IB · DP · Biology

3 hours 15 questions

Structured Questions: Paper 2

9.1 Transport in the Xylem of Plants

9.1.1 Transpiration in Plants / 9.1.2 The Transpiration Stream / 9.1.3 The Roots & Water Transport / 9.1.4 Adaptations of Xerophytes / 9.1.5 Skills: Drawing Xylem Vessels / 9.1.6 Skills: Experiments Investigating the Rate of Transpiration

Easy (5 questions)	/44
Medium (5 questions)	/44
Hard (5 questions)	/67
Total Marks	**/155**

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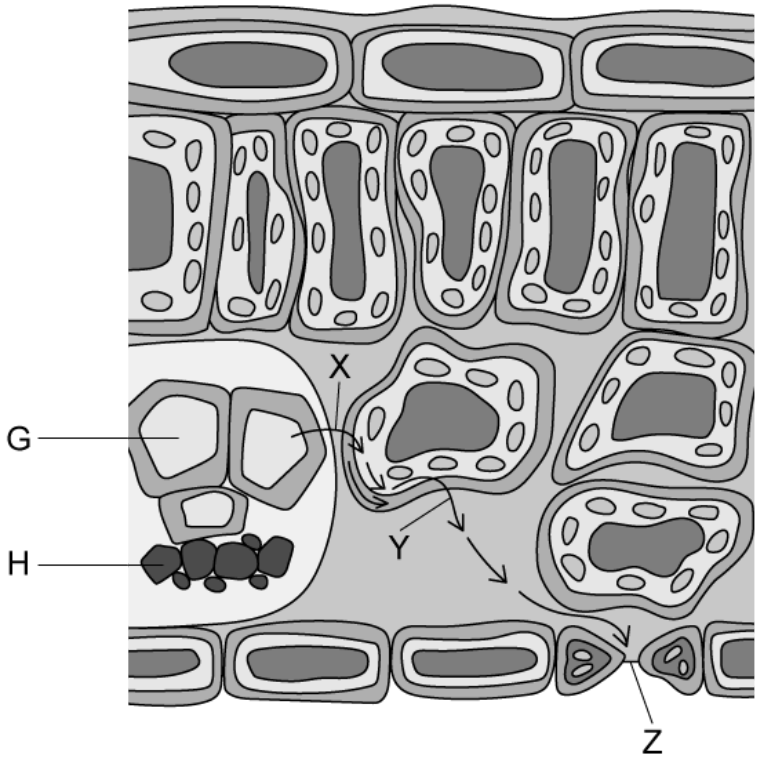
Easy Questions

1 (a) The image shows the cross section of a leaf.



Identify the substance which is represented by the arrows in the diagram.

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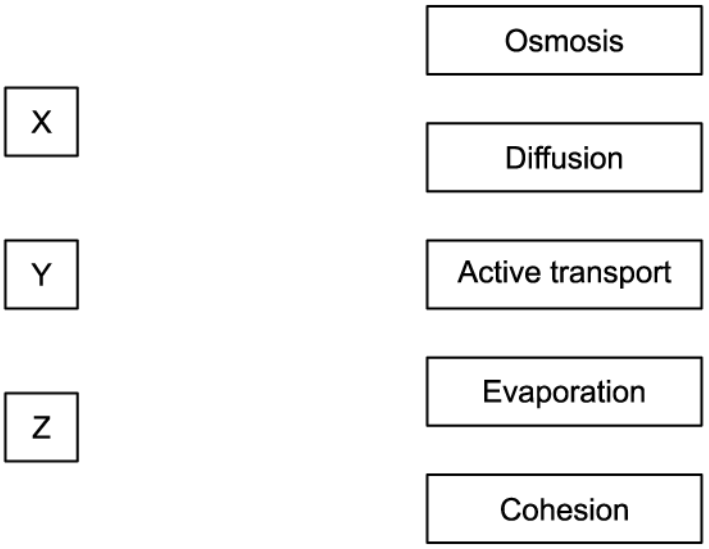
(1 mark)

(b) Draw three lines to correctly identify the method of particle movement shown in the diagram from part **a)**.



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(3 marks)

(c) (i) Identify the letters from the diagram in part a) that represents the xylem.

[1]

(ii) Describe **one** adaptation of the xylem which makes it suitable for its function.

[1]

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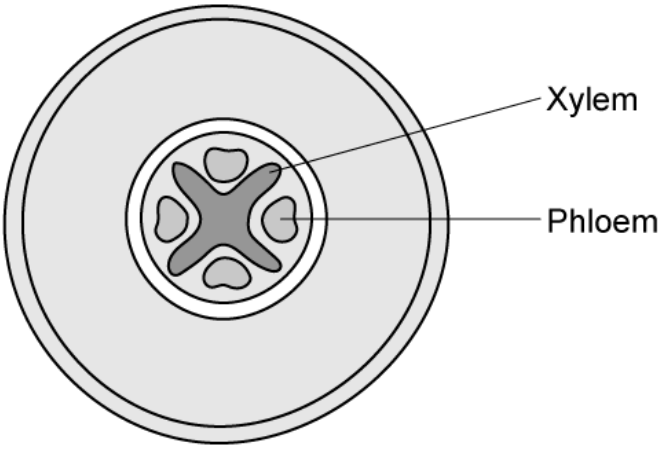
(2 marks)

(d) The diagram below represents a plant organ.



State the name of this organ.

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(1 mark)

2 (a) The transpiration stream relies on cohesion to maintain a continuous column of water in the xylem.

Define the meaning of the term 'cohesion'.

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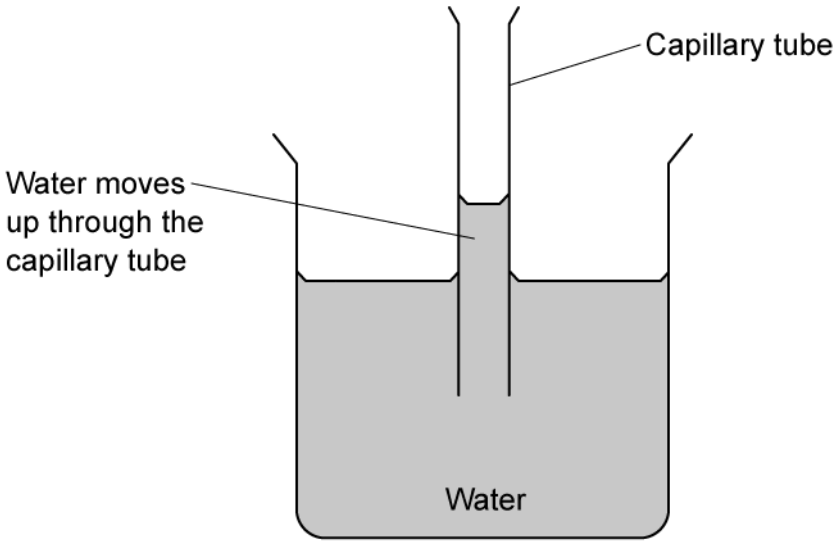
(1 mark)

(b) Capillarity is a term used to describe the movement of water through narrow diameter tubing, called capillary tubing, against the force of gravity. This phenomenon is represented by the image in the diagram.



In combination with the cohesion described at part **a)**, identify **one** other property of water which allows transport through the capillary tube.

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(1 mark)

(c) Capillary tubing, such as that shown in part **b),** can be used to model the process of transpiration.

State a reason for the use of models in science.

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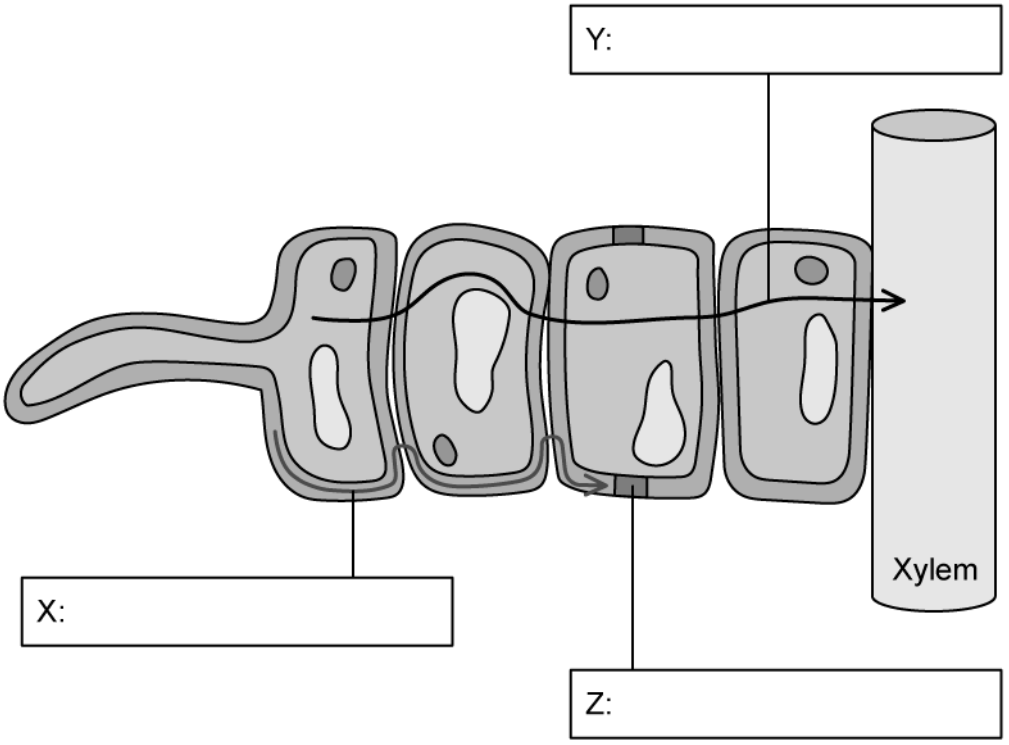
(1 mark)

3 (a) The image shows the movement of water through the cells in the root.



Label the diagram by adding the following to the correct parts:

- Apoplast pathway
- Symplast pathway
- Casparian strip

(3 marks)

(b) Explain the effect that the casparian strip have on the movement of water through the root.

(2 marks)

(c) Movement of water into the root occurs by osmosis.

Describe the process used by plant roots to ensure the osmolarity of the root cells is higher than the surrounding soil.

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(2 marks)

(d) Some plants develop mutualistic relationships with soil fungi.

Identify the key benefit to the fungus of this relationship with the plant.

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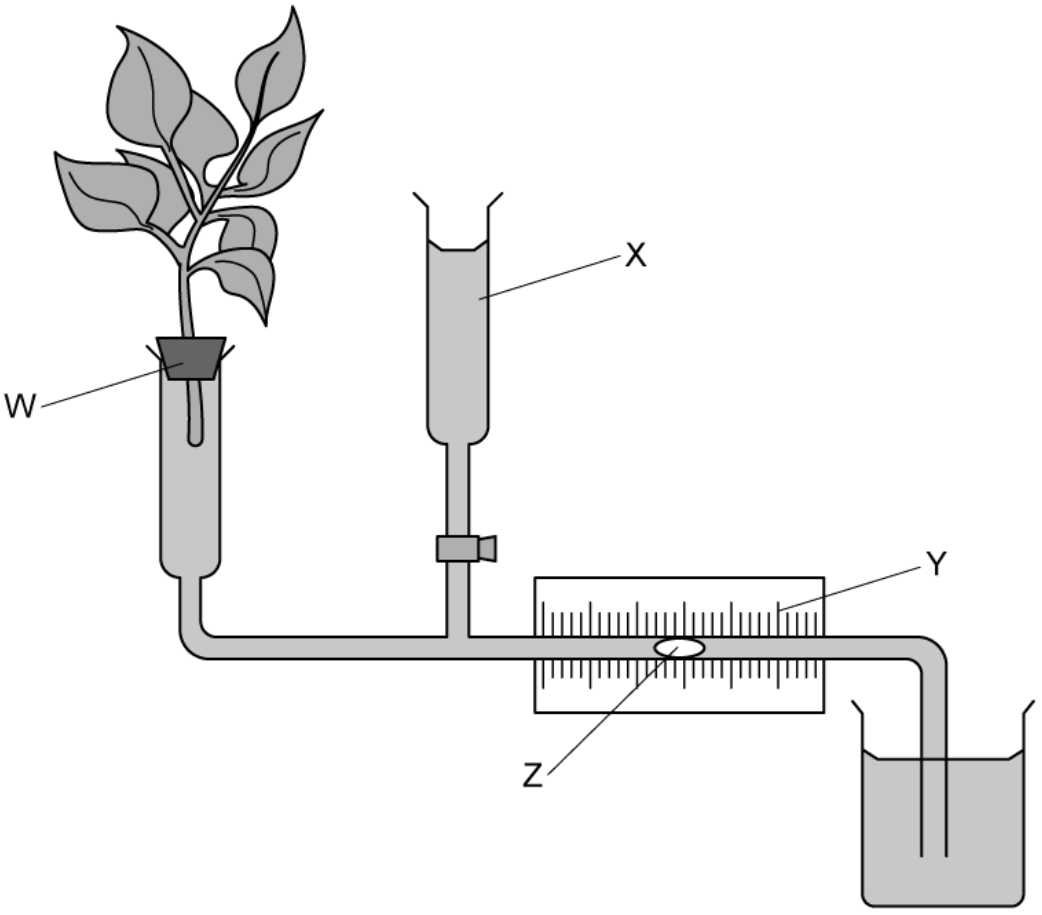
(1 mark)

4 (a) A bubble potometer can be used to investigate the rate of transpiration.

The diagram shows the apparatus required in a bubble potometer.



The table shows some of the functions of this apparatus.

Function	Letter
Used to measure the distance moved by the bubble in cm	
Prevents evaporation of water from the equipment	
Adds water to the equipment to reset the bubble	
Indicates the volume of water used in transpiration	

Complete the table with the letters which correctly represent the feature described.

(3 marks)

(b) Some students set up a potometer similar to the one in part **a)**, in a classroom at 20 °C with no air movement. Over the course of 25 minutes, they calculated that 7.5 mm^3 of water was lost through transpiration.

Calculate the rate of transpiration shown by the shoot, in **mm^3 hr^{-1}.**

(2 marks)

(c) To see the effect of different environmental factors on the rate of transpiration, the students adjusted the temperature, air movement, humidity and light intensity in the room.

Identify what the students would expect to happen to the rate of transpiration in the following scenarios, by completing the table below:

Scenario	Effect on transpiration (increase/decrease/no effect)
Increased the room temperature	
Turned on a fan	
Turned on a humidifier	
Surrounded the plant by lamps	

(4 marks)

(d) During the set up of the potometer shown in part **a)**, the plant stem was cut underneath water before being positioned in the equipment as shown.

Explain why is it necessary to cut the stem underneath the water for this investigation.

(2 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Draw a labelled diagram of the vascular system seen in the cross section of a plant stem.

(4 marks)

(b) Outline the features of xerophytes which make them adapted for living in areas where water is scarce.

(6 marks)

(c) Describe the route of water as it moves through a plant in the transpiration stream.

(5 marks)

Medium Questions

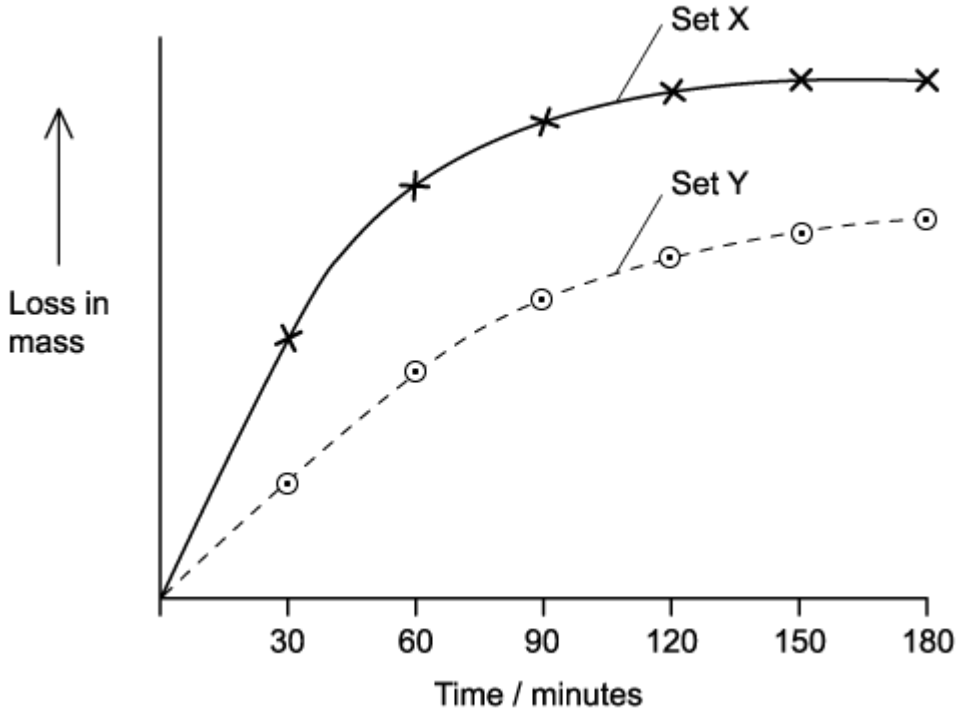
1 (a) Define the term *transpiration*.

.....

(1 mark)

(b) Holly is a common type of evergreen plant that can be found in British gardens. The leaves of holly bushes possess particularly thick waxy cuticles. A student investigated the rate of transpiration in holly leaves. They cut 10 leaves for set **X** and 10 leaves for set **Y**. The student then covered the leaves in set **Y** in petroleum jelly. After weighing each set of leaves, they attached the leaves in each set to a separate wire.The student then weighed each set of leaves at 30-minute intervals for a duration of 3 hours.

Their results are seen in the graph below.



Environmental conditions can affect the rate of transpiration in plants. State **two** environmental variables that should be controlled in this investigation.

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(2 marks)

(c) As seen in the graph in part b), between 90 minutes and 120 minutes the rate of transpiration begins to slow in both sets of leaves.

Explain why this happens.

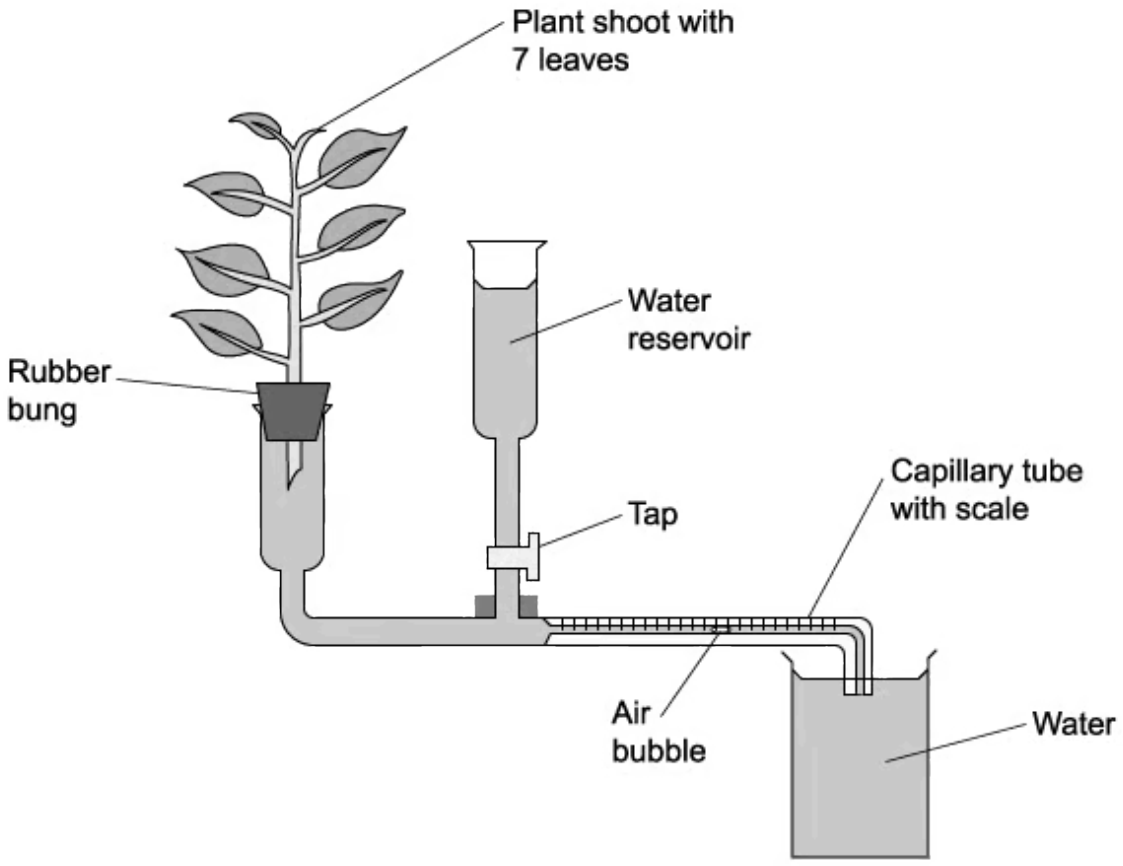
(3 marks)

(d) The results for the leaves in set **X** are different from the leaves in set **Y**.

Suggest an explanation for this.

(2 marks)

2 (a) A potometer can be used to investigate the water uptake of plants under different conditions. The diagram below shows how a student set up a potometer to investigate the rate of water uptake in a plant shoot.



When setting up the potometer one of the precautions the student took to ensure reliable measurements of water uptake was to dry off the leaves before taking any measurements.

Suggest a reason for this.

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(1 mark)

(b) Identify **two** other precautions the student should take when setting up the potometer apparatus to ensure they obtain reliable results.

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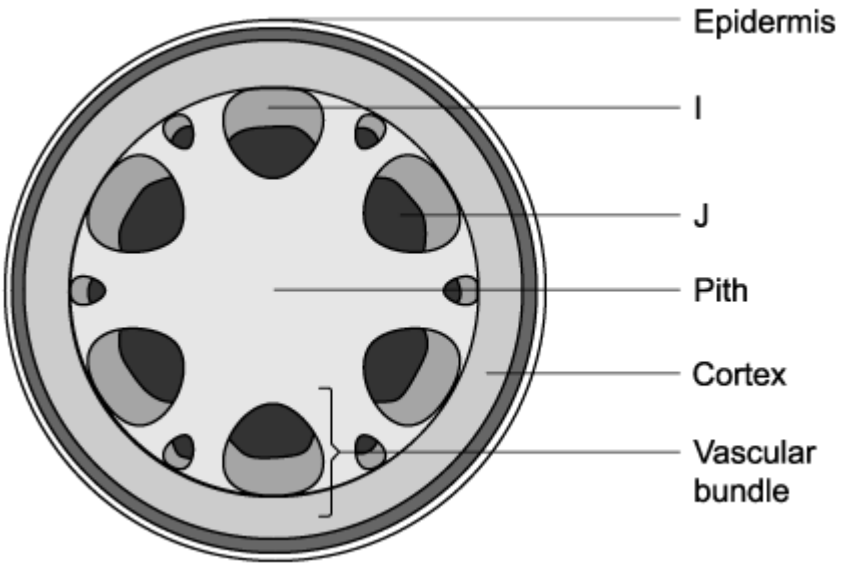
(2 marks)

(c) A potometer measures the water uptake of a plant in a given time.

Suggest **three** reasons why the measurements taken from a potometer do not represent the true rate of transpiration in a plant.

(3 marks)

3 (a) The diagram below shows a transverse section (TS) of a plant stem.



Identify the structure found at **J** and state its function.

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(2 marks)

(b) In xylem vessels, hydrogen bonds form between polar water molecules.

Describe the role that hydrogen bonding plays in the cohesion-tension theory of water transport in the xylem of plants.

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(3 marks)

(c) Marram grass is commonly found on sand dunes, an example of a dry environment where plants have evolved to survive.

Explain how marram grass leaves are adapted to minimise water loss.

(3 marks)

4 (a) Explain how a plant replaces the water it loses via transpiration.

(4 marks)

(b) Explain what is meant by the term *halophyte*.

(1 mark)

(c) Give **two** adaptations that a typical halophyte might have to help it survive in these conditions.

(2 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Describe how a porous pot can be used to model the evaporation of water that occurs from the leaves of a plant.

(3 marks)

(b) Angiosperms (commonly known as flowering plants) are a group of plants that have vascular tissue, whereas bryophytes (mosses, liverworts and hornworts) are a group of plants that lack vascular tissue.

Suggest some advantages of possessing vascular tissue.

(4 marks)

(c) Explain how minerals are absorbed into plant roots from the soil.

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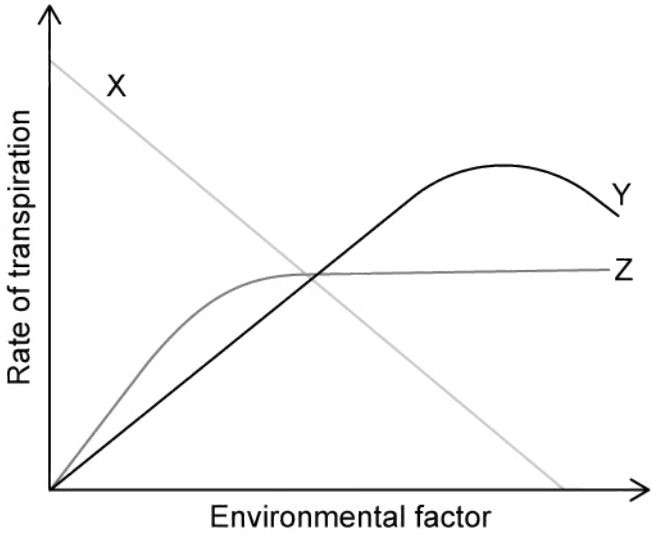
(8 marks)

Hard Questions

1 (a) The graph shows the effect of three different environmental factors on the rate of transpiration in a terrestrial plant.



(i) Identify which environmental conditions may be represented by the lines **X, Y** and **Z**.

X	
Y	
Z	

[3]

(ii) Explain the reasons for your choice.

[3]

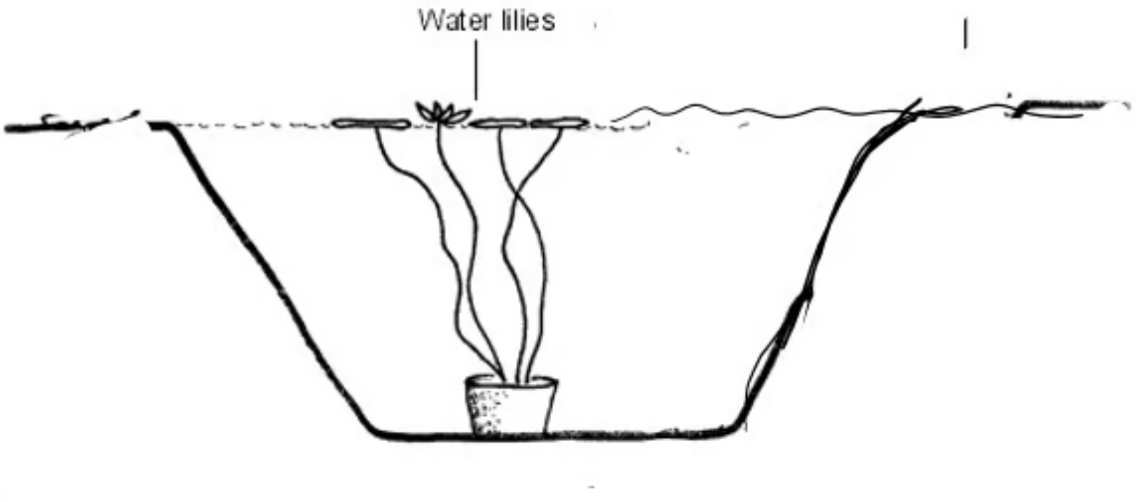
(6 marks)

(b) Explain why the trend shown by line **Y** in the graph at part **a)**, could result in decreased growth of a terrestrial plant.

(3 marks)

(c) Hydrophytes are aquatic plants which are adapted to living in very wet environments.

Water lilies are an example of a hydrophyte which has evolved to show higher rates of transpiration in order to support their growth in garden ponds.



Some adaptations of water lilies include the following:

- A thinner or absent waxy cuticle
- Stomata on the upper side of the leaf
- Large flat leaves

Use the image above and your knowledge of plant leaf structure and transpiration to explain how these adaptations may help to maximise the rate of transpiration in hydrophytes.

(3 marks)

(d) Terrestrial plants will often not survive if they are surrounded by water in the same way as the hydrophytes described in part **c)**. Flooding of crop fields has become a severe problem in the US with detrimental effects on the growth of crop plants such as potatoes and beans. Crops growing in flooded soil are unable to absorb sufficient amounts of water through their roots, leading to wilting of their leaves.

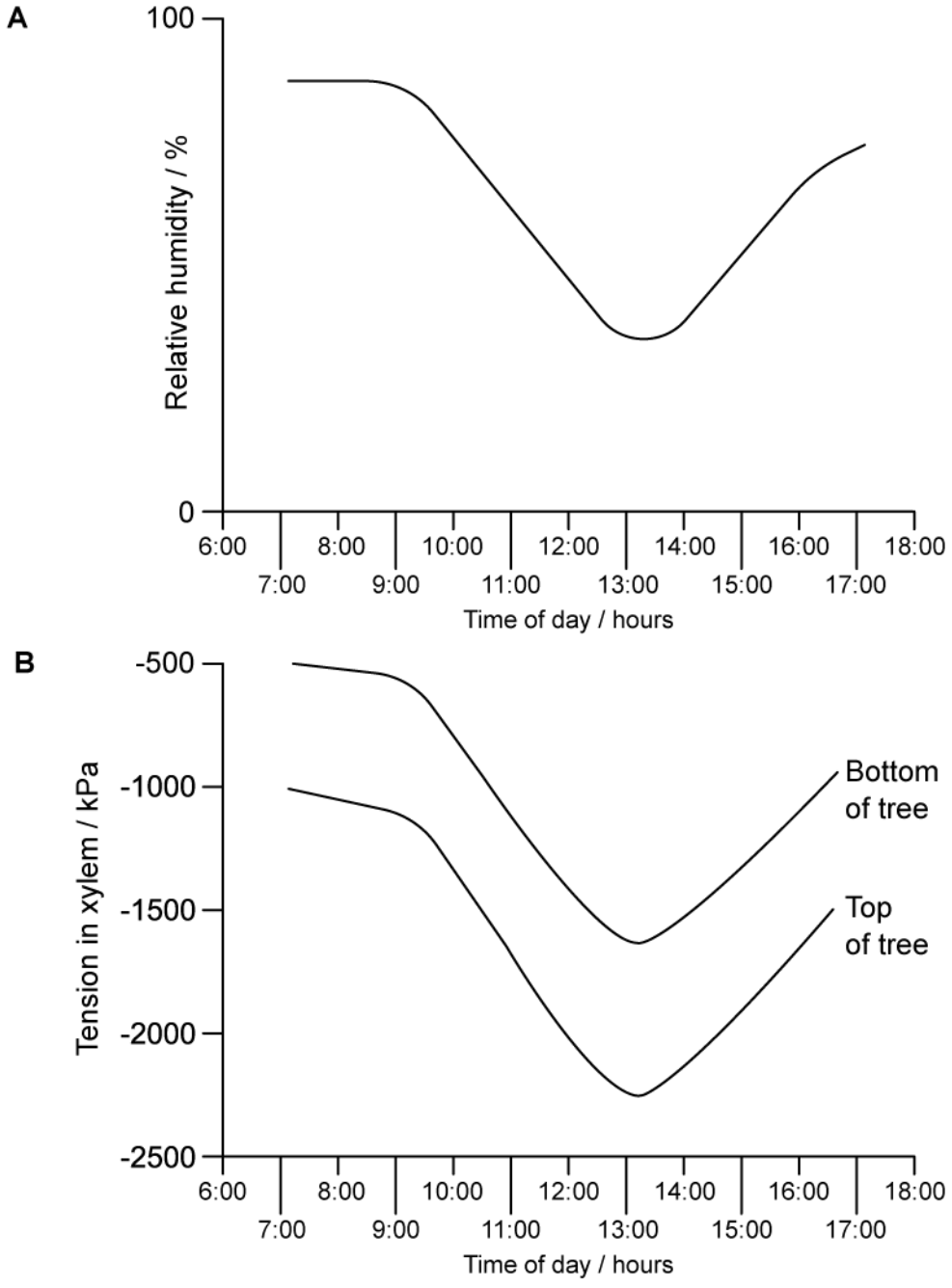
Explain why, in the event of a flood, the uptake of water into the root cells may be reduced.

(3 marks)

(e) Suggest what effect flooding may have on the rate of transpiration in crop plants.

(2 marks)

2 (a) The effect of humidity on the transpiration stream within the xylem of an oak tree was investigated, the results are displayed in the graphs below.



Describe how the trends shown in graph **A** compare with the trends shown in graph **B.**

(4 marks)

(b) Outline how the changes in humidity lead to the changes in water tension measured in the xylem at the top of the tree.

(4 marks)

(c) During the investigation, the scientist also measured the diameter of the tree trunk, the results can be seen in the table below:

Time	Circumference of the trunk (cm)
7:00	97.5
9:00	97.4
11:00	96.5
13:00	95.7
15:00	95.7
17:00	96.3
19:00	97.3
21:00	97.4
23:00	97.5

Explain how this data and the data in the graphs from part **a)** support the cohesion-tension theory.

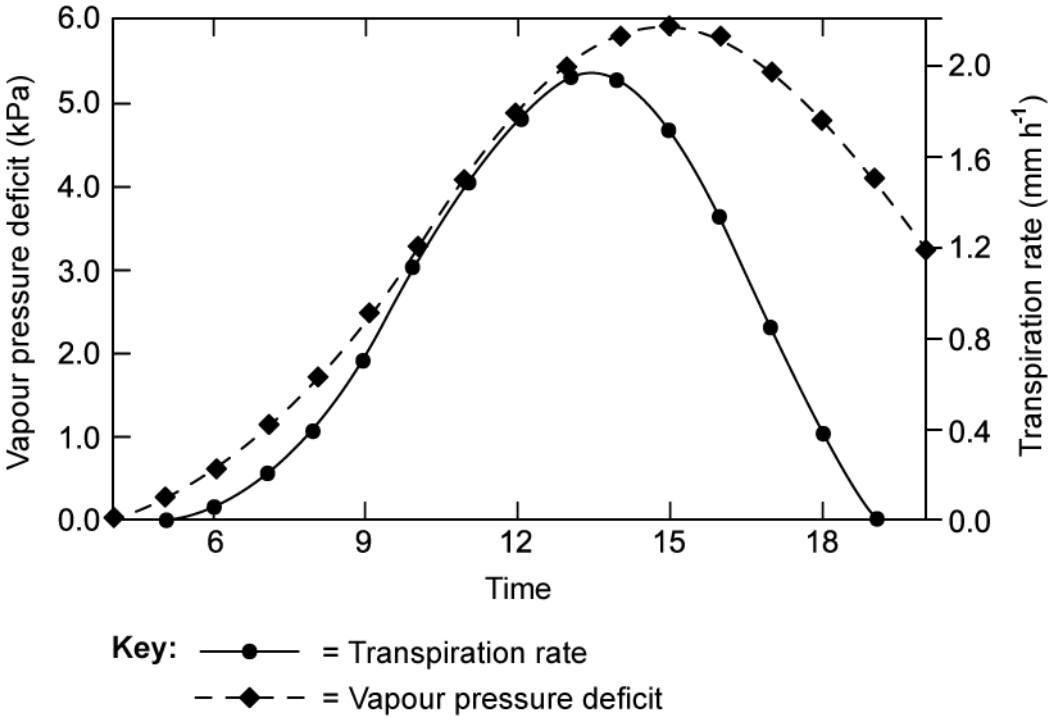
(4 marks)

(d) The scientist who carried out the investigation in part **a)** concluded from his data that water moves through the xylem through the cohesion tension mechanism.

Evaluate his conclusion based on the validity of the evidence provided by the results of this investigation.

(5 marks)

3 (a) The graph shows the relationship between vapour pressure deficit and the rate of transpiration in wheat plants.



Vapour pressure deficit (VPD) is the difference between the amount of moisture in the air and how much moisture the air can hold when its saturated.

Using this information, state whether a high vapour pressure deficit would indicate that air humidity was high or low.

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(1 mark)

(b) With reference to the data shown in the graph from part **a),** explain the effect that VPD has on transpiration of wheat between 6:00 and 12:00.

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(3 marks)

(c) Explain the pattern seen in the results from part **a)** between 13:00 and 18:00.

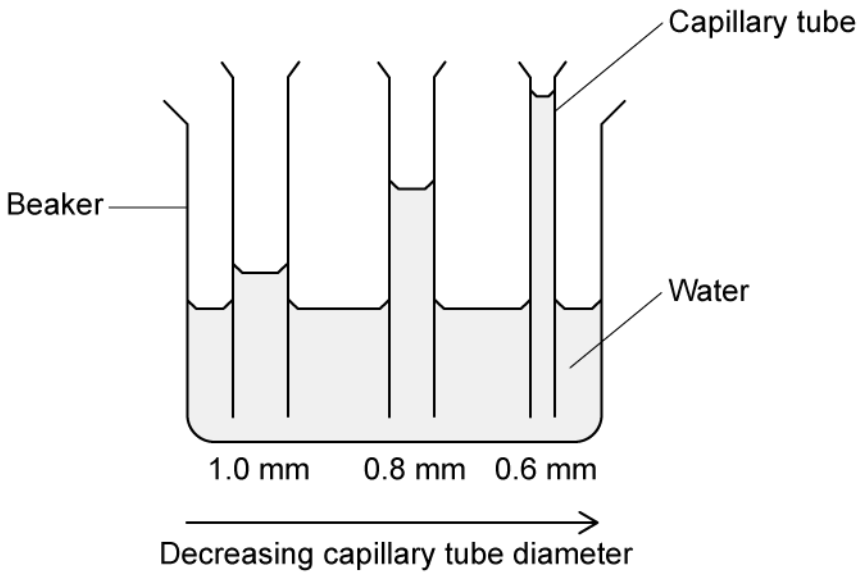
(2 marks)

(d) Suggest how information about vapour pressure deficit may be useful for growers of wheat plants.

(3 marks)

4 (a) Some students were investigating the effect of capillary tube diameter on the uptake of water by capillary action.

They set up three capillary tubes with diameters of 0.6 mm, 0.8 mm and 1.0 mm and measured the distance moved by water in 30 seconds. Their results can be seen below:



Explain the observations made by the students.

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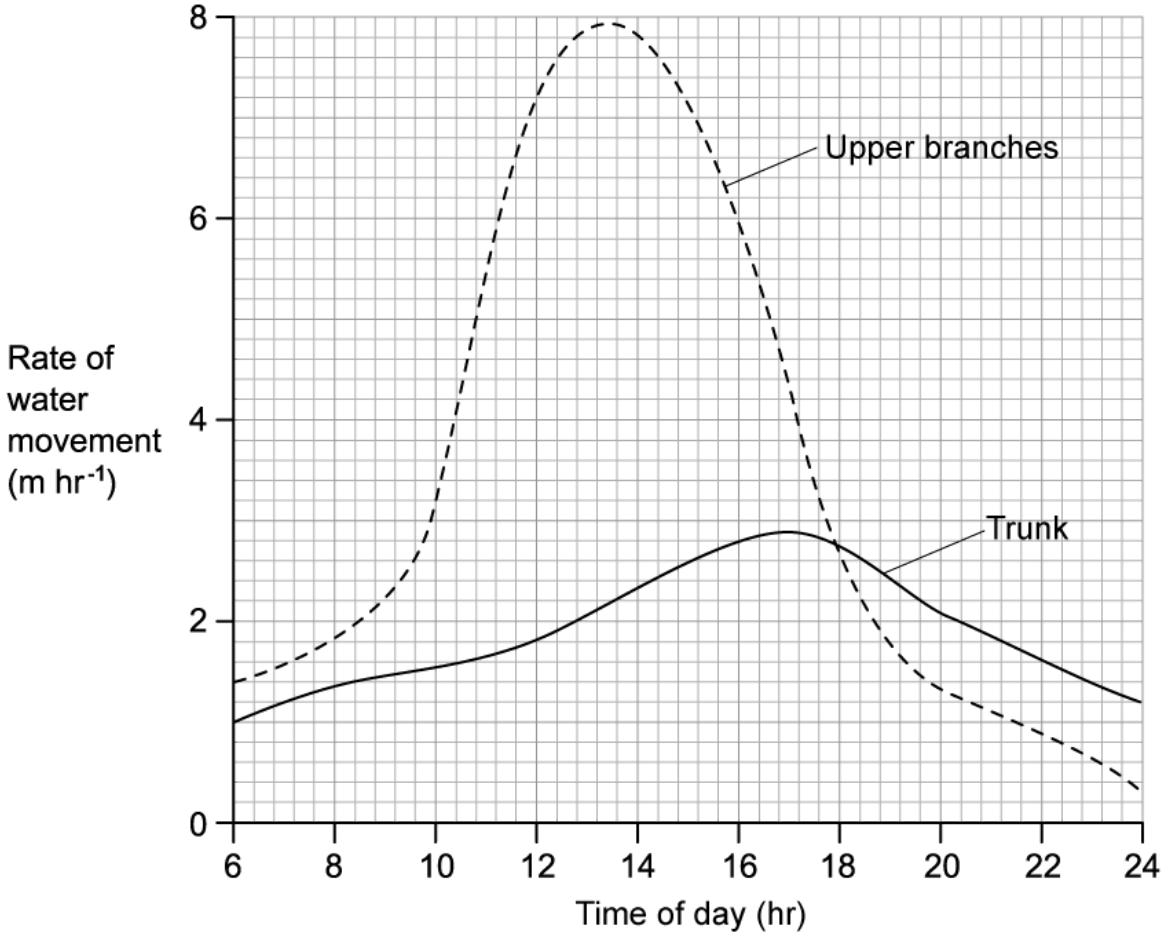
(2 marks)

(b) The graph shows the differences in water movement in the xylem of a tree. The measurements were taken in the branches at the top of the tree and in the trunk of the tree.



Using ideas illustrated by the capillary model in part **a)**, explain the results shown in the graph.

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(2 marks)

(c) Identify a limitation of using capillary tubing as a model to represent the movement of water through the xylem.

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(2 marks)

(d) The students set up a potometer with a 0.8 mm diameter capillary tube to measure the rate of transpiration in a branch removed from a tree. Over a period of 30 minutes, the students noted that the bubble moved 13.7 cm.

Calculate the rate of transpiration shown by the leaf in mm^3hr^{-1}. Use the equation πr^2 to calculate the area of a circle.

(3 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Describe the pressure changes which occur in the xylem as a result of water moving through the transpiration stream.

(4 marks)

(b) Compare and contrast the different adaptations of xerophytes and halophytes.

(7 marks)

(c) Outline the routes that water can take from the soil, through the root cortex to the xylem.

(4 marks)