H2

ANDERSON SERANGOON JUNIOR COLLEGE

HIGHER 2

2023 JC2 PRELIMINARY EXAMINATION

CANDIDATE NAME							
CLASS					INDEX NUMBER		

BIOLOGY

9744/04

Paper 4 Practical

30 August 2023

Wednesday

2 hours 30 minutes

Candidates answer on the Question Paper.
Additional Materials: As listed in the Confidential Instructions.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
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.

At the end of the examination, fasten all your work securely together.

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

Shift
Laboratory

For Examiner's Use	
1	
2	
3	
Total	/55

This document consists of **19** printed pages and **1** blank page.

Answer **all** questions.

1 Plant cells contain enzymes that catalyse metabolic reactions. Some of these enzymes catalyse the release of oxygen from hydrogen peroxide.

A plant extract solution can be produced which will contain these enzymes.

When hydrogen peroxide and a plant extract solution are mixed, oxygen is released. The oxygen forms bubbles that make a foam on the surface.

You are required to investigate the effect of pH on the progress of the enzyme-catalysed reactions by:

- changing the pH using buffers
- measuring the height of the foam produced by the release of oxygen.

To follow the progress of this reaction, you will need to measure the height of foam at different times for a total of 3 minutes.

(a) (i) Decide how often you will take these measurements, including the final height of the foam at 3 minutes.

State the times when you will measure the height of foam.

……..……..……

……..……..……..[1]

(ii) Fig. 1.1**A** shows how a test-tube will be set up at the start (0 minutes).

Fig. 1.1**B** shows the test-tube after 3 minutes.

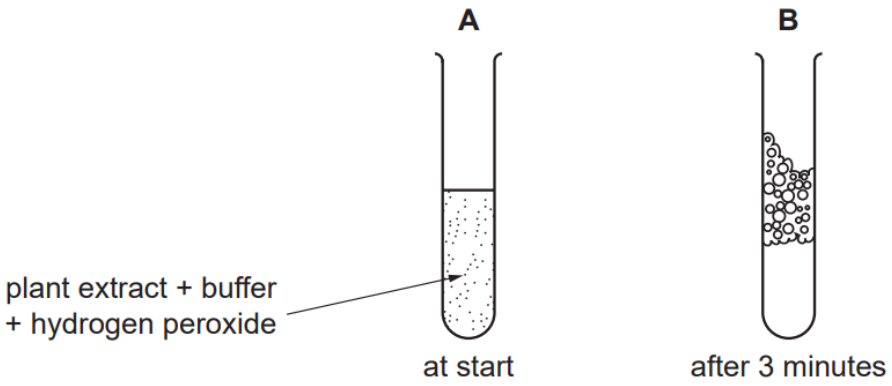

Fig. 1.1

The top of the foam may not form an even layer, so you will need to decide where to measure the layer of the foam.

Draw a double-headed arrow ↕ on Fig. 1.1**B** to show where you will measure this layer of foam. [1]

You are provided with:

labelled	contents	volume / cm^3
E	plant extract solution	40
H	hydrogen peroxide solution	70
B4	buffer pH4	10
B5	buffer pH5	10
B7	buffer pH7	10
B9	buffer pH9	10
B10	buffer pH10	10
U	unknown buffer	10
D	liquid detergent	10

If any of these liquids come into contact with your skin, wash off immediately under cold water. It is recommended that you wear suitable eye protection.

Temperature affects the rate of an enzyme-catalysed reaction and may be a significant source of error.

You are required to measure the temperature of the room before the start of the investigation and when all the measurements have been recorded.

Proceed as follows:

Read step 1 to step 9.

1. Measure the temperature of the room and record this measurement in **(b)(iii)** on page 6.

2. Put 1 cm^3 of buffers **B4, B5, B7, B9, B10** into separate test-tubes.

3. Put 2 cm^3 of **E** into each test-tube. Gently shake to mix well.

4. Put 1 drop of **D** into each test-tube. Do **not** mix.

*The reaction will start as soon as **H** is added to the mixture of **E** and buffer.*

5. Put 5 cm^3 of **H** into **one** of the test-tubes.

6. Immediately start timing.

7. Using the strip of graph paper provided, measure the height of the foam as decided in **(a)(ii)**, at each of your sampling times as stated in **(a)(i)**, until you have recorded the final measurement at 3 minutes. Record your measurements in **(b)(i)**.

If the foam flows over the top of the test-tube, **stop timing**. Record the measurement of the height of the foam to the top of the test-tube **and** add an asterisk (*) to show that the foam has flowed over.

8. Repeat step 5 to step 7 with each of the other buffer solutions.

9. Measure the temperature of the room now that all the measurements have been recorded. Record the temperature in **(b)(iii)**.

(b) (i) Record your results for the height of foam in an appropriate table below.

[4]

(ii) Using your raw results for **pH 5**:

- State the highest height of foam. ..... mm
- State the first time when this height was reached. ..... seconds

Using these measurements, calculate the rate of production of oxygen, as millimetres per second (mm s^{-1}).

Show your working.

rate of oxygen production = ... mm s^{-1}
[2]

(iii) State the temperature of the room before the start of the investigation.

..... °C

State the temperature of the room after all the measurements have been recorded.

..... °C

State the difference between this temperature and the temperature of the room at the start of the investigation.

difference = ... °C

Explain whether temperature is a significant source of error in this investigation.

……..……..……

……[1]

You are now required to estimate the pH of the buffer in **U** using the same procedure.

10. Put 1 cm^3 of **U** into a test-tube and repeat step 3 to step 7. Record your results in **(b)(iv)**.

(iv) Record the maximum height of foam using **U**.

..... mm [1]

(v) Using the result in **(b)(iv)** and the results in **(b)(i)**, estimate the pH of **U.**

pH = ... [1]

(vi) This procedure investigated the effect of pH on the activity of the enzymes in a plant extract solution.

To modify this procedure for investigating the effect of substrate concentration on the activity of enzymes in the plant extract solution, the pH should be kept the same.

You will plan but not carry out a dilution of 5.0% hydrogen peroxide solution using distilled water to reduce its concentration. You are required to make up at least 10 cm^3 of each diluted solution.

Describe and show how you will prepare the range of different concentrations of hydrogen peroxide.

……

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……

……

[3]

(vii) Describe how the dependent variable could be measured more accurately than measuring the height of foam. You may use a labelled diagram in the space provided.

……

……

……

……

space for diagram

[1]

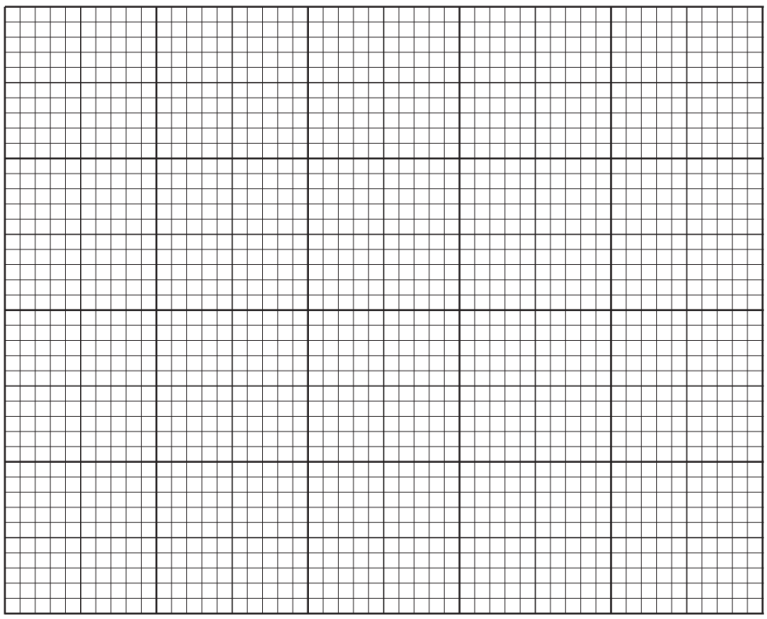
(c) A student investigated the effect of temperature on the rate of enzyme activity in a plant extract solution. All the other variables were standardised.

The results are shown in Table 1.1.

Table 1.1

temperature / ^{o}C	rate of enzyme activity / arbitrary units
5	6.5
16	39.0
27	31.0
38	9.5
49	1.0

(i) Plot a graph of the data shown in Table 1.1.



[4]

(ii) Use your graph to estimate the rate of enzyme activity at 32 ^{o}C. Show on your graph how you obtained your data.

…….. arbitrary units [1]

(iii) Explain the differences in the effects of changing pH and temperature on the rate of enzyme-catalysed reactions.

……..……..

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……..……..

……...

……..…….[2]

[Total: 22]

2 You are required to plan, but not carry out, an investigation into the effect of different wavelengths of light on the rate of photosynthesis in two different species of garden plant, plant **A** and plant **B**. Both plants differ in their ability to produce chlorophyll b which absorbs mainly red and blue-violet light.

Plant **A** Normal wild type (presence of chlorophyll b)
Plant **B** Chlorophyll b deficient

The rate of photosynthesis can be determined by measuring the time taken for blue DCPIP to decolourise. DCPIP is a blue dye, which acts as a hydrogen ion and electron acceptor. As DCPIP accepts hydrogen ions or electrons, it is reduced and becomes colourless.

These are the equipment and materials, which you must use in your plan.

- filtered leaf extracts from plant **A** and plant **B**
- a bench lamp
- blue, yellow and red colour filters
- 1% DCPIP solution
- capillary tubes (50 mm in length)
- stopwatch
- petri dishes
- white tile
- ruler
- aluminium foil
- glass rods

You can also select from the following apparatus in your plan:

- a variety of different sized beakers, measuring cylinders or syringes for measuring volume
- teat pipettes

(a) Given the blue, yellow and red colour filters, complete the table below to show how to produce the key wavelengths of visible light (red, orange, yellow, green, blue, violet).

You may experiment with the colour filters and lamp provided.

colour	colour filter(s) used	wavelength / nm
red	red only	625
orange		590
yellow	yellow only	565
green		520
blue		435
violet		380

[2]

(b) Plan an investigation into the effect of different wavelengths of light on the rate of photosynthesis in plant **A** and plant **B**.

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 diagram(s), 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 repeatable 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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…….[11]

[Total: 13]

3 During the question you will require access to a microscope and slide **K1**.

K1 is a slide of a stained transverse section through a leaf of a plant that grows in full sunlight and is adapted to relatively hot and bright conditions.

You are not expected to be familiar with this specimen.

(a) Use your microscope to observe the different tissues in the region of slide **K1** shown by the shaded area in Fig. 3.1.

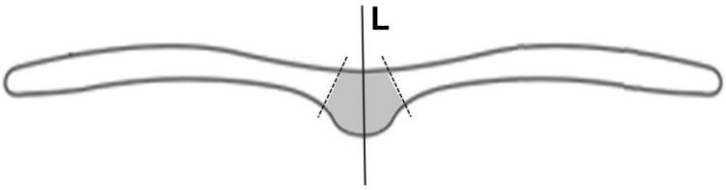

Fig. 3.1

(i) Select the largest cell in the region of slide **K1** shown by the shaded area in Fig. 3.1.

Use the space provided to make a large drawing of this cell **and** one other cell that this cell is touching.

Labels are **not** required.

[2]

(ii) Use the space provided to draw a large plan drawing of the part of the leaf on slide **K1** shown by the shaded area in Fig. 3.1.

A plan drawing shows the arrangement of different tissues, including their correct shapes and proportions. No cells should be drawn.

Labels are **not** required.

[3]

(b) You are required to determine the thickness of the leaf on slide **K1**, along the line **L** labelled on Fig. 3.1 using low power (x4 objective lens).

(i) You are first required to calibrate the eyepiece graticule, using the clear plastic ruler provided.

Describe how to determine the length of one eyepiece graticule unit.

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……[2]

(ii) Carry out your method in **(b)(i)**, to determine the length of one eyepiece graticule unit.

Show your working.

one eyepiece graticule unit = ……..…… mm [2]

(iii) Using your answer to **(b)(ii)**, determine the thickness of the leaf on slide **K1**, along the line **L** labelled on Fig. 3.1.

thickness = ……..…… mm [2]

(iv) Explain why the method in **(b)(i)** is likely to lead to an inaccurate determination of the length of one eyepiece graticule unit in **(b)(ii)**.

……

……

……[1]

(v) State two ways in which the accuracy of your answer in **(b)(iii)** can be improved.

1 ……

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……

2 ……

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……[2]

(c) Fig. 3.2 is a photomicrograph of a stained transverse section through another species of leaf that also grows in a hot and bright environment.

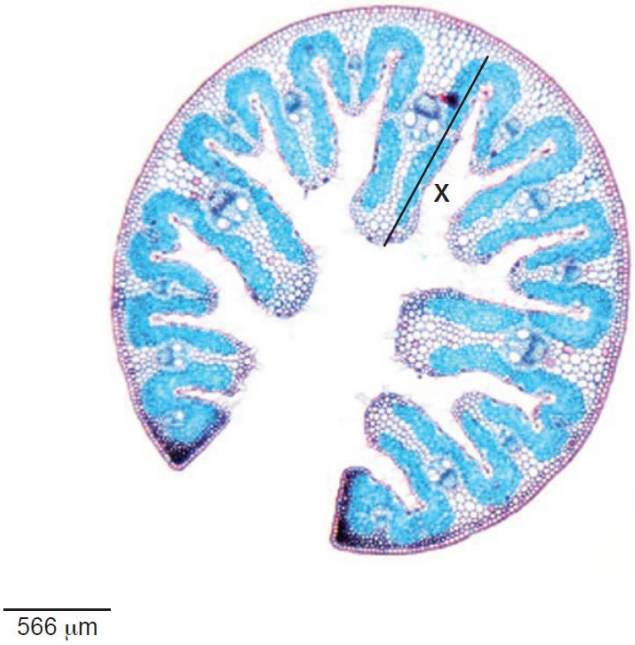

Fig. 3.2

(i) Calculate the actual length of the fold shown by line **X**, using the scale bar.

Show your working.

actual length = …… mm [2]

(ii) Complete Table 3.1 to identify different features of the leaf on Slide **K1** and in Fig. 3.2 that allow them to be adapted to hot and bright environments.

Explain your answer.

Table 3.1

	feature	explanation of how feature allows leaf to be adapted to hot and bright environments
leaf on slide **K1**		
leaf in Fig. 3.2		

[4]

[Total: 20]

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