1. Question part 1/4 | 5090 Oct-Nov 2023 P4 V1 Q1

1 Hydrogen peroxide is a toxic waste product found in cells. Catalase, an enzyme present in cells, breaks down hydrogen peroxide to produce water and oxygen.

$$\text{hydrogen peroxide} \xrightarrow{\text{catalase}} \text{water + oxygen}$$

When potato tissue is added to a solution of hydrogen peroxide in a test-tube the catalase in the potato cells causes bubbles of oxygen to be produced. If some detergent is added to the hydrogen peroxide solution the oxygen bubbles are trapped to produce a layer of bubbles that rises up the test-tube. The height of this layer of bubbles indicates how much catalase activity there has been.

A student used this method to investigate the activity of the catalase in potato tissue by following these instructions:

- Label three large test-tubes **A**, **B** and **C**.
- Add 5 cm^3 of hydrogen peroxide solution to each test-tube. **Hydrogen peroxide is an irritant that may cause damage to eyes and skin.**
- Add 1 cm^3 of detergent to the hydrogen peroxide solution in each test-tube.
- Cut three pieces of potato measuring 10 mm × 10 mm × 10 mm.
- Add one of the pieces of potato to test-tube **A**. It will sink to the bottom of the hydrogen peroxide solution.
- Immediately start your timer and observe the piece of potato. Bubbles of oxygen will rise to the surface and form a layer at the top of the hydrogen peroxide solution.
- Measure the height of this layer at 2, 4 and 6 minutes from the start and record these measurements. The height of the layer of bubbles should be measured from the top of the hydrogen peroxide solution to the top of the layer of bubbles as shown in Fig. 1.1.

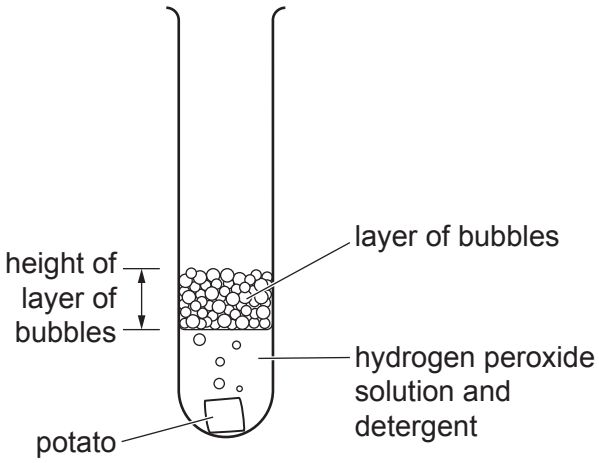

Fig. 1.1

1. Question part 2/4 | 5090 Oct-Nov 2023 P4 V1 Q1

- Cut the second piece of potato into four equal parts and add them to test-tube **B**.
- Start your timer and repeat the measurements as for test-tube **A**.
- Cut the third piece of potato into eight equal parts and add them to test-tube **C**.
- Start your timer and repeat the measurements as for test-tube **A**.

(a) **(i)** State a safety precaution that the student should take while doing the investigation with hydrogen peroxide solution.

..... [1]

The student recorded the measurements in a notebook as shown in Fig. 1.2.

Height of layer of bubbles in millimetres

Minutes	2	4	6
$1cm^3$ of potato	12	18	23
Potato cut into 4 parts	14	22	31
Potato cut into 8 parts	19	31	38

Fig. 1.2

(ii) Enter the headings in Table 1.1.

[2]

(iii) Complete Table 1.1 by entering the student's results.

Table 1.1

.....	.....		
	test-tube A	**test-tube B**	**test-tube C**
2			
4			
6			

[3]

1. Question part 3/4 | 5090 Oct-Nov 2023 P4 V1 Q1

Cutting the potato pieces into smaller parts increases the surface area of the potato.

(iv) Describe the effect of increasing the surface area of the potato and explain what caused this effect.

description .....

.....

explanation .....

.....

.....

[3]

The student found that the top of the layer of bubbles was not always flat when they had to measure the height of the layer.

(v) Suggest what they could do to ensure that the measurements taken every two minutes were comparable.

.....

..... [1]

(vi) The student noticed two unexpected problems during the investigation. Suggest how each may have affected the results.

1. bubbles sometimes stuck to the potato

suggestion .....

.....

2. some of the eight parts of potato in test-tube **C** stuck together

suggestion .....

.....

[2]

(vii) Suggest how the student can prove that it is the activity of the enzyme catalase that produces the bubbles.

.....

..... [1]

1. Question part 4/4 | 5090 Oct-Nov 2023 P4 V1 Q1

(b) Another student investigated the activity of catalase in potato by measuring the volume of oxygen produced. They added cubes of potato to hydrogen peroxide solution in the apparatus shown in Fig. 1.3.

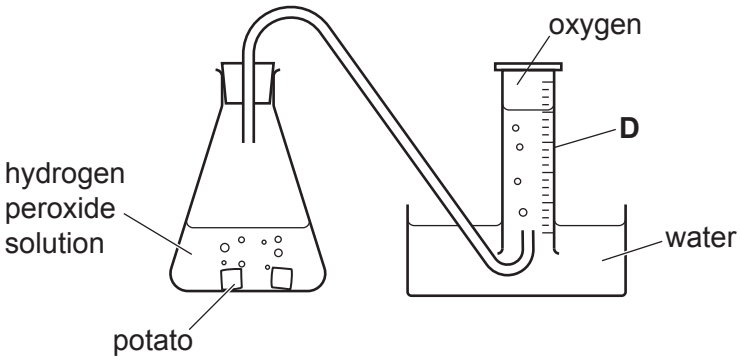

Fig. 1.3

(i) Name the piece of apparatus labelled **D**.

..... [1]

(ii) Design an investigation to determine the effect of **temperature** on the activity of catalase in potato.

Use the apparatus shown in Fig. 1.3.

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.....

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..... [6]

[Total: 20]

2. Question part 1/4 | 5090 May-June 2025 P4 V2 Q1

1 Catalase is an enzyme found in living cells. This enzyme catalyses the breakdown of hydrogen peroxide into oxygen and water. Some plant cells are a source of catalase.

If some material from a plant is crushed and added to water, a suspension of the contents of the plant's cells can be obtained.

When hydrogen peroxide solution is added to this suspension, the oxygen produced is released as bubbles of gas. These bubbles collect to form a foam on top of the suspension.

The height of any foam produced can be measured. Greater height indicates greater catalase activity.

A student investigated the activity of catalase in the cells of three different species of plant by measuring the height of foam produced in each. They used three suspensions of cells, one each of celery, apple and potato, provided in separate beakers.

The student followed these instructions:

- use a clean stirring rod to stir the celery cell suspension in the beaker
- use a syringe to add 2 cm^3 of celery cell suspension to a clean test-tube
- use a clean syringe to add 2 cm^3 of hydrogen peroxide solution to this test-tube
- immediately start timing
- after 60 seconds, measure the height of any foam produced and record your measurement.

Repeat these instructions using the apple cell suspension and then the potato cell suspension.

(a) Fig. 1.1 shows the total contents of each of the three test-tubes after 60 seconds.

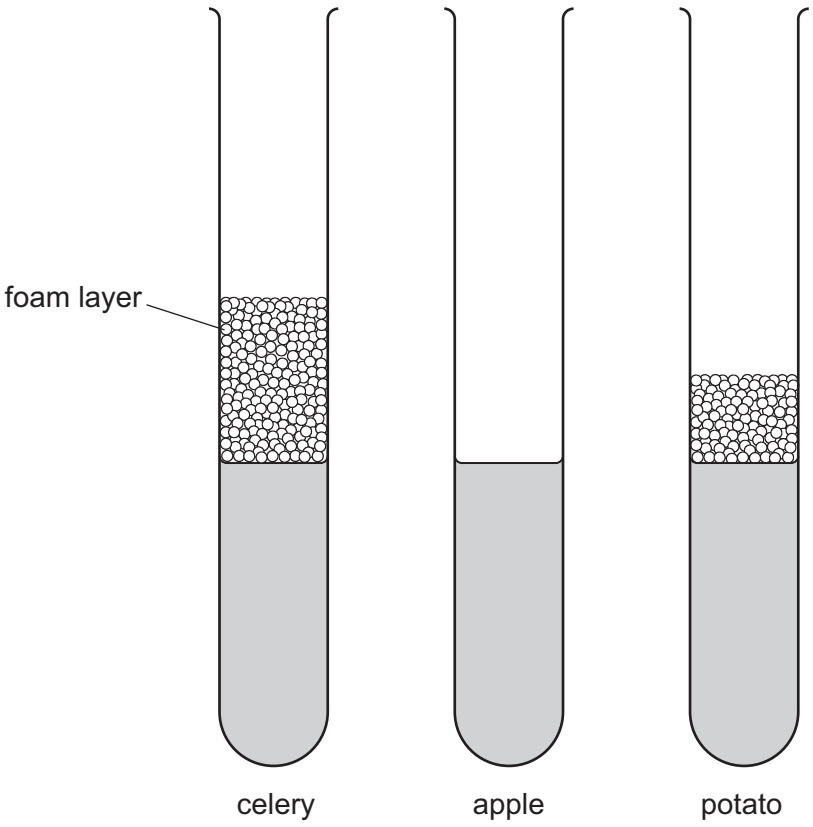


Fig. 1.1

(i) Measure the height of any foam produced in each test-tube and record these values in a table. [7]

(ii) Use your results to place the three species of plant cells in order of catalase activity.

most active .....

.....

least active .....

[1]

(b) (i) Suggest why the three plant tissues were crushed before adding the hydrogen peroxide solution.

.....

..... [1]

(ii) Suggest why the plant suspensions were stirred before adding the hydrogen peroxide solution.

.....

.....

..... [2]

(iii) State **one** variable that was controlled in this investigation.

.....

..... [1]

(iv) Suggest **two** reasons why repeating the investigation would give the student more confidence in the results.

1 .....

.....

2 .....

.....

[2]

(c) Another student used the same procedure using a celery cell suspension and hydrogen peroxide. Instead of using a test-tube, they used a measuring cylinder. They measured the total volume of the contents of the measuring cylinder every minute for 5 minutes.

These measurements are shown in Table 1.1. The student did not record the measurement at 4 minutes.

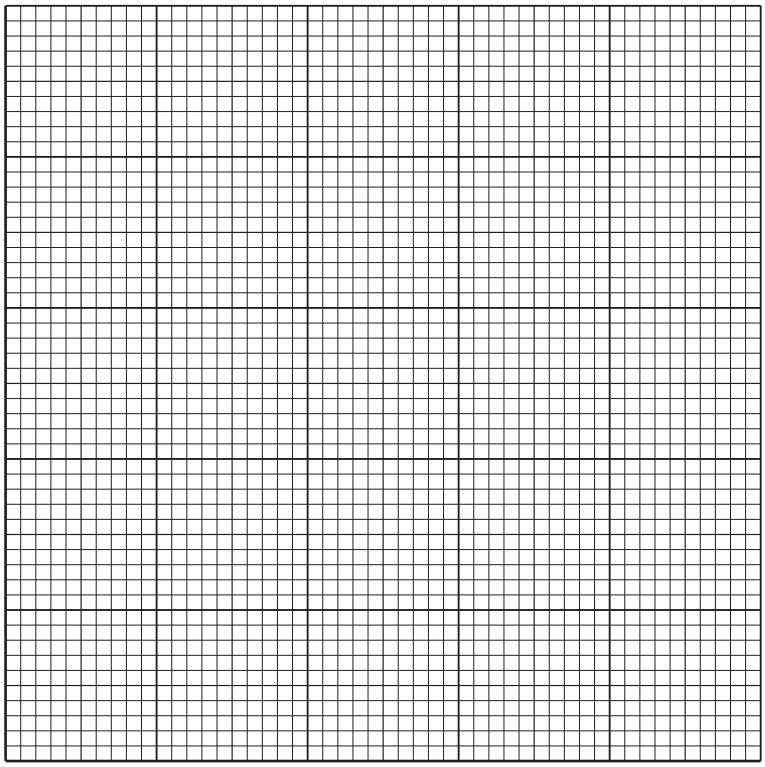
Table 1.1

time / minutes	total volume of contents / cm^3
0	4.0
1	11.0
2	16.0
3	19.5
5	20.5

2. Question part 4/4 | 5090 May-June 2025 P4 V2 Q1

(i) Construct a graph of the data in Table 1.1 on the grid below.

Join your plotted points with ruled, straight lines. [4]



(ii) Use your graph to estimate the total volume of the contents of the measuring cylinder at 4 minutes.

Show your working on your graph.

total volume at 4 minutes ..... [3]

(iii) Describe and explain the shape of your graph.

.....

.....

.....

.....

..... [3]

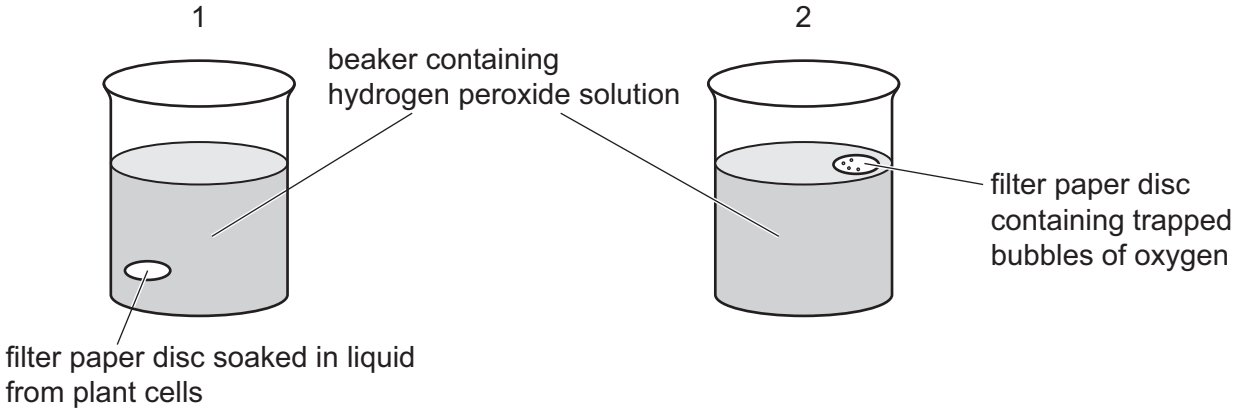
[Total: 24]

3. Question part 1/3 | 5090 Oct-Nov 2025 P4 V2 Q1

1 Hydrogen peroxide is a harmful waste product in living cells. The enzyme catalase breaks down hydrogen peroxide into water and oxygen.

Some students investigated catalase in tissues from different plants. They used small filter paper discs. The filter paper discs were placed on the cut surface of plant tissues to absorb liquid from the cells. The liquid from the cells might contain catalase.

Fig. 1.1 shows how the students were able to tell if catalase was present in tissues from different plants.



A filter paper disc soaked in liquid from plant cells was dropped into the hydrogen peroxide solution and sank to the bottom.

If catalase was present, bubbles of oxygen formed. The bubbles of oxygen were trapped in the filter paper disc making it float to the surface.

Fig. 1.1

The students were given 2 cm × 2 cm × 2 cm cubes of tissue from three different plants labelled **A**, **B** and **C**, small filter paper discs and a beaker of hydrogen peroxide solution.

The students followed this procedure.

- Cut the piece of plant tissue **A** in half.
- Use forceps to place a filter paper disc onto a cut surface of plant tissue **A**, to absorb liquid from the cells.
- After 1 minute, use forceps to pick up the filter paper disc from the cut surface of plant tissue **A**.
- Drop the filter paper disc into the beaker of hydrogen peroxide solution and immediately start timing. The filter paper disc will sink to the bottom of the beaker.
- Observe the filter paper disc until it reaches the surface of the hydrogen peroxide solution, then stop timing. If a filter paper disc does **not** float within 4 minutes (240 seconds) stop timing and record the time taken for the filter paper disc to reach the surface as >240.
- Record the time taken, to the nearest whole second, for the filter paper disc to reach the surface of the hydrogen peroxide solution.
- Use forceps to remove the filter paper disc from the beaker of hydrogen peroxide solution and place it in the waste container provided.
- Rinse and dry the forceps.
- Repeat the procedure **two** more times with filter paper discs on the same cut surface of plant tissue **A**.
- Repeat all of the procedure for filter paper discs on plant tissue **B** and then again for plant tissue **C**.

3. Question part 2/3 | 5090 Oct-Nov 2025 P4 V2 Q1

Fig. 1.2 shows a student's notebook. The student has recorded their results to the nearest whole second. The result for the third filter paper disc on plant tissue **A** is missing from their notes.

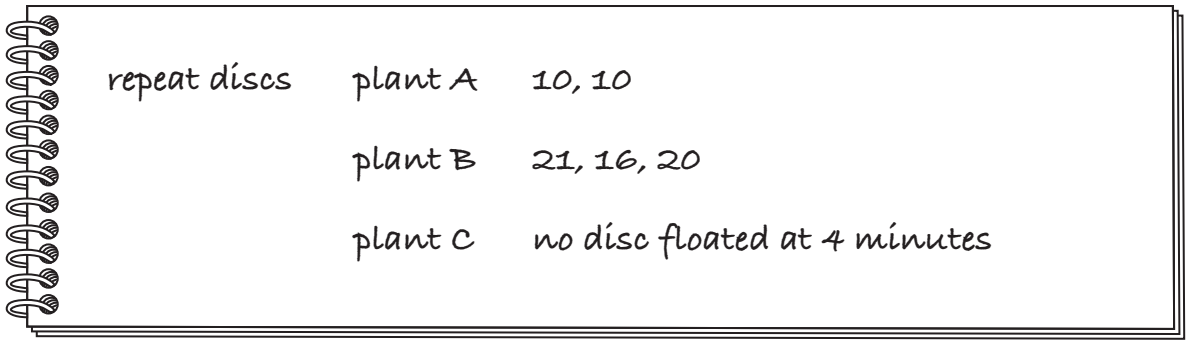


Fig. 1.2

Fig. 1.3 shows the time taken for the third filter paper disc on plant tissue **A** to reach the surface.



Fig. 1.3

3. Question part 3/3 | 5090 Oct-Nov 2025 P4 V2 Q1

(a) (i) Complete the headings in Table 1.1. [1]

Table 1.1

.....	.....			
	disc 1	**disc 2**	**disc 3**	**mean**
A				
B				
C				

(ii) Enter the data from Fig. 1.2 and Fig. 1.3 into Table 1.1.

Calculate the mean times for the filter paper discs, from tissues **A**, **B** and **C**, to reach the surface. Record all the values to the nearest whole second.

[4]

(iii) Using the results in Table 1.1, state what you can conclude about catalase in plant tissues **A**, **B** and **C**.

tissue **A** .....

.....

tissue **B** .....

.....

tissue **C** .....

.....

[3]

(b) (i) Suggest why the filter paper discs were left on the cut surfaces of the plant tissues for the same length of time.

.....

.....

.....

..... [2]

(ii) Suggest a suitable control for this investigation.

.....

..... [1]

[Total: 11]