1 **(a)** Transpiration is the loss of water vapour from the aerial parts of a plant.

(i) Name the pores through which most water vapour is lost from a leaf.

..... **[1]**

(ii) Describe how the guard cells surrounding the leaf pores are adapted to their role.

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..... **[2]**

(iii) Name **one** other part of the leaf from which water may be lost.

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..... **[1]**

(b) Water lost from the leaf must be replaced with water from the xylem.

Complete the following passage about movement of water from the xylem to the cells of the leaf using the most appropriate terms.

When water is lost from the cells of the leaf it reduces the .....

in those cells. As a result, water enters the cells by ..... .

This process occurs across the plasma membrane which is ..... .

If all the water lost from the leaf cells is not replaced, they lose .....

and the leaf may wilt. **[4]**

(c) The cohesion-tension theory is often used to explain the mechanism by which water moves up the xylem from the roots to the leaves.

Use this theory to explain how water moves from the roots to the leaves.

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..... **[3]**

[Total: 11]

2 Plants transport water and assimilates through specialised tissues.

(a) Fig. 4.1 shows a tissue plan of a vertical section through part of a leaf.

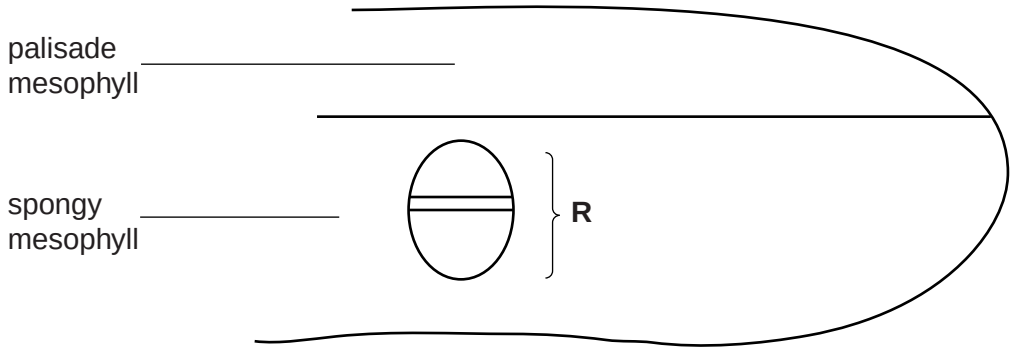

Fig. 4.1

(i) **On Fig. 4.1**, identify with a letter **X** the position of the xylem **and** identify with a letter **P** the position of the phloem.

The answer to this question should be drawn on Fig. 4.1. **[1]**

(ii) Name structure **R**.

..... **[1]**

(b) The majority of cells in phloem tissue are either companion cells or sieve tube elements.

A scientist isolated companion cells and conducted some experiments to investigate the mechanism involved in loading sucrose into the sieve tubes.

He recorded the following observations:

observation 1 isolated companion cells became slightly negatively charged compared with their surroundings

observation 2 companion cells could decrease the pH of the surrounding solution from 7.0 to 5.6

observation 3 the pH inside the companion cells rose from 7.0 to 8.2

observation 4 treatment with cyanide (which stops aerobic respiration) prevents the change in pH occurring

From **observation 1**, the scientist concluded that the mechanism involved a transfer of charged particles (ions) between the companion cells and their surroundings.

(i) What conclusions can be drawn from **observations 2 and 3** about the mechanism?

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..... **[2]**

(ii) What conclusions can be drawn from **observation 4** about the mechanism?

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..... **[1]**

(c) The scientist drew a diagram to explain the mechanism used to load sucrose into the sieve tube elements.

His diagram is shown in Fig. 4.2.

A
charged particles are removed from the companion cells

B
co-transport of charged particles and sucrose into the companion cells

C
sucrose moves into the sieve tube elements

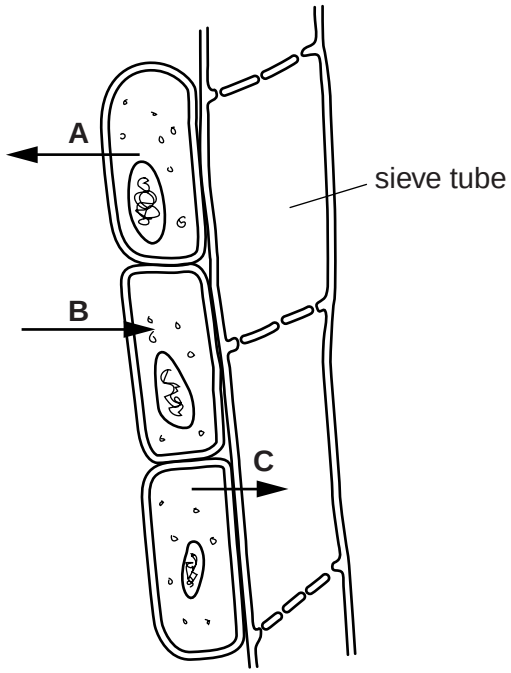

Fig. 4.2

(i) The following paragraph is an extract from the scientist's work.

Complete the paragraph.

At step **A**, charged particles are moved out of the companion cells by the process of ..... . This creates a ..... gradient between the companion cell and its surroundings. At step **B**, the charged particles and assimilates are co-transported by ..... diffusion into the companion cells. The assimilates build up in the companion cells and move by ..... into the sieve tube elements at step **C**. Assimilates, such as sucrose and ..... , can be loaded in this way. **[5]**

(ii) The structure of cells is usually adapted to carry out their functions.

The scientist used an electron microscope to look for further evidence to support the mechanism involved in loading sucrose into the sieve tubes.

Suggest what evidence the scientist might expect to see in companion cells, using an electron microscope.

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..... **[2]**

[Total: 12]

3 **(a)** Distinguish between the term *transpiration* and the *transpiration stream*.

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..... **[3]**

(b) Xerophytes are plants that are adapted to living in dry conditions.

The lists below describe four general features of leaves. From each list, select the leaf that belongs to a xerophyte.

Place a tick (✓) in the correct box. The first one has been done for you.

Presence of hairs on leaves

Leaf **A**	no	
Leaf **B**	yes	✓
Leaf **C**	no	

Mean number of stomata (cm^{-2})

Leaf **D**	30 000	
Leaf **E**	23 000	
Leaf **F**	13 000	

Mean surface area of one leaf (cm^2)

Leaf **G**	0.2	
Leaf **H**	10.0	
Leaf **I**	23.0	

Thickness of cuticle (μm)

Leaf **J**	4.25	
Leaf **K**	8.50	
Leaf **L**	2.00	

[3]

(c) The transport system of multicellular plants consists of xylem and phloem tissue.

The table below contrasts the structure and roles of xylem and phloem.

Complete the table using the most appropriate word or words.

Xylem	Phloem
xylem transports water and	phloem transports assimilates such as .....
 	sieve tubes contain perforated cross walls
xylem vessel walls are impregnated with	sieve tube walls have no additional support
xylem vessel walls contain ..... that allow water to pass into adjacent vessels	there are many gaps in the cell walls between companion cells and sieve tube elements called .....

[4]

[Total: 10]

4 **(a)** A student used a potometer to investigate the effect of leaf area on the rate of transpiration.

This apparatus is shown in Fig. 4.1.

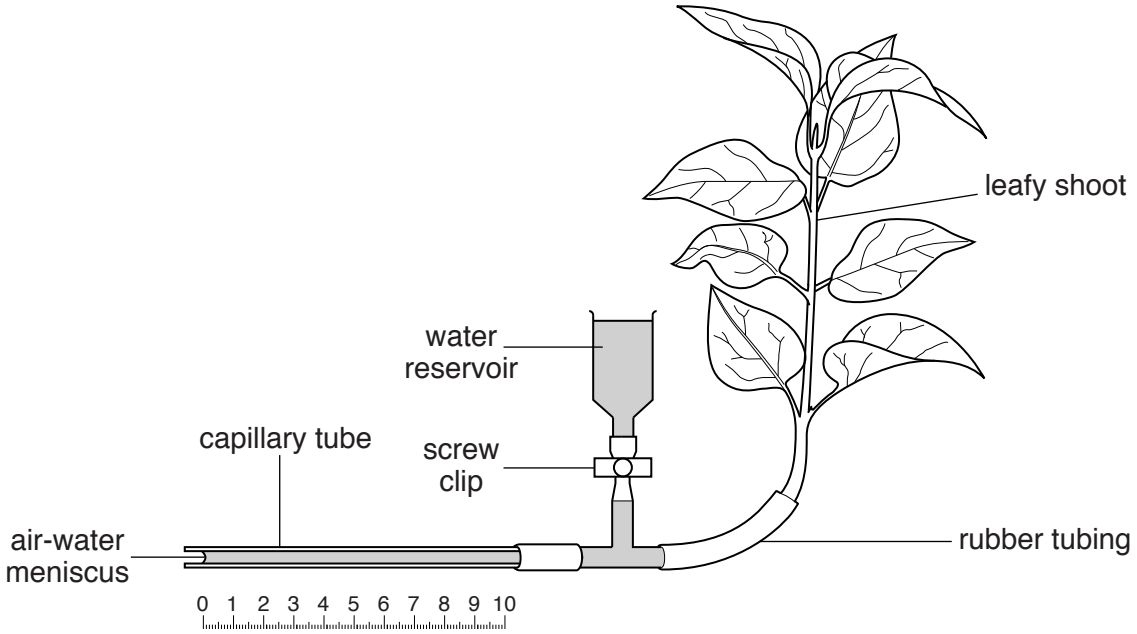

Fig. 4.1

The student presented the results of their investigation in a table, as shown below.

Number of leaves present on shoot attached to potometer	Mean rate of bubble movement
0	7
2	28
4	49
6	73
8	92

Table 4.1

(i) State what information the student has **not** included in their table of results.

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..... **[2]**

(ii) Describe **and** explain the data shown by the student's results.

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..... **[3]**

(b) As part of the evaluation of the investigation, the student wrote the following statements:

1 One limitation is that the leaves were not all the same size.

2 I assembled the potometer under water and the leaves got wet.

3 During my investigation the sun came out and the lab warmed up very quickly.

For each statement, explain why this may affect the results **and** suggest how the student could improve the investigation.

Statement 1

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Statement 2

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Statement 3

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[6]

[Total: 11]

5 Fig. 6.1 shows an aphid feeding from a plant stem. The aphid feeds by inserting its tube-like mouthparts into the tissue that transports sugar solution. Some details of this transport tissue are shown in the vertical section.

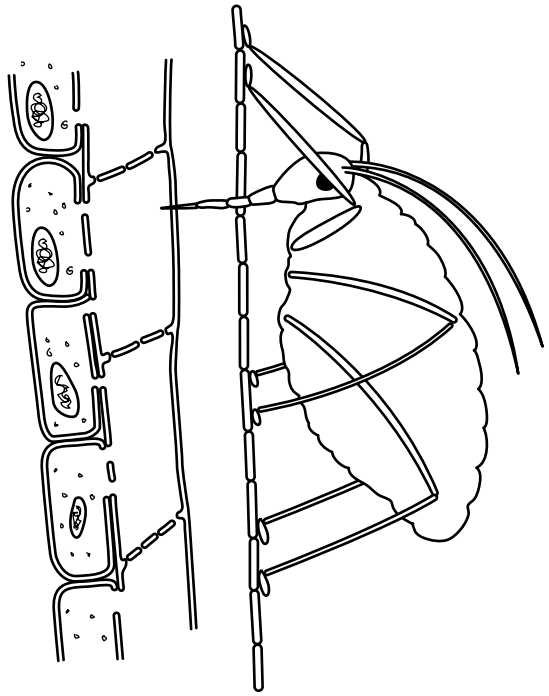

Fig. 6.1

(a) (i) Name the sugar most commonly transported through the stem of a plant **and** the tissue that transports this sugar.

sugar .....

tissue ..... **[1]**

(ii) Sugar molecules are actively loaded into the transport tissue.

Describe how active loading takes place.

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..... **[3]**

(b) A classic experiment investigated the effect of temperature on the rate of sugar transport in a potted plant.

Aphid mouthparts were used to take samples of sugar solution from the transport tissue in the stem. The sugary solution dripped from the mouthparts. The number of drips per minute was counted.

The procedure was repeated at different temperatures.

Table 6.1 shows the results obtained.

Table 6.1

temperature (°C)	number of drips per minute
5	3
10	6
20	14
30	26
40	19
50	0

Suggest brief explanations for these results.

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..... **[3]**

[Total: 7]

6 **(a)** A student used a potometer to investigate the effect of light intensity on the rate of transpiration in a healthy leafy shoot.

The results obtained are shown in Table 5.1.

Table 5.1

light intensity in arbitrary units (a.u.)	rate of transpiration (mm min^{-1})			
	trial 1	trial 2	trial 3	mean
10	5.0	7.0	5.0	5.7
20	5.0	7.0	5.0	5.7
30	12.0	12.0	11.0	11.7
40	24.0	23.0	26.0	24.3
50	32.0	33.0	32.0	32.3

(i) Describe the trend shown in the mean rate of transpiration as light intensity increases from 20 to 50 a.u.

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..... **[2]**

(ii) Suggest why the rate of transpiration did not change between light intensities 10 a.u. and 20 a.u.

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..... **[1]**

(b) **(i)** Explain why transpiration is unavoidable during the day.

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..... **[3]**

(ii) Fig. 5.1, **on the insert**, is a photograph of a transverse section of a leaf taken from a xerophyte.

Describe the xerophytic features of this leaf **and** explain how each feature reduces loss of water vapour.

In your answer you should use appropriate technical terms, spelt correctly.

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..... **[5]**

[Total: 11]