Cambridge Assessment International Education

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BIOLOGY **9700/31**

Paper 3 Advanced Practical Skills 1 **May/June 2022**

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 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.

You will estimate the concentration of molecule **R** in a sample of plant extract **U**.

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3
10R	10% solution of molecule **R**	none	100
W	distilled water	none	100
U	unknown concentration of molecule **R** in a plant extract	none	40
A	sulfuric acid solution	harmful irritant	20
K	potassium manganate(VII) solution	irritant	20

If any of the solutions come into contact with your skin, wash off immediately under cold water.

It is recommended that you wear suitable eye protection and wear gloves to protect your hands when using **A** and **K**.

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[Turn over

(a) You will need to carry out a **serial** dilution of the 10% molecule **R** solution, **10R**, to reduce the concentration by **half** between each successive dilution.

You will need to prepare **four** concentrations of molecule **R** solution in addition to the **10% molecule R** solution, **10R**.

After the serial dilution is completed, you will need to have 10 cm^3 of each concentration available to use.

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

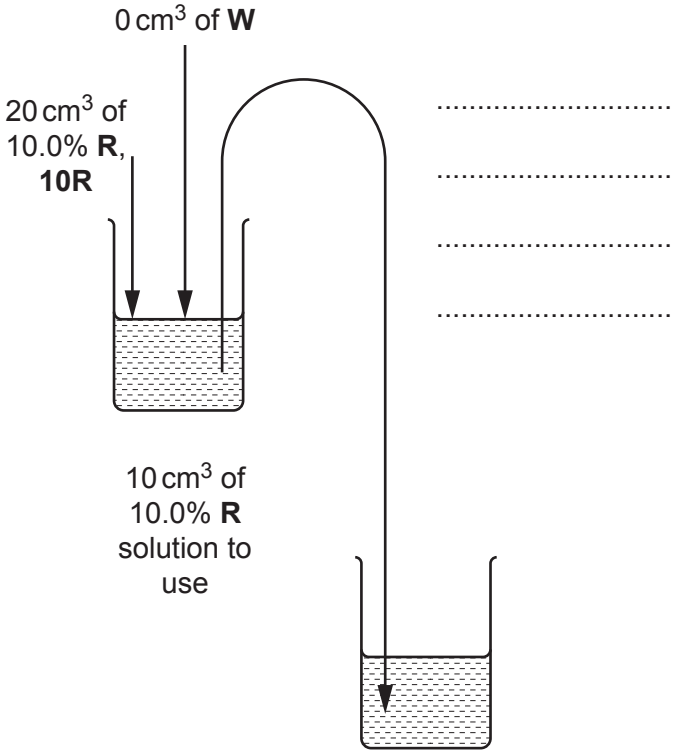
Fig. 1.1 shows the first two beakers you will use to make your serial dilution. You will need to draw **three** additional beakers.

For each beaker add labelled arrows to show:

- the volume of molecule **R** solution transferred
- the volume of distilled water, **W**, added.

Under each beaker, state the concentration of molecule **R** solution.

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.....

.....

Fig. 1.1

[3]

Molecule **R** changes an acidified potassium manganate(VII) solution, **K**, from a pink colour to colourless.

The lower the concentration of molecule **R**, the greater the volume of **R** needed to change the potassium manganate(VII) from pink to colourless (the end-point).

Carry out step 1 to step 12.

step 1 Prepare the concentrations of molecule **R** solution, as decided in **(a)(i)**, in the beakers provided.

step 2 Label 5 test-tubes with the concentrations of **R** you prepared in step 1.

step 3 Put 1 cm^3 of **A** into the test-tube labelled 10%.

step 4 Put 1 cm^3 of **K** into the same test-tube and mix well.

step 5 Put the nozzle of a clean 10 cm^3 syringe into the beaker containing 10% **R**.

step 6 Pull the plunger out to the 5 cm^3 mark so that 5 cm^3 of 10% **R** enters the syringe.

step 7 Put the syringe containing 10% **R** into the test-tube from step 4 as shown in Fig. 1.2.

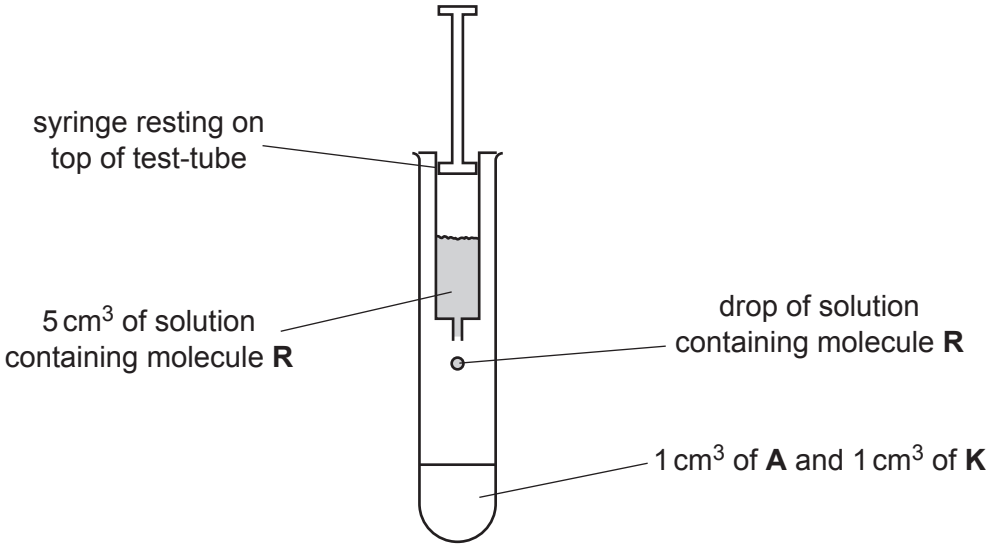


Fig. 1.2

You will be counting the number of drops needed to change **K** from pink to colourless (the end-point).

step 8 Gently press the plunger to add one drop of solution containing molecule **R**.

step 9 Mix well.

step 10 If the mixture stays pink repeat step 8 and step 9. Count the number of drops released to reach the end-point. If the number of drops needed to reach the end-point is more than 100, record as 'more than 100'.

step 11 Record the results in **(a)(ii)**.

step 12 Repeat step 3 to step 11 for each of the concentrations of molecule **R** prepared in step 1.

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(ii) Record your results in an appropriate table.

[5]

(iii) State **two** significant sources of error when measuring the dependent variable in this investigation.

.....

.....

.....

.....

..... [2]

(iv) Suggest how you could improve the procedure to reduce **one** of the errors stated in **(a)(iii)**.

.....

.....

..... [1]

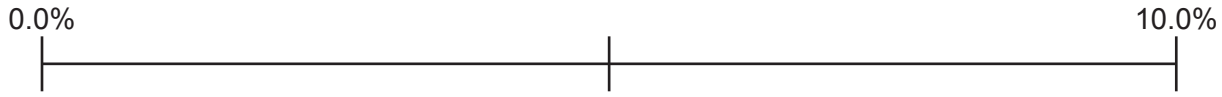
step 13 Repeat step 3 to step 10 with **U**, the unknown concentration of molecule **R**.

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

(v) State the number of drops of **U** needed to reach the end-point ..... [1]

(vi) Complete Fig. 1.3 to show the positions of each of the percentage concentrations of molecule **R** solution recorded in **(a)(ii)**.

[1]



percentage concentration of molecule **R**

Fig. 1.3

(vii) Use your results in **(a)(ii)** and **(a)(v)** to estimate the concentration of molecule **R** in solution **U**.

Show this estimate of the concentration of **U** on Fig. 1.3, by placing the letter **U** on the line in the correct position.

[1]

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

The student added a fixed volume of the extract to acidified potassium manganate(VII) and timed how long it took to reach the end-point.

The results are shown in Table 1.2.

Table 1.2

plant extract	time / s
B	15
C	59
D	42
E	10
F	7

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

Use a sharp pencil.

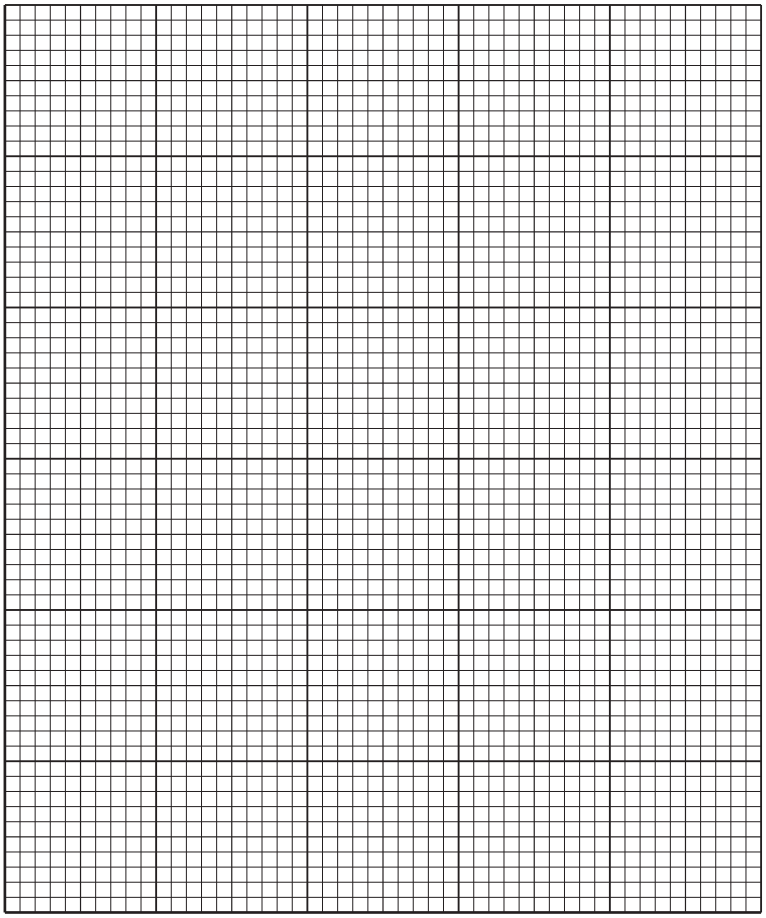


Fig. 1.4

[4]

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

..... [1]

(c) 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. 1.5.

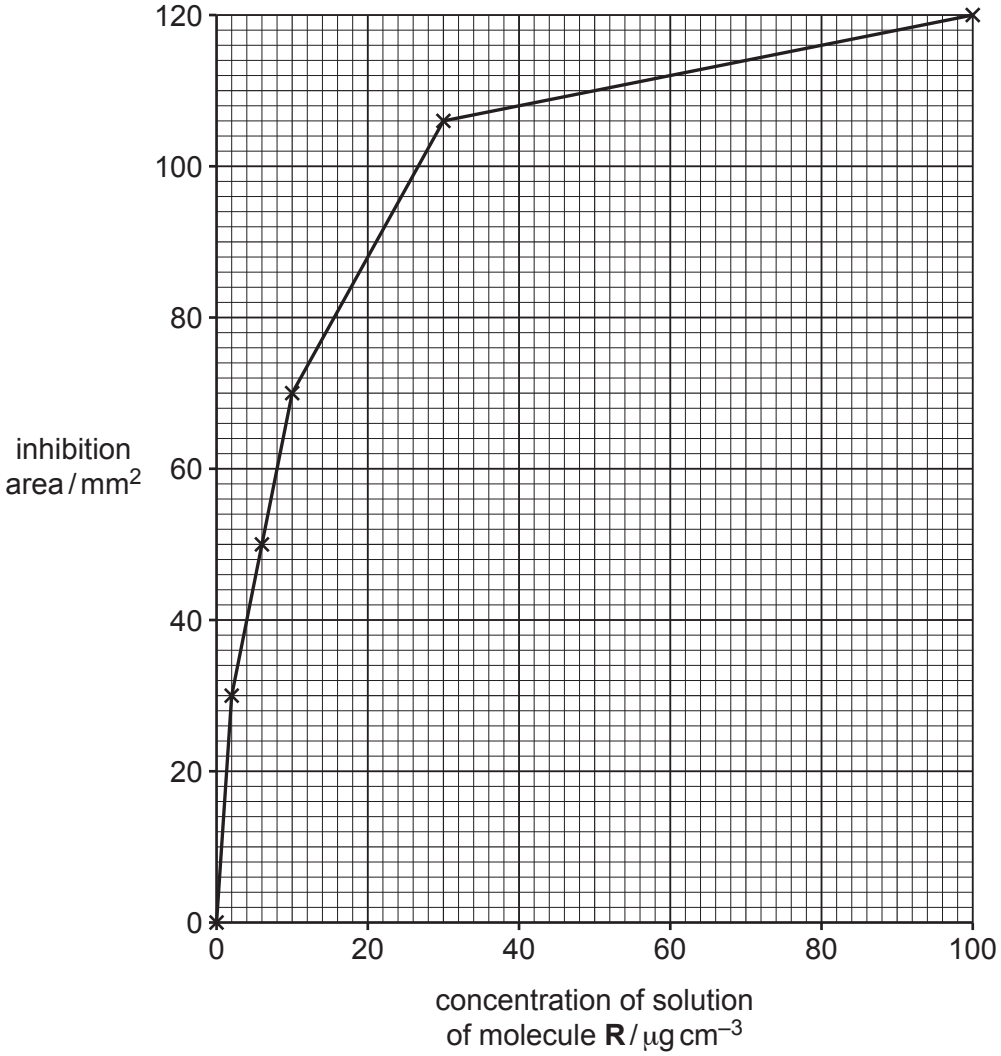


Fig. 1.5

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(i) Use the graph in Fig. 1.5 to estimate the concentration of plant extract that results in an inhibition area of 92 mm^2.

concentration of plant extract = ... [1]

(ii) Suggest how the molecule in the plant extract may inhibit the growth of the bacteria.

.....

.....

.....

.....

..... [2]

[Total: 22]

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

(a) **(i)** Draw a large plan diagram of the whole section on **J1**. Use a sharp pencil.

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

[5]

(ii) The leaf section on **J1** is from a plant that lives at high altitudes in very cold conditions. In the winter the ground is often frozen and plants are unable to take up water.

Suggest **one** observable feature of the leaf section on **J1** which enables it to survive in these conditions.

.....

..... [1]

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(iii) Observe the cells in the epidermis of the section on **J1**.

Select a line of four adjacent cells that make up this tissue.

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

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

[5]

(b) Fig. 2.1 is a photomicrograph of a stained transverse section through a different type of leaf from **J1**.

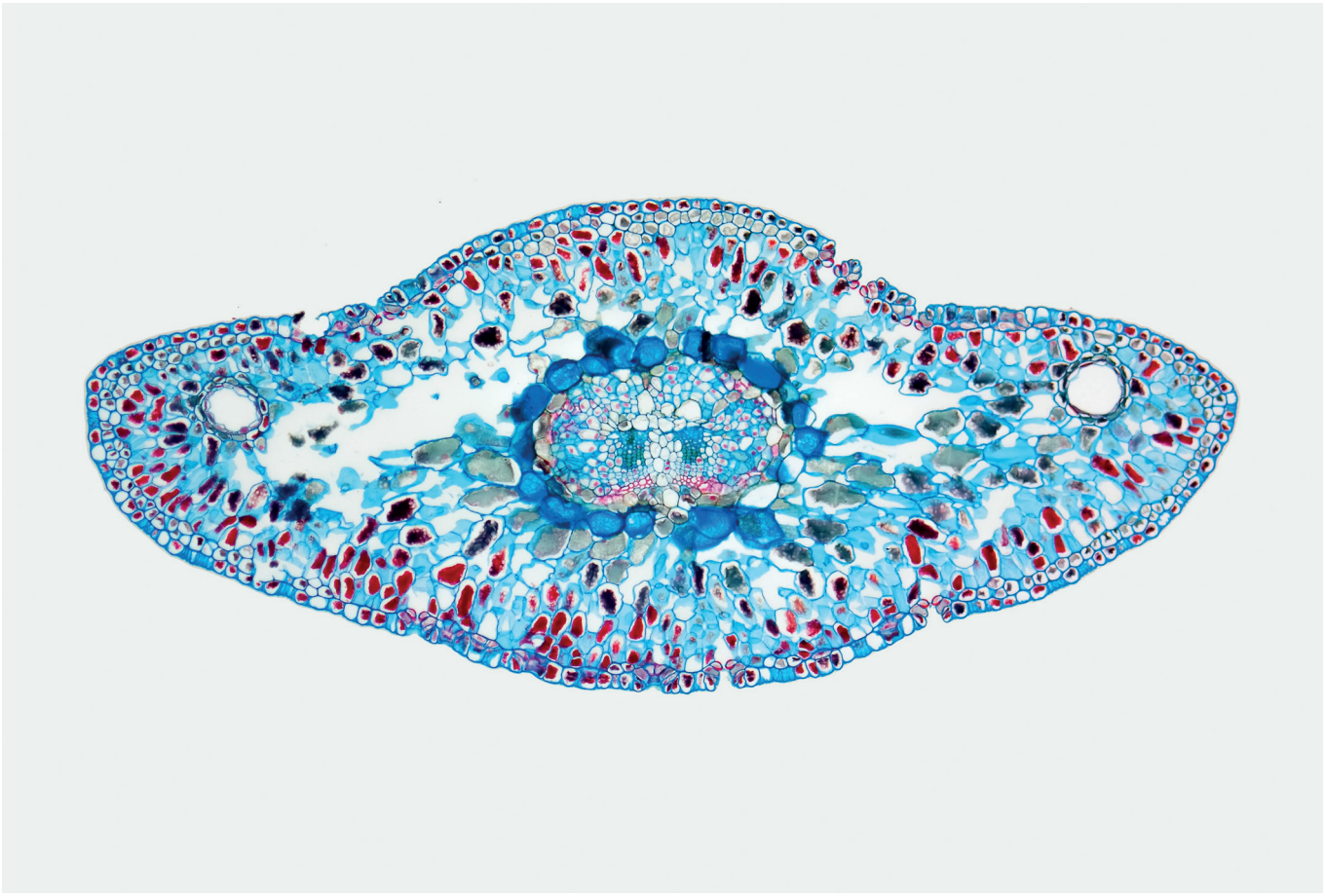


Fig. 2.1

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Identify **three** observable **differences** between the leaf section on **J1** and the leaf section in Fig. 2.1.

Record these three observable differences in Table 2.1.

Table 2.1

feature	J1	Fig. 2.1

[3]

(c) Fig. 2.2 is the same photomicrograph as that in Fig. 2.1, with the line **X**–**Y** drawn across its width.

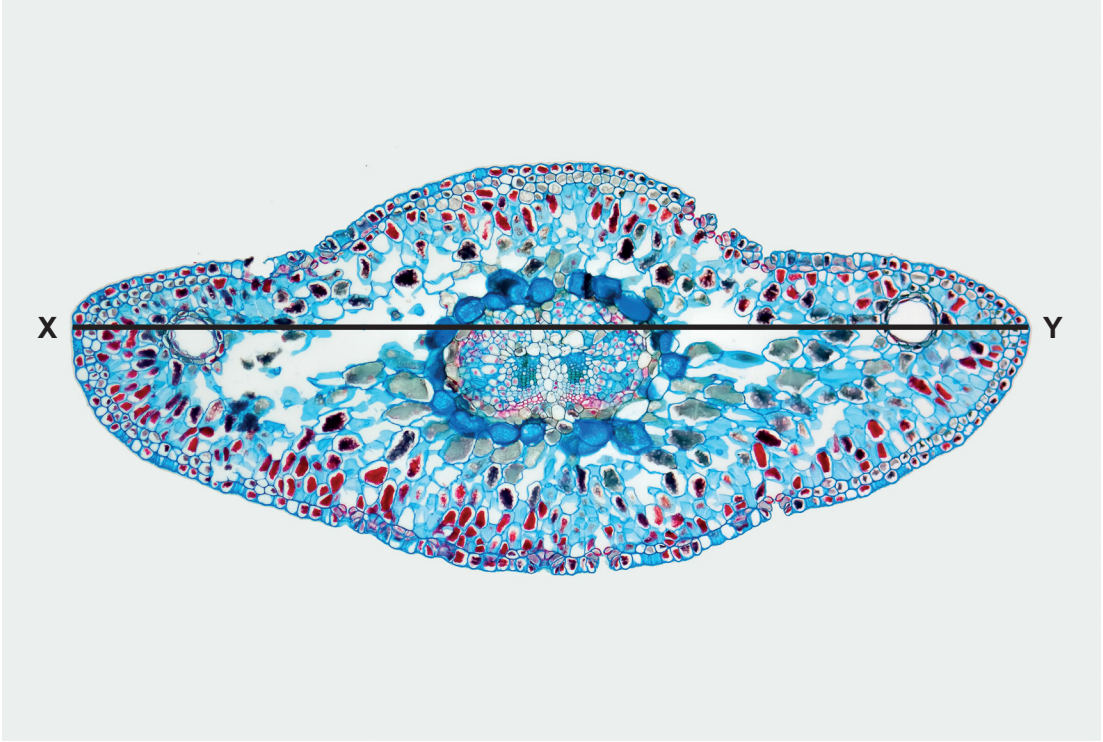


Fig. 2.2

In Fig. 2.2 the line **X**–**Y** is drawn across the width of the leaf. Use the line **X**–**Y** and the scale bar to calculate the actual width of the leaf.

Show your working.

actual width of leaf = ... [4]

[Total: 18]

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Cambridge International AS & A Level

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BIOLOGY **9700/32**

Paper 3 Advanced Practical Skills 2 **May/June 2022**

2 hours

You must answer on the question paper.

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

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1 Plant tissues contain the enzyme catalase which catalyses the breakdown of hydrogen peroxide into oxygen gas and water.

Ascorbic acid acts as an inhibitor of catalase.

You will investigate the effect of changing ascorbic acid concentration on catalase inhibition.

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3
H	hydrogen peroxide solution	harmful irritant	50
W	distilled water	none	50
A	1 mol dm^{-3} ascorbic acid solution	irritant	10

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

It is recommended that you wear suitable eye protection.

You are also provided with five cylinders of potato tissue, labelled **P**.

(a) You will need to carry out a serial dilution of the 1 mol dm^{-3} ascorbic acid, **A**, to reduce the concentration by a **factor of ten** between each successive dilution.

You will need to prepare four concentrations of ascorbic acid in addition to the 1 mol dm^{-3} ascorbic acid solution, **A**.

After the serial dilution is completed, you will need to have 9 cm^3 of each concentration available to use.

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

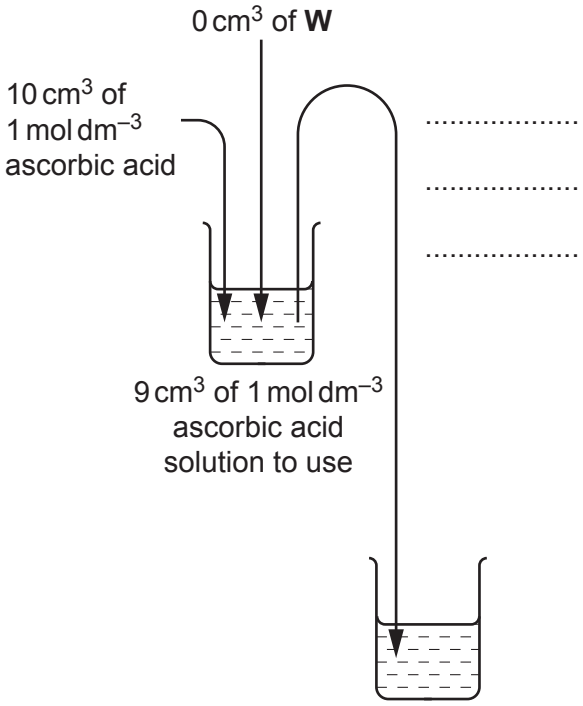
Fig. 1.1 shows the first two beakers you will use to make your serial dilution. You will need to draw **three** additional beakers.

For each beaker, add labelled arrows to show:

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

Under each beaker, state the concentration of ascorbic acid solution.

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0 cm3 of W
10 cm3 of 1 mol dm–3 ascorbic acid
9 cm3 of 1 mol dm–3 ascorbic acid solution to use

.....

.....

.....

.....

.....

.....

.....

Fig. 1.1

[3]

Carry out step 1 to step 13.

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

step 2 Label test-tubes with the ascorbic acid concentrations prepared in step 1.

step 3 Label another test-tube **0**.

step 4 On a white tile carefully cut the cylinders of potato tissue into thin discs that are approximately 1–2 mm thick.

You will need to cut at least 70 discs.

step 5 Place 10 potato discs into each labelled test-tube.

step 6 Add 1 cm^3 distilled water, **W**, to the test-tube labelled **0**.

step 7 Add 1 cm^3 of each concentration of ascorbic acid to the appropriately labelled test-tubes.

step 8 Set up the apparatus as shown in Fig. 1.2 using the test-tube labelled **0**. The syringe barrel should be fully submerged in the beaker of water, **B**.

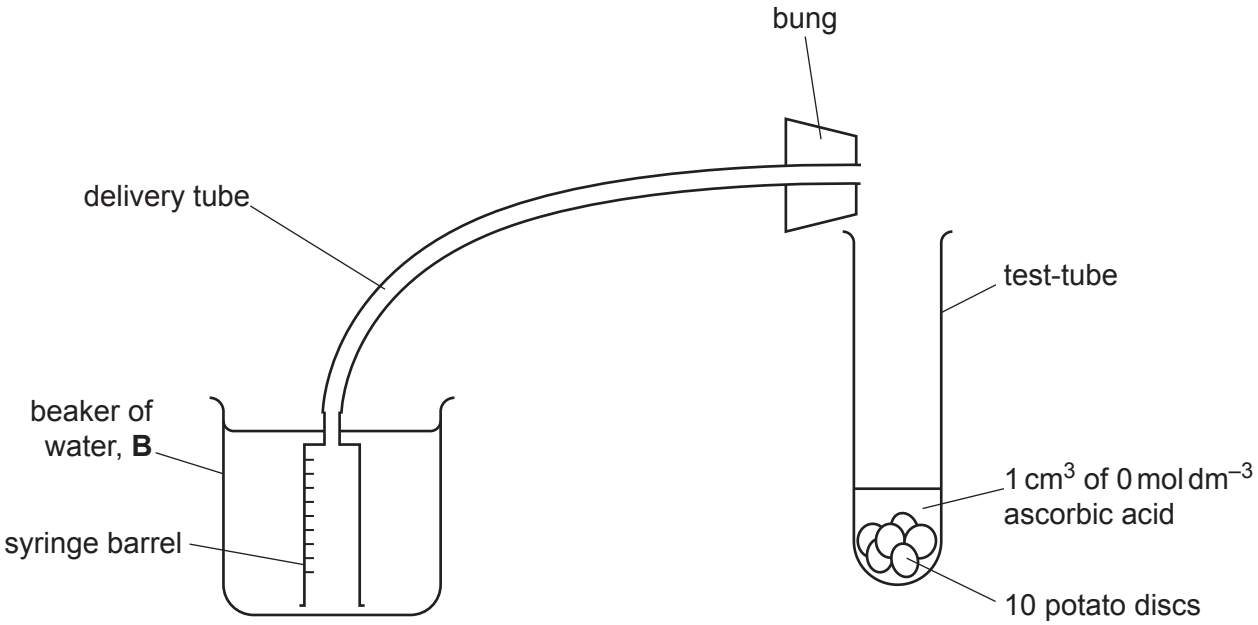


Fig. 1.2

step 9 Add 5 cm^3 of hydrogen peroxide solution **H** to the test-tube labelled **0**. Place the bung into the top of the test-tube, making sure that the syringe barrel stays fully submerged.

step 10 Record in **(a)(ii)** the **initial volume** of gas in the syringe barrel then start the stop-clock.

step 11 After 2 minutes record in **(a)(ii)** the **final volume** of gas in the syringe barrel. If the syringe barrel is full of gas, record as 10.

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step 12 Repeat step 9 to step 11 with each of the test-tubes labelled in step 2.

step 13 Calculate the **total** volume of gas produced at each concentration of ascorbic acid. Record these processed results in **(a)(ii)**.

(ii) Record your results in an appropriate table, including raw results **and** processed results.

[6]

(iii) Use your results in **(a)(ii)** to identify the **greatest** volume of gas produced in the reaction.

greatest volume of gas produced = ...

Use your answer to calculate the **rate** of gas production.
Show your working.

rate of gas production = ... $cm^3\,min^{-1}$
[2]

(iv) Describe **two** improvements to the procedure that would make the measurements more accurate.

1 .....

.....

2 .....

.....
[2]

Carry out step 14 to step 18.

step 14 Label a test-tube **T**.

step 15 Put 5 cm^3 of **H** into test-tube **T**.

step 16 Use a thermometer to measure the temperature of **H** in test-tube **T**. Record this value, to the nearest 0.5 °C, in **(b)(i)**.

step 17 Add 10 discs of potato tissue to test-tube **T** and start timing.

step 18 After 2 minutes measure the temperature of the mixture in test-tube **T**. Record this value, to the nearest 0.5 °C, in **(b)(i)**.

(b) (i) State the temperature of **H before** adding potato discs (step 16). ..... °C

State the temperature of **H** 2 minutes **after** adding potato discs (step 18).

..... °C

Calculate the **change** in temperature after 2 minutes. ..... °C
[2]

(ii) State whether temperature is a significant source of error in this investigation.

Explain your answer.

.....

..... [1]

(c) A study was carried out in which volunteers were given different daily doses of ascorbic acid (vitamin C) in addition to their normal diet. The maximum ascorbic acid concentration in the blood plasma of each volunteer was measured.

The results are shown in Table 1.2.

Table 1.2

ascorbic acid daily dose / mg	maximum ascorbic acid concentration in blood plasma / μmol dm^{-3}
0	6
50	25
200	68
500	75
1000	75

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

Use a sharp pencil.

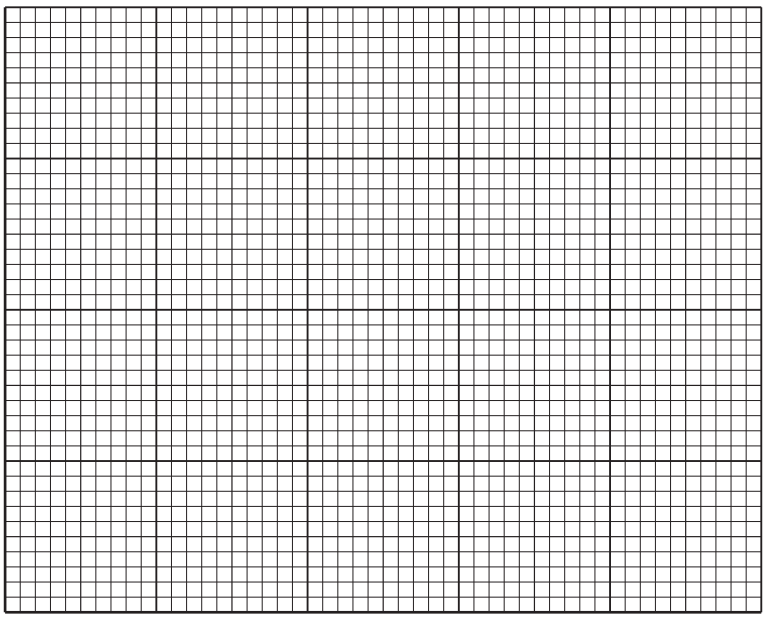


Fig. 1.3

[4]

(ii) Suggest an explanation for the results for a daily dose of 0 mg and the results for daily doses of between 500–1000 mg.

0 mg .....

.....

500–1000 mg .....

.....

[2]

[Total: 22]

2 **K1** 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 **K1** indicated by the shaded region in Fig. 2.1. Use a sharp pencil.

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

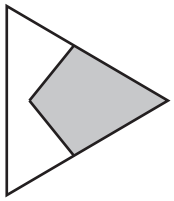


Fig. 2.1

[5]

(ii) Observe one of the larger vascular bundles of the section on **K1**.

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

Each xylem vessel element must touch at least **two** other 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 wall of **one** xylem vessel element.

[5]

(b) Fig. 2.2 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 mm.

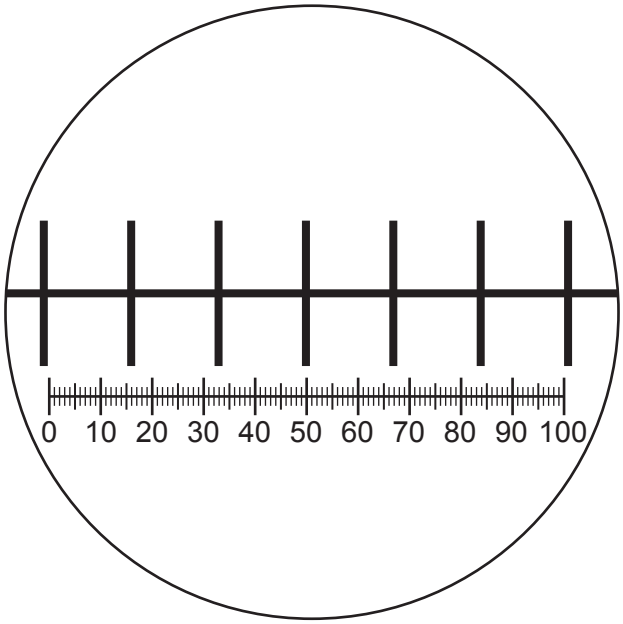


Fig. 2.2

(i) Use Fig. 2.2 to calculate the actual length of one eyepiece graticule unit.

Show your working.

actual length = ...
[3]

Fig. 2.3 shows a photomicrograph of a transverse section through a different stem to **K1**. This was taken with the same microscope and lenses used to take Fig. 2.2. The eyepiece graticule has been placed across the diameter of the section.

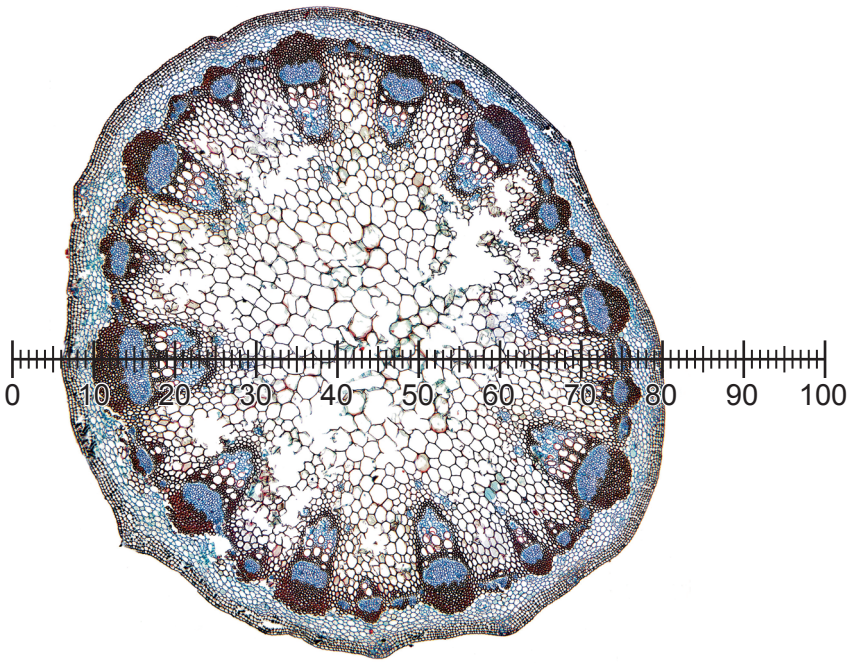


Fig. 2.3

(ii) Use the calibration of the eyepiece graticule from **(b)(i)** to calculate the actual diameter of the section in Fig. 2.3.

Show your working.

actual diameter = ...
[2]

(iii) Identify **three** observable differences, other than size and colour, between the stem section on **K1** and the stem section on Fig. 2.3.

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

Table 2.1

feature	K1	Fig. 2.3

[3]

[Total: 18]

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BIOLOGY **9700/33**

Paper 3 Advanced Practical Skills 1 **May/June 2022**

2 hours

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1 Plant cells contain an enzyme which catalyses the breakdown of hydrogen peroxide, releasing oxygen, as shown in Fig. 1.1.

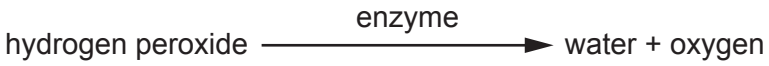


Fig. 1.1

You will investigate the effect of pH on the activity of this enzyme.

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3
H	hydrogen peroxide solution	harmful irritant	130
E	enzyme solution	harmful irritant	20
B5	pH5 buffer	none	20
B6	pH6 buffer	none	20
B7	pH7 buffer	none	20
B8	pH8 buffer	none	20
B9.5	pH9.5 buffer	none	20

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

It is recommended that you wear suitable eye protection.

When discs of filter paper that have been soaked in **E** are put into hydrogen peroxide solution, **H**, the discs rise to the surface as **H** is broken down. The higher the activity of **E**, the faster the discs rise.

(a) (i) Explain why the discs rise.

.....

.....

..... [1]

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A student investigated the effect of pH on the activity of enzyme **E**.

The student suggested the hypothesis:

*As the pH of the buffer containing **E** increases, the activity of **E** decreases.*

Carry out step 1 to step 16 to test the student's hypothesis.

step 1 Label 5 beakers with **E5**, **E6**, **E7**, **E8** and **E9.5**.

step 2 Put 10 cm^3 of **B5** buffer solution into the beaker labelled **E5**.

step 3 Repeat step 2 by putting the appropriate buffer solution into the beakers labelled **E6**, **E7**, **E8** and **E9.5**.

step 4 Stir **E** and put 2 cm^3 of **E** into each of the labelled beakers used in step 2 and step 3. Swirl each beaker to mix the contents.

step 5 Leave the beakers for 2 minutes.

step 6 Label a small beaker **H** and put 60 cm^3 of solution **H** into this beaker.

step 7 After 2 minutes (step 5) stir **E9.5**.

step 8 Pick up one disc of filter paper using forceps.

step 9 Continue to hold the disc in the forceps **and**:

- dip the disc in **E9.5** for 5 seconds
- put the disc at the bottom of the liquid in the beaker labelled **H**.

step 10 Immediately release the disc from the forceps and start timing.

step 11 Stop timing when the disc reaches the surface of the liquid.
You may find it helps to observe the disc with a piece of black card behind the beaker.

step 12 Record in **(a)(ii)** the time taken for the disc to reach the surface of **H**. If the time taken for the disc to rise to the surface is longer than 180 seconds, record as 'more than 180'.

step 13 Remove the disc from the beaker using the forceps and put it on a paper towel.

step 14 Dip the forceps in the water in the container labelled **For washing**. Dry the forceps with a paper towel.

step 15 Repeat step 7 to step 14 **two more** times, using **E9.5**.

step 16 Repeat step 7 to step 15 using **E8**, **E7**, **E6** and **E5**.

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(ii) Record your results in an appropriate table, including raw results **and** processed (mean) results.

[5]

(iii) The student suggested the hypothesis:

As the pH of the buffer containing **E** *increases, the activity of* **E** *decreases.*

Tick (✓) **one** box to show whether or not your **processed** results support this hypothesis.

support ☐

do **not** support ☐

Explain how the trend in your **processed** results provides evidence for this decision.

.....

.....

..... [1]

(iv) State the independent variable in this investigation.

..... [1]

(v) Describe an appropriate control for this investigation.

.....

.....

..... [1]

(vi) One possible source of error in this investigation is reusing the same hydrogen peroxide solution for all the discs.

Suggest a reason why reusing the same hydrogen peroxide solution is a possible source of error.

.....

.....

.....

State how you could reduce this source of error.

.....

.....

.....
[2]

(vii) Describe how you could modify your procedure to determine the optimum pH for this enzyme.

.....

..... [1]

(b) Temperature is another factor that affects the activity of an enzyme.

You will show the effect of preheating the enzyme at two different temperatures, before measuring the activity of this enzyme. You will select two temperatures and standardise the pH by choosing an appropriate buffer.

(i) Measure the room temperature.

room temperature ..... [1]

(ii) Select two temperatures between room temperature and 50 °C.

State the temperatures you have selected. .....

..... [1]

step 17 Prepare a water-bath at the lowest temperature you stated in **(b)(ii)**.

(iii) You will need to standardise the pH by choosing an appropriate mixture of buffer and enzyme, **E5**, **E6**, **E7**, **E8** or **E9.5**.

State the mixture of buffer and enzyme you will use. ..... [1]

step 18 Label one test-tube **T1** and label another test-tube **T2**.

step 19 Stir the mixture of buffer and **E** you chose in **(b)(iii)** and put approximately 5 cm^3 into each of the test-tubes **T1** and **T2**.

step 20 Put test-tube **T1** into the water-bath and leave it for 5 minutes.

step 21 Empty the small beaker labelled **H** into the container labelled **For waste**.

step 22 Put 60 cm^3 of **H** into the small beaker labelled **H**.

step 23 After 5 minutes (step 20) pour the mixture from test-tube **T1** into a clean beaker.

step 24 Pick up one disc of filter paper using forceps.

step 25 Continue to hold the disc in the forceps **and**:

- dip the disc in the mixture in the beaker for 5 seconds
- put the disc at the bottom of the liquid in the beaker labelled **H**.

step 26 Immediately release the disc from the forceps and start timing.

step 27 Stop timing when the disc reaches the surface of the liquid.
You may find it helps to observe the disc with a piece of black card behind the beaker.

step 28 Record in **(b)(iv)** the time taken for the disc to reach the surface of **H**. If the time taken for the disc to rise back to the surface is longer than 180 seconds, record as 'more than 180'.

step 29 Remove the disc using the forceps and put it on a paper towel.

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step 30 Dip the forceps in the water in the beaker labelled **For washing**. Dry the forceps with a paper towel.

step 31 Heat the water-bath to the other temperature you stated in **(b)(ii)**.

step 32 Put test-tube **T2** into the water-bath and leave it for 5 minutes.

step 33 After 5 minutes (step 32) pour the mixture from test-tube **T2** into a clean beaker.

step 34 Repeat step 24 to step 28.

(iv) Record your results for **T1** and **T2**.

T1 .....

T2 .....

[1]

(v) Explain the effect of increased temperature on the activity of enzyme **E**.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 19]

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

(a) **(i)** Draw a large plan diagram of the whole section on **L1**. Use a sharp pencil.

Use **one** ruled label line and label to identify a trichome.

[5]

(ii) Observe the upper epidermis and the layer of cells beneath it on the section of the leaf on **L1**.

Select a group of four adjacent cells, **two** cells from the upper epidermis and **two** cells from the layer below the upper epidermis.

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

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

[5]

(b) Fig. 2.1 shows an image of some epidermal cells from the surface of a different leaf, viewed under a microscope.

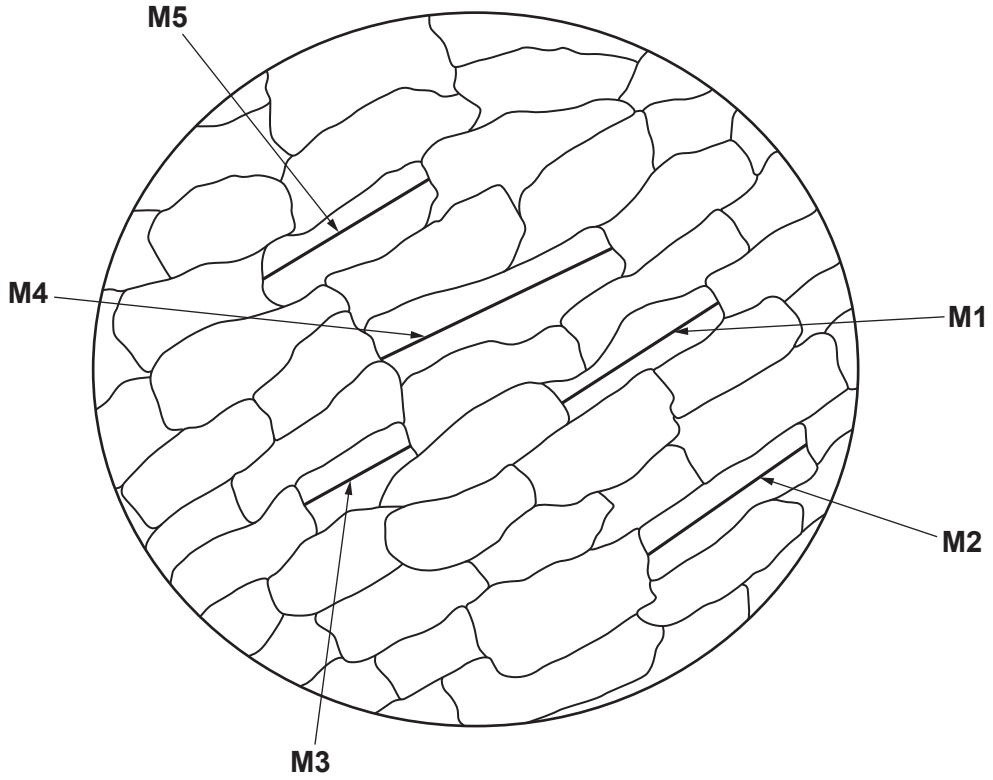


Fig. 2.1

(i) Measure the lengths of the epidermal cells using the lines **M1**, **M2**, **M3**, **M4** and **M5** in Fig. 2.1 and calculate the mean length of the lines.

Show your working.

M1 = **M2** = **M3** = **M4** = **M5** =

mean length of lines = ... [2]

(ii) Using the scale bar and the mean length of lines from **(b)(i)**, calculate the mean actual length of the epidermal cells.

Show your working.

mean actual length = ... μm [2]

Turn over for Question 2(c)

(c) Plants of the same species were grown for 6 months. Each plant was grown in a different percentage of shade.

After 6 months, the mean specific leaf area was recorded, as shown in Table 2.1.

Table 2.1

percentage shade	mean specific leaf area / $cm^2 g^{-1}$
5	118
40	140
50	151
60	153
90	206

(i) Plot a graph of the data shown in Table 2.1 on the grid in Fig. 2.2.

Use a sharp pencil.

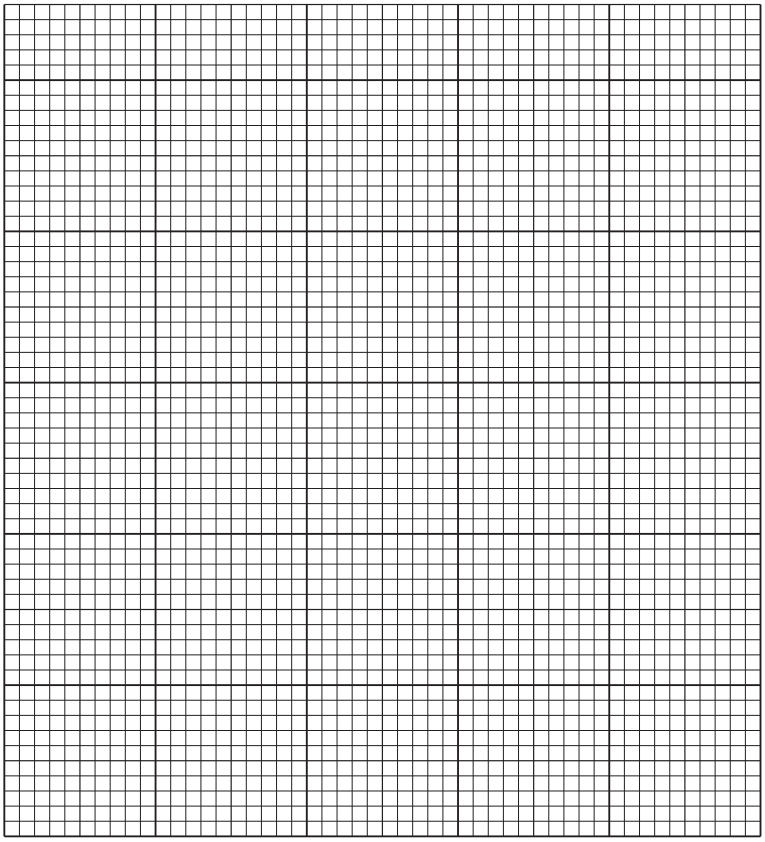


Fig. 2.2 [4]

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(ii) Using the data in Table 2.1 and your graph in Fig. 2.2, describe the trend in mean specific leaf area.

.....

.....

.....

.....

..... [2]

(iii) Use the graph in Fig. 2.2 to find the mean specific leaf area in 30% shade.

mean specific leaf area ..... $cm^2\ g^{-1}$
[1]

[Total: 21]

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BIOLOGY **9700/34**

Paper 3 Advanced Practical Skills 2 **May/June 2022**

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	
2	
Total	

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1 In industry it is important that scientists are able to estimate the concentration of chemicals in plant extracts such as fruit juice.

Sucrose is a non-reducing sugar that can be hydrolysed to form reducing sugars.

You will prepare known concentrations of a reducing sugar by serial dilution. You will then use the known concentrations to estimate the concentration of a reducing sugar produced by hydrolysis of a sucrose solution.

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3
R	1.0% reducing sugar solution	none	50
B	Benedict's solution	harmful irritant	30
W	distilled water	none	100

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) You will need to carry out a **serial** dilution of the 1.0% reducing sugar solution, **R**, to reduce the concentration by **half** between each successive dilution.

You will need to prepare **four** concentrations of solution in addition to the 1.0% reducing sugar solution, **R**.

After the serial dilution is completed, you will need to have 10 cm^3 of each concentration available to use.

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

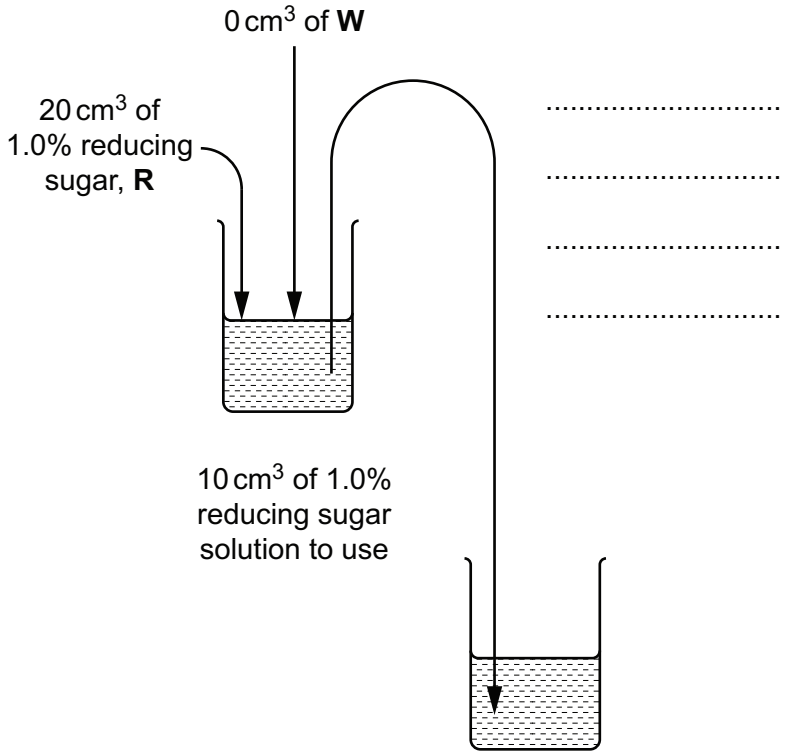
Fig. 1.1 shows the first two beakers you will use to make your serial dilution. You will need to draw **three** additional beakers.

For each beaker add labelled arrows to show:

- the volume of reducing sugar solution transferred
- the volume of distilled water, **W**, added.

Under each beaker, state the concentration of reducing sugar solution.

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0 cm3 of W
20 cm3 of 1.0% reducing sugar, R
10 cm3 of 1.0% reducing sugar solution to use

.....

.....

.....

.....

.....

.....

.....

.....

Fig. 1.1

[3]

Carry out step 1 to step 11.

step 1 Set up a water-bath and heat it to boiling ready for step 6.

step 2 Prepare the concentrations of reducing sugar solution, as decided in **(a)(i)**, in the beakers provided.

step 3 Label the test-tubes with the concentrations you prepared in step 2.

step 4 Put 2 cm^3 of each reducing sugar concentration into the appropriately labelled test-tube. Put these test-tubes into a test-tube rack.

step 5 Put 2 cm^3 of Benedict's solution, **B**, into each of the test-tubes from step 3. Shake gently to mix.

step 6 Put the test-tube labelled 1.0% into the boiling water-bath. Start timing.

step 7 Measure the time taken to the first appearance of a colour change in the test-tube. If there is no colour change after 120 seconds, stop timing and record as 'more than 120'.

step 8 Record the result from step 7 in **(a)(ii)**.

step 9 Remove the test-tube from the water-bath. Put the test-tube in the test-tube rack.

step 10 Repeat step 6 to step 9 with the remaining concentrations of reducing sugar.

step 11 Turn off the water-bath. You will need this again in step 16 and in step 23.

(ii) Record your results in an appropriate table.

[5]

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(iii) State **one** significant source of error when measuring the dependent variable in this investigation.

.....

.....

..... [1]

(iv) Suggest how you could improve the procedure to reduce the error you stated in **(a)(iii)**.

.....

.....

..... [1]

Question 1 continues on page 6.

You will:

- carry out the test for non-reducing sugar on the unknown concentration of sucrose, **U**
- estimate the concentration of the reducing sugar fructose in **U**.

You are provided with the materials shown in Table 1.2. You will also need to use the Benedict's solution, **B**, shown in Table 1.1.

Table 1.2

labelled	contents	hazard	volume / cm^3
U	unknown concentration of sucrose solution	none	20
H	dilute hydrochloric acid	irritant	10
A	10 g sodium hydrogencarbonate powder	none	–

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

It is recommended that you wear suitable eye protection.

Carry out step 12 to step 27.

step 12 Heat the water-bath to boiling ready for step 16 and step 23.

step 13 Label a clean test-tube **U**.

step 14 Put 2 cm^3 of **U** into the test-tube labelled **U**.

step 15 Put 2 cm^3 of **H** into this test-tube. Shake gently to mix.

step 16 Put test-tube **U** into the boiling water-bath. Leave the test-tube for 2 minutes.

step 17 After 2 minutes, remove the test-tube from the water-bath and put it into the beaker labelled **For cooling**.

step 18 Leave the test-tube in the beaker for 3 minutes.

step 19 After 3 minutes, use a spatula to put a small amount of **A** into test-tube **U**. The mixture will fizz and rise up the test-tube.

step 20 Repeat step 19 until there is no more fizzing and there is a small amount of **A** in the bottom of the test-tube.

step 21 Put 4 cm^3 of **B** into test-tube **U**.

step 22 Shake the test-tube gently to mix.

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step 23 Put test-tube **U** into the boiling water-bath. Start timing.

step 24 Measure the time taken to the first appearance of a colour change in the test-tube. If there is no colour change after 120 seconds, stop timing and record as 'more than 120'.

step 25 Record the result in **(a)(v)**.

step 26 Remove the test-tube from the water-bath. Put the test-tube in the test-tube rack.

step 27 Turn off the water-bath.

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

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

(vi) Using results from **(a)(ii)** and **(a)(v)**, estimate the concentration of reducing sugars in **U**.

concentration of reducing sugars in **U** ..... %

Calculate the concentration of fructose in **U**. Explain how you determined this concentration.

concentration of fructose in **U** ..... %

explanation .....

.....

.....

.....

.....

.....

[2]

(b) A student investigated the effect of different concentrations of sucrose solution on the mass of pieces of potato tissue.

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 1.3 shows the results of this investigation.

Table 1.3

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

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

Use a sharp pencil.

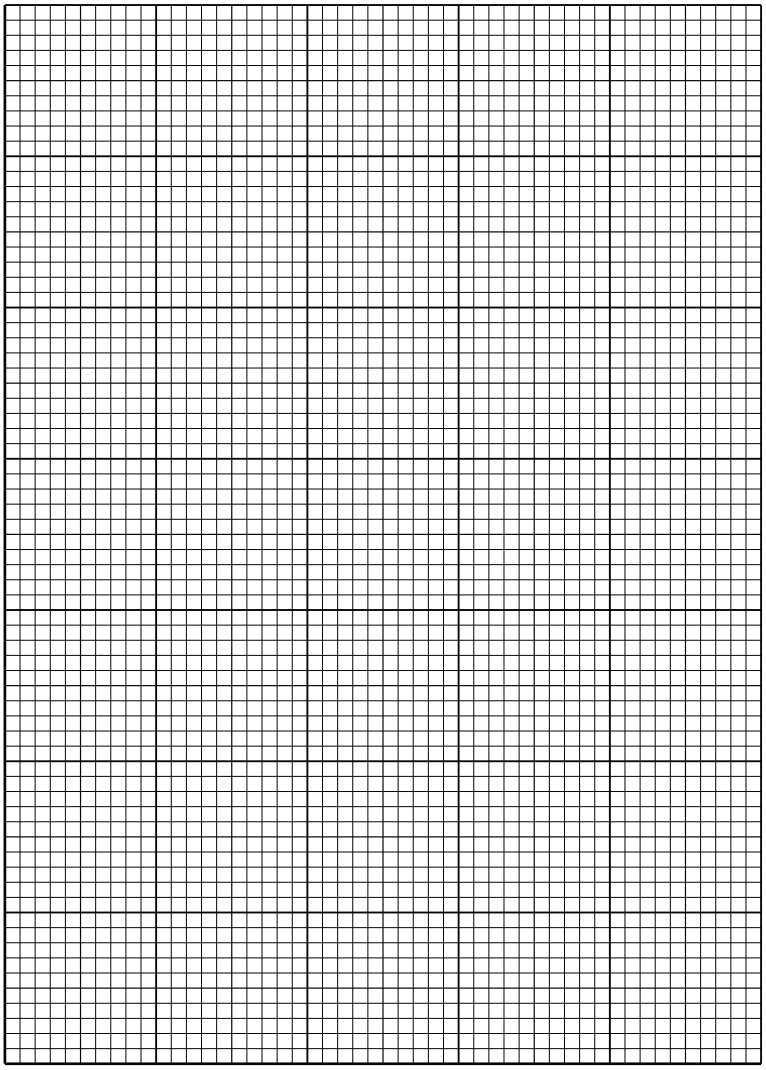


Fig. 1.2

[4]

(ii) Using your knowledge of water potential, explain the difference in the change of mass between the potato piece in the 0.4 mol dm^{-3} sucrose solution and the potato piece in the 1.0 mol dm^{-3} sucrose solution.

.....

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 20]

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

(a) **(i)** Draw a large plan diagram of the whole section on **M1**. Use a sharp pencil.

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

[4]

(ii) Observe the epidermis and the layer of cells beneath it on the section of the root on **M1**.

Select a group of four adjacent cells: **two** cells from the epidermis and **two** cells from the layer below the epidermis.

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

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

[5]

(b) Fig. 2.1 is a photomicrograph of a stained transverse section through a root of a different type of plant.

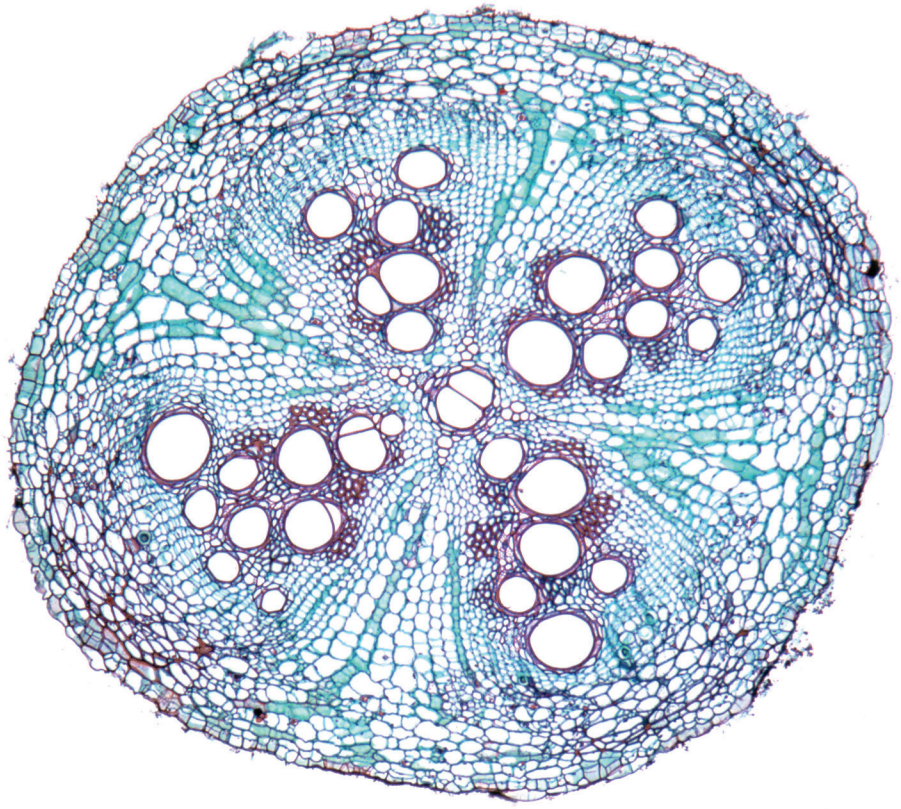


Fig. 2.1

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Identify **three** observable differences, other than size and colour, between the root section on **M1** and the root section shown in Fig. 2.1.

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

Table 2.1

feature	M1	Fig. 2.1

[4]

(c) Fig. 2.2 is the same photomicrograph as that in Fig. 2.1, with the line **X–Y** drawn across its width.

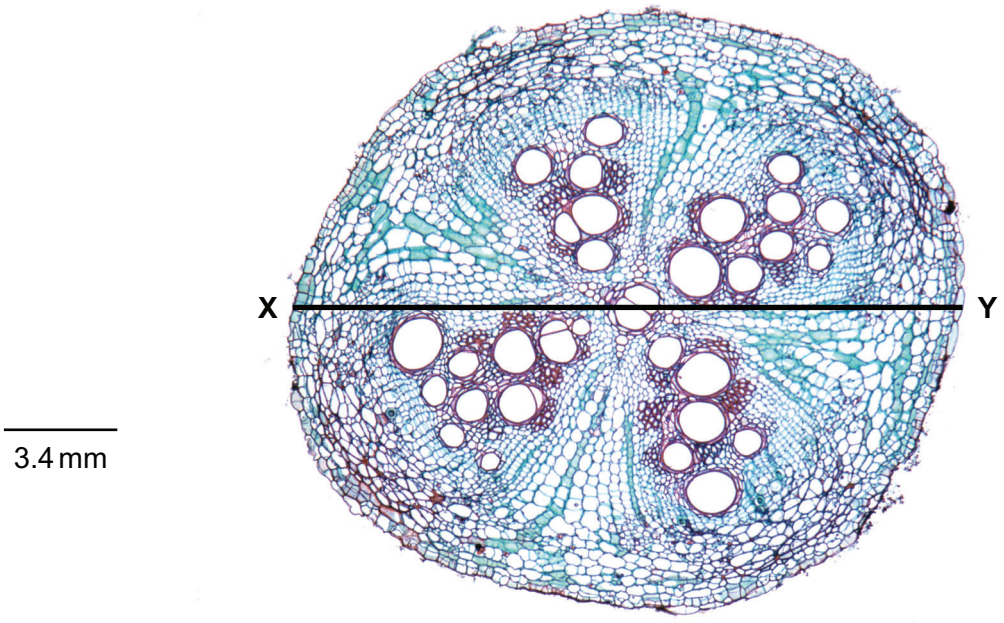


Fig. 2.2

(i) In Fig. 2.2 the line **X–Y** is drawn across the diameter of the root section.

Use the line **X–Y** and the scale bar to calculate the actual diameter of the root section.

Show your working and use appropriate units.

actual diameter of the root section = ... [3]

(ii) Calculate the area of the root section in Fig. 2.2, using the actual diameter from **(c)(i)** and the equation:

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

Show your working and use appropriate units.

area of root section = ... [2]

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(iii) Suggest why the answer to **(c)(ii)** is an estimate of the area of the root section shown in Fig. 2.2 rather than the actual area.

.....

..... [1]

(iv) Suggest how a more accurate estimate of the area of the root section shown in Fig. 2.2 could be made.

.....

..... [1]

[Total: 20]

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BIOLOGY **9700/35**

Paper 3 Advanced Practical Skills 1 **May/June 2022**

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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2	
Total	

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[Turn over

1 The enzyme invertase catalyses the hydrolysis (breakdown) of sucrose to fructose and glucose.

You will investigate the effect of enzyme concentration on this enzyme-catalysed reaction.

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3
R	60 $mmol\,dm^{-3}$ reducing sugar solution	none	50
B	Benedict's solution	harmful irritant	50
W	distilled water	none	200
E	1.0% invertase solution	harmful irritant	20
S	30 $mmol\,dm^{-3}$ sucrose solution	none	50

If **B** or **E** come into contact with your skin, wash off immediately under cold water.

It is recommended that you wear suitable eye protection.

You will need to:
- prepare a range of reducing sugar solutions to use as standards
- investigate the effect of invertase concentration on the breakdown of sucrose.

Carry out step 1 to step 10.

step 1 Set up a water-bath and heat to boiling ready for step 7.

step 2 Label four small beakers **60**, **30**, **6** and **0.6**.

Table 1.2 shows the instructions for making four solutions of different reducing sugar concentration.

Table 1.2

reducing sugar concentration / $mmol\,dm^{-3}$	instructions
60	transfer 20 cm^3 of solution **R** into the beaker labelled **60**
30	put 10 cm^3 of solution **R** into the beaker labelled **30**, add 10 cm^3 of distilled water, **W**, and mix well
6	put 2 cm^3 of solution **R** into the beaker labelled **6**, add 18 cm^3 of distilled water, **W**, and mix well
0.6	put 2 cm^3 of the 6 $mmol\,dm^{-3}$ reducing sugar solution (from the beaker labelled **6**) into the beaker labelled **0.6**, add 18 cm^3 distilled water, **W**, and mix well

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step 3 Follow the instructions shown in Table 1.2 to produce the four reducing sugar concentrations shown.

step 4 Label 4 test-tubes **60**, **30**, **6** and **0.6**.

step 5 Put 2 cm^3 of each reducing sugar concentration into the appropriately labelled test-tube.

step 6 Add 2 cm^3 of **B** to each test-tube and shake gently to mix.

step 7 Put all four test-tubes into the boiling water-bath for 2 minutes.

step 8 After 2 minutes turn off the water-bath. You will need this again in step 11.

step 9 Remove the test-tubes from the water-bath and shake gently to mix the contents.

step 10 Observe the final colour of the contents of each test-tube and record your observations in **(a)**.

(a) Record the colour of the contents of each test-tube in Table 1.3.

Table 1.3

reducing sugar concentration / mmol dm^{-3}	**colour after 2 minutes**
60	
30	
6	
0.6	

[2]

Carry out step 11 to step 19.

step 11 Heat the water-bath to boiling ready for step 18.

You will need to carry out a **serial** dilution of the 1.0% invertase solution, **E**, to reduce the concentration by a **factor of ten** between each successive dilution.

You will need to prepare **four** concentrations of invertase in addition to the 1.0% invertase solution, **E**.

After the serial dilution is completed, you will need to have at least 9 cm^3 of each concentration available to use.

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

Fig. 1.1 shows the first two beakers you will use to make your serial dilution. You will need to draw **three** additional beakers.

For each beaker, add labelled arrows to show:
- the volume of invertase solution transferred
- the volume of distilled water, **W**, added.

Under each beaker, state the concentration of invertase solution.

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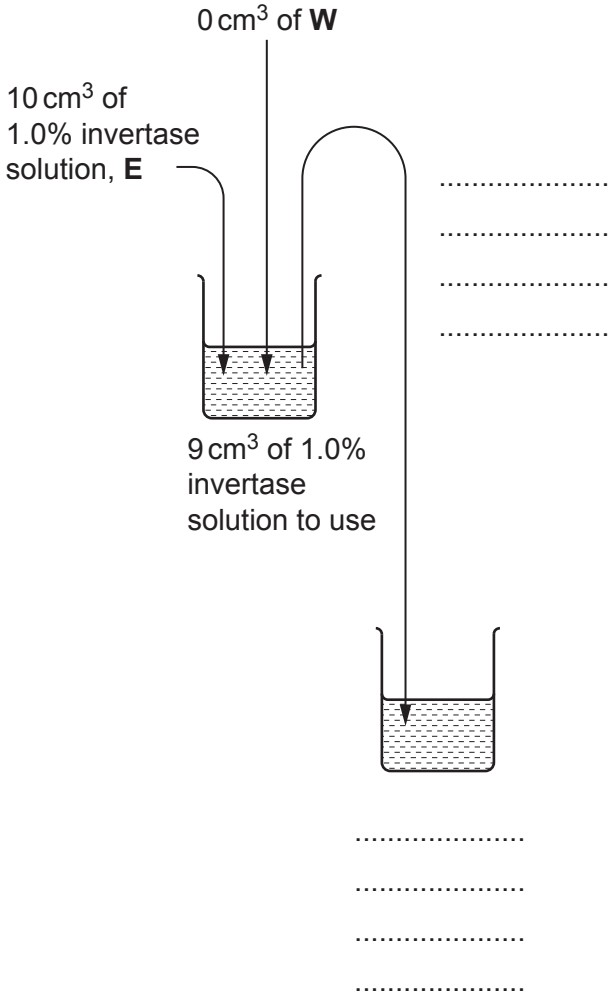

0 cm3 of W
10 cm3 of 1.0% invertase solution, E
.....
.....
.....
.....
9 cm3 of 1.0% invertase solution to use
.....
.....
.....
.....

Fig. 1.1

[3]

step 12 Prepare the concentrations of invertase solution, **E**, as decided in **(b)(i)**, in the beakers provided.

step 13 Label test-tubes with the concentrations of invertase solution decided in **(b)(i)**.

step 14 Put 1 cm^3 of each of the concentrations of invertase into the appropriately labelled test-tube.

step 15 Add 1 cm^3 of the 30 $mmol\,dm^{-3}$ sucrose solution, **S**, to each of the test-tubes and shake gently to mix.

step 16 Start timing and leave the test-tubes at room temperature for 3 minutes.

(ii) Record room temperature.

room temperature = ...

[1]

step 17 After 3 minutes, add 2 cm^3 of **B** to each test-tube and shake gently to mix.

step 18 Put all of the test-tubes into the boiling water-bath and leave them for 2 minutes.

step 19 After 2 minutes, carefully remove the test-tubes from the water-bath and shake gently to mix the contents. Record your results in **(b)(iii)**.

(iii) Record your results in an appropriate table.

[4]

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(iv) Using your results in **(a)** and **(b)(iii)**, estimate the concentration of reducing sugar for the highest concentration of invertase solution (1%) **and** for the lowest concentration of invertase solution, including appropriate units.

highest concentration (1%) .....

lowest concentration .....

[2]

(v) Describe how changing the concentration of invertase affects the concentration of reducing sugar produced.

.....

.....

..... [1]

(vi) Suggest **and** explain how increasing the temperature by 10 °C above room temperature would affect the results you obtained in (**b)(iii)**.

.....

.....

.....

.....

.....

.....

.....

..... [3]

(vii) Complete Table 1.4 by identifying **two** significant sources of error in this investigation.

Suggest how you would improve the procedure to reduce the effect of these errors.

Table 1.4

source of error	improvement

[4]

[Total: 20]

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.

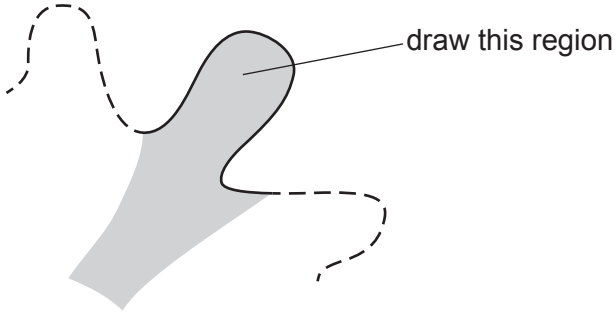


Fig. 2.1

[5]

(ii) Observe the epidermis of the stem on **N1**.

Select a group of four adjacent cells in the epidermis.

Each cell must touch at least one other cell.

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

[5]

(b) A riparian plant is a type of plant that grows beside rivers and may disperse its seeds by releasing them into flowing water.

Researchers investigated the effect of seed length on the distance the seeds travelled along a river. Seeds of different length were released and the distance they had travelled after 24 hours was measured.

Table 2.1 shows the results of the investigation.

Table 2.1

seed length / mm	distance travelled / m			
	trial 1	trial 2	trial 3	mean
2.0	207	194	210	204
5.0	202	211	200	204
10.0	212	206	210	
15.0	219	213	217	216
20.0	231	389	221	226

(i) Table 2.1 includes an anomalous result.

Draw a circle around the anomalous result.

[1]

(ii) Calculate the mean distance travelled for the seeds of length 10.0 mm.

Show your working.

mean distance travelled ..... m
[2]

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(iii) Plot a graph of the mean data in Table 2.1 on the grid in Fig. 2.2.

Use a sharp pencil.

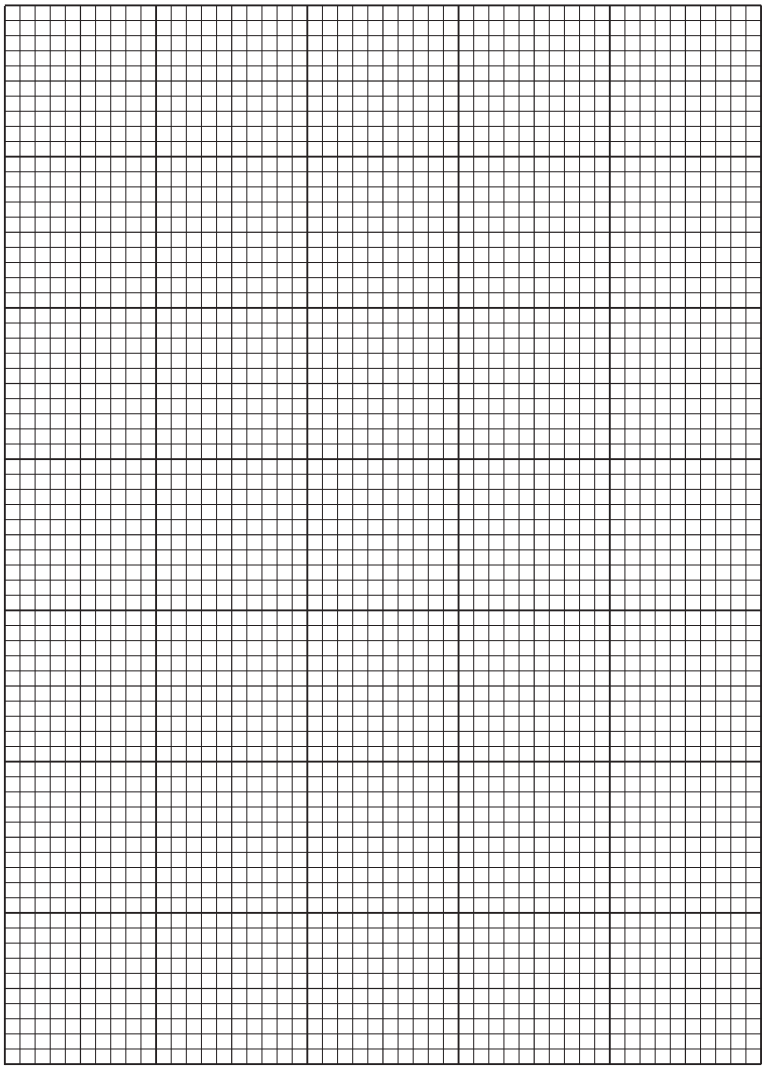
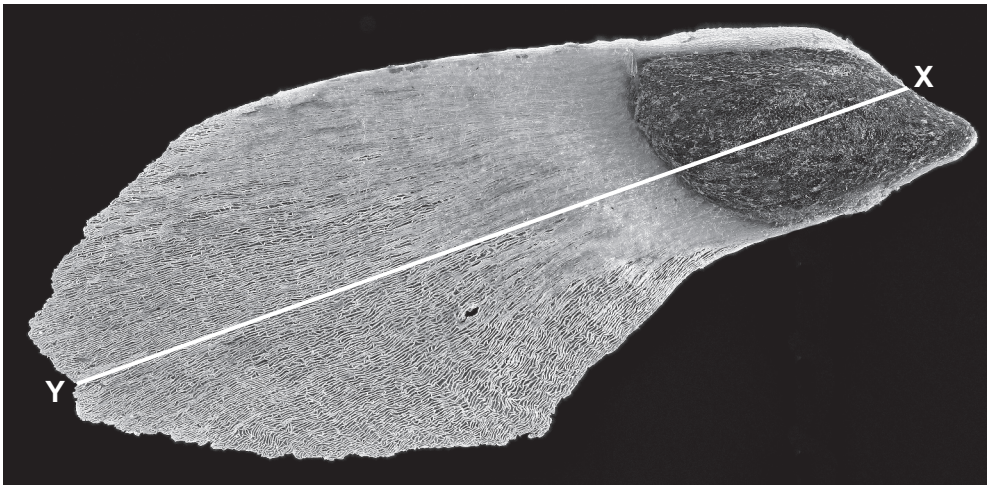


Fig. 2.2

[4]

(c) Fig. 2.3 is a photograph of the seed of a riparian plant.



magnification ×55

Fig. 2.3

In Fig. 2.3, the line **X**–**Y** is drawn across the length of the seed.

Use the line **X**–**Y** and the magnification to calculate the actual length of the seed.

Show your working and use appropriate units.

actual length of seed = ...
[3]

[Total: 20]

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