1. Question part 1/4 | 5090 May-June 2024 P4 V1 Q1

1 Respiration which releases energy from food in living organisms can be summarised by the following equation:

glucose + oxygen → carbon dioxide + water

A student investigated the rate at which oxygen was used for respiration by some small animals. The apparatus shown in Fig. 1.1 was used.

The apparatus was sealed by closing the clip so that any changes in the volume of gases in the test-tube and capillary tube resulted in the drop of coloured liquid moving.

The rate at which the drop of coloured liquid moves is related to the rate of uptake of oxygen by the small animals.

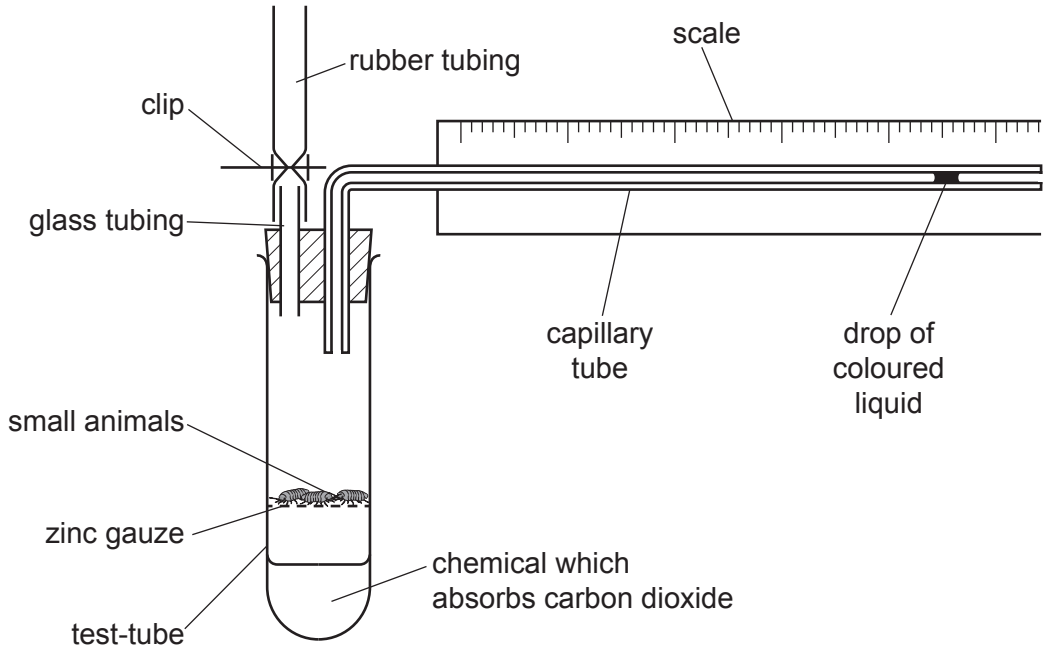

Fig. 1.1

When the small animals in the test-tube respire they take in oxygen and produce carbon dioxide.

(a) (i) Describe what happens to the carbon dioxide they produce.

.....

..... [1]

(ii) Explain why the drop of coloured liquid moves along the capillary tube towards the small animals.

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.....

.....

..... [2]

1. Question part 2/4 | 5090 May-June 2024 P4 V1 Q1

(b) At the start of the investigation the student read and recorded the starting position of the drop of coloured liquid against the scale. Then readings were taken every 10 minutes for 40 minutes. All readings were taken at the **left side** of the drop.

Fig. 1.2 shows the position of the drop at the start and after 40 minutes.

(i) Complete Table 1.1 by inserting these readings.

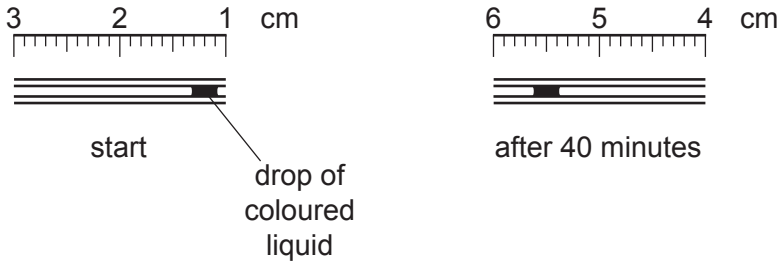


Fig. 1.2

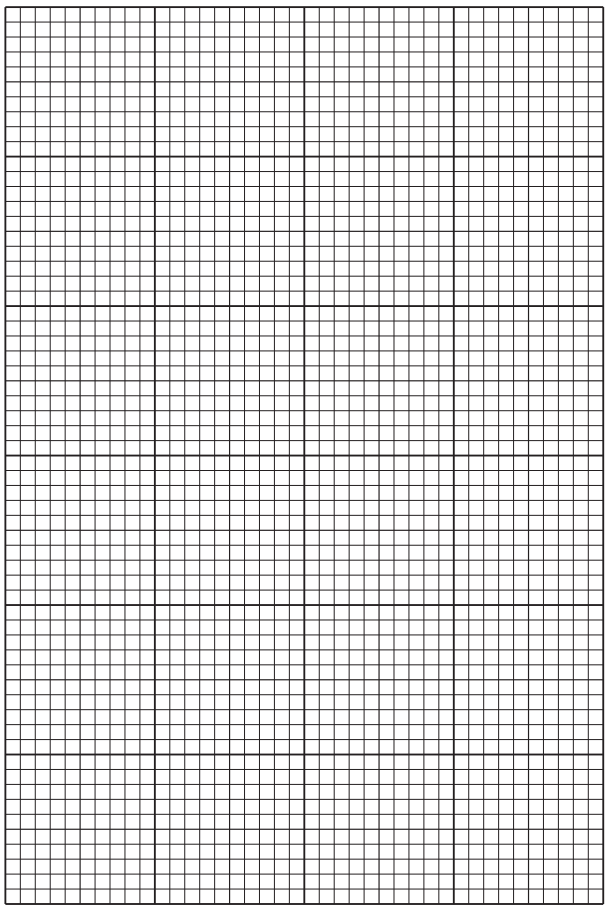
Table 1.1

time / minutes	position of drop / cm
0	
10	2.5
20	3.9
30	4.2
40	

[2]

1. Question part 3/4 | 5090 May-June 2024 P4 V1 Q1

(ii) Construct a graph of the data in the completed Table 1.1 on the grid below. Join your plotted points with ruled, straight lines. [4]



(iii) Use your graph to estimate the position of the drop at 25 minutes.

Show your working on the graph.

position of drop at 25 minutes ..... [3]

(c) (i) Calculate the distance moved by the drop during the investigation.

..... cm [1]

(ii) Calculate the rate of movement of the drop during the investigation in cm per minute.

Show your working.

rate of movement of drop ..... cm per minute [2]

1. Question part 4/4 | 5090 May-June 2024 P4 V1 Q1

(d) **(i)** Suggest why the student should repeat this investigation several times.

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.....

..... [2]

(ii) Suggest a control experiment for this investigation.

.....

.....

..... [1]

[Total: 18]

2. Question part 1/4 | 5090 Oct-Nov 2024 P4 V1 Q1

1 Yeast breaks down sugar (glucose) to provide energy for growth and reproduction by respiring anaerobically:

$$\text{glucose} \longrightarrow \text{carbon dioxide} + \text{alcohol}$$

Sugar is used in human food to make it taste sweet. Too much sugar in the diet can cause diseases. Sugar substitutes are available which taste as sweet as sugar.

A student decided to investigate whether yeast can use a sugar substitute for respiration.

Three test-tubes were set up as shown in Table 1.1.

Table 1.1

contents	**mixture in the test-tubes**		
distilled water / cm^3	15	15	15
yeast / g	1	1	1
test substance	1 g sugar	1 g sugar substitute	no addition

The three test-tubes were labelled so that they could be identified.

(a) (i) State the labels that you would use on the three test-tubes.

test-tube containing sugar: .....

test-tube containing sugar substitute: .....

test-tube with no addition: .....

[1]

A stirring rod was used to mix the contents of each test-tube.

(ii) Explain why it was important to clean the stirring rod after using it in each test-tube.

.....

..... [1]

2. Question part 2/4 | 5090 Oct-Nov 2024 P4 V1 Q1

The level of the mixtures in each test-tube was marked with a water-resistant marker. This was the starting level.

When the yeast respires, it produces bubbles of gas that are trapped in the mixture, making the level of the mixture rise up the test-tube.

The student used a large beaker as a water-bath to control the temperature of the test-tubes in this investigation. The temperature of the water at the beginning was 35 °C. The aim was to maintain this temperature throughout the investigation by adding hot or cold water.

The three test-tubes were placed in the water-bath, and a timer was started. At 5 minutes, 10 minutes and 15 minutes, the distances moved by the mixtures from the starting levels were measured and recorded. The temperature of the water-bath was also recorded.

Fig. 1.1 shows the lower parts of the test-tubes at 5 minutes and the water-bath thermometer reading at 5 minutes.

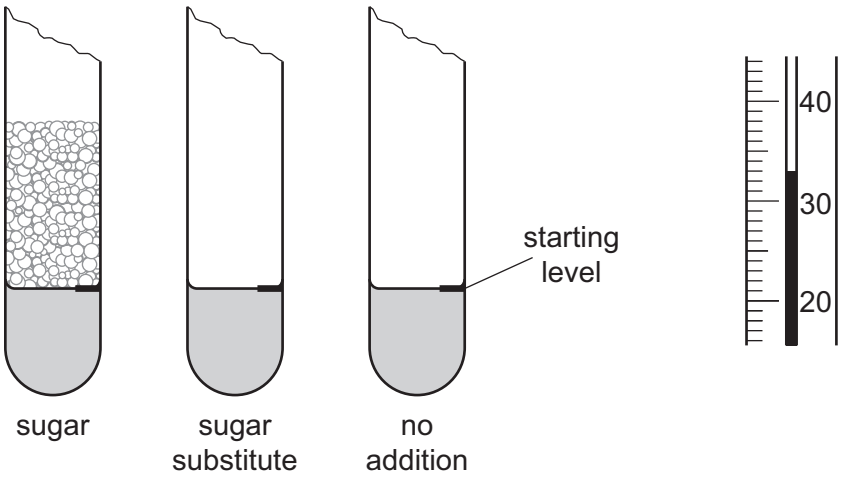

Fig. 1.1

Fig. 1.2 shows the results for 10 and 15 minutes recorded in the student's notebook.

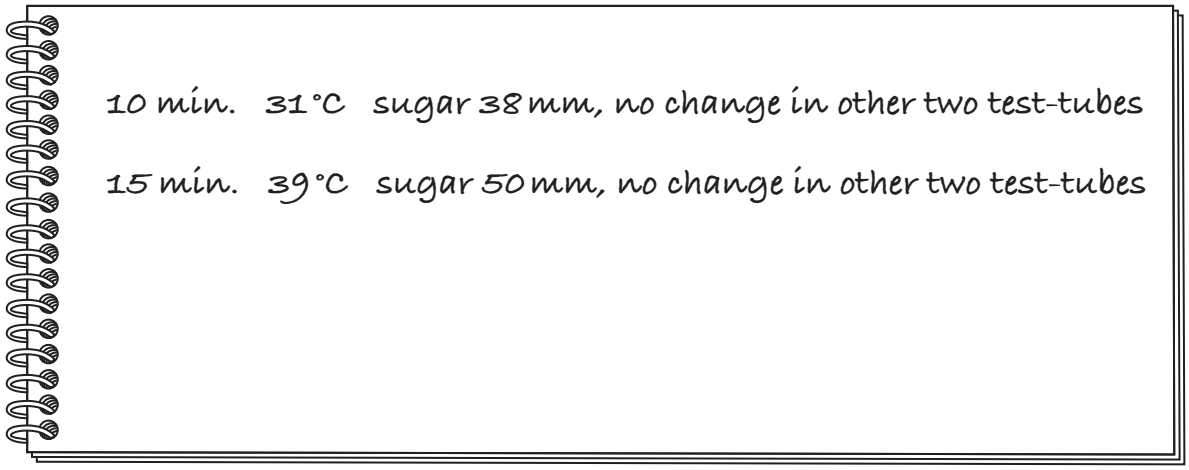

Fig. 1.2

2. Question part 3/4 | 5090 Oct-Nov 2024 P4 V1 Q1

(b) (i) Complete Table 1.2:

- Complete the headings.
- Using Fig. 1.1, measure the distances moved by the yeast mixtures from the starting levels in the three test-tubes and record them. Read the temperature shown on the water-bath thermometer in Fig. 1.1 and record it.
- Use the information in Fig. 1.2 to complete Table 1.2.

Table 1.2

.....	.....			temperature of water-bath /°C
	sugar	**sugar substitute**	**no addition**	
5				
10				
15				

[5]

(ii) Explain how the test-tube with no addition acted as a control in this investigation.

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..... [1]

(iii) State what conclusion you can make from the results of this investigation.

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..... [1]

(iv) Use the information in Fig. 1.1 and Fig. 1.2 to evaluate the student's control of the water-bath temperature.

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..... [1]

(v) Suggest why the temperature of the water-bath at 15 min was 39 °C.

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..... [1]

(c) The yeast's activity could also have been measured by recording any increase in the volume of the mixtures in the test-tubes.

Fig. 1.3 shows a test-tube with sugar, yeast and distilled water as seen from above. The distance above the marked starting level in this test-tube after 10 minutes was 3.8 cm.

The line between **A** and **B** indicates the diameter of the mixture within the test-tube.

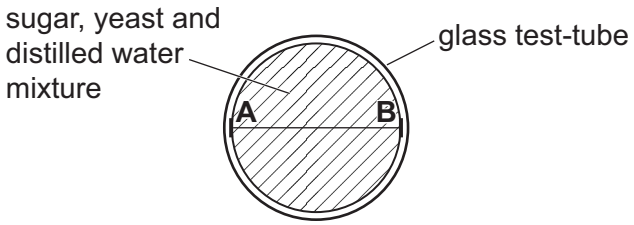


Fig. 1.3

(i) Measure and record the length of the line between **A** and **B**.

diameter of mixture within test-tube ..... cm

Calculate the increase in volume of the mixture in this test-tube after 10 minutes.

Use 3.14 as the value of π. Give your answer to 1 decimal place.

Show your working.

volume increase ..... cm^3

[4]

(ii) The apparatus used in this investigation is shown in Fig. 1.1. Suggest a piece of apparatus that could have been used in this investigation to directly measure the volume of the mixture. Describe how you would determine the increase in volume at each time interval using this apparatus.

apparatus .....

determination of increase in volume .....

.....

.....

[2]

[Total: 17]

3. Question part 1/3 | 5090 Oct-Nov 2024 P4 V1 Q2

2 When organisms respire aerobically they use oxygen and produce carbon dioxide.

Some students investigated the rate at which germinating seeds respired, using the apparatus in Fig. 2.1.

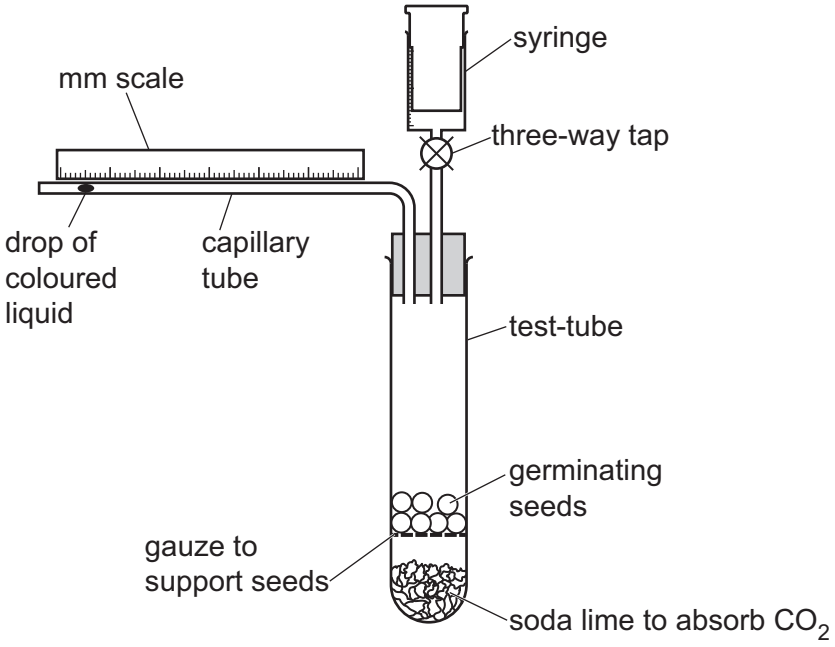


Fig. 2.1

Carbon dioxide produced by the germinating seeds was absorbed by the soda lime. As oxygen was used the volume of gas in the apparatus reduced and the drop of coloured liquid moved along the capillary tube towards the seeds.

The students moved the drop of coloured liquid in the capillary tube to the beginning of the scale (0 mm) by opening the three-way tap and using the syringe to carefully push air into the apparatus. They then closed the tap.

This was the start position for the drop of coloured liquid. Its position on the scale was recorded over the next four minutes. The movement of the drop of coloured liquid indicates the rate of respiration of the seeds.

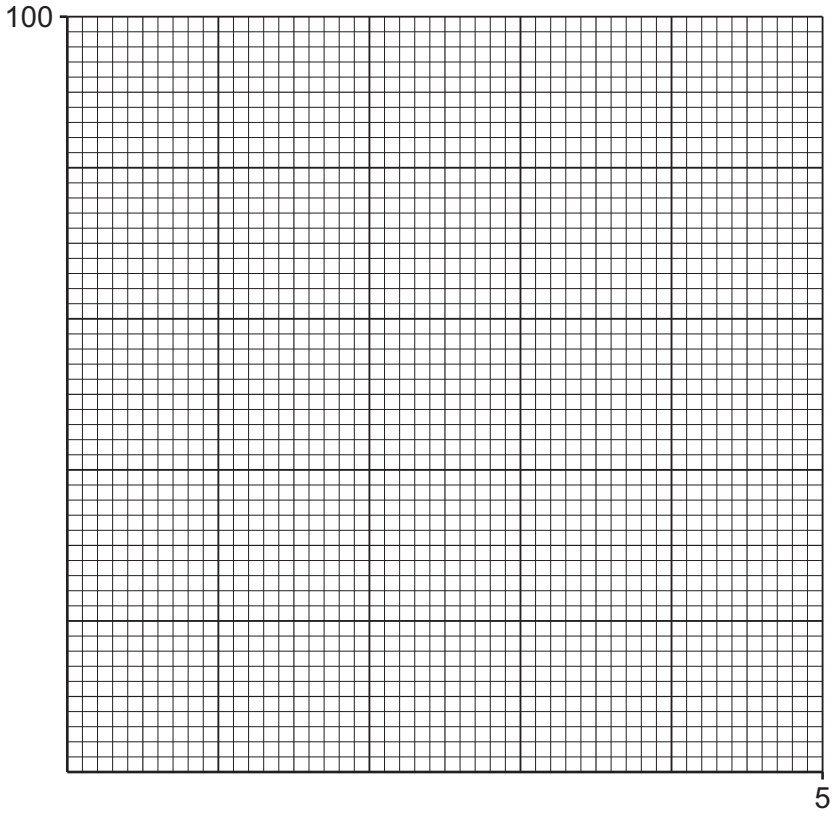
The students' results are shown in Table 2.1.

Table 2.1

time / minutes	position of drop of coloured liquid / mm
0	0
1	18
2	36
3	54
4	72

3. Question part 2/3 | 5090 Oct-Nov 2024 P4 V1 Q2

(a) (i) Construct a line graph of the data in Table 2.1 on the grid. The values for the end points of the axes are shown on the grid. Draw a straight line of best-fit to connect the points.



[4]

(ii) Use your graph to predict the position of the drop of coloured liquid at 5 minutes. Show your working on the graph.

position ..... mm [2]

(iii) Use the result at 4 minutes in Table 2.1 to calculate the rate of movement of the drop of coloured liquid caused by the respiration of the seeds.

Space for working.

rate of movement ..... [2]

3. Question part 3/3 | 5090 Oct-Nov 2024 P4 V1 Q2

(b) Plan an investigation to determine the effect of temperature on the rate of respiration in germinating seeds. Use the apparatus in Fig. 2.1 in your plan.

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..... [6]

[Total: 14]