1(a). Xylem and phloem are tissues involved in bulk transport in vascular plants.

The structure of the two tissues is different because the mechanism of transport in the two tissues is different.

On **Fig. 21.1**, draw and label the position of xylem and phloem tissues in the stem of a dicotyledonous (broad-leaved) vascular plant. Use the letter **X** to indicate the position of the xylem tissue and **P** to indicate the position of the phloem tissue.

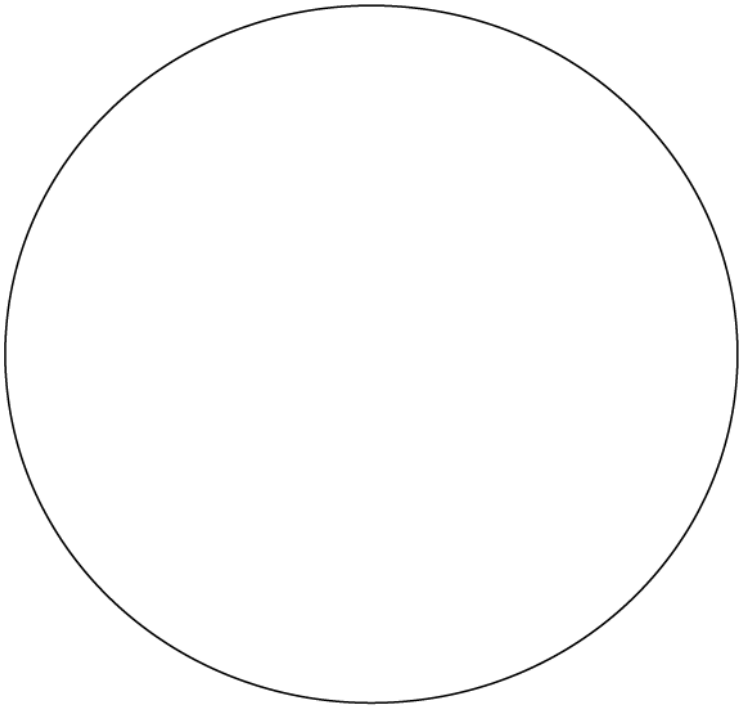

**Fig. 21.1**

**[2]**

(b). How do the following differ in xylem and phloem tissue?

(i) The type of cells present.

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[1]

(ii) The composition of the cell walls in the cells present.

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[1]

2.

(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.

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[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.

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[1]

3. * Explain a possible mechanism for the loading and transport of sugars in the phloem.

[6]

4. Spices are used to enhance the flavour of food in many different cultures. Many different species of plants are grown for spice production. These spices include ginger and cumin.

Ginger is obtained from the root of the plant *Zingiber officinale*.

* Describe a practical procedure that could be used on **roots** of *Z. officinale* to confirm that this is a species of monocotyledonous plant.

[6]

5. 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.

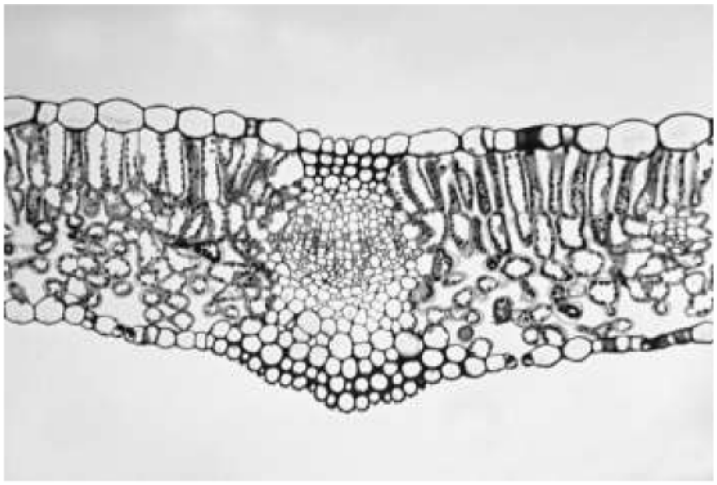

**Fig 4.1**

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]**

6. Flowering plants have developed organs, such as fruits, which act as 'sinks' in translocation.

Explain the role of a 'sink' in the mechanism of translocation.

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**[3]**

7. A student made the following comment:

'If most water vapour is lost from leaves through open stomata, more transpiration must happen during daylight hours.'

The student used the apparatus shown in Fig. 1.4 to test their hypothesis over a 24 hour period.

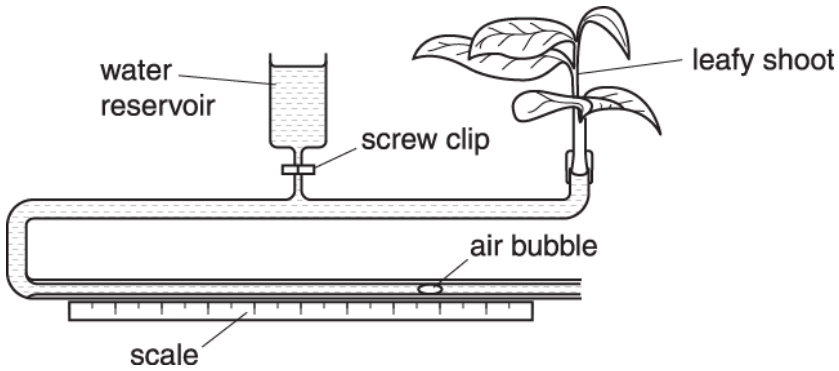


Fig. 1.4

(i) State the **dependent** variable in this investigation.

_____ [1]

(ii) Temperature is a variable that must be controlled in the investigation to obtain valid data.

State **one** other variable and explain how it will be controlled.

Variable _____

How variable is controlled _____

_____

_____

_____

[1]

8. State the correct term for the following definition.

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

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

9(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.

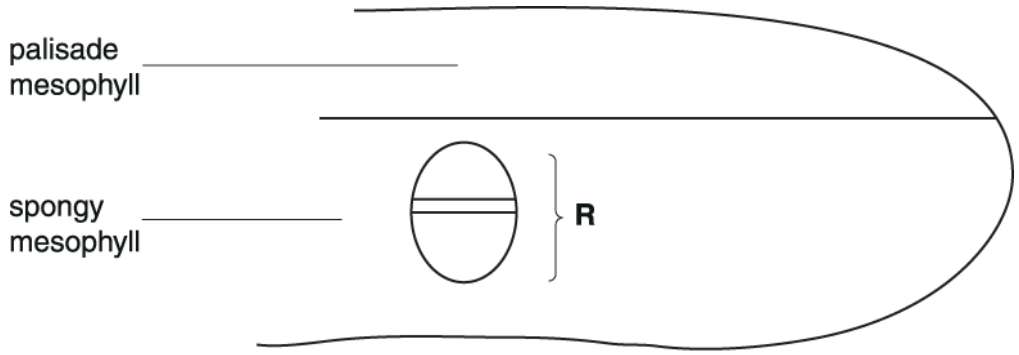


**Fig. 4.1**

(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?

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**[2]**

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

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**[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

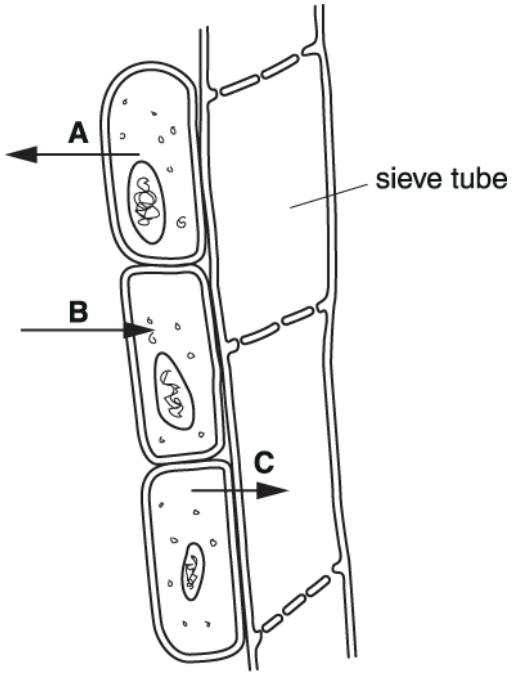


**Fig. 4.2**

(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.

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[2]

10(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.

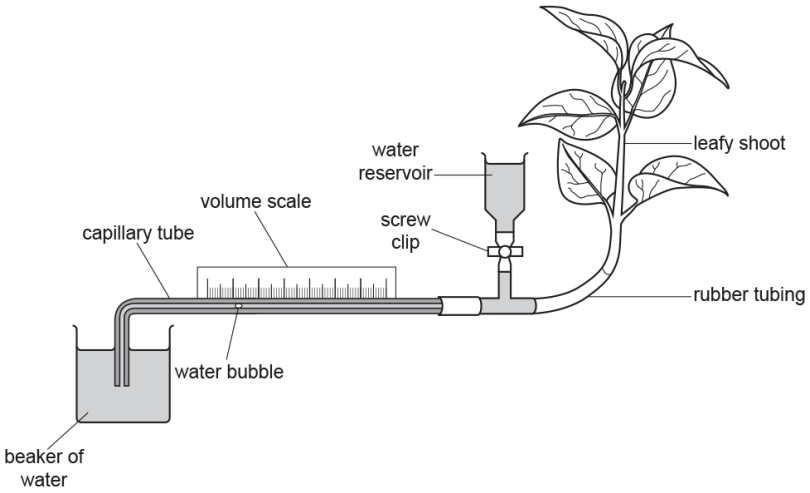


Fig. 33

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 ($m\,s^{-1}$) | 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.

---

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[1]

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

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

standard deviation = _____ **[2]**

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

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**[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]

11(a) Water must enter plants via the roots and move through the tissues to enter the xylem vessels.

. On Fig. 6, **draw** the **apoplast** pathway taken by water from point **X** in the soil to point **Y** in the xylem.


Fig. 6

[2]

(b). Complete the sentences below about the movement of water through xylem vessels.

As water molecules move through xylem vessels they are attracted to each other by _____ forces.

The water molecules are also attracted to the walls of the xylem vessel by _____ forces.

The walls of the xylem vessel are strengthened by_____ which is impermeable to water.

The movement of water between xylem vessels can therefore only occur through pores,

known as _____.

[4]

12(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 / mg $cm^{-2}$ 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.

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**[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.

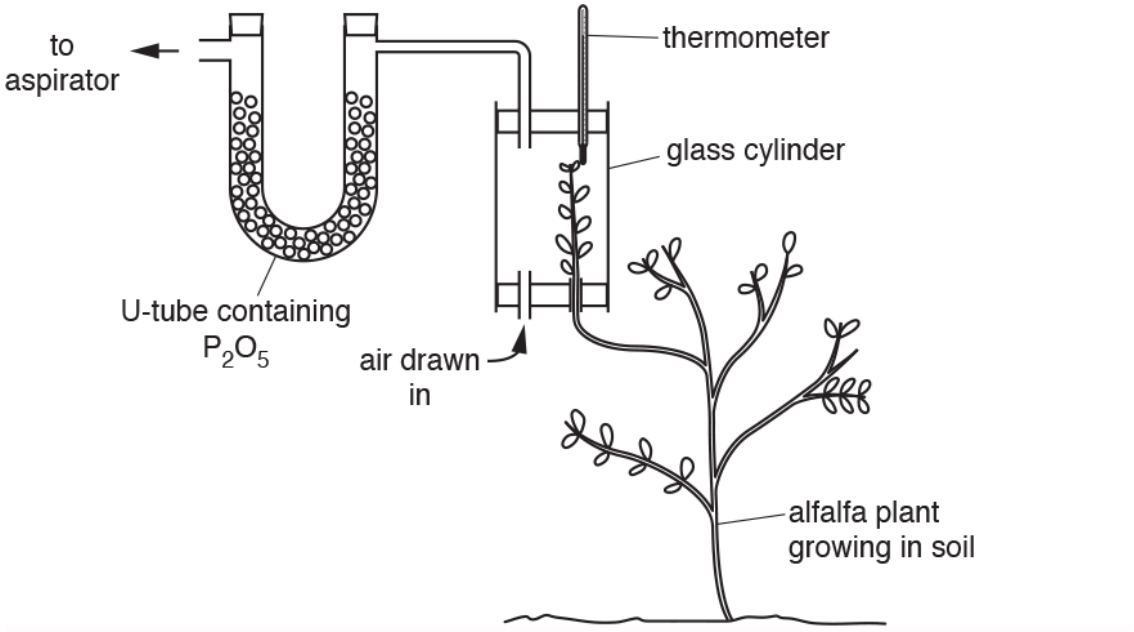



Fig. 2

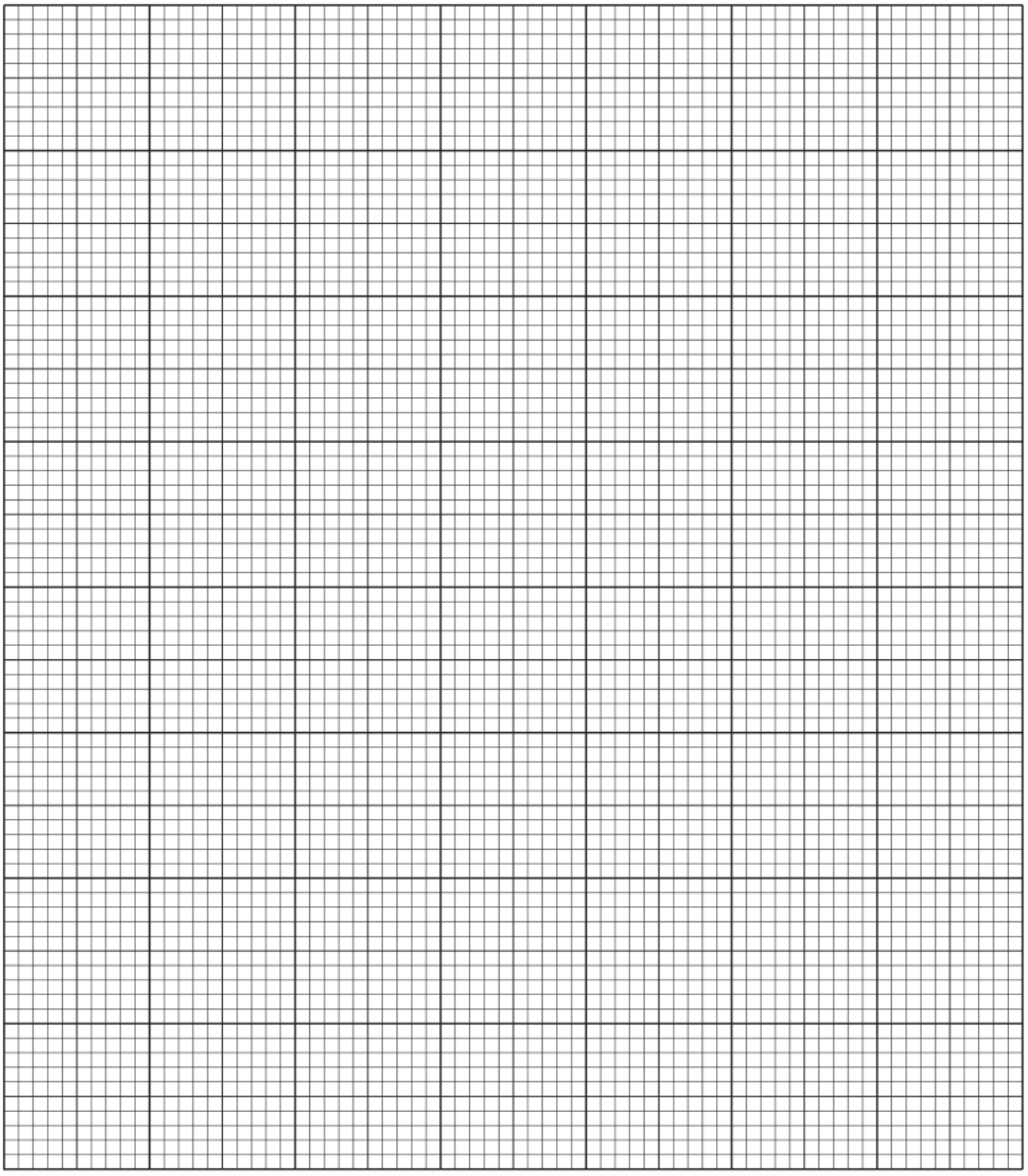
The aspirator created a steady flow of air into the cylinder past the stem of the alfalfa and through the U-tube. Phosphorous pentoxide ($P_2O_5$) absorbed any water in the air flowing through the U-tube. The mass of the U-tube was measured at ten minute intervals for one hour in order to calculate the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

13(a) A student used the following procedure to test different organs from a tomato plant for the presence of sucrose.

.

1. Remove a leaf from the tomato plant and after dipping it into boiling water grind it using a mortar and pestle.
2. Add water to the ground up leaf and filter the mixture.
3. Pour a small sample of the filtrate into a test tube and add dilute hydrochloric acid.
4. Place the test tube into a water bath.
5. Remove the test tube from the water bath and add sodium hydrogen carbonate.
6. Add Benedict's reagent and then place the test tube back into the water bath.
7. Record the colour of the contents of the test tube.
8. Repeat steps 1 to 7 with stem and root samples taken from the same tomato plant.

Table 5 shows the observations recorded by the student.

| **Plant organ being tested** | **Observations** |
|---|---|
| Leaf | Blue-green |
| Stem | Green-orange |
| Root | Blue-green |

Table 5

(i) The student made the following statement:

**My observations support the theory of translocation.**

Using the information in Table 5 and your knowledge of translocation discuss the validity of this statement.

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[4]

(ii) State **three** modifications to the procedure that would allow the observations in Table 5 to be reproducible.

1

2

3

[3]

(b). Tomato plants are broad-leaved crop plants.

Compare the structure of a tomato plant with that of a cereal crop plant, such as wheat with regards to their transport systems.

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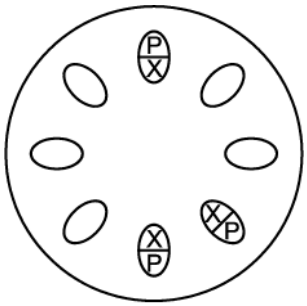
[3]

END OF QUESTION PAPER

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 1 | a | | vascular bundles drawn with both tissues **AND**<br>arranged in a circle just inside the circle (1)<br><br>bundle to have phloem / P on the outside and xylem / X on the inside (1) | 2 |  <br><br>Fig 21.1 |
| | b | i | xylem contains, xylem vessels (tracheids / fibres), phloem contains, sieve tube (elements) and companion cells (1) | 1 | **ALLOW** xylem has lignin, phloem does not |
| | | ii | xylem has cellulose and lignin, phloem has cellulose | 1 | |
| | | | **Total** | **4** | |
| 2 | | i | **any 3 from:**<br>(active transport) into root hairs (1)<br>apoplast / symplast pathway (1)<br>through epidermis / cortex layers (1)<br>via xylem vessel to (root) nodule (1) | 3 | |
| | | ii | Krebs cycle | 1 | **ALLOW** TCA cycle / citric acid cycle |
| | | | **Total** | **4** | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 3 | | | * **Level 3 (5–6 marks)**<br>A detailed explanation of both loading and movement by mass flow, including reference to sources and sinks and the features and roles of the sieve tube elements and companion cells.<br><br>*There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.*<br><br>**Level 2 (3–4 marks)**<br>A partial explanation of both loading and movement by mass flow. Includes reference to sources and sinks or the features or roles of the sieve tube elements or companion cells.<br><br>*There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.*<br><br>**Level 1 (1–2 marks)**<br>An explanation of either loading or movement.<br><br>*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.*<br><br>**0 marks**<br>No response or no response worthy of credit. | 6 | Examples of relevant material could include the following:<br><br>*Loading*<br><br>• loading into companion cells<br>• location of companion cells at a source or named source<br>• active loading of sucrose (using ATP)<br>• mitochondria presence in companion cells<br>• description of mechanism of H+ gradient and co-transport<br>• movement via plasmodesmata into sieve tube elements.<br><br>*Movement*<br><br>• mass flow from source to sink<br>• ref to high hydrostatic pressure at source<br>• ref to inflow of water by osmosis at the source (creating the pressure)<br>• ref to passage through sieve plates or cytoplasmic connections<br>• ref to low hydrostatic pressure at the sink<br>• ref to unloading at the sink.<br><br>**ALLOW** use of annotated diagrams |
| | | | **Total** | 6 | |

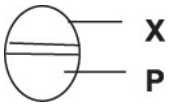
| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 4 | | | Read through the whole answer from start to finish, concentrating on features that make it a stronger or weaker answer using the indicative scientific content as guidance. The indicative scientific content indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance.<br><br>Using a 'best-fit' approach based on the science content of the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, **best** describes the overall quality of the answer using the guidelines described in the level descriptors in the mark scheme.<br><br>Once the level is located, award the higher or lower mark.<br><br>**The higher mark** should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.<br><br>**The lower mark** should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.<br><br>**In summary:**<br><br>• **The science content determines the level.**<br>• **The communication statement determines the mark within a level.**<br><br>**Level 3 (5–6 marks)**<br>A detailed description of sectioning, staining, mounting and microscopy is given with details of monocot root structural features.<br><br>*There is a well developed description of methodology which is clear and logically structured. The information presented is relevant.* | 6 | **Indicative scientific points may include:**<br><br>• reference to transverse sections<br>• reference to method of obtaining thin sections (e.g. use of sharp blades or microtome)<br>• reference to staining<br>• reference to named stain (e.g. toluidine blue)<br>• reference to different colours for different tissues / differential staining<br>• detail of colours (for toluidine blue, xylem is blue, phloem purple)<br>• reference to mounting on slide and use of cover slip<br>• reference to focus or magnification used<br>• reference to presence of endodermis<br>• reference to circle of xylem and phloem in monocot roots (within endodermis)<br>• reference to presence of 'X' shaped xylem in dicot roots (within endodermis)<br>• reference to phloem between the arms of the 'X' shape<br>• reference to using a fresh specimen<br><br>**ALLOW** information presented as annotated diagrams. |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | | Level 2 (3–4 marks)<br>A description of some of the stages in sectioning, staining, mounting and microscopy is given with some features of monocot root structural features.<br><br>*There is a description of methodology which has some structure. The information presented is largely relevant.*<br><br>Level 1 (1–2 marks)<br>A description of either sectioning, staining, mounting or microscopy is given. Features of monocot root structure may be missing or incorrect.<br><br>*There is a description of some methodology which may be unstructured. Some irrelevant or incorrect information may be presented.*<br><br>0 marks<br>No response or no response worthy of credit. | | |
| | | | Total | 6 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 5 | | | *LP plan must only show tissue layers with no cell detail.*<br><br>*In addition there should not be any shading or other detail within the plan.*<br><br>4 distinct layers shown<br>**AND**<br>drawn to appropriate scale (1)<br><br>area of vascular bundle shown<br>**AND**<br>labelled (1)<br><br>three tissues labelled correctly from list (1)<br>three tissues annotated correctly from list (1)<br><br>• cuticle, **and** visible detail<br>• upper epidermis, **and** visible detail<br>• palisade mesophyll layer, **and** visible detail<br><br>• spongy mesophyll layer, **and** visible detail<br>• vascular bundle, **and** visible detail<br>• xylem tissue, **and** visible detail<br>• phloem tissue, **and** visible detail | 4 | **DO NOT ALLOW** if cells to be drawn (ONLY areas of tissue to be drawn)<br><br>**DO NOT ALLOW** for just labelling tissue annotation (description of visible feature needed)<br><br>e.g. thin<br>e.g. single layer of cells, absence of chloroplasts<br>e.g. rectangular cells, presence of (many) chloroplasts, wider layer<br>e.g. circular cells, less chloroplasts, thicker layer<br>e.g. stained red, stained green<br>e.g. stained red, angular inner lumen<br>e.g. stained green |
| | | | **Total** | 4 | |
| 6 | | | removes sucrose from phloem ✓<br>decreases hydrostatic pressure at (sink) end of sieve tube ✓<br>*idea that* it lowers sucrose concentration because sucrose is used for respiration / metabolism ✓<br>*idea that* sucrose removed from phloem (so) water potential increases in phloem ✓ | 3 max | **ACCEPT** assimilates for sucrose<br><br>**Examiner's Comments**<br><br>**AO1** and **AO2** were addressed in this question which had a plant theme in an evolutionary context.<br><br>It appeared that candidates did not understand the 'role of a sink' and few candidates achieved full marks. It is important that candidates read questions carefully as many candidates spent time describing other details such as the role of the source or the mechanism of translocation rather than answering the actual question. |
| | | | **Total** | 3 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 7 | | i | Dependent Variable<br>(distance) moved by meniscus / air bubble ✓ | 1 | ACCEPT water uptake<br>IGNORE references to transpiration<br><br>Examiner's Comments<br><br>Not as many candidates got (i) correct as they should have done, as candidates often incorrectly stated water loss by transpiration. |
| | | ii | wind (speed) and suitable control<br><br>or<br><br>surface area of leaves and suitable control<br><br>or<br>humidity and suitable control ✓ | 1 | IGNORE light intensity as this is the independent variable or temperature as this is stated in the question<br>IGNORE references to time / water<br><br>ACCEPT movement of air<br>e.g. either by setting the fan to constant speed or by placing the plant shoot and potometer at set distances from the fan or methods used to prevent draughts<br><br>e.g. use the same size leaves or same number of leaves<br><br>Examiner's Comments<br><br>The most common correct response in (ii) was wind and to carry out the investigation with closed windows and doors. Candidates who mentioned leaves often did not mention surface area or gave the control simply as the amount of leaves. There were many incorrect responses referring to time of day and light intensity. |
| | | | Total | 2 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 8 | | | 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**<br><br>**Examiner's Comments**<br><br>This term was well known to the majority of candidates. |
| | | | **Total** | **1** | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 9 | a | i | letter **X** marking upper part of vascular bundle<br>**and**<br>letter **P** marking lower part of vascular bundle ; | 1 |  <br>ACCEPT Xylem and Phloem<br>DO NOT CREDIT Y<br><br>Examiner's Comments<br><br>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<br><br>Examiner's Comments<br><br>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 ;<br><br>(ions are) moved out of the cells / move into surrounding (solution) ; | 2 | IGNORE descriptions of observations 2 and / or 3<br>IGNORE ref to $OH^?$ / alkaline substances<br><br>Note do not need to refer to hydrogen ions for mp 2<br><br>Note that 'hydrogen ions move out of the cell' = 2 marks<br><br>Examiner's Comments<br><br>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<br><br>IGNORE 'mechanism / active loading, does not work in presence of cyanide' as too vague<br><br>Examiner's Comments<br><br>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 ;<br><br>concentration / pH / $H^+$ / proton / electrochemical ;<br><br>facilitated ;<br><br>diffusion ;<br><br>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**<br>**IGNORE** active loading<br><br>**IGNORE** high **DO NOT ACCEPT** diffusion<br><br>**ACCEPT** facilitated diffusion<br><br>**ACCEPT** plasmodesmata<br>**DO NOT CREDIT** facilitated diffusion<br><br>**DO NOT CREDIT** glucose / fructose / ions<br><br>**Examiner's Comments**<br><br>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 ;<br><br>plasmodesmata (between companion cell and sieve tube) / described ;<br><br>many ribosomes / extensive RER ;<br><br>many proteins in the, plasma / cell surface, membrane ; | 2 | IGNORE qualification of type of protein<br><br>Examiner's Comments<br><br>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 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 10 | a | i | any 1 from:<br>cut shoot under water ✓<br>connect shoot to rubber tubing under water ✓<br>ensure tight fit between shoot and rubber tubing ✓<br>seal with Vaseline ✓<br>set up the potometer under water ✓ | max 1 | Examiner's Comments<br>(a)(i) and (b) tested AO1, with most of the remainder testing AO2 criteria.<br>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<br>Examiner's Comments<br>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 | *Description:*<br>faster the wind speed, faster the (rate of) water uptake ✓<br><br>*Explanation:*<br>wind <u>increases</u> water (vapour) potential gradient (between airspaces in leaf and air in environment) ✓<br>faster diffusion of water <u>vapour</u> / increased transpiration rate ✓ | 3 | ORA<br><br>ALLOW wind <u>increases</u> concentration / diffusion gradient<br>Examiner's Comments<br>(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 ✓<br>light intensity ✓<br>temperature ✓ | max 2 | Examiner's Comments<br>(a)(iv) was answered well and only a few candidates did not achieve these marks. |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | v | water used in photosynthesis / hydrolysis ✓<br>water produced in respiration / condensation reactions ✓<br>water used to maintain turgor pressure ✓ | max 2 | Examiner's Comments<br>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 | | *Mechanism*<br>ANY TWO FROM<br>*(Apoplast):*<br>through, cell walls / extracellular spaces ✓<br>stopped by, suberin / Casparian strip ✓<br><br>*(Symplast):*<br>through cytoplasm ✓<br>(from cell-to-cell) via plasmodesmata ✓<br>By osmosis from a high to low water potential / along a water potential gradient ✓<br><br>PLUS<br>Correctly identifies apoplast and symplast pathways ✓ | max 3 | DO NOT ALLOW concentration gradient<br>Examiner's Comments<br>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 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 11 | a | | line passes through cell wall ✓<br><br>line passes around Casparian strip ✓ | 2 | **Note:** line must begin from an external cell wall<br>  <br>**Examiner' Comments**<br>The apoplastic pathway was often incorrectly drawn by candidates and water often shown to pass through the Casparian strip. |
| | b | | cohesive ✓<br><br>adhesive ✓<br><br>lignin ✓<br><br>(bordered) pits ✓ | 4 | **Examiner' Comments**<br>Candidates usually scored well for **Q6(d)** however plasmodesmata were often given, incorrectly, as the last point. |
| | | | **Total** | 6 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 12 | a | | *(Coleus & Portulaca respectively)*<br><br>13.4 **AND** 27.3 ✓ | 1 | Examiner's Comments<br><br>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 ✓<br><br>air movement / draughts ✓<br><br>light intensity ✓<br><br>water (given to pot plants) ✓ | 2 max | ALLOW wind for 'air movement'<br><br>Examiner's Comments<br><br>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. |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | ii | *Yes because*<br><br>Higher rate (compared to potometer) in , pots / normal , for, daisy / coleus / portulaca✓<br><br>geranium / plant, with lowest rate has no difference ✓<br><br>% (rate in potometer compared to pots) increases as transpiration rate in pots decreases (from geranium – coleus)✓<br><br>comparative figures to include 2 plants in pots with 2 plants in potometers **AND** mg $cm^{-2}$ (leaf) $hr^{-1}$✓<br><br>*No because* coleus has lower % but lower rate (in pots) **OR**<br>daisy has higher % but higher rate (in pots) ✓ | 3 | **IGNORE** ref to *large difference* as in stem of question.<br><br>**ALLOW** the lowest value of 0.65 shows no difference between pots and potometer<br><br>**ALLOW** an analysed comparison e.g. *'a daisy has a 5x faster rate mg $cm^{-2}$ (leaf) $hr^{-1}$ in a pot but only a 3.7x increase in portulaca'*.<br><br>Examiner's Comments<br><br>Candidates struggled to interpret the data in order to support (or not) Freeman's conclusions.<br>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. |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | c | i | *line graph with:*<br>• both axes scaled appropriately<br><br>**AND** correct axis labels ✓<br><br>• **all** points correctly plotted to within ± half square ✓<br><br>• 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<br>i.e. x-axis label: time / min<br>y-axis label: Increase in mass of tube / mg<br><br>line must pass through zero and majority of other data points.<br><br><u>Examiner's Comments</u><br><br>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. |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | ii | 1. calculation of gradient from graph = 6.25 ✓<br><br>2. rate of transpiration = 6.25 / 22.28 = 0.2805 ✓<br><br>3. $2.81 \times 10^{-1}$ mg $min^{-1}$ $cm^{-2}$ / $1.69 \times 10^{2}$ mg $cm^{-2}$ $h^{-1}$ ✓ | 3 | **ALLOW** gradient in the range 6.18 to 6.32<br><br>**ALLOW** range of 0.2774 to 0.2837<br>**ALLOW** answer to any number of significant figures (correctly rounded)<br>**ECF** value of gradient / 22.28<br><br>**ALLOW** range of $2.78 \times 10^{-1}$ mg $min^{-1}$ $cm^{-2}$ to $2.84 \times 10^{-1}$ mg $min^{-1}$ $cm^{-2}$<br>**ECF** from mp2 value to 2 dp in standard form with correct units.<br><br>Examiner's Comments<br><br>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.<br><br>There are tutorials and quizzes to assist with obtaining gradients:<br><br>http://www.ocr.org.uk/qualifications/by-subject/biology-related/maths-for-biology/m3-graphs/<br><br>and for writing answers in standard form:<br><br>http://www.ocr.org.uk/qualifications/by-subject/biology-related/maths-for-biology/m0-arithmetic-and-numerical-computation/<br><br>Key<br><br>OCR support |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | | Total | 12 | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 13 | a | i | *Support statement*<br>(blue-green) result in leaf shows little sucrose present<br>OR<br>(green-orange) result in stem shows (greater) concentration of sucrose present ✓<br>(so) supports loading of sucrose into phloem , from source / as it is produced ✓<br>(blue-green) result in root shows sucrose is used by , roots / sinks ✓<br>(so) supports starch formation/use in respiration<br><br>*Do not support statement*<br>*idea that* (Benedict's) test does not distinguish between reducing and non-reducing sugars ✓<br><br>the blue-green result for , leaf / root , extract could be interpreted as a negative test ✓ | max 4 | ALLOW sucrose is converted to starch in roots<br><br>ALLOW does not distinguish between glucose and sucrose<br>ALLOW reducing sugar / glucose , could be causing positive result<br><br><u>Examiner's Comments</u><br><br>Most candidates had a good understanding of translocation but many did not demonstrate understanding of the colour changes seen in a Benedict's test. A number of candidates thought that water caused the colour changes. |
| | | ii | Any three from:<br>same temperature of water bath ✓<br>(equal) volume of Benedict's / test solutions ✓<br>excess sodium hydrogen carbonate needed ✓<br>same time left in water bath ✓<br>use method for obtaining quantitative results ✓ | 3 | ALLOW boiling water bath<br><br>ALLOW must be added until mixture stops fizzing<br>e.g. filter precipitate and weigh<br>e.g. use colorimeter |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | b | | tomato plants are dicot(yledon)s **AND** cereal crops are monocot(yledon)s ✓<br><br>*Differences*<br>tomato plant leaves have branching veins ✓<br>tomato plant stems have vascular bundles arranged in rings ✓<br>AVP ✓<br><br>*Similarities*<br>both have vascular bundles ✓ | 3 | **2 max for differences ALLOW ora**<br><br>e.g. xylem in tomato plant root arranged in shape of cross **ora**<br><br>**ALLOW** both have phloem / xylem<br><br>Examiner's Comments<br><br>Some candidates did not remember the vascular bundle arrangement in dicot roots and stems, and gave an answer that was the wrong way around. There were also a few unusual spellings of monocotyledon and dicotyledon. Transport systems were quite often referred to with no other detail and it was also stated by some candidates that monocots do not need these systems or need smaller systems. |
| | | | Total | 10 | |