marks)

7 Darwin suggested the theory of natural selection.

(a) Explain how natural selection occurs.

(3)

(b) Latitude is a measure of distance from the Earth's equator.

Scientists investigated the effect of latitude on:

- the time taken for new species to evolve
- the number of living species.

The table shows the scientists' results.

Latitude in degrees North of equator	Time taken for new species to evolve in millions of years	Relative number of living species
0 (at the equator)	3–4	100
25	2	80
50	1	30
75 (in the Arctic)	0.5	20

As latitude increases environmental conditions become more severe.

(i) Describe the patterns shown by the data.

(2)

(ii) Suggest explanations for the patterns you have described in part (b)(i).

(2)

(Total 7 marks)

8

The photographs show four different species of bird.

Great tit



© JensGade/iStock

Blue tit



© Marcobarone/iStock

Coal tit



© MikeLane45/iStock

Long-tailed tit



© AndrewHowe/iStock

The table gives information about the four species of bird in winter.

Bird species	Mean body mass in grams	Mean energy needed in kJ per day	Mean percentage of day spent feeding
Great tit	21	84.2	75
Blue tit	12	62.4	81
Coal tit	9	49.5	88
Lond-tailed tit	7	42.0	92

(a) (i) Calculate the energy needed per day per gram of body mass for the blue tit.

Answer = _____ kJ per day per gram of body mass

(2)

- (ii) Describe the trend for energy needed per day per gram of body mass for the four species of bird.

(1)

- (iii) Suggest an explanation for the trend you have described in part (a)(ii).

(2)

- (b) Describe and explain the trend shown by the data for the time spent feeding in winter for the birds.

(2)

(Total 7 marks)

9

On a rocky shore, when the tide goes in and out, organisms are exposed to the air for different amounts of time.






- (a) On hot, windy days when the tide is out the concentration of the salt solution in rock pools may become very high.

What term is used to describe organisms that can survive in severe conditions such as very high concentrations of salt solution?

(1)

- (b) Periwinkles are types of snail.
Students surveyed the different types of periwinkle living on a rocky shore.

The diagram shows the results of the students' survey.
The highest position that the sea water reaches on the shore is called the high tide level.
Each bar represents the range of habitats for each type of periwinkle.

Position on shore	Small periwinkle	Rough periwinkle	Common periwinkle	Flat periwinkle
High tide level  Low tide level				

- (i) Which **two** types of periwinkle are likely to compete with each other to the greatest extent?

(1)

- (ii) Explain your answer to part (b)(i).

(1)

- (iii) The small periwinkle can survive much nearer to the high tide level than the flat periwinkle.

Suggest **two** reasons why the flat periwinkle cannot survive near to the high tide level.

1. _____

2. _____

(2)

(Total 5 marks)

Mark schemes

- 1** (a) wing pattern similar to *Amauris*
allow looks similar to Amauris 1
- birds assume it will have an unpleasant taste 1
- (b) mutation / variation produced wing pattern similar to *Amauris*
do not accept breeds with Amauris
do not accept idea of intentional adaptation 1
- these butterflies not eaten (by birds) 1
- these butterflies breed **or** their genes are passed to the next generation 1
- [5]**
- 2** (a) (i) to get data re position of seaweed / of organism 1
- in relation to distance from sea / distance down shore / how long each seaweed was exposed 1
- (ii) repeat several times
minimum = 2 repeats 1
- elsewhere along the shore 1
- (iii) bladder wrack is further up the shore (than the sea lettuce) / exposed for longer
ignore found in dry areas / on bare rock 1
- sea lettuce (only) in rock pools / in the sea / (only) in water 1
- (b) gets more light / closer to light
allow better access to CO₂ 1
- (so) more photosynthesis
allow 1 mark for light for photosynthesis
allow 1 mark for CO₂ for photosynthesis
ignore reference to oxygen for respiration
'more' only needed once for 2 marks 1
- [8]**

3 (a) Scotland 1

any **one** from

- Scotland 15 to 20% / about $1/5^{\text{th}}$ to $1/7^{\text{th}}$ but England and Wales / the others are less / lower / reasonable estimated figures
- $\frac{13.4}{79}$ is greater than England / $\frac{11.4}{130}$ and Wales / $\frac{2.8}{21}$

1

(b) (i) broadleaf woodlands have more grey squirrels **or** broadleaf woodlands have less red squirrels

allow converse referring to conifers

1

(ii) Wales has more conifers and / but more grey squirrels **or**

Wales has less broadleaf and / but more grey squirrels

allow converse for red squirrels

1

(c) any **three** from:

answers must be comparative they = grey squirrels

grey squirrels

allow converse arguments for red squirrels

- have wid er range/ more types of food
- are resistant to parapox (virus) but reds are not
ignore reference to other disease
- have more young each year / litter
- young more likely to survive (in mixed populations)

3

[7]

4 (a) any **two** from:

- fewer trees to take in carbon dioxide for photosynthesis
- decomposers / microorganisms respire (as they decay debris) releasing carbon dioxide
- burning of wood releases carbon dioxide

allow carbon dioxide released by burning fossil fuels in vehicles / factories

2

(b) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a 'best – fit' approach to the marking.

0 marks

No relevant content.

Level 1 (1 – 2 marks)

There is a brief description of some steps in the process but the order is not clear with little biological vocabulary used.

Level 2 (3 – 4 marks)

There is a reasonably clear description of the process involving many of the steps and using some biological vocabulary.

Level 3 (5 – 6 marks)

There is a clear, logical and detailed scientific description of the process using appropriate biological vocabulary.

examples of biology points made in the response:

- this contains mineral ions (and organic matter)
- this increases growth of algae / water plants
- the plants / algae (underneath) die
- due to lack of light / photosynthesis / space
- decomposers / microorganisms feed on decaying matter **or** multiply rapidly
- the respiration of decomposers uses up all the oxygen
- so invertebrates die due to lack of oxygen
- this is called eutrophication

6

[8]

5

(a) guard cell

ignore stoma / stomata

1

(b) Species A:

allow converse points for species B

stomata open in dark / at night **or** close in light / in day

1

stomata closed during warm(est) period **or** open when cool(er)

1

heat (energy) / warmth increases evaporation / transpiration

must give explicit link between heat and transpiration

1

reduces water loss / evaporation / transpiration

ignore photosynthesis

1

[5]

- 6 (a) use of quadrat / point frame
allow description 1
- randomly placed / random sampling
ignore reference to transects 1
- (b) (i) 6 1
- (ii) more light in A / in field / where sunny
ignore sun 1
- more / better / faster photosynthesis in A / with more light
allow converse 1
- (iii) use light meter / measure light intensity in both habitats 1
- take many measurements at same time of the day 1
- or**
- laboratory / field investigation with 2 batches high light and low light (1)
- count or number of flowers in each (1)
- counting point is dependent on investigation point*
- (c) more glucose / energy available
allow other named product eg protein
allow if more energy produced 1
- for growth
dependent on 1st mark 1
- 7 (a) variation (between organisms within species)
allow described example
*allow mutation – but **not** if caused by change in conditions* 1
- those most suited / fittest survive 1
- genes / alleles passed on (to offspring / next generation)
allow mutation passed on 1

[9]

(b) (i) any **two** from:

allow converse

- increase in latitude reduces number of (living) species
ignore references to severity of conditions
- increase in latitude reduces time for evolution (of new species)
- the less the time to evolve the fewer the number of (living) species

2

(ii) any **two** from:

*do **not** accept intention or need to evolve*

- (increase in latitude reduces number of (living) species because) less food / habitats / more competition at high latitude
allow only extremophiles / well-adapted species can survive
- (increase in latitude reduces time for evolution (of new species) because) severe conditions act more quickly / to a greater extent on the weakest
- (the less the time to evolve the fewer the number of (living) species because) species that evolve slowly don't survive

2

[7]

8

(a) (i) 5.2

award 2 marks for correct answer, irrespective of working or lack of it

award 1 mark for $62.4 \div 12$ only with incorrect or no answer

2

(ii) the smaller the (mass of the) bird the more energy is needed (per gram of body mass)

allow converse

ignore figures

1

(iii) smaller bird has larger surface area : volume / mass ratio

allow converse

1

so heat / energy lost more quickly

allow lose more heat / energy

if (a)(ii) describes a trend of more energy with increasing body mass

*allow **one** mark for idea of more energy needed for flight*

1

(b) larger birds spend less time feeding

accept converse

allow the less energy they need per day the longer they spend feeding

1

since they need less food per gram of body mass (to satisfy energy needs)

1

[7]

9

(a) extremophile(s)

1

(b) (i) common (periwinkle) and flat (periwinkle)

either order, both required

1

(ii) (common and flat) both live in the same habitat / area / named area

allow habitats overlap the most

1

(iii) any **two** from:

- would have wrong food
- would otherwise be exposed to (specific) predators
- cannot tolerate extended exposure to air **or** reduced submersion in seawater
allow cannot tolerate temperature / dehydration
- cannot tolerate high salt concentration (in rock pools)
allow low salt concentration (in rock pools)
- cannot compete with small periwinkle

2

[5]