Cambridge Assessment International Education

Cambridge International AS & A Level

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4838320638

BIOLOGY **9700/31**

Paper 3 Advanced Practical Skills 1 **October/November 2023**

2 hours

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

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1 You will investigate the effect of temperature on the production of carbon dioxide gas by yeast cells.

Yeast cells contain enzymes that break down glucose to release carbon dioxide and ethanol as shown in Fig. 1.1.

$$\text{glucose} \xrightarrow{\text{enzymes in yeast cells}} \text{carbon dioxide + ethanol}$$

Fig. 1.1

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3
Y	yeast cell suspension	none	100
G	glucose solution	none	20
H	hydrogencarbonate indicator	harmful irritant	15

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

It is recommended that you wear suitable eye protection.

You will need to:

- maintain samples of a yeast cell suspension at different temperatures
- count the number of bubbles of carbon dioxide produced.

(a) (i) Decide which temperatures you will use for your investigation. These temperatures should be below 65 °C.

State the temperatures that you will use in your investigation.

.....

[2]

Carry out step 1 to step 9.

step 1 Use the beakers labelled **water-bath**, **hot water** and **cold water** to set up and maintain a water-bath at the highest temperature you stated in **(a)(i)**. The temperature of the water-bath must be maintained.

step 2 Stir the yeast cell suspension, **Y**, and put 20 cm^3 of **Y** into the large test-tube.

step 3 Add 1 cm^3 of glucose solution, **G**, to the large test-tube and mix well.

step 4 Set up the apparatus as shown in Fig. 1.2.

You will use the same test-tube of hydrogencarbonate indicator for each trial.

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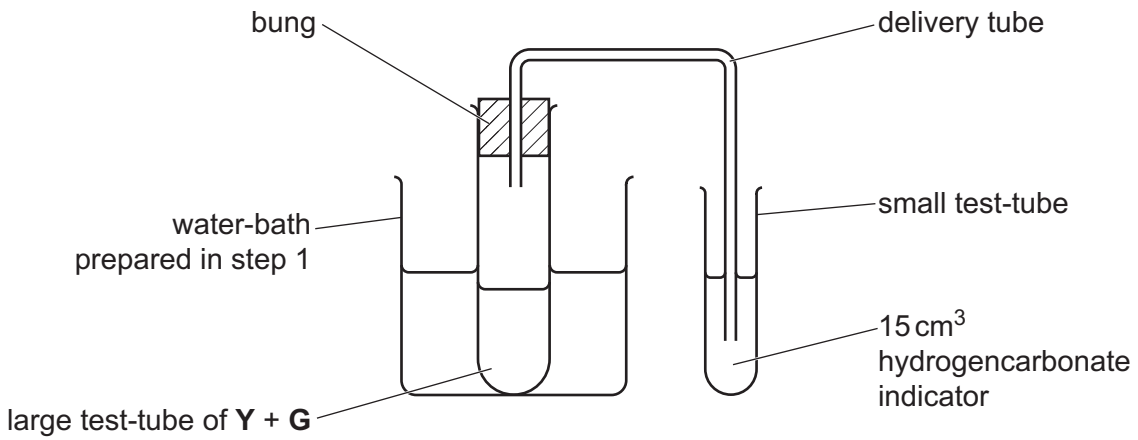


Fig. 1.2

step 5 Start timing and leave the apparatus for 60 seconds.

step 6 After 60 seconds, start counting the number of bubbles produced during the next 60 seconds.

Record your result in **(a)(ii)**.

step 7 Take the large test-tube out of the water-bath and remove the bung and delivery tube. Pour the contents of the large test-tube into the container labelled **For Waste**.

step 8 Adjust the temperature of the water-bath to the next highest temperature you stated in **(a)(i)**.

step 9 Repeat step 2 to step 8 until you have tested all the temperatures stated in **(a)(i)**.

(ii) Record your results in an appropriate table.

[5]

(iii) State the dependent variable in this investigation.

..... [1]

(iv) Observe the final colour of the hydrogencarbonate indicator.

State the final colour of the hydrogencarbonate indicator ..... [1]

(v) Suggest **one** conclusion from your observation in **(a)(iv)**.

.....

..... [1]

(vi) Identify **one** source of error in the procedure. Suggest an improvement to reduce this source of error.

error .....

.....

improvement .....

.....
[2]

(b) A student investigated the effect of copper ions on the growth of yeast cells.

Six yeast suspensions were made. For each suspension, 0.4 g of yeast was added to a nutrient solution. Different concentrations of copper ions were added to each yeast suspension. The mass of yeast in each suspension was measured after 24 hours.

The results are shown in Table 1.2.

Table 1.2

concentration of copper ions / parts per million (ppm)	mass of yeast / g
0.00	19.4
0.10	21.2
0.25	5.6
0.50	2.0
0.75	0.8
1.00	0.4

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(i) Plot a graph of the data shown in Table 1.2 on the grid in Fig. 1.3.

Use a sharp pencil.

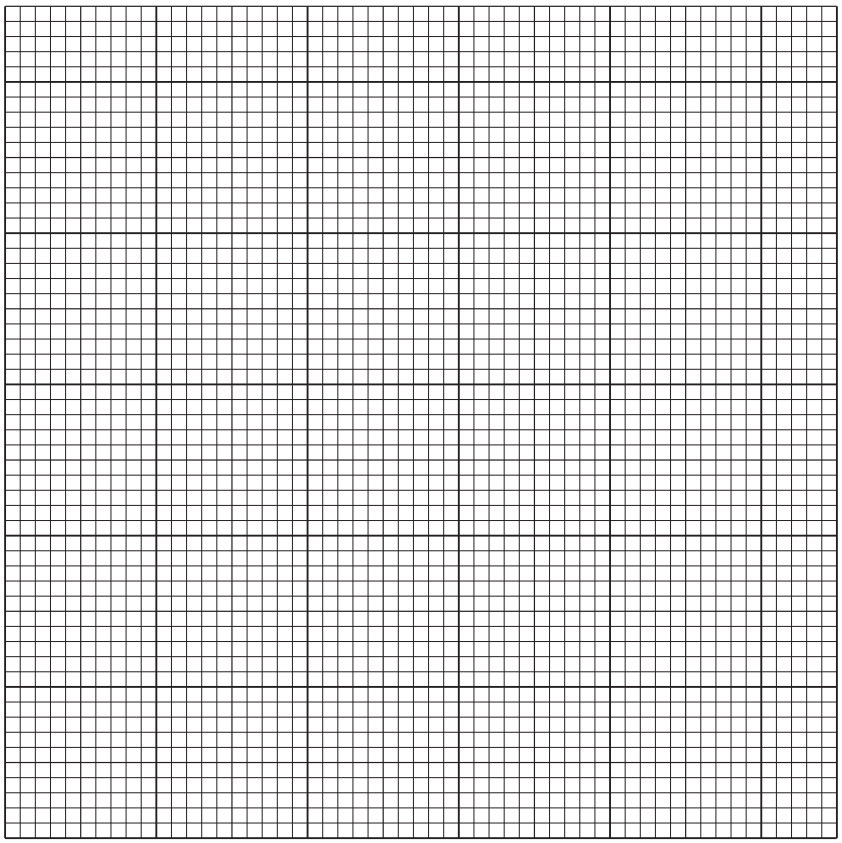


Fig. 1.3

[4]

(ii) Use your graph in Fig. 1.3 to estimate the concentration of copper ions that would result in a mass of 10.0 g of yeast cells.

Show on your graph how you obtained your answer.

concentration of copper ions = ... ppm

[2]

(iii) Copper ions act as non-competitive inhibitors for some enzymes.

Suggest an explanation for the results shown in your graph in Fig. 1.3.

.....

.....

.....

.....

..... [2]

(iv) Until the 1930s, most commercial fermenting equipment for growing yeast cells was made of copper. After this time, fermenting equipment was made using stainless steel instead of copper.

Use your graph in Fig. 1.3 to suggest why stainless steel was used instead of copper.

.....

.....

..... [1]

[Total: 21]

2 **J1** is a slide of a stained transverse section through a plant stem.

(a) **(i)** Draw a large plan diagram of the region of the stem on **J1** indicated by the shaded area in Fig. 2.1. Use a sharp pencil.

Use **one** ruled label line and label to identify **one** vascular bundle.

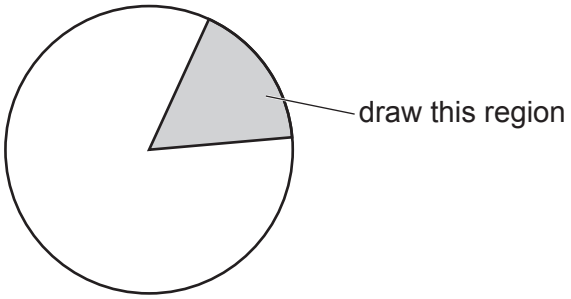


Fig. 2.1

[5]

(ii) Observe one vascular bundle of the section on **J1**.

Select **one** large xylem vessel element and a group of **three** adjacent, smaller xylem vessel elements.

- Make a large drawing of this group of **four** xylem vessel elements.
- Use **one** ruled label line and label to identify the cell wall.

[5]

(b) Fig. 2.2 is a photomicrograph showing the epidermis from another type of plant.

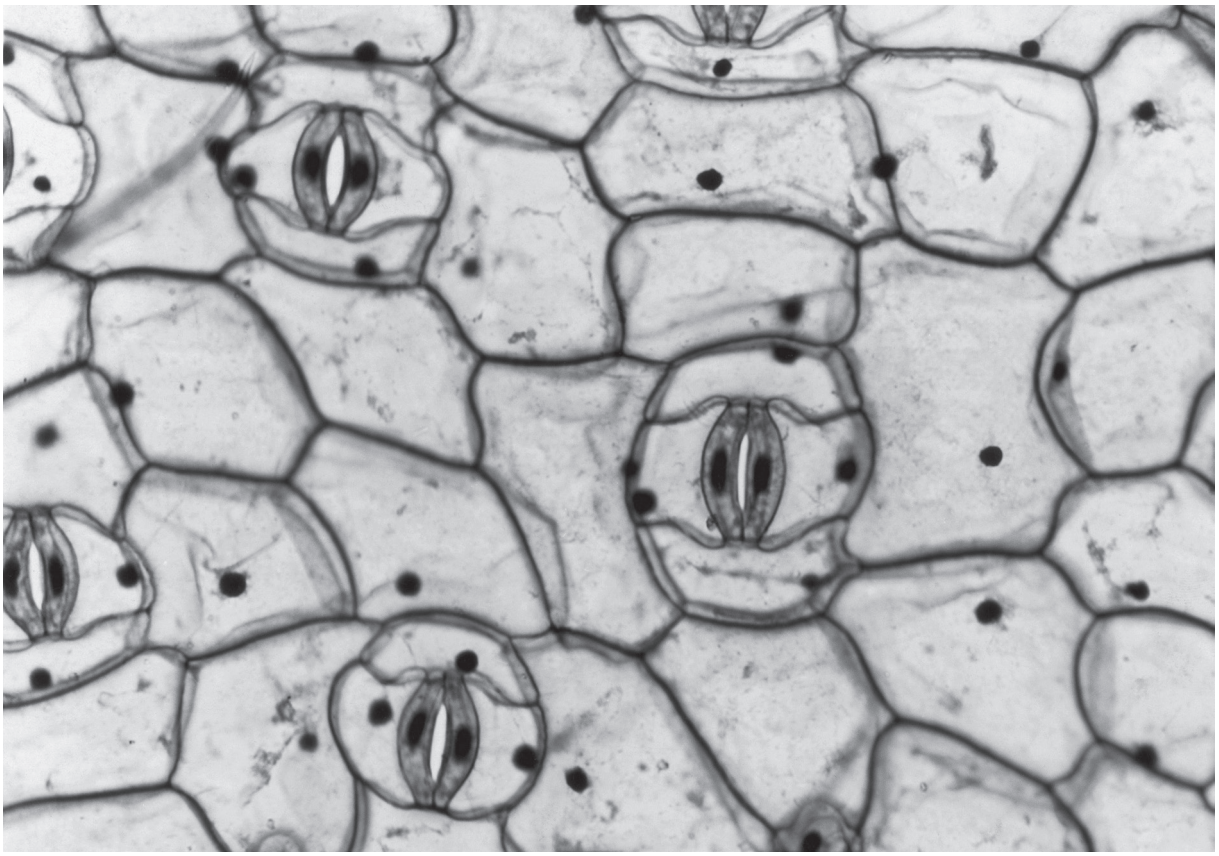


Fig. 2.2

The actual area of the epidermis visible in the photomicrograph in Fig. 2.2 is 0.04 mm^2.

The leaf from which Fig. 2.2 is taken has a total surface area of 2000 mm^2.

(i) Use Fig. 2.2 to estimate the total number of stomata on the leaf.

Show your working.

total number of stomata = ...
[3]

(ii) One way to improve the accuracy of the estimate of the total number of stomata on a leaf is to use a photomicrograph with a larger area.

State **one** other way to improve the accuracy of the estimate of the total number of stomata on a leaf.

.....

.....

..... [1]

(iii) Fig. 2.3 and Fig. 2.4 are photomicrographs of sections through the leaf surface of two different plants.

The photomicrographs in Fig. 2.3 and Fig. 2.4 have the same magnification.

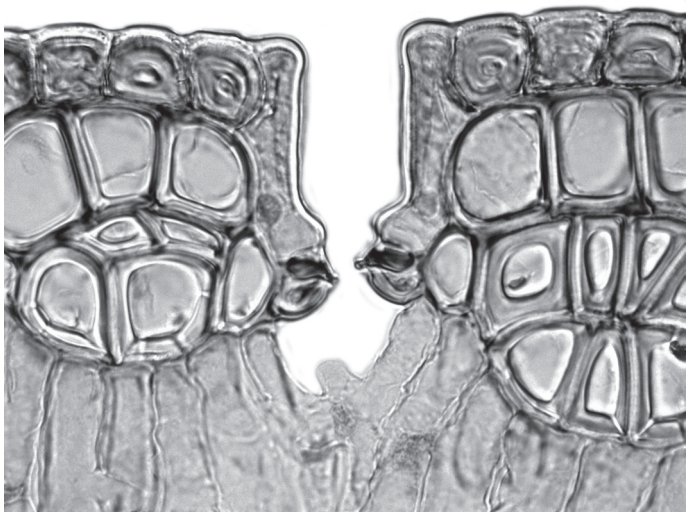


Fig. 2.3

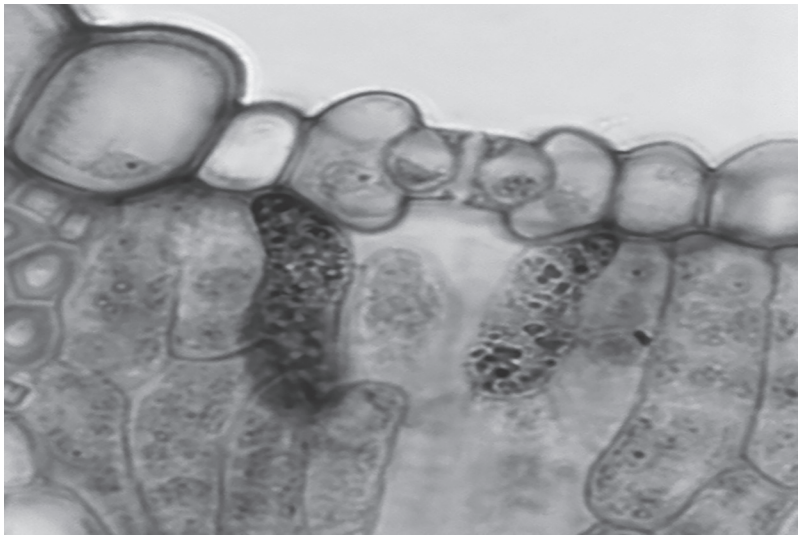


Fig. 2.4

Identify **three** observable differences between the leaf section shown in Fig. 2.3 and the leaf section shown in Fig. 2.4.

Record these **three** observable differences in Table 2.1.

Table 2.1

feature	Fig. 2.3	Fig. 2.4

[4]

(iv) Suggest the environment where the plant shown in Fig. 2.3 has grown.

.....

..... [1]

[Total: 19]

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BIOLOGY **9700/33**

Paper 3 Advanced Practical Skills 1 **October/November 2023**

2 hours

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[Turn over

1 Yeast cells contain enzymes that hydrolyse sucrose into reducing sugars, as shown in Fig. 1.1.

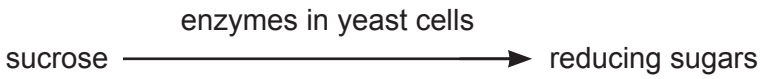


Fig. 1.1

You will investigate the activity of the enzymes in yeast cells.
The yeast cells will be immobilised in sodium alginate beads.

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3
Y	yeast cell suspension	none	30
A	sodium alginate solution	harmful irritant	20
C	calcium chloride solution	harmful irritant	30
S	sucrose solution	none	100
B	Benedict's solution	harmful irritant	30

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

It is recommended that you wear suitable eye protection.

You will investigate the activity of yeast enzymes by using different numbers of beads of immobilised yeast cells in sucrose solution, **S**.

Carry out step 1 to step 9 to immobilise the yeast cells in sodium alginate beads.

step 1 Put 10 cm^3 of **A** into a beaker.

step 2 Stir the yeast cell suspension **Y** with a glass rod.

step 3 Put 10 cm^3 of **Y** into the beaker containing **A** and mix well.

step 4 Put 20 cm^3 of **C** into another beaker.

step 5 Use a 10 cm^3 syringe to collect 10 cm^3 of the mixture of **A** and **Y**.

step 6 Hold this syringe over the beaker containing 20 cm^3 of **C** (step 4), as shown in Fig. 1.2.

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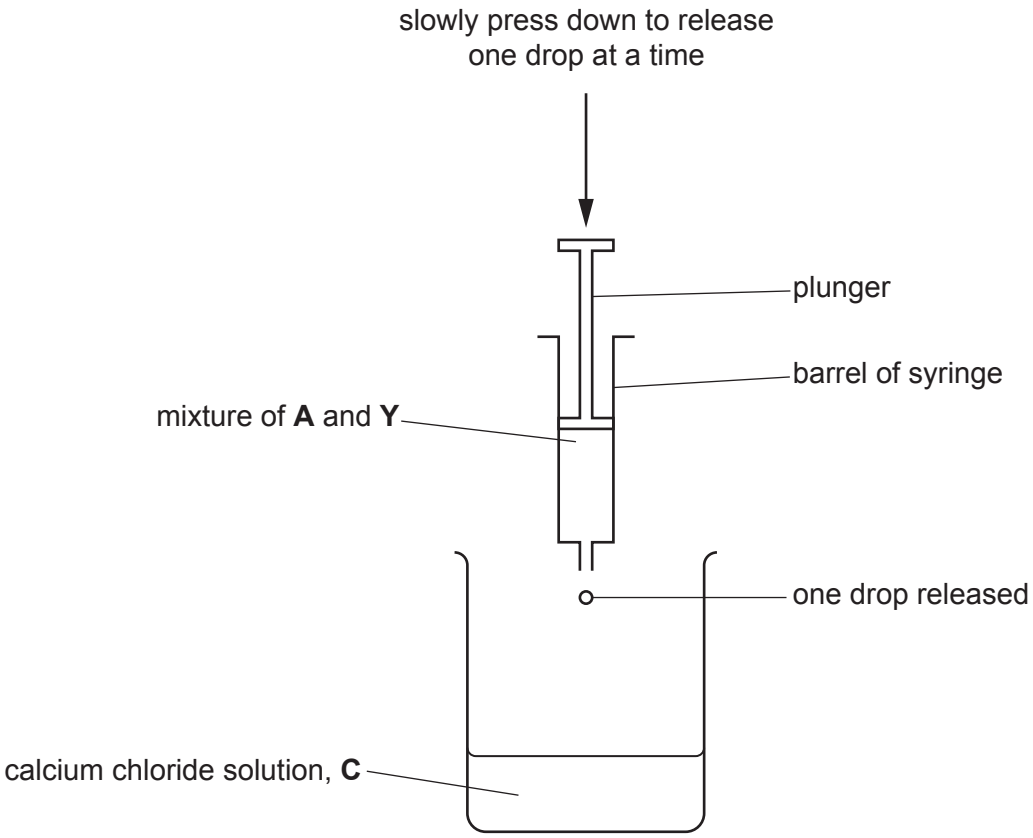


Fig. 1.2

step 7 Hold the barrel of the syringe with one hand while slowly pressing down on the plunger with the other hand so that a drop of the mixture is released into solution **C**. The drop will form a bead.

step 8 Repeat step 7 to make at least 31 beads.

The immobilised yeast beads must be left in the beaker for 5 minutes.

step 9 After 5 minutes tip the beads and the solution into a Petri dish.

You will test the activity of the yeast enzymes by using different numbers of beads (1, 2, 4, 8 and 16) in sucrose solution.

Carry out step 10 to step 20.

step 10 Label five beakers 1, 2, 4, 8 and 16 **and** label five test-tubes 1, 2, 4, 8 and 16.

step 11 Put 1, 2, 4, 8 or 16 beads into each of the appropriately labelled beakers, as shown in Fig. 1.3.

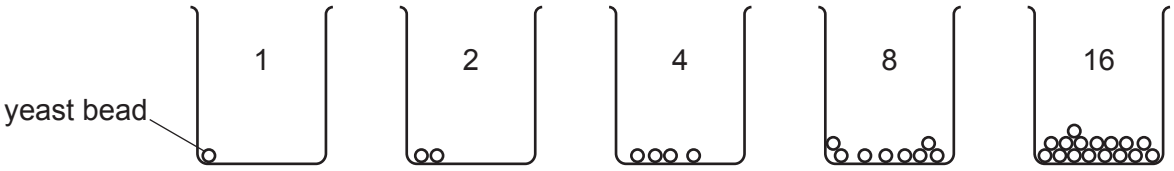


Fig. 1.3

step 12 Put 10 cm^3 of sucrose solution, **S**, into each of the beakers containing the beads.

step 13 Start timing and leave for 5 minutes. While you are waiting set up a water-bath ready for step 14 and step 19.

In step 19 you will use the water-bath to carry out the test for reducing sugars using Benedict's solution, **B**.

(a) (i) State the temperature you will use for the water-bath.

temperature ..... [1]

step 14 Heat the water-bath to the temperature stated in **(a)(i)**.

step 15 At the end of 5 minutes (step 13) stir the contents of each beaker.

step 16 Use a syringe to transfer 2 cm^3 of the solution from beaker 1 into the test-tube labelled 1.

step 17 Repeat step 16 for each of the beakers and test-tubes labelled 2, 4, 8 and 16.

step 18 Put 2 cm^3 of Benedict's solution, **B**, into each of the test-tubes labelled 1, 2, 4, 8 and 16.

step 19 Put test-tube 1 into the water-bath at the temperature stated in **(a)(i)** and time how long before the appearance of the first colour change. If there is no colour change after 2 minutes, stop timing and record as 'more than 120'.

Record your result in **(a)(ii)**.

step 20 Repeat step 19 for the other test-tubes, 2, 4, 8 and 16.

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(ii) Record your results in an appropriate table.

[5]

(iii) State the independent variable in this investigation.

..... [1]

(iv) State **one** main source of error in this investigation.

.....

.....

..... [1]

(v) A student set up a beaker as a control experiment. The result of the control experiment showed that the sucrose was hydrolysed by an enzyme.

Suggest what substances the student put in the beaker for the control experiment.

.....

..... [1]

(vi) The procedure described in step 1 to step 20 investigated the effect of changing the number of yeast beads on the rate of hydrolysis of sucrose.

Describe how you would modify the procedure to investigate the effect of changing the concentration of the sucrose solution on the rate of hydrolysis of sucrose.

.....

.....

.....

.....

..... [2]

(b) Pectinases are enzymes that are used to increase the volume of fruit juice extracted from apples. Pectinases can be immobilised and placed inside a container with apple pulp as shown in Fig. 1.4. The fruit juice is then collected.

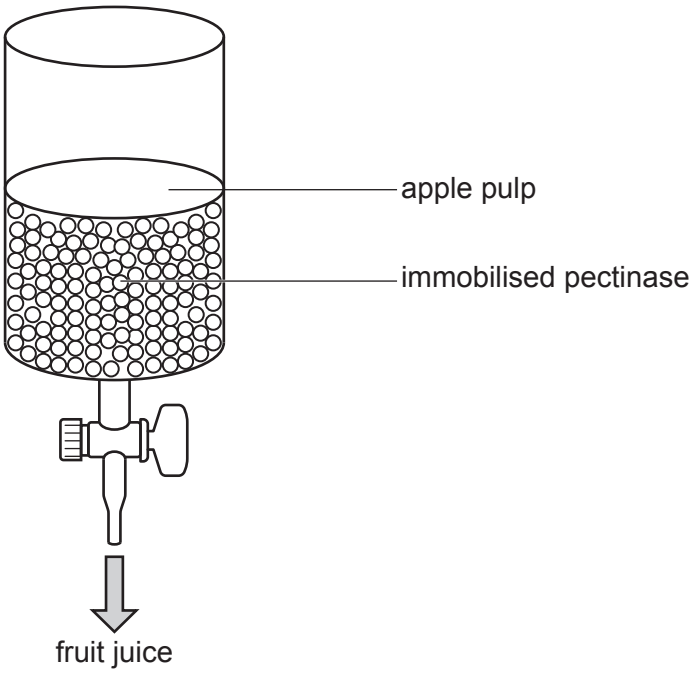


Fig. 1.4

A scientist carried out an investigation to determine the effect of temperature on the activity of immobilised pectinase by measuring the volume of fruit juice extracted.

All other variables were kept constant.

The results are shown in Table 1.2.

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Table 1.2

immobilised pectinase	
temperature / °C	**volume of fruit juice / cm^3**
30	38
40	54
50	79
60	98
70	62
80	4

(i) Plot a graph of the data in Table 1.2 on the grid in Fig. 1.5.

Use a sharp pencil.

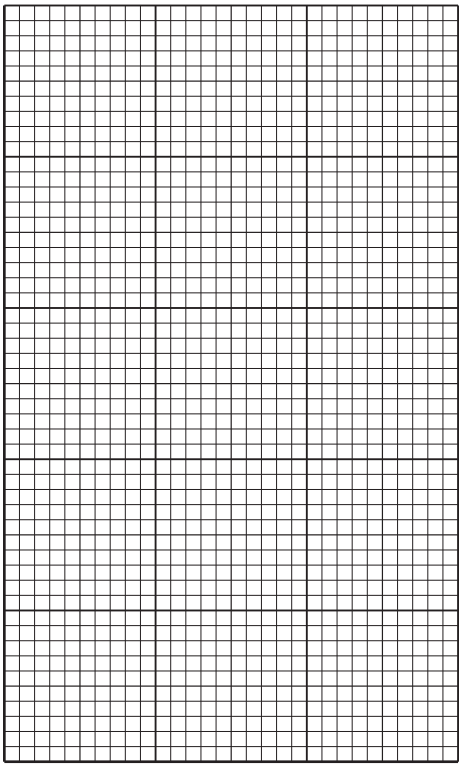


Fig. 1.5

[4]

(ii) Use your graph in Fig. 1.5 to estimate the volume of fruit juice extracted at 55 °C.

Show on your graph how you obtained your answer.

volume of fruit juice = ... cm^3 [2]

(iii) Describe the change in volume of fruit juice shown by your graph in Fig. 1.5.

.....

.....

.....

..... [2]

The scientist repeated the investigation replacing the immobilised pectinase with the same amount of pectinase but not immobilised in beads (free pectinase).

The results are shown in Table 1.3.

Table 1.3

free pectinase (not immobilised)	
temperature / °C	**volume of fruit juice / cm^3**
30	52
40	85
50	98
60	41
70	12
80	4

(iv) Suggest an explanation for why more fruit juice was obtained when using the free pectinase between the temperatures of 30 °C and 50 °C than when using immobilised pectinase.

.....

.....

..... [1]

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(v) Suggest an explanation for why more fruit juice was obtained when using immobilised pectinase between the temperatures of 60 °C and 70 °C than when using the free pectinase.

.....

.....

..... [2]

[Total: 22]

2 **K1** is a slide of a stained transverse section through a plant leaf.

(a) **(i)** Draw a large plan diagram of the whole leaf on **K1**. Use a sharp pencil.

Use **one** ruled label line and label to identify the epidermis.

[5]

(ii) Observe the cells in the epidermis of the leaf on **K1**.

Select a line of **four** adjacent epidermal cells.

Each cell must touch at least **one** of the other epidermal cells.

- Make a large drawing of this line of **four** cells.
- Use **one** ruled label line and label to identify the cell wall.

[5]

Fig. 2.1 is a photomicrograph of a stained transverse section of a leaf from a different type of plant.

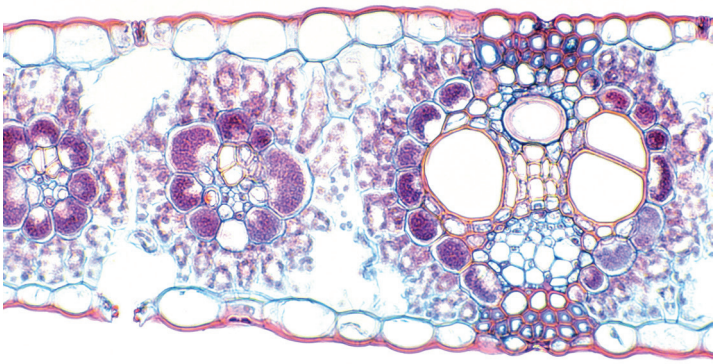


Fig. 2.1

(b) Identify **three** observable differences between the leaf on **K1** and the leaf shown in Fig. 2.1.

Record these **three** observable differences in an appropriate table.

[4]

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Fig. 2.2 is an enlarged version of the transverse section of the leaf shown in Fig. 2.1.

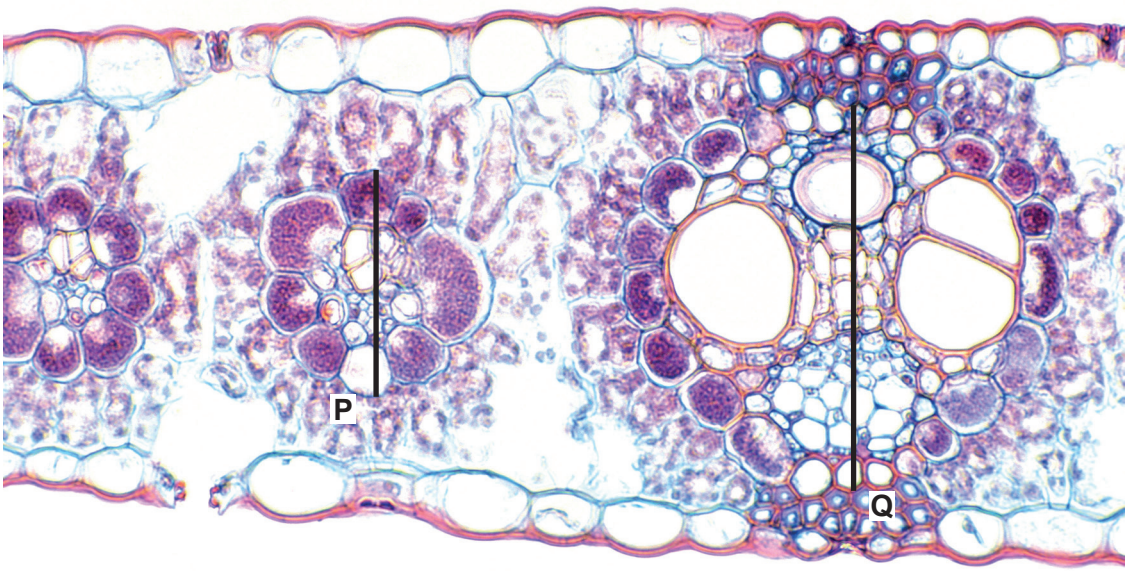


Fig. 2.2

(c) (i) Measure line **P** and line **Q** to find the length of vascular bundle **P** and the length of vascular bundle **Q** as shown in Fig. 2.2.

length of vascular bundle **P** = ...

length of vascular bundle **Q** = ...
[2]

(ii) Calculate the percentage difference in length between vascular bundle **P** and vascular bundle **Q**.

Show your working and give your answer to **two** significant figures.

answer = ... %
[2]

[Total: 18]

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Cambridge International AS & A Level

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BIOLOGY **9700/34**

Paper 3 Advanced Practical Skills 2 **October/November 2023**

2 hours

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

INSTRUCTIONS

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1 The progress of some enzyme-catalysed reactions can be followed by measuring the time taken for the substrate to be hydrolysed.

The enzyme amylase catalyses the hydrolysis of starch to maltose.

You will investigate the effect of different concentrations of amylase on the hydrolysis of starch.

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3	risk
E	2.0% amylase solution	irritant	50	.....
S	1.0% starch solution	none	50	.....
W	distilled water	none	100	
iodine	iodine solution	irritant	25	.....
U	unknown concentration of amylase solution	irritant	10	

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

It is recommended that you wear suitable eye protection.

(a) (i) Think about the hazards of using the materials in Table 1.1 and decide whether the risk of using **E**, **S** and **iodine** is **low**, **medium** or **high**.

Complete Table 1.1, using the words **low**, **medium** or **high**, to state the risk of using **E**, **S** and **iodine**. You may use each word once, more than once or not at all. [1]

You will need to:

- prepare different concentrations of amylase solution
- record the time taken for the amylase to hydrolyse starch
- use your results to estimate the concentration of an unknown solution of amylase, **U**.

You will need to use proportional dilution to make different concentrations of amylase solution, **E**.

You will need to prepare 10 cm^3 of each concentration, using **E** and **W**.

Table 1.2 shows how to prepare two of the concentrations you will use.

Decide which other concentrations of amylase solution you will use.

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(ii) Complete Table 1.2 to show how you will prepare the other concentrations.

Table 1.2

percentage concentration of amylase solution	volume of E / cm^3	volume of W / cm^3
2.0	10.0	0.0
0.4	2.0	8.0

[2]

During the investigation you will be sampling at intervals and using iodine solution to test for the presence of starch. The end-point is reached when the iodine solution is a dark yellow-brown. There may also be some specks of blue-black present in the iodine solution. These specks can be ignored.

Carry out step 1 to step 14.

step 1 Prepare the concentrations of amylase solution as shown in Table 1.2, in the beakers provided. Mix well.

step 2 Label test-tubes with the concentrations of amylase solution prepared in step 1.

step 3 Label the white tile with the numbers shown in Fig. 1.1.

The numbers indicate the sampling times in seconds.

step 4 Put **one** drop of **iodine** on the white tile at each sampling time, as shown in Fig. 1.1.

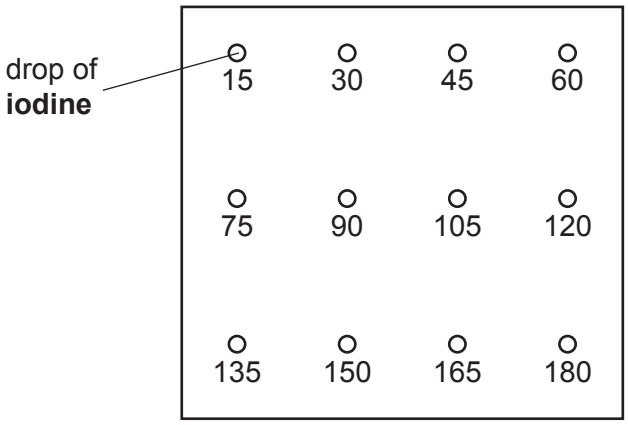


Fig. 1.1

step 5 Put 3 cm^3 of **S** into each of the test-tubes labelled in step 2.

step 6 Put 1 cm^3 of the 2.0% amylase solution, **E**, into the test-tube labelled 2.0%. Use a glass rod to mix.

step 7 Start timing.

step 8 After 15 seconds, use the glass rod to transfer a drop of the mixture from the test-tube onto the drop of **iodine** that is labelled **15**, on the white tile.

step 9 Clean the glass rod with a paper towel.

step 10 Repeat step 8 to step 9 at 15-second intervals until the end-point is reached.

step 11 Record in **(a)(iii)** the time when the end-point is first observed.

If the end-point is not reached at 180 seconds, record as 'more than 180'.

step 12 Clean the white tile with a damp paper towel and then dry the white tile. Make sure all the numbers are still visible.

step 13 Put **one** drop of **iodine** on the white tile at each sampling time, as shown in Fig. 1.1.

step 14 Repeat step 6 to step 13 using the other concentrations of amylase solution you prepared in step 1.

(iii) Record your results in an appropriate table.

[5]

(iv) State the independent variable in this investigation.

..... [1]

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Carry out step 15 to step 23.

step 15 Put **one** drop of **iodine** on the white tile at each sampling time, as shown in Fig. 1.1.

step 16 Label a test-tube with the letter **U**.

step 17 Put 3 cm^3 of **S** into this test-tube.

step 18 Put 1 cm^3 of solution **U** into the same test-tube. Use a glass rod to mix.

step 19 Start timing.

step 20 After 15 seconds, use the glass rod to transfer a drop of the mixture from the test-tube onto the drop of **iodine** that is labelled **15**, on the white tile.

step 21 Clean the glass rod with a paper towel.

step 22 Repeat step 20 to step 21 at 15-second intervals until the end-point is reached.

step 23 Record, in **(a)(v)**, the time when the end-point is first observed.

If the end-point is not reached at 180 seconds, record as 'more than 180'.

(v) State the result for **U**.

result for **U** ..... [1]

(vi) Using your results in **(a)(iii)** and **(a)(v)**, estimate the concentration of amylase in **U**.

..... [1]

(vii) Suggest **one** source of error in the procedure described in step 10 of this investigation.

..... [1]

(viii) Suggest how you could make **one** improvement to reduce the source of error stated in **(a)(vii)**.

.....

.....

.....

..... [1]

(ix) Describe how you would modify the procedure to investigate the effect of **pH** on the time taken for amylase to hydrolyse starch.

.....

.....

.....

.....

..... [2]

(b) A student investigated the effect of different substrate concentrations on the activity of an enzyme in the presence of an inhibitor.

The concentration of the inhibitor was standardised.

The results are shown in Table 1.3.

Table 1.3

concentration of substrate / mol dm^{-3}	rate of reaction / arbitrary units
0.0	0.000
0.2	0.750
0.4	1.375
0.6	1.800
0.8	2.175
1.0	2.250

(i) Plot a graph of the data in Table 1.3 on the grid in Fig. 1.2.

Use a sharp pencil.

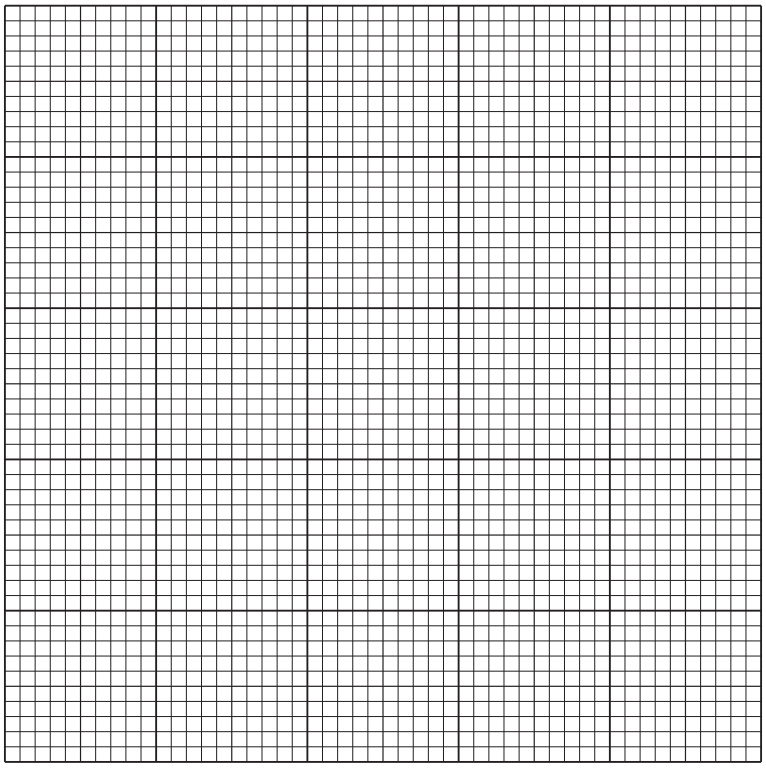


Fig. 1.2

[4]

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(ii) Use your graph in Fig. 1.2 to determine the rate of reaction when the concentration of substrate is $0.45\,mol\,dm^{-3}$.

rate of reaction = ... arbitrary units [1]

(iii) The V_{max} of this enzyme is 2.250 arbitrary units.

Using this information and the graph in Fig. 1.2, state whether the inhibitor is a competitive inhibitor or a non-competitive inhibitor.

.....

Explain your answer.

.....

.....

.....

..... [2]

[Total: 22]

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

(a) **(i)** Draw a large plan diagram of the region of the leaf on **M1** indicated by the shaded area in Fig. 2.1.

Use a sharp pencil.

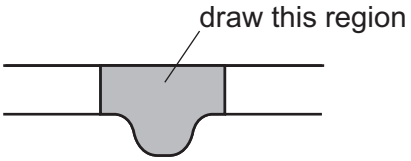


Fig. 2.1

Use **one** ruled label line and label to identify the palisade tissue.

[5]

(ii) Observe the cells in the upper epidermis on the section of the leaf on **M1**.
Select a line of **four** adjacent epidermal cells.

Each cell must touch at least **one** of the other epidermal cells.

- Make a large drawing of this line of **four** epidermal cells.
- Use **one** ruled label line and label to identify the cell wall of **one** epidermal cell.

[4]

(b) Fig. 2.2 is a photomicrograph of a stained transverse section of a different leaf from **M1**.

You are not expected to be familiar with this specimen.

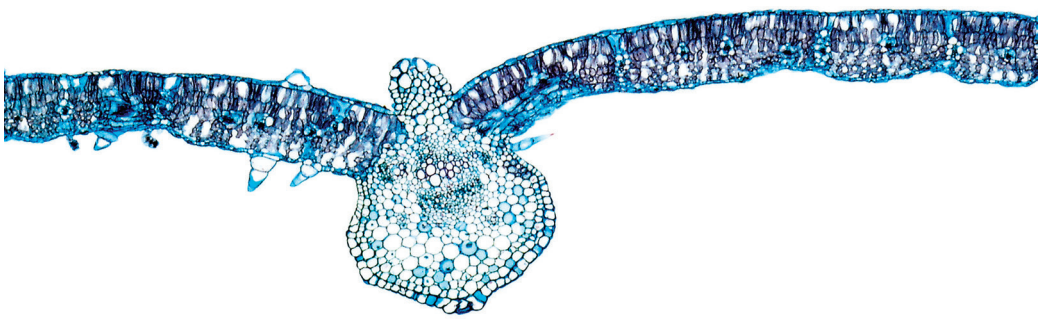


Fig. 2.2

Identify **three** observable differences, other than colour, between the leaf section in Fig. 2.2 and the leaf section on **M1**.

Record these **three** observable differences in Table 2.1.

Table 2.1

feature	Fig. 2.2	M1

[4]

(c) Fig. 2.3 shows a diagram of a stage micrometer scale that is being used to calibrate an eyepiece graticule.

The length of one division on this stage micrometer is **1.0 mm**.

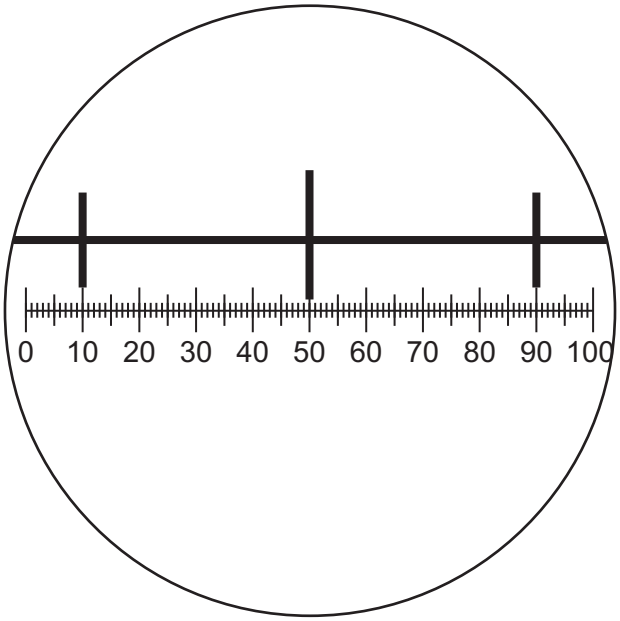


Fig. 2.3

(i) Use Fig. 2.3 to calculate the actual length of one eyepiece graticule unit.

Show your working and give your answer in micrometres (μm).

actual length = ... μm
[3]

Fig. 2.4 is the same photomicrograph as that shown in Fig. 2.2. This was taken using the same microscope and eyepiece graticule as in Fig. 2.3.

The eyepiece graticule scale has been placed across the midrib of the leaf section.

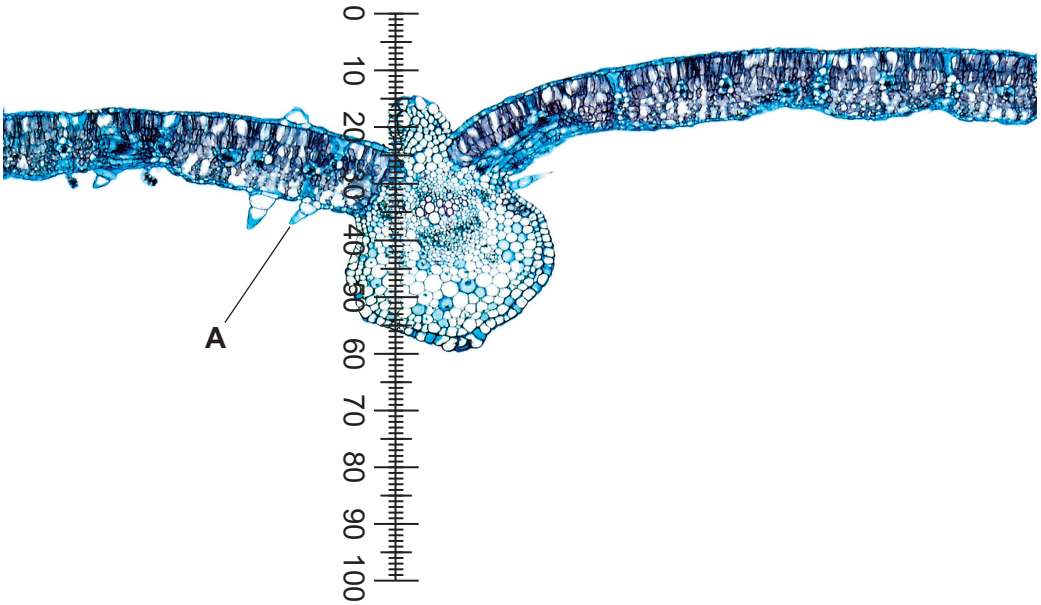


Fig. 2.4

(ii) Use the calibration of the eyepiece graticule unit from **(c)(i)** to calculate the actual thickness of the midrib of the leaf section in Fig. 2.4.

Show your working and use appropriate units.

actual thickness of the midrib of the leaf section = ... [1]

(iii) Suggest a possible function of the structure labelled **A** in Fig. 2.4.

.....

.....

..... [1]

[Total: 18]

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BIOLOGY **9700/35**

Paper 3 Advanced Practical Skills 1 **October/November 2023**

2 hours

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

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Total	

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1 When potato cells are placed into different concentrations of sodium chloride solution, water moves between the sodium chloride solution and the potato cells.

You will investigate the effect of different concentrations of sodium chloride solution on potato tissue.

You will need to:
- prepare different concentrations of sodium chloride solution, **S**
- put potato tissue into the different concentrations of sodium chloride solution
- record the angle the potato tissue bends
- use your results to estimate the concentrations of unknown concentrations of sodium chloride solutions, **U1** and **U2**.

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3
P	7 pieces of potato tissue	none	–
S	10.0% sodium chloride solution	none	200
U1	unknown concentration of sodium chloride solution	none	50
U2	unknown concentration of sodium chloride solution	none	50
W	distilled water	none	200

It is recommended that you wear suitable eye protection.

(a) You will need to use proportional dilution to make five different concentrations of sodium chloride solution, **S**.

You will need to prepare 50 cm^3 of each concentration, using **S** and **W**.

Table 1.2 shows two of the concentrations you will use.

Decide which **three** other concentrations of sodium chloride solution you will use.

(i) Complete Table 1.2 to show how you will prepare the other concentrations.

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Table 1.2

percentage concentration of sodium chloride	volume of S /cm^3	volume of W /cm^3
10	50	0
0	0	50

[2]

Carry out step 1 to step 16.

step 1 Label five beakers with the percentage concentrations of sodium chloride solution stated in Table 1.2.

step 2 Prepare the concentrations of sodium chloride solution, stated in Table 1.2, in the beakers labelled in step 1.

step 3 Put a piece of potato tissue into each of the beakers you labelled in step 1, as shown in Fig. 1.1.

step 4 Put a piece of potato tissue into each of the beakers labelled **U1** and **U2**, as shown in Fig. 1.1.

step 5 Start timing.

step 6 Leave the pieces of potato tissue in the sodium chloride solutions for 20 minutes.

While you are waiting, use your time to continue with other parts of Question 1.

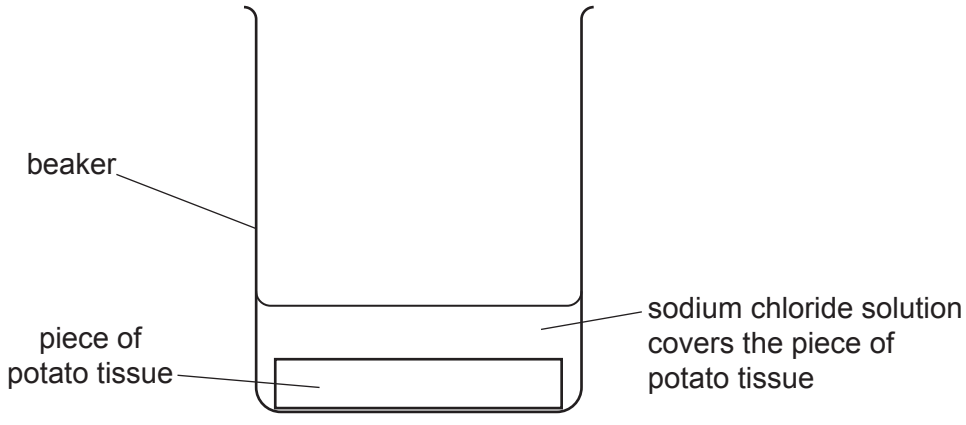


Fig. 1.1

You are provided with two sheets of A4 paper, each showing four protractors.
Do **not** cut these into separate protractors. Do **not** remove them from the plastic covering.

You will use the protractors to measure the angle the pieces of potato tissue bend after being left for 20 minutes in the sodium chloride solutions.

step 7 After 20 minutes (step 6) remove the piece of potato tissue from the 10.0% sodium chloride solution and put it onto a paper towel to remove the excess liquid.

step 8 Put the piece of potato tissue on the vertical line of a protractor, as shown in Fig. 1.2.

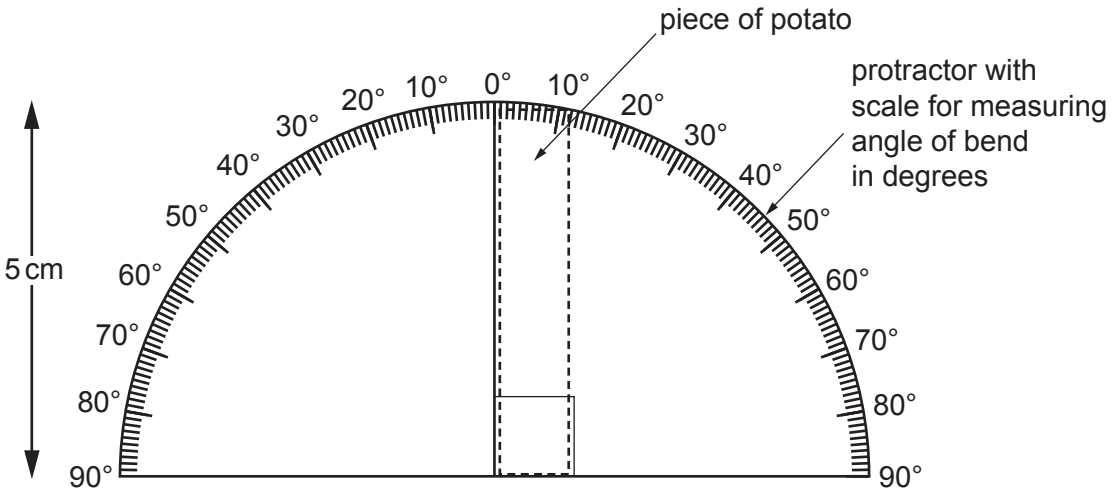


Fig. 1.2

step 9 Put your finger on the bottom of the potato tissue and press firmly, as shown in Fig. 1.3. Hold the potato tissue firmly in this position.

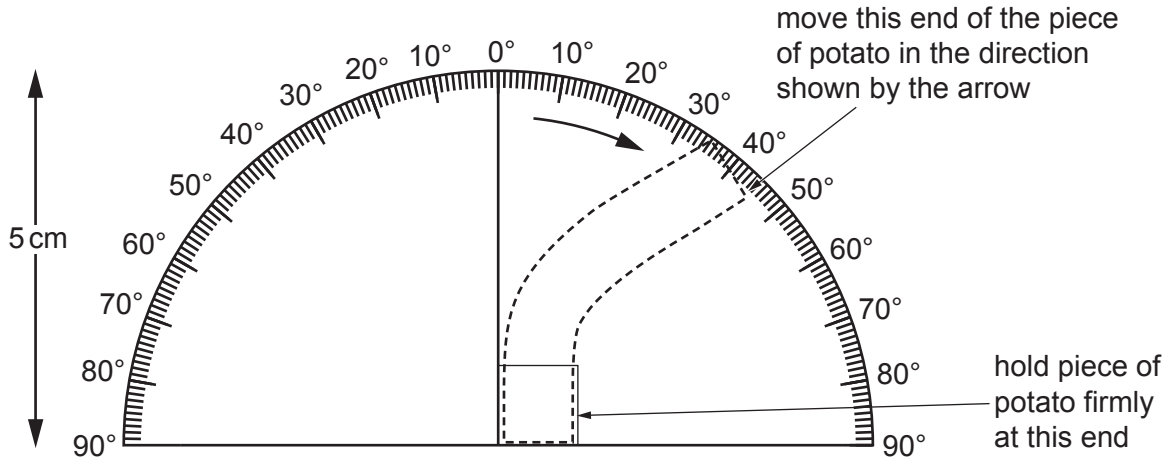


Fig. 1.3

step 10 Move the top of the potato tissue, as shown in Fig. 1.3, until there is strong resistance.

step 11 Mark the position of the top of the potato tissue on the protractor, as shown in Fig. 1.4.

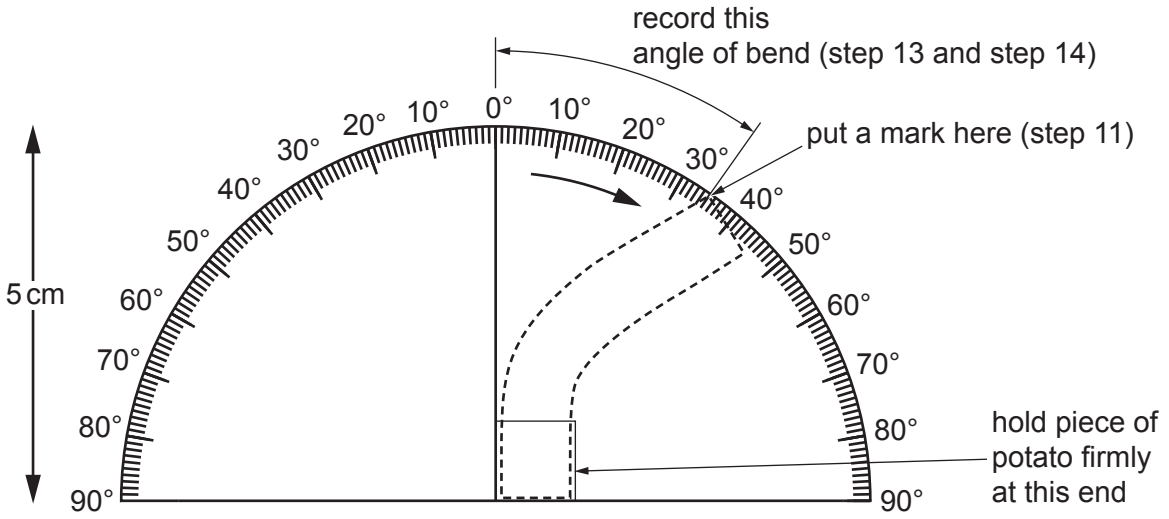


Fig. 1.4

step 12 Remove the potato tissue and put it in the container labelled **For waste**.

step 13 Measure the angle between the mark and the vertical line on the protractor, as shown in Fig. 1.4.

step 14 Record your result in **(a)(ii)**.

step 15 Repeat step 7 to step 14 using the potato tissue from the other concentrations of sodium chloride solution prepared in step 2.

step 16 Repeat step 7 to step 13 using the potato tissue from **U1** and **U2**. Record your result for **U1** and for **U2** in **(a)(iv)**.

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(ii) Record your results in an appropriate table.

[4]

(iii) State the independent variable.

..... [1]

(iv) State the result for **U1** and **U2**.

result for **U1** .....

result for **U2** .....
[1]

(v) Use your results in **(a)(ii)** to estimate the concentration of sodium chloride in **U1** and **U2**.

estimate of **U1** = ... %

estimate of **U2** = ... %
[2]

(vi) Explain, in terms of water potential, the difference between the result for **U1** and the result for **U2**.

.....

.....

.....

.....

..... [3]

(vii) Suggest how you could make improvements to the procedure so that a more accurate estimate of the concentration of sodium chloride in **U1** and **U2** could be obtained.

.....

.....

.....

.....

.....

.....

.....

.....

..... [3]

(b) A scientist measured the concentration of sodium chloride in extracts from different vegetables.

The results are shown in Table 1.3.

Table 1.3

type of vegetable extract	concentration of sodium chloride / mg 100 cm^{-3}
green beans (GB)	3
cauliflower (CA)	33
celery (CE)	115
broccoli (BR)	89
green cabbage (GC)	20

(i) Draw a bar chart of the data in Table 1.3 on the grid in Fig. 1.5.
Use a sharp pencil.

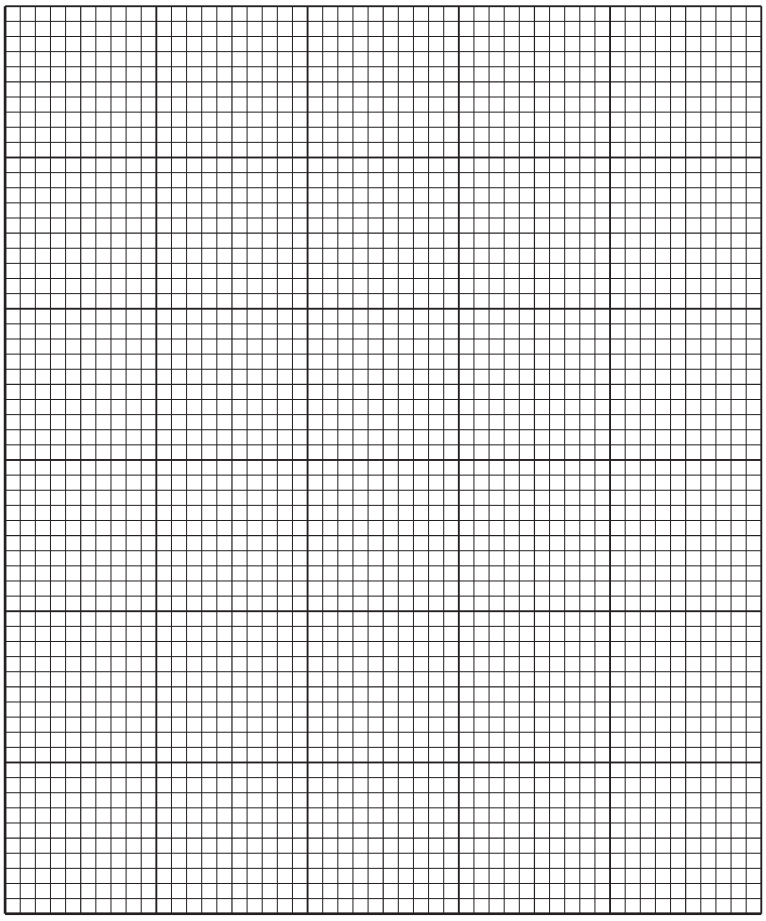


Fig. 1.5

[4]

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(ii) The scientist then placed pieces of plant tissue from each of the vegetables in Table 1.3 into 100 mg 100 cm^{-3} sodium chloride solution. The dimensions of the pieces of plant tissue were standardised.

The plant tissues were left in the solution for 1 hour.

The scientist then observed the cells in these tissues using a microscope.

The scientist noted that, in many of the plant tissues, there were many plasmolysed cells. For one tissue there were no plasmolysed cells on the slide.

Using this information and Table 1.3, suggest which vegetable resulted in no plasmolysed cells.

..... [1]

[Total: 21]

2 **L1** is a slide of a stained transverse section through a plant stem.

(a) **(i)** Draw a large plan diagram of the region of the stem on **L1** indicated by the shaded area in Fig. 2.1. Your drawing should include at least one vascular bundle. Use a sharp pencil.

Use **one** ruled label line and label to identify the epidermis.

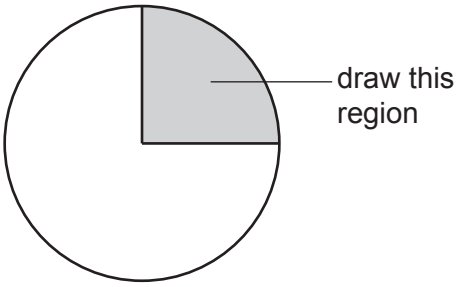


Fig. 2.1

[5]

(ii) Observe the vascular tissue on the section of the stem on **L1**.

Select **one** large xylem vessel element and a group of **three** adjacent, smaller xylem vessel elements.

- Make a large drawing of this group of **four** xylem vessel elements.
- Use **one** ruled label line and label to identify the cell wall.

[5]

(b) Fig. 2.2 is a photomicrograph of a stained transverse section through a different stem from **L1**.

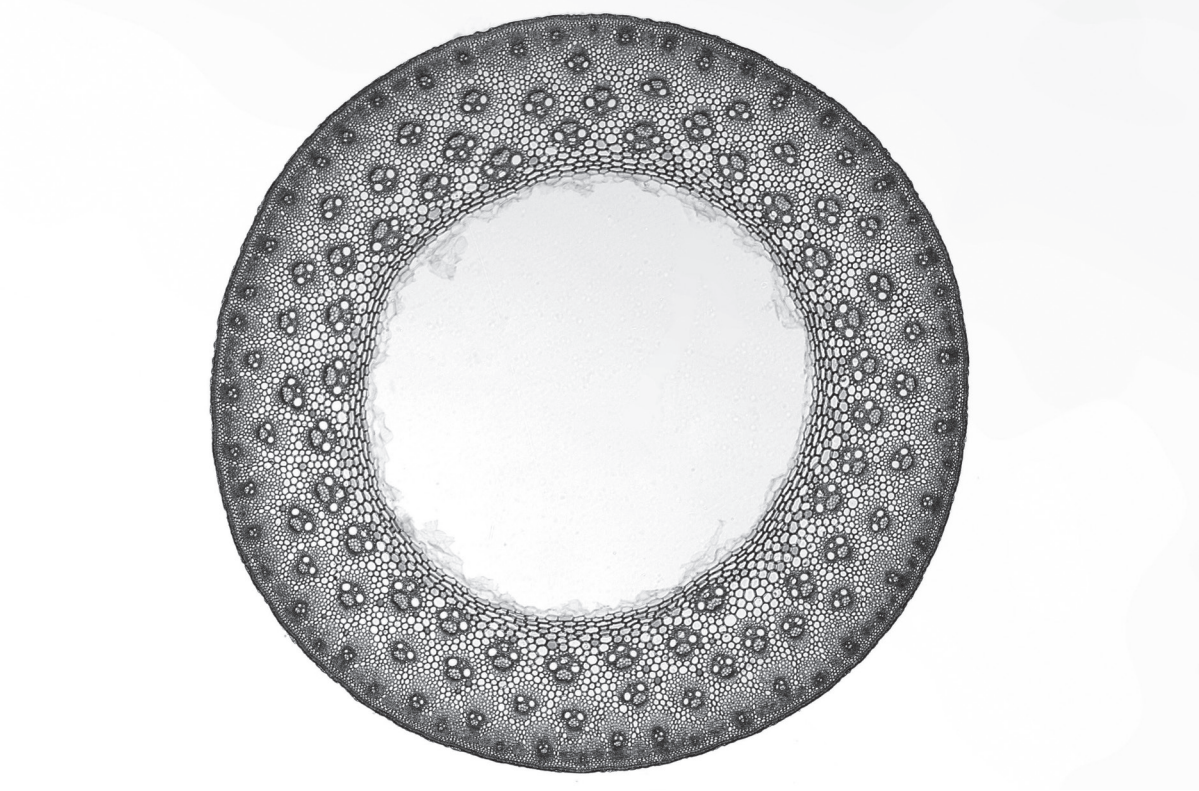


Fig. 2.2

Identify **three** observable differences, other than colour, between the stem section in Fig. 2.2 and the stem section on **L1**.

Record these **three** observable differences in Table 2.1.

Table 2.1

feature	Fig. 2.2	L1

[4]

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(c) Fig. 2.3 is the same photomicrograph as that shown in Fig. 2.2.

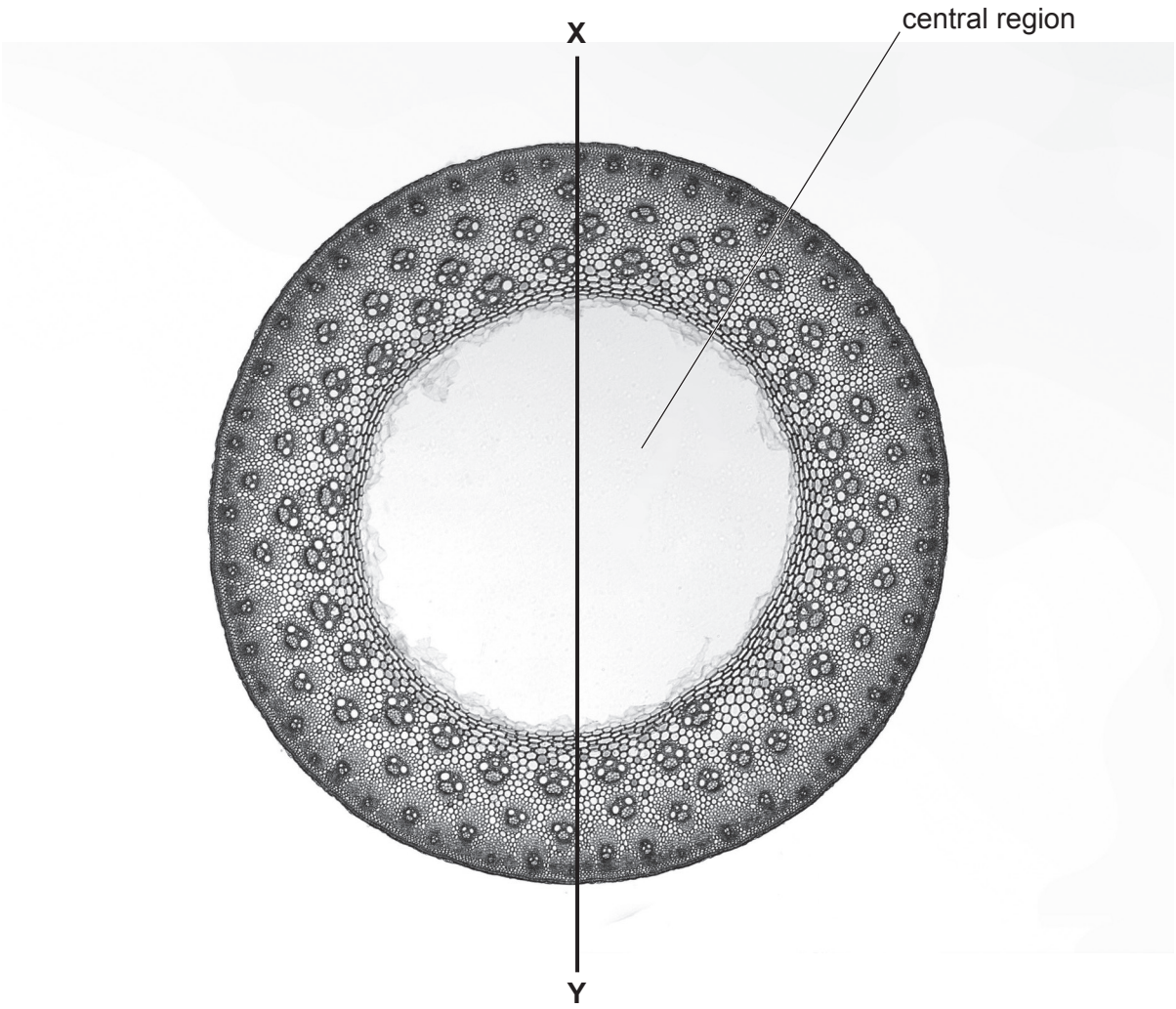


Fig. 2.3

(i) Along the line **X**–**Y**, measure the diameter of the whole stem section **and** the diameter of the central region.
Use appropriate units.

diameter of whole stem section .....

diameter of central region .....
[2]

(ii) Calculate the area of the whole stem section and the area of the central region using your answers in **(c)(i)** and the equation:

$$\text{area} = \pi r^2$$

Show your working.

area of whole stem section .....

area of central region .....
[2]

(iii) State the ratio of the area of the whole stem section to the area of the central region.

ratio ..... [1]

[Total: 19]

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BIOLOGY **9700/36**

Paper 3 Advanced Practical Skills 2 **October/November 2023**

2 hours

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

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1 Agar stained with universal indicator can be used to investigate diffusion.

When hydrochloric acid diffuses into the agar it changes the colour from green to pink.

You will investigate the diffusion of different concentrations of hydrochloric acid in agar.

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3
H	2.0 mol dm^{-3} hydrochloric acid	irritant	20
W	distilled water	none	30
	2 Petri dishes containing agar	none	–
sheet T	sheet T	–	–

If **H** comes into contact with your skin, wash off immediately with cold water.

It is recommended that you wear suitable eye protection.

You will need to:

- prepare different concentrations of hydrochloric acid, **H**
- measure the diffusion distance for each concentration of hydrochloric acid.

You will need to carry out a **serial** dilution of the 2.0 mol dm^{-3} hydrochloric acid, **H**, to reduce the concentration by **half** between each successive dilution.

You will need to prepare **four** concentrations of hydrochloric acid in addition to 2.0 mol dm^{-3} hydrochloric acid, **H**.

After the serial dilution is completed, you will need to have 5 cm^3 of each concentration available to use.

(a) (i) Complete Fig. 1.1 to show how you will prepare your serial dilution.

Fig. 1.1 shows the beakers you will use.

For each beaker, add labelled arrows to show:

- the volume of hydrochloric acid transferred
- the volume of distilled water, **W**, added.

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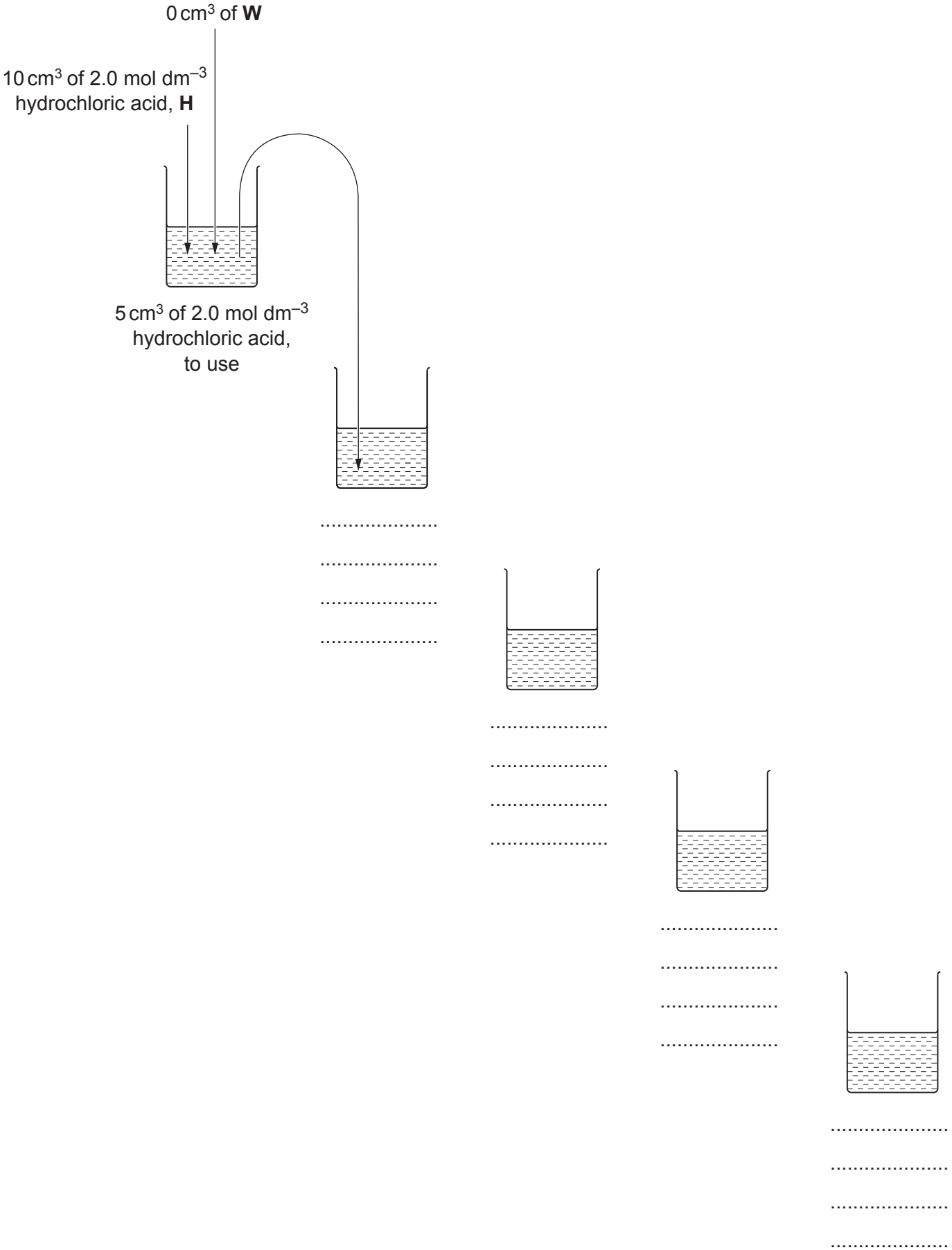

0 cm3 of W
10 cm3 of 2.0 mol dm–3 hydrochloric acid, H
5 cm3 of 2.0 mol dm–3 hydrochloric acid, to use
.....
.....
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.....
.....

Fig. 1.1

[3]

step 1 Prepare the concentrations of hydrochloric acid, as decided in **(a)(i)**, in the beakers provided.

The different concentrations of hydrochloric acid will be put into wells cut into the agar.

The position of one well is shown in Fig. 1.2.

You need to decide where to put **four** more wells in the agar in each Petri dish so that the wells are positioned away from each other and away from the edge of the Petri dish. Hydrochloric acid will diffuse into the agar around each well.

(ii) Complete Fig. 1.2 by:

- drawing **four** small circles to show where you have decided the wells should be positioned in the agar
- labelling the **five** small circles in Fig. 1.2 with the concentrations of hydrochloric acid you prepared in step 1.

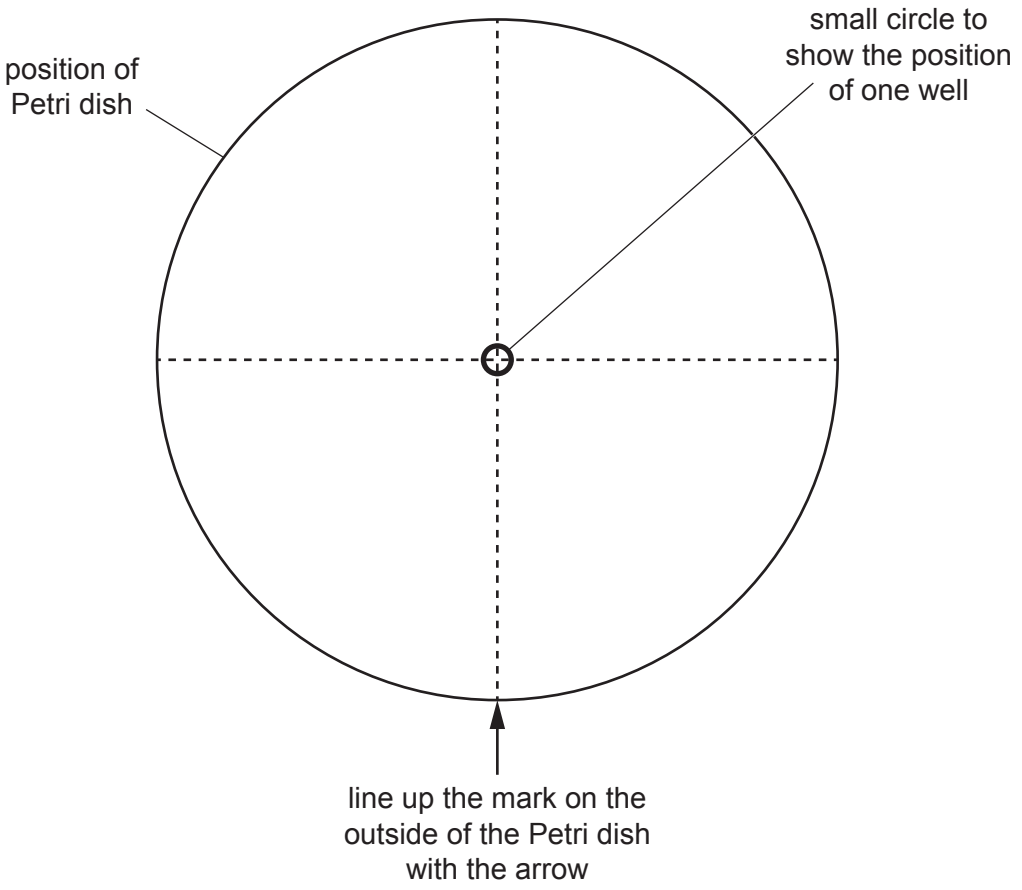


Fig. 1.2

[1]

Carry out step 2 to step 14.

step 2 Draw a mark on the outside edge of one of the Petri dishes containing agar.

step 3 Put the Petri dish on Fig. 1.2 so that the mark on the edge of the Petri dish lines up with the arrow in Fig. 1.2. Keep the Petri dish in this position over Fig. 1.2 for the whole of step 4.

step 4 Use a straw to cut wells in the agar at the positions of the small circles on Fig. 1.2:

- put the end of a straw on the surface of the agar over the centre small circle
- carefully push the straw into the agar
- lift up the straw to leave a well in the agar
- hold the straw over the container labelled **For waste**
- blow gently through the straw to remove the agar from the end of the straw
- if the small circle of agar is **not** lifted by the straw, use a scalpel or mounted needle to carefully remove the agar and put it in the container labelled **For waste**.

step 5 Remove the Petri dish from Fig. 1.2 and leave it for use in step 7.

step 6 Repeat step 2 to step 4 with the other Petri dish containing agar.

You are provided with **sheet T** for use in step 7 and step 8.

step 7 Put one of the Petri dishes on circle **A** on **sheet T** so that the mark on the edge of the Petri dish lines up with the arrow.

step 8 Put the other Petri dish on circle **B** on **sheet T** so that the mark on the edge of the Petri dish lines up with the arrow.

step 9 For each Petri dish, **A** and **B**, use a pipette to carefully put 2.0 mol dm^{-3} hydrochloric acid, **H**, into the appropriate well in the agar, as labelled in Fig. 1.2.

step 10 Repeat step 9 for the other concentrations of hydrochloric acid labelled in Fig. 1.2.

Do **not** move the Petri dishes after the wells have been filled with the hydrochloric acid.

step 11 Start timing.

Between step 11 and step 12, you will be leaving the Petri dishes on **sheet T** for 20 minutes.

Use this time to continue with other parts of Question 1.

step 12 After leaving the Petri dishes for 20 minutes, use a pipette to remove the hydrochloric acid from the wells in both Petri dishes. Put this hydrochloric acid into the beaker labelled **For waste**.

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step 13 Measure the diffusion distance, as shown in Fig. 1.3, for each concentration of hydrochloric acid in both Petri dishes.

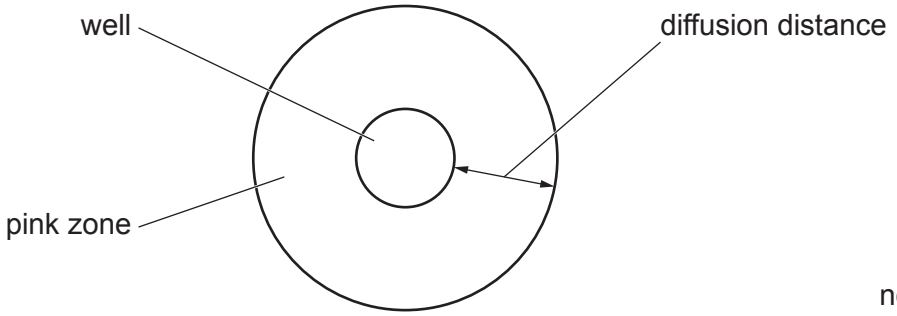


Fig. 1.3

step 14 Record your results in **(a)(iii)**.

(iii) Record your results in an appropriate table.

[5]

(iv) Calculate the rate of diffusion for 2.0 mol dm^{-3} hydrochloric acid, **H**.

Show your working and use appropriate units.

rate = ... [2]

(v) A student observed that the rate of diffusion was **not** constant during the investigation.

Suggest how the student could modify the procedure to investigate the change in the rate of diffusion.

.....

.....

.....

.....

.....

..... [3]

(b) A scientist studied the rate of absorption of the amino acid alanine through the wall of the small intestine.

A concentration gradient was maintained throughout the investigation and all other variables were kept constant.

The results are shown in Table 1.2.

Table 1.2

percentage concentration of alanine	rate of absorption / $\mu m\ h^{-1}$
5	300
14	950
30	1625
50	1750
70	1775

(i) Plot a graph of the data shown in Table 1.2 on the grid in Fig. 1.4.

Use a sharp pencil.

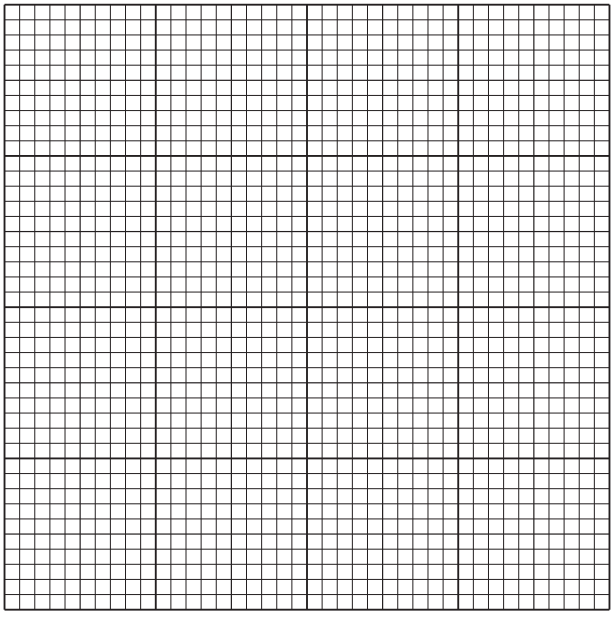


Fig. 1.4

[4]

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(ii) Amino acids are transported into cells by facilitated diffusion.

Explain the shape of your graph in Fig. 1.4.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 21]

2 **N1** is a slide of a stained transverse section through a plant stem.

(a) **(i)** Draw a large plan diagram of the region of the stem on **N1** indicated by the shaded area in Fig. 2.1. Use a sharp pencil.

Use **one** ruled label line and label to identify the epidermis.

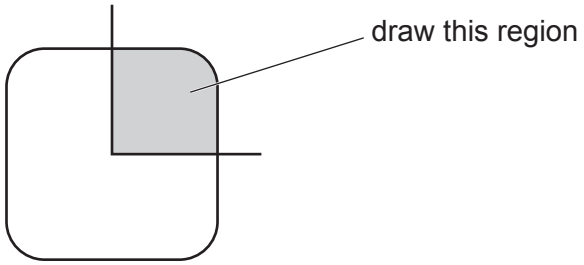


Fig. 2.1

[5]

(ii) Observe the xylem on the section of the stem on **N1**.

Select a line of **four** adjacent xylem vessel elements.

Each xylem vessel element must touch at least **one** of the other xylem vessel elements that you have selected.

- Make a large drawing of this line of **four** xylem vessel elements.
- Use **one** ruled label line and label to identify the lumen.

[5]

(b) Fig. 2.2 is a photomicrograph of a stained transverse section through a different stem from **N1**.

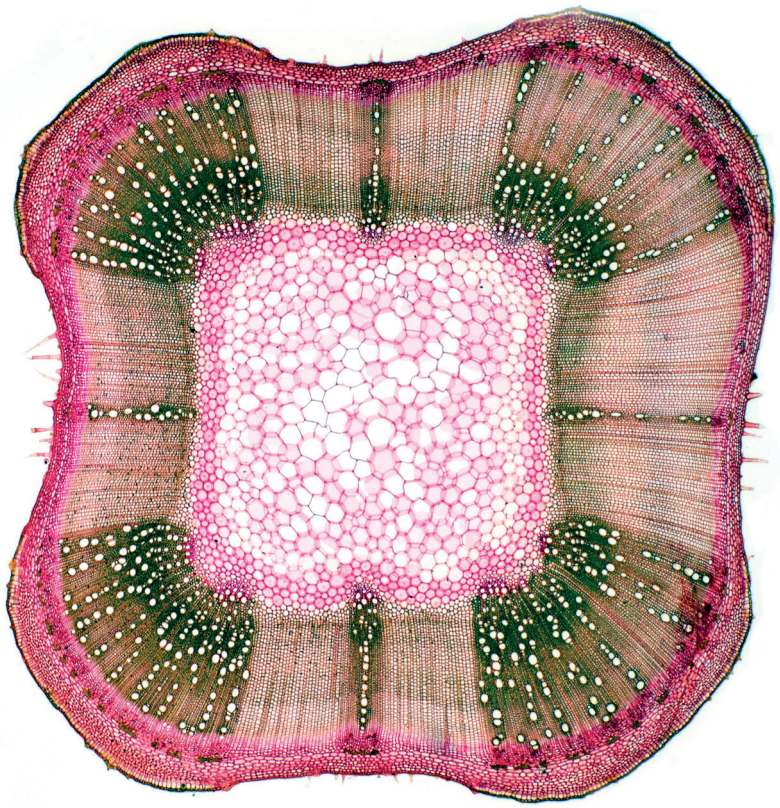


Fig. 2.2

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The section on **N1** and the section in Fig. 2.2 have some similar structures.

One example of a similar structure is shown in Table 2.1.

Identify **three** more observable structures that are similar on the section on **N1** and the section in Fig. 2.2 and describe how each observable structure is similar.

Record and describe these **three** observable similarities in Table 2.1.

Table 2.1

similar structure	how the structures are similar
xylem	xylem vessel elements present in distinct lines in the vascular bundles

[4]

(c) Fig. 2.3 is the same photomicrograph as that shown in Fig. 2.2.

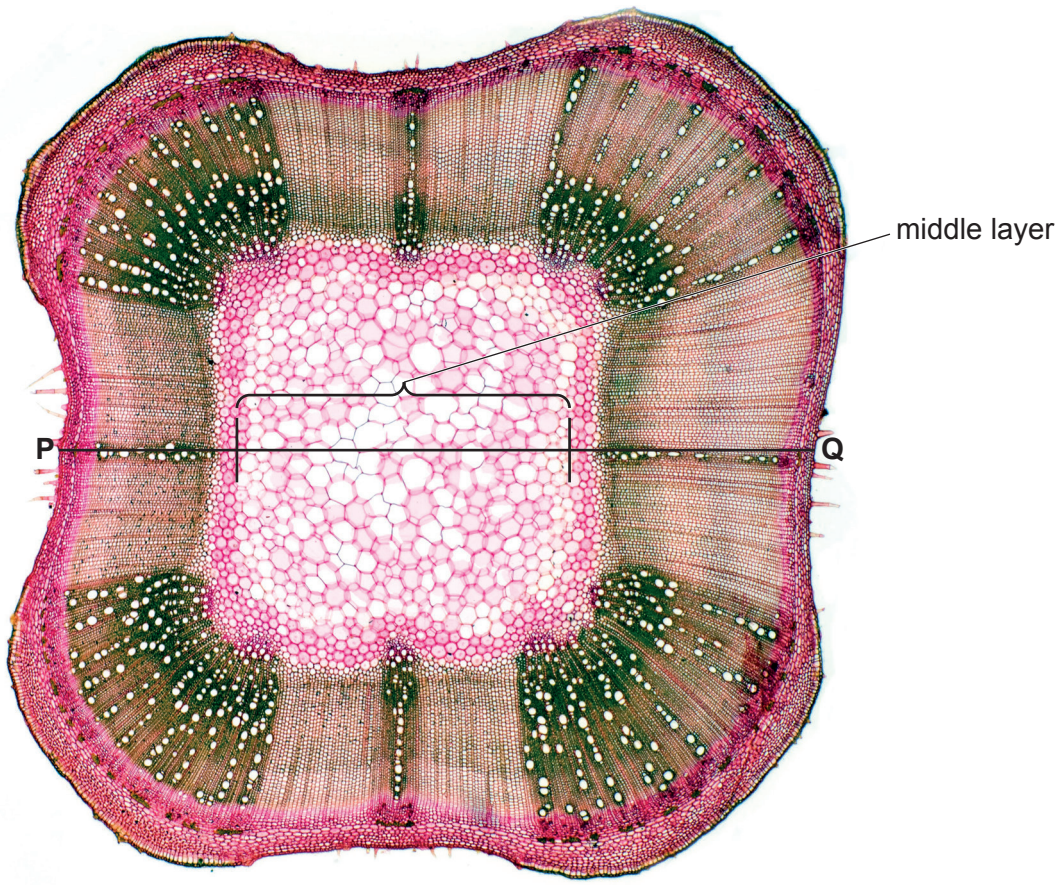


Fig. 2.3

(i) In Fig. 2.3 the line **P**–**Q** represents the width of the whole stem section. The middle layer of the stem section is also labelled.

Calculate the width of the middle layer as a percentage of the width of the whole stem section.

Show your working and give your answer to **two** significant figures.

answer = ... % [4]

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(ii) The width of the middle layer varies at different positions around the stem.

State how to determine the mean width of the middle layer of the stem section in Fig. 2.3.

.....

..... [1]

[Total: 19]

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