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DUNMAN HIGH SCHOOL

Preliminary Examination

Year 6

H2 BIOLOGY

Paper 4 Practical

9744/04

2 September 2025

2 hours 30 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your centre number, index number, name and class at the top of this page.

Give details of the practical shift and laboratory, where appropriate, in the boxes provided.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions in the spaces provided on the question paper.

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

The number of marks is given in brackets [] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	20
2	23
3	12
Total	55

This document consists of **20** printed pages.

- 1 During this question you will require access to a microscope and slide **Y**.
Slide **Y** is a slide of a transverse section of a leaf from a yew tree.
You are **not** expected to be familiar with this specimen.

(a) Draw a large plan diagram of the whole transverse section of the leaf on slide **Y**.

A plan diagram shows the arrangement of different tissues.

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

No cells should be drawn.

Labels are **not** required.

- (b) Observe the outer layer of cells on the upper surface of the leaf on slide **Y**. This outer layer is called the upper epidermis and is one cell thick.

The upper surface of the leaf can be identified using Fig. 1.1.

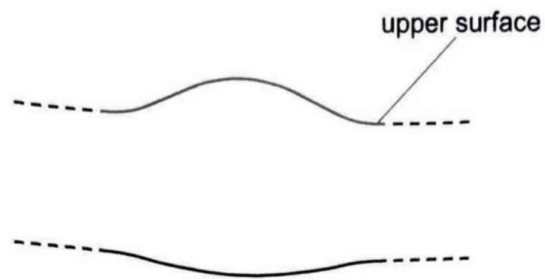


Fig. 1.1

Select a group of four cells comprising two cells from the upper epidermis and two cells from the layer below the upper epidermis.

Each cell must touch at least two other cells in the group.

Make a large drawing of this group of four cells.

(c) Fig. 1.2 is a photomicrograph of a stained transverse section of a different leaf.

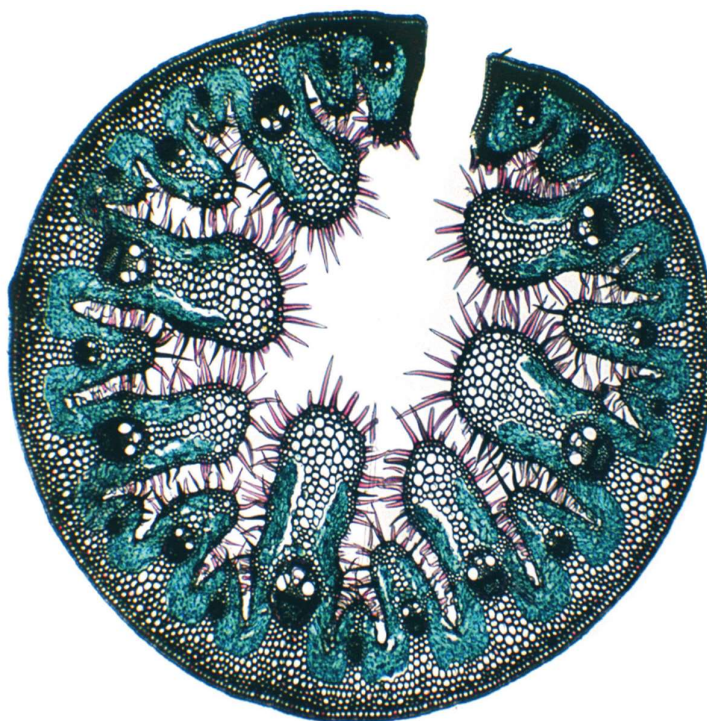


Fig. 1.2

- (i) Identify **two** observable differences, other than colour, between the leaf section in Fig. 1.2 and the leaf section on slide Y.

Record these differences in Table 1.1.

Table 1.1

Feature	Fig. 1.2	Y

[2]

- (ii) The leaf section shown in Fig. 1.2 is from a xerophytic plant which grows in sand dunes where there is very little water.

State **two** observable features of the leaf section shown in Fig. 1.2 which help the plant to survive in dry conditions. Explain how each feature allows the plant to survive in dry conditions.

Feature 1:

.....

Explanation:

.....

.....

Feature 2:

.....

Explanation:

.....

..... [2]

(d) Fig. 1.3 is the same photomicrograph as that shown in Fig. 1.2.

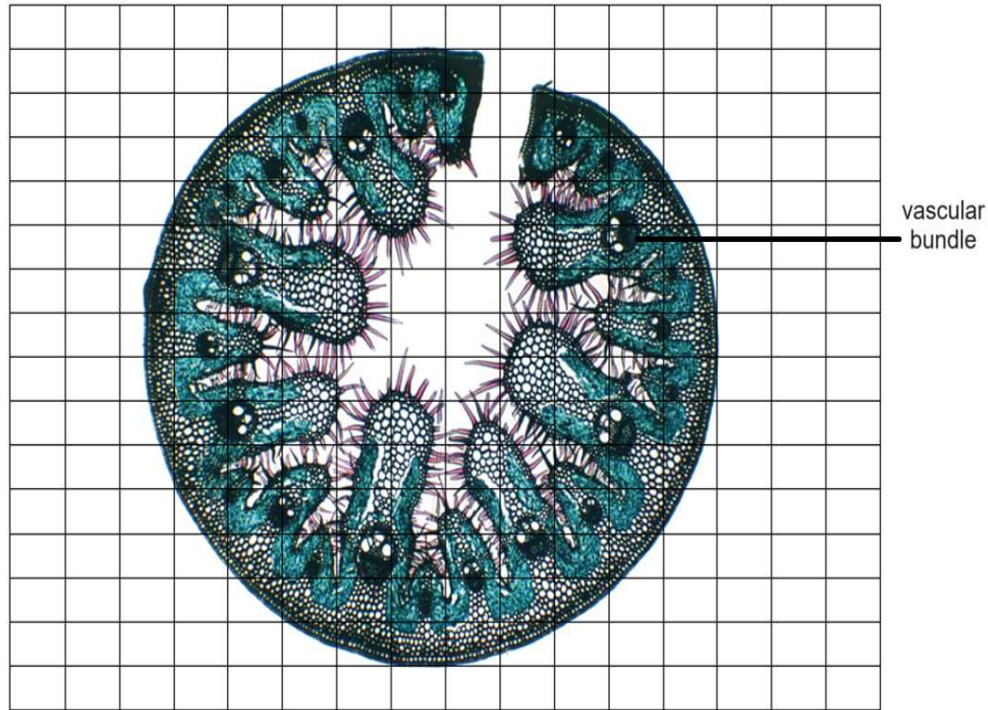


Fig. 1.3

You will need to use the grid to find the area of vascular bundles and the total area of the leaf section in Fig. 1.3.

Each square of the grid is 1 cm^2 .

In some squares, the leaf section or vascular bundle does not fill the whole square. You are to count the squares that are half full as $\frac{1}{2}$, and count the squares that are more than half full and full as 1.

- (i) State the area of the vascular bundles and the total area of the leaf section in Fig. 1.3.

area of vascular bundles = cm^2

total area of leaf section = cm^2
[2]

- (ii) Calculate the area of the vascular bundles as a percentage of the total area of the leaf section.

Show your working.

percentage = [2]

- (e) Fig. 1.4 shows a photomicrograph of a stage micrometer scale that is being used to calibrate an eyepiece graticule.

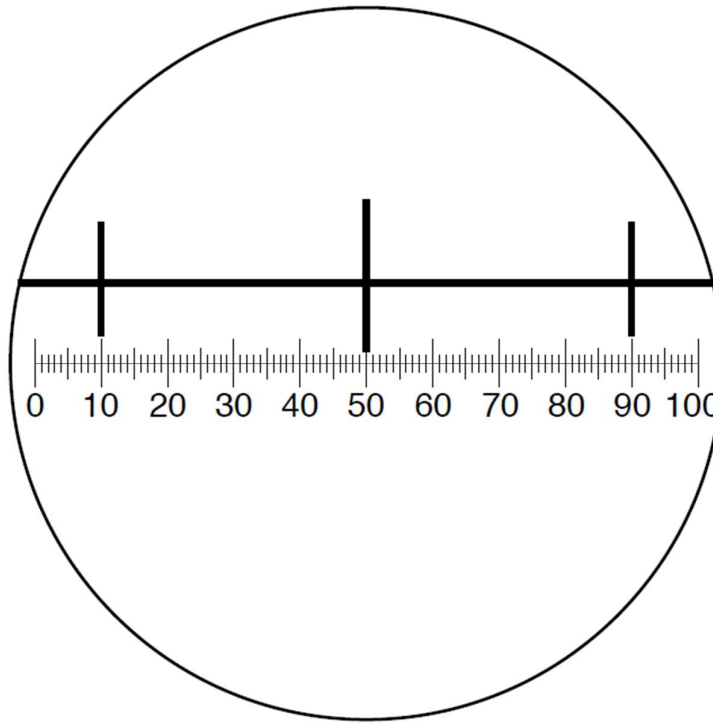


Fig. 1.4

One division, on either the stage micrometer scale or the eyepiece graticule, is the distance between the two adjacent lines.

- (i) Calculate the actual length of one eyepiece graticule unit shown in Fig. 1.4.

Give your answer in micrometers.

Show your working.

actual length of one eyepiece graticule unit = [3]

[Total: 20]

- 2 Yeast cells contain the enzyme catalase which catalyses the breakdown of hydrogen peroxide, releasing oxygen.

You will investigate the effect of pH on the activity of catalase in an extract from yeast cells. You will need to immobilise the yeast cells in sodium alginate beads.

When a bead containing yeast cells is dropped into hydrogen peroxide solution the bead will sink. As oxygen is released the bead will rise. The more oxygen released, the faster the bead will rise.

You are provided with the materials shown in Table 2.1.

Table 2.1

labelled	contents	hazard	volume/cm ³
Y	yeast cell suspension	none	15
H	3.0% hydrogen peroxide solution	harmful irritant	30
S	sodium alginate solution	none	30
C	calcium chloride solution	none	30
B3	buffer pH 3	none	10
B4	buffer pH 4	none	10
B6	buffer pH 6	none	10
B7	buffer pH 7	none	10
B8	buffer pH 8	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.

Carry out step 1 to step 20.

- step 1 Put 10 cm³ of **C** into a boiling tube.
- step 2 Put 5 cm³ of **S** into a small beaker.
- step 3 Stir **Y** and put 3 cm³ of **Y** into the beaker used in step 2. Mix well.
- step 4 Use a 5 cm³ syringe to collect 2 cm³ of the mixture of **S** and **Y** (prepared in step 3).
- step 5 Position the 5 cm³ syringe over the boiling tube containing **C** as shown in Fig. 2.1.

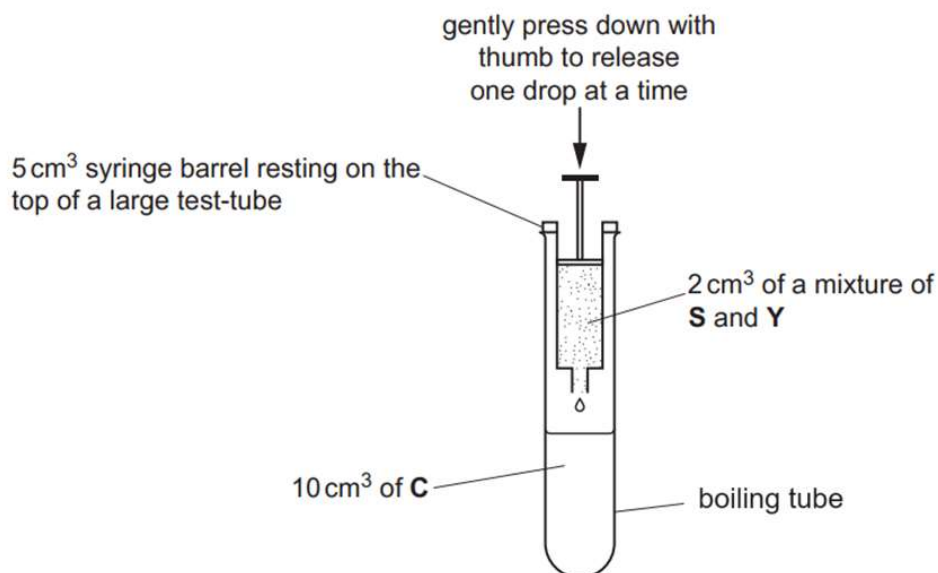


Fig. 2.1

- step 6 Gently press down on the plunger of the 5 cm³ syringe with your thumb to release one drop into solution **C**. The drop should form a bead.
- step 7 Repeat step 6 until you have used all 2 cm³ of the mixture. Leave the beads in the solution **C** for 1 minute.
- step 8 Tip the contents of the boiling tube from step 7 into a Petri dish.
- step 9 Add 2 cm³ of each pH buffers **B3**, **B4**, **B6**, **B7** and **B8** into the five empty vials.
- step 10 Put **two** beads into each of the vials containing pH buffers **B3**, **B4**, **B6**, **B7** and **B8**.
- step 11 Label a test-tube **B3**.
- step 12 Put 3 cm³ of the pH buffer **B3** into the test-tube labelled **B3**.

- step 13 Put 3 cm³ of hydrogen peroxide solution, **H**, into this test-tube and shake to mix. Leave this test-tube in a test-tube rack.
- step 14 Pick up a bead from the pH buffer **B3** using a spatula.
- step 15 Drop the bead into the test-tube from step 13. Start timing when the bead reaches the bottom of the test-tube.
- step 16 Time how long it takes for the bead to reach the surface of the liquid.
- If the bead does not reach the surface after 60 seconds, stop timing and record as 'more than 60'.
- step 17 Record the result from step 16 in **(a)(i)**.
- step 18 Pick up the second bead from the pH buffer **B3** using a spatula.
- step 19 Repeat step 15 to step 17.
- step 20 Repeat step 11 to step 19 with the remaining pH buffers instead of **B3**.
- (a) (i)** Record your results in an appropriate table.

[5]

- (ii)** State the independent variable in this investigation.

..... [1]

- (iii)** State **one** significant source of error in this investigation.

.....

.....

..... [1]

You will need to estimate the pH of the solution, **U**.

You are provided with **U**, as shown in Table 2.2.

Table 2.2

labelled	contents	hazard	volume/cm ³
U	solution of unknown pH	none	10

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

It is recommended that you wear suitable eye protection.

Carry out step 21 to step 28.

step 21 Put **one** bead into the beaker containing solution **U**.

step 22 Label a clean test-tube **U**.

step 23 Put 3 cm³ of solution **U** into the test-tube labelled in step 22.

step 24 Put 3 cm³ of hydrogen peroxide solution into this test-tube. Leave this test tube in a test-tube rack.

step 25 Pick up the bead from the beaker containing solution **U**, using blunt forceps.

step 26 Drop the bead into the test-tube from step 24. Start timing when the bead reaches the bottom of the test-tube.

step 27 Time how long it takes for the bead to reach the surface of the liquid. If the bead does not reach the surface after 60 seconds, stop timing and record as 'more than 60'.

step 28 Record the result from step 27 in **(a)(iv)**.

(iv) State the result for solution **U**.

result for solution **U** [1]

(v) Using your results from **(a)(i)** and **(a)(iv)**, estimate the pH of solution **U**.

pH of solution **U** [1]

- (vi) In the procedure described in step 1 to step 20, the effect of pH on catalase activity was investigated.

Describe how you would modify this procedure to investigate the effect of concentration of **substrate** on the time taken for the beads to rise.

.....

.....

.....

.....

..... [2]

- (b) Immobilised enzymes are often used in industry. For example, the enzyme lactase is used to produce lactose-free milk.

A student measured the initial rate of reaction of human lactase at different concentrations of lactose and plotted a graph, as shown in Fig. 2.2.

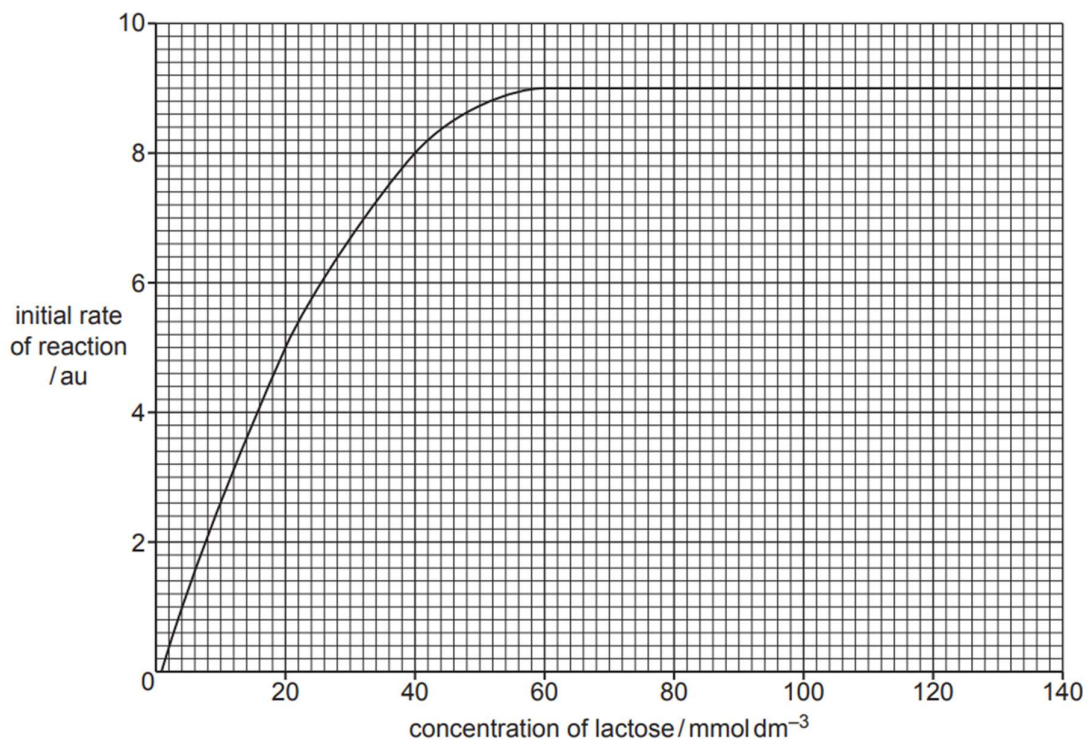


Fig. 2.2

- (i) Explain the change in the initial rate of reaction between:

20 mmol dm⁻³ and 40 mmol dm⁻³ of lactose

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60 mmol dm⁻³ and 140 mmol dm⁻³ of lactose

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..... [4]

- (ii) Use the graph in Fig. 2.2 to estimate the Michaelis-Menten constant (K_m) of lactase.

Show your working **on the graph** in Fig. 2.2.

$$K_m = \dots\dots\dots \text{mmoldm}^{-3} \text{ [2]}$$

- (c) Lactose is found in the milk of many mammals.

A scientist investigated the concentration of lactose in the milk of different mammals.

Table 2.3 shows the results of this investigation.

Table 2.3

type of mammal	concentration of lactose / mmoldm^{-3}
rabbit (RA)	60.0
seal (SE)	2.5
goat (GO)	137.5
sheep (SH)	150.0
horse (HO)	222.5

- (i) Plot a bar chart of the data shown in Table 2.3 on the grid in Fig. 2.3.

Use a sharp pencil.

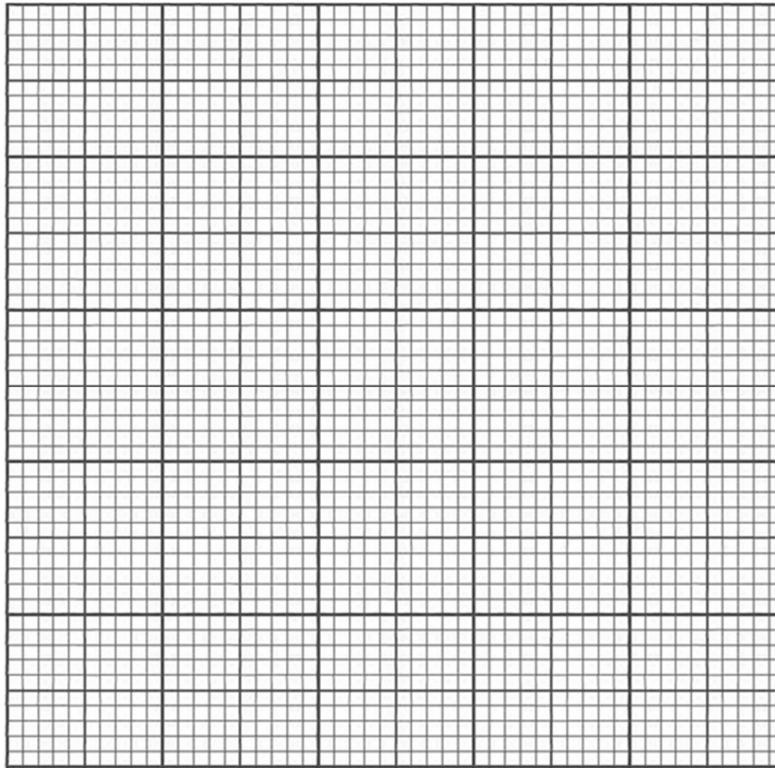


Fig. 2.3

[4]

- (ii) Using the data from Table 2.3, calculate what percentage more lactose is present in the mammal with the highest concentration of lactose in its milk compared to the mammal with the lowest concentration of lactose in its milk.

Show your workings.

..... % [2]

[Total: 23]

- 3 When yeast cells respire aerobically, they release carbon dioxide which can be used as a measure of the rate of respiration.

Carbon dioxide can be bubbled through barium hydroxide solution which absorbs the carbon dioxide forming insoluble barium carbonate. This causes a decrease in the concentration of the barium hydroxide solution which is proportional to the mass of carbon dioxide present.

Barium hydroxide is a base, so barium hydroxide solutions cause the indicator phenolphthalein to turn pink. When a pink mixture of barium hydroxide solution and phenolphthalein indicator is neutralised with hydrochloric acid, the colour will change from pink to colourless.

In the absence of carbon dioxide, 5.0 cm^3 of 0.1 mol dm^{-3} hydrochloric acid is required to neutralise 10.0 cm^3 of $0.025 \text{ mol dm}^{-3}$ barium hydroxide. A 10.0 cm^3 syringe can be used to carry out this titration to a suitable level of accuracy.

After bubbling carbon dioxide through fresh barium hydroxide solution, the mass of carbon dioxide absorbed can be calculated from the decrease in volume of hydrochloric acid required to neutralise the remaining barium hydroxide solution. 1.0 cm^3 of 0.1 mol dm^{-3} hydrochloric acid is equivalent to 2.2 mg of carbon dioxide.

- (i) Using this information and your own knowledge, design an experiment to test the hypothesis that:

“The rate of respiration in yeast cells is dependent on the concentration of sucrose solution”.

You must use:

- 1.0 mol dm^{-3} sucrose solution,
- $0.025 \text{ mol dm}^{-3}$ barium hydroxide solution,
- 0.1 mol dm^{-3} hydrochloric acid,
- 1.0% phenolphthalein indicator,
- distilled water,
- active yeast cell suspension,
- apparatus shown in Fig. 3.1, which can be used to collect the carbon dioxide released.

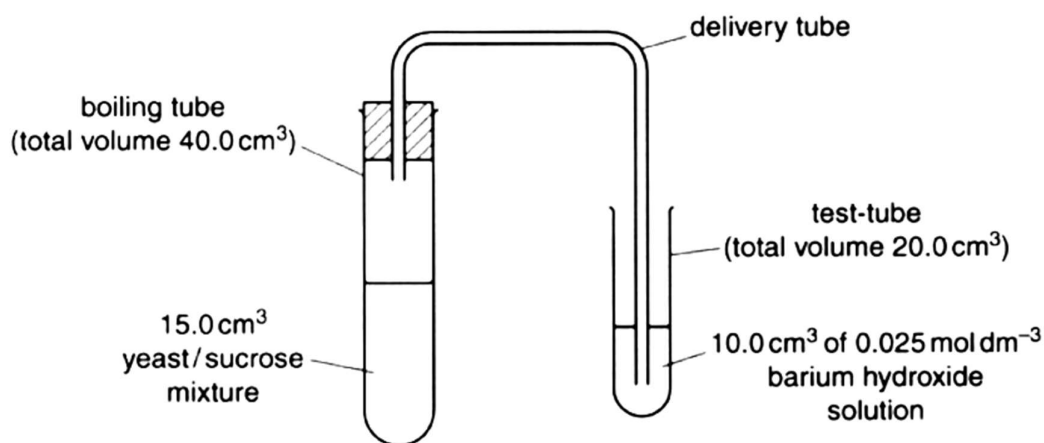


Fig. 3.1

You should select from the following apparatus:

- any normal laboratory glassware e.g. test-tubes, beakers, measuring cylinders, graduated pipettes, glass rods, etc.,
- syringes,
- pipette fillers,
- white tile or white card,
- timer e.g. stopwatch or stopclock.

Your plan should:

- have a clear and helpful structure such that the method you use is able to be repeated by anyone reading it,
- be illustrated by relevant diagrams, if necessary,
- identify the independent and dependent variables,
- describe the method with the scientific reasoning used to decide the method so that the results are as accurate and reliable as possible,
- include layout of results tables and graphs with clear headings and labels,
- use the correct technical and scientific terms,
- include reference to safety measures to minimise any risks associated with the proposed experiment.

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