Answer **all** the questions.

1(a). Plants transport water and assimilates through specialised tissues.

Fig. 4.1 shows a tissue plan of a vertical section through part of a leaf.

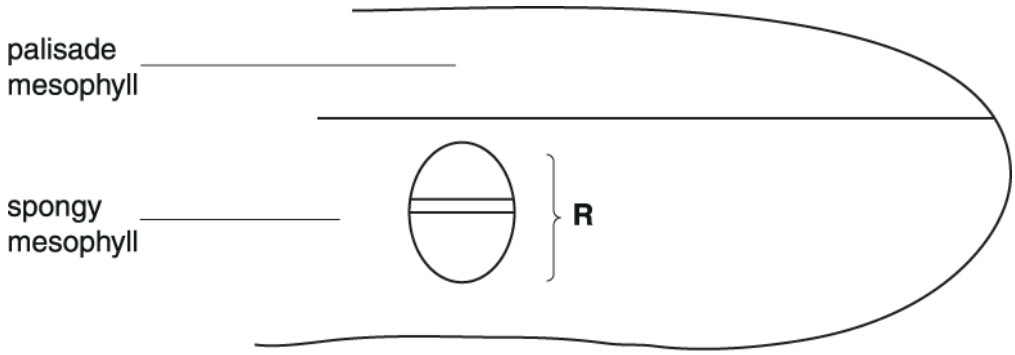


Fig. 4.1

(i) **On Fig. 4.1**, identify with a letter **X** the position of the xylem **and** identify with a letter **P** the position of the phloem.

The answer to this question should be drawn on Fig. 4.1.

[1]

(ii) Name structure **R.**

[1]

(b). The majority of cells in phloem tissue are either companion cells or sieve tube elements.

A scientist isolated companion cells and conducted some experiments to investigate the mechanism involved in loading sucrose into the sieve tubes.

He recorded the following observations:

observation 1	isolated companion cells became slightly negatively charged compared with their surroundings
observation 2	companion cells could decrease the pH of the surrounding solution from 7.0 to 5.6
observation 3	the pH inside the companion cells rose from 7.0 to 8.2
observation 4	treatment with cyanide (which stops aerobic respiration) prevents the change in pH occurring

From **observation 1**, the scientist concluded that the mechanism involved a transfer of charged particles (ions) between the companion cells and their surroundings.

(i) What conclusions can be drawn from **observations 2 and 3** about the mechanism?

---

[2]

(ii) What conclusions can be drawn from **observation 4** about the mechanism?

---

[1]

(c). The scientist drew a diagram to explain the mechanism used to load sucrose into the sieve tube elements.

His diagram is shown in Fig. 4.2.

A
charged particles are removed from the companion cells

B
co-transport of charged particles and sucrose into the companion cells

C
sucrose moves into the sieve tube elements

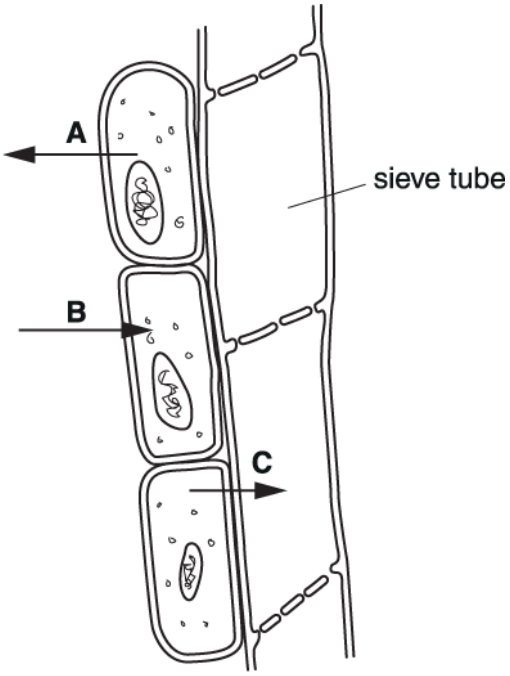


Fig. 4.2

(i) The following paragraph is an extract from the scientist's work.

Complete the paragraph.

At step **A**, charged particles are moved out of the companion cells by the process of _____ .

This creates a _____ gradient between the companion cell and its surroundings. At step **B**, the charged particles and assimilates are co-transported by _____ diffusion into the companion cells.

The assimilates build up in the companion cells and move by _____ into the sieve tube elements at step **C**. Assimilates, such as sucrose and _____, can be loaded in this way.

[5]

(ii) The structure of cells is usually adapted to carry out their functions.

The scientist used an electron microscope to look for further evidence to support the mechanism involved in loading sucrose into the sieve tubes.

Suggest what evidence the scientist might expect to see in companion cells, using an electron microscope.

---

[2]

2. State the correct term for the following definition.

The pathway that transports water along cell walls and between cells in plants.

---

[1]

3. Translocation occurs through the sieve elements by _____**1**_____ . Sucrose is loaded into the phloem at regions of the plant known as _____**2**_____ . This mechanism is _____**3**_____ . The addition of sucrose _____**4**_____ the water potential of the sieve element sap. This causes water to enter from surrounding tissues by _____**5**_____ which in turn increases the _____**6**_____ of the sap.

Which words correctly complete the numbered gaps **1**–**6**?

	1	2	3	4	5	6
A	active transport	sources	active	raises	osmosis	concentration
B	mass flow	sources	active	lowers	active transport	pressure
C	mass flow	sinks	passive	raises	diffusion	concentration
D	mass flow	sources	active	lowers	osmosis	pressure

Your answer ☐

[1]

4(a). Xylem vessel elements are produced from non-xylem cells in meristematic tissue.

Fig. 23.1 shows an electronmicrograph of xylem tissue.

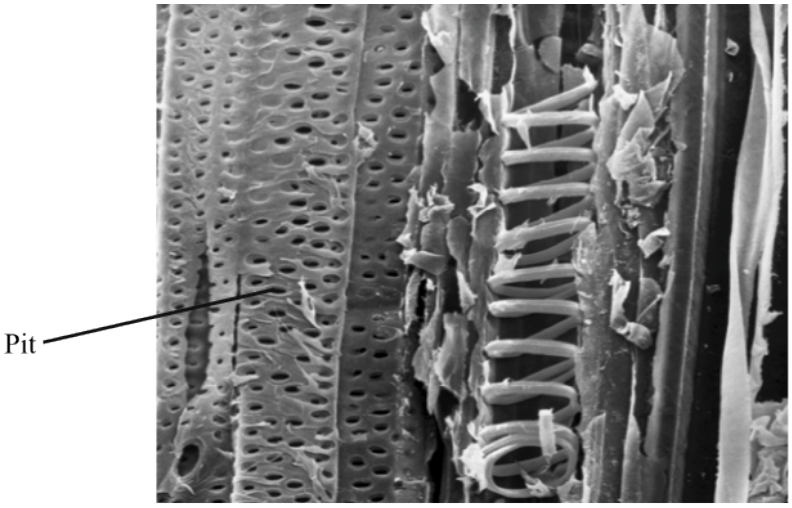


Fig. 23.1

State the function of the pits in xylem tissue.

[1]

(b). Xylem forms part of a plant's transport system.

Explain why large multicellular plants need a transport system.

[3]

(c). Fig. 23.2 shows a cross section of a plant stem. The vascular bundles containing xylem found in most other flowering plants are absent. There are many air spaces in the stem.

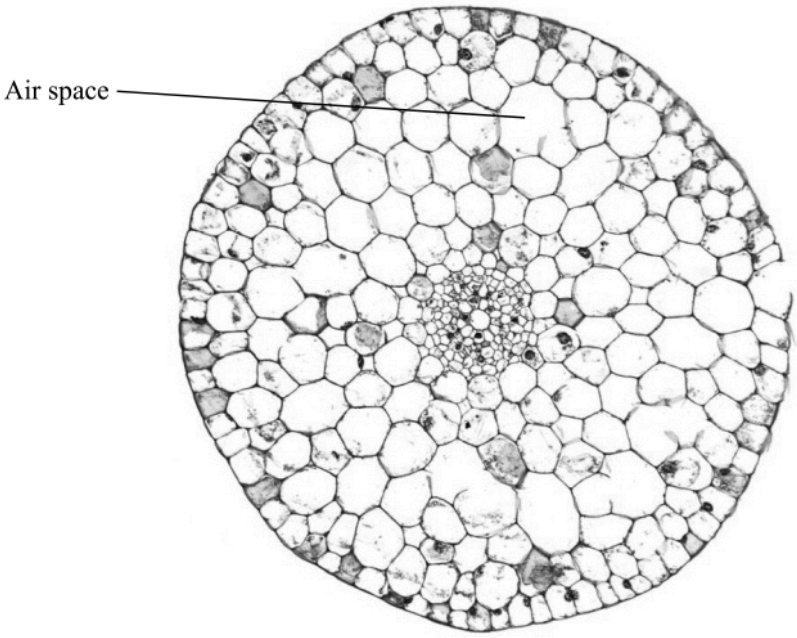


Fig. 23.2

Suggest and explain **two** likely adaptations of the **leaves** of the plant in Fig. 23.2.

1

2

---

[2]

5. The following statements refer to the movement of water from the cortex of the root into the xylem.

Which of the following statements is / are true?

Statement 1: Most of the water moves across the root cortex by the apoplast pathway.
Statement 2: At the endodermis water has to enter the symplast pathway.
Statement 3: Casparian strips in the endodermis contain the chemical lignin.

A 1, 2 and 3
B Only 1 and 2
C Only 1 and 3
D Only 1

Your answer ☐

[1]

6. **Fig. 22.1** shows a transverse section of the stem of a typical pondweed viewed using a × 10 objective lens. Part of a graticule is shown below the stem. The markings on the graticule are 0.1 mm apart.

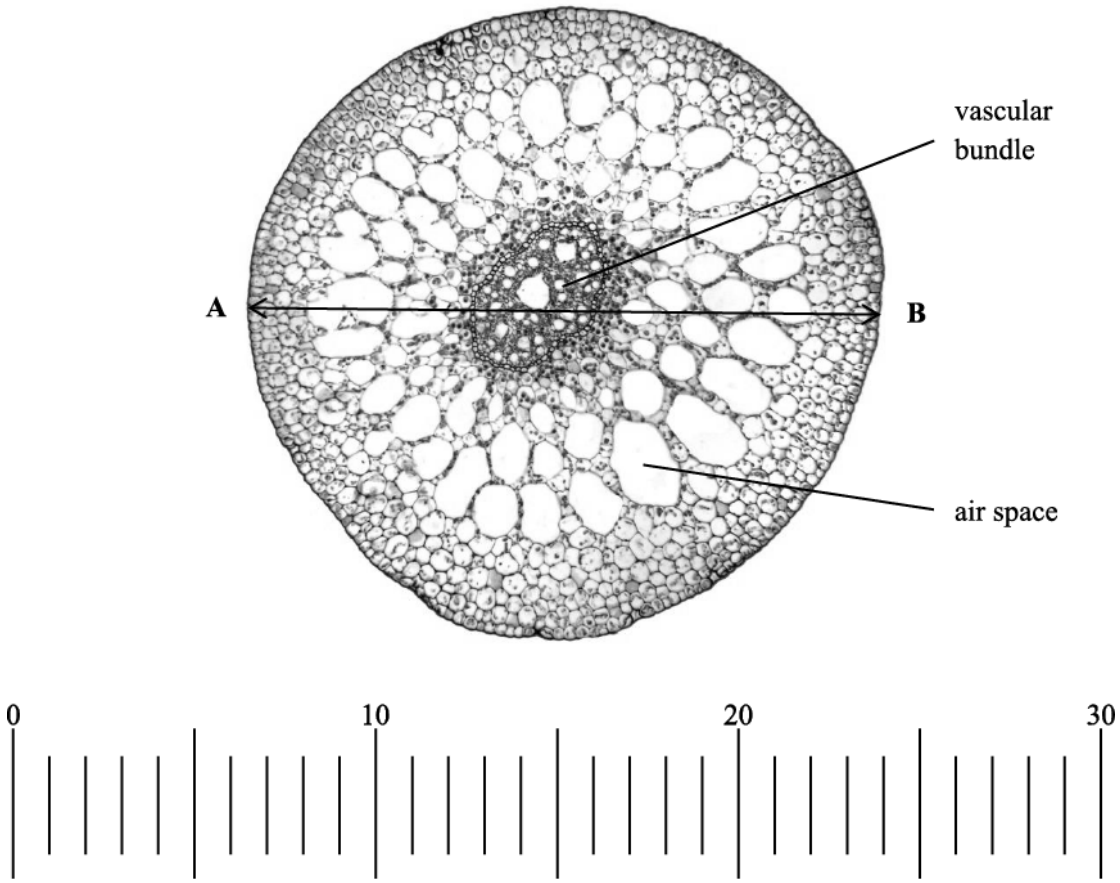


Fig. 22.1

A student was asked to view cells from the phloem in transverse section using a high power objective lens. **Fig. 22.2** shows two diagrams of phloem tissue.

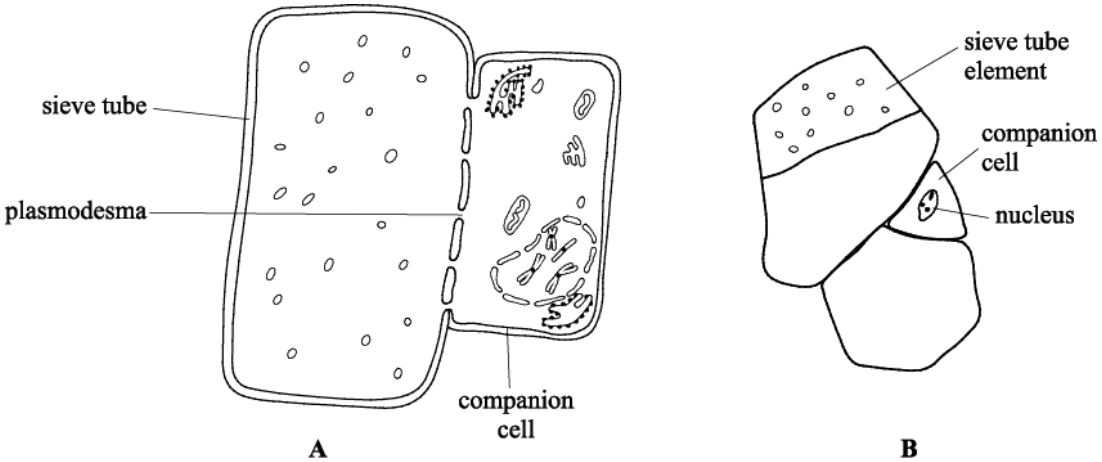


Fig. 22.2

(i) Which diagram is the more accurate representation of what the student could see?
Justify your decision using **two** separate features of the diagrams.

---

[2]

(ii) State what is meant by the *resolution* of a microscope.

---

[1]

(iii) The slide viewed to draw the diagrams in **Fig. 22.2** had been stained.

Table 22.1 shows a list of stains and the cell feature that can be stained.

Stain	Cell feature stained
Nile blue	nuclei
eosin	cytoplasm
Sudan red	cell membrane
iodine	starch

Table 22.1

Which stain had the student used? Explain your answer.

---

[2]

7. **Fig. 25.1** shows a potometer.

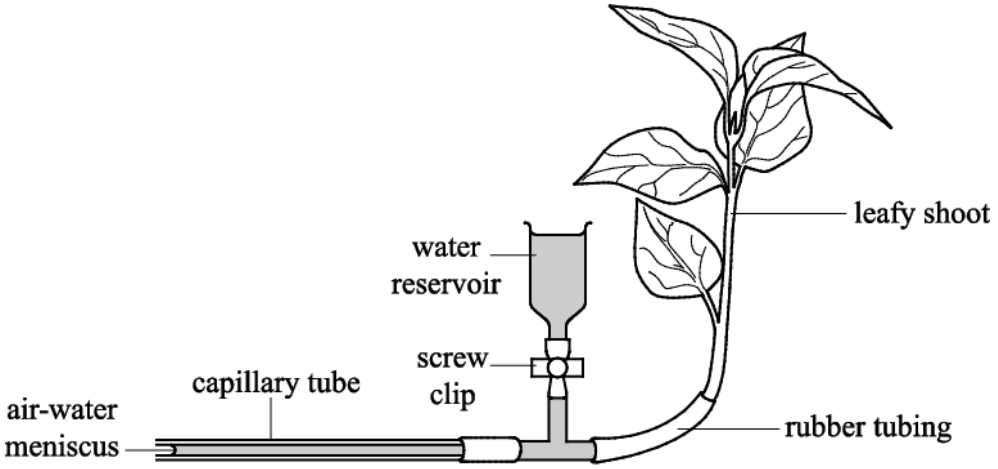


Fig. 25.1

(a) A student used this apparatus to investigate the role of stomata in transpiration. The student noted the position of the air-water meniscus each minute for five minutes.

The student then covered the underside of one of the leaves in petroleum jelly before repeating the measurements. This was continued until the undersides of all the leaves had been covered.
Table 25.1 shows the results.

Number of leaves with undersides covered in petroleum jelly	Position of meniscus (mm) at					
	0 min	1 min	2 min	3 min	4 min	5 min
0	0	23	44	65	84	102
1	0	20	40	58	77	95
2	0	16	31	47	61	76
3	0	11	23	37	50	62
4	0	9	17	24	32	40
5	0	6	11	16	22	28

Table 25.1

The student presented these results as a graph. **Fig. 25.2** shows the graph.

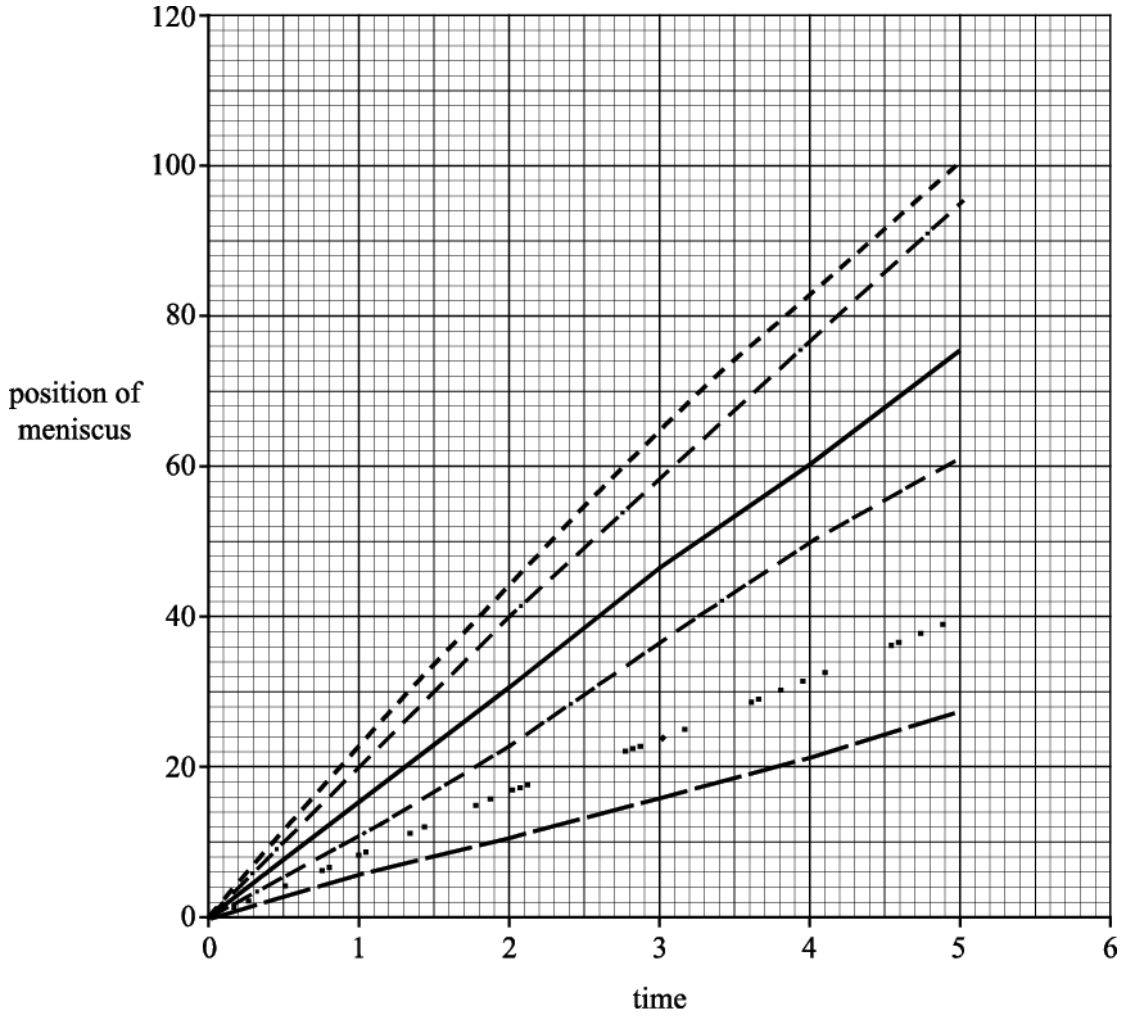


Fig. 25.2

(i) State two different types of information the student has missed from the graph.

---

[2]

(ii) Use the graph to calculate the minimum rate of transpiration.

Show your working.

Answer _____ mm min^{-1} **[2]**

(b) Suggest how water is being lost from the cut stem when all the leaves have been treated with petroleum jelly.

_____

_____ **[2]**

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

_____

_____ **[2]**

8. The following mechanisms are used to move water through plants:

(i) diffusion
(ii) osmosis
(iii) mass flow.

Which row correctly identifies the mechanism used at each point of the transpiration stream?

	Into root cells	**Across root via symplast pathway**	**Up the stem in the xylem**	**Across leaf via apoplast pathway**	**Out of leaf via stomata**
A	osmosis	osmosis	mass flow	mass flow	diffusion
B	diffusion	osmosis	osmosis	mass flow	diffusion
C	diffusion	osmosis	osmosis	mass flow	osmosis
D	osmosis	osmosis	mass flow	mass flow	osmosis

Your answer ☐

[1]

9(a). Following their formation, assimilates are transported throughout the plant by translocation in phloem.

Phloem sap mainly consists of carbohydrate in the form of sucrose, but also contains other solutes.

(i) Suggest why it is beneficial to the plant for the carbohydrate to be transferred throughout the plant in the form of sucrose rather than as an alternative carbohydrate.

---

[2]

(ii) How is transport in the phloem similar to and different from transport in the xylem?

Similar _____

Different _____

---

[2]

(b). Assimilates are loaded into the phloem at the 'source' and then transported to the 'sink'.

(i) Explain, with a suitable example, how some parts of the plant can act as both a 'source' and a 'sink'.

---

[2]

(ii) * **Fig. 19.1** is a diagram that represents the loading of sucrose into the phloem at the 'source'.

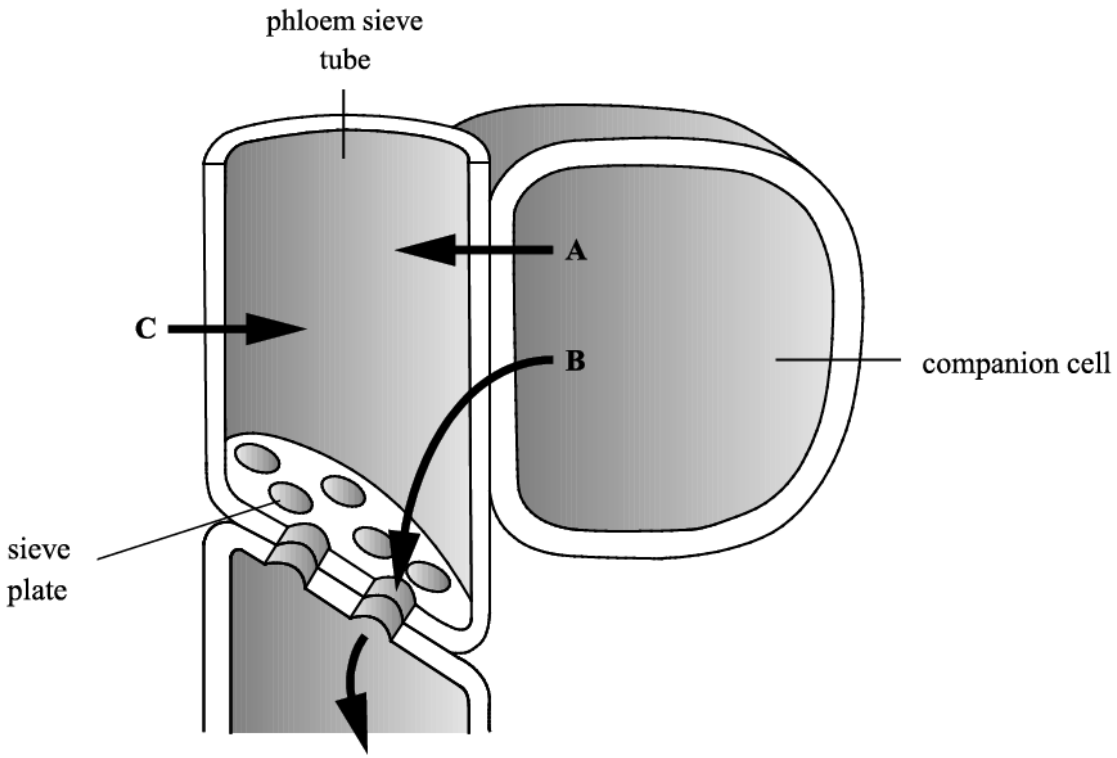


Fig. 19.1

With reference to **Fig. 19.1**, explain the process of the loading of sucrose into the phloem and its movement in the phloem.

[6]

(c). **Fig. 19.2** is a diagram of a potato plant. Potatoes are tubers which are underground storage organs.

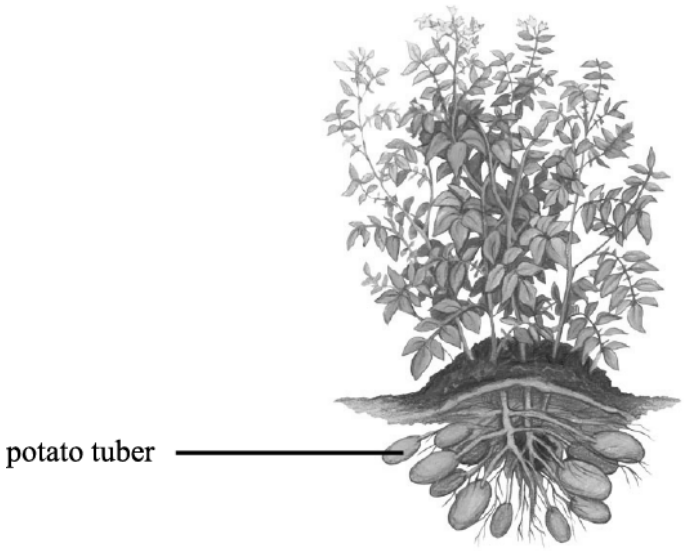


Fig. 19.2

Actively growing tissues have a high demand for carbohydrates. This means that a lot of phloem sap is directed to these tissues and requires sucrose to be unloaded in large amounts.

In an investigation, potato plants were modified by having a gene for invertase inserted into their DNA so that the gene for invertase would be expressed in the tubers. Invertase is responsible for catalysing the hydrolysis of the disaccharide sucrose.

A trial experiment was carried out to compare the properties of the modified plants with those that had not been modified. After harvesting, the tubers of three of each type of plant were compared. The results are shown in **Table 19.1**.

	Modified	**Not modified**
Mean number of tubers per plant	2.2	5.3
Mean mass per tuber (g)	49.7	16.8
Mean sucrose concentration (mg g^{-1} tuber mass)	1.4	13.7
Mean glucose concentration (mg g^{-1} tuber mass)	36.3 ± 3.5	1.9 ± 0.3
Invertase activity (arbitrary units)	62.1	1

Table 19.1

(i) Name the bond that is hydrolysed by invertase.

---

[1]

(ii) The potato tubers contain monosaccharides.

Compare the concentration of monosaccharides in the modified tubers with those that were not modified.

---

[2]

(iii) In the modified plants, the unloading of sucrose is increased in the tubers compared with those that were not modified.

The transport of sucrose to the tubers was also increased in the modified plants.

Using the data and the information given, deduce a possible mechanism to account for the increased unloading and transport of sucrose in the modified plants.

---

[4]

(iv) The trial experiment compared the properties of modified potato plants with those that were not modified.

Analyse the data and draw conclusions about the yield of the tubers of modified plants compared with those tubers from plants which had not been modified.

---

[3]

10. The following passage has four key terms missing:

Meristem cells in plants are used to generate new plant tissues. When _____ tissue is formed, _____ impregnates the cell walls, making them impermeable to water. All cytoplasm is lost. When _____ tissue is formed, cytoplasm remains, but the _____ _____ become elongated and lose most of their cytoplasm.

What is the correct order of missing terms?

A sclerenchyma, phloem, lignin, xylem vessels
B xylem, lignin, parenchyma, phloem vessels
C phloem, collenchyma, xylem, sieve tube elements
D xylem, lignin, phloem, sieve tube elements

Your answer ☐

[1]

11. The table below shows a series of statements about systemic and pulmonary circulation.

Row	Systemic circulation	Pulmonary circulation
A	higher pressure	lower pressure
B	equal pressure	equal pressure
C	lower pressure	higher pressure
D	medium pressure	absent

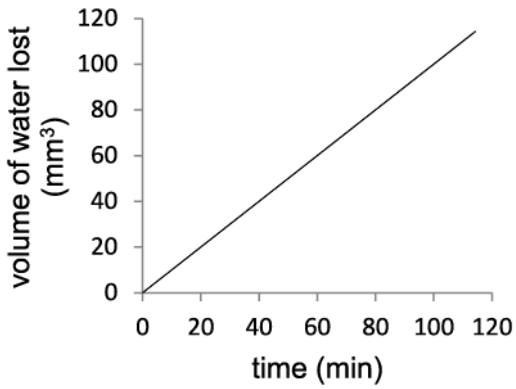
Which of the rows, **A** to **D**, correctly describes a closed, double circulatory system?

Your answer ☐

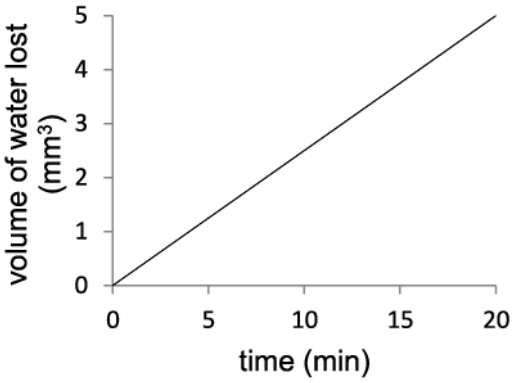
[1]

12. The following graphs show results from an experiment to investigate the rate of transpiration of the same plant in different environments.

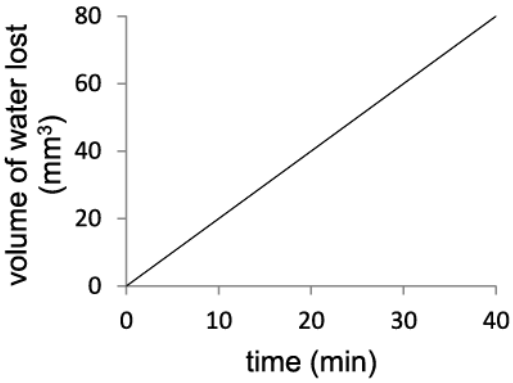
A



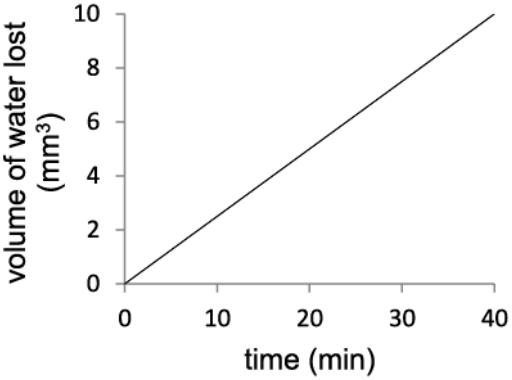
B



C



D



Which graph, **A** to **D**, shows the results for when the plant is being grown in the least humid environment?

Your answer ☐

[1]

13. *Heliamphora*, shown in Fig. 18.1, is a genus of carnivorous plant. Its leaves are adapted to form water-filled traps for insects. The insects are attracted by nectar, then fall into the traps and drown. The plants digest the insects and absorb the mineral ions produced. This allows *Heliamphora* to survive in soils with low mineral content.

Fig. 18.1

Fig 18.2 shows a transverse section of part of a *Heliamphora* stem, with three tissues labelled.

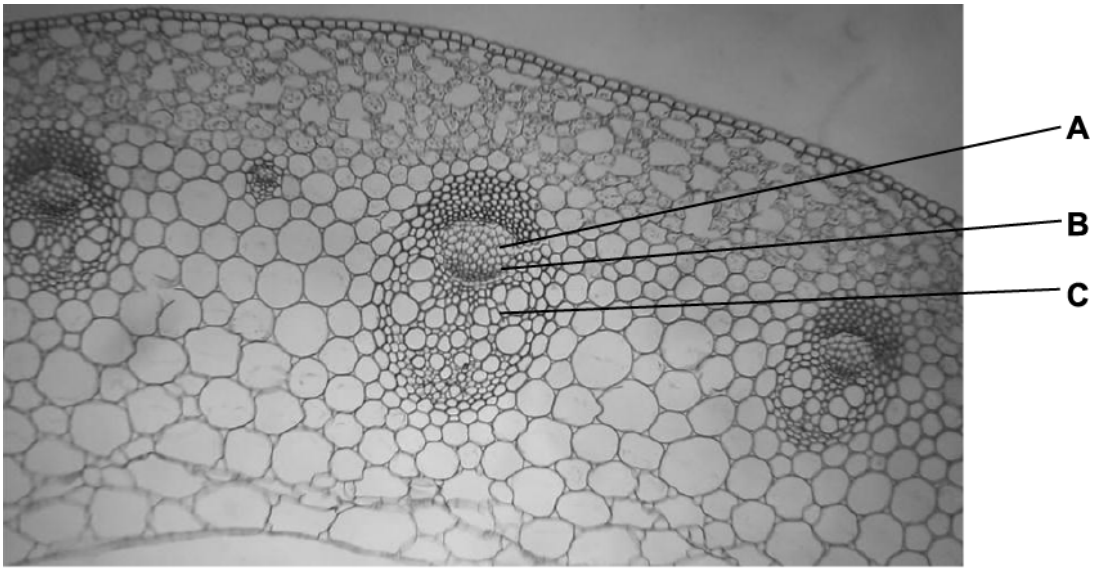


Fig. 18.2

(i) Identify the tissues labelled by the following letters:

A

C

---

[2]

(ii) The tissue labelled **B** is cambium.

What type of cell makes up this tissue?

---

[1]

14(a). The water calthrop, *Trapa natans,* lives in lakes and other water bodies. Its leaves float on the surface of the water. Its stems trail just under the surface of the water.

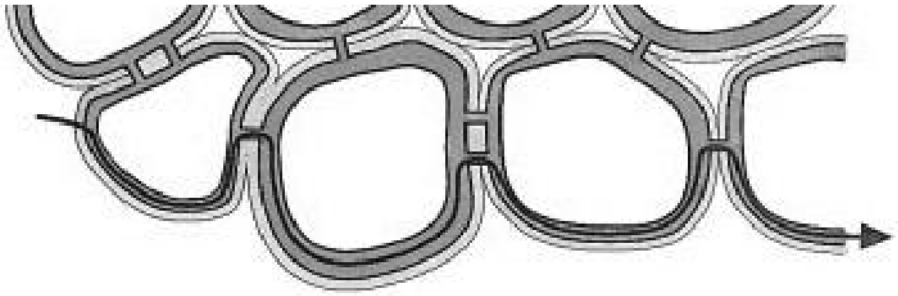
(i) What name is given to plants like *T. natans*, which are adapted to life in water?

---

[1]

(ii) Fig. 20.1 shows cells from the stem of *T. natans*. Water travels between the cells by two different pathways, **X** and **Y**.

X



Y

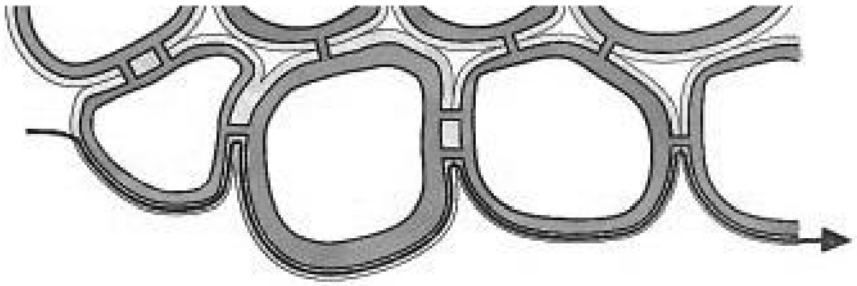


Fig. 20.1

Name the pathways represented by diagrams **X** and **Y**.

X

Y

---

[2]

(b). A potometer was used to calculate the rate of transpiration from leaves of *T. natans* with different surface areas.

Table 20.1 shows the data obtained during the investigation.

Surface area of leaf (cm^2)	Time (min)	Distance moved along capillary tubing (mm)
39.6	0	0
	20	4
	40	8
	60	10
	80	12
69.4	0	0
	20	6
	40	9
	60	13
	80	18
99.2	0	0
	20	7
	40	15
	60	23
	80	38

Table 20.1

(i) Give **two** factors that need to be controlled in this investigation in order to obtain valid data.

1 ----------

---

2 ----------

---

[2]

(ii) In its natural habitat, *T. natans* has many leaves with a surface area greater than 99.2 cm^2. Explain why this does not affect the rate of transpiration in a way which would be harmful for the plant.

---

[1]

15. This question is about the impact of potentially harmful chemicals and microorganisms.

(i) Salts that a plant needs, such as nitrates and phosphates, are taken into root hair cells by active transport.

For which macromolecule does a plant need both nitrogen **and** phosphorus?

[1]

(ii) Flooding of fields by seawater can damage crops. Seawater contains dissolved salts, including sodium chloride.

How would flooding affect soil water potential?

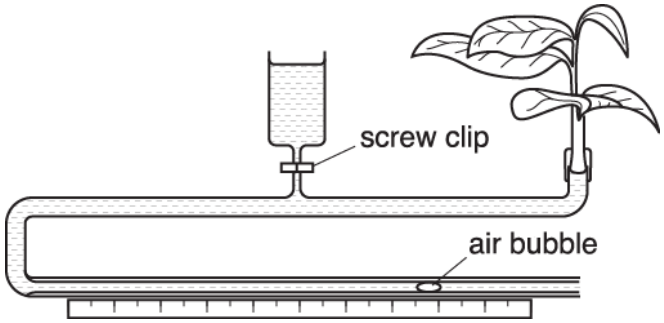
[1]

(iii) Sodium chloride in solution dissociates into Na^+ and Cl^-.

Explain how the Casparian strip prevents these ions from reaching the xylem of the plant by the apoplast pathway.

[2]

16. A diagram of a potometer is shown below.



Which of the following options, **A** to **D**, is a precaution that is **not** needed when setting up a potometer?

A Remove excess water from the surface of the leaves before readings are taken.
B The screw clip must be opened while taking the readings.
C The shoot should be cut whilst under water.
D There should be no extra air bubbles.

Your answer ☐

[1]

17. Halophytes are plants that have the ability to live in soils with a very low water potential. In the UK these plants form part of salt marsh communities.

Suggest **and** explain how the root hairs of halophytes are able to absorb water by osmosis from the soil of the salt marsh.

[2]

18(a). The following statements summarise the results from experiments designed to discover more about the translocation of organic materials in the phloem.

A	Any increase in the sugar content of leaves is followed by a similar change in the sieve tube contents in the stem.
B	The rate of transport increases with increasing temperature, reaching a maximum at 25 °C before decreasing at higher temperatures.
C	Translocation stops when stems are treated with a substance that inhibits respiration.
D	Sugars can be transported both up and down the plant.
E	Aphids can be used to sample phloem sap.
F	Roots, young leaves and growing fruits will import sugars.

State all the letters that provide evidence for the following conclusions:

Translocation is an active process.

Sugars are translocated from source to sink.

---

[4]

(b). Explain how mass flow of the phloem sap occurs in plants with a vascular system.

---

[3]

19. Plants contain specialised cells.

Cells in the phloem are specialised so that translocation can occur.

What is meant by translocation?

---

[2]

20(a). Complete the following paragraph about the transport of water across the root cortex.

Water can follow different pathways from the epidermis to the xylem in the root.

In the apoplast pathway, water passes between the cells and through the _____.

In the symplast pathway, water enters the cell cytoplasm by osmosis and passes from cell to cell via specialised cell junctions called _____.

At the _____ layer, water passing between the cells must enter the symplast pathway because passage between the cells is blocked by the _____.

[4]

(b). The uptake of water from the soil is dependent upon its availability. Some plants living in habitats where water is not easily available are adapted to conserve water.

As part of an investigation, a student measured the surface area of a sample of leaves. The student selected leaves from a variety of habitats, placed each leaf on graph paper and drew the outlines. The outlines are shown in Fig. 3.2.

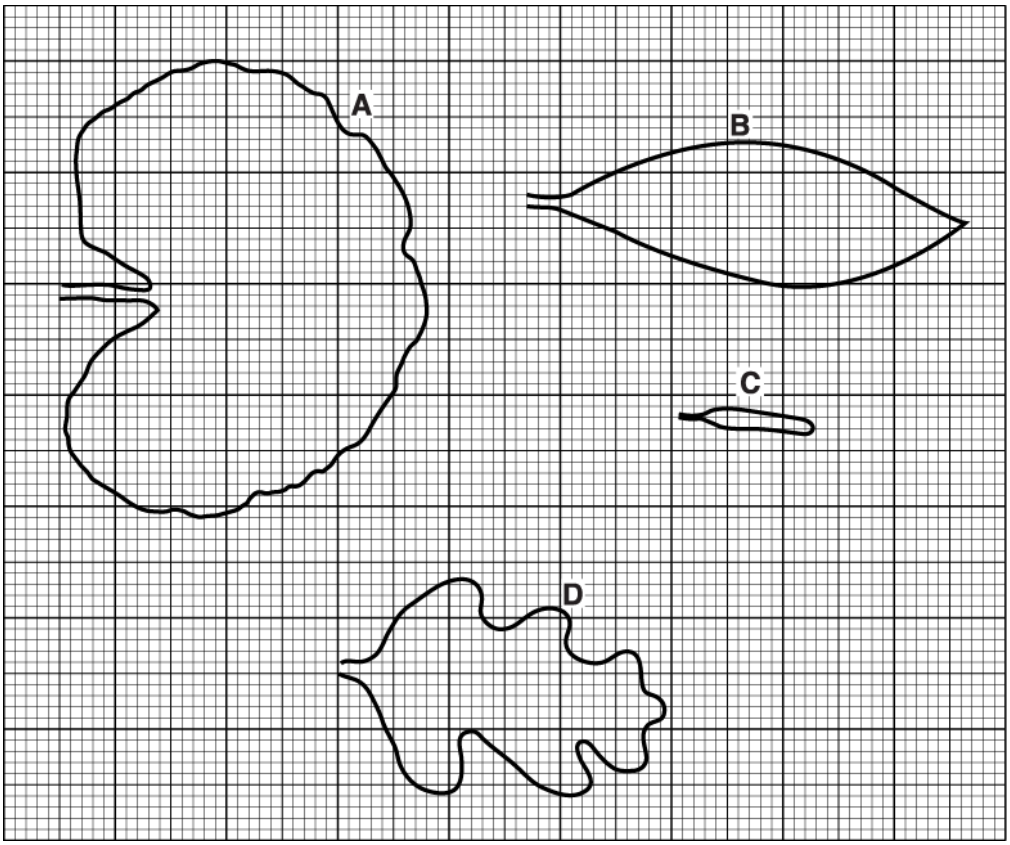


Fig. 3.2

(i) Which leaf, **A, B, C** or **D**, is most likely to have come from a plant adapted to living in a habitat with low water availability?

_____

[1]

(ii) Explain the reason for your choice in **(i)**.

_____

_____

_____ **[1]**

(iii) State **one other** adaptation that leaves might have to conserve water.

_____

_____

_____ **[1]**

(c). One environmental factor that affects the loss of water **vapour** from the leaves is air movement.

Explain how increased air movement increases the loss of water vapour from the leaves.

_____

_____

_____

_____

_____

_____ **[2]**

21(a). Mosses are small plants with no true roots. Each plant is anchored by simple root-like structures which do not contain vascular tissue.

The leaves of moss plants are usually one cell thick and are attached to a thin stem. Neither the leaves nor stem contain vascular tissue.

Fig. 5.1 shows a leaf from a typical moss plant.

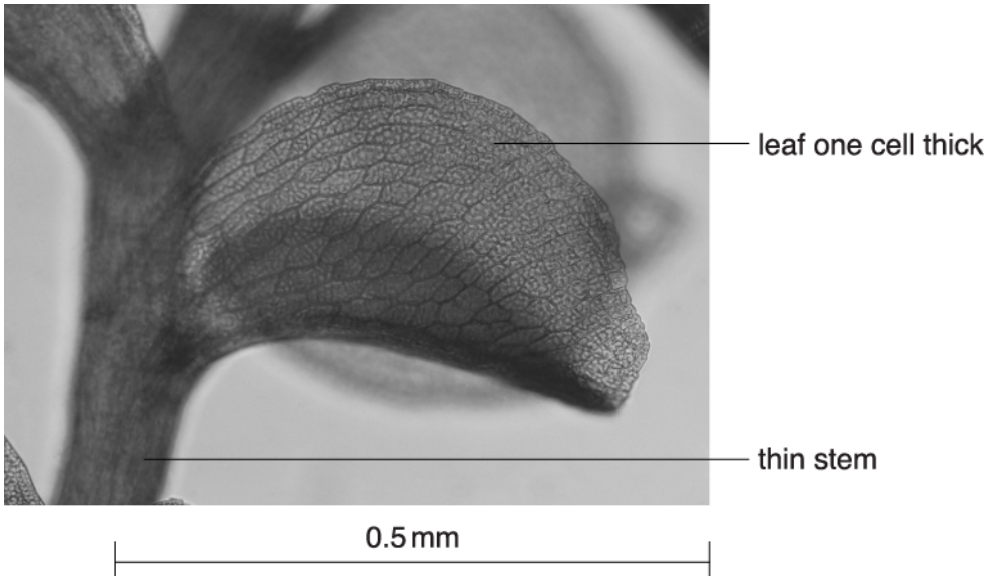


Fig. 5.1

Suggest **and** explain how the absence of vascular tissue might affect the size to which moss plants can grow.

---

[2]

(b). Although a moss plant has no vascular tissue, water still moves through the plant from the root-like structures to the leaves.

Use your knowledge of the mechanisms of water transport to explain the movement of water through the moss plant.

In your answer you should use appropriate technical terms, spelled correctly.

---

[4]

22(a). Transpiration is the loss of water vapour from the aerial parts of a plant.

(i) Name the pores through which most water vapour is lost from a leaf.

---

[1]

(ii) Describe how the guard cells surrounding the leaf pores are adapted to their role.

---

[2]

(iii) Name **one** other part of the leaf from which water may be lost.

---

[1]

(b). Water lost from the leaf must be replaced with water from the xylem.

Complete the following passage about movement of water from the xylem to the cells of the leaf using the most appropriate terms.

When water is lost from the cells of the leaf it reduces the _____

in those cells. As a result, water enters the cells by _____ .

This process occurs across the plasma membrane which is _____ .

If all the water lost from the leaf cells is not replaced, they lose _____

and the leaf may wilt.

[4]

(c). The cohesion-tension theory is often used to explain the mechanism by which water moves up the xylem from the roots to the leaves.

Use this theory to explain how water moves from the roots to the leaves.

---

[3]

23(a). Fig. 2.1 shows some undifferentiated plant cells, such as those found at the tips of roots and shoots.

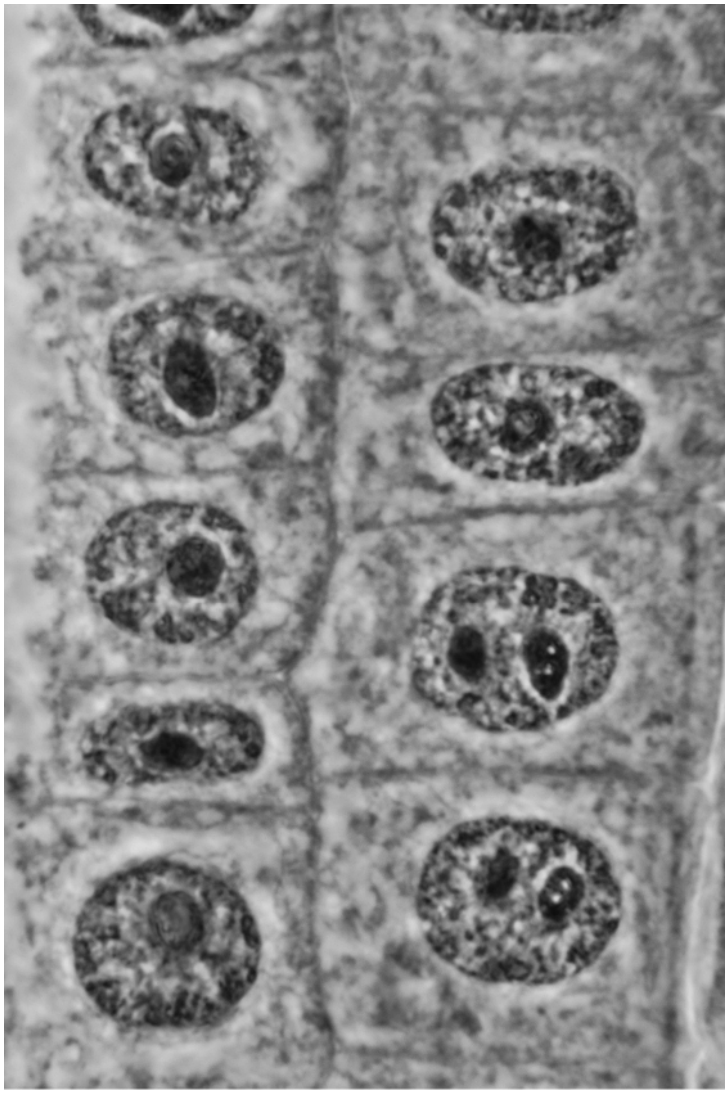


Fig. 2.1

(i) Name the type of tissue that undergoes cell division to form these undifferentiated plant cells.

---------- **[1]**

(ii) State the features shown in Fig. 2.1 that would **not** be found in mature xylem vessels.

---------- **[2]**

(iii) Describe how the structure of the cell walls in xylem vessels would differ from the cell walls shown in Fig. 2.1.

---**[2]**

(b). Name **two** types of cell that can be found in **phloem** tissue.

---**[2]**

24. Neonicotinoids are chemicals with a similar structure to nicotine. The effects of these chemicals on insects have led to their use as insecticides over the last 20 to 30 years.

(i) Neonicotinoid insecticide molecules are absorbed by the roots and leaves of maize plants.

Describe how, once these molecules have been absorbed, they may be transported to the fruits of the maize plant.

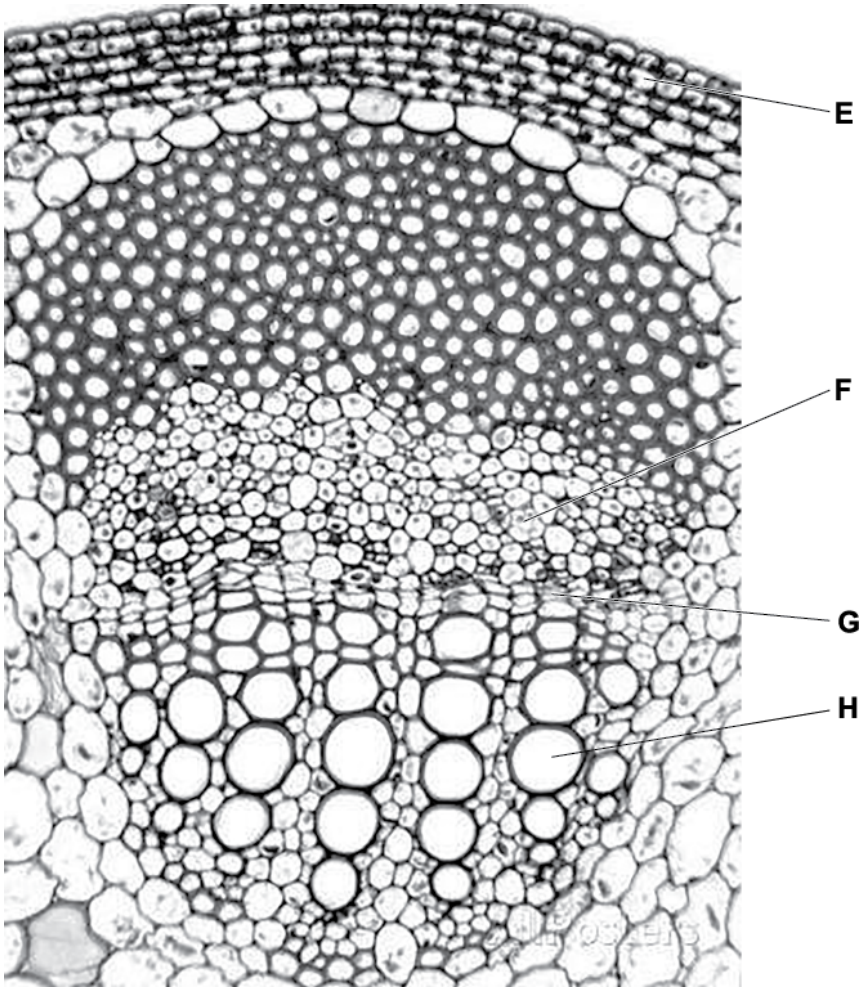
---**[2]**

(ii) Despite the similarity to nicotine, neonicotinoids have been permitted for use on crops that would be used for human consumption.

Suggest why neonicotinoids have been considered to be safe.

---**[1]**

25. Below is a light microscope image of a transverse section of part of a plant stem.



Which row, **A** to **D**, lists the correct labels for this image?

	E	**F**	**G**	**H**
A	xylem	meristem	epidermis	phloem
B	epidermis	phloem	cambium	xylem
C	meristem	phloem	xylem	root hair
D	xylem	cambium	phloem	meristem

Your answer

[1]

26(a). Fig. 3.1 shows a bubble alga, *Valonia ventricosa*, which is one of the largest unicellular organisms in the world.

Fig. 3.1

Calculate the surface area to volume ratio of a bubble alga that has a diameter of 2.5 cm.

Assume the bubble alga is spherical. Show your working.

Answer = _____ **[3]**

(b). Multicellular organisms, such as plants, have evolved internal transport systems.

(i) Explain the benefit to plants of internal transport systems.

---

[2]

(ii) The transport systems of plants contain cells that are specialised to perform a particular function.

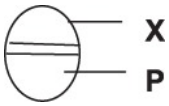
The table below shows information about three types of specialised plant cell. Three boxes have been completed already.

Complete the rest of the table by placing the correct responses in the empty boxes.

Cell	Location	Example of a substance transported	Contains chloroplasts? (□ or □)
Guard cell		carbon dioxide	
Companion cell			□
Root hair cell	roots		

[3]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1	a	i	letter **X** marking upper part of vascular bundle **and** letter **P** marking lower part of vascular bundle ;	1	 **ACCEPT** Xylem and Phloem **DO NOT CREDIT Y** **Examiner's Comments** Many candidates were able to label the xylem and phloem in the diagram correctly. They could achieve this by writing inside the correct part of the diagram or using label lines. However, a good proportion had the labels reversed or did not draw suitable label lines. Candidates should be trained through their practical work to draw and label diagrams accurately. Some candidates missed the question despite the presence of a statement to remind them to answer this part of the question on the diagram.
		ii	vascular bundle / vein ;	1	**IGNORE** tissue / midrib **Examiner's Comments** Most candidates correctly named structure R as a vascular bundle or vein.

Question			Answer/Indicative content	Marks	Guidance
	b	i	(the charged particles are) hydrogen ions / H^+ / protons ; (ions are) moved out of the cells / move into surrounding (solution) ;	2	**IGNORE** descriptions of observations 2 and / or 3 **IGNORE** ref to OH^- / alkaline substances **Note** do not need to refer to hydrogen ions for mp 2 **Note** that 'hydrogen ions move out of the cell' **= 2 marks** **Examiner's Comments** Candidates were provided with the results of an investigation and asked to draw conclusions from the evidence. Most candidates correctly identified the charged particles as hydrogen ions and many appreciated that these ions were moved out of the companion cells. Other candidates seemed confused and referred to acidic substances or alkaline substances rather than to ions. Many candidates tried to describe the process of active loading rather than focus their response on the specific question asked. It is important to train candidates to read the question carefully and restrict their response to answering only that question.
		ii	active transport involved / cyanide prevents active transport / (mechanism) is active / (mechanism) needs energy / (mechanism) needs ATP ;	1	**IGNORE** descriptions of observation 4 e.g. no ATP is made **IGNORE** 'mechanism / active loading, does not work in presence of cyanide' as too vague **Examiner's Comments** Many candidates appreciated that the evidence suggested a need for ATP and an active process to ensure that the hydrogen ion concentration gradient is set up. However, many candidates simply stated that respiration must occur for the process to go ahead.

Question			Answer/Indicative content	Marks	Guidance
	c	i	active transport ; concentration / pH / H^+ / proton / electrochemical ; facilitated ; diffusion ; amino acids ;	5	**Mark the first answer.** If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then **= 0 marks** **IGNORE** active loading **IGNORE** high **DO NOT ACCEPT** diffusion **ACCEPT** facilitated diffusion **ACCEPT** plasmodesmata **DO NOT CREDIT** facilitated diffusion **DO NOT CREDIT** glucose / fructose / ions **Examiner's Comments** Was a gap fill question in which the candidate's knowledge of the active loading process was tested. Most candidates scored two or three marks appreciating that active transport must be required to create a concentration gradient and that the hydrogen ions must move through the membrane by facilitated diffusion, while the sucrose could diffuse through plasmodesmata into the sieve tube. Few candidates appreciated that assimilates are molecules that have become part of the organism and that amino acids are often transported. This part of the question was more difficult as the molecule mentioned had to be an assimilate and one that is transported in the phloem.

Question			Answer/Indicative content	Marks	Guidance
		ii	many / large, mitochondria ; plasmodesmata (between companion cell and sieve tube) / described ; many ribosomes / extensive RER ; many proteins in the, plasma / cell surface, membrane ;	2	**IGNORE** qualification of type of protein **Examiner's Comments** Candidates were asked what evidence for the active loading mechanism might be gained from observation using an electron microscope. Most candidates appreciated that mitochondria were required to produce the ATP used in active transport. Some did not link the need for many mitochondria in particularly active tissues. Fewer candidates were able to provide a second line of evidence such as the presence of plasmodesmata. Weaker candidates need to be trained to recall what features of cells are visible under an electron microscope as some were suggesting that the movement of sucrose and even hydrogen ions could actually be observed.
			Total	**12**	
2			apoplast / apoplastic ;	1	**Mark the first answer for each question part.** If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = **0 marks** **Examiner's Comments** This term was well known to the majority of candidates.
			Total	**1**	
3			D	1	
			Total	**1**	

Question			Answer/Indicative content	Marks	Guidance
4	a		lateral movement of water	1	
	b		*idea of* long distance from external surface to cells (1) small surface area to volume ratio (1) diffusion not fast enough (1) named example of substance that is transported e.g. sucrose (1)	3	**ALLOW** from source to sink / root to leaf etc.
	c		no / thin, (waxy) cuticle **and** *idea that* wax production is a waste (1) large surface area to, increase / maximise, photosynthesis, as transpiration is not an issue (1) many stomata to, increase / maximise, gas exchange (1) stomata on the top surface, as gas concentration is higher in air than water (1)	2	**ALLOW** stomata do not close at night to maximise gas exchange
			Total	**6**	
5			B	1	
			Total	**1**	
6		i	*B* comment about detail of organelles (1) comment about shapes of cells (1)	2	**No Mark for identification of B** e.g. light microscope would not allow nuclear pores / ribosomes / endoplasmic reticulum / plasmodesmata to be seen. e.g. sieve tube elements are angular / hexagonal.
		ii	the ability to see more detail / separate two objects (1)	1	
		iii	Nile blue (1) to increase contrast / to make nuclei visible / to show no nuclei in sieve tubes (1)	2	
			Total	**5**	

Question			Answer/Indicative content	Marks	Guidance
7	a	i	*two from* units on axes (1) plotted points (1) title (1)	2	
		ii	= 5.25 (mm min^{-1}) (1)(1)	2	**ALLOW** answer in range 5.0 to 6.0 **(**mm min^{-1}) **ALLOW** one mark for correct working if final answer incorrect e.g. $\frac{21-0}{4}$
	b		evaporation (1) from upper leaf surfaces (1)	2	
	c		*two from* not all lower leaf surface covered (1) leaks in apparatus (1) shoot not cut under water (1) error in reading position of meniscus (1)	2	e.g. seal around the plant is not airtight.
			Total	**8**	
8			A	1	
			Total	**1**	

Question			Answer/Indicative content	Marks	Guidance
9	a	i	sucrose is soluble so can be transported in sap (1) but metabolically (relatively) inactive so no, used / removed, during transport (1)	2	
		ii	*similar – one of* solutes carried in solution in both (1) both carry mineral salts (1) both use, mass flow / generated hydrostatic pressure (1) *different – one of* transport in phloem can take place in different directions **and** transport in xylem only takes place up the plant (1) phloem carries carbohydrates **and** xylem does not (1) phloem transport uses living cells **and** xylem does not (1) xylem uses, capillary action / cohesion and adhesion, **and** phloem does not (1)	2	
	b	i	certain parts can store and then release carbohydrates when needed (1) suitable examples include root or leaf, which can act as sink or source at different times of year (1)	2	

Question			Answer/Indicative content	Marks	Guidance
		ii	* **Level 3 (5–6 marks)** A clear, thorough explanation, showing a good understanding of the principles of loading into phloem, incorporating use of the diagram. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** A partial explanation showing some understanding of the principles of loading into phloem. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** An attempt including some correct principles, but likely to be confused, showing limited understanding of the principles of loading into phloem. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.	6	**Relevant principles include:** • **B** / sucrose, pumped from companion cell into phloem sieve tube • by active transport • H^+ / proton, co-transport of sucrose • reduces water potential of sieve tube • **A** / water, enters sieve tube from companion cell • **C** / water, enters sieve tube from xylem • increased pressure forces flow of sap down phloem • through the pores in the sieve plates.
	c	i	glycosidic	1	
		ii	*two from* 19 × greater in modified (1) 1811% increase in modified compared with unmodified (1) standard deviation indicates greater spread of data for modified (1)	2	

Question			Answer/Indicative content	Marks	Guidance
		iii	*two from* sucrose unloaded at sinks and invertase converts sucrose into, glucose / monosaccharide (1) increases sucrose concentration gradient between phloem and sink (1) causes increased unloading of sucrose from phloem (1) *two from* increases solute gradient between source and sink (1) removal of water from phloem increases pressure gradient between source and sink (1) contributes to increased movement in phloem (1)	4	
		iv	modified produce fewer **and** larger tubers (1) **ora** modified produce greater mass of tuber (1) **ora** 109.34 g for modified **and** 89.04 g for not modified (1)	3	
			Total	**22**	
10			D	1	
			Total	**1**	
11			A	1	
			Total	**1**	
12			C	1	
			Total	**1**	
13		i	**A** phloem (1) **C** xylem (1)	2	
		ii	meristem	1	**ALLOW** meristematic **DO NOT ALLOW** stem cells / undifferentiated cells
			Total	**3**	

Question			Answer/Indicative content	Marks	Guidance
14	a	i	hydrophyte	1	
		ii	**X** symplast (1) **Y** apoplast (1)	2	
	b	i	temperature (1) humidity (of air) (1) air currents (1) light intensity (1) *idea of* health of leaves (1)	2	**DO NOT ALLOW** species of leaves **DO NOT ALLOW** surface area **IGNORE** age of leaf (as this is correlated with surface area) **IGNORE** air bubbles in potometer, etc. **DO NOT ALLOW** 'warmth' or 'heat' **ALLOW** water (vapour) potential **DO NOT ALLOW** 'moisture' or 'water levels' alone **ALLOW** wind **ALLOW** 'leaves should not be damaged'
		ii	*high rate of transpiration does not matter because:* (plant lives in an) aquatic / AW habitat, so water lost is easily / AW, replaced (1)	1	**IGNORE** references to hydrophyte adaptations
			Total	**6**	
15		i	DNA / RNA / nucleic acid	1	
		ii	lower / reduce / make more negative	1	
		iii	*two from* **1** strip is impervious to, water / solutions (1) **2** forces water / solutions, to pass through, <u>plasma</u> / <u>cell surface</u>, membrane (1) **3** phospholipid (bilayer), repels / AW, ions / charged particles (1)	2	**1 IGNORE** ref to suberin. **3** The idea of charge / ion impermeability is wanted here. **ALLOW** answer in terms of ions / charged particles needing channels because phospholipid bilayer does not allow charged particles through.
			Total	**4**	

Question			Answer/Indicative content	Marks	Guidance
16			B	1	**Examiner's Comments** This was another question that drew upon the candidates' practical skills. Again, it might have been that some candidates misread the question and suggested a precaution that is needed, accounting for the incorrect answers seen.
			Total	**1**	

Question			Answer/Indicative content	Marks	Guidance
17				2	**IGNORE** ref to large surface area and short diffusion path **IGNORE** ref to solute potential / isotonic **ACCEPT** Ψ for water potential 'it' or 'they' = root hairs **IGNORE** ref to roots or root cells unqualified as hairs
			there is a lower water potential inside root hair (cells) □		**ACCEPT** root hair, has / creates, a lower water potential (than soil) **ACCEPT** maintains / sets up / establishes, a (steep) water potential gradient Look for a comparison in water potential between the cell and the soil
			actively transport / pump, (mineral) ions / salts, into root hair(s) (cells) **or** root hair(s) (cells) store / contain, (mineral) ions / salts / solutes □		**IGNORE** solutes / sugars / hydrogen ions **ACCEPT** named ions **ACCEPT** named ions **ACCEPT** named solutes e.g. sugars
					Examiner's Comments This question highlighted the failure of many candidates to use the correct scientific terminology. In particular was the use of 'concentration gradient' without showing an appreciation of, or even mentioning, water potential, despite the previous parts of the question being on that subject. Where active transport was mentioned some thought it was the water that was pumped into the cell or that transpiration was also involved. Many candidates understood the principal of reducing the water potential of the root hair cells but failed to gain credit by referring to the roots or the plant without specifying the 'root hair cells'.They also talked about the large surface area of root hair cells, which also failed to gain credit.
			Total	**2**	

Question			Answer/Indicative content	Marks	Guidance
18	a		B C ☐☐	2	One mark for each correct answer e.g. B C = 2 B or C (only) = 1 B D✗ = 1 If one extra incorrect letter = max1 If two extra incorrect letters = 0 marks e.g. B C D ✗ = 1 B C D ✗ E ✗ = 0
			A D F ☐☐	2	**If any incorrect or extra letters are written, cross each one.** e.g. A D E✗ Then look at any correct letters written. We have 1 cross so only 1 more mark available, A and D both right so gets this 1 mark) e.g. A D E✗ C✗ We have 2 crosses so 0 marks even though the correct letters have also been given **If no extra or incorrect letters are written:** Three answers written, all correct = 2 marks A, D, F = 2 Two answers written, both correct = 1 mark A, D = 1 A, F = 1 D, F = 1 One answer written and correct = 0 A = 0 F = 0 D = 0 **Examiner's Comments** Most candidates gained some credit here but only a few gained all four marks. Commonly, correct responses were contradicted by incorrect answers particularly when identifying the evidence for translocation as an active process. It would seem that these students have limited experience of interpreting data/observations or relating them to processes.

Question			Answer/Indicative content	Marks	Guidance
	b		1 sugar / sucrose / assimilates, in the sieve tube (elements) ☐ 2 (assimilates) enter, sieve tube / phloem (at source) **and** lowers water potential (in sieve tube)☐ 3 water enters (sieve tube), by osmosis / down water potential gradient / described **and** increases hydrostatic pressure ☐ 4 (assimilates) leave, sieve tube / phloem (at sink) **and** increases water potential (inside sieve tube) ☐ 5 water leaves (sieve tube), by osmosis / down water potential gradient / described **and** lowers hydrostatic pressure ☐ 6 (assimilates) move, from high to low (hydrostatic) pressure / down pressure gradient ☐	max 3	2 **IGNORE** details of loading mechanism and companion cells 6 **IGNORE** 'mass flow' as given in Q **Examiner's Comments** A significant number of candidates were able to describe the process of mass flow correctly but failed to gain credit by not specifying that the sieve tube elements of the phloem that are involved. Some talked about loading sap rather than sucrose. Many also concentrated on a detailed description of the loading mechanism rather than fully addressing the information required. There was some evidence of a lack of care when reading the question. Often there was confusion with the transport in the xylem, e.g. sugars moving along symplast / apoplast pathways, by cohesion and adhesion. The term 'concentration gradient' was

Question			Answer/Indicative content	Marks	Guidance
					commonly uses as a catch-all phrase to explain the movement of anything from one place to another. The terminologies of water potential gradient and/or hydrostatic pressure gradient were only correctly used by the better candidates. It seems that few candidates appreciate that a pressure gradient is set up between the source and sink.
			Total	**7**	
19			transport / movement / mass flow, of, assimilates / sucrose / amino acids; from source to sink / description;	2	**IGNORE** ref to (organic) solutes / food / glucose / sugars e.g. from cells / tissues / site where produced to cells / tissues / site where used **ACCEPT** named source AND sink **Examiner's Comments** Generally well answered and candidates only lost marks because their answer was too vague. Examples of vagueness include using the term ‘sugar’ rather than ‘sucrose’ and not making clear that transport was ‘from source to sink’. Some candidates confused translocation with active loading at the source and gave detailed descriptions of how sucrose is loaded into the sieve tubes.
			Total	**2**	

Question			Answer/Indicative content	Marks	Guidance
20	a		cell walls; plasmodesma(ta); endodermis / endodermal; Casparian strip;	4	**DO NOT CREDIT** Caspian / Caspiran **Examiner's Comments** Candidates were mostly able to complete this gap-fill exercise correctly. Some candidates did not manage all the gaps correctly but even the weakest candidates usually managed two marks of the four available. A few candidates incorrectly wrote ‘epidermis’ or 'endothelium' rather than endodermis.
	b	i	C;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
		ii	small(er) <u>surface area</u> means less, evaporation / transpiration;	1	**Mark independent of (i)** **Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **IGNORE** less water loss / fewer stomata **DO NOT CREDIT** small surface area to volume ratio **DO NOT CREDIT** no, transpiration / evaporation **Examiner's Comments** The vast majority of candidates realised that leaf C was from a plant adapted to living in an environment with low water availability. Most based their decision on the small surface area of the leaf. However, some candidates confused leaf surface area with its surface area to volume ratio. A significant minority of candidates failed to explain that a small surface area would lead to less evaporation or loss of water vapour (transpiration).

Question			Answer/Indicative content	Marks	Guidance
		iii	thick (waxy) cuticle; few stomata; stomata, sunken / in pits; hairs / hairy; leaf, curled / rolled; dense spongy mesophyll; closure of stomata, during day / when water availability low;	max 1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **Examiner's Comments** Most candidates knew that having hairs or a thick waxy cuticle would help conserve water although some failed to specify that the waxy cuticle would be thick. Other correct responses included sunken stomata and curled leaves.
	c		water vapour around the, stomata / leaf surface, is blown away; reduces water (vapour) potential around, stomata; *idea of*: increases / maintains, water (vapour) potential gradient (between air space in leaf and outside);	max 2	**IGNORE** moisture (for all mark points) **ACCEPT** boundary layer reduced **ACCEPT** evaporated water as water vapour **ACCEPT** relative humidity for water potential **IGNORE** diffusion gradient / concentration gradient **Examiner's Comments** The best candidates could give a clear and succinct explanation, howevermany candidates described how water molecules leave the leaf but then failed to give a clear link to 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.
			Total	**9**	

Question			Answer/Indicative content	Marks	Guidance
21	a		must remain small OR cannot grow tall / large / big; no support from vascular tissues / vascular bundles / xylem; use only diffusion / no mass flow / no rapid transport; diffusion too slow (to enable substances to move large distances); idea of: short diffusion pathway / large surface area to volume ratio;	Max 2	**Examiner's Comments** a good number of candidates spotted that without vascular tissue the moss would lack support and would therefore collapse if it got too large. The absence of vascular tissue and thus a transport system also means that moss plants must remain quite small so that they maintain a large surface area to volume ratio and a short diffusion distance. This is because the plant must rely only on diffusion (and osmosis) to absorb and transport materials. Only the best candidates really appreciated this argument and not many were able to write it clearly and succinctly. Weaker candidates suggested that without a transport system the plant would not be able to transport any water and nutrients or that the lack of vascular tissue meant an absence of meristematic tissue and hence the plants had no ability to grow at all.
	b		*1. idea of* water lost by **evaporation / transpiration / evapotranspiration;** 2. (water moves by) **symplast** and **apoplast** pathways; 3. through / along cell walls by, **capillary action / adhesion** (apoplast pathway); **1.** (water loss) reduces the **water potential** of (leaf) cells; 2. water moves from higher water potential to lower water potential / down **water potential gradient** (symplast pathway); 3. by **osmosis** (symplast pathway); 4. through **plasmodesmata** (symplast	max 4	**DO NOT CREDIT** mp 2 – 7 in context of water uptake **DO NOT CREDIT mp 3–7 in context of movement in xylem either stated or implied** AWARD **only** where it is clear that the movement is in contextof apoplast. **ACCEPT Ψ** **IGNORE** osmosis if used in context of apoplast pathway

Question			Answer/Indicative content	Marks	Guidance
			pathway); **max 3** **QWC;** **max 1**		Place a green blob next to each word and a tick next to the pencil. Award if any two terms spelt correctly and used in correct context from: **apoplast** **osmosis** **symplast** **adhesion** **capillary action** **plasmodesmata** **evaporation** (allow correct derivatives) **transpiration** **evapotranspiration** **water potential** **water potential gradient** **Examiner's Comments** Despite being told three times earlier in the question that moss plants do not have vascular tissue, many candidates described the transport of water through the xylem. Stronger candidates were able to gain marks by describing the apoplast and symplast pathways and linking these to changes in water potential and osmosis caused by loss of water at the leaves. Few candidates, however, referred to changes of water potential in cells and many gave rather vague descriptions of water potential gradients or hydrostatic pressure gradientsexisting between the roots and leaves.
			Total	**6**	

Question			Answer/Indicative content	Marks	Guidance
22	a	i	Stoma(ta);	1	**Examiner's Comments** As an easy starter question candidates were asked to name the pores through which water vapour was lost from a leaf. Most students gave the expected response: 'stomata'. However, a few had obviously misread the question as 'name the process' and gave the response: 'transpiration'.
		ii	*idea of:* unevenly thickened (cell) <u>wall</u>; able to, change shape / bend; transport proteins / ion pumps, in plasma membrane;		Statement should be comparative **CREDIT** wall beside pore thicker / wall is thicker on one side **ACCEPT** refs to: thick inner **and** thin outer walls / inner wall thicker / outer wall thinner **ACCEPT** thickened for thicker **CREDIT** so can bend **DO NOT CREDIT** 'contract' 'recoil' 'move' **IGNORE** functions such as 'open / close stoma' 'flexible' 'expand' 'stretch' 'bulge'

Question			Answer/Indicative content	Marks	Guidance
		ii	(presence of) chloroplasts (to provide, ATP / energy);	2max	**ACCEPT** mitochondria **IGNORE** chlorophyll **DO NOT CREDIT** 'produce / make energy' **Examiner's Comments** Many candidates knew that the guard cells are adapted by having walls that were unevenly thickened so that the cell will bend when it becomes turgid. Some candidates referred to the cells expanding or swelling without a reference to a change of shape; this was not felt to be sufficient for credit to be awarded. Some candidates also gained credit for the fact that these cells use energy and therefore need organelles that can release ATP – although the majority of these candidates suggested that many mitochondria were present rather than chloroplasts. A small minority also gave the higher level response that the plasma membrane contains some form of transport proteins that pump ions into or out of the cell to cause changes in turgidity. Many weaker responses focussed on the function of the guard cells by describing how an increase in turgidity causes the stoma to open. These responses suggest that the question had not been read and interpreted correctly. Centres should ensure that all candidates are aware that adaptations may be structural or physiological and enable processes to occur.

Question			Answer/Indicative content	Marks	Guidance
		iii	epidermis / cuticle;	1	**Mark the first answer**. If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ACCEPT** guard cell **IGNORE** 'surface' **Examiner's Comments** Examiners were hoping to see the response 'epidermis' or 'waxy cuticle' and were pleased that a good proportion of candidates gave this response. However, Examiners were surprised at how often responses such as 'roots' or 'root hair cells' appeared. Many candidates stated that water is lost from the leaf via 'the mesophyll' or 'spongy mesophyll cells' – however, these are part of the pathway that leads to loss from the stomata and gained no credit. Weaker responses included 'surface' or 'photosynthesis' which were not considered to be a named part of the leaf.

Question			Answer/Indicative content	Marks	Guidance
	b			4	**Mark the first answer on each prompt line.** If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = **0 marks**
			water potential;		**DO NOT CREDIT** water potential gradient **IGNORE** Ψ
			osmosis;		**IGNORE diffusion**
			selectively / partially / differentially, permeable;		**DO NOT CREDIT** semi permeable
			turgidity / turgor(pressure);		**ACCEPT** 'turgidness' **IGNORE** shape / rigidity / stability
					Examiner's Comments Examiners are often surprised at how well this type of 'cloze' question manages to differentiate between candidates at this level. The expected responses were: 'water potential', 'osmosis', 'selectively permeable' and 'turgidity'. Many candidates managed three marks but only the best achieved all four. The last space, requiring the term 'turgidity', was the most frequently completed incorrectly. Examples of responses given for the fourth gap included: 'volume', 'strength', 'rigidity' and 'shape'.
	c			3 max	**IGNORE** refs to adhesion / capillarity
			evaporation at top of, plant / xylem;		**ACCEPT** leaf or named part of leaf **IGNORE** ref to transpiration / loss of water vapour
			(creates) tension in xylem;		**IGNORE** xylem (vessels) under tension
			water molecules, stick together / are cohesive / form a chain or column;		**CREDIT** water molecules, attracted together /(hydrogen) bonded together / form a continuous stream
			(column / chain) pulled up (by tension);		**IGNORE** column, moves up / sucked up **ACCEPT** column drawn up **ACCEPT** description if linked to tension at

Question			Answer/Indicative content	Marks	Guidance
					top e.g. tension at top forces water up **DO NOT CREDIT** chain 'pushed' up xylem **Examiner's Comments** This question attempted to separate out one specific theory used to explain how water is moved up the xylem from the other theories. Examiners hoped to see responses that described evaporation of water at the leaves causing tension in the xylem which could pull a column of cohesive water molecules up the plant. Concise, relevant responses were rare. Many candidates did not read the question carefully or simply chose to write everything they had learned about the transport of water through a plant. Many candidates were unable to separate the cohesion-tension theory from other ideas and their responses included lots of unnecessary detail about how water enters at the roots and moves across the root to the xylem or about how root pressure is created. Cohesion between water molecules was well understood but the role of tension was less well appreciated. Many responses confused the effect of water loss creating tension with a gradient in the hydrostatic pressure up the stem. Statements such as 'water vapour is lost from the aerial parts of the plant via transpiration' occurred frequently, which suggests that students have learned ideal answers from previous exams and are simply regurgitating them without considering the specific question asked. Some candidates confused adhesion and cohesion.
			Total	**11**	

Question			Answer/Indicative content	Marks	Guidance
23	a	i	meristem(atic);	1	**IGNORE** position in plant such as 'root tip', cambium **Examiner's Comments** This was well answered with the majority of candidates giving the correct response (meristem). The most common error was to name the sites in the plant where meristematic tissue is found (root tip or shoot tip) or stating 'cambium'.
		ii	nucleus / nucleolus / chromatin; cytoplasm; cross / end, (cell) walls;	2 max	**Read through and award marks for correct features** **IGNORE** ref to other individual organelles / vacuole **IGNORE** nucleous **DO NOT CREDIT** 'two nuclei in one cell' **CREDIT** end plates **ACCEPT** no end walls / no nucleus / no cytoplasm **IGNORE** walls between cells **Examiner's Comments** A good proportion of candidates gained full credit for stating 'nucleus' and 'cytoplasm'. Some correctly described 'no end walls'. The most common misconceptions were 'vacuole' and 'other organelles' or naming specific organelles such as 'mitochondria' – none of these features are visible in the photograph supplied. There was a feeling that many less able candidates were simply listing differences from memory rather than referring to the photographs.

Question			Answer/Indicative content	Marks	Guidance
		iii	thicker; lignified; contain (bordered) pits;	2max	**IGNORE** stronger **CREDIT** have lignin /contain lignin / reinforced with lignin / impregnated with lignin **DO NOT CREDIT** have lignin on the walls / lined by lignin / surrounded by lignin **IGNORE** ref to pattern of thickening **IGNORE** 'pore' **Examiner's Comments** Many candidates correctly stated that xylem vessel walls are 'impregnated with lignin' or some variation of this. However some failed to achieve credit because of poor expression - stating that lignin 'lined' or 'coated' the cell walls. Many candidates also correctly identified the pits in the walls of mature xylem vessels, although a few erroneously referred to these as 'pores' or 'plasmodsemata'. Only a very few candidates stated that the walls would be thicker. Unfortunately, a number of less able candidates lost marks because they described the adaptations of xylem tissue forming hollow tubes or referred to a lack of end walls between the cells rather than referring to the structure of the wall itself.
	b		sieve (tube) element; companion (cell); parenchyma;	2 max	**IGNORE** 'sieve tube' 'sieve cell' **ACCEPT** fibres / sclereids / sclerenchyma **Examiner's Comments** Was generally well answered with at least one marking point achieved by most candidates, usually for 'companion cells'. The common error was not giving the correct full name of the sieve tube elements – many candidates wrote simply 'sieve tubes' or 'sieve cells'
			Total	**7**	

Question			Answer/Indicative content	Marks	Guidance
24		i	in xylem (by),cohesion-tension / transpiration (stream); in phloem (by), translocation / mass flow;	2	**ALLOW** transport in phloem from roots **only if** clearly in the context of being associated with transport of (stored) assimilates from roots **Examiner's Comments** Most responses only referred to the xylem or phloem as tissues involved in transporting neonicotinoids, but the correct mechanism linked to each of these was also needed to gain marks.
		ii	*idea that* neonicotinoids have, little / no, effect (on humans);	1	e.g. they don't harm humans neonicotinoids, do not bind/ not complementary, to receptors neonicotinoids broken down in digestion concentrations used in insecticides, very low / not high enough, to affect humans neonicotinoids not present in part of plant consumed by humans neonicotinoids break down before plant consumed **Examiner's Comments** The majority of candidates were able to suggest why neonicotinoids are considered to be safe. Ideas of them not binding to receptors or being broken down in the digestive system were most frequently given.
			Total	**3**	
25			B □	1	
			Total	**1**	

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>26</td><td>a</td><td></td><td>2.4 (SA) : 1.0 (volume)□□□</td><td>3</td><td>If correct answer not given AWARD 1 mark for calculating surface area = 19.625

AWARD 1 mark for calculating volume = 8.177</td></tr>
<tr><td></td><td>b</td><td>i</td><td>surface area: volume ratio too small □

idea of diffusion from outer surface not sufficient □

(transport system) ensures molecules / nutrients / sugars / water, reach all tissues s □

(allows) high metabolic rate □</td><td>2 max</td><td></td></tr>
<tr><td></td><td></td><td>ii</td><td>
<table>
<tr><th>Cell</th><th>Location</th><th>Example of a substance transported</th><th>Contains chloroplasts? (✓ or X)</th></tr>
<tr><td>Guard cell</td><td>Leaf</td><td>carbon dioxide</td><td>✓</td></tr>
<tr><td>Companion cell</td><td>Vascular tissue / phloem / next to sieve tube</td><td>Sucrose</td><td>X</td></tr>
<tr><td>Root hair cell</td><td>roots</td><td>Nitrate ions</td><td>X</td></tr>
</table>
✓ ✓ ✓
</td><td>3</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>8</td><td></td></tr>
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