Civics Group	Index Number	Name (use BLOCK LETTERS)

H2

ST. ANDREW'S JUNIOR COLLEGE
2023 JC2 PRELIMINARY EXAMINATION

H2 BIOLOGY **9744/04**

Paper 4: Practical Exam

Tuesday 22 August 2023 2 hours 30 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and index number on all the work you hand in.
Give details of the practical shift and laboratory, where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use a HB pencil for any diagram, graph or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions in in the spaces provided on the Question paper.

The use of an approved scientific calculator is expected, where appropriate. You may lose marks if you do not show your working or if you do not use appropriate units.

The number of marks is given in brackets [ ] at the end of each question or part question.

IMPORTANT INFORMATION TO CANDIDATES:

Candidates with access to **microscope** at the start of the paper are given the **first 1h 15 min** to use them. Please answer **QUESTION 3** within this time frame. Once you have finished working with the microscope, you can move on to **QUESTION 1 or 2**.

Candidates with no access to microscope at the start of the paper should proceed with **QUESTION 1 or 2** first. You will be given access to the microscope at **1h 15 min after the start of the paper**.

Shift
Laboratory

For Examiner's Use	
1	/ 25
2	/ 12
3	/ 18
Total	**/ 55**

This document consists of **21** printed pages.

[Turn over

1 You will investigate the water potential of potato cells.

When pieces of potato are put into a sucrose solution, water will move by osmosis into and out of the potato cells. The overall direction of water movement depends on the difference between the water potential of the potato cells and the water potential of the sucrose solution.

- If the overall movement of water is out of the potato cells, the sucrose solution will become less concentrated.
- If the overall movement of water is into the potato cells, the sucrose solution will become more concentrated.

Fig. 1.1 shows how the change in concentration of the sucrose solution after 15 minutes can be assessed. A blue dye is added to the sucrose solution around the potato pieces at the end of the 15 minutes. The blue dye does not affect the concentration of the sucrose solution. After mixing, a drop of the blue sucrose solution is added to the original sucrose solution in a separate test-tube.

The movement of the blue drop is then observed.

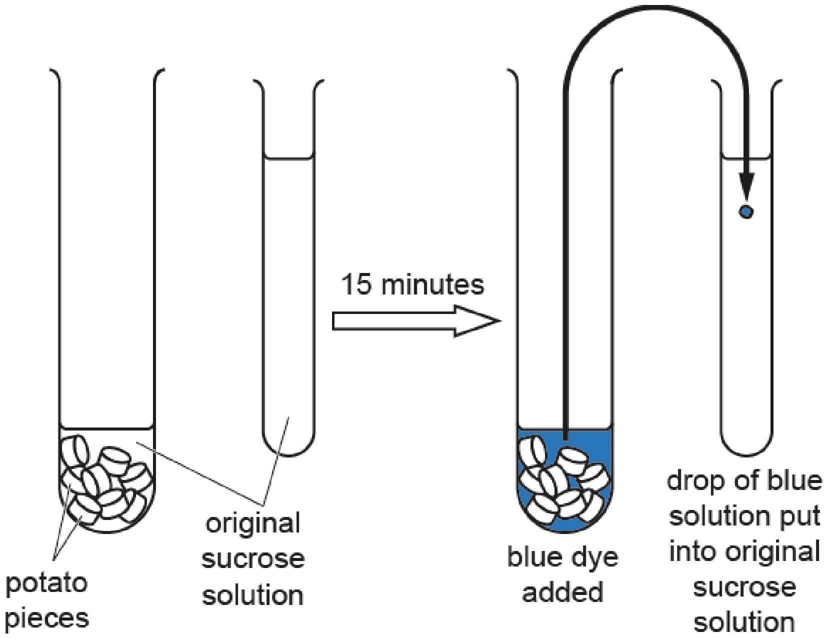

Fig. 1.1

- If the sucrose solution has become less concentrated, then the density of the sucrose solution will have decreased.
- If the sucrose solution has become more concentrated, then the density of the sucrose solution will have increased.

(a) (i) When two solutions of different density are added to one another without mixing, the denser solution will sink to the bottom and the less dense solution will rise to the top.

Complete Fig. 1.2 by drawing an arrow on each test-tube, as shown in the key, to predict how you expect the drop of blue solution to move.

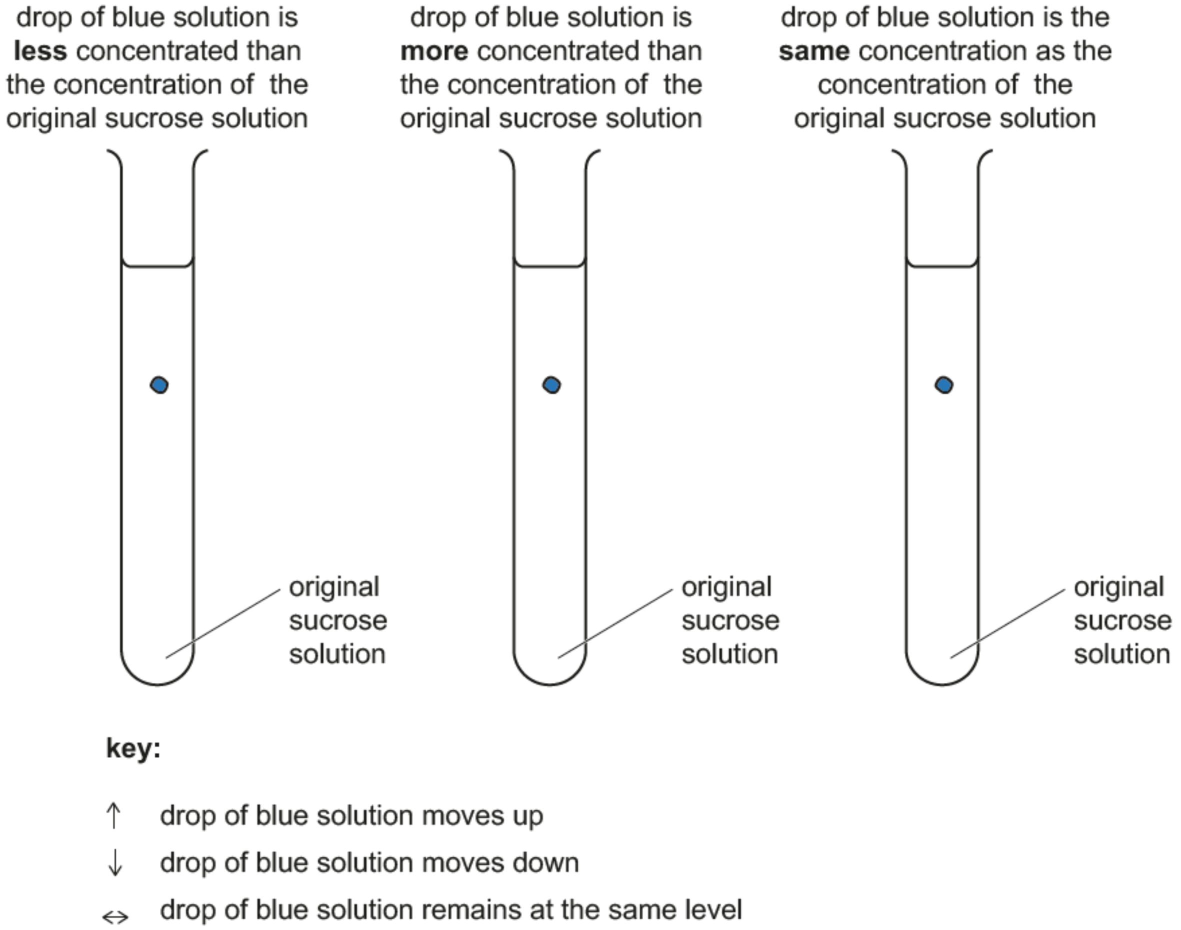

Fig. 1.2

[1]

You are provided with:

- 5 potato cylinders, in a Petri dish labelled **P**
- $150 cm^3$ 1.00 mol dm^{-3} sucrose solution S, in a container labelled **S**
- $250 cm^3$ distilled water W, in a container labelled **W**
- $20 cm^3$ blue dye M, in a container labelled **M**

If **M** comes into contact with your skin, wash it off immediately under cold water.

It is recommended that you wear suitable eye protection.

You will carry out a **serial** dilution of the 1.00 mol dm^{-3} sucrose solution, **S**, to reduce the concentration by **half** between each successive dilution.

You will need to prepare **four** concentrations of sucrose solution in addition to the 1.00 mol dm^{-3} sucrose solution, **S**.

After the serial dilution is completed, you will need to have 50.0 cm^3 of each concentration available to use.

(ii) Complete Table 1.1 to show how you will make the concentrations of the sucrose solutions needed.

Table 1.1

	sucrose solution				
concentration of sucrose solution / mol dm^{-3}	**1.00**				
concentration of sucrose solution to be diluted / mol dm^{-3}					
volume of the sucrose solution to be diluted / cm^3					
volume of distilled water to make the dilution / cm^3					

[3]

Read steps **1-22.**

Proceed as follows.

1 Prepare the concentrations of sucrose solution, as decided in **(a)(ii)**, in the beakers provided.

2 Label five boiling tubes with the concentrations of sucrose solution prepared in step 1, including 1.00 mol dm^{-3}.

3 Put the five potato cylinders onto a white tile.

(iii) The potato cylinders all have the same diameter.

State the method that you will use to standardise the surface area of all five potato cylinders.

....

....

....[1]

4 Carry out the method stated in **(a)(iii)** for each of the five potato cylinders.

5 Cut one of the potato cylinders into eight pieces of approximately the same length.

6 Put the eight **pieces** of potato into one of boiling tubes labelled in step 2.

Record the length of each potato **piece**.

length of potato piece = ...cm

7 Repeat step 5 and step 6 for the four other potato cylinders so that there are eight pieces of potato in each of the boiling tubes labelled in step 2.

You will put sucrose solution into each boiling tube to **just** cover the eight pieces of potato.

You will need to standardise the volume of sucrose solution put into each of the boiling tubes.

(iv) State the volume of sucrose solution you will use to just cover the eight pieces of potato in each boiling tube.

volume = ... [1]

8 Put each concentration of sucrose solution prepared in step 1, including 1.00 mol dm^{-3}, into the appropriately labelled boiling tube. For each boiling tube, use the volume of sucrose solution stated in **(a)(iv)** to cover the potato pieces.

9 Leave the pieces of potato in the sucrose solutions for 15 minutes. While you are waiting, continue with step 10 to step 13.

10 Label five test-tubes with the concentrations of sucrose solution that you have used in step 8.

11 Put a mark 5.0 cm from the bottom of each of the test-tubes, as shown in Fig. 1.4.

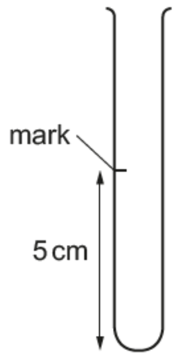

Fig. 1.4

12 Put 15.0cm^3 of 1.00 mol dm^{-3} sucrose solution into the appropriately labelled test-tube.

13 Repeat step 12 with each of the other concentrations of sucrose solution.

14 After leaving the pieces of potato for 15 minutes in step 9, put 1.0 cm^3 of the blue dye, **M**, into each of the boiling tubes containing eight pieces of potato in sucrose solution.

15 Swirl the contents of the boiling tubes to mix **M** with the sucrose solution. The blue dye may not mix in completely. This will not affect the results.

16 Use a pipette to remove a sample of the blue solution from around the pieces of potato in the boiling tube to which 1.00 mol dm^{-3} sucrose solution had been added.

Throughout step 17 to step 20, the pipette must be held still so that its position does not change.

Drops can then be released and observed without disturbing the sucrose solution.

17 Put the end of the pipette into the test-tube containing 1.00 mol dm^{-3} sucrose solution.

The end of the pipette should be level with the mark on the test-tube, as shown in Fig. 1.5.

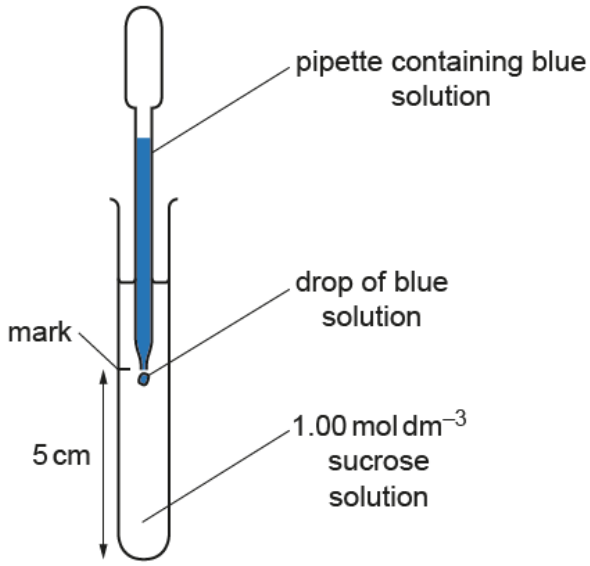

Fig. 1.5

18 Keeping the end of the pipette as still as possible, release a drop of the blue solution from the pipette.

19 Observe the direction **and** time taken for the drop of blue solution to reach the top or bottom of the test tube.

20 Repeat step 18 and step 19 two more times.

21 Record your observations in **(a)(v)**.

22 Repeat step 16 to step 21 for the other concentrations of sucrose solution. In step 17 and step 18, make sure that drops of the blue solution from each boiling tube are released into the test-tubes labelled with the same concentration of sucrose.

(v) Record, in an appropriate table, your observations of the direction **and** the time taken for the drops to reach the top or the bottom of the test tube.

You may use the same symbols in **(a)(i)** to show the direction of movement of the drops. If no movement occurs, record the time taken as ' – '.

[6]

(vi) Using your results in **(a)(v)**, estimate the concentration of sucrose solution that has a water potential equal to the water potential of the potato cells.

concentration of sucrose solution = ... mol dm^{-3}

[1]

(vii) Describe how you would modify the procedure to obtain a more accurate estimate in **(a)(vi)**.

....

....

....

....[2]

(viii) Describe the movement of water molecules when the water potential of the sucrose solution surrounding the piece of potato is the same as the water potential of the potato cells.

……

……

……

……[2]

(ix) State **one** source of error in the procedure that you have carried out.

……

……[1]

(b) Another student investigated the effect of different concentrations of sucrose solution by modifying the experiment and measuring the change in mass of potato tissues after being immersed in sucrose solutions instead.

The mass of each piece of potato tissue was measured before and after soaking in different concentrations of sucrose for 1 hour and the change in mass calculated.

Table 1.2 shows the results of this investigation.

Table 1.2

concentration of sucrose solution / mol dm^{-3}	**change in mass / g**
0	+0.60
0.2	+0.31
0.4	0.00
0.6	–0.29
0.8	–0.45
1.0	–0.66

(i) Use the grid provided to display the relationship between sucrose concentration and change in mass, as shown in Table 1.2.

[4]

(ii) Using your knowledge of water potential, explain the difference in the change of mass in the potato piece immersed in 1.0 mol dm^{-3} sucrose solution.

……

……

……

……

……

……[3]

[Total : 25]

2 When bananas ripen, they turn brown in colour. This is due to the formation of a brown product called melanin.

The enzyme catechol oxidase acts on its substrate, catechol, leading to the formation of a brown product, melanin, as shown in Fig. 2.1.

$$\underset{\text{(pale pink substrate)}}{\text{catechol}} \xrightarrow{\text{catechol oxidase}} \underset{\text{(brown product)}}{\text{melanin}}$$

Fig. 2.1

As melanin is produced, the colour of the reaction mixture changes to brown. The intensity of the brown colour produced is proportional to the concentration of melanin. The more active the enzyme, the more intense the brown colour.

A colorimeter is used to measure the absorbance of the reaction mixture. Absorbance is a measure of the light absorbed by a coloured solution. With the reaction shown in Fig. 2.1, the more intense the brown colour, the higher the absorbance.

Catechol oxidase can be extracted from bananas.

(a) Design an experiment to investigate the effect of catechol concentration on the catechol oxidase-catalysed reaction shown in Fig. 2.1.

In your plan, you **must** use :

- An extract of catechol oxidase enzyme solution prepared and kept cold until needed
- A stock solution of 1.0% catechol solution
- A buffer solution of pH 7.0

You may select from the following apparatus and plan to use appropriate additional apparatus :

- normal laboratory glassware, e.g. test-tubes, boiling tubes, beakers, measuring cylinders, graduated pipettes, glass rods, etc
- colorimeter
- access to hot water and ice
- syringes
- timer, e.g. stopwatch

Your plan should:

- have a clear and helpful structure such that the method you use is able to be repeated by anyone reading it
- be illustrated by relevant diagrams, if necessary
- identify the dependent variable and the independent variable
- identify the variables you will need to control
- use the correct technical and scientific terms
- indicate how the results will be recorded and analysed.

[Total: 12]

3 During this question you will require access to a microscope and slide M**1**.

M1 is a slide of a stained transverse section through a leaf of a land plant.

You are not expected to be familiar with this specimen.

(a) Use your microscope to observe the different tissues in the region of slide M1 shown by the shaded area in Fig. 3.1.

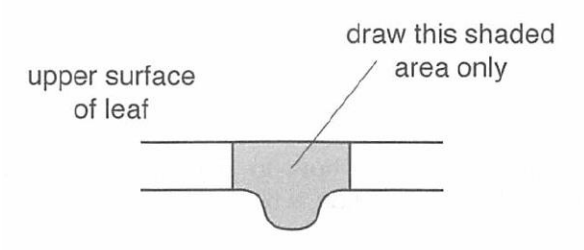

Fig. 3.1

(i) Use the space provided to draw a large plan diagram of the part of the leaf on slide **M1** shown by the shaded area in Fig. 3.1.

A plan diagram shows the arrangement of different tissues, including their correct shapes and proportions. No cells should be drawn.

Labels are **not** required.

[4]

(ii) Observe the outer layer of cells on the upper surface of the leaf on slide **M1**. This outer layer of cells is called the upper epidermis.

Select four cells from the upper epidermis that form a chain.

Make a large drawing of this chain of **four** cells.

Labels are not required.

[4]

(iii) In land plants, one of the main functions of the epidermis is to reduce water loss.

From your observation of slide **M1**, suggest **one** way in which the upper epidermis of land plants is adapted to reduce water loss.

……...

……[1]

(b) Fig. 3.2 is a photomicrograph of a different part of the same leaf.

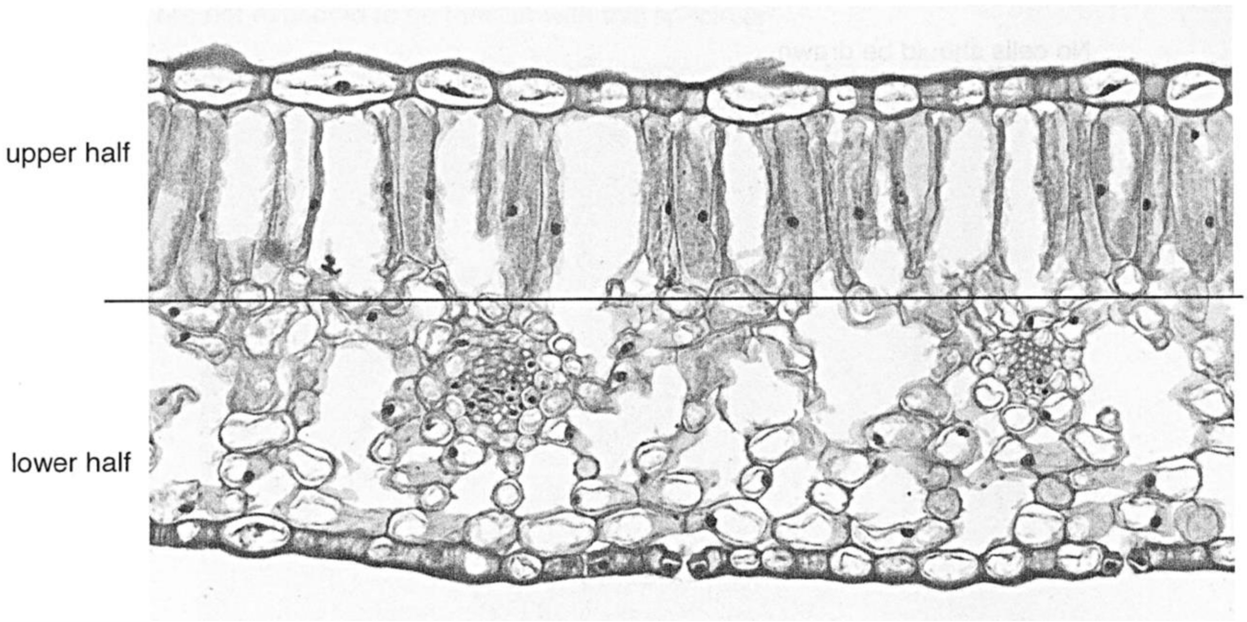

Fig. 3.2

(i) There are observable differences between the upper and lower halves of the leaf shown in Fig. 3.2. Identify three differences between the upper and lower halves of the leaf.

For each of the three differences, draw one label line to a feature in Fig. 3.2 that shows this difference. Label the three features **F, G** and **H**.

You may label each feature in either the upper half or the lower half of Fig. 3.2. Each labelled feature must relate to a separate difference.

Complete Table 3.1 to describe the differences between the upper and lower halves of the leaf for each of these **three** features.

Table 3.1

feature	upper half	lower half
F		
G		
H		

[4]

(ii) Fig. 3.3 shows a diagram of a stage micrometer scale that is being used to calibrate an eyepiece graticule.

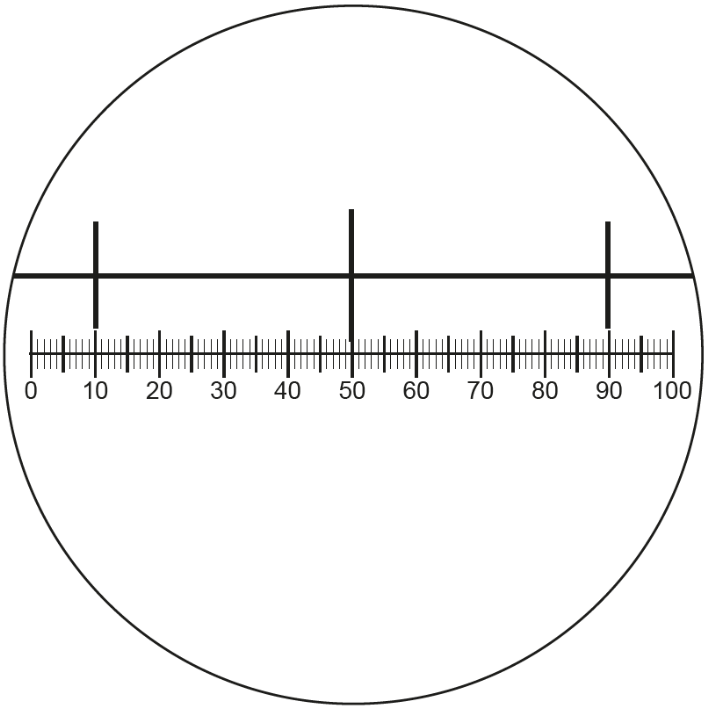

Fig. 3.3

The length of one division on this stage micrometer is **0.8 mm**.

Use Fig. 3.3 to calculate the actual length of one eyepiece graticule unit.

Show your working.

[3]

Fig. 3.4 shows the same specimen as Fig. 3.2 viewed through a microscope fitted with the eyepiece graticule shown in Fig. 3.3.

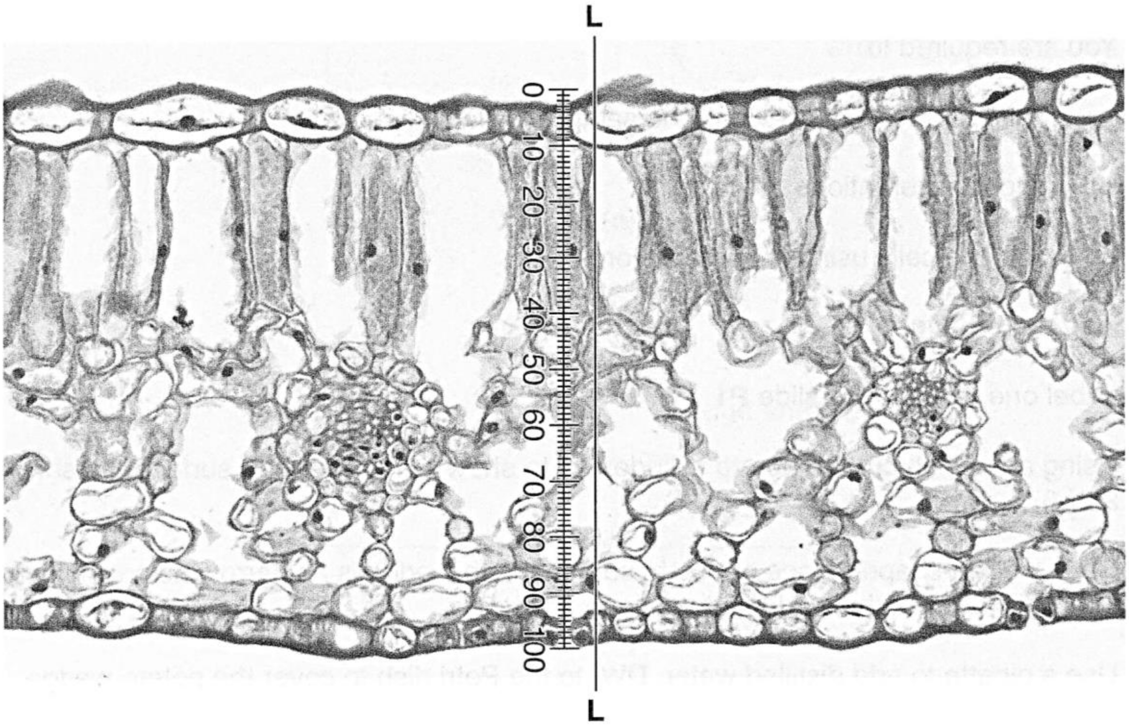

Fig. 3.4

(iii) Use your answer to (b)(ii) to find the actual thickness of the leaf at the position shown by the line L-L in Fig. 3.4.

Show your working.

[2]

[Total : 18]