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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

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BIOLOGY **9700/31**

Paper 3 Advanced Practical Skills 1 **October/November 2025**

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 [ ].

For Examiner's Use	
1	
2	
Total	

This document has **16** pages. Any blank pages are indicated.

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1 The bacterium *Streptococcus pneumoniae* is commonly found in the throat. *S. pneumoniae* produces hydrogen peroxide as it grows. A sample can be taken from a patient's throat and tested to measure the concentration of hydrogen peroxide. This can be used as a measure of the growth of the bacteria.

You will determine the growth of bacteria by measuring the concentration of hydrogen peroxide in a solution that represents a sample taken from a patient. You will do this by measuring how long it takes for a sample of hydrogen peroxide to cause a colour change in a reaction mixture. The faster the mixture changes to a blue-black colour, the higher the concentration of hydrogen peroxide, and the greater the growth of bacteria.

You will use a range of known concentrations of hydrogen peroxide to estimate the concentration of hydrogen peroxide in a sample.

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3
R1	dilute sulfuric acid	irritant	100
R2	starch solution	low	10
R3	potassium iodide solution	low	10
R4	sodium thiosulfate solution	low	10
H	2.0% hydrogen peroxide solution	irritant	25
U	solution representing patient sample	irritant	10
W	distilled water	low	100

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

It is recommended that you wear suitable eye protection.

You will need to carry out a **serial** dilution of the 2.0% 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 2.0% hydrogen peroxide solution, **H**.

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

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

Each beaker should have:

- a labelled arrow to show the volume of hydrogen peroxide solution transferred
- a labelled arrow to show the volume of distilled water, **W**, added
- a label under the beaker to show the concentration of the hydrogen peroxide solution.

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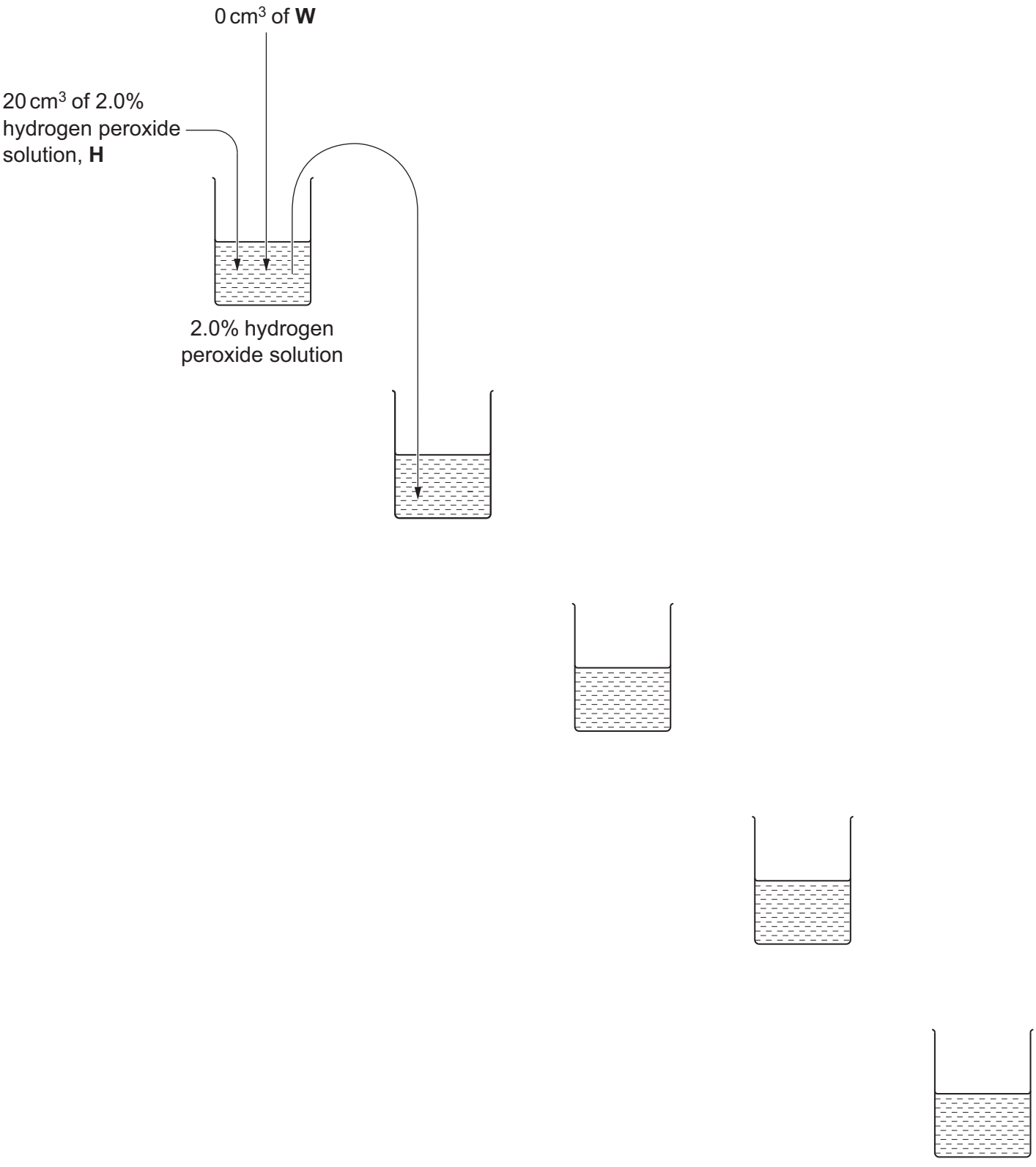


Fig. 1.1

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Carry out step 1 to step 17.

step 1 Prepare the concentrations of hydrogen peroxide solution as shown in Fig. 1.1.

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

step 3 Put 10 cm^3 of **R1** into each test-tube.

step 4 Put 1 cm^3 of **R2** into each test-tube.

step 5 Put 1 cm^3 of **R3** into each test-tube.

step 6 Put 1 cm^3 of **R4** into each test-tube.

step 7 Stir the contents of each test-tube with a glass rod.

step 8 Put 1 cm^3 of the 2.0% hydrogen peroxide solution into the appropriately labelled test-tube.

step 9 Stir the contents of the test-tube and immediately start timing.

step 10 Record in **(a)(ii)** the time taken for a blue-black colour to appear.

If the blue-black colour does **not** appear after 180 seconds, stop timing and record as 'more than 180'.

step 11 Repeat step 8 to step 10 with the other concentrations of hydrogen peroxide solution prepared in step 1.

(ii) Record your results in an appropriate table.

[5]

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A sample can be taken from a patient's throat and tested to measure the concentration of hydrogen peroxide. You will be testing a solution, **U**, that represents a sample taken from a patient's throat.

You will need to estimate the concentration of hydrogen peroxide in **U**. This can be used as a measure of the growth of bacteria.

step 12 Label 3 test-tubes **U1**, **U2** and **U3**.

step 13 Repeat step 3 to step 7.

step 14 Add 1 cm^3 of **U** to test-tube **U1**.

step 15 Stir the contents of the test-tube and immediately start timing.

step 16 Record in **(a)(iii)** the time taken for a blue-black colour to appear.

step 17 Repeat step 14 to step 16 using test-tubes **U2** and **U3**.

(iii) Record the time taken for a blue-black colour to appear.

U1 = ...

U2 = ...

U3 = ...
[1]

(iv) Calculate the mean time taken for the blue-black colour to appear for sample **U**.

Show your working.

mean time = ...
[1]

(v) Use your results in **(a)(ii)** and **(a)(iv)** to estimate the concentration of hydrogen peroxide in sample **U**.

concentration of hydrogen peroxide in sample **U** = ... [1]

(vi) Explain why repeating the measurement for sample **U** allows you to have more confidence in your estimate.

.....

.....

..... [1]

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(vii) With reference to your estimate for sample **U**, describe **one** other modification to the procedure that would allow a more accurate estimate of the concentration of hydrogen peroxide in sample **U**.

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..... [1]

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(b) Scientists investigated the effect of temperature on hydrogen peroxide production in a different species of bacterium, *Streptococcus pyogenes*.

Cultures of the bacterial cells were incubated at 2 different temperatures for 168 hours. The percentage of bacterial cells that were able to produce hydrogen peroxide was measured.

The results are shown in Table 1.2.

Table 1.2

time / hours	percentage of bacterial cells able to produce hydrogen peroxide	
	bacterial cells at 20 °C	bacterial cells at 37 °C
24	6.0	3.0
48	10.0	3.0
72	12.0	3.2
96	16.0	5.2
168	19.8	5.4

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

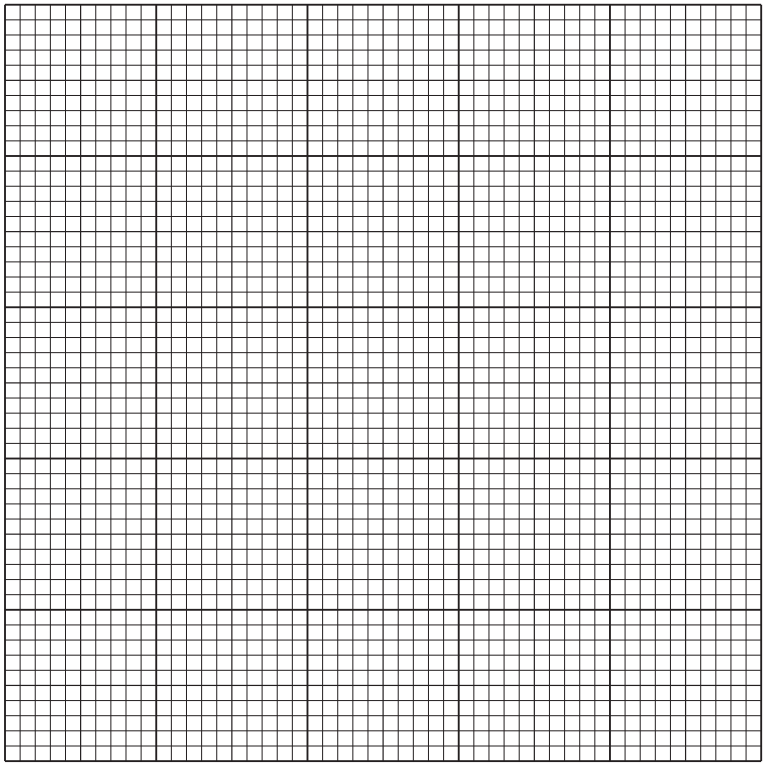


Fig. 1.2

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(ii) State **two** conclusions from the results of the investigation at the 2 temperatures.

1 .....

.....

.....

.....

2 .....

.....

.....

.....

[2]

(iii) A sample was taken at 20 °C that showed 14.5% of the bacteria were able to produce hydrogen peroxide.

Use your graph in Fig. 1.2 to estimate when the sample was taken.

Show on your graph how you obtained your estimate, and give your answer to the nearest hour.

sample taken ..... hours

[2]

(iv) State **one** variable that the scientists would need to keep constant so that the results at the 2 temperatures could be compared.

.....

.....

..... [1]

[Total: 22]

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

(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 xylem.

[5]

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(ii) Observe the epidermis of the stem on **J1**.

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

Each cell must touch at least **one** other cell.

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

[5]

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(iii) Fig. 2.1 is a photomicrograph of a stained transverse section of a stem from a different type of plant from **J1**.

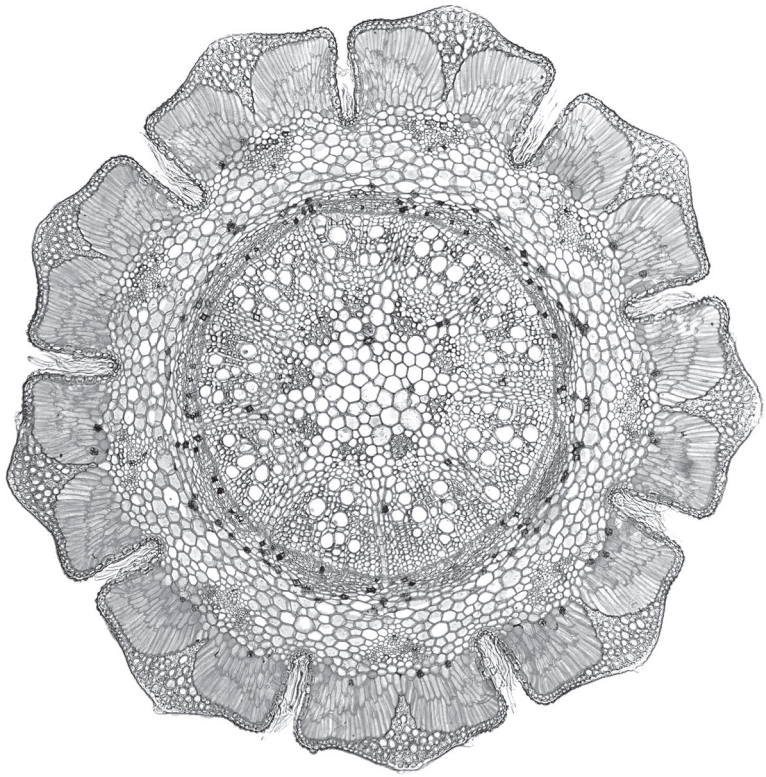


Fig. 2.1

Identify **three** observable differences, other than colour, between the stem section on **J1** and the stem section in Fig. 2.1.

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

Table 2.1

feature	J1	Fig. 2.1
1		
2		
3		

[3]

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

You will calculate the density of vascular bundles in the stem section. The circle represents the area of the stem.

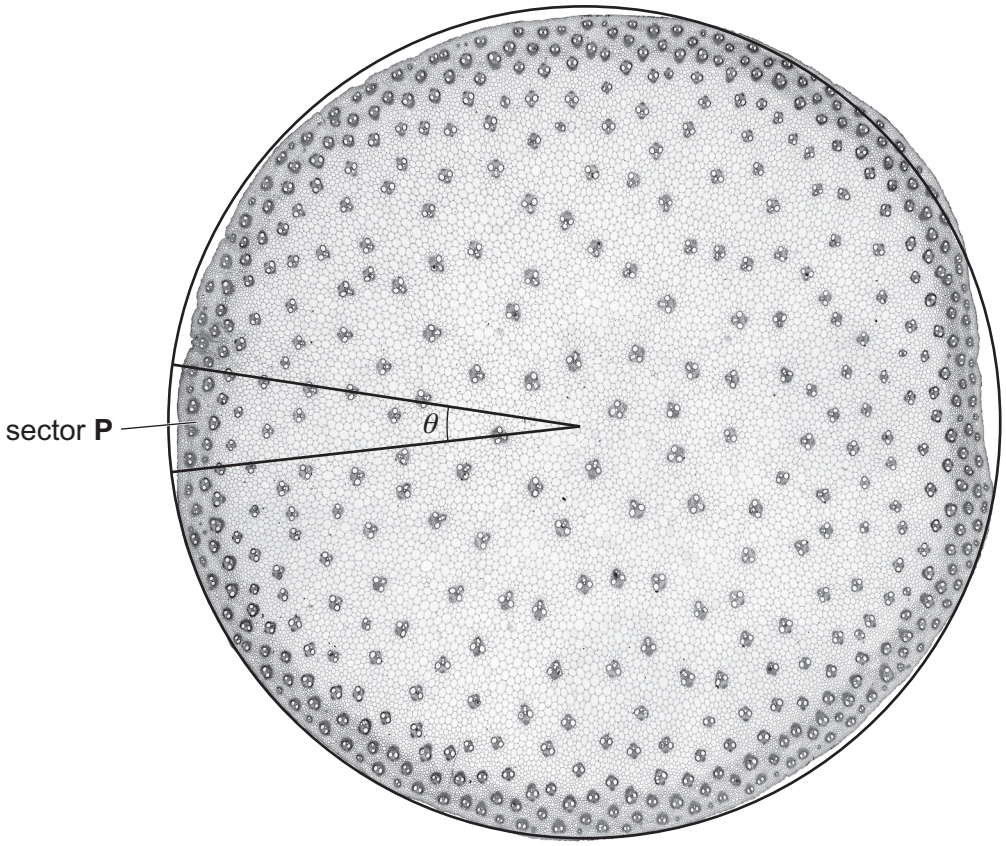


Fig. 2.2

(i) To calculate the density of vascular bundles you will first need to count the number of whole vascular bundles in sector **P**.

number of whole vascular bundles in sector **P** = ... [1]

(ii) Use your answer to **(b)(i)** to estimate the total number of vascular bundles in the stem section shown in Fig. 2.2.

angle θ = 15°

Show your working.

total number of vascular bundles = ...
[2]

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(iii) The stem section shown in Fig. 2.2 has an actual area of 44 mm^2.

Use your answer in **(b)(ii)** to calculate the density of vascular bundles in the stem section.

Give your answer to **two** significant figures.

Show your working.

vascular bundle density = ... mm^{-2}
[2]

[Total: 18]

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