Name:_____ Period:____

Plant Transport and Transpiration Problem Set

Answer all questions on the problem set prior to your test on plant transport and transpiration. This problem set is worth 25 points and is due the day of your test.

1 Which statement explains how mass flow arises in sieve tube elements?

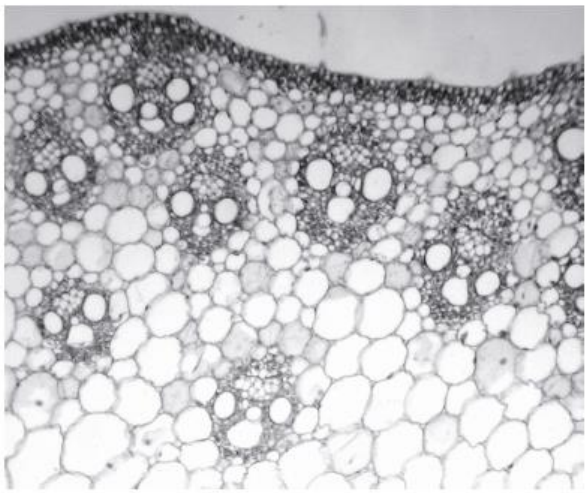
A Sucrose actively loaded into sieve tube elements decreases the water potential causing the hydrostatic pressure to increase.

B Sucrose actively loaded into sieve tube elements increases the water potential causing the hydrostatic pressure to decrease.

C Sucrose diffused into sieve tube elements decreases the water potential causing the hydrostatic pressure to increase.

D Sucrose diffused into sieve tube elements increases the water potential causing the hydrostatic pressure to decrease.

2 A student was asked to draw a plan diagram of the plant tissue shown in the photomicrograph and to annotate two observable features.



What are the correct annotations?

A epidermis darkly stained layer of cells, xylem hollow vessels

B epidermis formed of single layer of cells, xylem strengthened by lignin

C phloem small cells, xylem empty cells to transport water

D vascular bundles arranged in a regular pattern, xylem large dead cells

3 Which of the following are included in the apoplast pathway?

1 living components

2 plant vacuoles

3 cell walls

4 xylem vessels

A 3 only

B 1 and 2 only

C 3 and 4 only

D 1, 2 and 4 only

4 Which row identifies the tissue that contains the Casparian strip and the molecule forming this strip?

	tissue	molecule
A	cortex	lignin
B	endodermis	suberin
C	epidermis	cellulose
D	xylem	lignin

5 Which statement explains why the circumference (girth) of a tree is less in the middle of the day than at night?

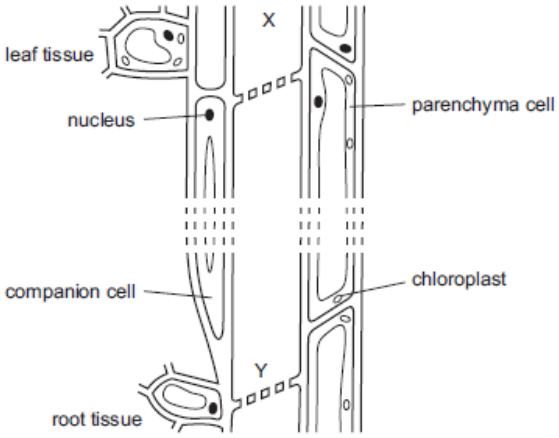
A Mineral uptake by the root hair cells decreases during the night because root pressure has decreased.

B Stomata close during the night and there is a build-up of water in the vascular tissue within the stem.

C The phloem sieve tubes fill with dissolved solutes because the translocation rate is reduced at night.

D There is less tension in the xylem vessels at night because the rate of transpiration is at a minimum.

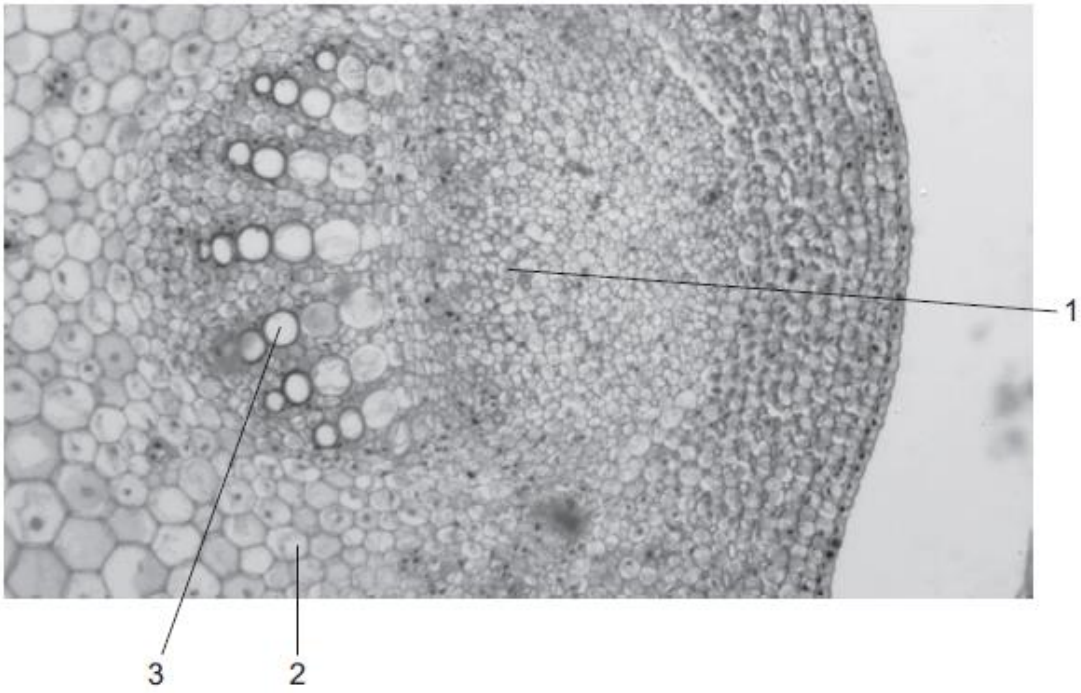
6 Sucrose is transported in solution in the phloem of plants. Transport takes place from sources to sinks. The process depends on differences in hydrostatic pressure between the sources and the sinks.



Which tissues are either a source or a sink and what is the hydrostatic pressure at X and Y within the phloem?

	tissue		hydrostatic pressure	
	leaf	root	high	low
A	sink	source	X	Y
B	sink	source	Y	X
C	source	sink	X	Y
D	source	sink	Y	X

7 The photomicrograph shows a vascular bundle.



Which describes the relationship of water potential in the labelled cells?

A cell 3 less negative than cell 1

B cell 2 less negative than cell 3

C cell 3 more negative than cells 1 and 2

D cells 1, 2 and 3 have the same water potential

8 Which processes are involved in transport in both phloem and xylem?

1 diffusion

2 mass flow

3 osmosis

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

9 Water that is present inside a root hair cell may leave the cell and pass to the xylem.

Through which pathway **must** the water travel?

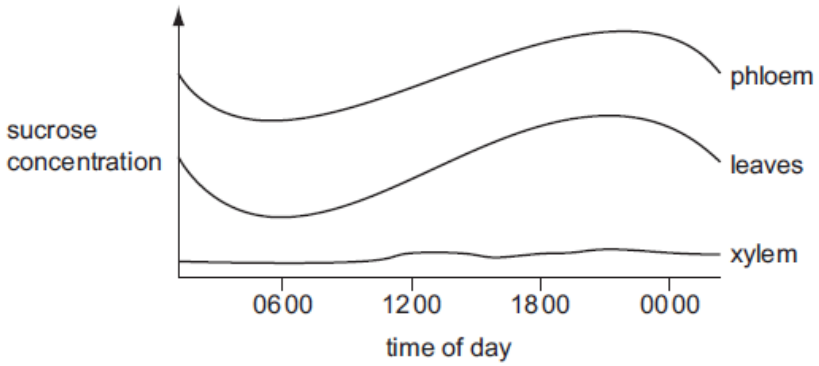
A apoplast

B plasmodesmata

C symplast

D vacuoles

10 The graph shows the results of measuring the concentration of sucrose in the xylem, phloem and leaves of a plant during 24 hours.



Which conclusion can be drawn from these results?

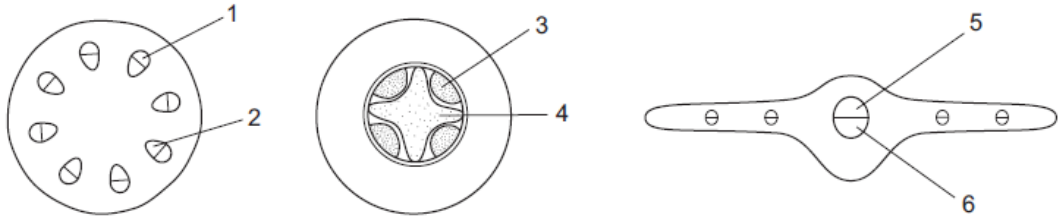
A Osmosis moves water from the xylem to the phloem.

B Sucrose is actively transported into the phloem from the leaves.

C Sucrose is moved in both directions in the phloem.

D Xylem tissue uses sucrose as a source of energy.

11 The diagrams represent the cross section of the stem, root and leaf of a non-woody dicotyledonous plant. In each section the distribution of the tissues is shown.



Which sequence of numbers correctly identifies the distribution of xylem and phloem in the stem, root and leaf?

	xylem			phloem		
A	1	3	5	2	4	6
B	1	4	6	2	4	5
C	2	3	6	1	3	5
D	2	4	5	1	3	6

12 What occurs in the sieve tube elements of a photosynthesising leaf and an actively growing root?

	sieve tube elements in leaf	sieve tube elements in root
A	water potential decreases	sugars are moved in
B	water potential decreases	sugars are moved out
C	water potential increases	sugars are moved in
D	water potential increases	sugars are moved out

13 Some soil-borne fungi cause wilting in crop plants by growing within the xylem vessels.

Which process will be directly affected by these fungi?

A cohesion between water molecules

B development of root pressure

C mass flow during translocation

D uptake of water by root hair cells

14 What occurs in the sieve tube elements of a photosynthesising leaf and an actively growing root?

	sieve tube elements in leaf	sieve tube elements in root
A	water potential decreases	sugars are moved in
B	water potential decreases	sugars are moved out
C	water potential increases	sugars are moved in
D	water potential increases	sugars are moved out

15 A plan diagram is made of a transverse section of a leaf.

Which features should be seen in the diagram?

1 the overall distribution of tissues

2 the relative thicknesses of the tissue layers

3 those cells which contain chloroplasts

A 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

16 Different substances, such as sucrose and amino acids, can move in different directions in the phloem sieve tubes.

Which statement explains this?

A Active transport occurs in some phloem sieve tubes and mass flow in other phloem sieve tubes.

B Both active transport and mass flow occur in each individual phloem sieve tube.

C Mass flow occurs in both directions at once in each individual phloem sieve tube.

D Mass flow occurs in different directions in different phloem sieve tubes at the same time.

15 Thale cress, *Arabidopsis thaliana*, is used to study the roles of genes and proteins in plants.

The cell membranes of the root hairs of *A. thaliana* contain proteins called aquaporins that allow the movement of water between the soil and the cytoplasm as shown in Fig. 2.1.

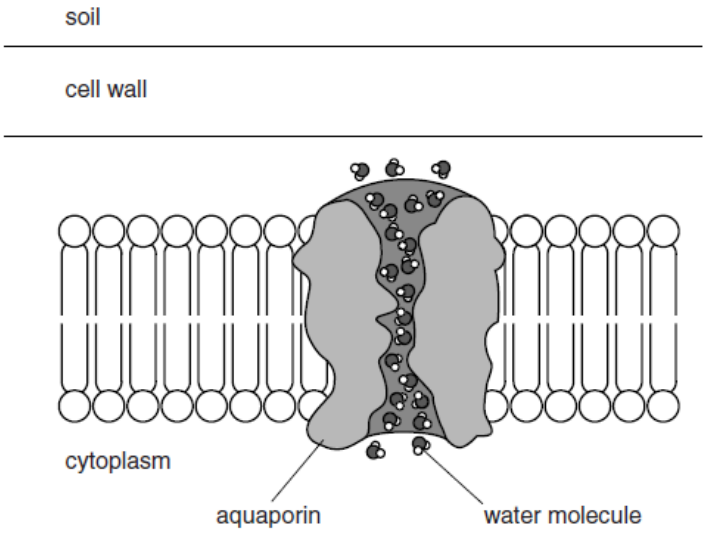


Fig. 2.1

(a) With reference to Fig. 2.1:

(i) explain how water is absorbed by root hairs of *A. thaliana*

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..... [3]

(ii) state why aquaporins are necessary in cell surface membranes.

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..... [1]

(b) Describe the pathway taken by water from the cytoplasm of the root hair cell to a xylem vessel in the centre of the root.

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An investigation was carried out to find the effect of an enzyme in *A. thaliana* on the composition of the cuticle. The enzyme is involved in the production of lipid that accumulates in the cuticle.

Plants were discovered with a mutation of the gene that codes for the enzyme.

Some of these mutant plants (Group **A**) were grown in pots and their rate of transpiration was determined over three days. They were compared with control plants (Group **B**) in which the gene was switched on and the enzyme present. The results are shown in Fig. 2.2.

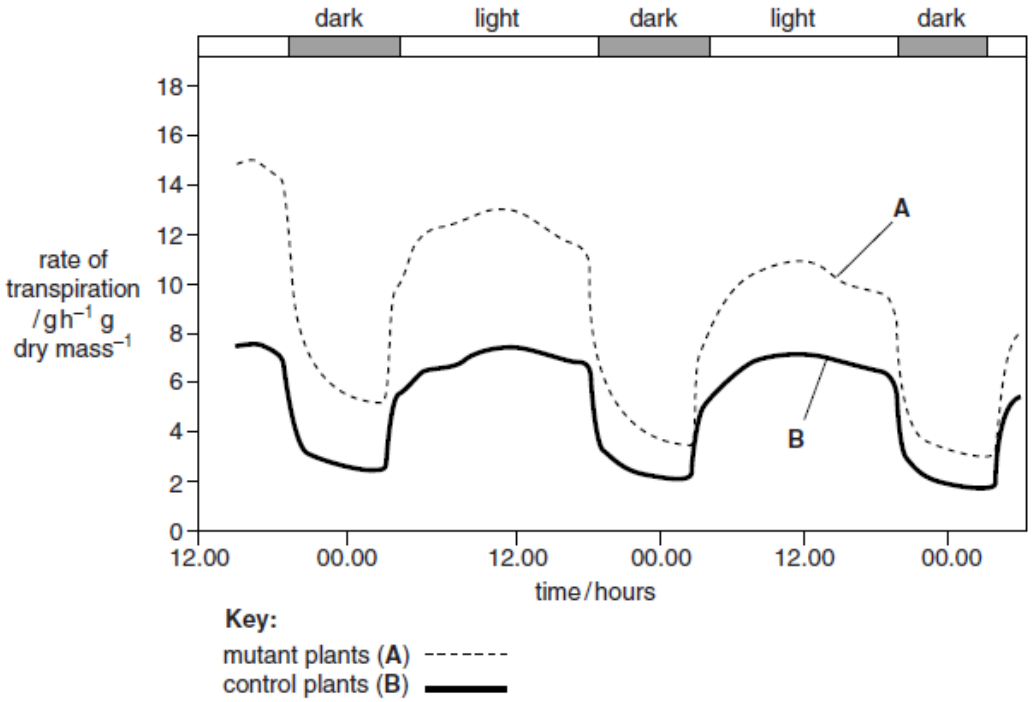

Fig. 2.2

(c) With reference to Fig. 2.2, explain:

(i) why the rate of transpiration is higher during the day than at night in both groups of plants

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..... [1]

(ii) how the results show that the cuticle is less effective in the mutant plants.

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..... [3]

[Total: 11]

16 Fig. 6.1 shows a phloem sieve tube element, its companion cell and a mesophyll cell in the leaf of a photosynthesising plant.

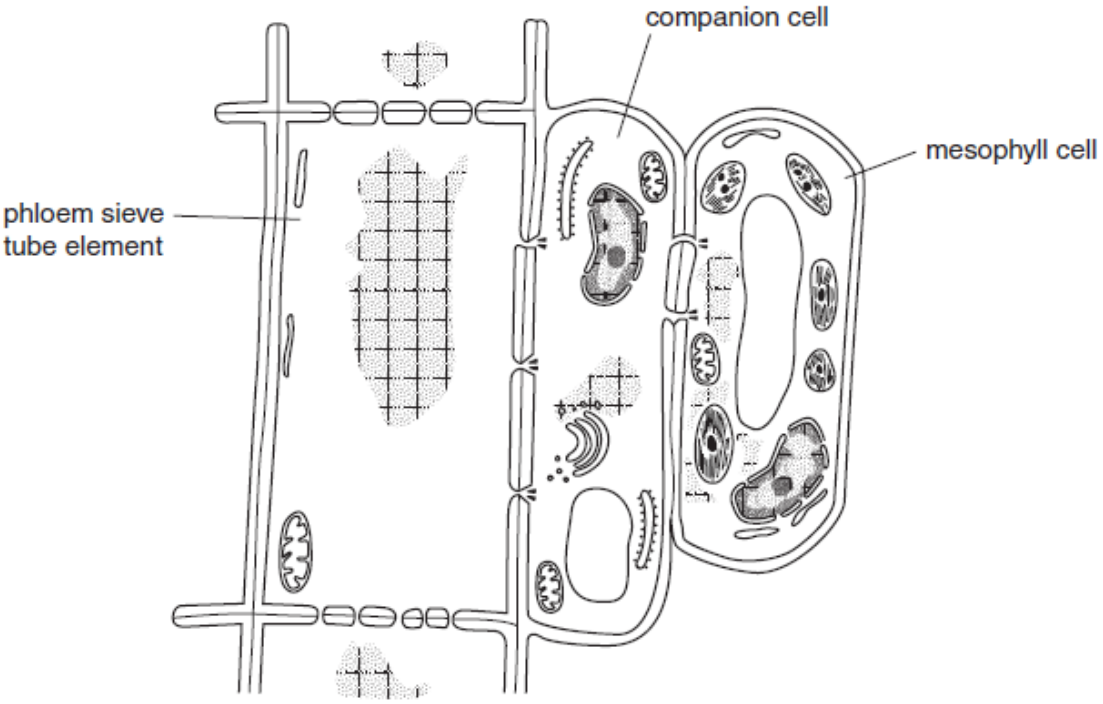

Fig. 6.1

(a) Use label lines and the letters **C** to **E** to identify the following on Fig. 6.1.

C – a structure involved in ribosome synthesis

D – an organelle that is involved in the modification and packaging of proteins

E – an organelle that is involved in aerobic respiration [3]

(b) The concentration of sucrose in the sap of the phloem sieve tube element is much higher than in the cytoplasm of the photosynthesising cell.

Describe **and** explain how sucrose is transported from the photosynthesising cell to the phloem sieve tube element.

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..... [4]

[Total: 7]

17 **(a)** Table 2.1 shows eight ions that are biologically important.

Table 2.1

ammonium (NH_4^+)	**A**
hydrogen (H^+)	**B**
hydrogen carbonate (HCO_3^-)	**C**
iron (Fe^{2+})	**D**
magnesium (Mg^{2+})	**E**
nitrate (NO_3^-)	**F**
phosphate (PO_4^{3-})	**G**
sulfate (SO_4^{2-})	**H**

Choose one ion to match each of the following statements. In each case write **one** letter from Table 2.1. You may use each letter (**A** to **H**) once, more than once or not at all.

(i) A component of polynucleotides.

.....[1]

(ii) Ion produced by enzyme activity inside red blood cells.

.....[1]

(iii) Ion used in the production of all amino acids in chloroplasts.

.....[1]

(iv) Ion that diffuses through carrier proteins with sucrose into companion cells in phloem tissue.

.....[1]

(v) Component of haem group in haemoglobin that binds oxygen.

.....[1]

(b) The enzyme nitrogenase is found in free-living and symbiotic nitrogen-fixing bacteria. Nitrogenase catalyses the reaction:

$$N_{2\,(g)} + 6\,e^- + 8H^+_{(aq)} \rightarrow 2NH_4^+{}_{(aq)}$$

Some nitrogenase enzymes have vanadium ions in their active sites; others have molybdenum ions.

Explain how the enzyme nitrogenase functions in the fixation of nitrogen.

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(c) Some pea plants were grown with their roots in a solution of mineral ions. The solution was kept aerated for three days.
The concentrations of five ions in the solution and in the root tissue were determined after the three days. The results are shown in Table 2.2.

Table 2.2

ion	concentration / mmol dm^{-3}	
	surrounding solution	root tissue
potassium (K^+)	1.0	75.0
magnesium (Mg^{2+})	0.3	3.5
calcium (Ca^{2+})	1.0	2.0
phosphate (PO_4^{3-})	1.0	21.1
sulfate (SO_4^{2-})	0.3	19.7

With reference to Table 2.2, suggest how cell surface membranes of root cells are responsible for the concentrations of ions in the roots compared to the surrounding solution.

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[Total: 14]

18 Fig. 6.1 shows the pathway taken by water as it enters the root of a flowering plant.

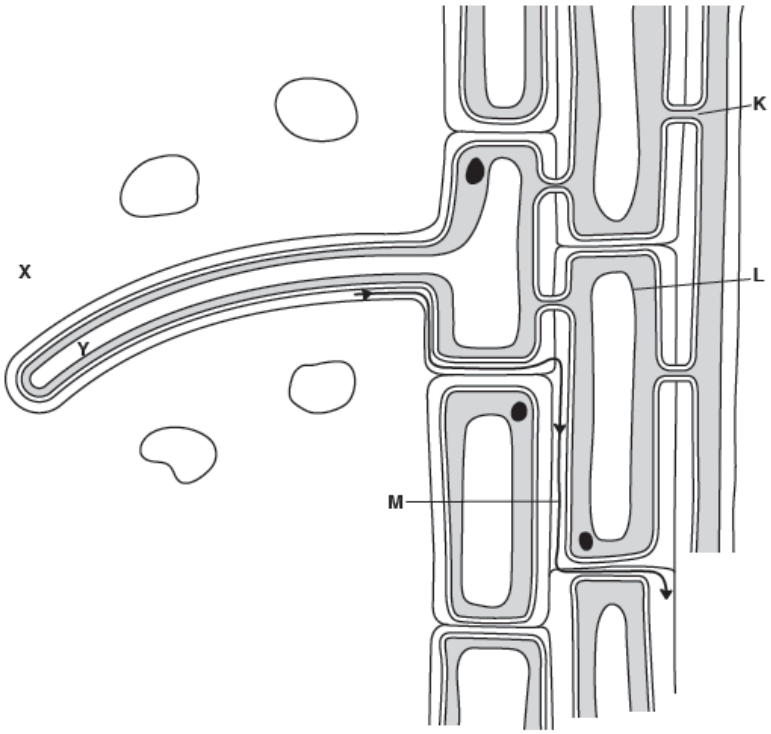

Fig. 6.1

(a) Explain how water passes from **X** to **Y**.

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..... [3]

(b) Name:

(i) the structures **K** and **L**

K .....

L .....

[2]

(ii) the pathway indicated by **M**.

.....[1]

[Total: 6]

19 **(a)** Explain what is meant by the term transpiration.

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.....[2]

The rates of transpiration of plants of two species, **A** and **B**, were measured over a period of seven hours. The results are shown in Fig. 4.1.

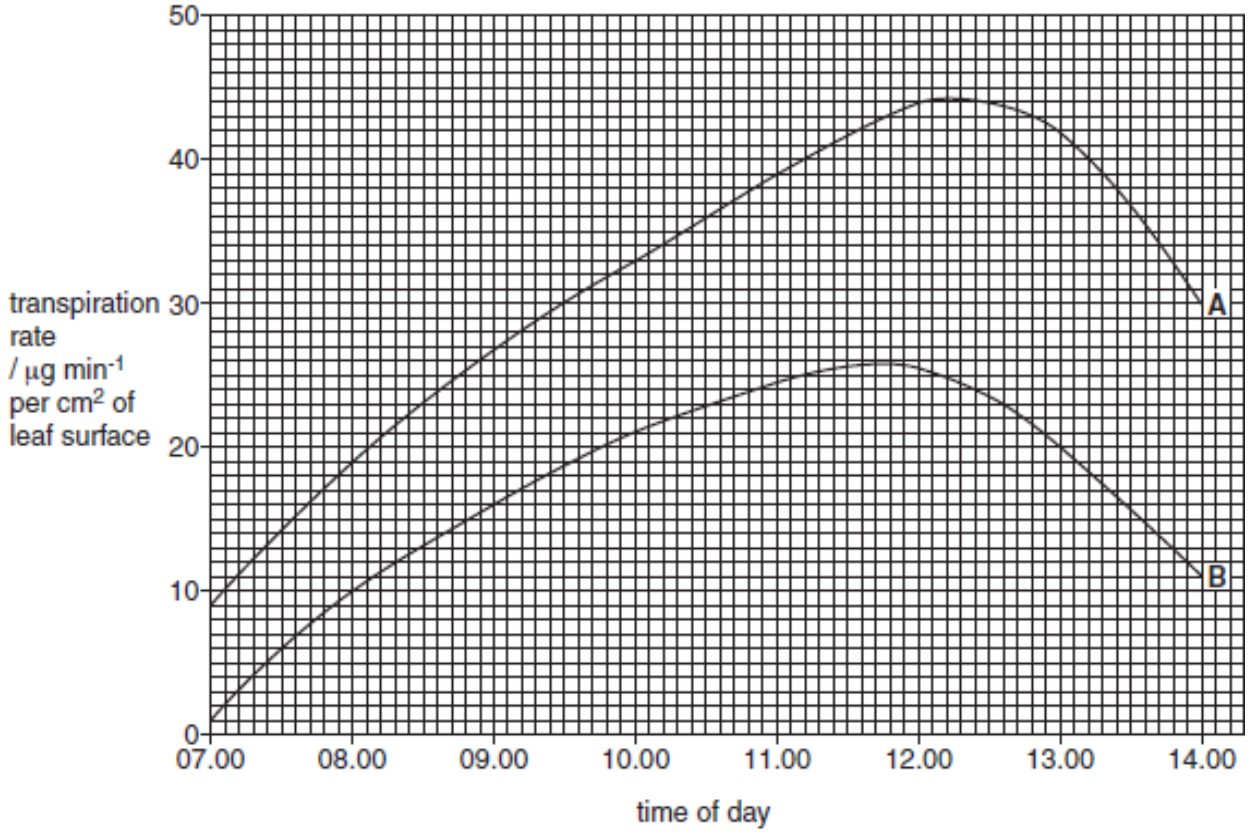

Fig. 4.1

(b) With reference to Fig. 4.1, compare the rates of transpiration of the two species over the seven hour period.

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.....[4]

(c) State two possible features of the **leaves** of species **B** that could explain the different rates of transpiration in comparison with species **A**.

Explain how each feature acts to reduce transpiration.

feature .....

explanation .....

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feature .....

explanation .....

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.....[4]

[Total: 10]

20

The enzyme sucrase is used by many organisms for the hydrolysis of sucrose. Fig. 3.1 shows a diagram of the enzyme and its substrate.

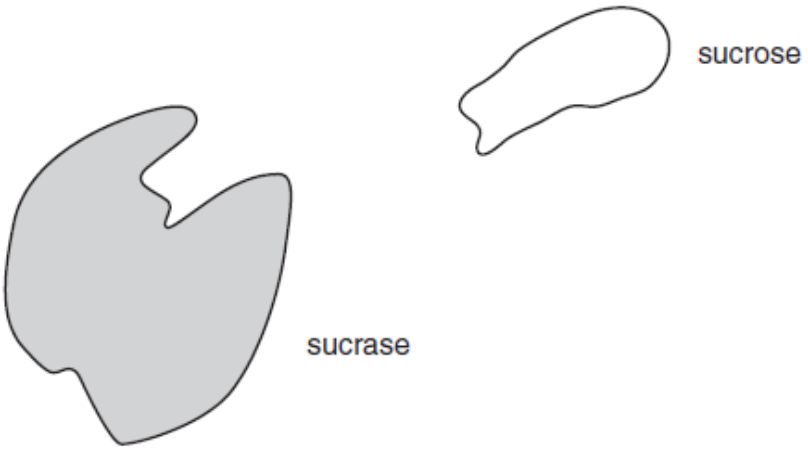

Fig. 3.1

(a) **(i)** State the names of the products of the hydrolysis of sucrose.

.....[1]

(ii) With reference to Fig. 3.1, describe the mechanism of action of the enzyme in converting the substrate to products.

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..... [4]

(iii) Copper ions (Cu^{2+}) will inhibit the enzyme sucrase.
Suggest which type of inhibition occurs.

..... [1]

(b) Sucrose is one of the assimilates transported in the phloem sieve tubes of plants from source to sink. Sucrase is found in sinks.

(i) Suggest the role played by sucrase in the process of unloading of sucrose at sinks.

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(ii) Plant sink organs convert excess products of sucrose hydrolysis to storage molecules, such as starch.

Explain why these products of hydrolysis themselves cannot be stored in plant tissue.

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..... [3]

[Total: 11]