Cambridge Assessment International Education

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8688570978

BIOLOGY **9700/31**

Paper 3 Advanced Practical Skills 1 **October/November 2021**

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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Before you proceed, read carefully through the **whole** of Question 1 and Question 2.

Plan the use of the **two hours** to make sure that you finish the whole of Question 1 and Question 2.

1 The kidneys are the organs that remove waste products from the blood and produce urine.

Urine can be tested as part of a health check.

People who have kidney disease or a urinary tract infection (UTI) may have unusually high concentrations of protein in their urine.

You will be testing a solution that represents urine and will be referred to as 'mock urine'. This represents a sample of urine from a patient with a possible kidney disease or urinary tract infection.

You will determine the concentration of protein in this sample of mock urine.

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3
P	1.0% protein solution	none	30
W	distilled water	none	50
C	0.15% copper sulfate solution	none	20
K	5.0% potassium hydroxide solution	harmful irritant	20
U	mock urine	none	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) You will need to carry out a **serial** dilution of the 1.0% protein solution, **P**, to reduce the concentration by **half** between each successive dilution.

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

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.

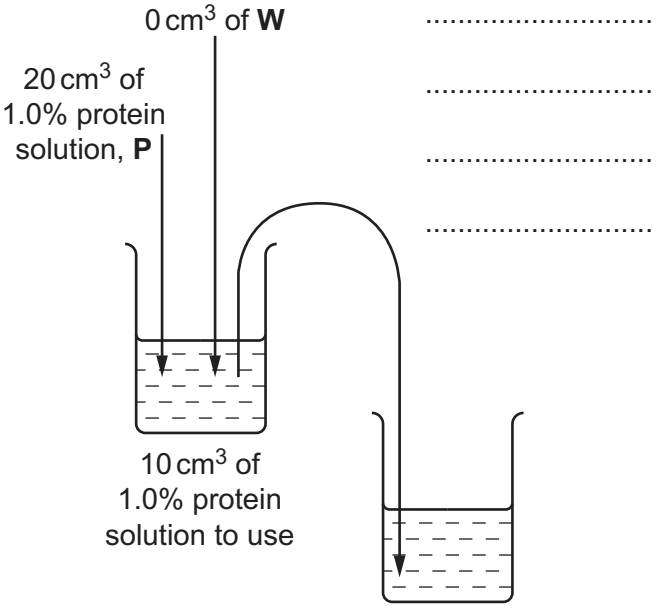
Fig. 1.1 shows the first two beakers you will use to make your serial dilution. You will need to draw **three** additional beakers.

For each beaker add labelled arrows to show:

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

Under each beaker, state the concentration of protein solution.

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0 cm3 of W
20 cm3 of 1.0% protein solution, P
10 cm3 of 1.0% protein solution to use

.....

.....

.....

.....

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.....

.....

.....

Fig. 1.1

[3]

Carry out step 1 to step 9.

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

   Use a glass rod to mix the protein solutions.

2. Label five of the test-tubes with the concentrations you prepared in step 1.

3. Put 1 cm^3 of each concentration of protein solution into the appropriately labelled test-tube.

4. Label another test-tube **0.0%** and put 1 cm^3 of distilled water, **W**, into this test-tube.

5. Put 1 cm^3 of **K** into each of the labelled test-tubes. Shake gently to mix.

6. Put 1 cm^3 of **C** into each of the labelled test-tubes. Shake gently to mix.

7. Leave the test-tubes for 1 minute. Shake gently to mix.

8. Observe the colour of the liquid in each test-tube.
   To see the colour more clearly, it may help to hold a piece of white paper behind the test-tube.
   You may see the same colour in more than one test-tube.

9. Record your results in **(a)(ii)** using the symbols shown in Table 1.2.

Table 1.2

colour	symbol
dark purple	++++++
purple	+++++
pale purple	++++
blue	+++
very pale blue/purple	++
no colour	+

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(ii) Record your results in an appropriate table.

You may use the same symbols for more than one test-tube.

[4]

(iii) State the independent variable in the investigation you have just carried out.

..... [1]

You are provided with a sample of mock urine, **U**. This represents a sample of urine from a patient being tested for possible kidney disease.

10. Label a test-tube, **U**.

11. Put 1 cm^3 of **U** into the test-tube.

12. Repeat step 5 to step 8 for **U**. Record your result for **U** in **(a)(iv)** using the symbols shown in Table 1.2.

(iv) Record your result for **U**.

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

(v) Fig. 1.2 shows a scale of protein concentrations used in this investigation. The position for 1.0% and 0.0% are shown on the scale.

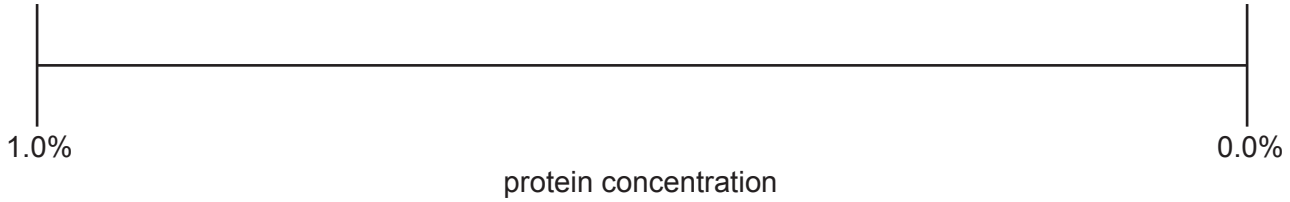


Fig. 1.2

Complete the scale in Fig. 1.2 by showing the positions of the protein concentrations you prepared in step 1. [1]

(vi) Use your results in **(a)(ii)** and **(a)(iv)** to estimate the protein concentration of **U**.
Show your estimate of **U** on Fig. 1.2 by drawing an arrow (↓) at the correct position on the scale. Label the arrow **U**. [1]

Table 1.3 shows the total mass of protein present in urine over 24 hours for people with different medical conditions.

Table 1.3

medical condition	**total mass of protein in urine / mg 24 h^{-1}**
no condition	<150
urinary tract infection	150–200
kidney tubular disease	200–500
glomerular disease	>500

The 1.0% protein solution you used in **(a)(i)** represents a urine sample collected over a period of 24 hours that contains 1000 mg of protein.

(vii) State the possible medical condition of the patient indicated by **U**, using your result in **(a)(vi)**.

..... [1]

(viii) Your result for **U** may be anomalous.

State how you could confirm that your result for **U** is correct.

.....

..... [1]

(ix) Glucose is another molecule that may be detected in urine during a health check.

A sample of urine from a patient tested positive for glucose.

Suggest how you would obtain an estimate of the **concentration** of glucose in the sample of urine.

.....

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.....

.....

..... [3]

(b) *Escherichia coli* bacteria were isolated from patients with a urinary tract infection. The bacteria were tested with six different antibiotics. The percentage of resistant bacteria was calculated for each antibiotic.

Table 1.4 shows the results.

Table 1.4

antibiotic	percentage of resistant bacteria
ciprofloxacin (C)	23.5
co-trimoxazole (T)	31.5
imipenem (I)	0.0
nitrofurantoin (N)	0.5
ampicillin (A)	59.0
amoxicillin (M)	2.0

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(i) Plot a bar chart of the data in Table 1.4 on the grid in Fig. 1.3.

Use a sharp pencil for drawing bar charts.

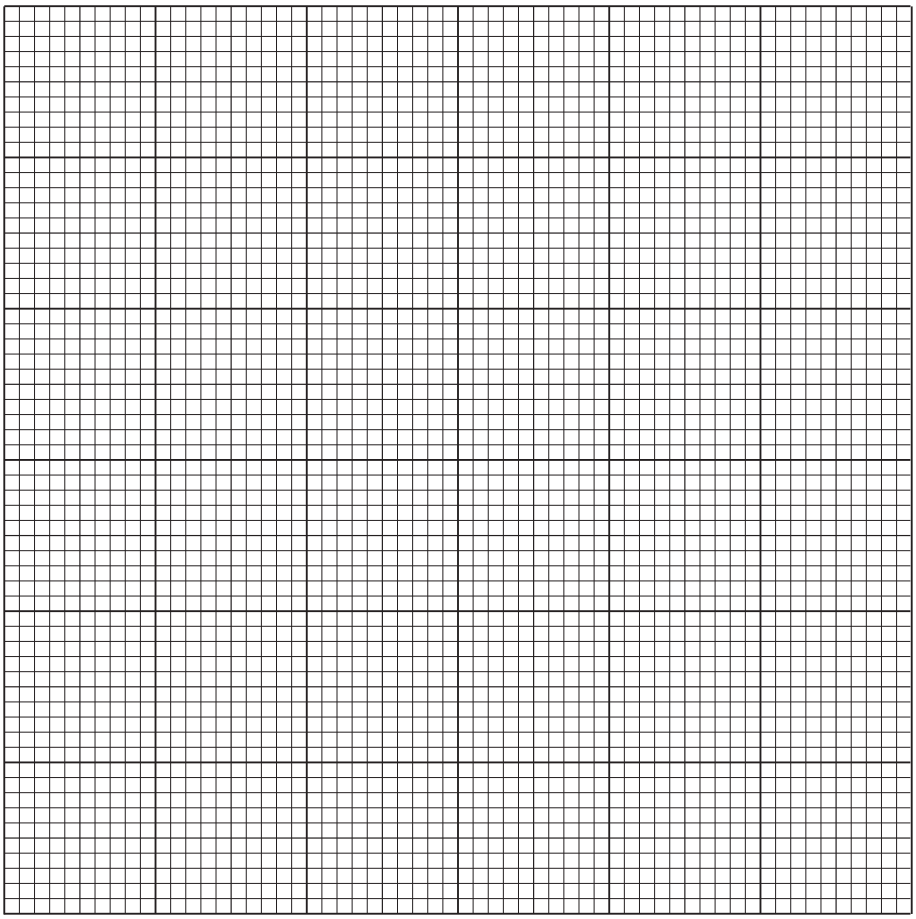


Fig. 1.3

[4]

(ii) Ampicillin was first used in 1961 and imipenem was first used in 1985.

Suggest why the percentage of resistant bacteria is higher for ampicillin than imipenem.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 23]

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

(a) Set up the microscope so that you can observe the section on **J1**.

Observe the different tissues in the area on **J1** shown by the shaded region in Fig. 2.1 (midrib).

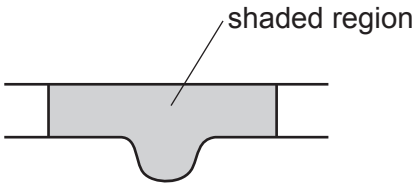


Fig. 2.1

Use a sharp pencil for drawing.

(i) Draw a large plan diagram of the area of the section on **J1** shown by the shaded region in Fig. 2.1.

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

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

[5]

(ii) Observe the cells in the layer below the upper epidermis of the midrib of the section on **J1**.

Select **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. 2.2 is a photomicrograph of a stained transverse section through a leaf of a different type of plant.

Fig. 2.2 has been annotated to describe **one** observable difference between the leaf section in Fig. 2.2 and on **J1**.

Annotate Fig. 2.2 to describe **three** other observable differences between the leaf section in Fig. 2.2 and on **J1**.

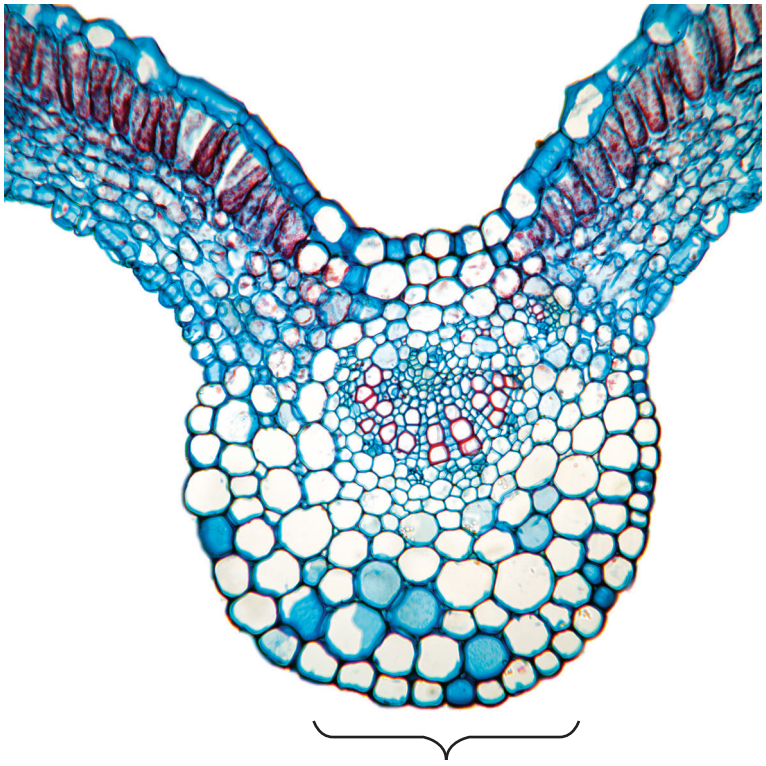


Fig. 2.2

[3]

(c) Fig. 2.3 is a photomicrograph of the same leaf section as in Fig. 2.2, viewed using a microscope with an eyepiece graticule placed across the section.

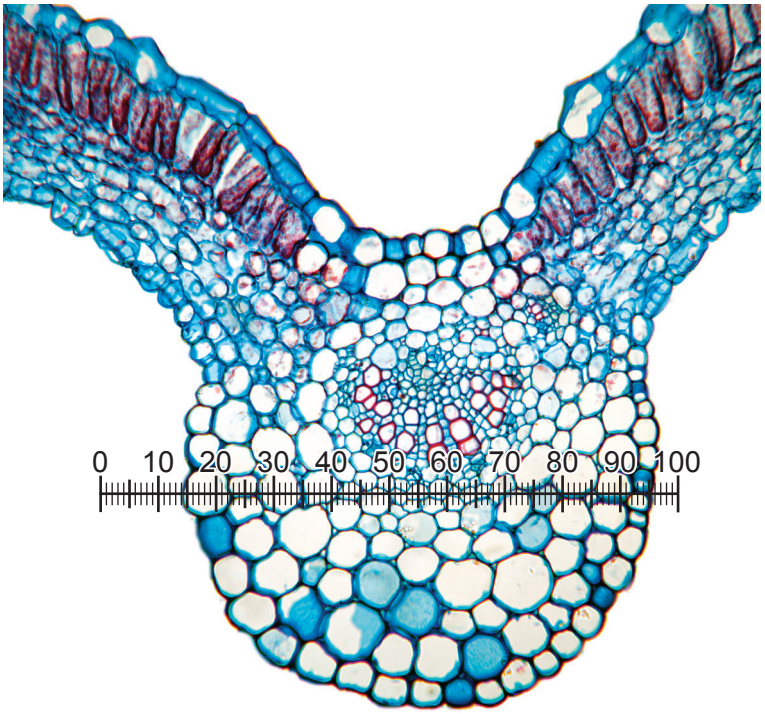


Fig. 2.3

An eyepiece graticule scale is shown on Fig. 2.3.
The calibration of the eyepiece graticule scale is:
1 eyepiece graticule division = 13.7 μm

Use the calibration of the eyepiece graticule scale to calculate the actual width of the midrib, shown in Fig. 2.3.

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

actual width of the midrib = ... [4]

[Total: 17]

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Cambridge International AS & A Level

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8097364595

BIOLOGY **9700/33**

Paper 3 Advanced Practical Skills 1 **October/November 2021**

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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INFORMATION

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Before you proceed, read carefully through the **whole** of Question 1 and Question 2.

Plan the use of the **two hours** to make sure that you finish the whole of Question 1 and Question 2.

1 During the manufacture of a fruit juice, an unwanted colour can sometimes appear in the juice. An enzyme can be used to remove this colour.

You will carry out an investigation to determine the concentration of enzyme that is most effective at removing the colour in mock fruit juice, **J**. Solution **J** is not real fruit juice, so is **not** safe to drink.

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3
J	mock fruit juice	harmful	60
E	2.0% enzyme solution	harmful irritant	25
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 2.0% enzyme solution, **E**, to reduce the concentration by **half** between each successive dilution.

You will need to prepare **four** concentrations of enzyme solution in addition to the 2.0% enzyme solution, **E**.

After the serial dilution is completed you 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.

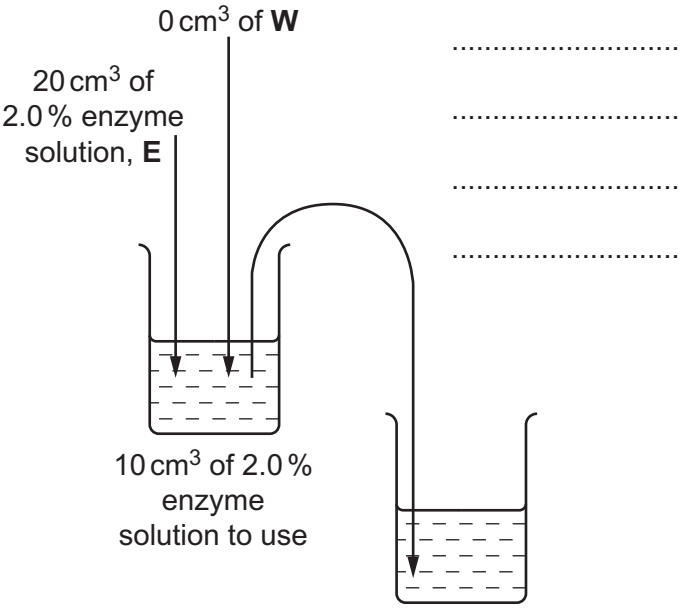
Fig. 1.1 shows the first two beakers you will use to make your serial dilution. You will need to draw **three** additional beakers.

For each beaker add labelled arrows to show:

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

Under each beaker, state the concentration of enzyme solution.

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0 cm3 of W
20 cm3 of 2.0 % enzyme solution, E
10 cm3 of 2.0 % enzyme solution to use

.....

.....

.....

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.....

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.....

.....

Fig. 1.1

[3]

Carry out steps 1 to 10.

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

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

3. Put 5 cm^3 of **J** into each test-tube.

4. Using the beakers labelled **hot water** and **cold water**, set up a water-bath with water at approximately 40 °C. Maintain the water-bath at approximately 40 °C during step 5 to step 8.

5. Put the test-tubes from step 3 into the water-bath. Leave the test-tubes for 3 minutes.

6. Put 5 cm^3 of the 2.0% enzyme solution into the appropriately labelled test-tube. Shake gently to mix.

7. Repeat step 6 with the other concentrations of enzyme solution you prepared in step 1.

8. Start timing and leave the test-tubes in the water-bath for 10 minutes.

While you are waiting carry on with Question 1.

9. After 10 minutes (step 8) remove the test-tubes from the water-bath. Observe the colour of the solution in each test-tube.
   To see the colour more clearly, it may help to hold a piece of white paper behind the test-tube.
   You may see the same colour in more than one test-tube.

10. Record your results in **(a)(ii)** using the symbols shown in Table 1.2.

Table 1.2

intensity of colour	symbol
dark blue	**+++++**
	++++
decreasing intensity of blue colour	**+++**
	++
no colour	**+**

(ii) Record your results in an appropriate table.

You may use the same symbols for more than one test-tube.

[5]

(iii) Using your results in **(a)(ii)**, state which concentration of enzyme removed the colour most effectively.

..... [1]

(iv) Using your knowledge of enzymes, explain the trend in your results.

.....

.....

..... [1]

(v) State **one** variable, **other than** temperature, that needs to be controlled in this investigation.

..... [1]

(vi) The procedure used in this investigation has several sources of error. Table 1.3 shows one of these sources of error.

Complete Table 1.3 by:

- stating **two** other sources of error
- describing an improvement to the procedure for each of the **three** sources of error.

Table 1.3

source of error	how to improve the procedure
the test-tube with 2.0% enzyme was left for longer than the other test-tubes	

[5]

(b) Grapes are a type of fruit that can be eaten freshly picked or dried.

Table 1.4 shows the sugar content of fresh grapes and dried grapes.

Table 1.4

type of sugar	sugar content / g per 100 g of grapes	
	fresh	dried
glucose	6.5	27.0
fructose	7.5	29.5
sucrose	0.5	1.0

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

Use a sharp pencil for drawing graphs.

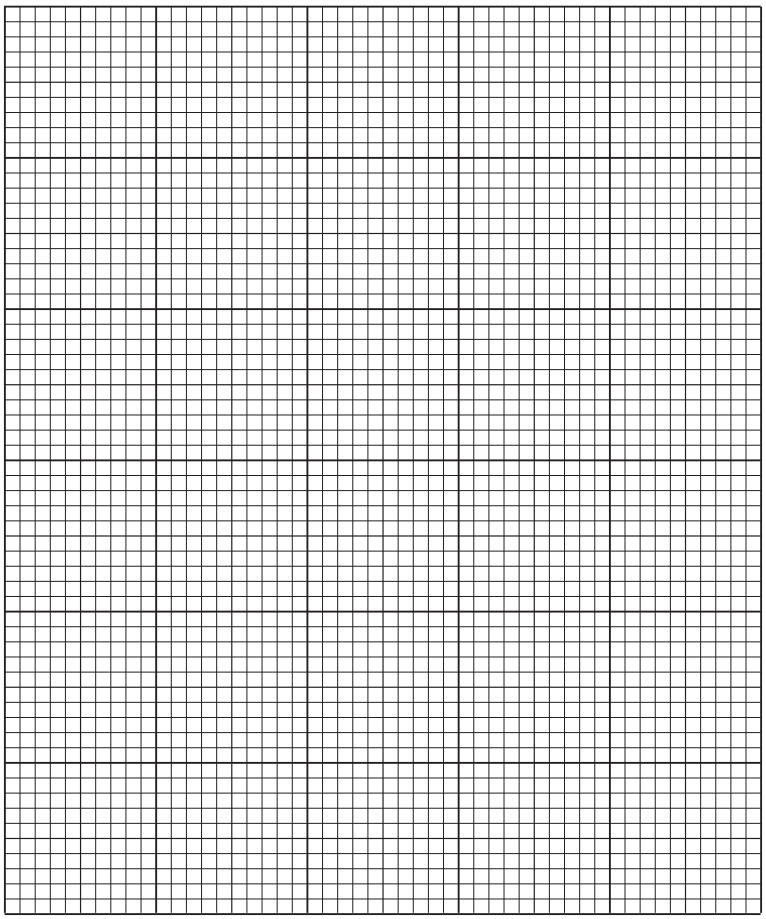


Fig. 1.2

[4]

(ii) The concentration of all sugars in dried grapes is higher than in fresh grapes.

Calculate the percentage increase in the concentration of glucose in dried grapes.

Show your working.

answer = ...% [2]

(iii) Suggest why the glucose concentration is higher in the dried grapes than in the fresh grapes.

.....

.....

..... [1]

[Total: 23]

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

(a) Set up the microscope so that you can observe the section on **K1**.

Observe the different tissues in the area on **K1** shown by the shaded region in Fig. 2.1.

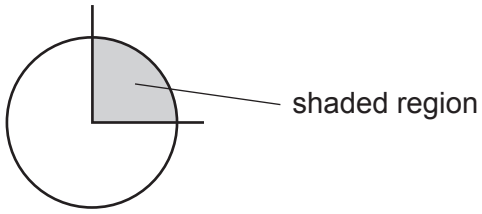


Fig. 2.1

Use a sharp pencil for drawing.

(i) Draw a large plan diagram of the area of the section on **K1** shown by the shaded region in Fig. 2.1.

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

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

[5]

(ii) Observe the vascular tissue of the section of the stem on **K1**.

Select **one** large xylem vessel element and **three** adjacent smaller cells.

Each smaller cell must touch the large xylem vessel element and at least **one** of the other smaller 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]

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(b) Fig. 2.2 is a photomicrograph of a stained transverse section through a root of a different type of plant.

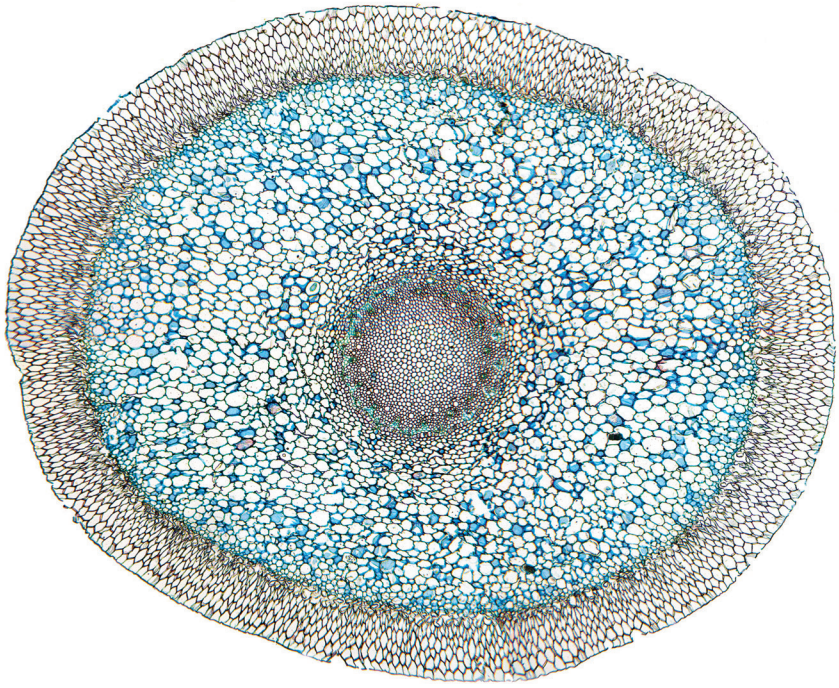


Fig. 2.2

Identify the observable differences between the section on **K1** and the section in Fig. 2.2.

Record the observable differences in Table 2.1.

Table 2.1

feature	K1	Fig. 2.2

[4]

(c) Fig. 2.3 is a photomicrograph of the same root section as in Fig. 2.2, viewed using a microscope with an eyepiece graticule placed across the section.

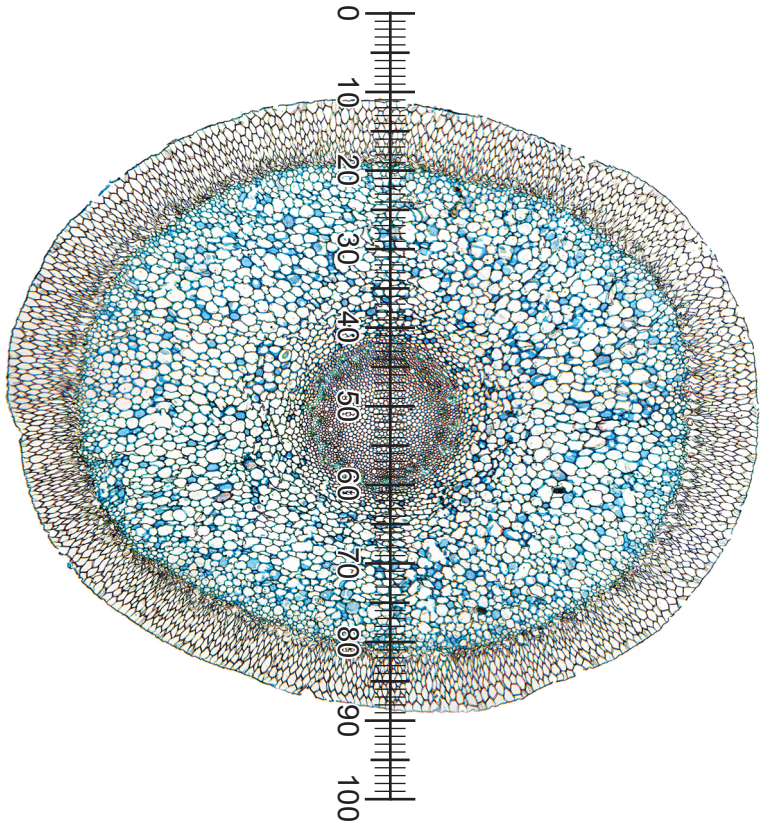


Fig. 2.3

An eyepiece graticule is shown on Fig. 2.3.
The calibration of the eyepiece graticule scale is:
1 eyepiece graticule division = 67.0 μm.

Use the calibration of the eyepiece graticule scale to calculate the actual diameter of the section in Fig. 2.3.

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

actual diameter = ... [3]

[Total: 17]

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Cambridge International AS & A Level

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CANDIDATE NUMBER

8611816848

BIOLOGY **9700/34**

Paper 3 Advanced Practical Skills 2 **October/November 2021**

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.
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Before you proceed, read carefully through the **whole** of Question 1 and Question 2.

Plan the use of the **two hours** to make sure that you finish the whole of Question 1 and Question 2.

1 Visking tubing is a selectively permeable membrane, similar to a cell membrane. Some biological molecules are able to diffuse through the Visking tubing membrane.

You will investigate the effect of temperature on the diffusion of reducing sugar through the Visking tubing membrane into the surrounding water.

You will need to:

- prepare a serial dilution of 10.0% reducing sugar, **R**
- estimate the concentration of reducing sugar in the water at two different temperatures.

You are provided with the materials shown in Table 1.1 and Table 1.2.

Table 1.1

labelled	contents	hazard	volume / cm^3
R	10.0% reducing sugar solution	none	30
G	20.0% reducing sugar solution	none	30
B	Benedict's solution	harmful irritant	30
W	distilled water	none	100

Table 1.2

labelled	details
V	2 lengths (15 cm) of Visking tubing in a beaker of water
P	beaker containing water at **room temperature**
Q	beaker containing **hot** water

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

It is recommended that you wear suitable eye protection.

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(a) You will set up the apparatus as shown in Fig. 1.1 using step 1 to step 6.

1. Tie a knot in one piece of the Visking tubing as close as possible to one end, so that the end is sealed.

2. To open the other end, wet the Visking tubing and rub the tubing gently between your fingers and thumb.

3. Put 10 cm^3 of **G** into the Visking tubing.

4. Rinse the outside of the Visking tubing by dipping it into the water in the beaker labelled **V**.

5. Put the Visking tubing into the **large** test-tube labelled **P1**. Put this test-tube into a test-tube rack.

6. Fold the open end of the Visking tubing over the top of the large test-tube. Use a paper clip to hold the Visking tubing in place as shown in Fig. 1.1.

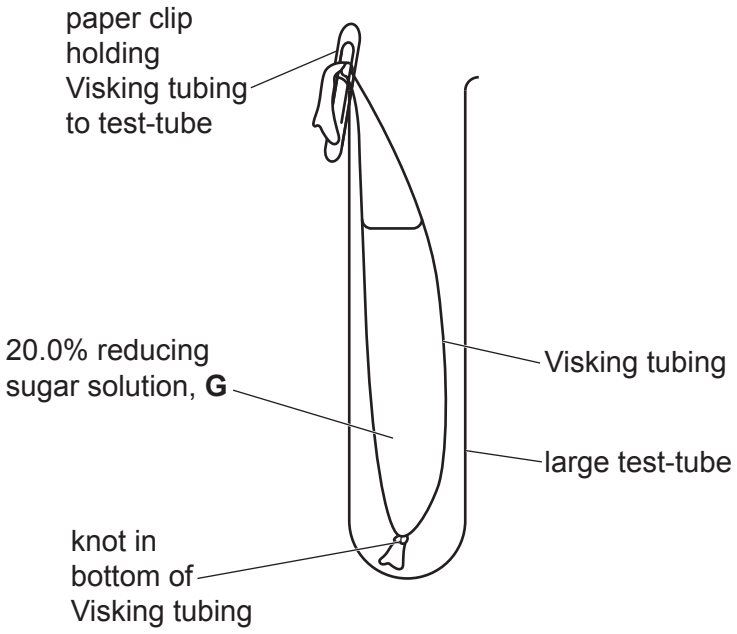


Fig. 1.1

Carry out step 7 to step 15.

7. Repeat step 1 to step 6 with the other piece of Visking tubing and the large test-tube labelled **Q1**.

8. Record the temperature of the water in beaker **P**. ..... °C

9. Prepare a water-bath at 60 °C using beaker **Q**. The water may need to be heated.

10. Use a syringe to transfer distilled water, **W**, into each of the large test-tubes containing the Visking tubing.

    The level of water in each large test-tube must be just above the level of **G** in the Visking tubing, as shown in Fig. 1.2.

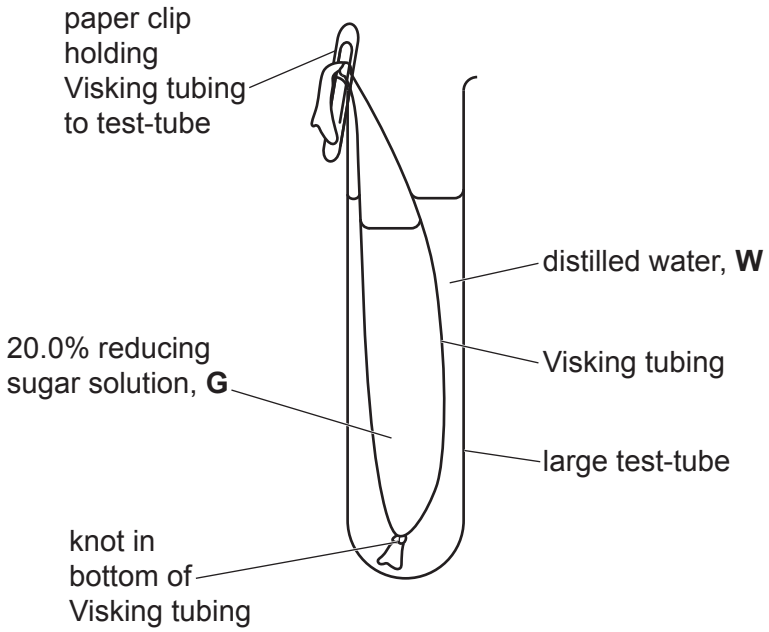


Fig. 1.2

11. Put the test-tube **P1** containing Visking tubing into beaker **P**.

12. Put the test-tube **Q1** containing Visking tubing into beaker **Q**.

13. Start timing and leave for **at least** 10 minutes. During this 10 minutes continue with step 14 to step 18.

14. Put 2 cm^3 of distilled water, **W**, into each of the small test-tubes **P2** and **Q2**. Draw a line on each test-tube at the level of the water.

15. Pour this water into the container labelled **For waste**. Put test-tubes **P2** and **Q2** into a test-tube rack ready for step 21 and step 22.

You will now need to carry out a **serial** dilution of the **10.0%** reducing sugar solution, **R**, to reduce the concentration by **a factor of 10** between each successive dilution.

You will need to prepare **four** concentrations of reducing sugar solution in addition to the 10.0% reducing sugar solution, **R**.

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

(i) Complete Fig. 1.3 to show how you will prepare your serial dilution.

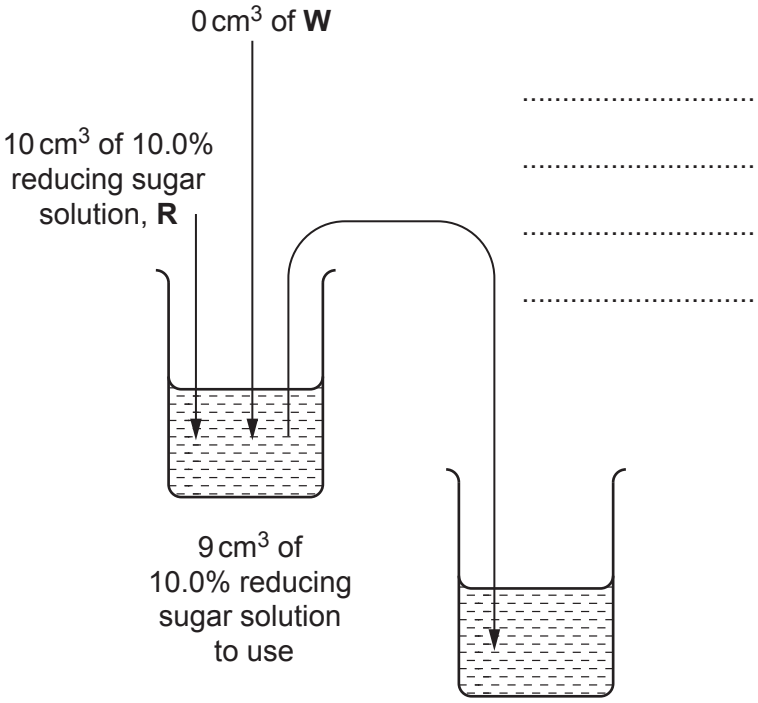
Fig. 1.3 shows the first two beakers you will use to make your serial dilution. You will need to draw **three** additional beakers.

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
10 cm3 of 10.0% reducing sugar solution, R
9 cm3 of 10.0% reducing sugar solution to use

.....

.....

.....

.....

.....

.....

.....

.....

Fig. 1.3

[3]

Carry out step 16 to step 29.

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

17. Label five **small** test-tubes with the concentrations you prepared in step 16.

18. Put 2 cm^3 of each concentration of reducing sugar solution into the appropriately labelled test-tube. Put these five test-tubes into a test-tube rack ready for step 24.

19. After at least 10 minutes (step 13), remove test-tubes **P1** and **Q1** from the beakers and put them in a test-tube rack.

20. Remove the Visking tubing from test-tubes **P1** and **Q1** and put these into the container labelled **For waste**. Do **not** throw away the solution remaining in the test-tubes.

21. Use a pipette to transfer solution from the large test-tube **P1** into the small test-tube **P2**, up to the line you drew in step 14.

22. Use a pipette to transfer solution from the large test-tube **Q1** into the small test-tube **Q2**, up to the line you drew in step 14.

23. Carefully remove some water from beaker **Q** so there is approximately 250 cm^3 of water in the beaker. Use this as a water-bath and heat to boiling ready for step 25.

24. Put 2 cm^3 of Benedict's solution, **B**, into each of the five small test-tubes from step 18. Shake gently to mix.

25. Put the test-tube labelled 10.0% into the boiling water-bath. Start timing.

26. 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'.

27. Record the result from step 26 in **(a)(ii)**.

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

29. Repeat step 25 to step 28 with the remaining concentrations of reducing sugar solution.

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(ii) Record your results in an appropriate table.

[5]

30. Put 2 cm^3 of Benedict's solution, **B**, into test-tube **P2**. Shake gently to mix.

31. Put this test-tube into the boiling water-bath. Start timing.

32. 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'.

33. Record the result from step 32 in **(a)(iii)**.

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

35. Repeat step 30 to step 34 with test-tube **Q2**.

(iii) Result for **P2** .....

Result for **Q2** .....

[2]

(iv) Using your results from **(a)(ii)** and **(a)(iii)** estimate the concentration of reducing sugar in **P2** and **Q2**.

concentration of reducing sugar in **P2** .....

concentration of reducing sugar in **Q2** .....
[2]

(v) Explain the difference between your results for **P2** and **Q2**.

.....

.....

..... [1]

(vi) State the dependent variable in the investigation you have just carried out.

..... [1]

(vii) Identify **one** source of error in step 24 to step 29.

Suggest an improvement to the method which will reduce the effect of this error.

error .....

.....

improvement .....

.....

.....
[2]

(viii) Suggest how you could modify this procedure to obtain a more accurate estimate of reducing sugar concentration in **P2** and **Q2**.

.....

.....

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.....

.....

..... [2]

(b) A student investigated the effect of the concentration of acid on the distance it diffused through agar blocks containing universal indicator over a period of two minutes.

The results are shown in Table 1.3.

Table 1.3

concentration of hydrochloric acid / mol dm^{-3}	distance acid diffused in 2 minutes / mm
1.00	9.0
0.89	8.5
0.75	4.5
0.45	4.0
0.27	3.8

Plot a graph of the data in Table 1.3 on the grid in Fig. 1.4.

Use a sharp pencil for drawing graphs.

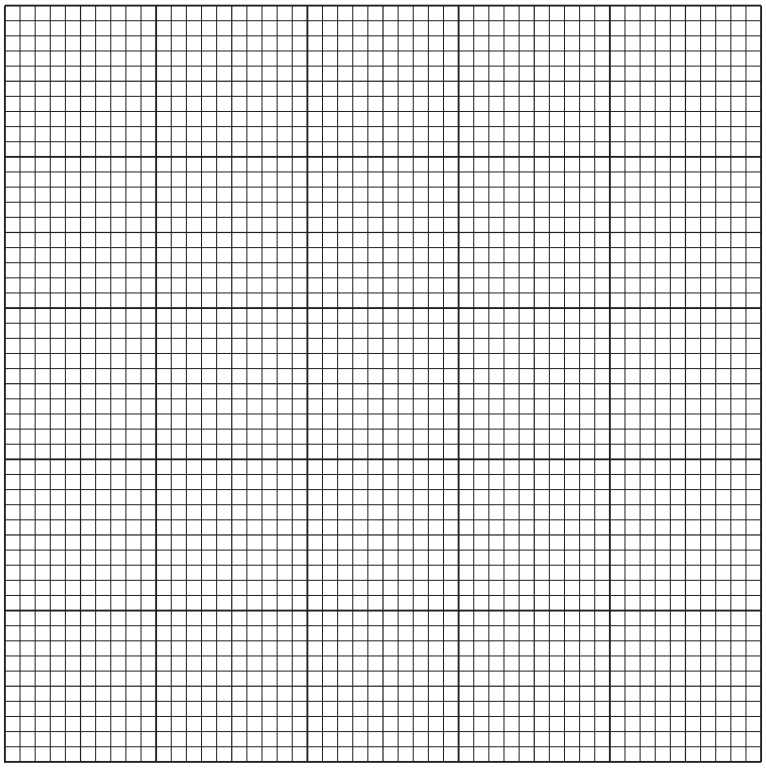


Fig. 1.4

[4]

[Total: 22]

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

(a) Set up the microscope so that you can observe the section on **L1**.

Use a sharp pencil for drawing.

(i) Draw a large plan diagram of the whole section of the plant organ on **L1**. Your drawing should show the correct shapes and proportions of the different tissues.

Use **one** ruled label line and label to identify the layer containing xylem.

[4]

(ii) Identify the plant organ on **L1**.

.....

Give a reason for your answer.

.....

.....

.....

..... [2]

(iii) Observe the epidermis and the layer of cells beneath it on the section of the plant organ on **L1**.

Select **two** epidermal cells and **two** adjacent, touching cells from the layer under 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.

[4]

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

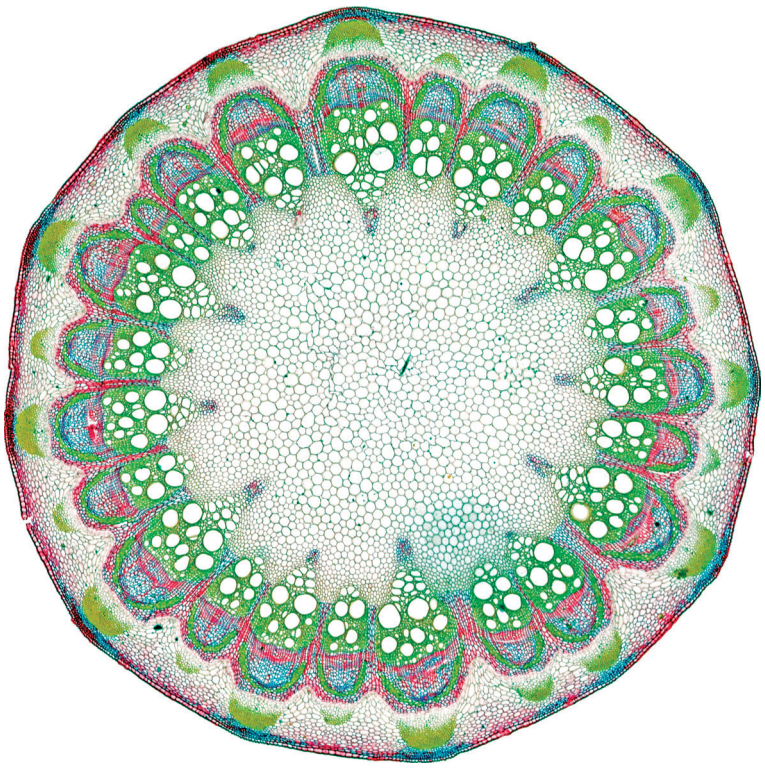


Fig. 2.1

Identify the observable differences between the section on **L1** and the section in Fig. 2.1.

Record the observable differences in Table 2.1.

Table 2.1

feature	L1	Fig. 2.1

[3]

(c) Fig. 2.2 is a photomicrograph of the same section that is in Fig. 2.1.

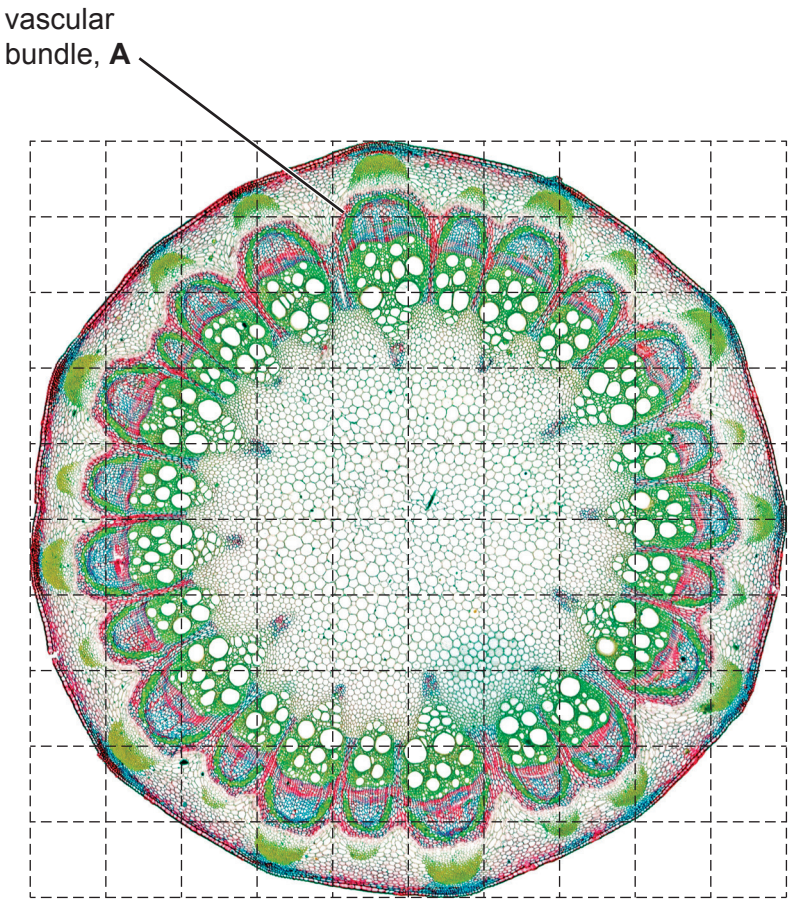


Fig. 2.2

You will need to use the grid to find the area of the vascular bundle labelled **A and** the total area of the plant organ section in Fig. 2.2.

Each square of the grid is 1 cm^2.

Some squares are not completely filled by the section.

(i) Describe the method you will use to decide which of these squares to include.

.....

.....

..... [1]

(ii) Use the grid to estimate the area of the vascular bundle labelled **A** and the total area of the plant organ section in Fig. 2.2.

area of vascular bundle **A** = ... cm^2

total area of the section = ... cm^2

[2]

(iii) Calculate the area of the vascular bundle, **A**, as a percentage of the total area of the plant organ section.

Show your working.

answer = ... %
[2]

[Total: 18]

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BIOLOGY **9700/35**

Paper 3 Advanced Practical Skills 1 **October/November 2021**

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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Before you proceed, read carefully through the **whole** of Question 1 and Question 2.

Plan the use of the **two hours** to make sure that you finish the whole of Question 1 and Question 2.

1 Plant cells contain the enzyme catalase which catalyses the breakdown of hydrogen peroxide, releasing oxygen.

When a mixture of hydrogen peroxide and plant extract is put into a syringe, bubbles of oxygen are released.

You are going to investigate the effect of substrate concentration on the activity of catalase.

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3
H	3.0% hydrogen peroxide solution	irritant	30
P	plant extract solution	none	40
U	unknown concentration of hydrogen peroxide solution	irritant	10
W	distilled water	none	100

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

It is recommended that you wear suitable eye protection and wear gloves to protect your hands when using hydrogen peroxide, **H** and **U**.

(a) You will need to carry out a **serial** dilution of the 3.0% hydrogen peroxide solution, **H**, to reduce the concentration by **half** between each successive dilution.

You will need to prepare **four** concentrations of hydrogen peroxide solution in addition to the 3.0% hydrogen peroxide solution, **H**.

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.

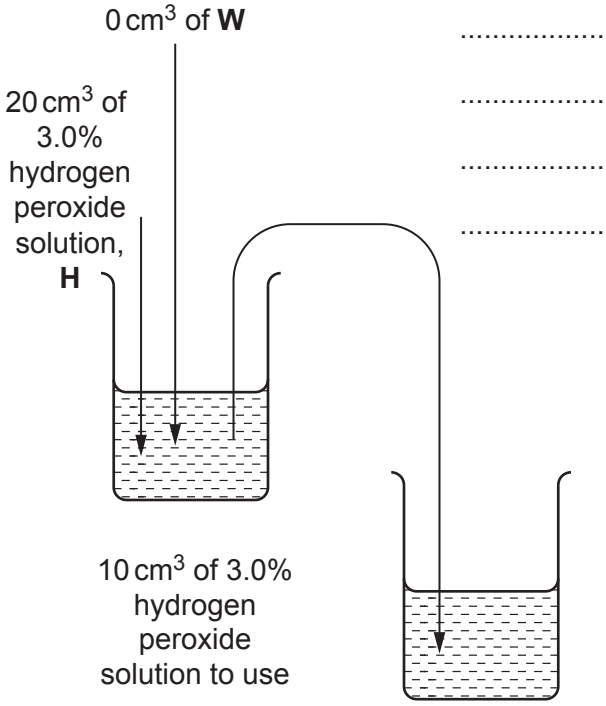
Fig. 1.1 shows the first two beakers you will use to make your serial dilution. You will need to draw **three** additional beakers.

For each beaker add labelled arrows to show:

- the volume of hydrogen peroxide solution transferred
- the volume of distilled water, **W**, added.

Under each beaker, state the concentration of hydrogen peroxide solution.

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0 cm3 of W
20 cm3 of 3.0% hydrogen peroxide solution, H
10 cm3 of 3.0% hydrogen peroxide solution to use

.....

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.....

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.....

.....

Fig. 1.1

[3]

Carry out step 1 to step 24.

1. Prepare the concentrations of hydrogen peroxide solution, as decided in **(a)(i)**, in the beakers provided.

2. Put **W** into the test-tube so that it is approximately half-full.

3. Use the glass rod to stir the plant extract solution, **P**.

4. Put the nozzle of a clean syringe into the beaker containing **P**.

5. Pull the plunger out to the 1 cm^3 mark so that **P** enters the syringe, as shown in Fig. 1.2.

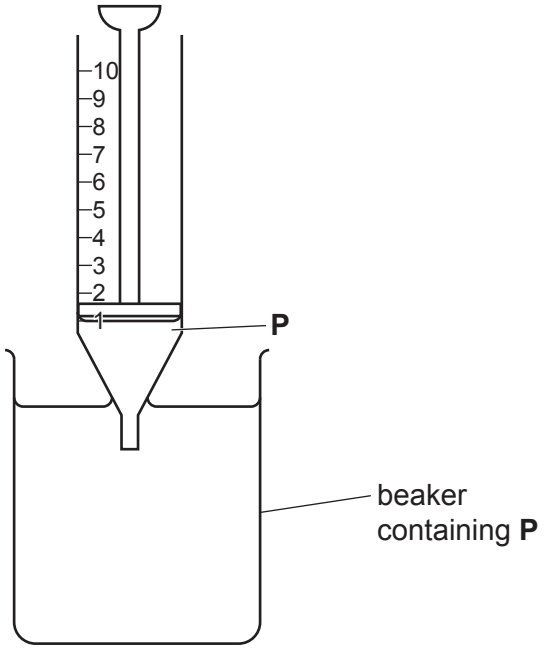


Fig. 1.2

6. Remove the syringe from the beaker containing **P** and wipe the nozzle with a paper towel.

7. Put the nozzle of the **same** syringe into the beaker containing 3.0% hydrogen peroxide solution, **H**.

8. Pull the plunger out to the 2 cm^3 mark so that 1 cm^3 of the 3.0% hydrogen peroxide solution enters the syringe, as shown in Fig. 1.3.

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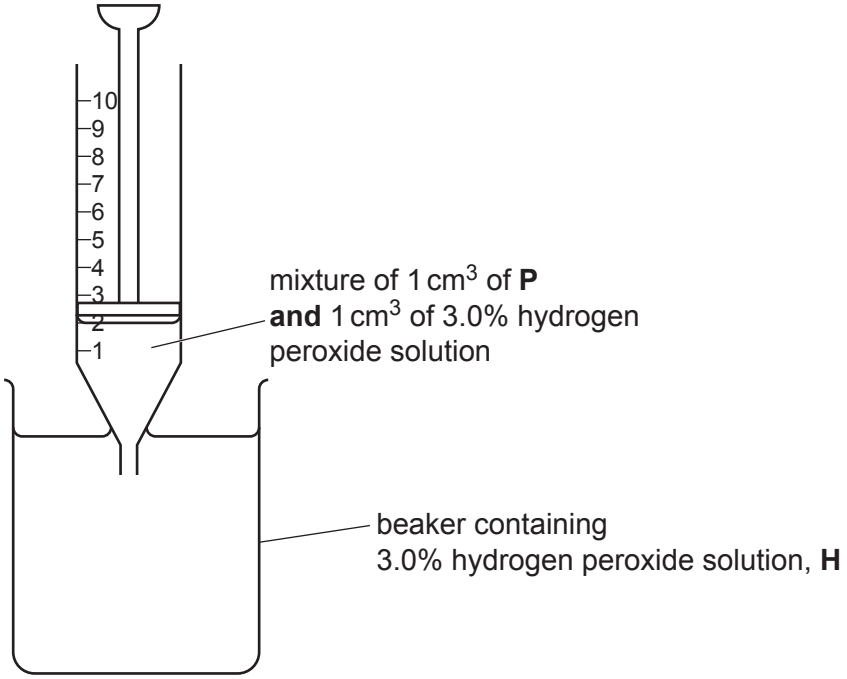


Fig. 1.3

9. Carefully wipe the nozzle with a paper towel to remove excess hydrogen peroxide solution.

10. Put the tubing onto the syringe nozzle.

11. Put the syringe into a beaker as shown in Fig. 1.4.

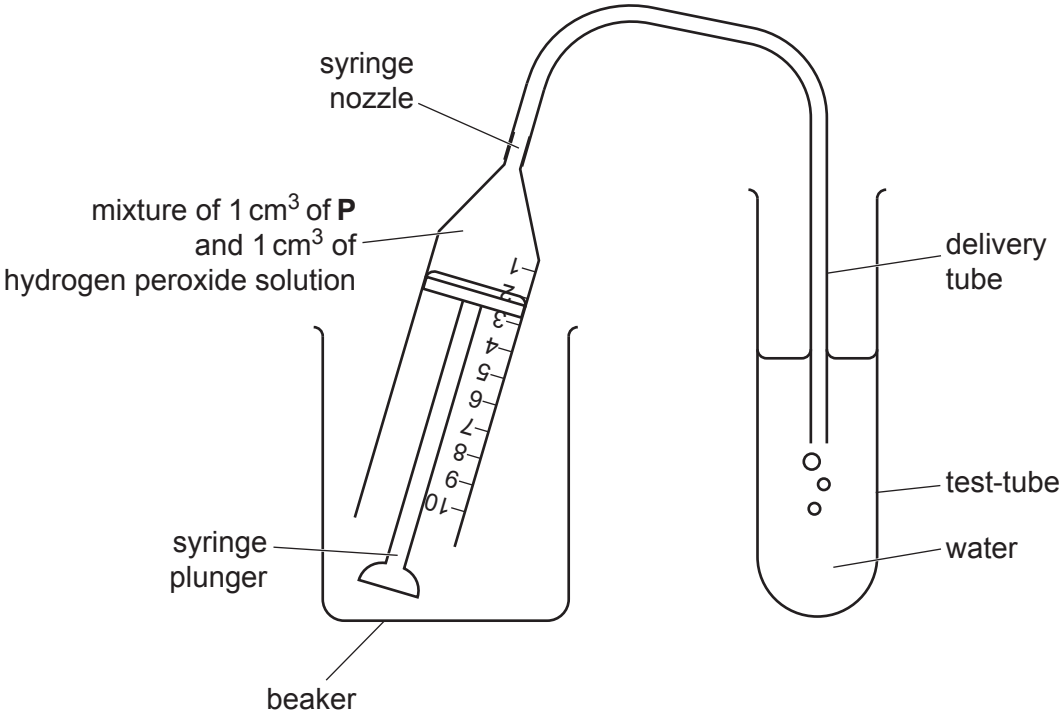


Fig. 1.4

12. Put the end of the delivery tube into the test-tube as shown in Fig. 1.4.

13. Start timing when the first bubble is observed in the water in the test-tube.

14. Count the number of bubbles produced in 120 seconds. Record the results in **(a)(ii)**.

15. Hold the syringe with the nozzle up and remove the tubing from the syringe. Put the tubing onto a paper towel.

16. Hold the syringe with the nozzle pointing downwards over the container labelled '**For waste**' and empty the syringe.

17. Fill the syringe with water from the container labelled '**For washing**'.

18. Put the tubing back onto the syringe nozzle.

19. Empty the syringe through the tubing into the container labelled '**For waste**'.

20. Repeat step 15 to step 19 twice more to wash the syringe and the tubing.

21. Remove the tubing from the syringe. Put the tubing onto a paper towel.

22. Repeat step 3 to step 21 with each of the other concentrations of hydrogen peroxide solution prepared in step 1.

(ii) Record your results in an appropriate table.

[5]

23. Repeat step 3 to step 13 with the unknown concentration of hydrogen peroxide solution, **U**.

24. Count the number of bubbles produced in 120 seconds. Record the result in **(a)(iii)**.

(iii) State the number of bubbles produced in 120 seconds for **U**. ..... [1]

(iv) Using your results from **(a)(ii)** and **(a)(iii)** estimate the concentration of **U**.

..... % [1]

(v) The volume of oxygen was measured by counting the number of bubbles.

Suggest why this is a source of error.

.....

..... [1]

(vi) Suggest an improvement to the procedure to provide a more accurate measurement of the volume of oxygen produced.

.....

.....

..... [1]

(vii) In the procedure described in step 1 to step 14, the effect of the concentration of hydrogen peroxide on catalase activity was investigated.

Describe how you would modify this procedure to investigate the effect of changing pH on the number of bubbles of oxygen produced.

.....

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.....

.....

..... [2]

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[Turn over

(b) A student carried out another investigation into the effect of temperature on the activity of catalase. Test-tubes containing plant extract and hydrogen peroxide were placed in thermostatically controlled water-baths at five different temperatures for 120 seconds.

The results are shown in Table 1.2.

The activity of the enzyme is shown in arbitrary units (au).

Table 1.2

temperature / °C	activity of enzyme / au
15.5	3.4
26.0	6.5
37.5	10.1
45.5	8.2
55.0	1.2

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

Use a sharp pencil for drawing graphs.

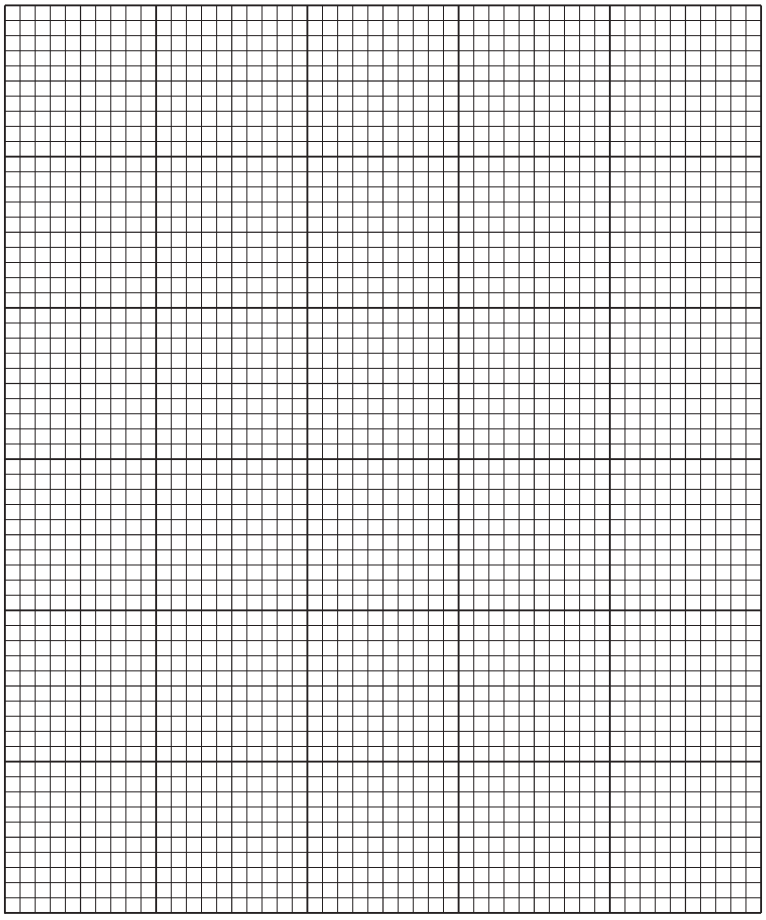


Fig. 1.5

[4]

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(ii) Use your graph to find the activity of the enzyme when the temperature was 30.1 °C.

activity of the enzyme = ... au [1]

(iii) Suggest an explanation for the difference in activity of the enzyme between 37.5 °C and 55.0 °C.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 22]

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

(a) Set up the microscope so that you can observe the section on **M1**.

Use a sharp pencil for drawing.

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

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

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

[5]

(ii) Observe the cells in the central tissue of the section on **M1**.

Select **four** adjacent, touching cells of the central tissue.

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 the cell wall of **one** cell.

[5]

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

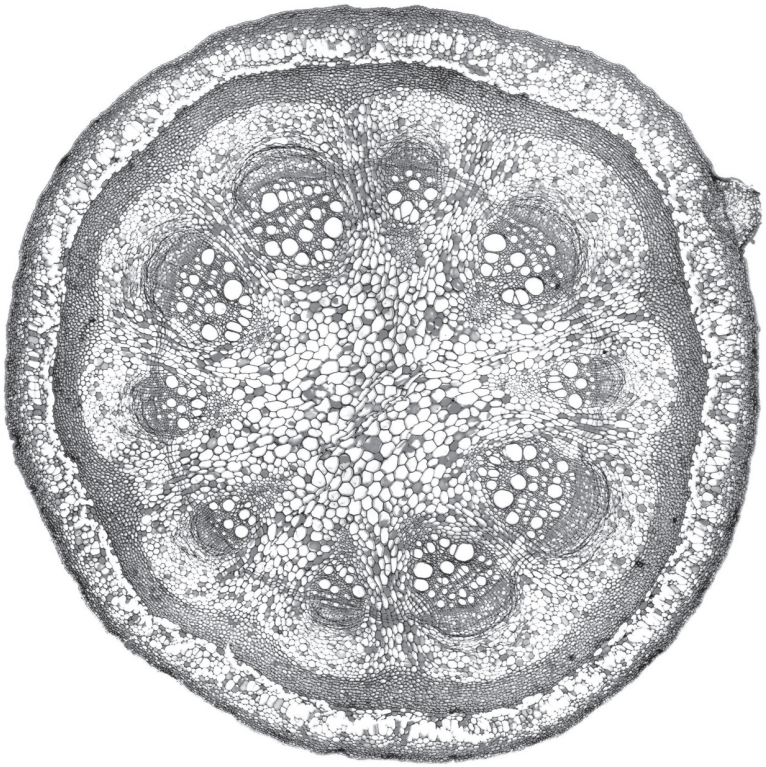


Fig. 2.1

Identify the observable **differences** between the section on **M1** and the section shown in Fig. 2.1.

Record the observable differences in Table 2.1.

Table 2.1

feature	M1	Fig. 2.1

[3]

(c) Fig. 2.2 is a photomicrograph of the same plant stem section that is in Fig. 2.1.

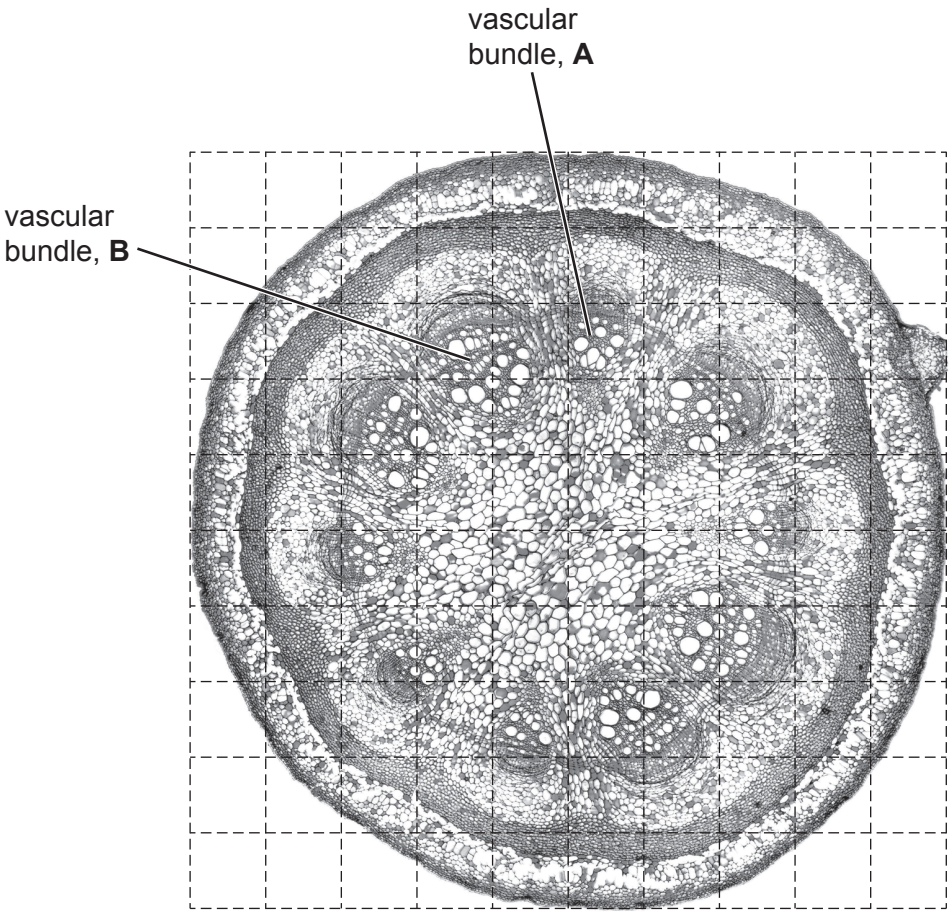


Fig. 2.2

You will need to use the grid to find the area of the vascular bundle labelled **A and** the area of the vascular bundle labelled **B** in Fig. 2.2.

Each square of the grid is 1 cm^2.

Some of the squares are not completely filled with vascular bundle tissue.

(i) Describe the method you will use to decide which of these squares to include.

.....

.....

..... [1]

(ii) Use the grid to estimate the area of the vascular bundle labelled **A** and the area of the vascular bundle labelled **B** in Fig. 2.2.

area of vascular bundle **A** = ... cm^2

area of vascular bundle **B** = ... cm^2

[2]

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(iii) Calculate the area of vascular bundle **A** as a percentage of the area of vascular bundle **B**.

Show your working.

answer = ... % [2]

[Total: 18]

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BIOLOGY **9700/36**

Paper 3 Advanced Practical Skills 2 **October/November 2021**

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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Before you proceed, read carefully through the **whole** of Question 1 and Question 2.

Plan the use of the **two hours** to make sure that you finish the whole of Question 1 and Question 2.

1 Catalase is an enzyme produced by bacteria. Catalase breaks down hydrogen peroxide to produce oxygen gas, as shown in Fig. 1.1.



Fig. 1.1

The activity of catalase can be used to determine the level of bacterial contamination in a food sample.

You will investigate catalase activity in two food samples, **F1** and **F2**.

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3
E	10.0% catalase solution	harmful irritant	30
F1	food sample 1	none	20
F2	food sample 2	none	20
H	hydrogen peroxide solution	harmful irritant	50
D	detergent solution	irritant	20
W	distilled water	none	200

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

It is recommended that you wear suitable eye protection.

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[Turn over

(a) You will need to carry out a **serial** dilution of the 10.0% catalase solution, **E**, to reduce the concentration of catalase by **half** between each successive dilution.

You will need to prepare **four** concentrations of catalase solution in addition to the 10.0% catalase solution, **E**.

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

(i) Complete Fig. 1.2 to show how you will prepare your serial dilution.

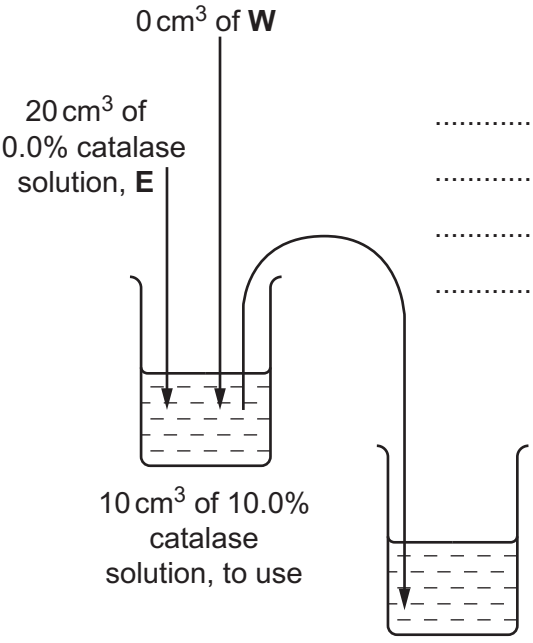
Fig. 1.2 shows the first two beakers you will use to make your serial dilution. You will need to draw **three** additional beakers.

For each beaker add labelled arrows to show:

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

Under each beaker, state the concentration of catalase solution.

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0 cm3 of W
20 cm3 of 10.0% catalase solution, E
10 cm3 of 10.0% catalase solution, to use

.....

.....

.....

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.....

.....

.....

.....

Fig. 1.2

[3]

Carry out step 1 to step 15.

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

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

3. Put 1 cm^3 of each concentration of catalase solution into the appropriately labelled test-tube.

4. Label another test-tube **0.0%** and put 1 cm^3 of distilled water, **W**, into this test-tube.

5. Put **one** drop of detergent solution, **D**, into each labelled test-tube. Mix gently.

When detergent is used, any oxygen produced by the breakdown of hydrogen peroxide is trapped as foam. The height of the foam can be used as a measure of the volume of oxygen produced.

6. Put 5 cm^3 of **H** into each labelled test-tube. This should be done by touching the nozzle of the syringe against the inside of the test-tube, as shown in Fig. 1.3. Gently push the plunger of the syringe so that **H** runs down the inside of the test-tube.

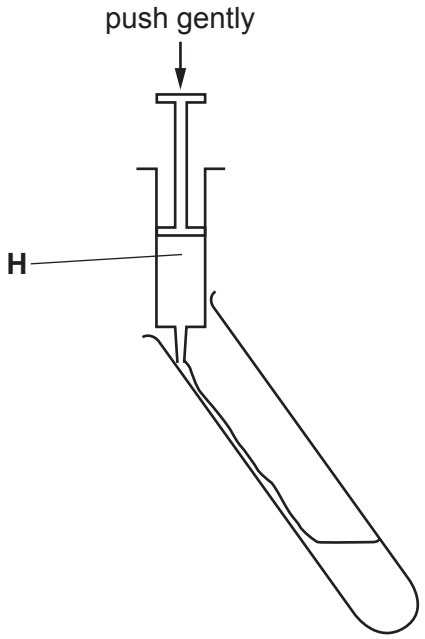


Fig. 1.3

7. Start timing. When the foam reaches the top of at least one of the test-tubes, **stop timing** and record this time.

   If the foam does **not** reach the top of any test-tube after 3 minutes, stop timing and record this time as '3 minutes'.

   time = ...

8. Measure the height of the foam in each test-tube. Record your results in **(a)(ii)**.

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(ii) Record your results in an appropriate table.

[4]

9. Label a test-tube **F1**, and label another test-tube **F2**.
10. Put 1 cm^3 of **F1** into the appropriately labelled test-tube.
11. Put 1 cm^3 of **F2** into the appropriately labelled test-tube.
12. Put **one** drop of **D** into each labelled test-tube. Mix gently.
13. Put 5 cm^3 of **H** into each labelled test-tube as described in step 6.
14. Start timing and leave for the time you recorded in step 7.
15. After this time (step 14), measure the height of the foam in each test-tube.

(iii) Record the height of the foam in each test-tube. Include appropriate units.

F1 .....

F2 .....

[2]

(iv) Use your results from **(a)(ii)** and **(a)(iii)** to estimate the concentration of catalase in food samples **F1** and **F2**.

F1 ..... %

F2 ..... %

[2]

(v) A source of error in this investigation is the difficulty of measuring the height of the foam.

Suggest an improvement to the procedure to provide a more accurate measurement of the volume of oxygen produced.

.....

.....

..... [1]

(vi) Suggest **one** reason for using a 0.0% concentration in this investigation.

.....

..... [1]

(vii) Describe how you could modify this procedure to obtain more accurate estimates of the concentrations of **F1** and **F2** in **(a)(iv)**.

.....

.....

..... [1]

(b) A culture of *Escherichia coli* bacteria was grown for 10 days and then placed in solutions of different glucose concentration. The rate of glucose uptake into the bacterial cells was calculated.

The results for *E. coli* are shown in Table 1.2.

Table 1.2

glucose concentration / mg dm^{-3}	glucose uptake rate / mg min^{-1}
0	0.0
25	1.0
40	2.5
60	4.8
75	5.1
100	5.1

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

Use a sharp pencil.

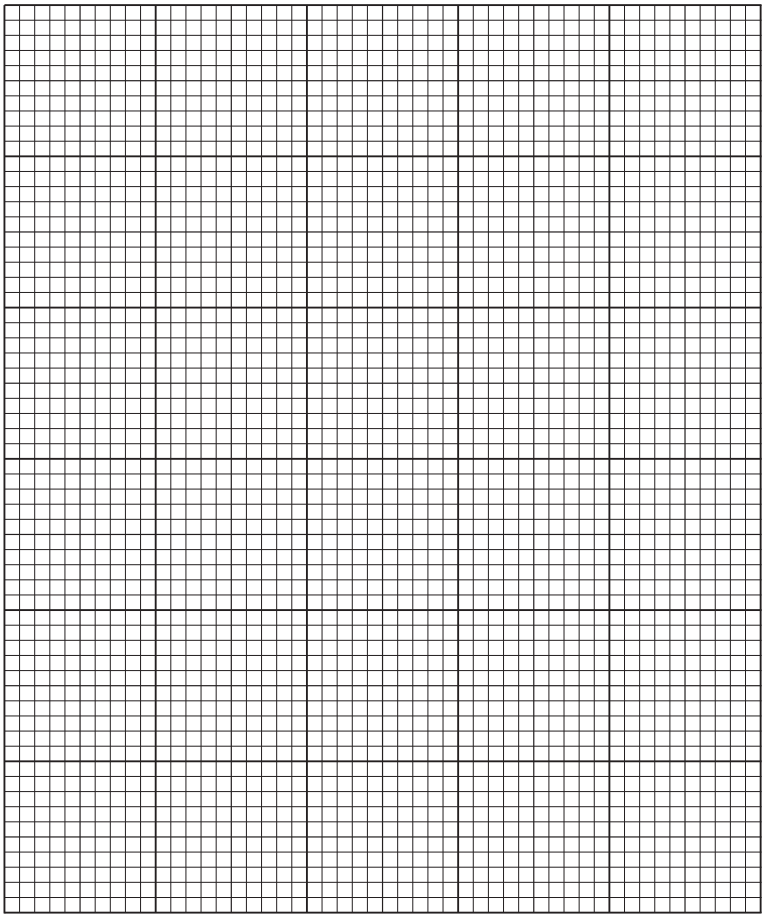


Fig. 1.4

[4]

(ii) Use your graph in Fig. 1.4 to suggest how glucose is transported into bacterial cells.

Suggest an explanation for your answer.

.....

.....

.....

..... [2]

(iii) The rate of glucose uptake in another culture of bacteria, *Chelatobacter heintzii*, was also calculated.

The results for *C. heintzii* are shown in Table 1.3.

Table 1.3

glucose concentration / mg dm^{-3}	glucose uptake rate / mg min^{-1}
0	0
25	4.6
40	6.2
60	7.0
75	7.0
100	7.0

Cultures of *E. coli* and *C. heintzii* bacteria were placed in the same container with 40 mg dm^{-3} glucose.

Use the data in Table 1.3 and your graph in **(b)(i)** to suggest which population of bacteria would grow the fastest.

Suggest an explanation for your answer.

.....

.....

.....

..... [2]

[Total: 22]

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

(a) Set up the microscope so that you can observe the section on **N1**.

Observe the different tissues in the area on **N1** shown by the shaded region in Fig. 2.1.

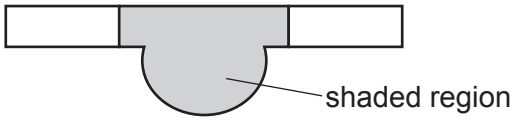


Fig. 2.1

Use a sharp pencil for drawing.

(i) Draw a large plan diagram of the area of the section on **N1** shown by the shaded region in Fig. 2.1.

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

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

[5]

(ii) Observe **one** vascular bundle of the section on **N1**.

Select **one** large xylem vessel element and **three** adjacent smaller cells.

Each smaller cell must touch the large xylem vessel element and at least **one** of the other smaller cells.

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

[5]

Question 2 continues on page 14

(b) Fig. 2.2 is a photomicrograph showing part of a leaf surface.

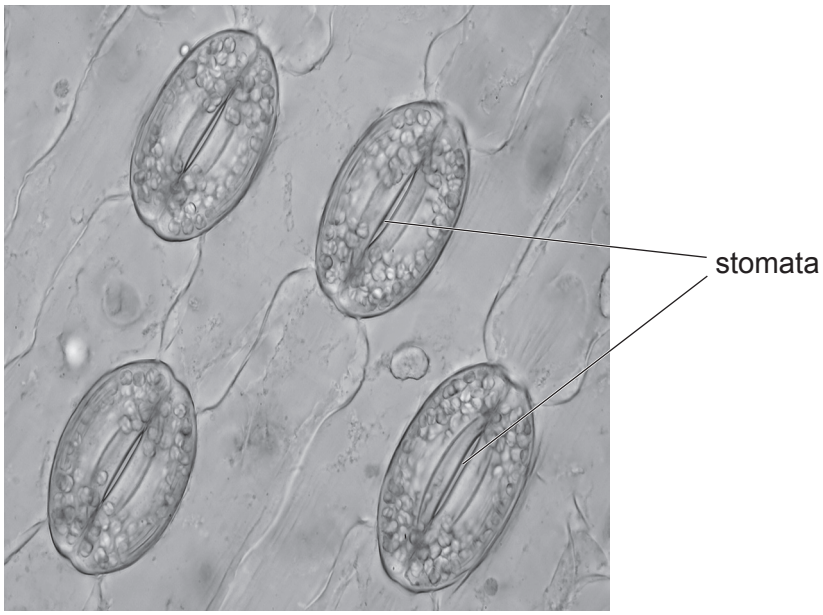


Fig. 2.2

The actual area of 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 20 cm^2.

1 cm^2 = 100 mm^2

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

Show your working.

number of stomata on the leaf = ...
[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]

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(iii) Fig. 2.3 is a photomicrograph showing part of a leaf surface of a different type of plant.

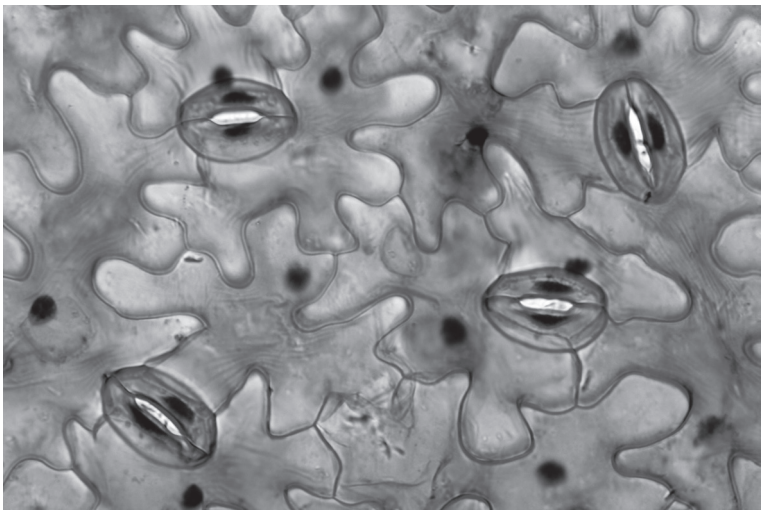


Fig. 2.3

Fig. 2.2 and Fig. 2.3 have the same magnification.

Identify the observable differences between the leaf surface shown in Fig. 2.2 and the leaf surface shown in Fig. 2.3.

Record the observable differences in Table 2.1.

Table 2.1

feature	Fig. 2.2	Fig. 2.3

[4]

[Total: 18]

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