



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2018

Centre Number

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Candidate Number

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Biology

StemUp Model Solution

Assessment Unit AS 2

assessing

Organisms and Biodiversity



[SBY21]

SBY21

WEDNESDAY 30 MAY, AFTERNOON

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Complete in black ink only. **Do not write with a gel pen.**

Answer **all eight** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 75.

Section A carries 60 marks. Section B carries 15 marks.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

You are reminded of the need for good English and clear presentation in your answers.

Use accurate scientific terminology in all answers.

You should spend approximately **20 minutes** on Section B.

You are expected to answer Section B in continuous prose.

Quality of written communication will be assessed in Section B.

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Section A

1 A variety of substances are required by living organisms in order to function.

Identify the substances described below:

- reduces surface tension in the moisture layer in the alveoli.

Surfactant

- directly converts fibrinogen to fibrin.

Thrombin

- waterproof component of the Casparian strip in the endodermis.

Suberin

- an oxygen store in red muscle.

Myoglobin

- carbohydrate transported by the phloem.

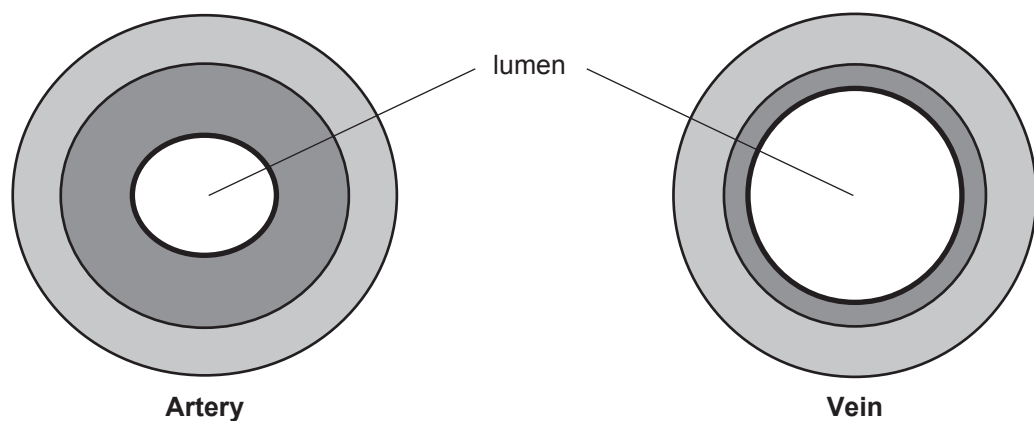
Sucrose

[5]

[Turn over



2 The diagram below represents sections through an artery and a vein.



(a) Describe and explain **two** structural differences shown between the artery and vein.

1. Arteries have thicker walls with more smooth muscle and elastic tissue, to withstand the high pressure blood and to allow stretch and recoil.

2. Veins have a larger lumen, which reduces friction (resistance) to the flow of the low pressure blood.

[2]



- (b) (i) Distinguish between the terms 'atherosclerosis' and 'atheroma', and explain their effect on blood flow in the artery.

Atherosclerosis is the disease in which the artery wall becomes thickened and hardened (reduced elasticity) due to the development of atheromas (plaques).

An atheroma is the build-up of fatty deposits (cholesterol) under the endothelium of the artery wall.

Atheromas narrow the lumen of the artery and restrict blood flow, making blockages (blood clots) more likely.

[3]

- (ii) The blood vessels of the heart can be investigated to diagnose atherosclerosis by injecting radioactive dye and taking an X-ray.

Name this procedure and the blood vessels involved.

Test *Angiography (angiogram)*

Blood vessels *Coronary arteries*

[2]

- (c) Capillaries are involved in the production of tissue fluid.

State the difference in composition between tissue fluid and blood.

Tissue fluid is plasma without the blood cells (and platelets) and without the large plasma proteins.

[1]

[Turn over]



3 Fick's Law shows how three factors affect the rate of diffusion:

$$\text{diffusion rate} \propto \frac{\text{surface area} \times \text{difference in concentration}}{\text{thickness of membrane}}$$

- (a) Compare and contrast **one** factor from Fick's Law as it relates to the gas exchange organs in plants and mammals. In your answer make reference to the structures involved.

Compare Both have a large surface area for gas exchange.

Contrast In plants the large surface area is provided by the spongy
mesophyll cells and air spaces of the leaf, whereas in mammals it is
provided by millions of lobed alveoli in the lungs.

[2]





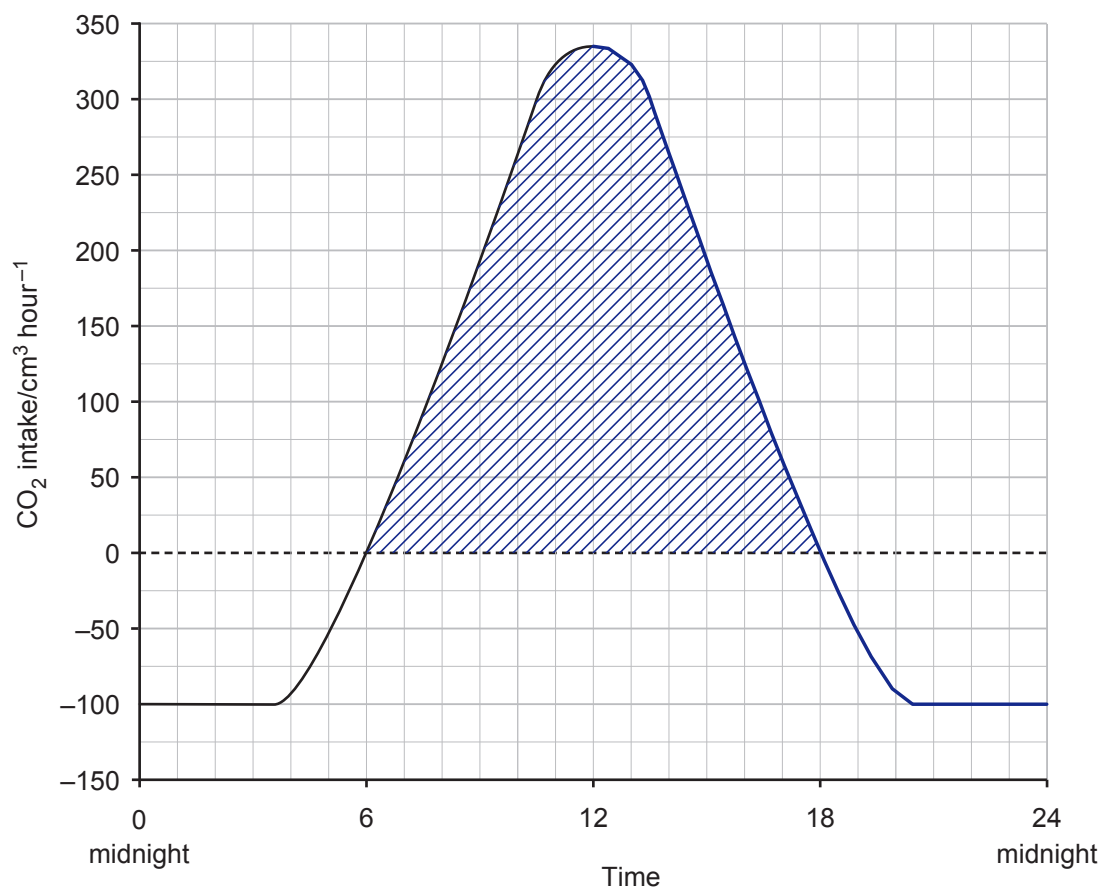
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(b) Below is a partially drawn graph showing the net carbon dioxide intake by a plant over the first 12 hours of a 24-hour period.



(i) Complete the graph to show the expected carbon dioxide intake for 12–24 hours. [2]

(ii) Describe and explain the carbon dioxide intake shown for 0–12 hours.

From 0 to 4 hours the CO_2 intake is negative ($-100 \text{ cm}^3 \text{ hour}^{-1}$), so

CO_2 is given out, because the plant is in darkness so only respiration is occurring.

At 6 hours there is no net intake or output of CO_2 ; this is the compensation point, where the rates of photosynthesis and respiration are equal.

From 6 to 12 hours CO_2 intake increases to about $335 \text{ cm}^3 \text{ hour}^{-1}$, because light intensity increases, so the rate of photosynthesis exceeds the rate of respiration.

[4]

(iii) Shade on the graph the area which represents a net gain in glucose.

Explain your answer.

The shaded area is above the zero line (6 to 18 hours), where there is net CO_2 intake, so glucose production in photosynthesis exceeds glucose loss in respiration.

[2]

[Turn over]



- 4 Biodiversity can be measured using Simpson's Index. An investigation was carried out to assess the biodiversity of plant species in three fields. Five 1m² quadrats were used in each field and the mean numbers of plants of five species were calculated. The results of the investigation and the calculated Simpson's Index for two of the fields are shown in the table below.

Plant species	Mean number of plants		
	Field A	Field B	Field C
common daisy	2	8	2
dandelion	1	13	1
meadow buttercup	2	9	5
white clover	8	11	15
rye grass	21	12	5
Simpson's Index	0.43	0.19	0.33

The formula for calculating Simpson's Index is:

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

where N = the total number of all organisms

n_i = the number of organisms of each individual species

- (a) (i) Using the values given and the formula above, calculate the Simpson's Index for **Field C**.

(Show your working.)

$$\sum n(n-1) = (2 \times 1) + (1 \times 0) + (5 \times 4) + (15 \times 14) + (5 \times 4)$$

$$= 2 + 0 + 20 + 210 + 20 = 252$$

$$N = 28, N(N-1) = 28 \times 27 = 756$$

$$D = 252 \div 756 = 0.33$$

0.33

[2]



(ii) Identify the field with the highest biodiversity.

Field B

[1]

(iii) Although **Field A** and **Field B** each contains all five species investigated, they are not considered equally diverse. Explain why.

In Field B the numbers of each species are similar (high species evenness), so no single species dominates.

Field A is dominated by rye grass (21 of its 34 plants), so its diversity is lower.

[2]

(b) Suggest **two** possible sources of error in this investigation.

1. *Misidentification of species, or difficulty identifying individual plants.*

2. *Plants missed as they are covered by other plants, not in season or eaten by herbivores.*

[2]

[Turn over]



Field B is grazed by cattle. It contains the largest number of dandelions, a species which has several adaptations that help it survive in this habitat. One of these is flattened leaves that grow close to the ground.

- (c) State the term used to describe an external structural adaptation and suggest how the adaptation described above helps the dandelion survive in this habitat.

Morphological adaptation.

The flattened leaves growing close to the ground are less likely to be damaged by trampling or grazing by the cattle (or by cutting).

[2]





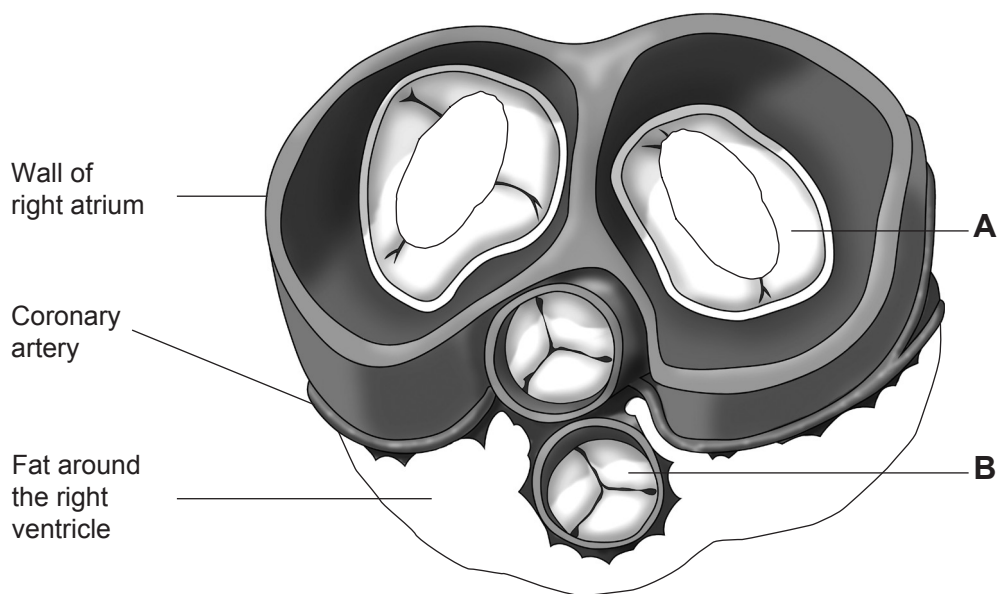
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- 5 When a mammalian heart is sectioned in a particular plane, all four valves can be observed as shown below.



© Monica Schroeder / Science Photo Library

- (a) (i) Identify the parts labelled A and B.

A Atrioventricular (bicuspid) valve

B Semilunar (aortic) valve

[2]

- (ii) Describe the state of the valves shown above and suggest which stage of the cardiac cycle is represented.

The atrioventricular valves are open and the semilunar valves are
closed.

This represents diastole (or atrial systole), when blood flows from
the atria into the ventricles.

[2]



- (b) Valves help to maintain one-way flow of blood through the heart. With reference to the structures and pressure changes involved, describe how blood leaves a ventricle.

The ventricles contract from the apex (bottom) upwards, increasing the pressure in the ventricle and forcing blood upwards.

Blood is prevented from flowing back into the atrium as the atrioventricular valves close.

When the pressure in the ventricle exceeds the pressure in the artery, the semilunar valves are forced open and blood leaves the heart.

[3]

- (c) A heart condition called hypertrophic cardiomyopathy (HCM) is characterised by thickened muscle in the ventricle wall, reducing the space inside the ventricle. Sufferers may experience dizziness, fainting or tiredness.

Suggest an explanation for these symptoms.

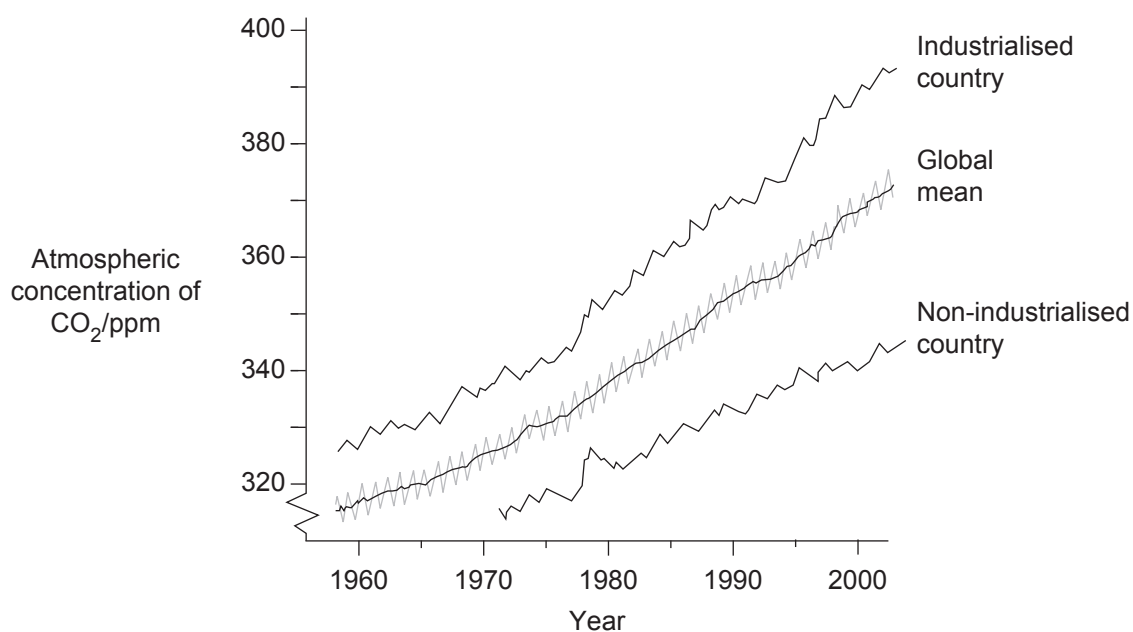
The smaller ventricle volume means less blood is pumped per beat (reduced cardiac output), so less oxygen reaches the brain and other tissues.

[1]

[Turn over]



- 6 In recent decades, global temperatures have been steadily increasing, a change which has been linked to rising global CO₂ levels. The graph below shows trends in atmospheric CO₂ concentrations in different parts of the world and the global mean.



© NOAA / Science Photo Library

- (a) It has been claimed that human activity is responsible for the change in atmospheric CO₂ concentrations. From the data, provide **one** piece of evidence to support this claim and **one** to reject it.

Support The atmospheric CO₂ concentration in the industrialised country
is much higher than in the non-industrialised country throughout.

Reject Even in the non-industrialised country the CO₂ concentration is
still increasing over time, so the rise is not due only to human activity.

[2]



- (b) The speckled wood butterfly (*Pararge aegeria*) is commonly found in woodland in southern parts of Britain. It was first classified by Carl Linnaeus in 1758 into the group of related genera called *Nymphalidae*. The species shows variation in body size and colour, with those in the northern parts of the ecological range tending to be larger and darker bodied.

- (i) Complete the table which shows the classification of the speckled wood butterfly.

Kingdom	<i>Animalia</i>
<i>Phylum</i>	Arthropoda
Class	Insecta
<i>Order</i>	Lepidoptera
Family	<i>Nymphalidae</i>
Genus	<i>Pararge</i>
Species	<i>aegeria</i>

[3]

- (ii) When Linnaeus classified *P. aegeria*, kingdom was the highest taxonomic rank. In 1990 an updated classification system was introduced by Carl Woese, to include the rank of domain.

State the domain for *P. aegeria*.

Eukaryota

[1]

- (iii) How could it be determined that butterflies of different body colours are the same species?

They are capable of interbreeding to produce fertile offspring (or by
DNA analysis, genetic fingerprinting).

[1]

[Turn over]



In the last 40 years, *P. aegeria* has significantly increased both its abundance and its ecological range in Britain. This is thought to be due to climate change, allowing the species to survive in more northerly habitats.

(c) Suggest **two** ways in which the increased ecological range of *P. aegeria* could impact on other species.

1. Increased food source for birds (their predators), so predator numbers may increase.

2. Increased competition with other butterflies (caterpillars) for food, and more plants eaten (damaged) by caterpillars.

[2]





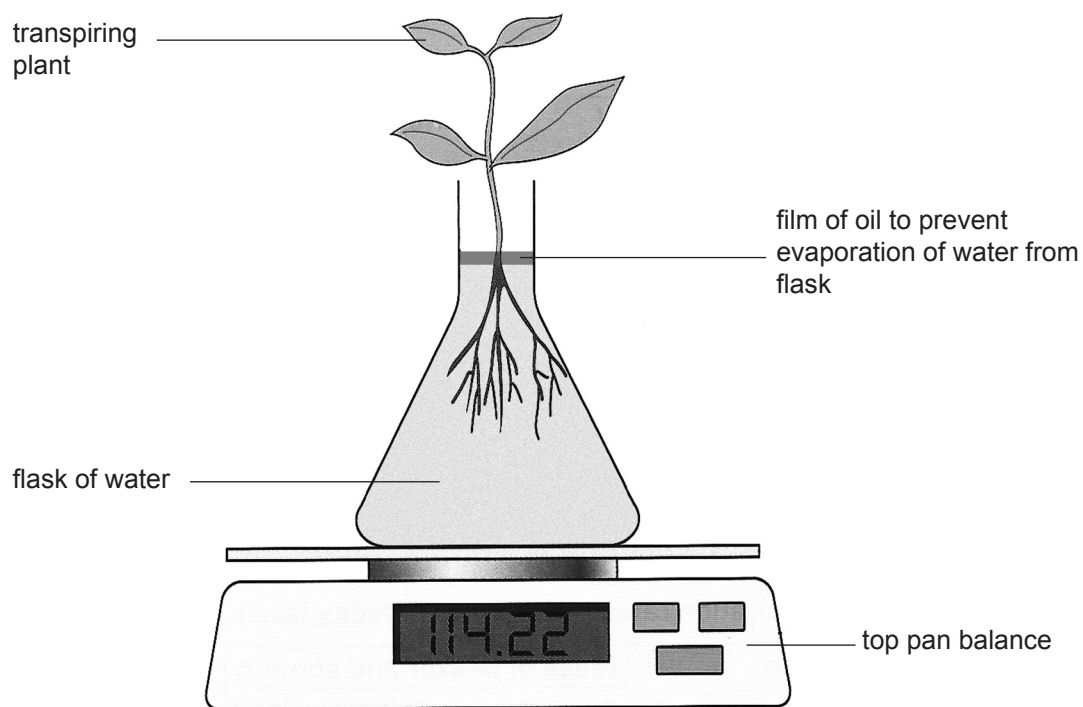
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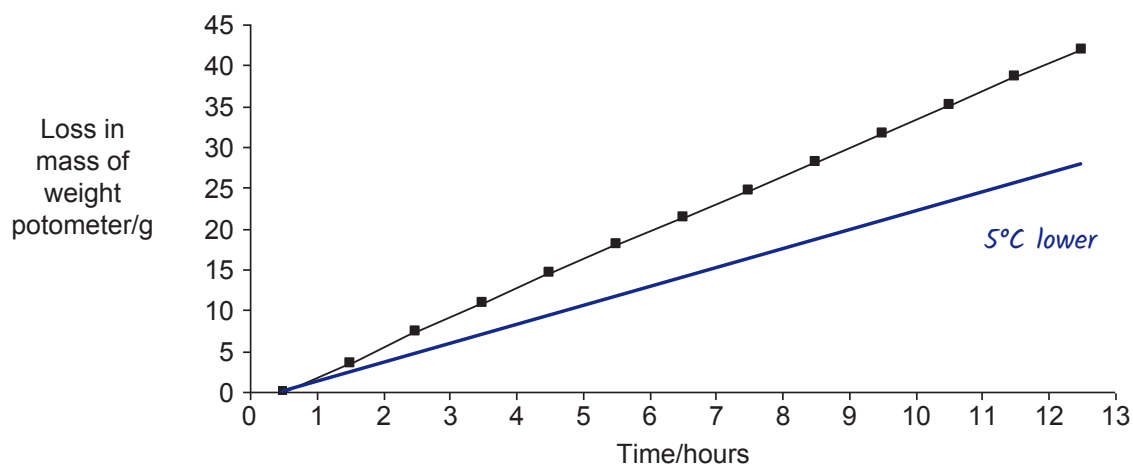


7 Transpiration can be measured using a weight potometer as shown below.



© Principal Examiner

A weight potometer was set up in a laboratory and the loss of mass was recorded at intervals over 12 hours in bright light, as shown below.



- (a) (i) Describe and explain the trend shown.

The plant loses mass steadily, at a constant rate of about 3.5 g per hour (about 42 g over 12 hours).

This is because water evaporates from the surfaces of the (spongy) mesophyll cells into the air spaces.

The water vapour then diffuses out through the stomata down a water potential gradient.

[3]

- (ii) Identify the evidence from the graph which suggests that the environmental conditions in the laboratory remained constant during the investigation.

The rate of water (mass) loss remains constant; the graph is a straight line.

[1]

- (b) (i) On the graph, sketch the results you would expect if the investigation was carried out with this plant in a laboratory where the temperature was 5°C lower.

[1]

- (ii) Explain your answer.

At a lower temperature the water molecules have less kinetic energy.

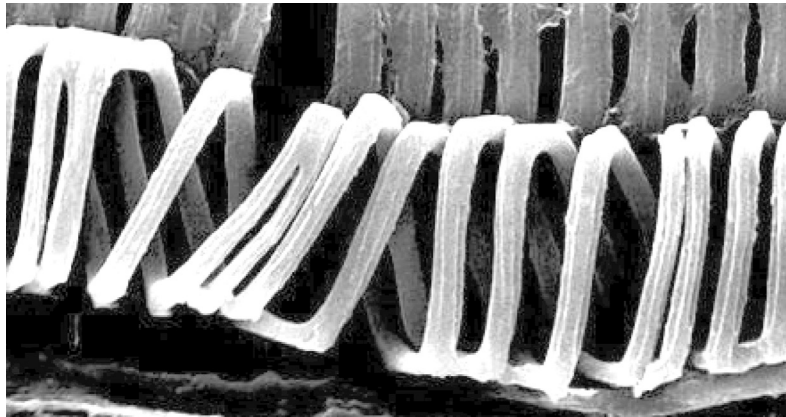
So water evaporates and diffuses out through the stomata more slowly, giving a lower rate of mass loss (a less steep straight line).

[2]

[Turn over]



The image below is a scanning electron micrograph (SEM) of xylem from a sweetgum plant. Transpiration involves the movement of water through this tissue. This movement of water creates strong forces within the xylem.



© P. Dayanandan / Science Photo Library

- (c) (i) Explain how strong forces arise within the xylem and describe how it is adapted to withstand these forces.

Transpiration pulls water up the xylem, creating a tension (negative pressure) in the column of water.

The xylem walls are strengthened (impregnated) with lignin, which prevents the vessels collapsing inwards.

[2]



- (ii) Identify evidence from the SEM that this is a young xylem vessel. Explain the advantage of the feature identified.

The lignin is laid down in a spiral pattern (spiral lignification).

This allows the xylem vessel to stretch (elongate) as the plant grows.

[2]



Section B

Quality of written communication will be assessed in this section.

- 8 Farming can have a negative impact on biodiversity. In the last 30 years, farmers in Northern Ireland have been encouraged to adopt a range of practices to help promote biodiversity on their land. In addition to these agricultural practices, several other initiatives have been introduced to conserve habitats and promote biodiversity, such as Areas of Special Scientific Interest (ASSI).

Describe and explain how agricultural practices can have a **negative** impact on biodiversity and name **two** other initiatives that have been introduced to conserve habitats and promote biodiversity in Northern Ireland. [15]

Monoculture is the practice of growing a single crop species over a large area. This reduces species diversity because there are fewer niches available, which also limits the number of herbivore species and the animals that feed on them.

Growing the same crop in one field year after year depletes the nutrient content of the soil, so artificial fertilisers are needed. These encourage fast growth of the crop, which outcompetes and eliminates slower growing native plant species. Continuous cultivation may also lead to loss of soil crumb structure, reducing the edaphic invertebrates and the plant species that can grow in the soil.

Fertilisers can leach into waterways and cause eutrophication. The use of slurry (organic fertiliser) is especially harmful: run-off increases the biochemical oxygen demand (BOD) as bacteria decompose it, so oxygen levels fall and aquatic biodiversity is reduced as fish and invertebrates die. The removal of hedgerows to create larger fields, or their mismanagement, such as cutting at the wrong time of year, reduces habitats and food



sources for plants and animals. It also removes wildlife corridors that link different habitats, which affects the dispersal of a range of organisms.

The increased use of pesticides kills organisms other than the target species, such as natural predators, and pesticides may bioaccumulate along food chains. Herbicides reduce the number of plant species, removing habitats and food. Harvesting right to the edge of fields removes predator strips, leading to poor biological control and a reduction in non-target species.

Increased stocking rates and heavy grazing reduce plant biodiversity due to grazing and trampling. Drainage schemes remove wetland habitats and the species adapted to them.

Two other initiatives introduced in Northern Ireland to conserve habitats and promote biodiversity are Special Areas of Conservation (SACs) and Biodiversity Action Plans (BAPs).

[Turn over



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Examiner Number

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