Mass Transport in Plants: AQA A Level Biology Exam Questions by Topic

18 questions · 53 marks · about 69 minutes. Answer in the spaces, then check the mark schemes at the end.

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Question 1 · AS Paper 2 · June 2017 · Q09.1 · 5 marks

0 9 . 1 Describe the cohesion-tension theory of water transport in the xylem.

[5 marks]

[Extra space]

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Question 2 · A level Paper 1 · June 2023 · Q02.3 · 3 marks

0 2 . 3 Lignin is a polymer found in the walls of xylem vessels in plants. Lignin keeps the xylem vessel open as a continuous tube.

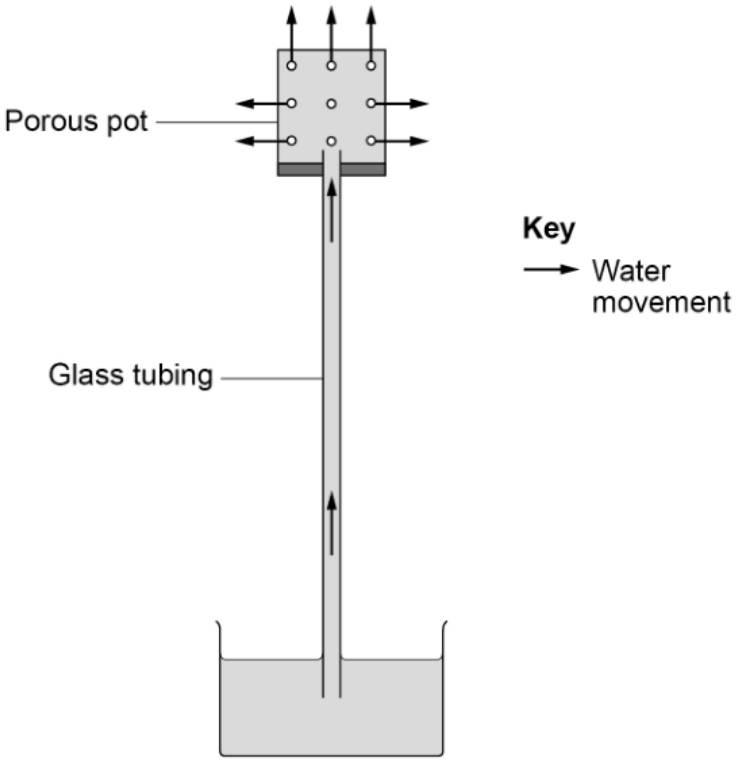
Explain the importance of the xylem being kept open as a continuous tube.

[3 marks]

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0 1 . 2 **Figure 1** shows that water loss from a porous pot can cause the upward movement of water.

Figure 1



Biologists have concluded that the experiment in **Figure 1** supports the cohesion–tension theory of water transport in the xylem.

Explain how this conclusion is supported by the experiment in **Figure 1**.

[3 marks]

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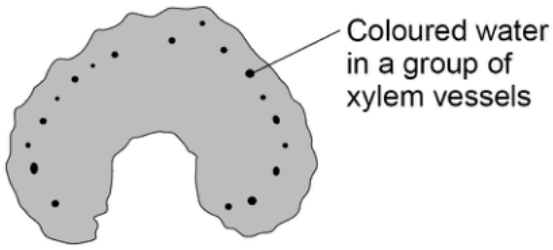
0 5 . 3 A different student used coloured water to investigate the movement of water in leaf stalks of celery.

During the procedure she:

- cut equal lengths of stalk from each plant
- put the cut end of each stalk into coloured water
- left these stalks to take up the coloured water for 20 minutes
- used a sharp scalpel to cut slices from the stalks at 1 mm intervals until she reached a slice with no coloured water.

Figure 6 shows a slice of leaf stalk with coloured water inside groups of xylem vessels.

Figure 6



Explain why coloured water moved up the stalks.

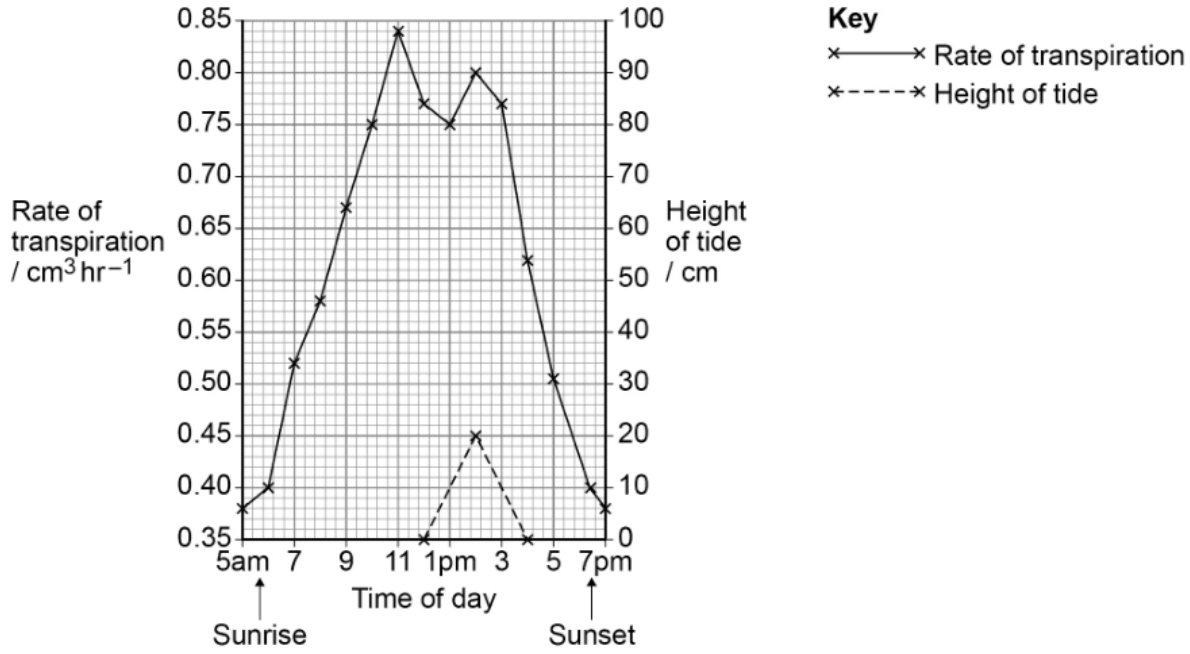
[3 marks]

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0 6 Mangrove trees grow near the sea. Sea water surrounds the lower parts of the trees at high tide.

Scientists investigated the rate of transpiration in a mangrove tree.
Figure 9 shows the scientists' results.

Figure 9



0 6 . 1 Explain the rate of transpiration between 5 am and midday shown in **Figure 9**.

[4 marks]

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Question 6 · AS Paper 1 · June 2025 · Q07.1 · 1 mark

0 7 . 1 Name the main carbohydrate transported through the phloem.

[1 mark]

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Question 7 · A level Paper 1 · June 2022 · Q09.1 · 5 marks

0 9 . 1 Describe the transport of carbohydrate in plants.

[5 marks]

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Question 8 · AS Paper 2 · November 2020 · Q08.2 · 3 marks

0 8 . 2 The mass flow hypothesis is used to explain the movement of substances through phloem.

Use your understanding of the mass flow hypothesis to explain how pressure is generated inside this phloem tube.

[3 marks]

Question 9 · information from earlier in the question

0 9 Read the following passage.

Carbohydrates are moved by mass transport in plants and in mammals. This movement is caused by a pressure gradient inside the transport vessels.

Plants transport most of their carbohydrate as sucrose. The phloem has sucrose-transport proteins in the cell-surface membrane. Potato plants with fewer sucrose-transport proteins produce fewer potatoes and accumulate sugars in their leaves.

Mammals do not have sucrose-transport proteins in their cell-surface membranes. They do have many monosaccharide-transport proteins in cell-surface membranes. These transport proteins allow monosaccharides through by facilitated diffusion.

Mammalian cells can change the number of glucose-transport proteins in their cell-surface membranes. The glucose-transport proteins are stored in internal membranes, then moved to the cell-surface membrane when they are needed. During exercise, there is a significant increase in glucose uptake by muscle cells.

Use the information in the passage and your own knowledge to answer the following questions.

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Question 9 · AS Paper 1 · June 2023 · Q09.2 · 2 marks

0 9 . 2 Potato plants with fewer sucrose-transport proteins produce fewer potatoes and accumulate sugars in their leaves (lines 4, 5 and 6).

Explain why.

[2 marks]

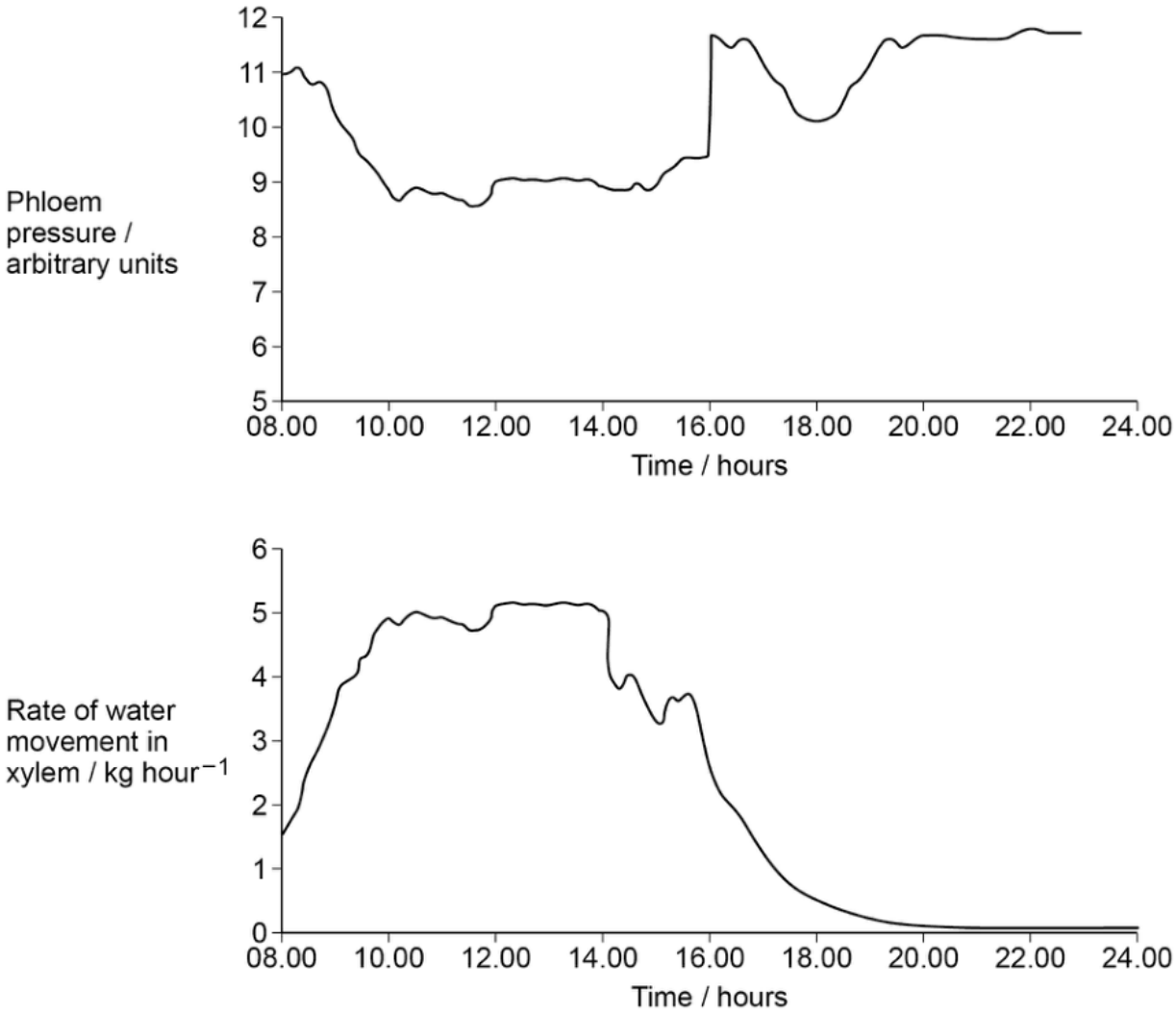
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Question 10 · information from earlier in the question

0 8 . 3 The scientist also measured changes in the phloem pressure and changes in the rate of water movement in the xylem of a willow plant at intervals during a day.

His results are shown in **Figure 6**.

Figure 6



Describe the relationship between phloem pressure and the rate of water movement in xylem in this plant.

[1 mark]

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Question 10 · AS Paper 2 · November 2020 · Q08.4 · 3 marks

0 8 . 4 Phloem pressure is reduced during the hottest part of the day. Use information in **Figure 6** along with your understanding of transpiration and mass flow to explain why.

[3 marks]

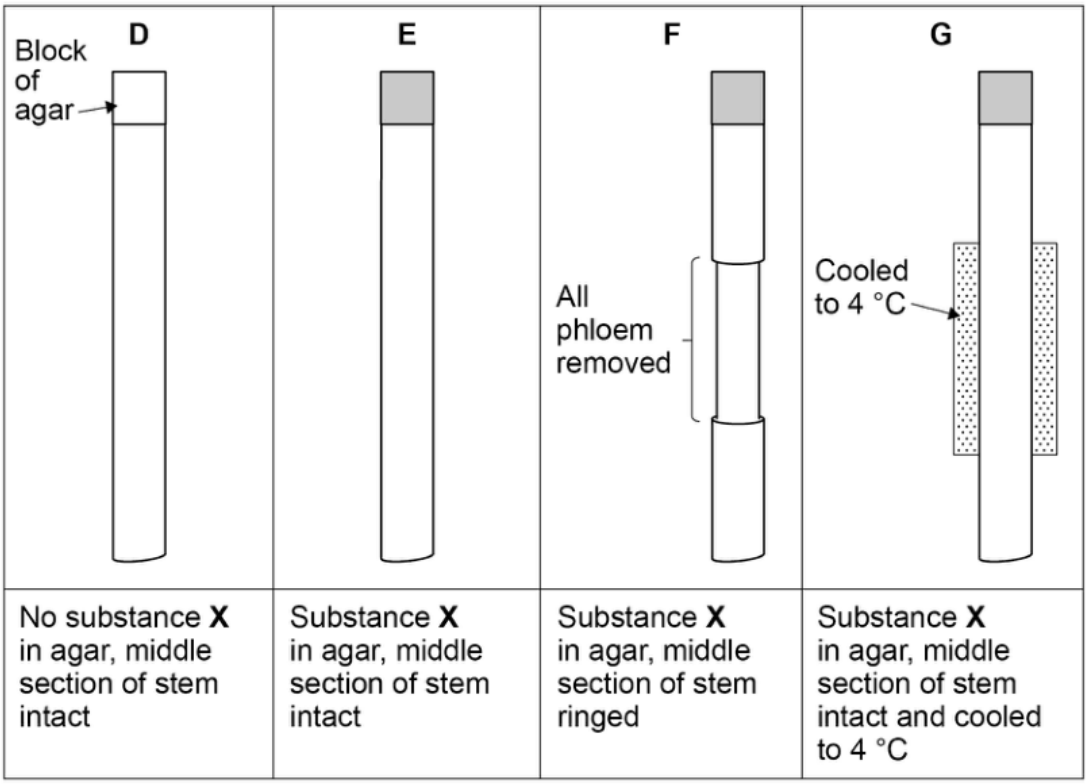
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0 6 Under the correct conditions, new roots grow from the cut end of a plant stem. A scientist investigated the effect of substance **X** on the growth of new roots.

She used a ringing experiment to investigate the movement of substance **X** in stems taken from lemon plants. She cut out a length of stem from each plant. She then put a small block of agar on the top of each length of stem. Some agar blocks contained substance **X**.

Figure 4 shows how she treated each length of stem.

Figure 4



She grew the lengths of stem in the same environmental conditions for 6 weeks, and then found the number of roots per length of stem. Roots grew at the other end of the stem from where the agar blocks were placed.

Table 3 shows the scientist's results.

Table 3

Treatment	Mean number of roots per length of stem
D	5
E	11
F	4
G	3

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Question 11 · AS Paper 2 · June 2018 · Q06.2 · 3 marks

0 6 . 2 Using **Figure 4** and **Table 3**, what can you conclude from treatments **D** and **E** about root growth?

[3 marks]

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Question 12 · AS Paper 2 · June 2018 · Q06.3 · 4 marks

0 6 . 3 The mass flow hypothesis is used to explain the movement of substances through phloem.

Evaluate whether the information from this investigation supports this hypothesis.
Do **not** consider statistical analysis in the answer.

[4 marks]

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0 8 Scientists investigated the effect of a heat treatment on mass transport in barley plants.

- They applied steam to one short section of a leaf of the heat-treated plants. This area is shown by the arrows in **Figure 9**.
- They did not apply steam to the leaves of control plants.
- They then supplied carbon dioxide containing radioactively-labelled carbon to each plant in the area shown by the rectangular boxes in **Figure 9**.
- After 4 hours, they:
  - found the position of the radioactively-labelled carbon in each plant. These results are shown in **Figure 9**.
  - recorded the water content of the parts of the leaf that were supplied with radioactively-labelled carbon dioxide. These results are shown in **Table 4**.

Figure 9

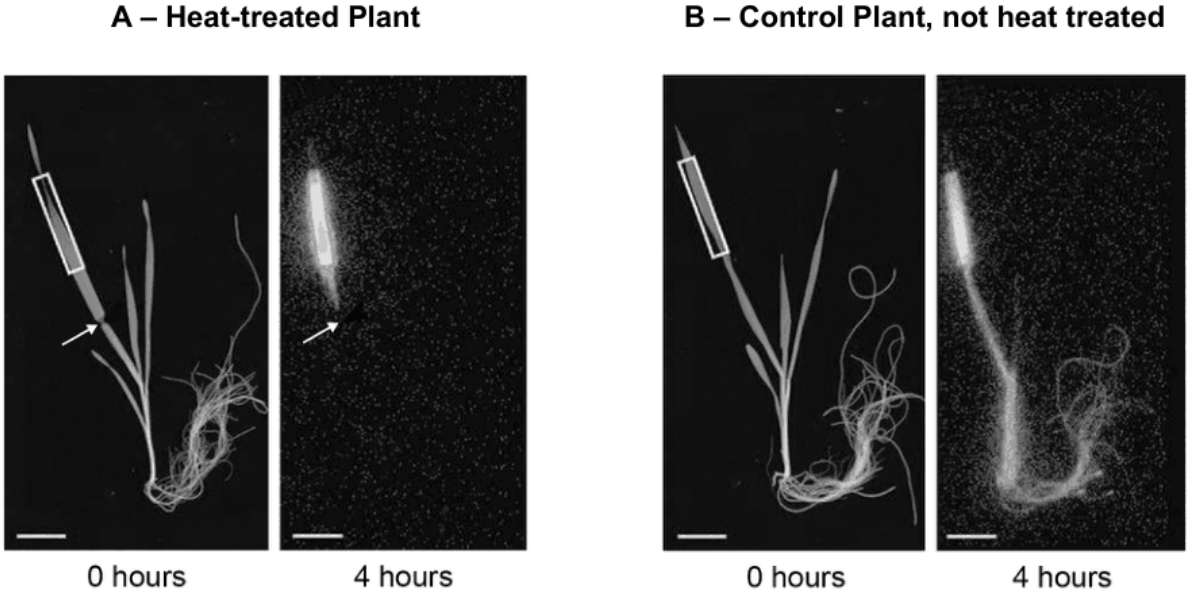


Table 4

Plant from which the leaf was taken	Water content of leaf / % of maximum (± 2 standard deviations)
Heat-treated Plant A	84.6 (±11.3)
Control Plant, not heat treated B	92.8 (±8.6)

0 8 . 1 The scientists concluded that this heat treatment damaged the phloem.

Explain how the results in **Figure 9** support this conclusion.

[2 marks]

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Scientists investigated the mass flow hypothesis in geranium plants.

The scientists:

- separated the phloem from the xylem in a part of the stem by placing an impermeable layer between them
- enclosed a leaf above the separated section, and supplied it with radioactive carbon dioxide ($^{14}CO_2$)
- illuminated the plant for 15 hours
- cut the stem into sections as shown in **Figure 9**
- measured the radioactivity in the phloem and xylem of each section.

Figure 9

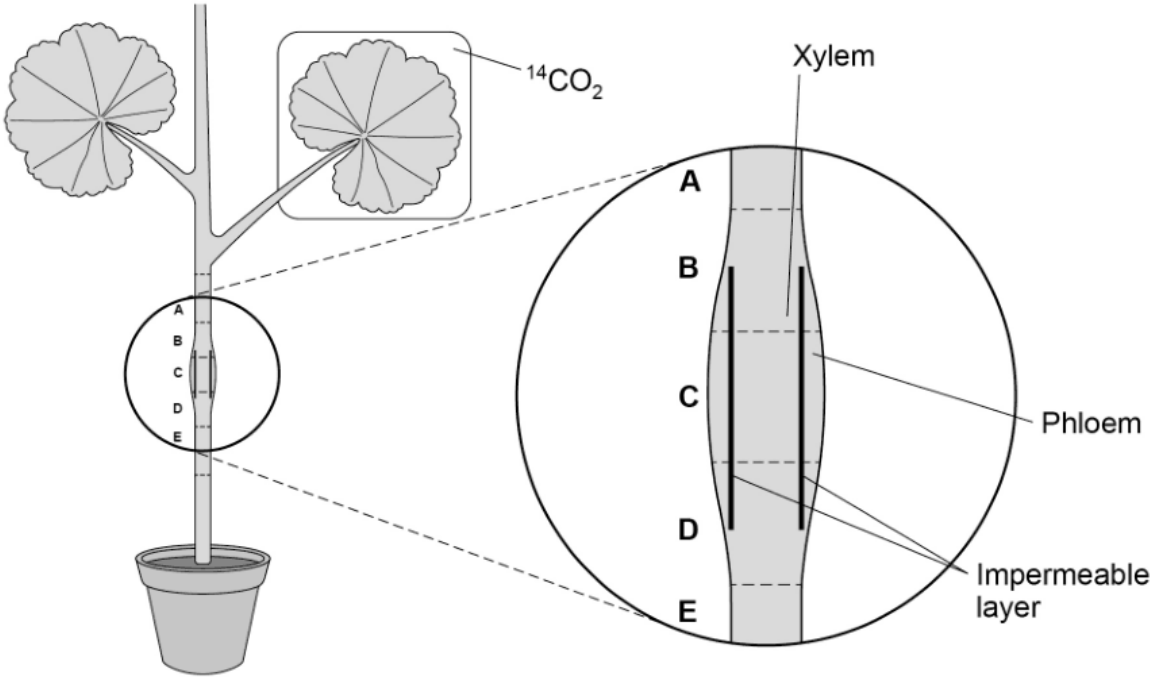


Table 4 shows the scientists' results.

Table 4

Section of tissue	Radioactivity in phloem / counts per minute	Radioactivity in xylem / counts per minute
A	41 100	24 210
B	2 761	755
C	130	74
D	101	47
E	157	75

0 7 . 3 The total radioactivity of the phloem and xylem tissues shown in **Table 4** was lower than the total radioactivity absorbed by the enclosed leaf.

Suggest **one** reason why.

[1 mark]

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Question 15 · AS Paper 1 · June 2025 · Q07.4 · 4 marks

0 7 . 4 The mass flow hypothesis states that organic substances are transported through the phloem, from leaves to all parts of plants.

Evaluate whether the information from this investigation supports this hypothesis.

Do **not** refer to statistical tests or sample size in your answer.

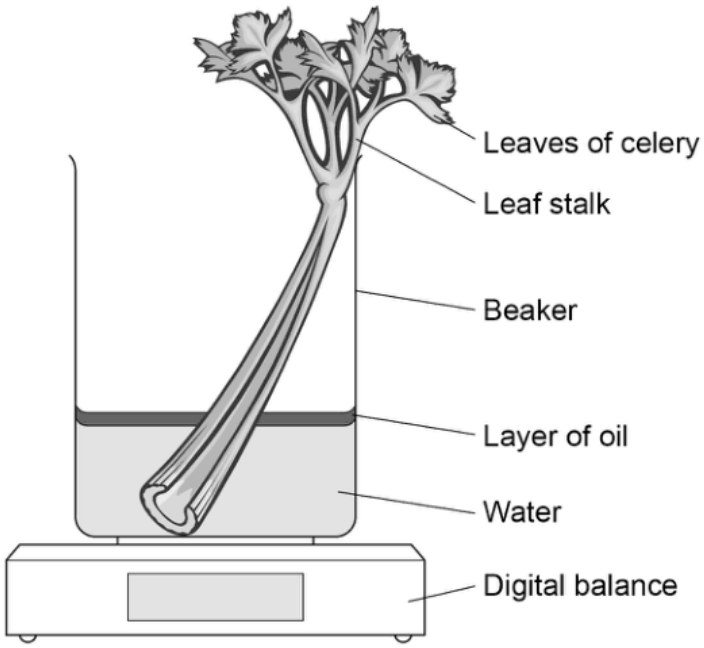
[4 marks]

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Question 16 · AS Paper 2 · June 2019 · Q05.1 · 2 marks

0 5 A student used the apparatus shown in **Figure 5** and a digital balance to determine the rate of water movement in a celery stalk in grams per hour per group of xylem vessels.

Figure 5



0 5 . 1 The student measured the time taken for water movement.
Give **two** other measurements he made to calculate the rate of water movement.

[2 marks]

1 _____

_____

_____

2 _____

_____

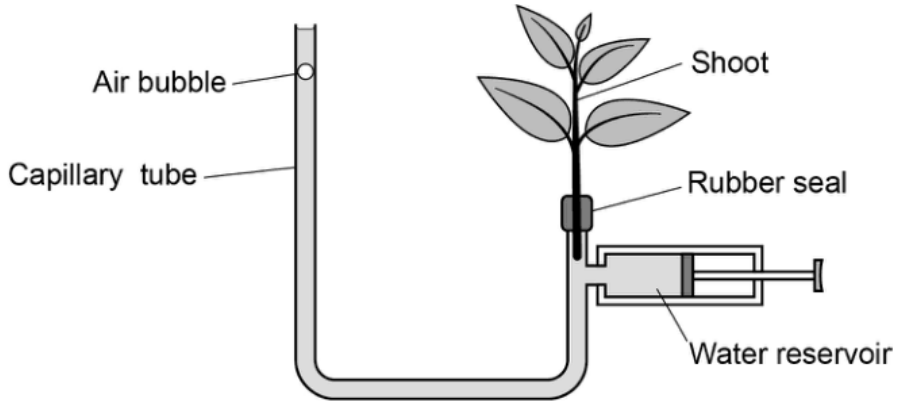
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Question 17 · information from earlier in the question

0 6 A student used a potometer to measure the movement of water through the shoot of a plant. The potometer is shown in **Figure 5**. As water is lost from the shoot, it is replaced by water from the capillary tube.

Figure 5



Question 17 · A level Paper 3 · June 2017 · Q06.3 · 1 mark

0 6 . 3 The rate of water movement through a shoot in a potometer may not be the same as the rate of water movement through the shoot of a whole plant.

Suggest **one** reason why.

[1 mark]

[Extra space]

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A scientist investigated factors that affect the shelf life of cut flowers.
A cut flower is the part of the stem with the flower bud attached after it has been cut from a plant.

The shelf life is the number of days the cut flowers are in good enough condition to be sold.

He:

- took 12 cut flowers from a rose plant
- determined the mean number of stomata per mm^2 on the leaves
- determined the transpiration rate for each cutting
- stored the cut flowers on a shelf in a brightly lit room
- determined the shelf life of the cut flowers.

Table 4 shows his results.

Table 4

Month cut flowers were obtained	Mean number of stomata / mm^{-2} (± 2 SD)	Mean transpiration rate / cm^3 day^{-1} (± 2 SD)	Mean shelf life / days (± 2 SD)
December	23 (± 2)	22 (± 3)	5 (± 1)
April	20 (± 3)	15 (± 2)	16 (± 2)

A value of ± 2 SD (standard deviations) from the mean includes over 95% of the data.

0 7 . 2 Using information in **Table 4**, what can you conclude about the effect of different factors on the mean shelf life of cut flowers?

Explain your conclusions.

[4 marks]

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Mark schemes

Question 1 · AS Paper 2 · June 2017 · Q09.1 · 5 marks

09.1	1. Water lost from leaf because of transpiration / evaporation of water (molecules) / diffusion from mesophyll / leaf cells; OR Transpiration / evaporation / diffusion of water (molecules) through stomata / from leaves; 2. Lowers water potential of mesophyll / leaf cells; 3. Water pulled up xylem (creating tension); 4. Water molecules cohere / 'stick' together by hydrogen bonds; 5. (forming continuous) water column; 6. Adhesion of water (molecules) to walls of xylem;	5 max	2. Accept Ψ or WP

Question 2 · A level Paper 1 · June 2023 · Q02.3 · 3 marks

02.3	1. (Allows unbroken) water column **OR** (So) no barrier to (water) movement; 2. Cohesion from H bonds between (all) water (molecules) **OR** Cohesion from (polar) attraction between (all) water (molecules); 3. Evaporation/transpiration creates tension (in column) **OR** Water moves from xylem (into cells) creates tension **OR** (To) pull up water creates tension (in xylem);	3 (3 x AO1)	1. Accept idea of continuous flow OR stream of water 1. Ignore chain of water molecules If 1, 2 or 3 are not awarded accept a principle mark for correct reference to <u>cohesion-tension</u> causing water movement

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01.2	1. Evaporation/transpiration (from the porous pot); 2. Tension created moves water (upwards); 3. Cohesion maintains the column of water **OR** Cohesion is due to hydrogen bonds between water (molecules);

3 (1 x AO2, 2 x AO3)	2. Accept 'negative pressure' for tension or 'water pulled' or 'suction'. Ignore adhesion but reject mark point 3 if adhesion used to describe attraction between water molecules.

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Question 4 · AS Paper 2 · June 2019 · Q05.3 · 3 marks

05.3	1. Water evaporates/is transpired (from leaves/ stalk/celery/plant); 2. Water potential gradient/lower water potential creates tension/pulls up water **OR** Osmosis creates tension/pulls up water; 3. Hydrogen bonds/cohesion/adhesion maintains column;	3

2. Accept negative pressure for tension

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Question 5 · A level Paper 1 · June 2022 · Q06.1 · 4 marks

06.1	1. (Rate of) transpiration/evaporation increases due to increased temperature **OR** (Rate of) transpiration/evaporation increases due to increased light intensity **OR** (Rate of) transpiration/evaporation increases due to decreased humidity **OR** (Rate of) transpiration/evaporation increases due to increased wind/air movement; 2. (So) increased kinetic energy (causing more water loss) **OR** (So) increased water potential gradient (so more water lost) **OR** (So) increased (water) diffusion gradient (so more water lost); 3. Stomata open (at sunrise/after 5 am) allowing gas exchange **OR** Stomata open (at sunrise/after 5 am) allowing carbon dioxide to enter; 4. (Some) stomata close at midday/after 11 am (reducing transpiration);

4 (4 x AO2)	Ignore reference to tide 1 and 2 Reject tide affecting transpiration/ water potential

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07.1	Sucrose;	1 (1 x AO1)

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Question 7 · A level Paper 1 · June 2022 · Q09.1 · 5 marks

09.1	1. <u>Sucrose</u> actively transported into phloem (cell); **OR** <u>Sucrose</u> is co-transported/moved with H^+ into phloem (cell); 2. (By) companion/transfer cells; 3. Lowers water potential (in phloem) **and** water enters (from xylem) by osmosis; 4. ((Produces) high(er) (hydrostatic) pressure; **OR** (Produces hydrostatic) pressure gradient; **5.** Mass flow **to** respiring cells **OR** Mass flow **to** storage tissue/organ; 6. Unloaded/removed (from phloem) by active transport;	5 max (5 x AO1)

1. Accept sieve (element/tube/cell) for phloem (cell)

4. Accept description of gradient, eg high<u>er</u> WP

5. Accept transport OR movement for flow

5. Accept buds/young leaves/fruit/seeds/shoot tip/root tip/ meristems/root

6 Accept facilitated diffusion

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Question 8 · AS Paper 2 · November 2020 · Q08.2 · 3 marks

08.2	1. Sucrose actively transported (into phloem); 2. Lowering/reducing water potential **OR** More negative water potential; 3. Water moves (into phloem) by osmosis (from xylem);	3

Question 9 · AS Paper 1 · June 2023 · Q09.2 · 2 marks

09.2	1. Carbohydrates made by photosynthesis (in the leaf); 2. Less sucrose transported into phloem at leaf/source **OR** Less sucrose transported to sink/potato/root **OR** Less sugar stored as starch;	2 (2 x AO2)

1. Accept 'sugars' or any named carbohydrate

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Question 10 · AS Paper 2 · November 2020 · Q08.4 · 3 marks

08.4	1. High (rate of) transpiration/evaporation; 2. Water lost through stomata **OR** (High) tension in xylem; 3. (Causes) less water movement from xylem to phloem **OR** Insufficient water potential in phloem to draw water from xylem;	3
TOTAL		**9**

Question 11 · AS Paper 2 · June 2018 · Q06.2 · 3 marks

06.2	1. (**D** shows) substance (X) is not required for (some) root growth / production of roots; 3 **OR** Substances (already) present in stem cause (some) root growth; 2. Substance X moves through plant; 3. (**E** shows) substance (X) causes / increases / doubles number of roots / root growth;	2. Accept X moves through stem / phloem

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06.3	**In support of mass flow hypothesis**	4 max
	1. **(F** shows) phloem is involved; 2. **(G** shows) respiration / active transport is involved (in flow / movement); 3. Because 4 °C / cooling reduces / slows / stops flow / movement; 4. The agar block is the source; 5. Roots are the sink; **Against the mass flow hypothesis** 6. No bulge above ringing (in **F**); 7. No (role for) osmosis / hydrostatic pressure / water movement; 8. Movement could be due to gravity; 9. Roots still grow without (intact/functioning) phloem; 10. No leaves / sugars / photosynthesis to act as a source;	

Each point must be clearly made in the context of support or against.

Ignore sugar / sucrose

3 max for "support" and 3 max for "against"

7. Accept no turgor pressure

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08.1	**EITHER** 1. The radioactively labelled carbon is converted into sugar/organic substances during photosynthesis; 2. Mass flow/translocation in the phloem throughout the plant only in plants that were untreated/**B**/control OR Movement of sugar/organic substances in the phloem throughout the plant only in plants that were untreated/**B**/control; **OR** 3. Movement in phloem requires living cells/respiration/active transport/ATP; 4. Heat treatment damages living cells **so** transport in the phloem throughout the plant only in plants that were untreated/**B**/control OR Heat treatment stops respiration/active transport/ATP production **so** transport in the phloem throughout the plant only in plants that were untreated/**B**/control;

2	Do not mix and match – award either mp1 and mp2 or mp3 and mp4. 1. For 'organic substance' accept named organic substance, eg glucose, sucrose, amino acid.

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Question 14 · AS Paper 1 · June 2025 · Q07.3 · 1 mark

07.3	1. Some **sugars** converted to cellulose/starch; 2. Some **sugars** used in respiration; 3. Some **sugars** not moved down; 4. Some **sugars** moved further down than E;	1 max (1 x AO2)	1, 2, 3 and 4. Accept 'organic substance' for sugars or any suitably named organic substance for sugars, e.g. glucose 3. Accept some sugars remain in the leaf

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07.4	(In support of mass flow hypothesis) 1. Radioactivity is higher in phloem than xylem; 2. Radioactivity found in sections below leaf **so** it moved down stem/plant; 3. Leaf is source **OR** Leaf produces organic substances; (Against mass flow hypothesis – **max 3**) 4. Some radioactivity present in xylem; 5. Only tested in one species **OR** Only tested in geraniums; 6. No evidence for transport above the leaf; 7. Movement could be due to gravity;	4 max (4 x AO3)

3. Accept leaf produces any named organic substance 6. Accept other leaves/fruit/flowers

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Question 16 · AS Paper 2 · June 2019 · Q05.1 · 2 marks

05.1	1. Initial **and** final mass (of beaker and all contents); 2. Number of (groups of) xylem vessels;	2	1. Accept change in mass/weight 1. Ignore volume 1. Reject change in mass of celery/beaker/water alone 2. Accept amount for 'number'

Question 17 · A level Paper 3 · June 2017 · Q06.3 · 1 mark

06.3	Plant has roots OR xylem cells very narrow;	1	Ignore references to air bubbles/mass flow/photosynthesis Accept xylem damaged when cut

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07.2	1. SDs do not overlap for (mean) shelf life **OR** SDs do not overlap for (mean) transpiration rate **OR** SDs do overlap for (mean) number of stomata; 2. Shelf life significantly longer/different in April; 3. No significant difference in (mean) number of stomata so unlikely/not linked to shelf life; 4. Significant difference in (mean) transpiration rate so (likely) linked with shelf life;	4 (4 x AO3)

2. Accept converse for December

2. 3. and 4. Accept equivalent statements to significance in terms of chance, e.g. for 4. 'difference in (mean) transpiration rate is not due to chance…'

If no marks awarded, allow 1 mark max for

(mean) transpiration rate affects shelf life

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