Name:		Centre/Index Number:		Class:	

DUNMAN HIGH SCHOOL
Preliminary Examination
Year 6

H2 BIOLOGY 9744/04

Paper 4 Practical

29 August 2023

2 hours 30 minutes

Candidates answer on the Question Paper

READ THESE INSTRUCTIONS FIRST

Write your centre number, index number, name and class at the top of this page.
Give details of the practical shift and laboratory where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions 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.

Shift
Laboratory

For Examiner's Use	
1	23
2	13
3	19
Total	55

This s consists of **15** printed pages (including this cover page) and **1** blank page.

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1 Enzyme **E** catalyses the hydrolysis of starch to maltose.

The progress of this enzyme-catalysed reaction can be followed by measuring the time taken for the substrate, starch, to disappear.

You will investigate the effect of compound C, **C1**, on the hydrolysis of starch.

If any solution comes into contact with your skin, wash off immediately under cold water.

You will need to dilute the 2.0% compound C solution, **C1**, which reduces the concentration by a **factor of ten** between four successive dilutions, to give **C2**, **C3**, **C4** and **C5**. Once the dilution has been completed, there is a volume of 10.0 cm^3 for each solution in each vial.

(a) (i) Complete Table 1.1 to show how you will make the concentrations of the compound C solutions, **C2**, **C3**, **C4** and **C5**.

Table 1.1

Label of compound C solution	Percentage concentration of compound C solution	Label of compound C solution to be diluted	Volume of compound C solution to be diluted / cm^3	Volume of distilled water to make up the dilution / cm^3	Total volume / cm^3
C1	**2.0**		**10.0**	**0.0**	10.0
C2	**0.2**	C1	**1.0**	**9.0**	10.0
C3	**0.02**	**C2**	**1.0**	**9.0**	10.0
C4	**0.002**	**C3**	**1.0**	**9.0**	10.0
C5	**0.0002**	**C4**	**1.0**	**9.0**	10.0

1. **Correct concentrations; 2. Correct volume of solutions and label of compound X; 3. Correct precision;**

[3]

(ii) Describe a suitable control for the experiment and explain its purpose.

1. [Description of control] A suitable control would be to replace compound C solution with an **equal volume** of **distilled water**;
2. [Purpose of control] To show that **change** in amylase activity is due to the presence of **compound C**;

[2]

(b) A student suggested the hypothesis that:

'the higher the concentration of compound C, the slower the breakdown of starch.'

The student carried out some preliminary tests to find the volumes of amylase and starch solutions to use when testing this hypothesis. The student found that the best volumes of compound C, amylase and starch solutions to use were in a ratio of 1 : 2 : 6.

Use the results of the tests to plan and carry out an investigation to provide results that will enable you to support or reject this hypothesis. If the complete breakdown of starch takes more than 180 seconds, record as 'more than 180'.

In addition to the 10 cm^3 of compound C solutions prepared according to Table 1 (without the control), you are provided with:

- **only** 20 cm^3 of amylase in a container, labelled **E**
- **only** 60 cm^3 of starch in a container, labelled **S**

Using the specimen tubes and the other apparatus provided, plan **and** carry out a method to obtain results to support or reject the student's hypothesis.

You may use the space below to make any notes. Read through **(b)(i)**, **(b)(ii)** and **(b)(iii)** before proceeding.

(i) State the dependent variable.

Time taken for **complete hydrolysis** of starch / time taken for **iodine solution to remain brown;**

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

(ii) Other than the volumes of solutions, state an additional variable to be controlled and explain how this variable can be controlled.

1. State suitable **value of temperature** of water bath where the test tubes containing the compound C, amylase and starch solutions will be immersed in;
2. Temperature can be controlled using **hot** and **cool** water, measured using a **thermometer**;

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

(iii) Outline the steps in your method that you used to collect results.

1. Using a 3 or 5 cm^3 syringe; prepare a solution of **1.0 cm^3** of compound C, **2.0 cm^3** of amylase and **6.0 cm^3** of starch in a test-tube;
   (appropriate volumes according to the 1:2:6 ratio)
2. Using a Pasteur pipette/dropper, take a sample of mixture **every 20 seconds** and place it on a **spotting tile**;
   (fixed time interval + spotting tile)
3. Using a Pasteur pipette/dropper, add **three drops of iodine** to sample and record the **time** using a stopwatch at which the mixture remains brown;

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

(iv) Record your results in a suitable format in the space provided.

Concentration of compound C / %	**Time taken for complete hydrolysis of starch / s**
2.0	
0.2	
0.02	
0.002	
0.0002	

1. **Correct table headings with proper units;**
2. **Correct precision;**
3. **Correct trend (decreasing time taken with increasing concentration of compound C);**

[3]

(v) State whether or not your results in (b)(iii) support the student's hypothesis.

Give a reason for your decision.

No, student's hypothesis is not supported as there was decreasing time taken for starch to change colour with increasing concentration of compound C, suggesting faster breakdown of starch; [1]

(vi) Vial **U** contains compound C of an unknown concentration.

Using your steps in **(b)(ii)** and results in **(b)(iii)**, estimate the concentration of compound C in **U**.

concentration of **U** **Actual: 0.2%** [1]

(vii) State **one** significant source of error in this investigation.

Explain why this is a source of error.

1. Difficulty in judging exact time of colour change as **perception** of colour change is **subjective** / colour may change between time intervals;
2. Hence the recorded time taken for the iodine solution to change colour may be **longer or shorter**, resulting in inaccurate results;

[2]

(viii) Suggest how you could make **one** improvement to the **independent** variable so that a more accurate estimate of the concentration of compound C in **U** can be obtained.

State suitable <u>range</u> of having <u>more</u> concentrations between the two concentrations that lie each side of the estimate; [1]

(ix) Suggest how you could make **two** improvements to the measuring of the **dependent** variable so that a more accurate estimate of the concentration of compound C in **U** can be obtained.

1. Use a **colourimeter** / **spectrometer** to record **absorbance** of solution;
2. Use **colour standards** to compare end-point colour;
3. Use **shorter timed intervals**;
4. Lengthen the duration of observation of 180 seconds, e.g., 5 min

[2]

(x) Other than washing off any solution that comes into contact with your skin with cold water, describe another safety precaution you would take and explain how it minimises any risks associated with the experiment.

1. **Wear gloves when handling compound C solution; as it may be a skin irritant;**
2. **Handle hot water (when preparing the water bath) with a towel; as it may scald the skin;**
3. **Handle glassware with care / dispose of broken glassware safely; to prevent being cut by broken glassware;**

[2]

[Total: 23]

2 Plant extracts contain molecules which have many uses in industry and as medicines.

It is important for scientists to be able to estimate the concentration of these molecules in plant extracts.

A student investigated the concentration of molecule **R** in extracts from different plants.

The student mixed a fixed volume of each plant extract with acidified potassium manganate(VII), a purple solution. When molecule **R** was present in the extract, it reacted with the potassium manganate(VII), causing the solution's colour to change from purple to colorless. The student timed how long it took for this colour change to occur which was used as an indicator of the reaction's end-point. By comparing the reaction times of different plant extracts using a stopwatch, the student could determine the relative concentration of molecule **R** in each plant sample.

The results are shown in Fig 2.1.

plant extract **B**

plant extract **C**

plant extract **D**

plant extract **E**

plant extract **F**

Fig. 2.1

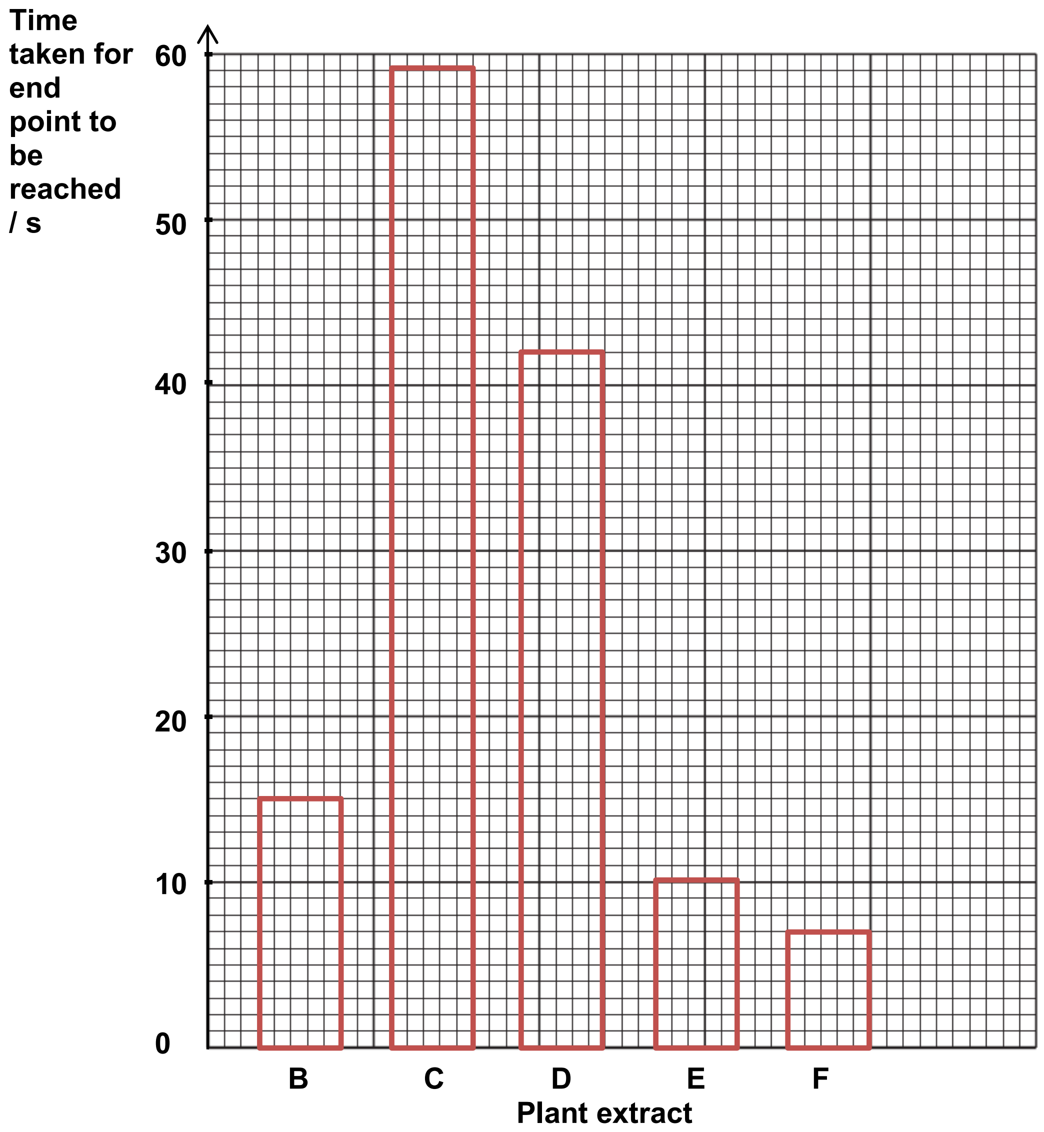
a. **(i)** Record the data in Fig. 2.1 in the space provided in an appropriate format.

plant extract	**Time taken for end-point to be reached / s**
B	15
C	59
D	42
E	10
F	7

1. **Correct table headers with independent variable on the leftmost column and dependent variable on the rightmost column with correct units;**
2. **Correct precision for time taken;**

[2]

(ii) Plot the data shown in **(a)(i)** on the grid provided in an appropriate format.



[5]

1. Appropriate axes labels with units;
2. Axes scaled appropriately so that graph takes up at least 50% of the grid on the y-axis and divisions are equidistant;
3. Appropriate graph used: <u>bar chart</u>;
4. Correct plotting of values;
5. 5 appropriately labelled bar charts: B, C, D, E, F

(iii) Suggest which plant extract would contain the highest concentration of **R.**

$\boxed{\textbf{F}}$ ....[1]

b. Scientists have suggested that a different molecule in the plant extract might act as an antibiotic.

The scientists tested this by:

- spreading bacteria over the surface of agar gel containing nutrients
- putting small drops ($3\,\mu m^3$) of different concentrations of the plant extract into separate wells in the agar gel
- incubating the agar gel for 20 hours
- measuring the inhibition area (where the bacteria were not observed) for each concentration of plant extract.

The results are shown in Fig. 2.2.

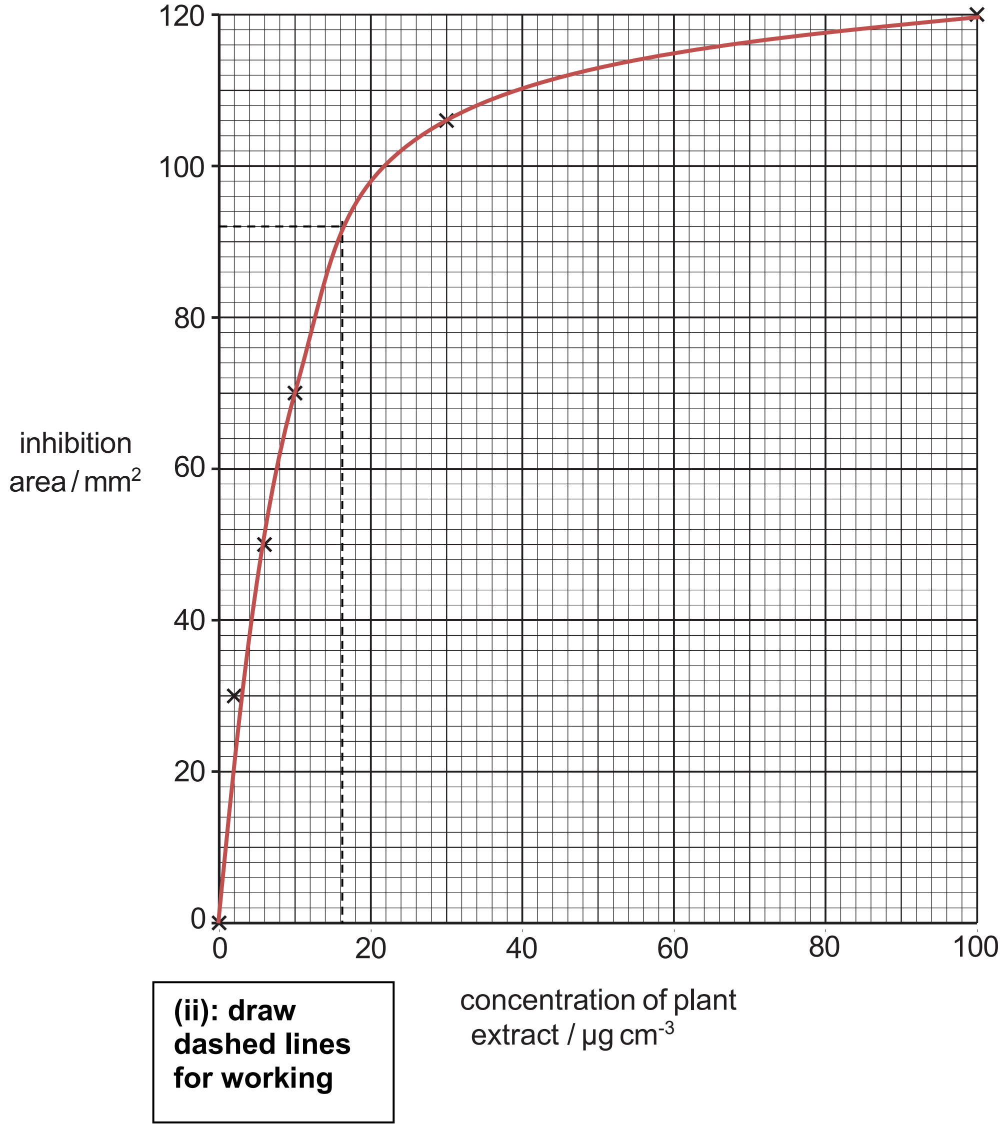


Fig. 2.1

(i) Draw a line of best fit in the grid provided in Fig. 2.1. [1]

(ii) Use the graph in Fig. 2.1 to estimate the concentration of plant extract that results in an inhibition area of 92 mm^2. Show on Fig. 2.1 how you obtained your answer.

16 $\mu g\ cm^{-3}$ / derived from graph

concentration of plant extract = ... [2]

(iii) Suggest two ways the molecule in the plant extract may inhibit the growth of the bacteria.

Any two from:

1. **prevents formation of cell wall / membrane;**
2. **can cause lysis of cell;**
3. **inhibits transcription / translation / protein synthesis**
4. **inhibits cell division / binary fission;**
5. **inhibits DNA replication;**
6. **AVP;**

[2]

[Total: 13]

3 *During this question you will require access to a microscope and slide **S1**.*

Fig. 3.1 is a photomicrograph of a stained transverse section through the stem of a plant species.

This plant grows in waterlogged conditions.

You are not expected to be familiar with this specimen.

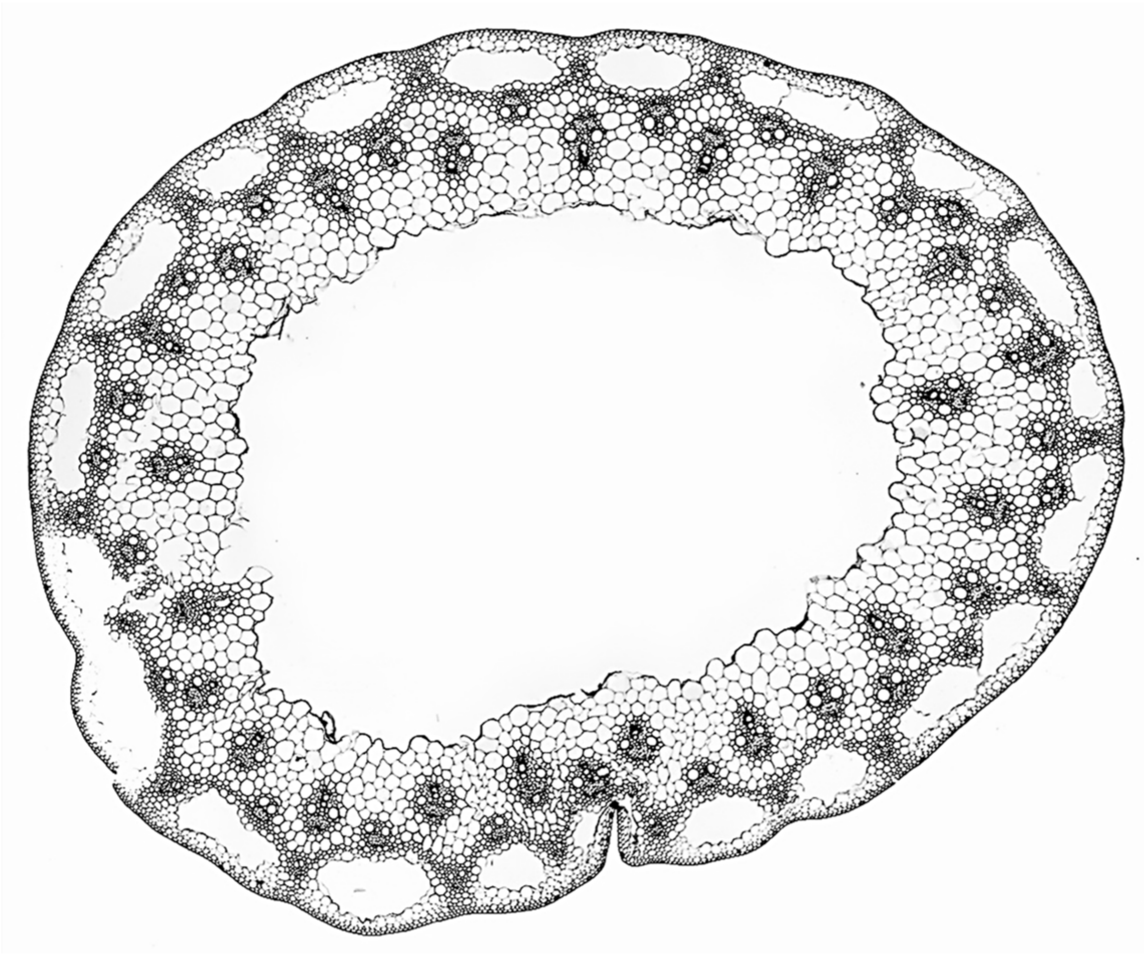


Fig. 3.1

c. **(i)** Use the space provided to draw a large plan diagram of the shaded area of the stem shown in **Fig. 3.2**.

A plan diagram shows the arrangement of the different tissues. No cells should be drawn.

Your drawing should show the correct shapes and proportions of the different tissues**.**

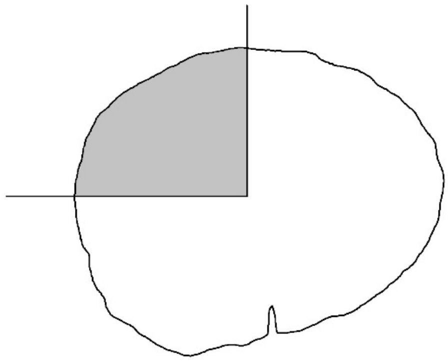
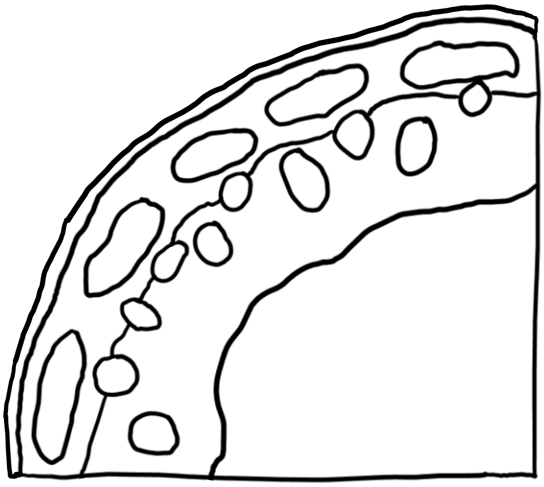


Fig. 3.2



1. **Size: at least 2/3 of space given;**
2. **Lines: smooth and continuous;**
3. **Accuracy: shows at 4-5 air spaces, at least 8 vascular bundles (not uniformly distributed)**
4. **Accuracy: shows 4 distinct layers;**
5. **Proportion: correct proportion of vascular bundles and layers (middle layer is slightly thicker than outer layer);**

[5]

(ii) Suggest one observable feature of the stem in Fig. 3.1 which supports the conclusion that this plant grows in waterlogged conditions.

feature ....

explanation .

Feature: has numerous air spaces;
Explanation: provide buoyancy;

....[2]

d. Slide S1 is a microscope slide of a stained transverse section through a stem from a different species of plant. The stem of this plant does not grow in waterlogged conditions.

(i) Use a suitable table to record observable differences between the specimen in Fig. 3.1 and the specimen on slide **S1**.

Feature	**Fig. 3.1**	**Slide S1**
Shape of stem	**Circular**	**Square;**
Distribution of vascular bundles	**Arranged as a ring surrounding the centre**	**Found at corners of stem;**
Number of vascular bundles	**Many**	**Few;**
Air spaces	**Numerous**	**None;**

1. **Organisation of table with appropriate headers;**
2. **Appropriate difference #1;**
3. **Appropriate difference #2;**

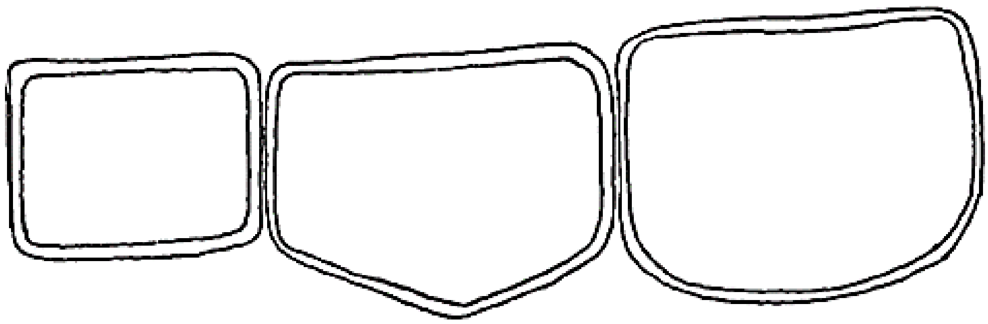
[3]

(ii) Observe the epidermal cells of the stem on S1.

Select **three** adjacent epidermal cells that are arranged end to end in a line.

Each cell must touch at least one other cell.

Make a large drawing of this line of **three** cells.



1. **Size: at least 2/3 of (horizontal) space given;**
2. **Lines: smooth and continuous;**
3. **Accuracy: 3 adjacent epidermal cells touching one another, with cellulose cell walls and no other organelles, cells should not have exactly the same shape as each other;**
4. **Proportion: correct proportion of cell wall thickness that is uniform and not too thick;**

[4]

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

One division, on either the stage micrometer scale or the eyepiece graticule, is the distance between two adjacent lines.

The length of one division on this stage micrometer is **0.1 mm**.

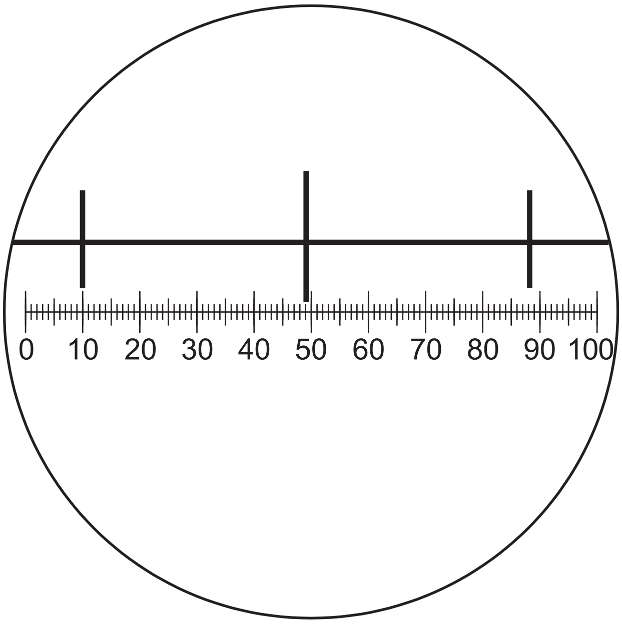


Fig. 3.3

(i) Calculate the actual length of one eyepiece graticule unit in µm**.**

Show all your workings clearly.

1. **1 stage micrometer division = 39 eyepiece graticule units;**
2. **1 eyepiece graticule unit = (0.1 x 1000) / 39 = 2.6 µm;**
3. **Correct precision for answer;**

.... [3]

Fig. 3.4 shows a photomicrograph of a transverse section through a leaf, taken using the same microscope with the same lenses as Fig. 3.3.

You are not expected to be familiar with this specimen.

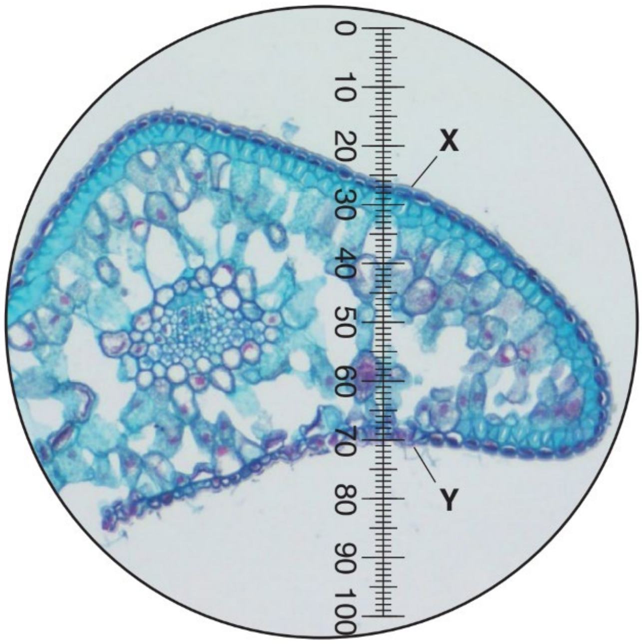


Fig. 3.4

(ii) Use the calibration of the eyepiece graticule unit from **(c)(i)** and Fig. 3.3 to calculate the actual length of the plant leaf from **X** to **Y**.

Show all the steps in your calculation and use appropriate units.

1. **Length of X to Y = 71 – 26 = 45 eyepiece graticule units**
2. **Actual length of X to Y = 45 x 2.6 = 117 μm ≈ 120 μm**

....[2]

[Total: 19]

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