1.14 Plant Tissues, Transport and Transpiration: 30-minute Pack

AQA 8464 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Xylem tissue is adapted for transporting water from the roots to the leaves. State two adaptations of xylem tissue for this function.

(Total for Question 1 is 2 marks)

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2 Water travels from the roots to the leaves of a plant, driven by transpiration.

(a) Define transpiration. **(1)**

(b) Describe the pathway taken by water from being absorbed by the roots to being lost from the leaves. **(4)**

(c) Explain how transpiration helps to supply the plant with water and dissolved mineral ions. **(2)**

(Total for Question 2 is 7 marks)

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3 A student investigated the effect of air temperature on the rate of water uptake by a leafy shoot, using a potometer. Light intensity, humidity and air movement were kept constant throughout.

Temperature (°C)	Rate of water uptake (mm^3/min)
10	12
20	24
30	39
40	41

(a) Calculate the percentage increase in the rate of water uptake between 10°C and 20°C. Show your working. **(2)**

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(b) Describe the overall trend shown by the data. **(2)**

(c) Explain, in terms of particles, why increasing temperature increases the rate of transpiration. **(3)**

(d) Suggest one reason why the increase in rate slows between 30°C and 40°C. **(2)**

(Total for Question 3 is 9 marks)

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4 Water lilies are plants that float on the surface of ponds, with the upper surface of each leaf exposed to the air and the lower surface resting flat on the water. Unlike most land plants, water lilies have almost all of their stomata on the upper surface of the leaf. Suggest why.

(Total for Question 4 is 3 marks)

5 A gardener notices that a potted plant, standing in a well-lit, warm greenhouse, wilts (droops) more quickly on windy days than on still days, even though she waters it the same amount each day. Explain, as fully as you can, why the plant loses water more quickly on windy days, and suggest what might happen to the plant's rate of photosynthesis as a result.

(Total for Question 5 is 6 marks)

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Mark scheme · 1.14 Plant Tissues, Transport and Transpiration: 30-minute Pack

Question 1

xylem cells are dead, and joined end to end with no end walls/cross walls, forming a continuous hollow tube through which water can flow freely, oe **B1**

the cell walls are thickened/strengthened with lignin, giving support and preventing the tube from collapsing, oe **B1**

Answer: Xylem cells are dead and joined end to end into a continuous hollow tube, with walls thickened by lignin, so water can flow freely while the tube stays supported and does not collapse.

Question 2

(a) the loss/evaporation of water vapour from a plant, mainly through the stomata (in the leaves), oe **B1**

(a) Answer: Transpiration is the loss of water vapour from a plant, mainly through the stomata in the leaves.

(b) water is absorbed from the soil into root hair cells by osmosis, oe **B1**

(b) water passes across the root (from cell to cell) and enters the xylem, oe **B1**

(b) water moves up through the xylem, from the root, through the stem, and into the leaves, oe **B1**

(b) water moves out of the xylem into the mesophyll cells, where it evaporates into the air spaces and diffuses out of the leaf through open stomata, oe **B1**

(b) Answer: Water is absorbed into root hair cells by osmosis, passes across the root into the xylem, moves up the xylem through the stem to the leaves, then moves into the mesophyll cells where it evaporates into the leaf's air spaces and diffuses out through open stomata.

(c) as water evaporates from the mesophyll cells and diffuses out of the stomata, it is replaced by water pulled up through the xylem from the roots, oe **B1**

(c) this continuous pull (the transpiration stream) also carries dissolved mineral ions up through the xylem to where they are needed for growth, oe **B1**

(c) Answer: Water lost from the leaves by transpiration is replaced by water pulled up through the xylem from the roots (the transpiration stream), and this same flow carries dissolved mineral ions up to where they are needed.

Question 3

(a) (24 - 12) / 12 x 100, oe **M1**

(a) 100% cao **A1**

(a) Answer: 100%

(b) as temperature increases, the rate of water uptake increases overall, oe **B1**

(b) the increase becomes smaller at higher temperatures, e.g. the rate rises by 15 mm^3/min between 20 and 30°C but only 2 mm^3/min between 30 and 40°C, so the rate begins to level off, oe with correct use of data **B1**

(b) Answer: The rate of water uptake increases as temperature increases, but the size of the increase gets smaller at higher temperatures, with the rate levelling off between 30 and 40°C.

(c) water molecules gain (kinetic) energy and move faster as temperature increases, oe **B1**

(c) this increases the rate of evaporation of water from the surfaces of the mesophyll cells into the air spaces of the leaf, oe **B1**

(c) it also increases the difference in water vapour concentration between inside the leaf and the air outside, increasing the rate of diffusion of water vapour out through the stomata, oe **B1**

(c) Answer: Higher temperature gives water molecules more kinetic energy, so they evaporate faster from the mesophyll cells into the leaf's air spaces; this increases the water vapour concentration gradient between the leaf and the outside air, so water vapour diffuses out through the stomata faster.

(d) at higher temperatures, the plant may begin to close its stomata (or guard cells may lose turgor), oe **B1**

(d) to prevent excessive water loss/wilting, which limits how much further the rate of transpiration can increase, oe **B1**

(d) Answer: At higher temperatures, the plant may start to close its stomata to prevent excessive water loss, which limits how much further the rate of water uptake can rise.

Question 4

the lower surface of the leaf is in direct contact with water, oe **B1**

stomata on the lower surface would be blocked/covered by water, oe **B1**

so gas exchange (and water loss) could not happen efficiently through the lower surface, meaning stomata must be on the upper surface, which is exposed to the air, to allow gas exchange, oe **B1**

Answer: The lower surface of a water lily leaf is in direct contact with the water, so stomata there would be blocked by water and could not exchange gases; the upper surface is exposed to the air, so stomata are found there instead, to allow gas exchange to still occur.

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Question 5

Level 3 A clear, logically linked explanation that covers both why wind increases the rate of transpiration (referring to the water vapour concentration gradient at the leaf surface) and its link to wilting, and the knock-on effect on stomatal closure and photosynthesis rate, using appropriate scientific vocabulary throughout.	**5-6**
Level 2 Some correctly linked reasoning showing how wind affects the rate of transpiration (e.g. referring to diffusion or water vapour being removed) and/or a link to wilting, but the explanation is incomplete, or the link to photosynthesis is missing or undeveloped.	**3-4**
Level 1 Basic, largely isolated statements, e.g. that wind increases water loss and/or the plant wilts, with little or no linking of ideas and limited use of scientific terms.	**1-2**
Level 0 No relevant content.	**0**

Indicative content:

- Transpiration is the loss of water vapour from the leaves, mainly through the stomata.
- Wind blows away/removes water vapour molecules from just outside the stomata (from the leaf surface).
- This maintains, or increases, the difference in water vapour concentration (the diffusion gradient) between the air spaces inside the leaf and the air outside.
- A steeper concentration gradient increases the rate of diffusion of water vapour out through the stomata, increasing the rate of transpiration.
- Faster transpiration means water can be lost from the plant faster than it is being absorbed and transported by the roots and xylem.
- If water loss exceeds water uptake, cells (such as mesophyll and guard cells) lose turgor, and the plant wilts.
- In response, guard cells may cause the stomata to partially or fully close, to reduce further water loss.
- If stomata close, less carbon dioxide can diffuse into the leaf.
- Since carbon dioxide is a raw material needed for photosynthesis, a reduced supply is likely to reduce the rate of photosynthesis.
- Reduced water availability in the leaf cells may also directly limit photosynthesis, since water is also a raw material for the reaction.

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