

OCR A-LEVEL BIOLOGY B • H422

BIOLOGY



EXAM QUESTION PACK

2.2.4 TRANSPORT SYSTEMS IN PLANTS

SCORE

/91

PERCENTAGE

%

STEMUP

These questions belong to OCR, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by OCR. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with OCR and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. OCR has not endorsed, approved or been involved in the production of it. OCR and the qualification titles used here belong to their respective owners and appear for identification only.

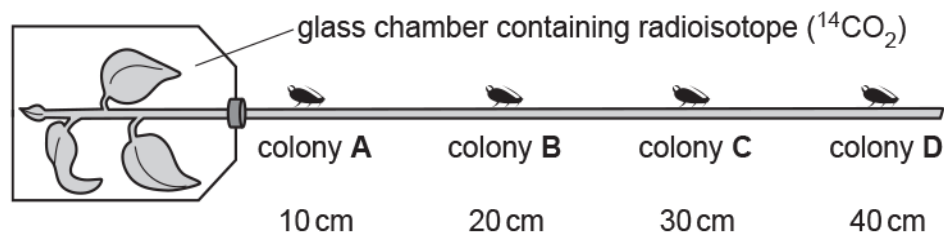
Where to find the originals

OCR publishes its past papers, mark schemes and examiner reports free of charge. Always check the current specification at ocr.org.uk before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

- 1 A group of students were investigating the rate of translocation in plants using aphids.

The diagram shows the apparatus used in their investigation.



The sap from each colony of aphids was analysed for the presence of radioactively labelled sugars.

Rate of translocation was calculated based on the time taken for the radioactively labelled sugars to be detected in each of the colonies positioned along the length of the stem.

- Diameter of the phloem tube was 2 mm
- Mean translocation rate calculated by the students was $0.5 \text{ cm}^3 \text{ hr}^{-1}$
- Volume of a cylinder = $\pi r^2 l$

In which of the aphid colonies, A to D, were radioactively labelled sugars first detected after 1.3 hours?

Your answer

[1]

2(a) During transpiration water vapour is lost from the leaves of a plant through stomata.

A group of students set up the potometer shown in Fig. 3.1 to estimate the rate of transpiration in *Pelargonium inquinans*, a dicotyledonous plant.

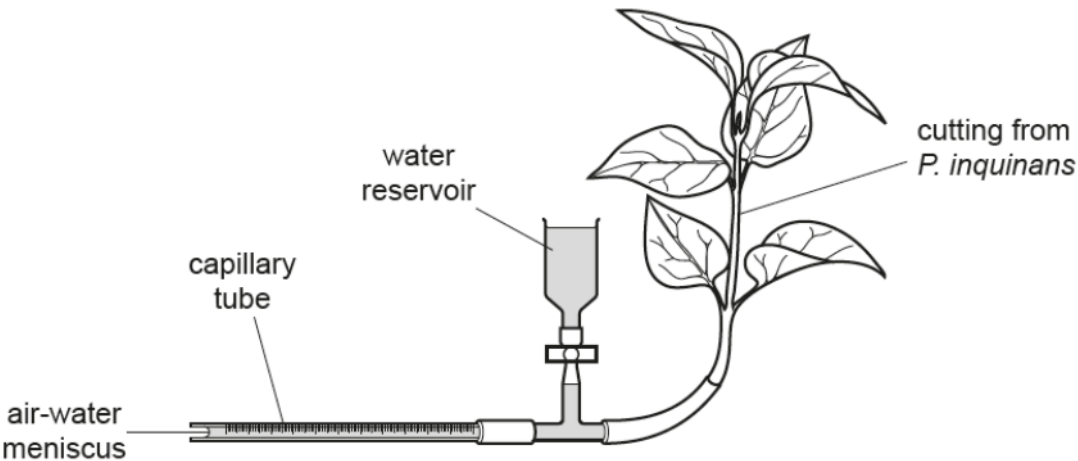


Fig. 3.1

Explain how this set up could be used to obtain valid results to estimate the rate of transpiration in *P. inquinans* at different light intensities.

[6]

- Fig. 3.3 shows some of the data from this investigation.

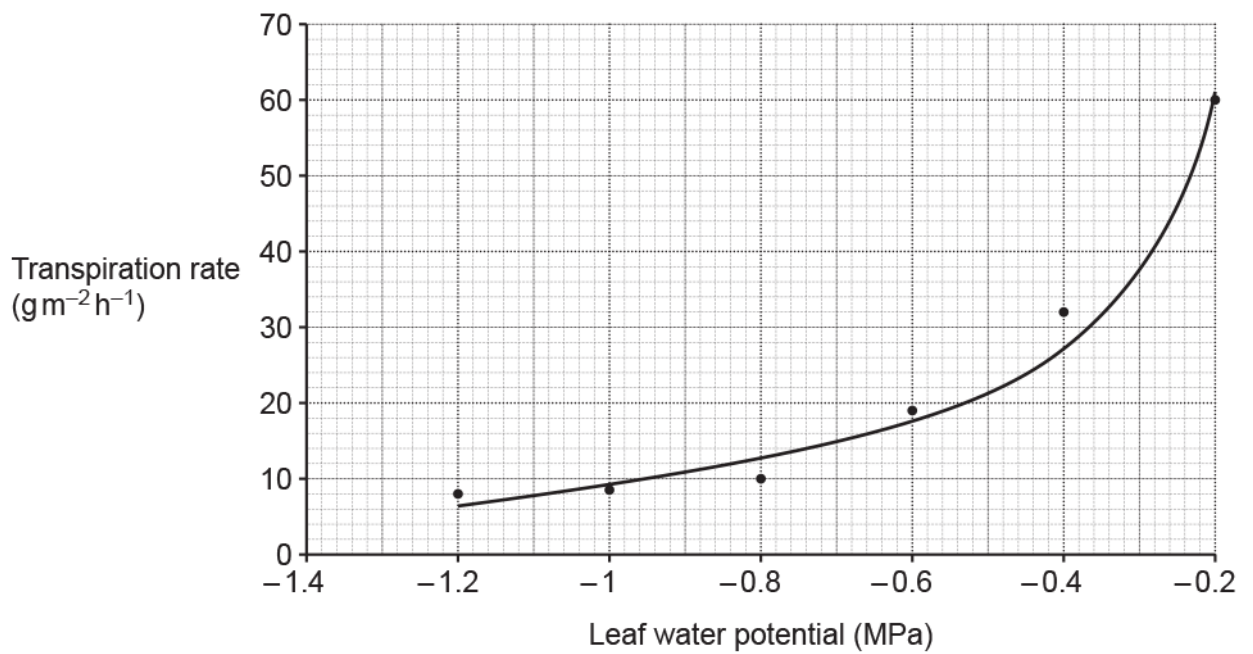


Fig. 3.3

- (i) Using Fig. 3.3, describe and explain the effect of **decreasing** leaf water potential on the transpiration rate for the plants in this investigation.

[2]

- (ii) Use the curve in Fig. 3.3 to calculate the rate of change in transpiration at -0.7 MPa .

Rate of change = ... $\text{g m}^2 \text{h}^{-1} \text{MPa}^{-1}$ [2]

- 3 A group of students set up the apparatus in Fig. 21.1 to estimate the rate of transpiration.

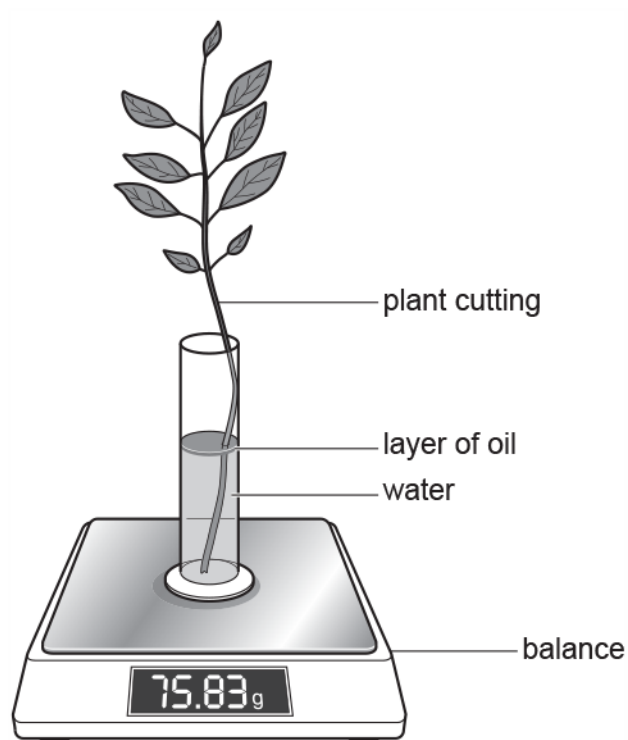


Fig. 21.1

The apparatus in Fig. 21.1 is designed to estimate rate of transpiration in the plant cutting by recording changes in mass over several days.

Explain why this method may not give a true measurement of the rate of transpiration.

[2]

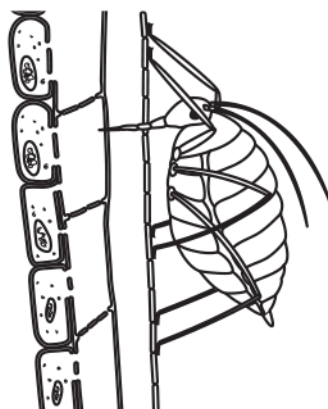
4(a) Translocation is the movement of organic substances made by a plant from one region to another along phloem tissue.

Explain why plants require transport systems.

[1]

(b) Aphids are small insects that feed on plants by inserting their tube-like mouthparts into phloem tissue, where they extract sap.

The diagram shows an aphid feeding from the stem of a plant.



(i) Name the sugar most commonly translocated.

[1]

(ii) After an aphid removes its mouthpart, sap continues to flow to the surface of the stem.

Explain why.

[2]

(iii) Some plant tissues are described as sources and sinks.

Explain why the stem tissue in the diagram could be described as neither a source nor a sink.

[1]

(iv) * Investigators could use the example of aphids in experiments to provide evidence of translocation. In these experiments, a fine glass tube is inserted into the phloem vessels and broken off at the stem surface. Droplets of sap forming at the stem surface drip from the plant.

Design an experiment using such tubes to investigate the effect of temperature on the rate of translocation.

In addition to basic laboratory apparatus, you are provided with the following:

- a room with temperature control
- plants with leafy tips and long, bare stems
- fine glass tubes.

Your answer should include details of appropriate methods to analyse data and measures to ensure validity of the results obtained.

[6]

5 At high altitude, the lower atmospheric pressure decreases the water content of air.

Which of the options, **A** to **D**, describes the likely consequence of high altitude on transport pathways in plants?

- A** increases translocation rate
- B** increases transpiration rate
- C** no effect on transport pathways
- D** prevents transpiration

Your answer ☐ [1]

- (i) Most ABA is produced in root hair cells and is carried in xylem tissue to the leaves.

ABA is transported to the xylem tissue via the apoplast pathway. Describe this pathway.

[2]

- (ii) Some ABA is produced in leaves and is transported to the rest of the plant in phloem tissue.

The photomicrograph in Fig. 32.1 is a transverse section through a stem.

State which letter, R to U, in Fig. 32.1 represents phloem tissue.

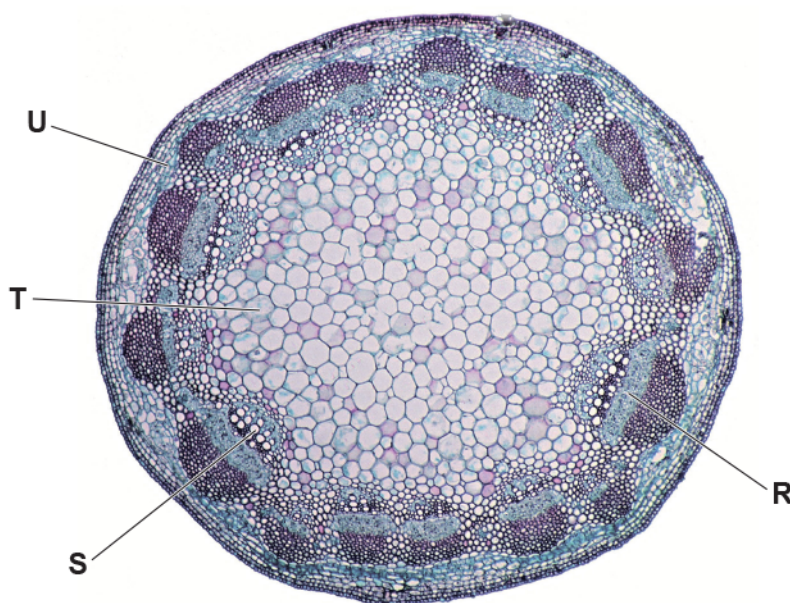


Fig. 32.1

(iii) Describe and explain **three** ways in which phloem tissue is adapted for the transport of sugars and other small molecules.

1

2

3

[3]

7 Which of the statements, **A** to **D**, is a correct description of why plants need transport systems?

- A Plants are multicellular.
- B Plants have a large surface area:volume ratio.
- C The metabolic rate of plants is high.
- D The required movement of some molecules cannot be met by diffusion alone.

Your answer

☐

[1]

- 8(a) A researcher examined two photomicrographs similar to that shown in Fig. 4 for seedlings of different ages. The total number of cells present in the root cap and the number of cells with an enlarged red vacuole were counted. The results are shown in Table 4.

Age of seedling (days)	Number of cells with an enlarged red vacuole	Total number of cells in root cap
5	12	40
10		85

Table 4

The researcher concluded that there was a 33% increase in the proportion of cells with an enlarged red vacuole between day 5 and day 10.

Calculate the number of cells with an enlarged red vacuole on day 10.

Give your answer to 2 significant figures.

[Write your answer in Table 4]

[2]

- (b) Fig. 4, below and on the Insert for H422/03, June 2019, is a photomicrograph of a root meristem and its root cap. A fluorescent staining technique has been used.

- The cells in the root cap are constantly dying and being replaced by new cells.
- The cells about to die have enlarged vacuoles.
- These enlarged vacuoles appear red in Fig. 4.

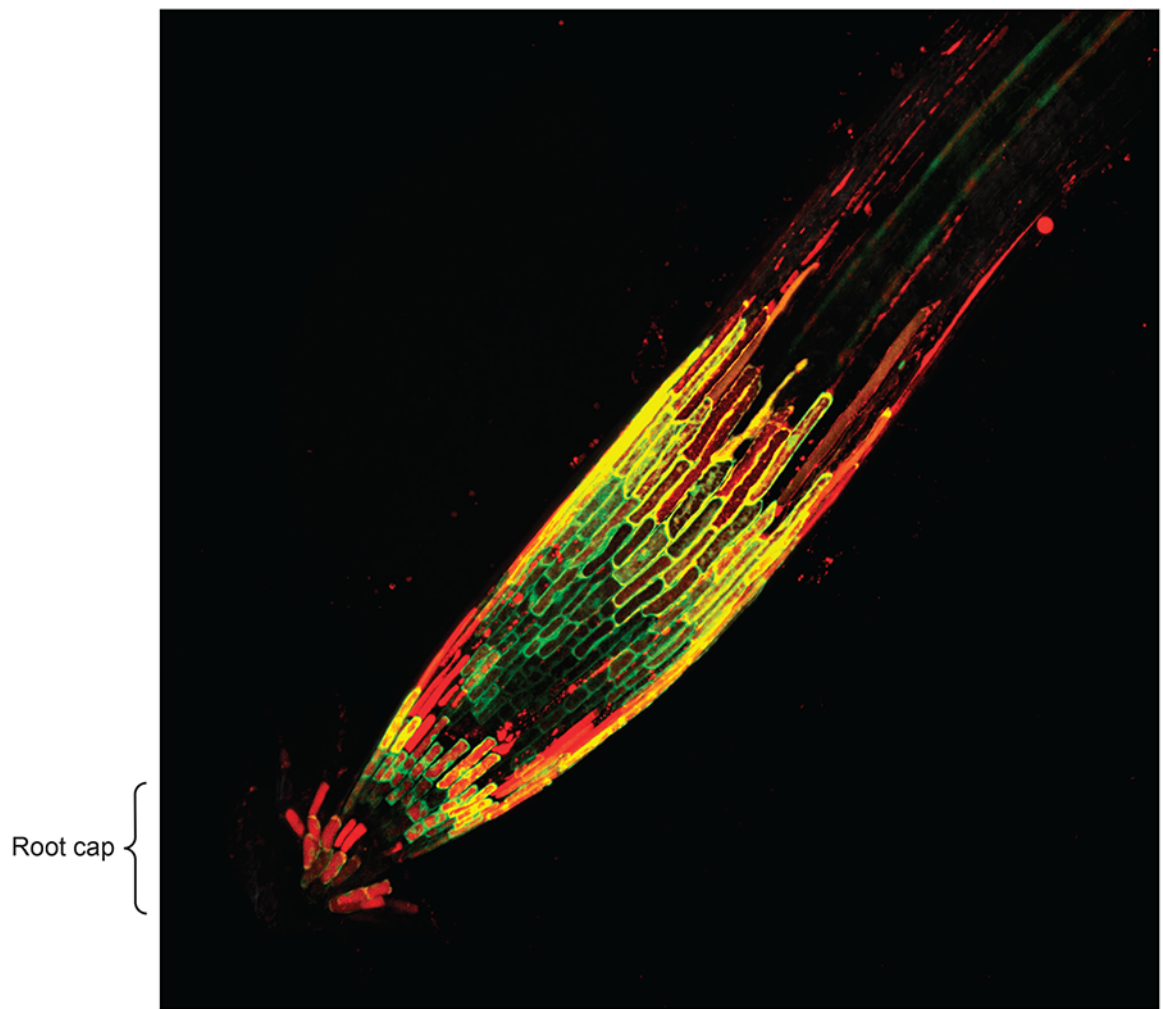


Fig. 4

Suggest the benefit for the plant of having a root cap.

----- [1]

9 Wind speed influences the rate of transpiration in a plant.

Which of the options, A to D, would **increase** in windy conditions?

- A kinetic energy of water molecules in leaf airspaces
- B probability that stomata are open
- C relative humidity of the atmosphere
- D water potential gradient between airspaces in the leaf and the atmosphere

Your answer

[1]

10(a) In 1908, American plant breeder George F. Freeman published a paper called 'A method for the quantitative determination of transpiration in plants'. Freeman was working on breeding drought-resistant varieties of alfalfa. He reasoned that individual plants with the lowest rates of transpiration would show greatest drought resistance and should be used in selective breeding.

The rate of transpiration can be measured by using:

- a potometer with a shoot cut from the plant
- a whole plant growing in a pot, where water loss is calculated by measuring loss of mass.

Freeman investigated whether results obtained using a potometer were comparable with those obtained with whole plants. He measured the rate of transpiration in four types of plant by using either a potometer with cut shoots or whole plants growing in pots. The results are shown in Table 2.1.

Plant	Average rate of transpiration / $\text{mg cm}^{-2} \text{ leaf hr}^{-1}$		Rate of transpiration in potometer as percentage of transpiration in pots (%)
	Pots	Potometer	
Daisy	7.21	1.44	20.0
Coleus	2.77	0.37	
Portulaca	1.72	0.47	
Geranium	0.65	0.65	100.0

Table 2.1

Complete Table 2.1 by calculating the missing percentages for Coleus and Portulaca.

Show your working.

[1]

(b)

- (i) Temperature was controlled in this experiment. State **two** other variables that should be controlled to ensure valid results in this experiment.

1 -----

2 -----

[2]

- (ii) Freeman made the following conclusions:

- There is a large difference between the rate of transpiration of a plant growing on its own roots ('normal' transpiration) and that of a cut shoot of the same plant placed in water.
- The difference is greatest in those plants having the highest rate of 'normal' transpiration.

Does the data in Table 2.1 support Freeman's conclusions? Give reasons for your answer.

----- [3]

- (c) Freeman then designed an experiment to allow him to measure the rate of transpiration in an alfalfa plant growing in soil in a greenhouse. Fig. 2 shows the apparatus he used.

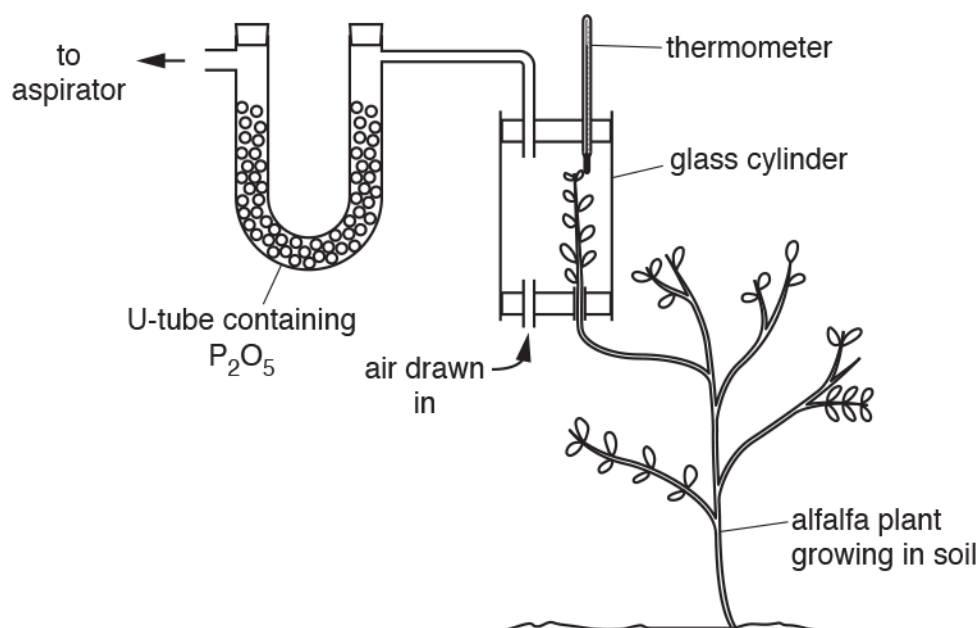


Fig. 2

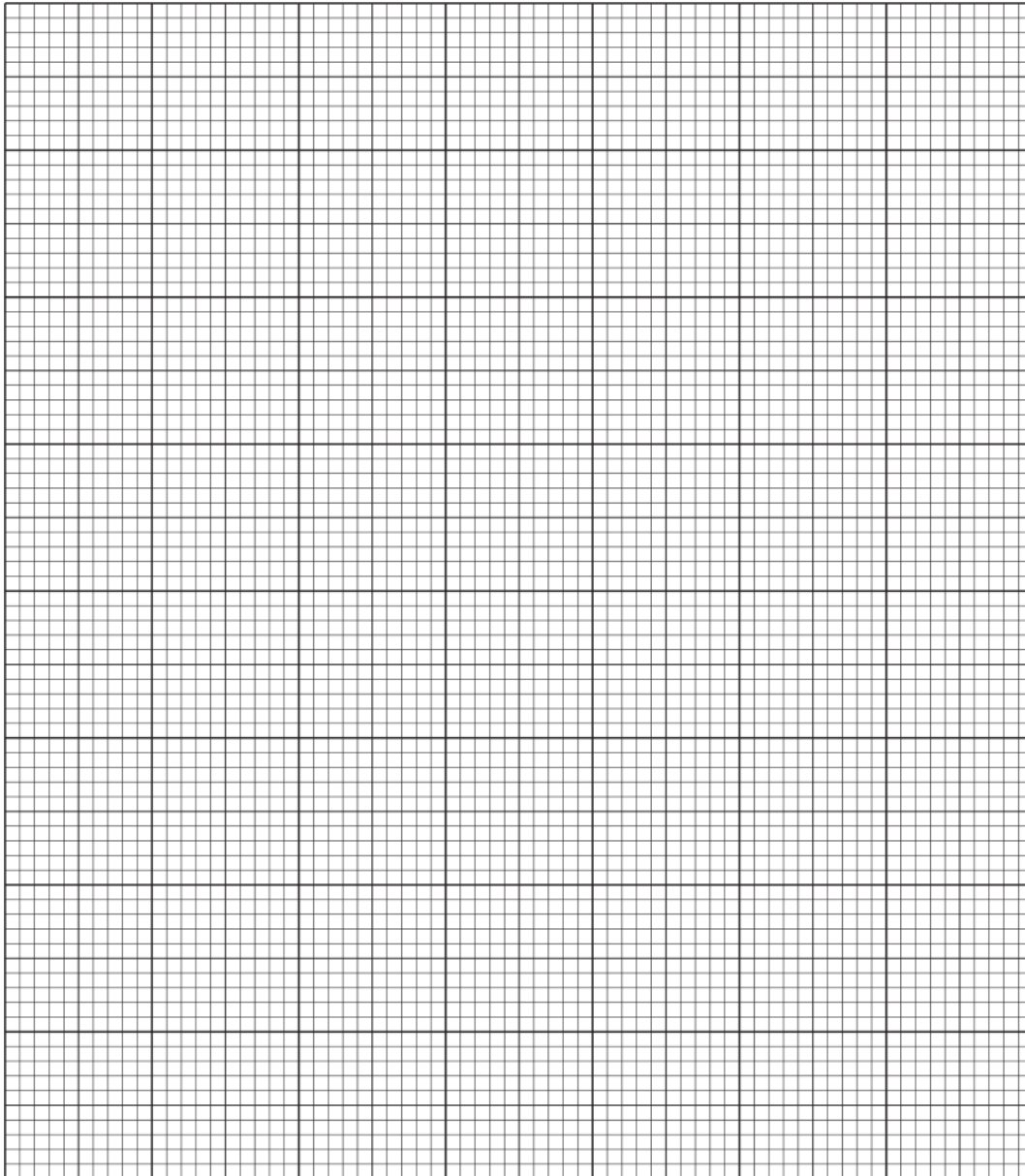
The aspirator created a steady flow of air into the cylinder past the stem of the alfalfa and through the U-tube. Phosphorous pentoxide (P_2O_5) absorbed any water in the air flowing through the U-tube. The mass of the U-tube was measured at ten minute intervals for one hour in order to calculate the rate of transpiration.

The results of one experiment are shown in Table 2.2.

Time (min)	Increase in mass of U-tube (mg)
0	0
10	65
20	120
30	184
40	255
50	309
60	379

Table 2.2

- (i) Plot a graph of the results in Table 2.2 on the grid below.



[3]

- (ii) The total area of leaves inside the cylinder was 22.28 cm^2 . Use this value and your graph to calculate the rate of transpiration.

Give your answer in standard form to **two** decimal places.

answer = ... units = ... [3]

11(a)

A potometer was used to investigate the effect of wind speed on the rate of transpiration in a leafy shoot.

The investigation was set up as shown in Fig. 33.

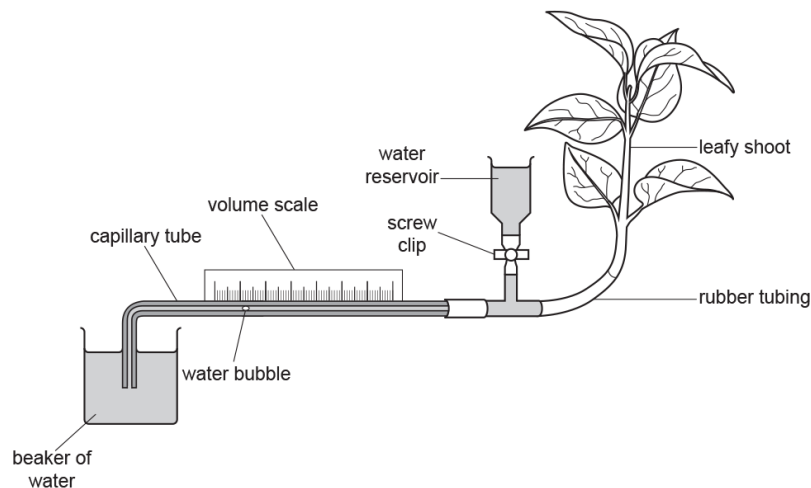


Fig. 33

To vary wind speed, a fan with five different speeds was positioned at a fixed distance from the leafy shoot.

The results of the investigation are shown in Table 33.

	Wind speed (ms ⁻¹)	Rate of water uptake (mm min ⁻¹)				
		Replicate 1	Replicate 2	Replicate 3	Mean	Standard deviation
1	0	0.3	0.3	0.3	0.30	0.00
2	2	2.6	2.5	2.5	2.53	0.06
3	4	5.0	4.8	4.9	4.90	0.10
4	6	7.0	7.0	7.2	7.07	
5	8	9.4	9.5	9.4	9.43	0.06

Table 33

- (i) Give **one** piece of advice when setting up the potometer to ensure a continuous stream of water between the capillary tube and the shoot.

-----[1]

- (ii) Using information in Table 33, calculate the standard deviation for the data from **row 4** (wind speed of 6 ms^{-1}).

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

standard deviation = _____ [2]

- (iii) Describe **and** explain the data trend in Table 33.

----- [3]

- (iv) State **two** environmental variables that should have been controlled during this investigation.

1

2
----- [2]

(v) Explain why the potometer only gives an estimate of the rate of transpiration.

[2]

(b) Plants take up water into the root hairs. The water is then transported into the vascular tissue via the root cortex. Describe how water travels through the root cortex in the apoplastic **and** symplastic pathways.

[3]

12 In a plant, sucrose is loaded into a companion cell using a protein carrier that co-transport H^+ ions.

Which of the options, **A** to **D**, is a correct description of how H^+ ions are co-transported?

- A** into the companion cell against the concentration gradient
- B** into the companion cell down the concentration gradient
- C** out of the companion cell against the concentration gradient
- D** out of the companion cell down the concentration gradient

Your answer

[1]

13 The walls of some plant cells are impregnated with a band of waterproof material known as a Casparian strip.

Which of the options, **A** to **D**, is the cell type that has a Casparian strip?

- A** companion cell
- B** endodermal cell
- C** root cortex cell
- D** root hair cell

Your answer

[1]

14(a) Fig. 2.1a and Fig. 2.1b are diagrams based on photomicrographs showing cross sections through two leaves.

- Fig. 2.1a is a cross section of a monocotyledonous leaf
- Fig. 2.1b is a cross section of a dicotyledonous leaf

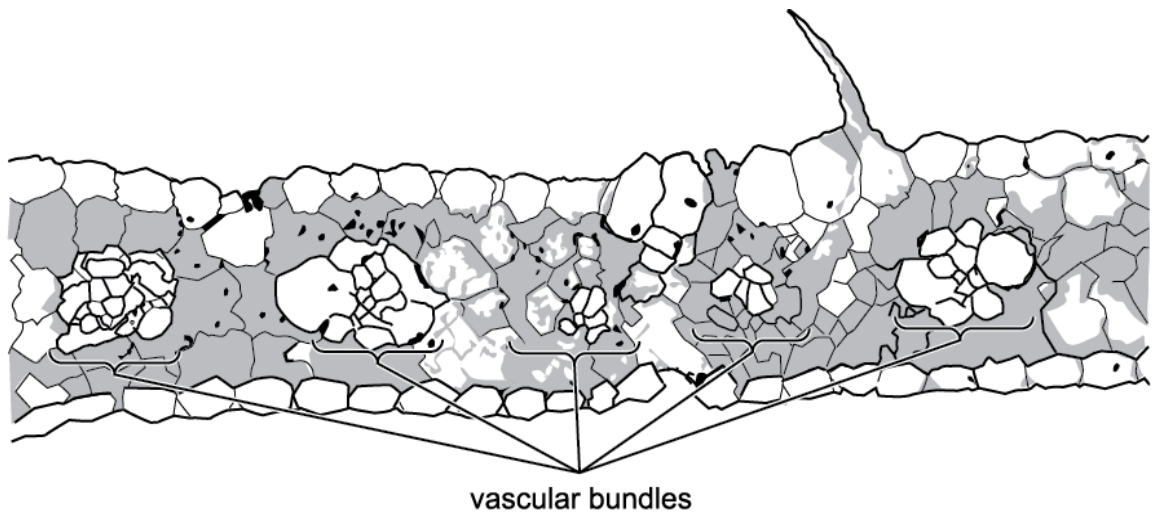


Fig. 2.1a

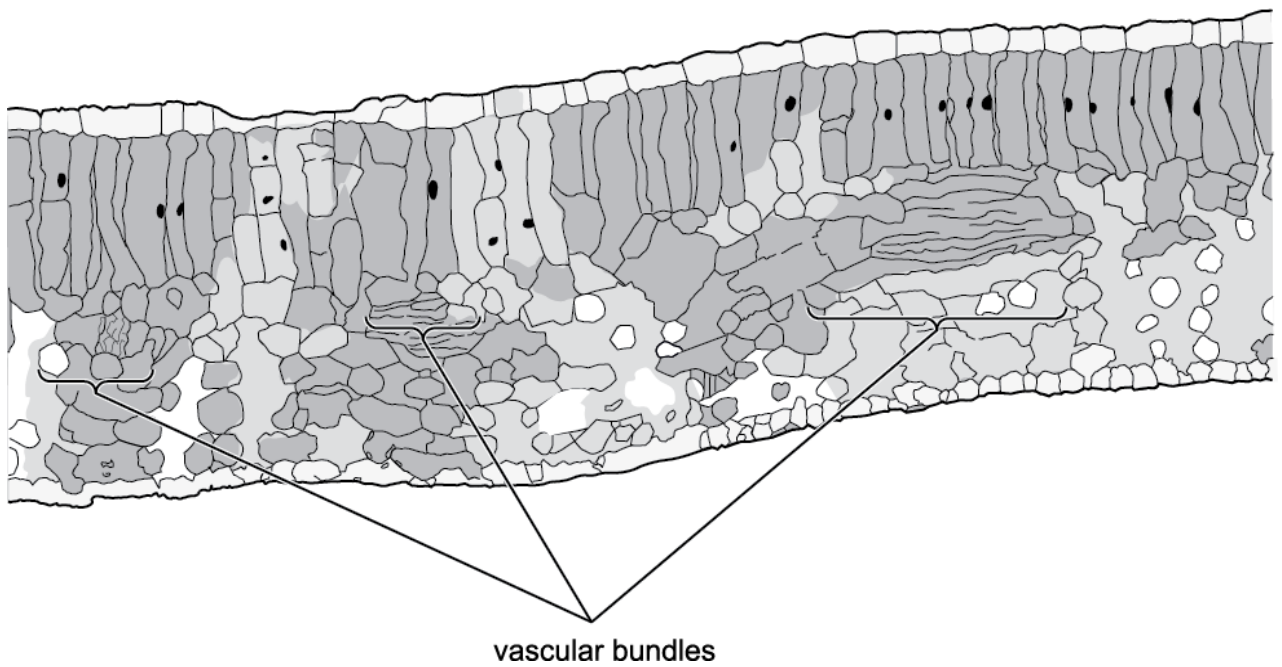


Fig. 2.1b

(i) Compare the appearance of the vascular bundles in Fig. 2.1a and Fig. 2.1b

----- [2]

- (ii) Explain how the features of monocotyledonous and dicotyledonous leaves result in the differences in the vascular bundles seen in the two cross sections.

----- [2]

- (b) In broad-leaved plants, water is moved over long distances in xylem vessels.

The diameter of the xylem vessel is one factor that can affect how easily the water can be moved.

The change in pressure required to move water in a xylem vessel can be calculated from the formula below.

$$\Delta P = \frac{0.15}{r}$$

ΔP = change in pressure (Pa)

r = radius in m

Calculate the change in pressure required to move water in a xylem vessel with a diameter of 100 μm .

Show your working. Give your answer to **one** significant figure.

Answer ----- kPa [2]

- (c) *The following extract describes an early investigation into the movement of water in xylem vessels.

The Swedish physicist Per Scholander devised a method of identifying the difference between water-filled xylem vessels and those without water. In one experiment, he punctured xylem tissue with an ice pick. He observed that the water below the puncture fell away rapidly, leaving an air-filled space below the puncture wound. The water then stayed at that lower level. The water above the puncture was seen to move rapidly upwards.

Describe the processes that result in the movement of water in xylem vessels **and** relate these to the observations described in the extract.

[6]

Catalase is found in peroxisomes in eukaryotic cells. Peroxisomes do not contain genetic material, but they replicate to form new peroxisomes. The enzymes in peroxisomes are synthesised on free ribosomes and transported into peroxisomes as polypeptide chains.

- (i) Name one plant vascular tissue that will **not** contain peroxisomes. Justify your answer.

tissue _____

justification _____

[1]

- (ii) Compare the formation of peroxisomes, as described above, with the formation of lysosomes.

[2]

16 As the human population continues to grow there is an ever increasing need to increase food production.

Alfalfa is grown mainly for animal feed as it is rich in protein, minerals and vitamins. The leaves can also be used as a dietary supplement in human nutrition.

Fig. 4.1 below shows the transverse section of an alfalfa leaf.

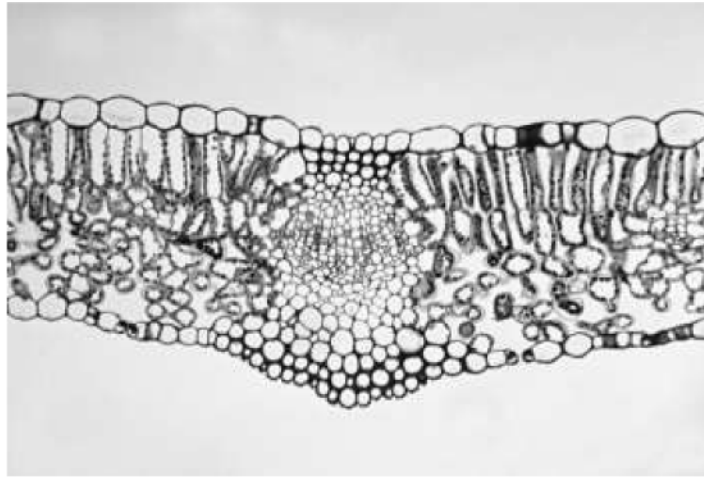


Fig 4.1

In the space below draw a labelled and annotated low power plan of the transverse section of the alfalfa leaf shown in Fig. 4.1.

[4]

- (i) Iron is essential for the activity of the nitrogen-fixing enzyme, nitrogenase.

Iron is present as ions in soil water but is not taken up by root nodules directly.

Describe how iron ions in soil water reach the root nodules.

[3]

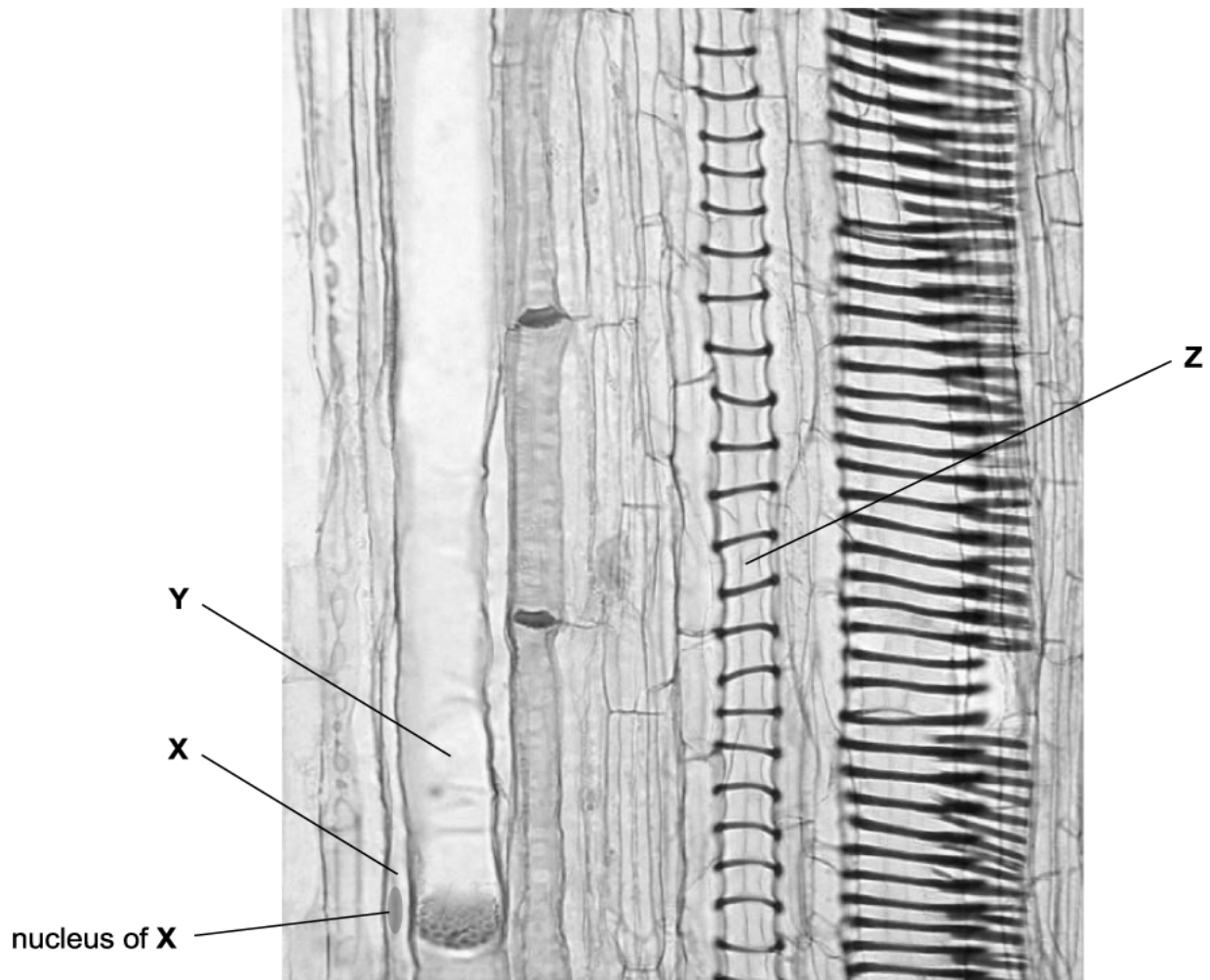
- (ii) *P. sativum* provides the nitrogen-fixing bacteria with a four-carbon molecule that can be oxidised to produce oxaloacetate and reduced NAD.

State the metabolic pathway in which oxaloacetate is an intermediate.

[1]

- 18 The photomicrograph below shows a longitudinal section through a plant stem.

Three structures found in the vascular tissue have been labelled X, Y and Z.



Which of the following statements is / are correct?

- Statement 1:** X and Y are connected by plasmodesmata.
Statement 2: Protein synthesis **cannot** occur in X.
Statement 3: The dark horizontal bands in Z are cellulose.

- A 1, 2 and 3 are correct
B Only 1 and 2 are correct
C Only 2 and 3 are correct
D Only 1 is correct

Your answer ☐

[1]

- 19 The control of growth in plants is achieved by plant hormones. Plant hormones can be produced in the locations where they have their effects or they can be transported from the regions where they are synthesised to the regions where they have their effects.

Suggest how the plant hormone gibberellic acid (gibberellin) is transported in plants.

----- [1]

An experiment was carried out into the role of plant hormones in germination. The experiment was carried out on winter barley seeds.

Four sterile starch agar plates were prepared containing the following solutions:

Plate 1 – distilled water

Plate 2 – gibberellic acid (GA) solution

Plate 3 – abscisic acid (ABA) solution

Plate 4 – GA and ABA solution

Winter barley grains were soaked for 24 hours and then cut in half as shown in Fig. 32.1.

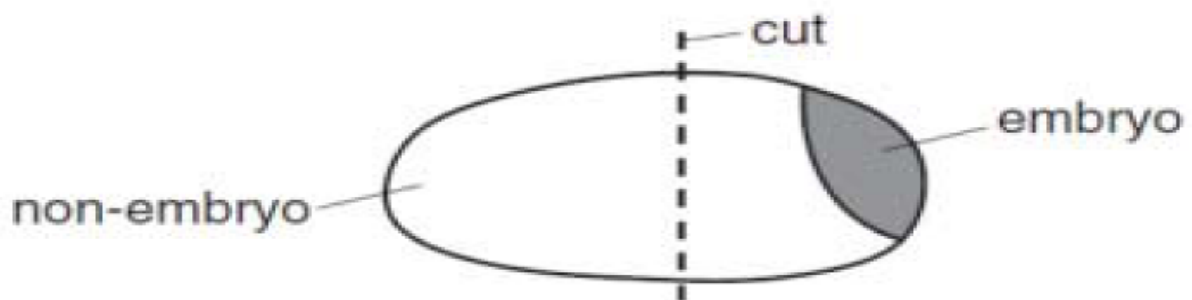


Fig. 32.1

Four non-embryo halves were placed cut side down onto each of the agar plates.

The plates were incubated at 20°C.

After incubation, iodine solution was added to each plate. The appearance of a plate after adding iodine solution is shown in Fig. 32.2.

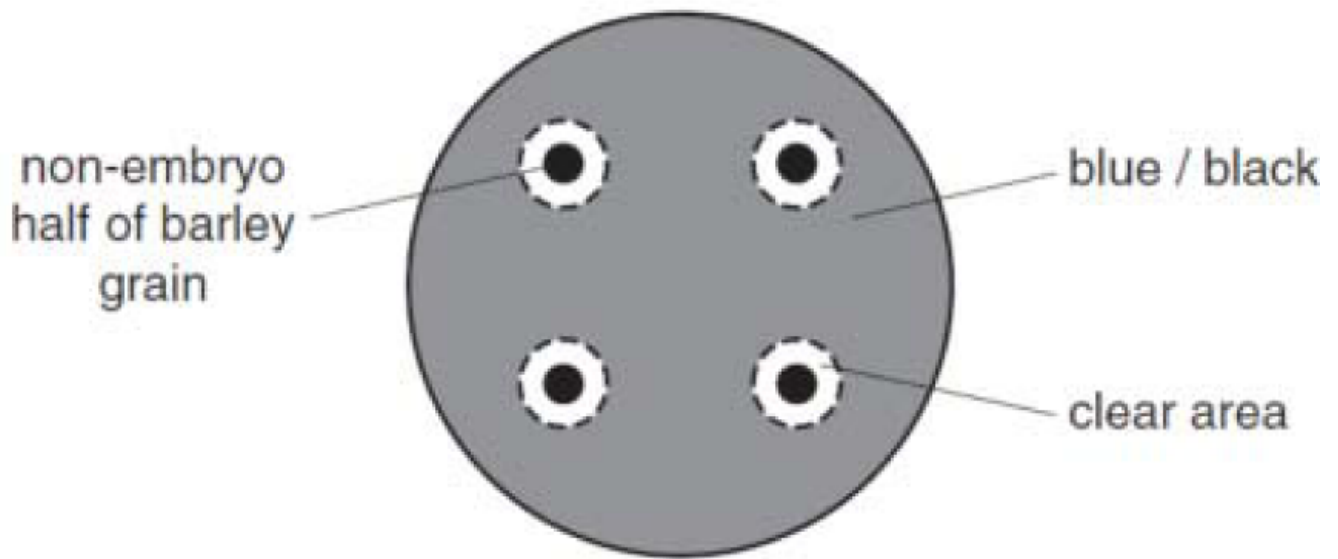


Fig. 32.2

The maximum diameter of the clear area surrounding each halved seed was recorded.

The results are shown in Table 32.1.

Agar plate		Maximum diameter of the clear area surrounding halved seed (cm)					
		Halved seed 1	Halved seed 2	Halved seed 3	Halved seed 4	Mean	Standard deviation
1	Distilled water	1.5	2.4	1.5	1.4	1.7	0.47
2	GA	2.0	1.3	2.5	2.2	2.0	
3	ABA	0.9	0.8	1.5	1.3	1.1	0.32
4	GA and ABA	1.2	1.2	1.0	1.2	1.2	0.10

Table 32.1

20 In Fig. 22.1, which of the following statements is **incorrect** about the movement of water across the root?

- A Water moves from cell A to cell B by the apoplast pathway
- B Water moves from cell A to cell B by the symplast pathway
- C Water moves from cell B to cell D by the apoplast pathway
- D Water moves from cell B to cell D by the symplast pathway

Your answer

[1]

21 Fig. 22.1 is a simplified diagram of cells in a dicotyledonous root.

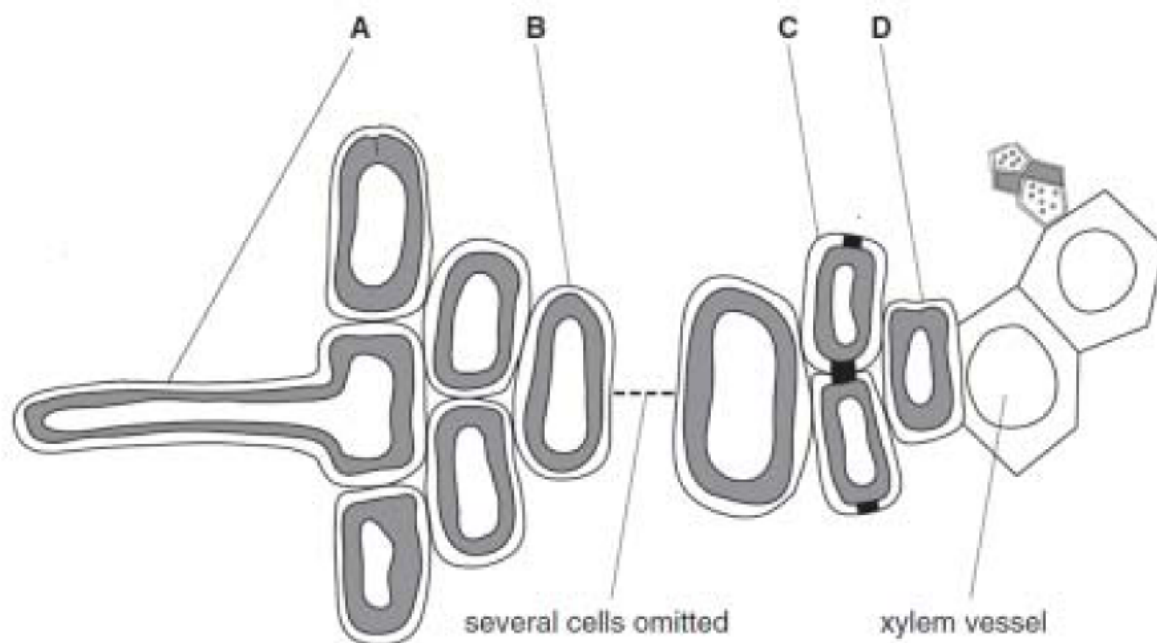


Fig. 22.1

Which of the following is a cell in the endodermis?

- A A
- B B
- C C
- D D

Your answer

[1]

22 Fig. 12.1 shows a section through a dicotyledonous plant leaf.

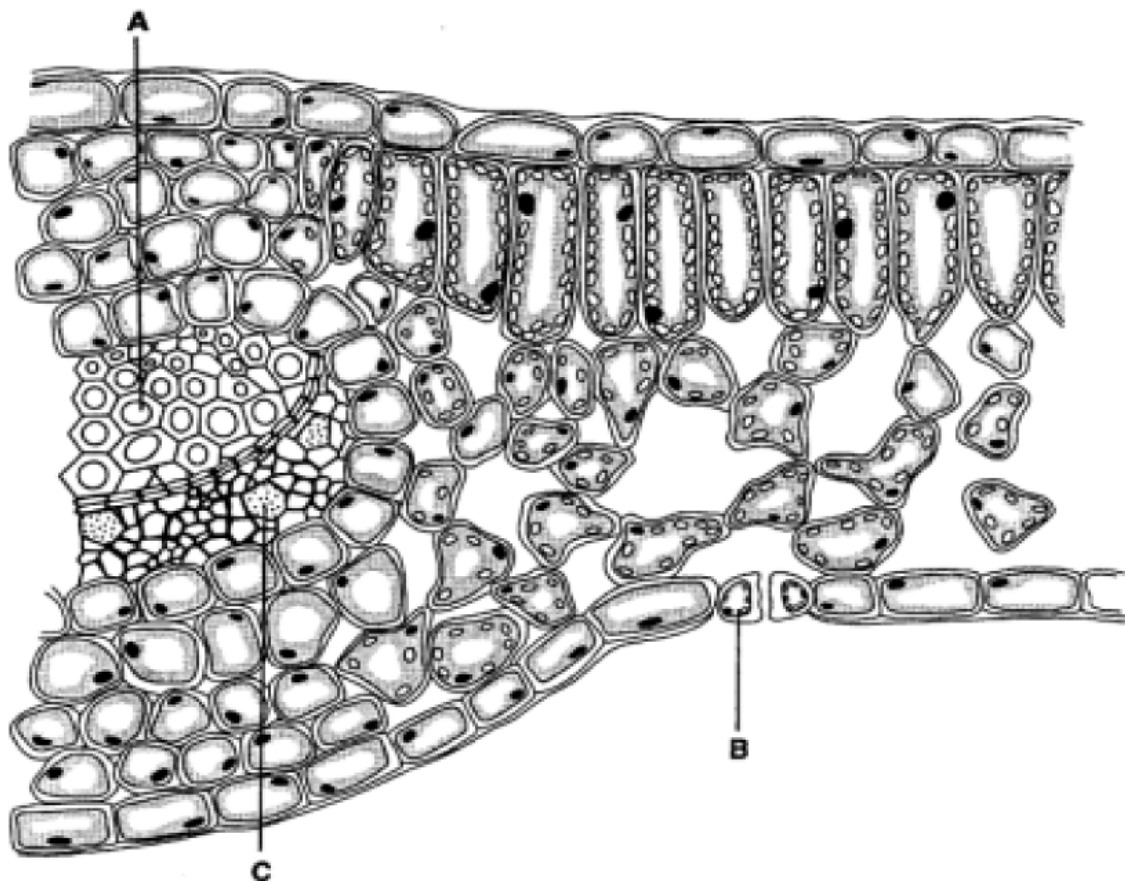


Fig. 12.1

Which of the cells labelled in Fig. 12.1 contain mitochondria?

- A A, B and C
- B A and C
- C B and C
- D B only

Your answer

[1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1			B	1(AO2.8)	
			Total	1	
2	a		<i>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</i> In summary: <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i> <i>Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.</i> <i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i> <i>award the higher mark where the Communication Statement has been met.</i> <i>award the lower mark where aspects of the Communication Statement have been missed.</i> The science content determines the level. The Communication Statement determines the mark within a level. Level 3 (5–6 marks) Detailed explanation of how to use the potometer to obtain valid results to estimate the rate of transpiration with clear reference to control variables and how they will be taken into account AND how a suitable number of different light intensities are determined AND how the raw data will be collected AND how the raw data can be processed to estimate the rate of transpiration. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i>	6(AO1.2) (AO3.4)	Indicative marking points e.g. Control variables - control variables e.g. species / number of leaves / leaf surface area / humidity / temperature / light source (wattage) / windspeed - detail of how control variables taken into account e.g. same species / same number of leaves / measure leaf surface area (so rate can be calculated per unit of SA) / measure humidity / temperature controlled room to standardise room temperature / same light bulb which acts as source / fan used at same speed Light intensity - place light source at a suitable range of distances from potometer - range of 5 distances stated for light source - use of light meter OR use of inverse square law to determine LI (from distance between light source and potometer) Dependent data - measure distance moved by air-water meniscus over set time period - collection of repeats Processing data - calculation of distance moved over set time period - conversion of distance moved to volume (using formula for cylinder) - calculation of rate of water uptake i.e. volume ÷ time - calculate of mean rate of water uptake - further processing e.g. calculation of SD or appropriate statistical analysis

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Level 2 (3–4 marks) Simple explanation of how to use the potometer to obtain valid results to estimate the rate of transpiration with reference to control variables and how some will be taken into account AND how different light intensities are determined AND how the raw data will be collected OR how the raw data can be processed to estimate the rate of transpiration. Mentions measuring movement of air-water meniscus but no detail of calculation or further processing. May only give details of different positions of light source with no further detail of suitable range and number of positions. <i>There is a line of reasoning presented with some structure. The information presented is mostly relevant and supported by some evidence.</i> Level 1 (1–2 marks) Limited explanation of how to use the potometer to obtain valid results to estimate the rate of transpiration with reference to control variables OR how different light intensities are determined OR how the raw data will be collected OR how the raw data can be processed to estimate the rate of transpiration. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>		e.g. use of unpaired t -test (to assess significant difference between 2 mean rates of water uptake at different light intensities)
	b	i	<i>Describe:</i> (as the leaf water potential decreases) rate of water loss decreases ✓ <i>Explain:</i> (because decreasing leaf water potential) lowers diffusion gradient (of water vapour), so less evaporation ✓	2(AO2.5)	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	correct tangent drawn, in contact with trend line at 0.7MPa ✓ correctly calculated rate of change ✓	2(AO2.8)	i.e. rate of change = change in y ÷ change in x
			Total	10	
3			<i>idea that</i> mass lost may not be just water ✓ some water used by plants e.g. for photosynthesis ✓	2 AO3.1	IGNORE references to the accuracy of the balance IGNORE references to water lost to atmosphere
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
4	a		required movement of substances not met by diffusion alone ✓	1 AO1.1	
	b	i	sucrose ✓	1 AO1.1	
		ii	hydrostatic pressure ✓ created by, movement of water into the phloem / ✓	2 AO2.5	
		iii	does not produce sucrose and does not store or consume sucrose (from phloem) ✓	1 AO2.1	ALLOW (stem is) responsible for transporting sugars between source and sink ALLOW sugars / glucose instead of sucrose
		iv	Summary of instructions to markers: <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i> <i>Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.</i> <i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i> ○ <i>award the higher mark where the Communication Statement has been met.</i> ○ <i>award the lower mark where aspects of the Communication Statement have been missed.</i> • <i>The science content determines the level.</i> • <i>The Communication Statement determines the mark within a level</i> Level 3 (5–6 marks) Provides a comprehensive description of apparatus setup and the method used to measure translocation rate. Methods for analysis of data should be described and ways to ensure validity should be discussed. <i>There is a well-developed line of reasoning</i>	6 AO3.3 3.4	Indicative scientific points may include <i>Measurement:</i> • numbers of drops • volume of sap in drops • over a period of time • repetitions <i>Apparatus:</i> • plant with stem (positioned horizontally) • description of use of glass tubes <i>Variables:</i> • temperature • suitable range of temperatures / or example • importance of controlled variables e.g. same height between tubes, same light intensity, same plant species, same plant height. <i>Data analysis:</i> • named statistical test in correct context, e.g. Student's t-test or Spearman's rank correlation coefficient • calculation of, averages / means • details of graph plotting

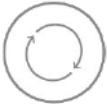
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			<i>which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Provides a comprehensive description of apparatus setup and the method used to measure translocation rate. Methods for analysis of data or ways to ensure validity should be discussed. <i>There is a line of reasoning presented with some structure. The information presented is mostly relevant and supported by some evidence.</i> Level 1 (1–2 marks) Provides a limited description of apparatus setup, which may not include the method used to measure translocation rate. Methods for analysis of data and ways to ensure validity will not be discussed. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks No response or no response worthy of credit.		
			Total	11	
5			B	1 AO2.5	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
6		i	movement through cell walls ✓ entry into cytoplasm at Casparian strip ✓ at endodermis ✓	max 2 AO1.2	ALLOW ref to outside plasma membrane ALLOW enters symplast pathway at Casparian strip <u>Examiner's Comments</u> Many candidates referred only to the movement between cell walls but for both marks the route to the xylem is needed (through the cytoplasm at the Casparian strip).
		ii	R ✓	1 AO2.3	<u>Examiner's Comments</u> Many candidates opted for the letter S, which is showing the xylem vessel, rather than R.  It is better to use actual photomicrograph when identifying the tissues in a stem, rather than using representations of the stem which sometimes might be misleading.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	plasmodesmata, for movement (of sucrose / molecules / ABA) between cells ✓ <i>companion cell:</i> many mitochondria, to provide ATP /for active transport (of sucrose into sieve tube) ✓ <i>sieve tube/element:</i> no nucleus / named organelles, so more space for flow of, sucrose / molecules / ABA ✓ end walls / sieve plates / pores, to allow movement of sucrose / molecules / ABA ✓	max 3 AO1.1 1.2	DO NOT ALLOW phloem has no nucleus / named organelles <u>Examiner's Comments</u> Candidates were sometimes not specific in their answers and referred to phloem tissue in general rather than the type of cells. For example, it needs to be stated that it is the companion cells and not the sieve tubes that have lots of mitochondria.  AFL Candidates need to be aware that phloem tissue comprises with both sieve tubes and companion cells.
			Total	6	
7			D	1 AO1.2	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
8	a		34 ✓✓	2 (AO 2.8)	ALLOW one mark for 33.915 • <u>proportion</u> of cells at 5 days is $12/40 = 0.3$ • 33% increase in the proportion is $1.33 \times 0.3 = 0.399$ (~40%) • $0.399 \times 85 = 33.915 = 34$ whole cells Examiner's Comments Only a few candidates were able to correctly calculate the number of cells with an enlarged red vacuole on day 10. Many candidates simply calculated the proportion of the number of cells with an enlarged vacuole to the total number of cells in the root cap and then repeated this for seedlings at day 10 and did not include a 33% increase in the proportion. Candidates should be encouraged to practice percentage increases and percentage decreases as a key mathematical skill. The key steps were as follows: Calculate the proportion of cells with an enlarged red vacuole at day 5: 12 out of 40 cells = $12 \div 40 = 0.3$ Calculate a 33% increase in the proportion: $1.33 \times 0.3 = 0.399$ Calculate 0.399 of 85 cells: $0.399 \times 85 = 33.915$ Round answer to meet the same formatting of the numerical answer as that in the table i.e. 2 significant figures = 34  OCR support Mathematical skills handbook can offer support on the calculation of percentage increase and percentage decrease: https://www.ocr.org.uk/Images/294471-biology-mathematical-skills-handbook.pdf There is a section on how to use ratios,

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance									
					fractions and percentages on page 12. Exemplar 3 <table border="1"><thead><tr><th>Age of seedling (days)</th><th>Number of cells with an enlarged red vacuole</th><th>Total number of cells in root cap</th></tr></thead><tbody><tr><td>5</td><td>12</td><td>40</td></tr><tr><td>10</td><td>34</td><td>85</td></tr></tbody></table> Table 4 The researcher concluded that there was a 33% increase in the proportion of cells with an enlarged red vacuole between day 5 and day 10. Calculate the number of cells with an enlarged red vacuole on day 10. Give your answer to 2 significant figures. $\frac{12}{40} \times 1.33 = 0.39$ $0.39 \times 85 = 33.15 \approx 34$ [Write your answer in Table 4] [2] This is a very rare correct response. The candidate has correctly determined the proportion of cells with a red vacuole to the total number of cells. They have then addressed the second stage of the question which is to calculate a 33% increase in the proportion. This stage of the question was missed by many candidates.	Age of seedling (days)	Number of cells with an enlarged red vacuole	Total number of cells in root cap	5	12	40	10	34	85
Age of seedling (days)	Number of cells with an enlarged red vacuole	Total number of cells in root cap												
5	12	40												
10	34	85												

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		<i>One from the following</i> protects the growing tip ✓ enables growth by covering the apical meristem in root ✓ protects the inner layer of cells (in the root tip) ✓ protects cells behind the cap ✓ prevent damage to, permanent tissue (in root tip) / AW, ✓	1 (AO 2.5)	IGNORE protects root, protects plant <u>Examiner's Comments</u> This question was only answered correctly by a few candidates with many candidates giving irrelevant suggestions e.g. "increasing the surface area for water (and/or mineral ion) uptake" or answers that were too superficial e.g. "to protect the root". Exemplar 2 <i>Seemingly small protect the root meristem as root cap can be replaced when they die. [1]</i> This exemplar scored full marks. This was one of the very few acceptable responses.
			Total	0	
9			D	1	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
10	a		(<i>Coleus</i> & <i>Portulaca</i> respectively) <u>13.4</u> AND <u>27.3</u> ✓	1	<u>Examiner's Comments</u> This was well answered with the majority of candidates achieving the mark. The most common error was failure to express the values to three significant figures, in line with the rest of the results in the table of data.
	b	i	(relative) humidity ✓ air movement / draughts ✓ light <u>intensity</u> ✓ water (given to pot plants) ✓	2 max	ALLOW wind for 'air movement' <u>Examiner's Comments</u> This was well answered with candidates clearly focusing on the main factors that have an effect on the rate of transpiration. There were general controlled variable answers like pH, so candidates could be reminded of the 'washing line' principle for factors that speed up the rate of transpiration.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	<i>Yes because</i> Higher rate (compared to potometer) in , pots / normal , for, daisy / coleus / portulaca✓ geranium / plant, with lowest rate has no difference ✓ % (rate in potometer compared to pots) increases as transpiration rate in pots decreases (from geranium – coleus)✓ comparative figures to include 2 plants in pots with 2 plants in potometers AND $\text{mg cm}^{-2} (\text{leaf}) \text{ hr}^{-1}$✓ <i>No because</i> coleus has lower % but lower rate (in pots) OR daisy has higher % but higher rate (in pots) ✓	3	IGNORE ref to <i>large difference</i> as in stem of question. ALLOW the lowest value of 0.65 shows no difference between pots and potometer ALLOW an analysed comparison e.g. '<i>a daisy has a 5x faster rate $\text{mg cm}^{-2} (\text{leaf}) \text{ hr}^{-1}$ in a pot but only a 3.7x increase in portulaca</i>'. <u>Examiner's Comments</u> Candidates struggled to interpret the data in order to support (or not) Freeman's conclusions. Candidates visibly separated the two conclusions and made it clear which conclusion they were discussing but kept referring to large differences as stated in the stem of the question. Candidates did not interpret the difference to the data headings in the table becoming particularly confused with the relevance of the % column. It may have helped candidates to label the data referring to pots as 'a' and data referring to potometers as 'b', labelled in the table. This would have avoided answers where it was not clear whether candidates were discussing transpiration from plants in pots or potometers.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c	i	<i>line graph with:</i> - both axes scaled appropriately AND correct axis labels ✓ all points correctly plotted to within $\pm$ half square ✓ - appropriate line of best fit ✓	3	divisions on each axis should be equidistant and plotted points should occupy at least 50% of the grid area i.e. x-axis label: time / min y-axis label: Increase in mass of tube / mg line must pass through zero and majority of other data points. <u>Examiner's Comments</u> This was well answered with few candidates incorrectly labelling the x and y axis. Data points were clearly plotted with small crosses. Marks were lost with candidates not plotting the zero data points. It should be stressed that all values in a table should be plotted and a line of best fit should pass through as many data points as possible.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	1. calculation of gradient from graph = 6.25 ✓ 2. rate of transpiration = $6.25 / 22.28 = 0.2805$ ✓ 3. $2.81 \times 10^{-1} \text{ mg min}^{-1} \text{ cm}^{-2} / 1.69 \times 10^2 \text{ mg cm}^{-2} \text{ h}^{-1}$ ✓	3	ALLOW gradient in the range 6.18 to 6.32 ALLOW range of 0.2774 to 0.2837 ALLOW answer to any number of significant figures (correctly rounded) ECF value of gradient / 22.28 ALLOW range of $2.78 \times 10^{-1} \text{ mg min}^{-1} \text{ cm}^{-2}$ to $2.84 \times 10^{-1} \text{ mg min}^{-1} \text{ cm}^{-2}$ ECF from mp2 value to 2 dp in standard form with correct units. Examiner's Comments Candidates struggled to correctly obtain a gradient from the graph but did follow through their answer correctly to obtain appropriate units. Many candidates struggled to write their answer in the required format and did not seem to appreciate the meaning of the term standard form.  There are tutorials and quizzes to assist with obtaining gradients: http://www.ocr.org.uk/qualifications/by-subject/biology-related/maths-for-biology/m3-graphs/ and for writing answers in standard form: http://www.ocr.org.uk/qualifications/by-subject/biology-related/maths-for-biology/m0-arithmetic-and-numerical-computation/ Key OCR support 

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Total	12	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
11	a	i	any 1 from: cut shoot under water ✓ connect shoot to rubber tubing under water ✓ ensure tight fit between shoot and rubber tubing ✓ seal with Vaseline ✓ set up the potometer under water ✓	max 1	Examiner's Comments (a)(i) and (b) tested AO1, with most of the remainder testing AO2 criteria. In (a)(i) the question addressed practical procedures and it was encouraging to see that most candidates were familiar with the setting up of the potometer.
		ii	0.12 ✓ ✓	2	ALLOW unrounded answer (0.115758...) for 1 mark Examiner's Comments The calculation of the standard deviation in (a)(ii) caused a few problems, although more than 50% achieved the full 2 marks. The most common mistake was candidates who thought that $n - 1 = 4$ (the number of treatments minus 1) rather than $n - 1 = 2$ (the number of replicates minus 1). Candidates should remember that the standard deviation is a measure of variation around the mean and n is the number of values that make up the mean.
		iii	<i>Description:</i> faster the wind speed, faster the (rate of) water uptake ✓ <i>Explanation:</i> wind <u>increases</u> water (vapour) potential gradient (between airspaces in leaf and air in environment) ✓ faster diffusion of water <u>vapour</u> / increased transpiration rate ✓	3	ORA ALLOW wind <u>increases</u> concentration / diffusion gradient Examiner's Comments (a)(iii) required a description of the data which was done well, followed by an explanation which they found more difficult. Few candidates could give a clear and succinct explanation. To achieve full marks candidates needed to give a clear link to increasing air movement reducing the water (vapour) potential around the stomata so that there was a steeper water (vapour) potential gradient. Too many candidates referred to water being blown off the leaf, some even describing droplets being blown away or water moving out of the leaf by osmosis.
		iv	humidity ✓ light intensity ✓ temperature ✓	max 2	Examiner's Comments (a)(iv) was answered well and only a few candidates did not achieve these marks.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		v	water used in photosynthesis / hydrolysis ✓ water produced in respiration / condensation reactions ✓ water used to maintain turgor pressure ✓	max 2	Examiner's Comments There was a poor understanding of what was required by (a)(v). Although many candidates seemed to appreciate that water uptake was not the same as transpiration, fewer were able to explain that water was used (and produced) in the plant. The most common correct answer was that water was used in photosynthesis but it was disappointing to see that few candidates appreciated that water is essential to maintain the turgor of a plant.
	b		<i>Mechanism</i> ANY TWO FROM <i>(Apoplast):</i> through, cell walls / extracellular spaces ✓ stopped by, suberin / Casparian strip ✓ <i>(Symplast):</i> through cytoplasm ✓ (from cell-to-cell) via <u>plasmodesmata</u> ✓ By osmosis from a high to low water potential / along a water potential gradient ✓ PLUS Correctly identifies apoplast and symplast pathways ✓	max 3	DO NOT ALLOW concentration gradient Examiner's Comments Overall (b) was answered well by a good number of candidates. There were, however, a few misconceptions identified; in particular candidates should realise that in osmosis water diffuses across a partially permeable membrane and therefore water cannot move by osmosis along the apoplast pathway. There were many correct responses describing the role of the Casparian strip.
			Total	13	
12			B ✓	1	Examiner's Comments This question should have been straightforward but candidates commonly answered C suggesting that they had confused the idea of sucrose moving out the companion cell into the sieve element with the loading of the companion cell from the source cell.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
13			B ✓	1	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
14	a	i	<i>idea that</i> cells are more distinct in Fig.2.1a / less distinct in 2.1b ✓ <i>idea that</i> bundles are similar sizes in 2.1a / vary in size in 2.1b ✓	2	ALLOW clearer / less clear
		ii	<i>idea that</i> veins parallel in monocot leaves and branch in dicot leaves ✓ <i>idea that</i> a cross section will cut dicot veins at different angles / cut monocot veins at same angle ✓	2	ALLOW 'vascular bundles' instead of veins
	b		3 (kPa) ✓✓	2	If answer is incorrect award 1 mark for 0.003 ($0.15 \div 50$) (r not converted to m) OR 3000 (not converted to kPa)
	c		<i>Please refer to the marking instructions on page X of this mark scheme for guidance on how to mark this question. In summary: Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i> <i>Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.</i> <i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i> ◦ <i>award the higher mark where the Communication Statement has been met.</i> ◦ <i>award the lower mark where aspects of the Communication Statement have been missed.</i> • <i>The science content determines the level.</i> • <i>The Communication Statement determines the mark within a level.</i>		

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Level 3 (5–6 marks) A comprehensive description of most of the processes involved in the movement of water in xylem, which relates these to the observations. <i>There is a well-developed line of reasoning which is clear and logically structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a continuous narrative.</i> Level 2 (3–4 marks) A description of some of the processes involved in the movement of water in xylem, which attempts to relate them to some of the observations. <i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.</i> Level 1 (1–2 marks) An outline of some of the processes involved in the movement of water in xylem is provided, which may not be linked to any observations. <i>The information is communicated with only a little structure. Communication is hampered by the inappropriate use of technical terms.</i> 0 marks No response or no response worthy of credit.	6	Indicative scientific points may include: - hydrogen bonding to explain cohesion between water molecules - adhesion of water molecules to the hydrophilic wall of the xylem vessel - loss of water by transpiration from the aerial parts of the plant - water evaporating from cell walls and diffusing into the atmosphere - water moving out of the leaf down a gradient of water potential - negative pressure creating a tension in the xylem vessel (observation) water above puncture pulled up due to tension (observation) puncture breaks tension so column falls back below puncture (observation) water only falls back so far and is held by adhesion - root pressure described as active transport of ions into the xylem tissue lowering water potential - water moves into the xylem down a water potential gradient creating a positive pressure
			Total	12	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
15		i	<i>tissue</i> (mature) xylem (no mark) <i>justification</i> <i>idea that xylem vessels, are hollow / have no cytoplasm / have no organelles ✓</i>	1	DO NOT ALLOW xylem without further explanation IGNORE reference to xylem being dead
		ii	lysosomal enzymes produced on, RER / rough endoplasmic reticulum ✓ <i>idea that</i> lysosomal enzymes are enclosed in vesicles ✓ lysosomes bud off Golgi (body) ✓	max 2	
			Total	3	
16			<i>LP plan must only show tissue layers with no cell detail.</i> <i>In addition there should not be any shading or other detail within the plan.</i> 4 distinct layers shown AND drawn to appropriate scale (1) area of vascular bundle shown AND labelled (1) three tissues labelled correctly from list (1) three tissues annotated correctly from list (1) • cuticle, and visible detail • upper epidermis, and visible detail • palisade mesophyll layer, and visible detail • spongy mesophyll layer, and visible detail • vascular bundle, and visible detail • xylem tissue, and visible detail • phloem tissue, and visible detail	4	DO NOT ALLOW if cells to be drawn (ONLY areas of tissue to be drawn) DO NOT ALLOW for just labelling tissue annotation (description of visible feature needed) e.g. thin e.g. single layer of cells, absence of chloroplasts e.g. rectangular cells, presence of (many) chloroplasts, wider layer e.g. circular cells, less chloroplasts, thicker layer e.g. stained red, stained green e.g. stained red, angular inner lumen e.g. stained green
			Total	4	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
17		i	any 3 from: (active transport) into root hairs (1) apoplast / symplast pathway (1) through epidermis / cortex layers (1) via xylem vessel to (root) nodule (1)	3	
		ii	Krebs cycle	1	ALLOW TCA cycle / citric acid cycle
			Total	4	
18			D	1	
			Total	1	
19			Any 1 from: by apoplast and symplast pathways in xylem / phloem by, diffusion / active transport	1	ALLOW by mass flow / translocation
			Total	1	
20			C	1	
			Total	1	
21			C	1	
			Total	1	
22			C	1	
			Total	1	