

1. (a) Root pressure is a force that is partly responsible for the movement of water through xylem in stems. Explain how the active transport of mineral ions into xylem vessels in the roots results in water entering these vessels and then being moved up the xylem tissue.

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(5)

- (b) The presence of an air bubble in a xylem vessel in the stem blocks the movement of water through that vessel. Use the cohesion-tension theory to explain why.

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(4)

**S** (c) Water vapour diffuses through open stomata into the atmosphere. Describe **two** structural adaptations of the leaves of xerophytes that reduce this loss. Using Fick's law, explain how these two adaptations reduce the rate of diffusion of water vapour into the atmosphere.

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(6)  
(Total 15 marks)

2. (a) Explain how water enters a plant root from the soil and travels through to the endodermis.

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(5)

(b) From the root, water is transported upwards through the stem. Explain how evaporation from the leaves can cause the water to move upwards.

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(4)

- S (c) In daylight, most of the water evaporates from the leaves but some is used by the plant. Describe the ways in which this water could be used by the plant.

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(6)  
(Total 15 marks)

3. Two theories have been put forward to explain the upward movement of water in the xylem in a tree.

- the cohesion-tension theory
- the root pressure theory

- (a) Describe **one** piece of evidence that supports the root pressure theory and explain how it supports this theory.

Evidence .....

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Explanation .....

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(2)

(b) The diameter of a tree is less during the day, when the tree is transpiring, than it is at night. Explain how this

(i) supports the cohesion-tension theory;

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(ii) does not support the root pressure theory.

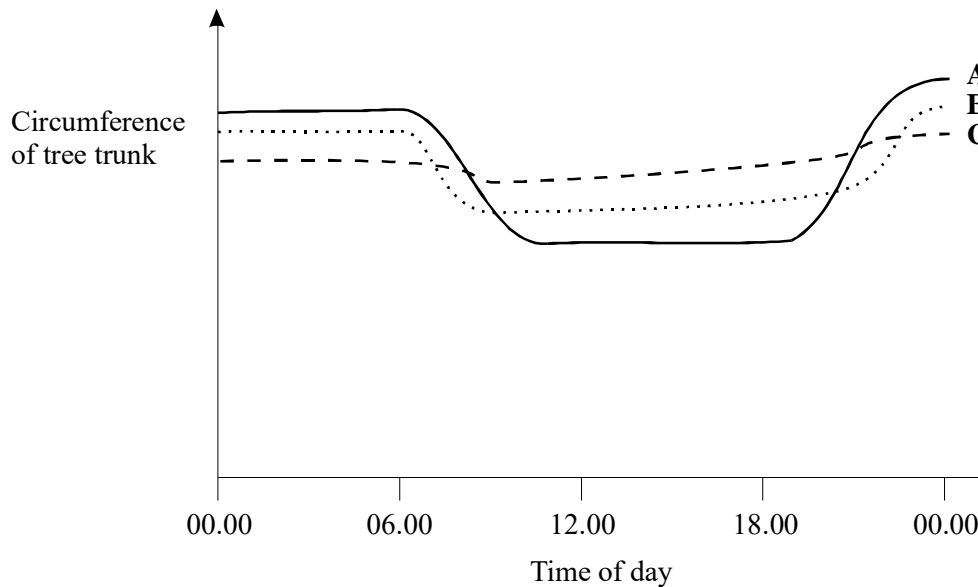
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(3)  
(Total 5 marks)

4. Change in the circumference of tree trunks can be related to change in the diameter of xylem vessels. The graph shows changes in circumference of three different species of trees measured on a hot dry day in June.



- (a) Use your knowledge of the cohesion-tension theory to explain the changes in the circumference of tree **A**.

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(5)

- (b) (i) Which of trees **A – C** is likely to be best adapted to a dry environment? Give the evidence in the graph which supports your answer.

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(1)

- (ii) Describe **two** features you would expect in the leaves of a tree adapted to a dry environment. Explain how each feature helps the tree's survival.

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(6)  
(Total 12 marks)

5. The table shows the results of an investigation into how the distribution of the roots of three species of grass varied with depth. The figures are given as percentages of the total root dry mass of the species concerned.

Soil depth/m	Species of grass		
	<i>Panicum maximum</i>	<i>Themedia triandra</i>	<i>Eragrostis superba</i>
0 – 0.4	64.9	66.5	73.6
0.4 – 0.8	14.2	25.9	15.5
0.8 – 1.2	12.1	5.6	7.4
1.2 – 1.6	4.7	1.4	2.6
1.6 – 2.0	2.6	0.6	0.8
2.0 – 2.4	1.2	0	0.1
2.4 – 2.8	0.3	0	0
Total dry mass/g per plant	114	58	27

- (a) All three of these species grow in hot, dry conditions. Which species would you expect to grow best if the ground was lightly sprinkled with water at regular intervals? Give an explanation for your answer.

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(2)

- (b) *Panicum maximum* is able to survive better than the other two species during lengthy periods of hot, dry weather. Use the data in the table to suggest an explanation.

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(2)

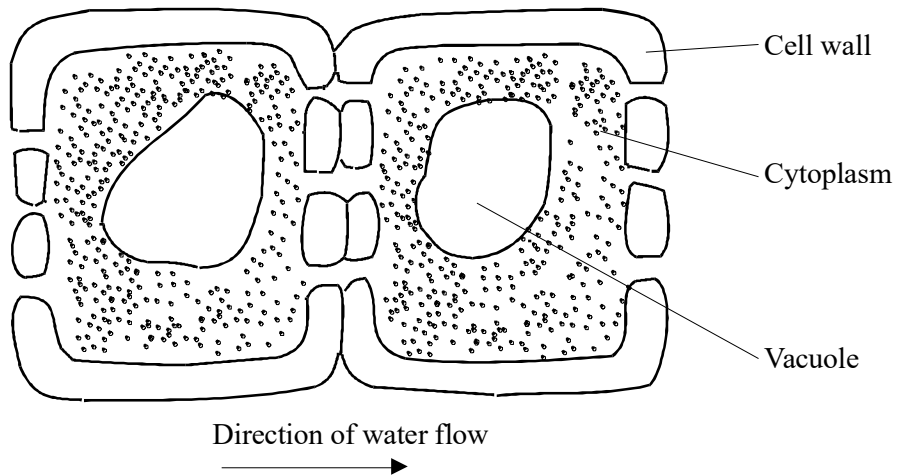


(c) Describe **two** ways in which the leaves of plants may be adapted for reducing water loss in hot, dry conditions.

- 1. ....
- .....
- 2. ....
- .....

(2)  
(Total 6 marks)

6. The diagram shows two cells from the root of a plant.



(a) On the diagram, draw arrows to show the apoplast pathway of water movement.

(1)

(b) Explain how the rate of water movement through the apoplast pathway is affected by increased humidity of air around the leaves.

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- .....
- .....

(2)

- (c) Weeds can be killed by watering the soil around the weed with a concentrated salt solution. Explain in terms of water potential how the weed is killed.

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(2)

- (d) Leaves from four different plants, **A**, **B**, **C** and **D** were detached and weighed. The mean number of stomata per  $\text{mm}^2$  was estimated. The leaves were hung from a line and left in the same environment. After 24 hours the leaves were reweighed. The table shows the results of this investigation.

	Plant <b>A</b>	Plant <b>B</b>	Plant <b>C</b>	Plant <b>D</b>
Percentage loss of mass	28	42	50	32
Mean number of stomata per $\text{mm}^2$	8	10	9	9

- (i) Which **two** plants are likely to show adaptations to a dry environment?  
What evidence in the table supports your answer?

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(1)

- (ii) The four species had similar numbers of stomata per  $\text{mm}^2$  per leaf surface. Explain **two** adaptations of leaf structure which could account for the differences in the amount of water lost by these plants.

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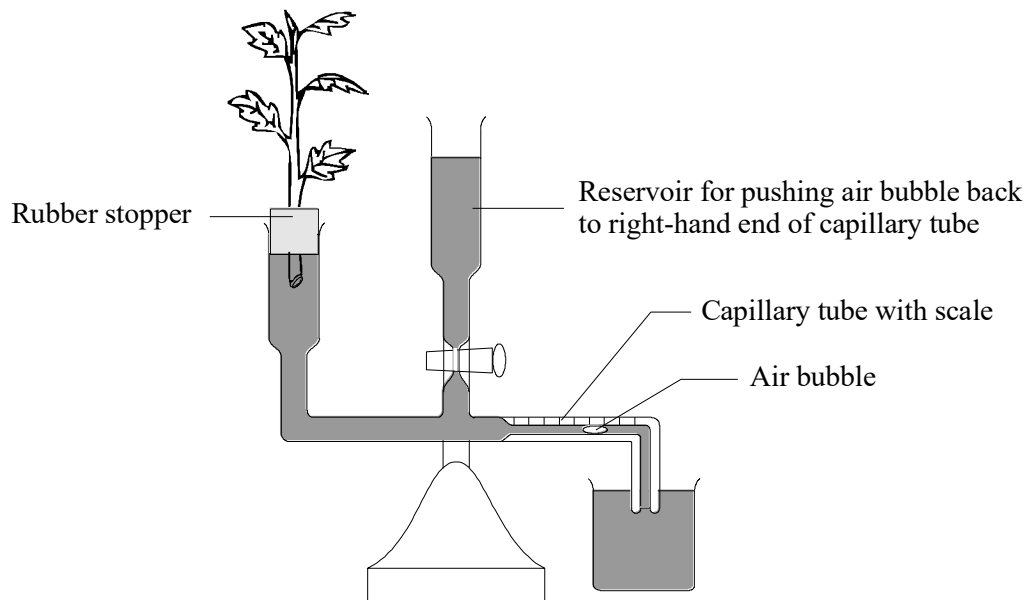
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(Total 8 marks)

7. A potometer can be used to measure the rate of water uptake by a plant shoot. One type of potometer is shown in the diagram.



(Reproduced from *Biological Functional Approach* - A Students Manual 2<sup>nd</sup> Edition by MBV Roberts, by permission of Nelson Thornes Ltd)

- (a) (i) What measurements must be made in order to calculate the rate of water uptake in  $\text{cm}^3$  per minute by this shoot?

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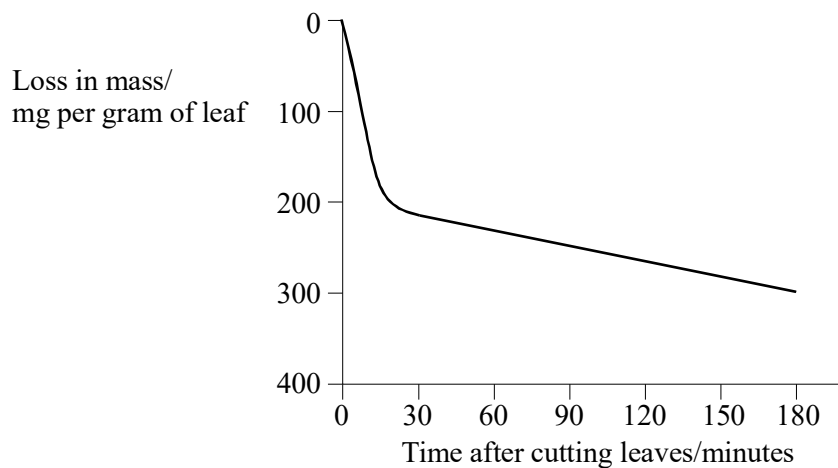
(2)

- (ii) It is assumed that water uptake is equivalent to water loss. What additional measurement should be made when using a potometer to compare the rate of transpiration of two different species of plant?

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(1)

- (b) Another method of investigating the rate of transpiration involves the regular weighing of detached leaves over a period of time. The graph shows the results of such an investigation.



Describe and explain the change in mass of the leaves over the period of this investigation.

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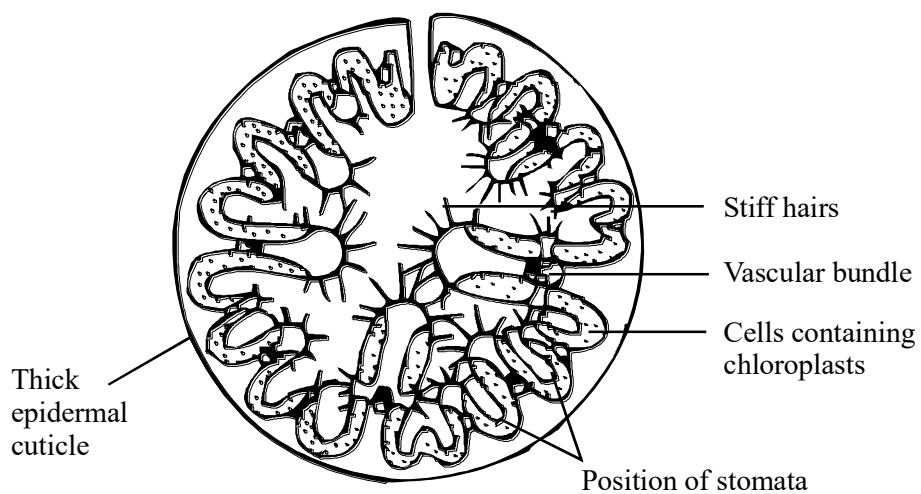
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(4)  
(Total 7 marks)

8. The drawing shows a section through a leaf of marram grass.



- (a) Describe **two** features shown on the drawing which help to reduce the rate of transpiration. Explain how each feature achieves this reduction.

Feature

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Explanation

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Feature

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Explanation

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(4)

- (b) Marram grass grows on sand dunes. The conditions found in this environment include high salt content in the soil and high air temperatures. Explain how these conditions could affect water uptake by this plant.

- (i) high salt content in the soil

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- (ii) high air temperatures

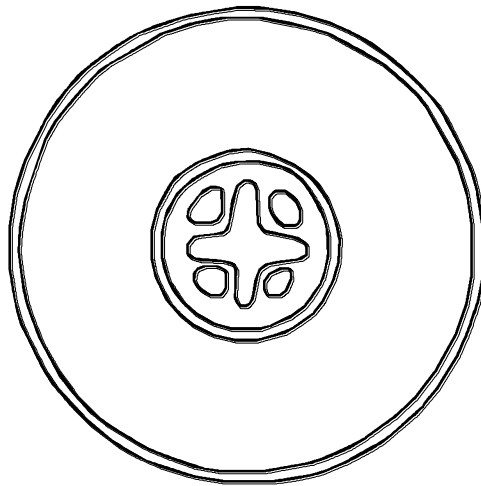
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(2)

(Total 6 marks)

9. The diagram shows a section through the root of a plant.



The roots of this plant were immersed in a dilute solution of phosphate ions. Oxygen was bubbled through the solution.

- (a) (i) Name and label on the diagram the tissue through which phosphate ions are transported up the root to the stem and leaves of the plant. (1)
- (ii) A supply of oxygen is necessary for the roots to take up phosphate ions from the solution. Explain why.

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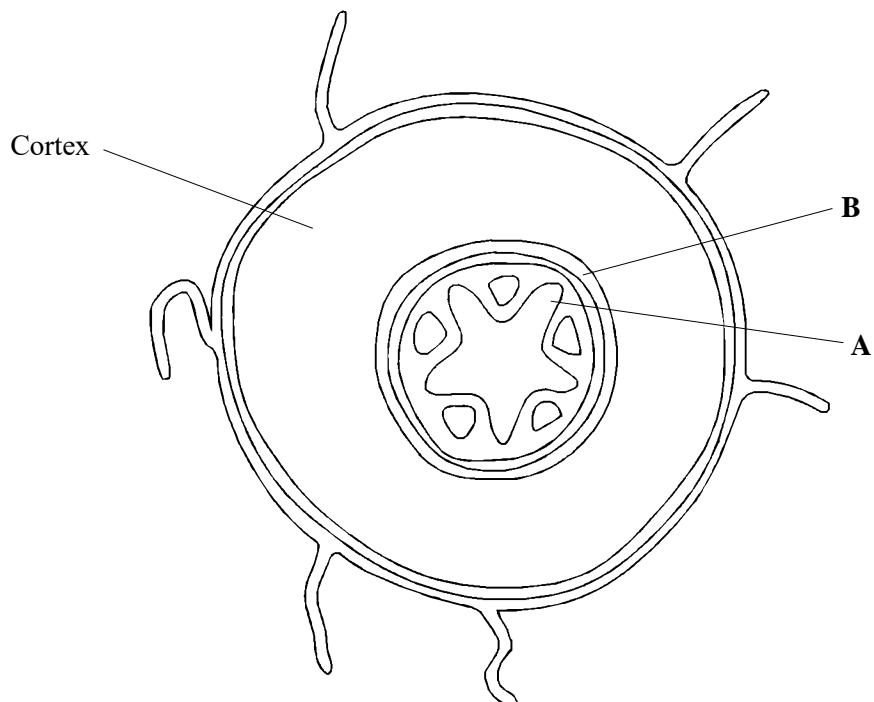
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(2)

- (b) Phosphate ions move across the root along the symplastic pathway. In the space below, draw a simple diagram showing two neighbouring root cells. Add arrows to the diagram to show the symplastic pathway.

(2)  
(Total 5 marks)

10. The diagram shows part of a cross-section through a primary root.



- (a) Name the tissues labelled **A** and **B**.

**A** .....

**B** .....

(2)



(b) Water enters root hair cells and moves across the cortex through both apoplast and symplast pathways.

(i) Which part of the cortex cells forms the apoplast pathway?

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(1)

(ii) Explain in terms of water potential how water enters root hair cells from the soil.

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(2)

**(Total 5 marks)**

**11.** (a) Describe how the structure of xylem is related to its function.

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(4)

(b) Describe the roles of root pressure and cohesion-tension in moving water through the xylem.

(i) root pressure

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(ii) cohesion-tension

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(8)

(c) Describe and explain how **three** structural features reduce the rate of transpiration in xerophytic plants,

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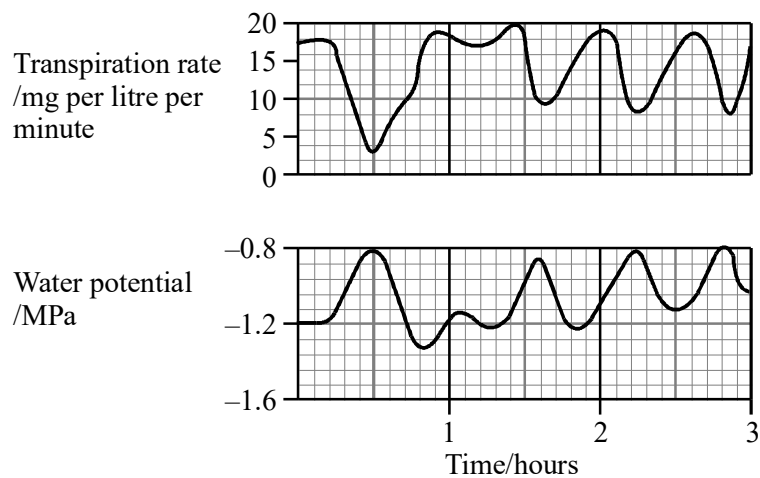
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(3)

(Total 15 marks)

12. (a) The graph shows the fluctuations in the transpiration rate of leaves and water potential of leaf cells of cotton plants during three hours of daylight.



- (i) Describe the relationship between the transpiration rate and water potential of cells of cotton leaves.

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(1)

- (ii) Explain how an increase in the rate of transpiration affects the water potential of leaf cells.

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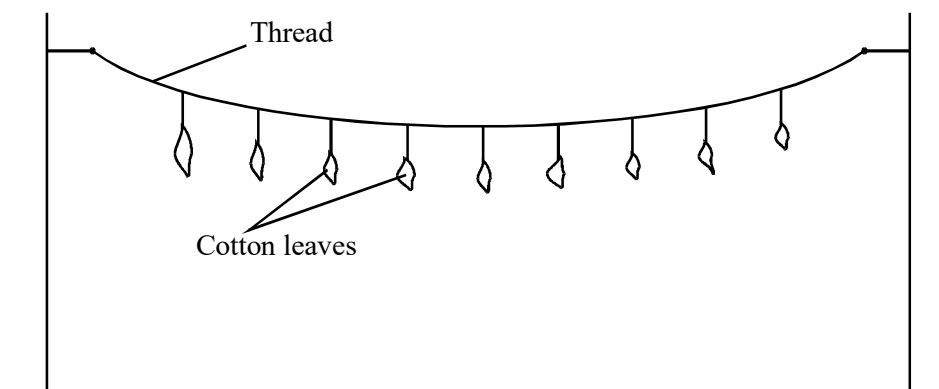
(2)

- (iii) How do the stomata cause the fluctuations in the transpiration rate shown in the graph?

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(1)

- (b) An investigation was carried out to measure the rate of transpiration of cotton leaves. Several leaves were attached together by thread as shown in the diagram.



The leaves were weighed every thirty minutes over a period of three hours. The table shows the results of this investigation.

Time/ minutes	Los in mass/ mg per gram of leaf
30	110
60	63
90	22
120	21
150	9
180	7

- (i) Describe the change in mass of the leaves over the period of this investigation.

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(1)

- (ii) Explain the change in mass of the leaves over the period of this investigation.

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(3)

- (iii) Suggest why several leaves were used in this investigation.

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(1)

(c) Describe **two** features you would expect in the leaves of a xerophyte which would reduce the rate of transpiration.

1 .....

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2 .....

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(2)

(d) Explain the effect on the rate of transpiration of

(i) an increase in air temperature;

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(2)

(ii) a decrease in water content of the soil.

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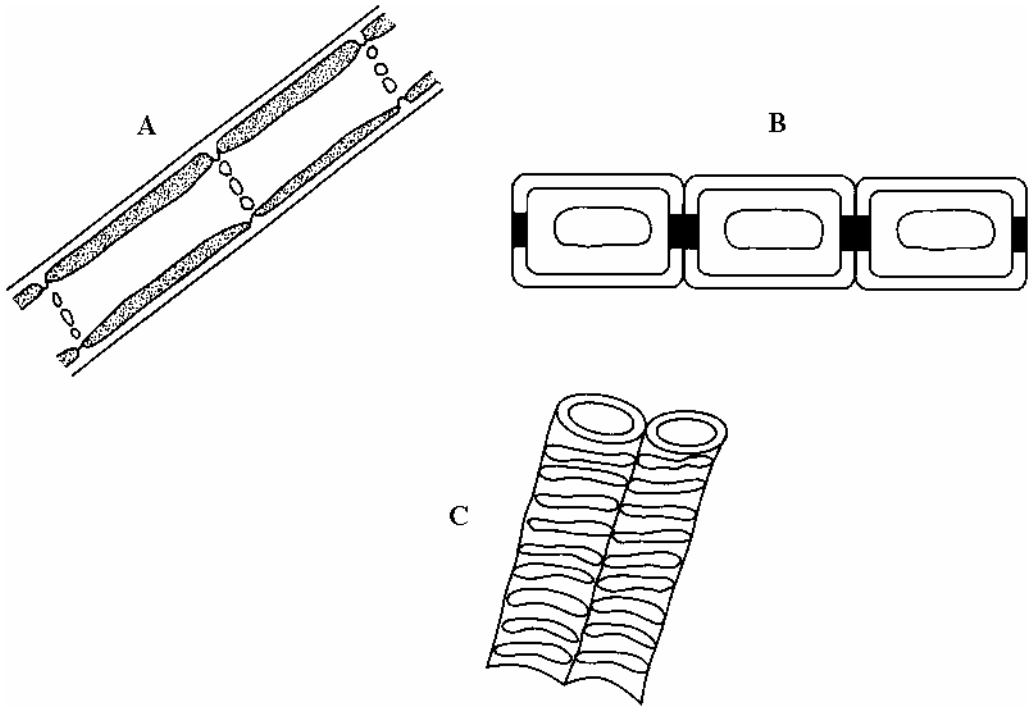
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(2)

**(Total 15 marks)**

13. **Figure 1** shows cells from three different tissues of a plant root.



**Figure 1**

(a) Name the tissues in diagrams **A**, **B** and **C**.

**A** .....

**B** .....

**C** .....

(3)

(b) Which of the tissues **A**, **B** or **C**

(i) transports sucrose;

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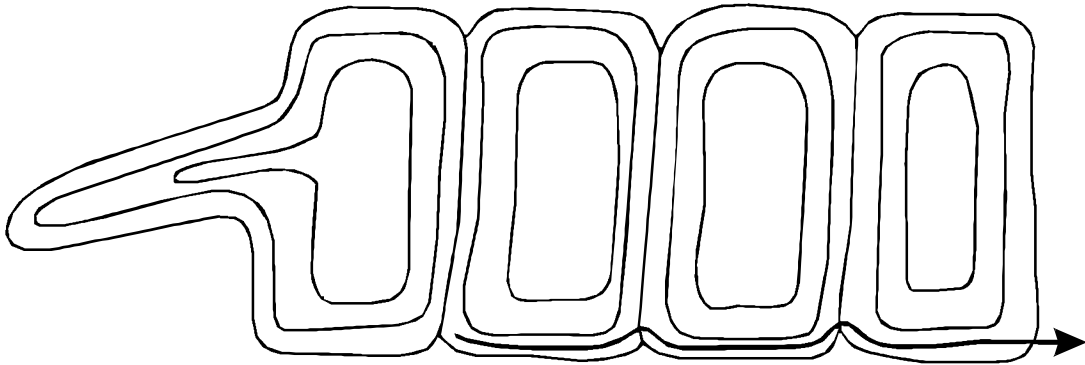
(1)

(ii) has lignified walls providing support?

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(1)

- (c) **Figure 2** shows cells from the root of a plant.



**Figure 2**

- (i) Explain in terms of water potential how water enters the root hair cell from the soil.

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(2)

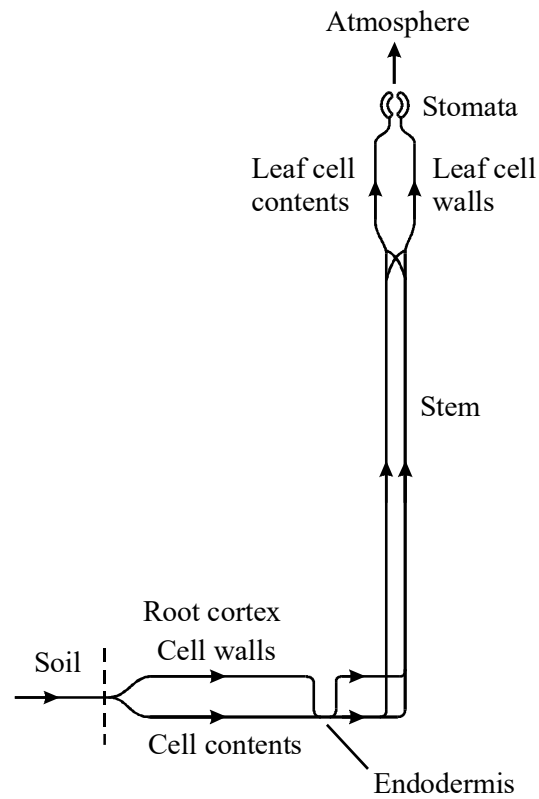
- (ii) Give the name of the pathway shown in **Figure 2** by which water is transported across the root.

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(1)

(Total 8 marks)

14. The diagram shows the pathway taken by water passing through a plant.



(a) Name

- (i) the process by which water enters root hairs from the soil.

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(1)

- (ii) the pathway through the cell walls of the root cortex.

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(1)



- (b) All water passes through the endodermis by the same pathway.  
Explain what causes this.

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(2)

- (c) Describe and explain how water moves through the trunk of a tree to the leaves

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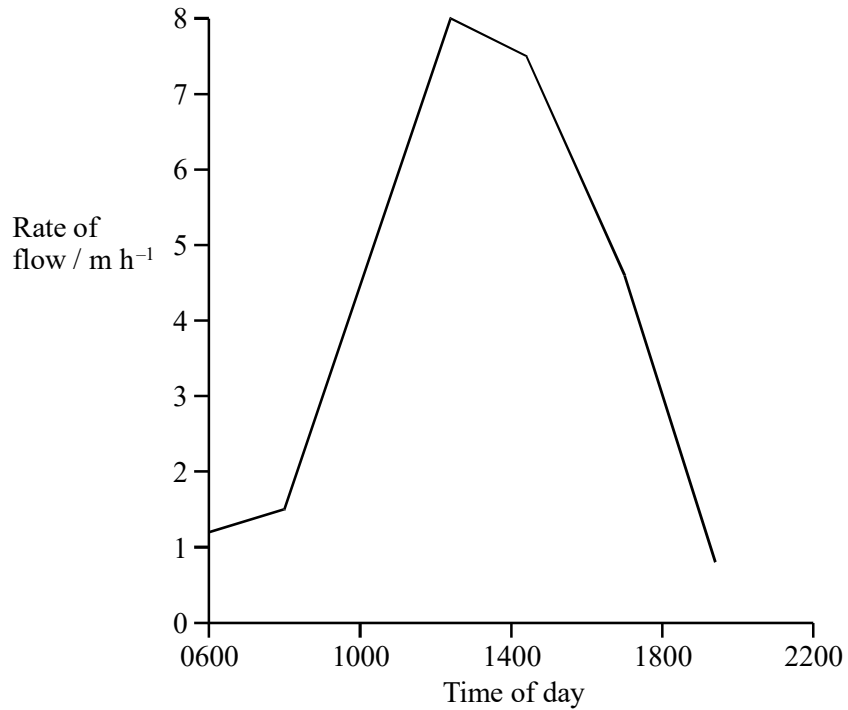
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(6)

- (d) The graph shows the rate of water flow through a branch near the top of a tree on a summer's day.



Describe and suggest explanations for the changes in the rate of flow during the day.

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(4)  
(Total 14 marks)

15. (a) The table shows the transpiration rate of a group of plants exposed to different humidities at a temperature of 25°C.

<b>Humidity / %</b>	<b>Transpiration rate / arbitrary units</b>
20	26.0
40	21.0
50	16.5
60	11.0
70	9.5

Describe and explain the relationship between humidity and transpiration rate.

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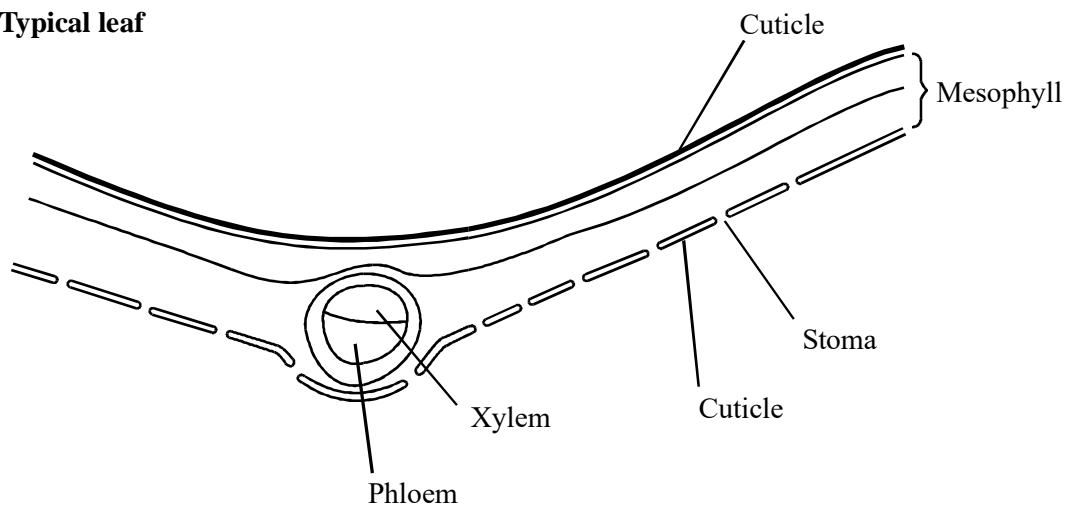
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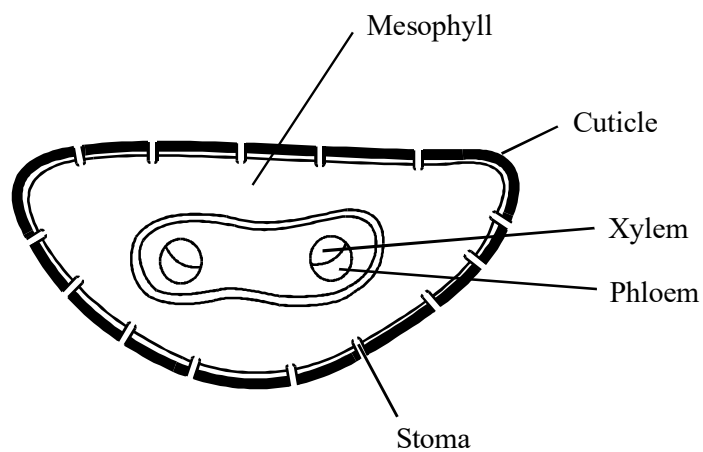
(3)

- (b) The diagrams show a section through a typical leaf and a section through a leaf from a xerophytic plant. The xerophytic leaf has a lower transpiration rate than the typical leaf.

**Typical leaf**



**Xerophytic leaf**



Describe **two** features shown in the diagram of the xerophytic leaf which reduce transpiration rate. Explain how each of these features contributes to a lower transpiration rate.

Feature 1 .....

Explanation .....

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Feature 2 .....

Explanation .....

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(4)  
(Total 7 marks)

16. (a) The apoplast pathway is one of the routes followed by water from a root hair, through the cortex, to the endodermis of the root.

(i) What is meant by the *apoplast* pathway?

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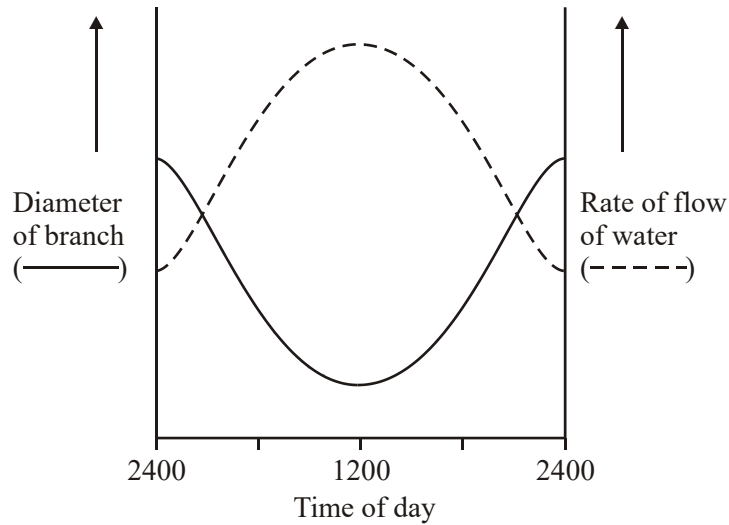
(1)

(ii) Explain how the structure of the endodermis affects the passage of water by this pathway.

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(3)

- (b) The diameter of a branch of a tree and the rate of flow of water through the branch were measured over a 24-hour period. The results are shown in the graph.



Using your knowledge of cohesion-tension theory

- (i) describe and explain the changes in rate of flow of water in the branch over the 24 hour period;

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(3)

- (ii) explain why the diameter of the branch decreased during the first 12 hours.

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(1)

- (c) A stem was cut from a transpiring plant. The cut end of the stem was put into a solution of picric acid, which kills plant cells. The transpiration stream continued. Suggest an explanation for this observation.

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(2)

**(Total 10 marks)**

17. (a) Describe how water is moved through a plant according to the *cohesion-tension* hypothesis.

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(4)

- (b) The mass of water lost from a plant was investigated. The same plant was used in every treatment and the plant was subjected to identical environmental conditions. In some treatments, these were coated with a type of grease. This grease provides a waterproof barrier. The results of the investigation are given in the table.

Treatment	Mass lost in 5 days / g
No grease applied	10.0
Grease applied only to the upper surface of every leaf	8.7
Grease applied to both surfaces of every leaf	0.1

(i) What is the advantage of using the same plant in every treatment?

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**(1)**



(ii) Why was it important to keep the environmental conditions constant?

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**(1)**

(iii) What is the evidence that the grease provides a waterproof barrier?

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**(1)**

- (c) (i) Calculate the mass of water lost in 5 days through the upper surface of the leaves.

Answer .....

(1)

- (ii) Use your knowledge of leaf structure to explain why less water is lost through the upper surface of leaves than is lost through the lower surface.

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(2)  
**(Total 10 marks)**

18. (a) Explain how each of the following is related to the function of xylem tissue.

(i) Xylem tissue contains hollow tubes.

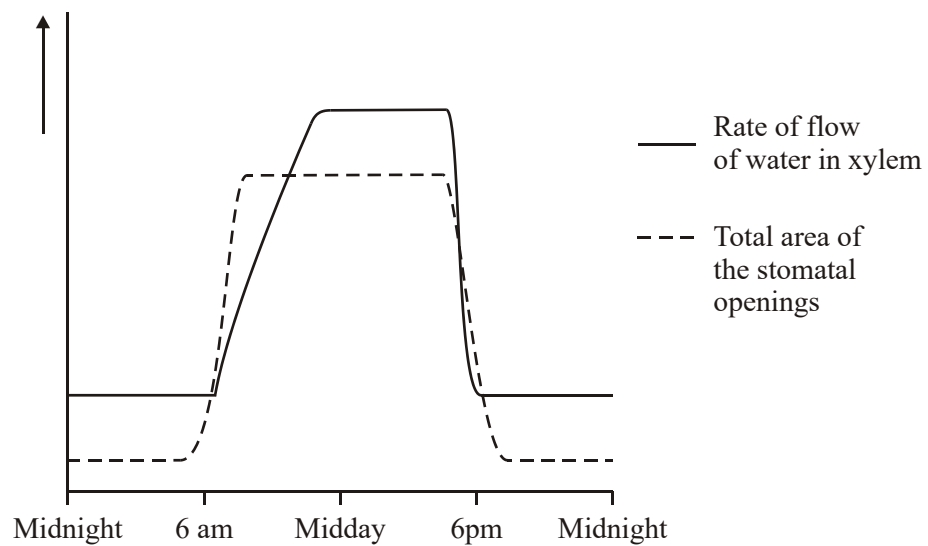
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(ii) Lignin is present in xylem cell walls.

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(2)

- (b) In an investigation the total area of the stomatal openings and the rate of flow of water through xylem were measured in a plant over a period of 24 hours. The results are shown in the graph.



- (i) Describe the relationship between the rate of flow of water and the total area of the stomatal openings for the period of time between midday and midnight.

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(1)

- (ii) Between 8 am and midday the rate of flow of water continues to rise although the total area of the stomatal openings remains constant. Explain why the rate of flow of water rises.

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(1)



- (iii) How would the curve showing the total area of the stomatal openings differ if the investigation was repeated on a dull day?

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(1)

(c) Some xerophytic plants have sunken stomata. Explain the advantage of this adaptation.

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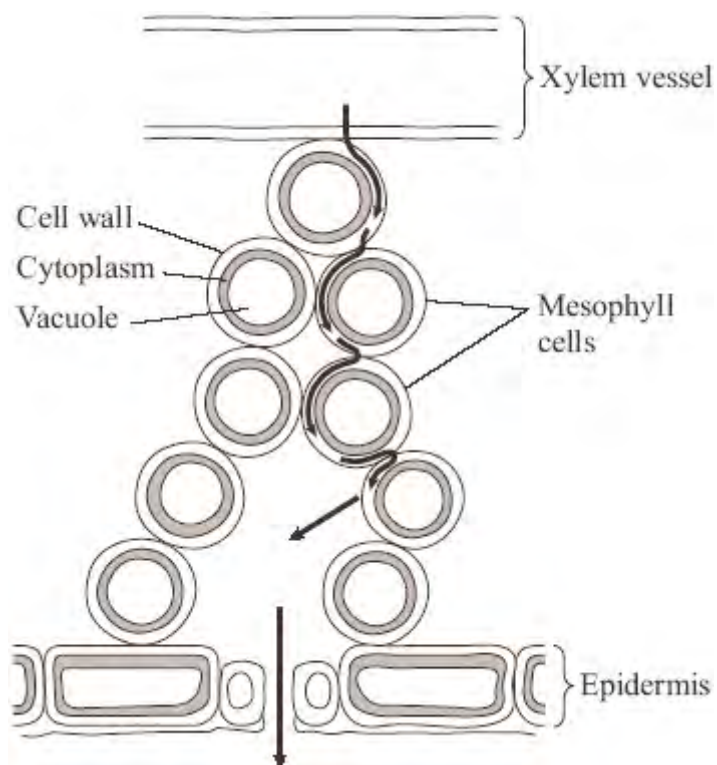
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(2)  
(Total 7 marks)

19. The diagram shows part of a leaf. The arrows show one pathway taken by water through the leaf and into the atmosphere.



(a) (i) Name the pathway shown.

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(1)

(ii) Describe and explain how water in the mesophyll cells passes out of the leaf.

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(3)

(b) Explain how **two** adaptations of their leaves reduce water loss from xerophytes.

Adaptation.....

Explanation.....

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Adaptation.....

Explanation .....

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(2)

(Total 6 marks)

20. (a) Explain how xylem tissue is adapted for its function.

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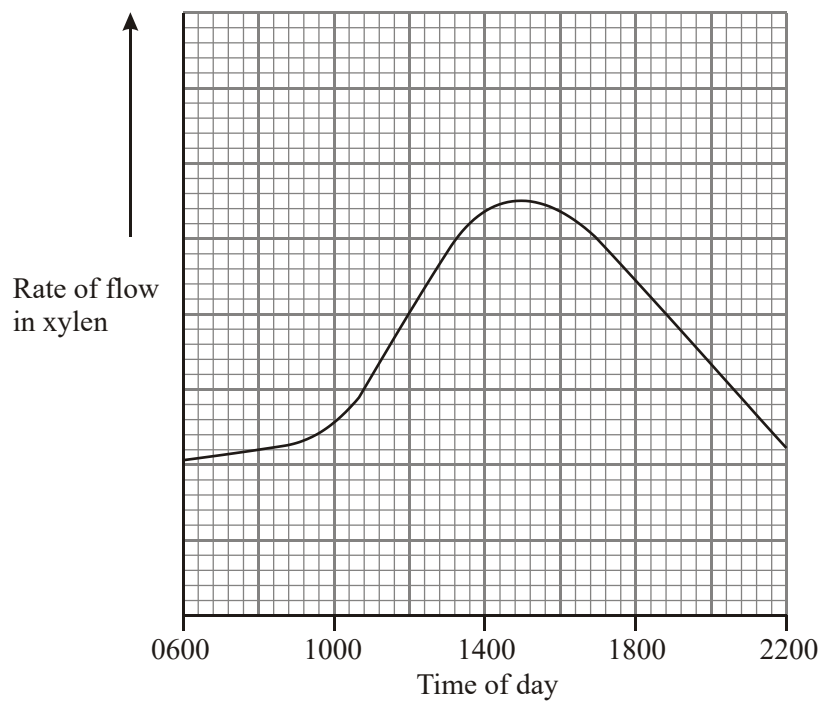
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(4)

(b) The graph shows the flow rate in the xylem in the trunk of a tree.





- (i) Explain the increase in the flow rate between 1000 and 1400 hours.

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(2)

- (ii) The diameter of the trunk decreased during the same period, reaching its minimum when the flow rate was highest. Use your knowledge of the cohesion-tension theory to suggest an explanation for this decrease.

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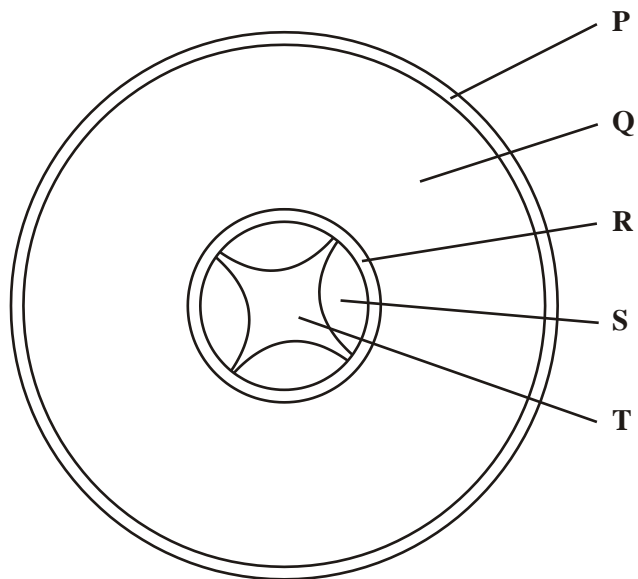
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(2)  
**(Total 8 marks)**

21. (a) **Figure 1** shows a section through the root of a young plant.

**Figure 1**



- (i) Name the part of the plant labelled **R**.

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(1)

(ii) Give the letter which labels a tissue that transports solutes from the leaves.

Answer .....

(1)

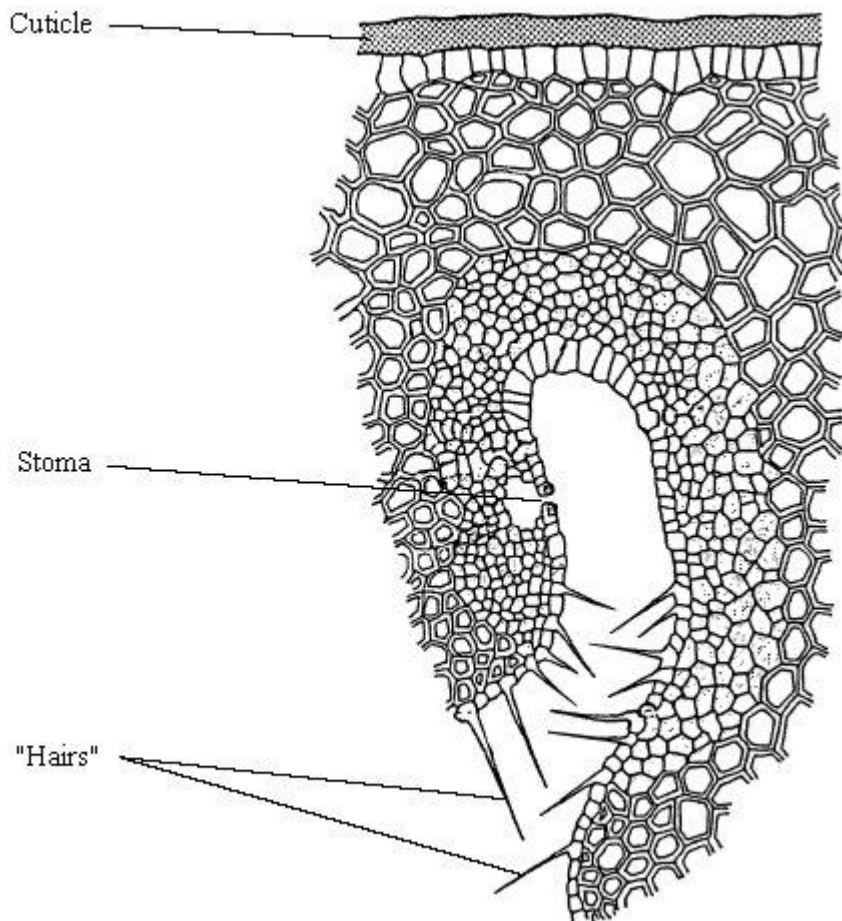
- (iii) Give the letter which labels a tissue that prevents the movement of water through the apoplast pathway.

Answer .....

(1)

- (b) **Figure 2** shows a single stoma and surrounding cells from the leaf of a xerophytic plant.

**Figure 2**



- (i) Explain how the cuticle reduces water loss.

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(1)



(ii) Explain how **one** of the other labelled parts reduces water loss.

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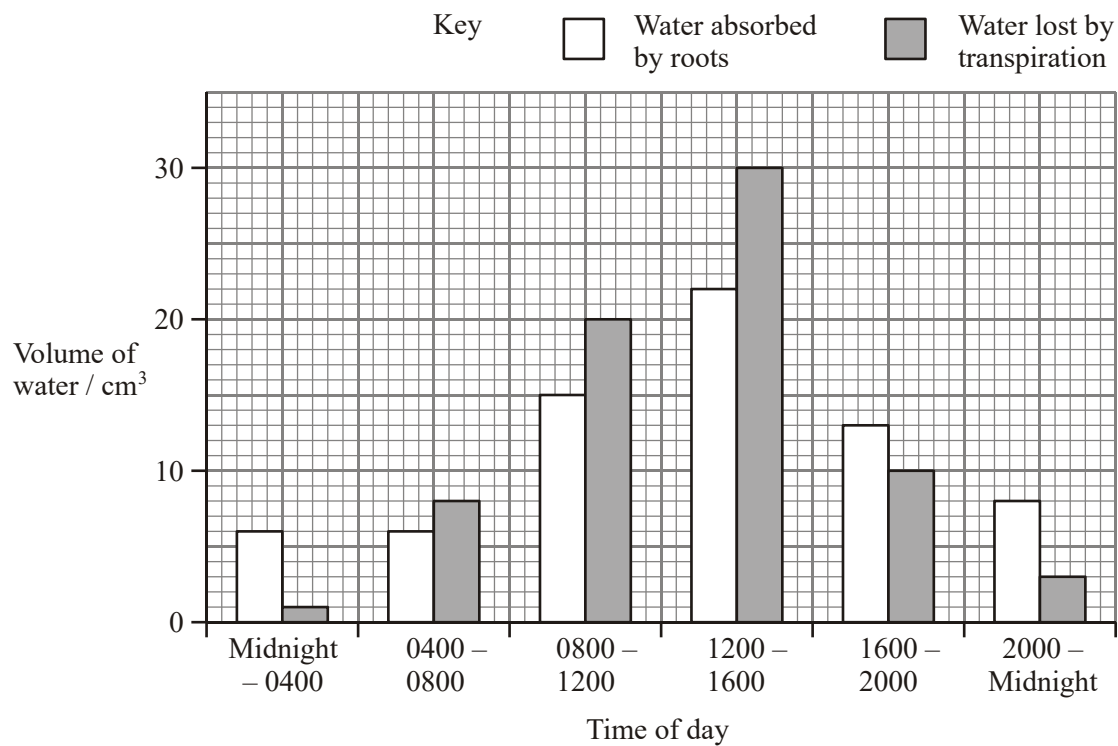
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(2)  
(Total 6 marks)

22. The volumes of water absorbed by the roots of a plant and lost by transpiration were measured over periods of 4 hours during one day. The bar chart shows the results.



- (a) (i) Describe the changes in the volumes of water absorbed and transpired between midnight and 1600.

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(2)

(ii) Explain these changes in the volumes.

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(2)

(b) Use your knowledge of the cohesion-tension theory to explain how water in the xylem in the roots moves up the stem.

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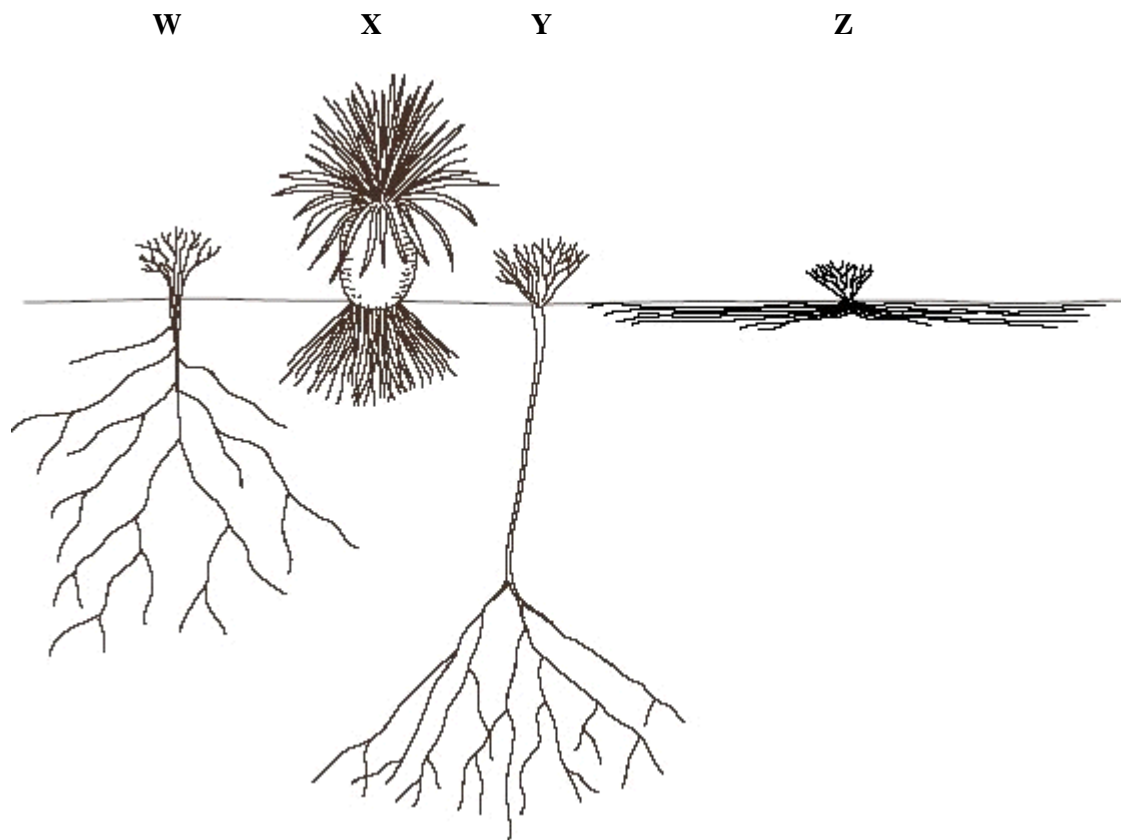
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(4)  
(Total 8 marks)

23. The drawing shows four common plants found in the Mojave Desert.



(a) Explain how **three** features of the plants shown in the drawing are adaptations to desert conditions.

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2 .....

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3 .....

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(3)

- (b) Resurrection plants can lose up to 95% of their water content without dying. They can survive for many years in this desiccated state and will revive within hours of rainfall. Suggest which of the plants **W** to **Z** is most likely to be a resurrection plant. Give a reason for your choice.

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(2)

(Total 5 marks)