

2 0 2 5

SECONDARY 4

G3 Express Exam Paper

G3 Pure Bio Practical

1	ACS Barker P3	Prelim
2	Dunman P3	Prelim
3	Edgefield P3	Prelim
4	Ngee Ann P3	Prelim
5	Paya Lebar P3	Prelim
6	Sembawang P3	Prelim

Islandwide Delivery



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Full Name	Index No.	Class



Anglo-Chinese School (Barker Road)

PRELIMINARY EXAMINATION 2025 SECONDARY 4 EXPRESS

BIOLOGY
6093/03

TIME: 1 HOUR 50 MIN

INSTRUCTIONS TO CANDIDATES:

Write your name and index number in the spaces 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 [] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	
2	
Total	/ 40

[Turn over

This question paper consists of 10 printed and 2 blank pages.

BLANK PAGE

1 You are advised to read the whole question before you start.

Living organisms are made up of essential biological molecules that play critical roles in sustaining life and supporting cellular functions.

These molecules vary in structure and function, contributing to processes such as energy provision, growth, and maintenance.

In this question, you are going to investigate the energy content in 1.0 g of unknown food samples S1 and S2.

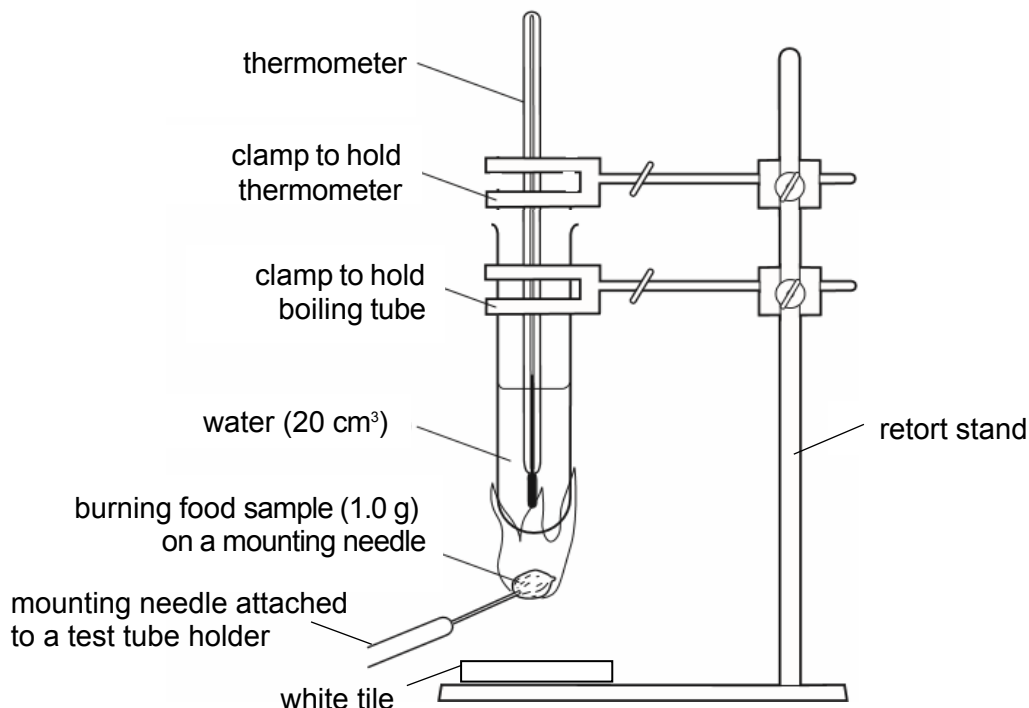


Fig. 1.1

Step 1 Set up the experiment as shown in Fig. 1.1.

Step 2 Measure 20 cm³ of water and pour into a boiling tube.

Step 3 Measure and record the initial temperature of the water.

Step 4 Carefully stick the mounting needle into **S1**.

DO NOT remove the attached test tube holder.

Step 5 Use the mounted needle (attached to a test tube holder), to hold **S1** in a flame until it starts to burn.

Ensure that you place your exam script away from the setup.

Step 6 Place **S1** under the boiling tube while it is still burning.

Step 7 Keep **S1** under the boiling tube until the flame goes out.

4EXP/6093/03/PRELIM/2025

5

Repeat steps 5 and 6 until it no longer relights.

Step 8 Measure and record the highest temperature of the water.

Step 9 Discard the burnt sample **S1** into the **waste** container.

Step 10 Repeat steps 1 to 9 for a new sample of **S1**.

Step 11 Calculate the average rise in temperature for **S1**.

Step 12 Repeat the experiment for **S2**.

(a) State two variables that are kept the same during this investigation

1

2 [2]

(b) (i) Present your results in a table in the space provided. [5]

- (ii) The energy contained in **S1** can be calculated using the formula below.

$$\text{Energy (J g}^{-1}\text{)} = \frac{\text{volume of water (cm}^3\text{)} \times \text{average rise in temperature (}^{\circ}\text{C)} \times 4.2}{\text{mass of S1 (g)}}$$

Use the formula to calculate the energy content (in joules per gram) of **S1**.

Show your working in the space provided.

Present your answer in **kilojoules per gram** and to **one decimal place**.

Energy content of **S1** kJ g⁻¹ [2]

- (c) (i) This is not a very accurate way of finding out the energy content of a piece of food.

Describe one key source of error and how it will affect the results of the experiment.

.....

 [2]

- (ii) Suggest a modification to the procedure to reduce the effect of the error described in (c)(i).

.....

 [2]

- (d) Table 1.1 shows the energy content per gram of different biological molecules.

Table 1.1

biological molecule	energy content / kJg^{-1}
carbohydrate	16.0
fat	38.0
protein	17.0

Using information from Table 1.1, suggest whether it is possible to deduce the specific biological molecule present in **S1** and **S2**.

Explain why.

.....

.....

.....

.....

[2]

- (e) Plants undergo photosynthesis in the presence of light to produce glucose, which is subsequently stored as starch in leaves.

Plants grown in different light intensities are reported to have different amounts of starch in their leaves.

Plan an experiment to investigate if there is a relationship on the effect of light intensity on the production of starch in leaves.

This image shows a full page of white paper with horizontal dashed lines, typical of primary school handwriting practice paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings present.

[6]

[Total: 21]

End of Question 1

Turn over to Page 8 for Question 2

- 2** Fig. 2.1 shows a photograph of the surface of a mammalian organ.

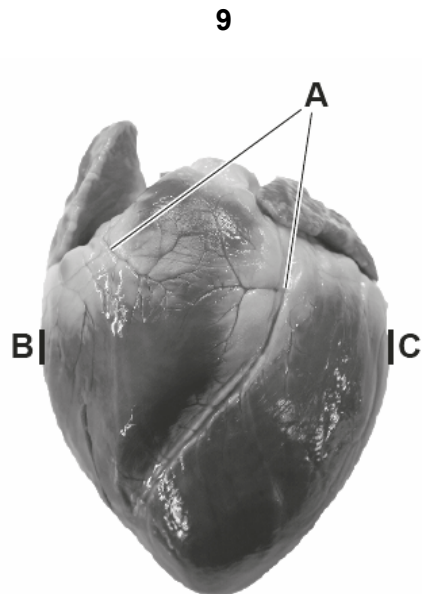


Fig. 2.1

- (a) **R** refers to blood vessels embedded in the mammalian organ.
)

Describe the importance of **R** in the organ shown in Fig. 2.1.

.....

.....

.....

[3
]

- (b) Based on positions **P** and **Q**, identify the chambers of the heart and suggest how these chambers support blood circulation.
)

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[3
]

- (c) Fig. 2.2 shows a cross-sectional view of an artery.
)

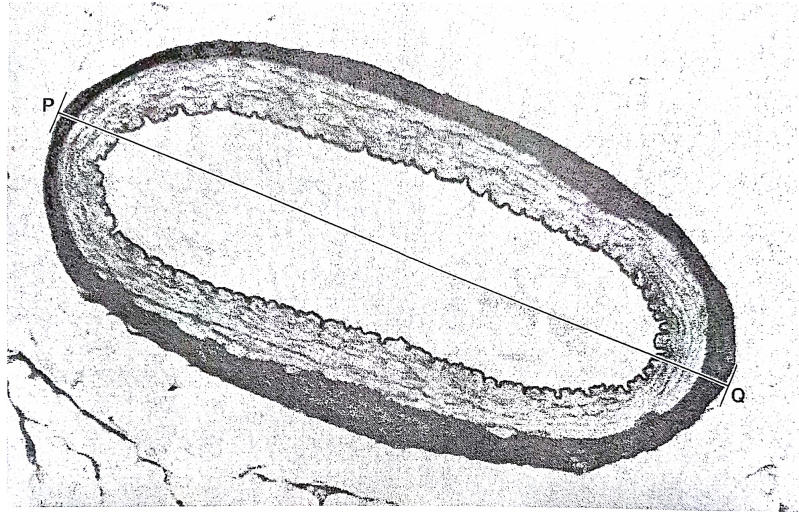


Fig 2.2

In the space provided, make a large outline drawing of Fig 2.2 to show the different regions of the artery. [4]

- (d) Describe one structural feature shown in Fig. 2.2 that enables the blood vessel to perform its function.

.....

.....

.....

[2]

- (e) (i) The actual length between **S** and **T** across artery shown in Fig. 2.2 is 3 mm.

Measure the length between **S** and **T** in Fig. 2.2 to calculate the magnification of the artery.

Show your working in the space provided below.

Present your answer to **one decimal place**.

Magnification = X [2]

- (ii) **On your drawing in 2(c)**, draw a line at the same location as the line **S–T** shown in Fig. 2.2. Measure and record the length of this line.

..... mm [2]

- (f) Use your measurements in **2(e)(i)** and **2(e)(ii)** to calculate the magnification of your drawing compared to Fig. 2.2.

Show your working clearly in the space provided below.

Present your answer to **one decimal place**.

Magnification = X [1]

- (g) Fig. 2.3 is a photomicrograph of a *Planaria*, a flatworm.

A typical adult flatworm reaches an average size of up to 10 mm in length and 0.5 mm in thickness.

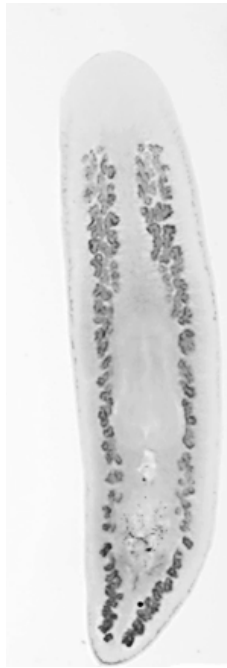


Fig. 2.3

Source: Wang, Y., Zayas, R. M., Guo, T., & Newmark, P. A. (2007). *Nanos function is essential for development and regeneration of planarian germ cells. Proceedings of the National Academy of Sciences*, 104(14), 5901–5906.

Describe how the structure of the flatworm allows it to survive without the organ shown in Fig. 2.1.

.....

.....

.....

..... [2]

[Total: 19]

END OF PAPER

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Qn	Marking Points	Marks																					
1(a)	Volume of water ; Size of boiling tube ; Distance between boiling tube and the Bunsen burner (with flame) ; [AW] R: mass of food sample	[2] Any 2 answers																					
1 (b)(i)	estimation for Lab confirmation <table border="1"> <thead> <tr> <th>sample</th><th>*initial temperature / °C</th><th>final temperature / °C</th><th>rise in temperature / °C</th><th>Average rise in temperature / °C</th></tr> </thead> <tbody> <tr> <td rowspan="2">S1</td><td>31.0</td><td>35.0 – 38.0</td><td>$\geq 10.0 < 25.0$</td><td rowspan="2">As per rise</td></tr> <tr> <td>31.0</td><td>35.0 – 38.0</td><td>$\geq 10.0 < 25.0$</td></tr> <tr> <td rowspan="2">S2</td><td>31.0</td><td>> 45.0</td><td>$> 15.0 < 40.0$</td><td rowspan="2">As per rise</td></tr> <tr> <td>31.0</td><td>> 45.0</td><td>$> 15.0 < 40.0$</td></tr> </tbody> </table> *dependent on actual day MP1: Appropriate header titles with units (proper table format) MP2: Rise in temperature for two of each sample (4 recorded values) with appropriate precision (1 dp) MP3: Appropriate precision for calculated values - Rise and Average rise in temperature; (1 dp) MP4: <u>Correct calculation</u> for rise and average rise in temperature MP5: Results follows expected trend data ; - Increase in temperature - S2 > S1 for rise in temperature	sample	*initial temperature / °C	final temperature / °C	rise in temperature / °C	Average rise in temperature / °C	S1	31.0	35.0 – 38.0	$\geq 10.0 < 25.0$	As per rise	31.0	35.0 – 38.0	$\geq 10.0 < 25.0$	S2	31.0	> 45.0	$> 15.0 < 40.0$	As per rise	31.0	> 45.0	$> 15.0 < 40.0$	[5]
sample	*initial temperature / °C	final temperature / °C	rise in temperature / °C	Average rise in temperature / °C																			
S1	31.0	35.0 – 38.0	$\geq 10.0 < 25.0$	As per rise																			
	31.0	35.0 – 38.0	$\geq 10.0 < 25.0$																				
S2	31.0	> 45.0	$> 15.0 < 40.0$	As per rise																			
	31.0	> 45.0	$> 15.0 < 40.0$																				
1 (b)(ii)	Data from 1(b) applied into formula ; Correct calculated value to J g⁻¹ ; Correct conversion to kJ g⁻¹ ;	[1] [1]																					
1 (c) (i)	Source of error (1) <u>Heat energy lost</u> to surroundings during burning process / relighting process ; OR (2) <u>Incomplete burning of sample</u> prevents all possible energy release ; OR (3) <u>Inconsistent distance</u> between <u>burning sample</u> and <u>boiling tube</u> ;	[1] Source + [1] Effect																					

	(4) <u>Inconsistent distance between food sample/Bunsen burner and boiling tube ;</u> Effect on results (1)(2) Results in <u>lower than expected</u> rise in temperature ; (3)(4) Results in <u>lower or higher than expected</u> rise in temperature ; OWTTE	
1 (c) (ii)	(1)(2) <u>Insulate boiling tube ;</u> To <u>reduce heat loss</u> from the boiling tube ; OR (3) Place the burning food sample at a fixed position ; <u>Reduce increase in temperature</u> due to radiating heat ; (4) Keep boiling tube at a fixed <u>distance away from the Bunsen flame ;</u> <u>Reduce increase in temperature</u> due to radiating heat ; Note: Proposed modification should match the identified key source of error.	[1] + [1]
1 (d)	Not possible (no mark); The food samples may <u>not</u> contain <u>only 1 biological molecule/ food type</u> ; OR Energy released in the experiment may not be attributed to <u>only 1 biological molecule</u> in the food sample Hence, the energy released may not be <u>fair comparison</u> to data table / energy released from S1 and S2 <u>cannot be derived from the data in the table</u>; [A/W]	

1 (e)	- Correctly identifies the experimental variables <table border="1" data-bbox="384 297 1220 1115"> <thead> <tr> <th data-bbox="384 297 611 371">*Constant (at least 2)</th><th data-bbox="611 297 943 371">Independent (changed)</th><th data-bbox="943 297 1220 371">Dependent (measured)</th></tr> </thead> <tbody> <tr> <td data-bbox="384 371 611 510">Use of same type / species / size / age of plant</td><td data-bbox="611 371 943 510">Illustrates the absence and presence of light in a controlled lab setting ; OR Lamp (light source) placed at <u>5 different distances at specified regular intervals</u> (values indicated) for different light intensities.</td><td data-bbox="943 371 1220 510">Compare area covered in <u>blue-black colouration</u> for Iodine test ;</td></tr> <tr> <td data-bbox="384 510 611 1115">Duration of experiment</td><td data-bbox="611 510 943 1115">Experiment should not be conducted within and outside the lab – varying other factors like humidity, water supply, etc.</td><td data-bbox="943 510 1220 1115"></td></tr> </tbody> </table> Preparations – Procedure 1 - Destarch two plants with leaves of similar age and size for <u>at least 2 days</u> (OR kept in dark room/cupboard) before conducting experiment ; - Select two different leaves still attached to the same plant, with one <u>covered by black paper</u> and other <u>exposed to light</u> for <u>*at least 3 – 4 hours</u> (duration to indicate suitability of procedure) <u>OR</u> - Select two different leaves still attached to two different plants, one plant exposed to light for at least 3 – 4 hours, while another kept in a dark cupboard/box Iodine Test – Procedure 2 - Remove the leaf and place it in <u>boiling water for 2 minutes</u> and thereafter, a boiling tube containing <u>3 – 5cm³ ethanol</u> in a beaker of hot water ; (NOTE: boiling water bath/heating the tube directly constitutes safety risk and will be rejected) - Place the decolourised leaf on a white tile and add a few drops of iodine solution to the entire leaf surface ; - Ensure reliability of data by repeating experiment measurement using another leaf from the same plant (with and without	*Constant (at least 2)	Independent (changed)	Dependent (measured)	Use of same type / species / size / age of plant	Illustrates the absence and presence of light in a controlled lab setting ; OR Lamp (light source) placed at <u>5 different distances at specified regular intervals</u> (values indicated) for different light intensities.	Compare area covered in <u>blue-black colouration</u> for Iodine test ;	Duration of experiment	Experiment should not be conducted within and outside the lab – varying other factors like humidity, water supply, etc.		[2] Variables must be indicated in the illustrated steps or as independent statements to support the experiment. Max [2] Max [2]
*Constant (at least 2)	Independent (changed)	Dependent (measured)									
Use of same type / species / size / age of plant	Illustrates the absence and presence of light in a controlled lab setting ; OR Lamp (light source) placed at <u>5 different distances at specified regular intervals</u> (values indicated) for different light intensities.	Compare area covered in <u>blue-black colouration</u> for Iodine test ;									
Duration of experiment	Experiment should not be conducted within and outside the lab – varying other factors like humidity, water supply, etc.										

	exposure to light); Leaves exposed to higher light intensity will exhibit/show larger area of blue-black colouration;	
2 (a)	Transports <u>oxygen and nutrients</u> to all <u>cardiac muscle tissues / heart muscle cells</u>; Facilitate <u>cellular respiration to allow energy release</u> for (cardiac) muscle tissue <u>contraction and relaxation</u> (of the heart); [A/V]	[1] [1] [1]
2(b)	P and Q are both <u>ventricles</u>; Both structures possess muscles to <u>contract and generate high blood pressure</u> to pump <u>blood out of the heart</u> ; to other parts of the body. Will accept comparison of structures to pump blood to different parts of the body (i.e. difference in thickness of muscle walls, left ventricle pumps blood to the rest of the body, right ventricle pumps blood to the lungs) [A/V]	[1] [1] [1]
2 (c)	MP1: Size of drawing to be bigger than Fig. 2.2 and cover more than 50% of space provided ; MP2: Lines are defined and continuous ; MP3: appropriate proportion for thickness of outer and inner tissue layers for the blood vessel; (relative to diameter of lumen) MP4: Undulating innermost tissue layer with relatively oval shaped lumen ; Note: No labels are required for the diagram	[4]
2 (d)	Thick muscular and elastic wall ; Withstand high blood pressure without rupturing ; OR Allows recoiling of vascular wall to push the blood along ;	[1] [1]
2 (e) (i)	Measure correct distance S-T in Fig 2.2 = 42 mm ;	[1]

	To the nearest 1mm ; Magnification = $42 / 3 = 14.0 \times$ 1m for working 1m for final answer	[1]
2 (e) (ii)	Clearly defined horizontal line ; Measure correct distance S-T in Fig 2.2 = ____ mm To the nearest 1mm ; <i>Note: Line must be drawn with a ruler</i>	[1] [1]
2 (f)	Magnification = Distance S-T in drawing / actual distance ST in Fig. 2.2	[1]
2 (g)	The flatworm's <u>small body/structure</u> which results in a <u>high surface area to volume ratio</u> ; <u>Facilitates rapid movement/exchange of substances in and out of the organism via diffusion</u> ; Hence, it does not require a transport system / heart and blood vessels to transport substances OR Has a thickness of 0.5 mm which is a <u>short diffusion distance</u> ; <u>Allows for rapid/fast rate of movement/exchange of substances in and out of the organism via diffusion</u> ; [A/W]	[1] [1]

END OF PAPER





DUNMAN SECONDARY SCHOOL

CANDIDATE
NAME

--

CLASS

--

INDEX
NUMBER

--	--

PRELIMINARY EXAMINATION 2025 SECONDARY 4 EXPRESS

BIOLOGY

Paper 3 Practical Test

6093/03

21 August 2025
1 hour 50 minutes

Candidates answer on the Question Paper

Additional Materials: As listed in the Confidential Instructions.

READ THESE INSTRUCTIONS FIRST

Please check that your name, class and index number are correctly written.
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, correction fluid or highlighters.

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	
Total	

This document consists of **12** printed pages.

1 You are advised to read the whole question before you start.

Proteins are an important part of our diet. These proteins are used in the body to make enzymes and other cell structures.

You are going to estimate the concentration of protein in two solutions, A and B, using a set of standard protein solutions.

You are provided with:

- 1% albumin solution, labelled **1% protein solution**
- distilled water, labelled **water**
- biuret reagent, labelled **biuret reagent**
- albumin solution in a test-tube labelled **A**
- albumin solution in a test-tube labelled **B**
- seven empty test-tubes
- test-tube rack
- three 5 cm³ syringes
- white tile
- stop-watch

You should wear eye protection when carrying out the investigation.

You are required to prepare seven dilutions of protein solution using the 1% protein solution and distilled water.

- Step 1 Label seven empty test-tubes **1, 2, 3, 4, 5, 6** and **7**.
- Step 2 Make the seven solutions containing different concentrations of protein shown in Table 1.1.
- To make solution **1**, use a 5 cm³ syringe to measure the volumes of 1% protein solution and distilled water as stated in Table 1.1. Add these volumes to test-tube labelled **1**. Continue this procedure until you have made all seven solutions in the seven labelled test-tubes.

Table 1.1

	test-tube number						
	1	2	3	4	5	6	7
volume of 1% protein solution / cm ³	4.00	3.00	2.00	1.00	0.50	0.25	0.00
volume of distilled water / cm ³	1.00	2.00	3.00	4.00	4.50	4.75	5.00
percentage concentration of protein solution		0.6	0.4	0.2		0.05	0

- (a) (i) Complete Table 1.1 by calculating the percentage concentration of the protein solutions in test-tubes **1** and **5**. Write your answers in Table 1.1.
- Show your working.

[2]

- Step 3 Add 2 cm³ of biuret reagent to each of the solutions in test-tubes **1** to **7**. Shake each test-tube gently to mix the contents.
- Step 4 Place the test-tubes in a test-tube rack in order of concentration, from the least concentrated to the most concentrated. Leave for 5 minutes.
- Step 5 You have been provided with two test-tubes labelled **A** and **B**. They contain protein solutions of unknown concentrations.
- Add 2 cm³ of biuret reagent to the protein solution in the test-tube labelled **A**. Shake the test-tube gently to mix the contents.

4

- Step 6 Add 2 cm³ of biuret reagent to the protein solution in the test-tube labelled **B**. Shake the test-tube gently to mix the contents.
- Step 7 Leave test-tubes **A** and **B** in a test-tube rack for 5 minutes. Continue with the other steps.
- Step 8 Hold each of the test-tubes **1** to **7** against a white background and record the colour in your table.
- Step 9 Give each of the test-tubes **1** to **7** a colour intensity score using the symbols in Table 1.2.

Test-tubes that have the same colour intensity should have the same score.

Table 1.2

colour intensity	palest → darkest			
score	+	++	+++	++++

- (ii) Present all your results for test-tubes **1** to **7** in a table in the space provided.

[4]

Step 10 Compare the colour intensity of the solutions in test-tubes **A** and **B** with the colour intensity of the solutions in test-tubes **1** to **7**.

(iii) Record the colour intensity scores for test-tubes **A** and **B**.

colour intensity score for test-tube **A**

colour intensity score for test-tube **B**

[1]

(iv) Use your table in (a)(ii) and Table 1.1 to estimate the percentage concentration of the protein solutions in test-tubes **A** and **B**.

concentration of the protein solution in test-tube **A**
%

concentration of the protein solution in test-tube
B.....%

[2]

(b) (i) Identify the control for this experiment and explain why it is used.

control

explanation

.....

.....

.

.....[2]

- (ii) Explain why the method used to find the concentration of the protein solutions in test-tubes **A** and **B** can only be an estimate.

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.....[2]

- (iii) State one possible source of error in this investigation and explain how you would improve the procedure to minimize the error.

source of error.....

improvement.....

.....

.

.....[2]

- (c) Some proteins, such as mycotoxins, found in food can be toxic to humans when ingested. Mycotoxins are commonly found in cereals, dried fruits, and nuts. During the processing of these foods, enzymatic hydrolysis is carried out to improve the safety of food by breaking down mycotoxins.

- (i) Name an enzyme that can break down mycotoxins.

.....[1]

- (ii) The maximum limit of mycotoxins in food is 20 mg/g or 0.02 percentage concentration of mycotoxin. A student would like to investigate the effectiveness of a particular enzyme used to break down mycotoxins in a sample of food so that it is safe for consumption.

Plan an investigation to find the concentration of enzyme needed to ensure safe levels of mycotoxin in a sample of food.

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[5]

[Total: 21]

- 2 The heart pumps blood to the body through the arteries. The rate of blood flow can be determined at certain sites around the body as a pulse. This can be used to estimate the heart rate.

(a) (i) On Fig. 2.1, label **two** sites where you can feel a pulse.

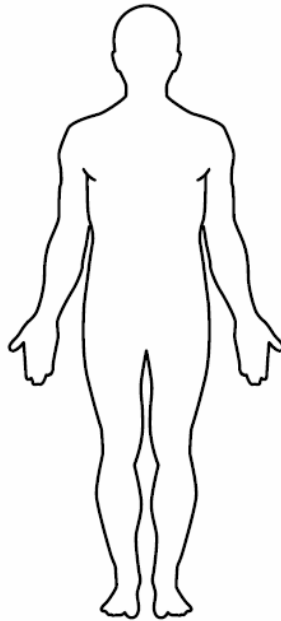


Fig. 2.1

[2]

- (ii) A student monitored their pulse rate after exercise. The student's pulse rate before exercise was 62 beats per minute.

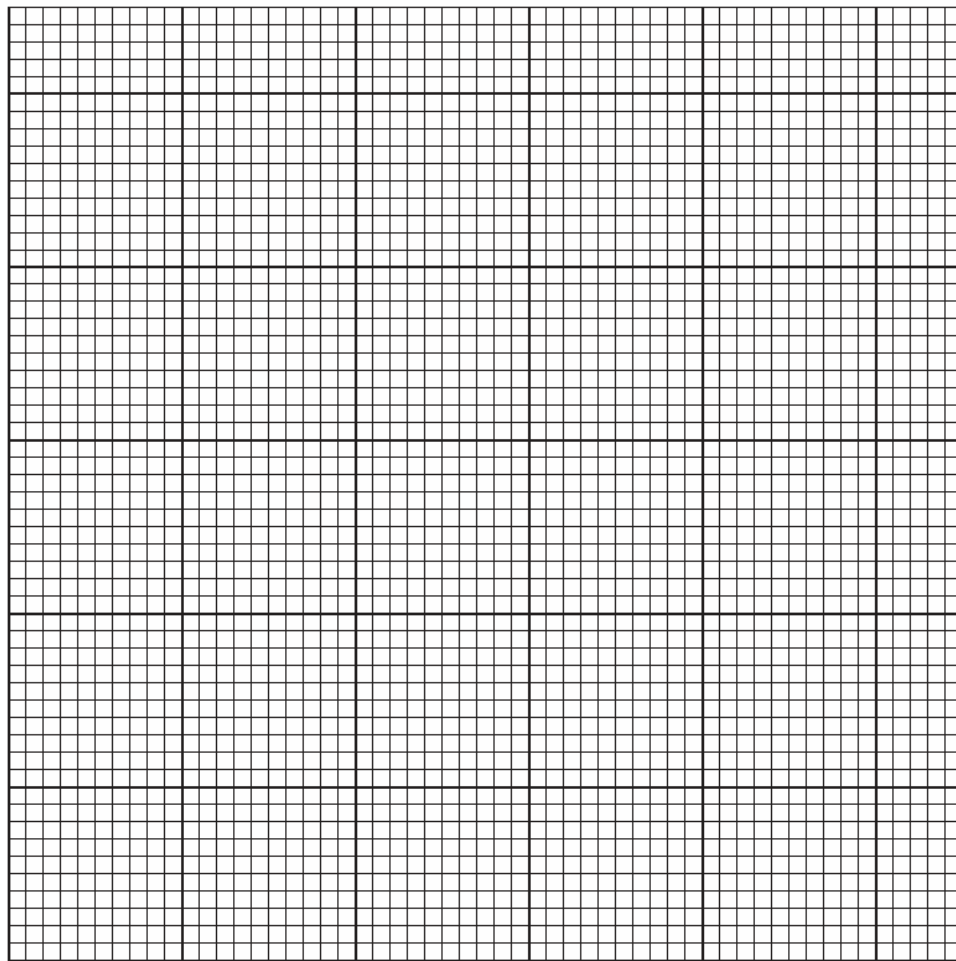
The results are shown in Table 2.1.

Table 2.1

time after exercise / minute	pulse rate / beats per minute
0	156
1	108

2	78
3	66
4	62
5	62

Use the grid provided to plot a graph to show how the pulse rate changes after exercise.



[4]

(iii) Describe the trend shown by the graph.

.....

.....[1]

- (b) The student monitored their pulse rate after exercise on three separate days and calculated their average pulse rate from the data they collected.

The results are shown in Table 2.2.

Table 2.2

time after exercise / minutes	pulse rate / beats per minute			average pulse rate / beats per
0	156	154	158	156
1	108	107	106	107
2	78	80	76	78
3	66	67	65	66
4	62	120	64	63
5	62	60	62	61

Explain why the average pulse rate at 4 minutes after exercise is calculate as 63 beats per minute rather than 82 beats per minute.

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.....

.....

.....[2]

(c) Fig. 2.2 shows a cross-section of an artery and a vein as seen using a light microscope.

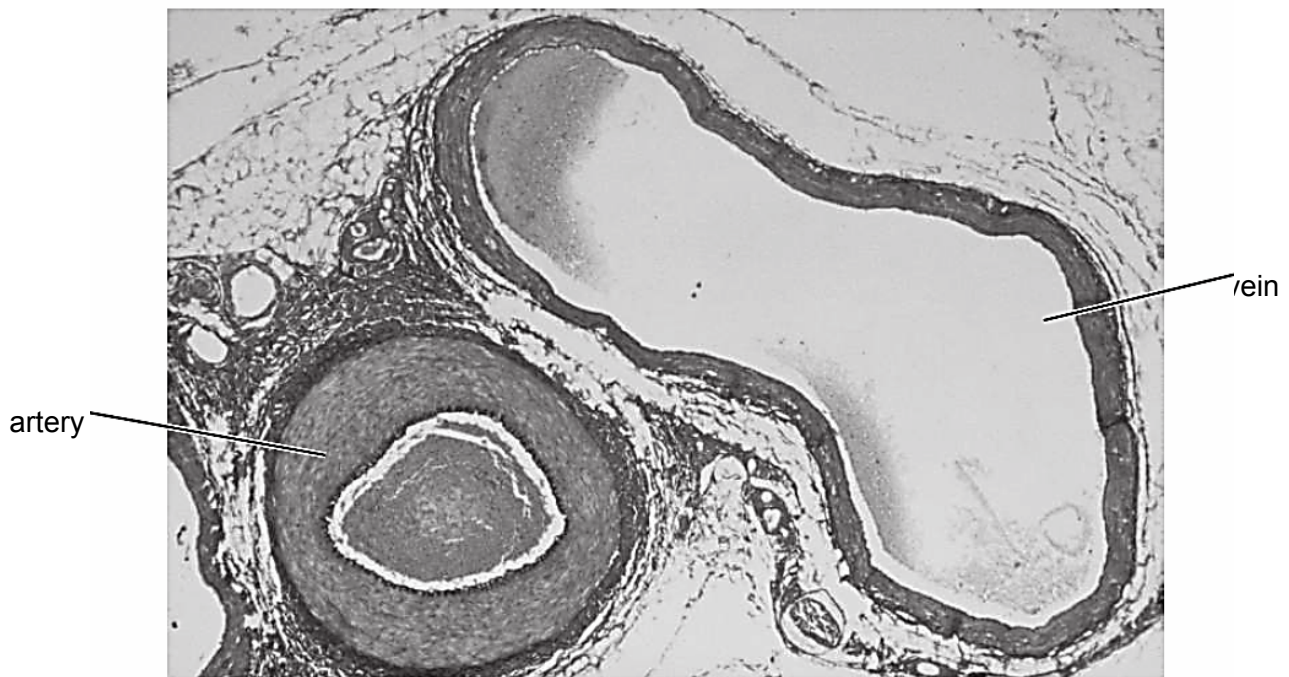


Fig. 2.2

x 125

- (i) Make a line drawing of the artery **only** as shown in Fig. 2.2. Show the layers present clearly.

Label the lumen of the artery on your drawing.

[4]

The diameter of the blood vessel in Fig. 2.2, shown by line **XY**, can be calculated using:

$$\text{diameter} = \frac{\text{measured}}{\text{magnification}}$$

- (ii) Measure, in mm, the length of line **XY** on Fig. 2.2.

measured length of **XY** mm [1]

- (iii) Use the information above and your answer to (ii) to calculate the diameter shown by line **XY**, in mm.

Show your working. Give your answer to one decimal place.

diameter mm [1]

- (iv) The length of **XY** is not the most accurate measurement of the diameter of the blood vessel in Fig. 2.2.

Suggest how you could determine a more accurate measurement of the diameter.

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 .

 .
[2]

(iv) State **two** visible differences between the artery and the vein shown in Fig. 2.2.

1.....

 .
 2.....

[2]

[Total: 19]







DUNMAN SECONDARY SCHOOL

CANDIDATE
NAME

CLASS

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NUMBER

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Total

1 You are advised to read the whole question before you start.

Proteins are an important part of our diet. These proteins are used in the body to make enzymes and other cell structures.

You are going to estimate the concentration of protein in two solutions, A and B, using a set of standard protein solutions.

You are provided with:

- 1% albumin solution, labelled **1% protein solution**
- distilled water, labelled **water**
- biuret reagent, labelled **biuret reagent**
- albumin solution in a test-tube labelled **A**
- albumin solution in a test-tube labelled **B**
- seven empty test-tubes
- test-tube rack
- three 5 cm³ syringes
- white tile
- stop-watch

You should wear eye protection when carrying out the investigation.

You are required to prepare seven dilutions of protein solution using the 1% protein solution and distilled water.

Step 1 Label seven empty test-tubes 1, 2, 3, 4, 5, 6 and 7.

Step 2 Make the seven solutions containing different concentrations of protein shown in Table 1.1.

To make solution 1, use a 5 cm³ syringe to measure the volumes of 1% protein solution and distilled water as stated in Table 1.1. Add these volumes to test-tube labelled 1. Continue this procedure until you have made all seven solutions in the seven labelled test-tubes.

Table 1.1

	test-tube number						
	1	2	3	4	5	6	7
volume of 1% protein solution / cm ³	4.00	3.00	2.00	1.00	0.50	0.25	0.00
volume of distilled water / cm ³	1.00	2.00	3.00	4.00	4.50	4.75	5.00
percentage concentration of protein solution	0.8	0.6	0.4	0.2	0.1	0.05	0

(a) (i) Complete Table 1.1 by calculating the percentage concentration of the protein solutions in test-tubes 1 and 5. Write your answers in Table 1.1.

Show your working.

test-tube 1: $4 / 5 = 0.8$

test-tube 5: $0.5 / 5 = 0.1$

correct working for test-tubes 1 & 5 [1]

correct percentage concentration for test-tubes 1 & 5 [1]

[2]

Step 3 Add 2 cm³ of biuret reagent to each of the solutions in test-tubes 1 to 7. Shake each test-tube gently to mix the contents.

Step 4 Place the test-tubes in a test-tube rack in order of concentration, from the least concentrated to the most concentrated. Leave for 5 minutes.

Step 5 You have been provided with two test-tubes labelled A and B. They contain protein solutions of unknown concentrations.

Add 2 cm³ of biuret reagent to the protein solution in the test-tube labelled A. Shake

the test-tube gently to mix the contents.

Step 6 Add 2 cm³ of biuret reagent to the protein solution in the test-tube labelled **B**. Shake the test-tube gently to mix the contents.

Step 7 Leave test-tubes **A** and **B** in a test-tube rack for 5 minutes. Continue with the other steps.

Step 8 Hold each of the test-tubes **1** to **7** against a white background and record the colour in your table.

Step 9 Give each of the test-tubes **1** to **7** a colour intensity score using the symbols in Table 1.2.

Test-tubes that have the same colour intensity should have the same score.

Table 1.2

colour intensity	palest  darkest			
score	+	++	+++	++++

(ii) Present all your results for test-tubes **1** to **7** in a table in the space provided.

percentage

colour

5

test-tube	concentration of protein solution	colour observed	intensity score
1	0.8		
2	0.6		
3	0.4		
4	0.2		
5	0.1		
6	0.05		
7	0		

- closed table drawn with ruled lines [1]
- appropriate headings [1]
- colour and score recorded for each test-tube [1]
- correct match for concentration and score [1]

[4]

Step 10 Compare the colour intensity of the solutions in test-tubes A and B with the colour intensity of the solutions in test-tubes 1 to 7.

(iii) Record the colour intensity scores for test-tubes A and B.

colour intensity score for test-tube A ++ or +++ [1]

colour intensity score for test-tube B ++++ [1]

[1]

(iv) Use your table in (a)(ii) and Table 1.1 to estimate the percentage concentration of the protein solutions in test-tubes A and B.

concentration of the protein solution in test-tube A between 0.05 and 0.2 [1] %

concentration of the protein solution in test-tube B between 0.4 to 0.8 [1] %

[2]

(b) (i) Identify the control for this experiment and explain why it is used.

control tube 7 / tube with only water / 0% protein [1]

explanation

To show that any colour change of the biuret solution is due to the presence of protein [1]

[2]

(ii) Explain why the method used to find the concentration of the protein solutions in test-tubes A and B can only be an estimate.

- Data collected / observed is qualitative (colour intensity) and not quantitative.
- Colour is subjective and may be judged differently by different observers.
- Similar concentrations may look the same as there are not enough intervals between concentrations / difficult to see minor differences in the shades of purple

any two [2]

[2]

(iii) State one possible source of error in this investigation and explain how you would improve the procedure to minimize the error.

source of error

The 5cm³ syringe was not accurate enough to measure volumes such as 0.75 cm³ and 0.50 cm³. [1]

improvement

Use a 1cm³ to measure small volumes such as 0.75 cm³ and 0.50 cm³. [1]

[2]

(c) Some proteins, such as mycotoxins, found in food can be toxic to humans when ingested. Mycotoxins are commonly found in cereals, dried fruits, and nuts. During the processing of these foods, enzymatic hydrolysis is carried out to improve the safety of food by breaking down mycotoxins.

- (i) Name an enzyme that can break down mycotoxins.

protease

[1]

[1]

- (ii) The maximum limit of mycotoxins in food is 20 mg/g or 0.02 percentage concentration of mycotoxin. A student would like to investigate the effectiveness of a particular enzyme used to break down mycotoxins in a sample of food so that it is safe for consumption.

Plan an investigation to find the concentration of enzyme needed to ensure safe levels of mycotoxin in a sample of food.

1. Independent variable: Concentration of enzyme

2. Select five different concentrations of enzyme solution e.g. 0.2%, 0.4%, 0.6%, 0.8% and 1.0% (Accept: other appropriate values and units)

3. Dependent variable: Colour intensity score of solutions after biuret test

4. How to obtain (method):

Add a fixed volume of the sample of food into each concentration of enzyme solution and place them in water bath for a fixed period of time. Test for presence of proteins using biuret test and record the colour observed and colour intensity score.

5. Constant variables:

- volume of enzyme solution
- volume of food sample
- duration of incubation
- temperature of water bath

6. Addressing aim of experiment:

Using results of this investigation and the data collected in (a)(ii), we can determine which enzyme concentration correspond to the colour intensity score of between 0 and 0.05 percentage concentration of protein.

This means that the enzyme has broken down the mycotoxins (protein) and any remaining mycotoxins is at a safe level for consumption.

[5]

[Total: 21]

- 2 The heart pumps blood to the body through the arteries. The rate of blood flow can be determined at certain sites around the body as a pulse. This can be used to estimate the heart rate.

- (a) (i) On Fig. 2.1, label **two** sites where you can feel a pulse.

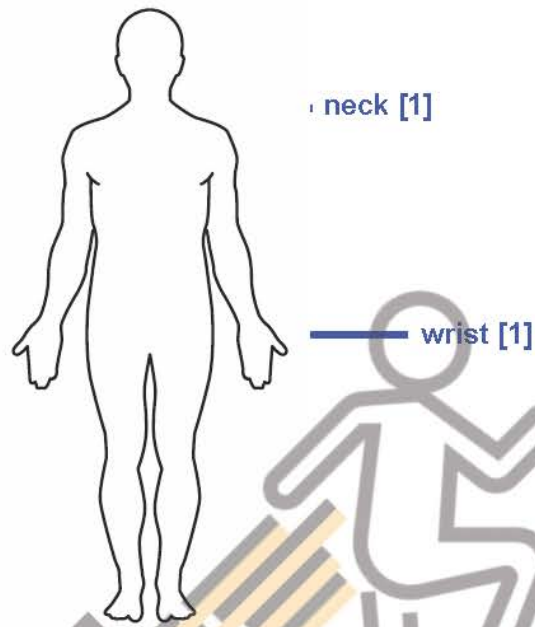


Fig. 2.1

[2]

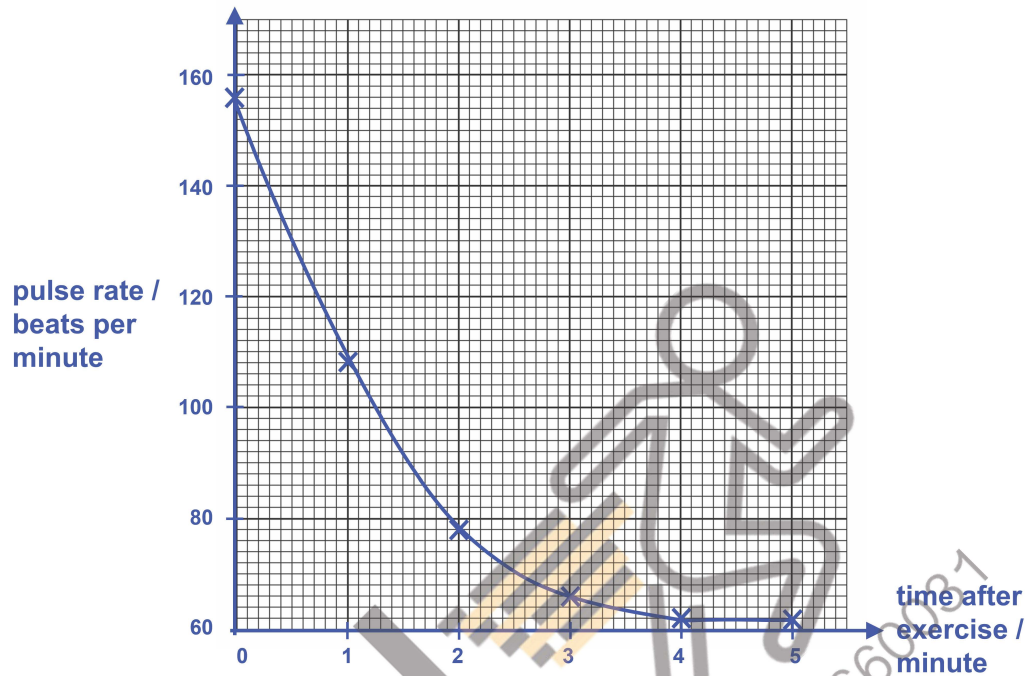
- (ii) A student monitored their pulse rate after exercise. The student's pulse rate before exercise was 62 beats per minute.

The results are shown in Table 2.1.

Table 2.1

time after exercise / minute	pulse rate / beats per minute
0	156
1	108
2	78
3	66
4	62
5	62

Use the grid provided to plot a graph to show how the pulse rate changes after exercise.



- labelled axes and units [1]
- appropriate scale [1]
- correct plotting points [1]
- best fit curve [1]

[4]

(iii) Describe the trend shown by the graph.

As time after exercise increases, pulse rate decreases. [1]

[1]

- (b) The student monitored their pulse rate after exercise on three separate days and calculated their average pulse rate from the data they collected.

The results are shown in Table 2.2.

Table 2.2

time after exercise / minutes	pulse rate / beats per minute			average pulse rate / beats per
0	156	154	158	156
1	108	107	106	107
2	78	80	76	78
3	66	67	65	66
4	62	120	64	63
5	62	60	62	61

Explain why the average pulse rate at 4 minutes after exercise is calculate as 63 beats per minute rather than 82 beats per minute.

- Based on the trend of data collected, 120 beats per minute is an anomalous result.
- This can be due to errors in recording or during data collection process.
- Hence, it should not be included while calculating the average pulse rate.

any 2 [2]

[2]

(c) Fig. 2.2 shows a cross-section of an artery and a vein as seen using a light microscope.

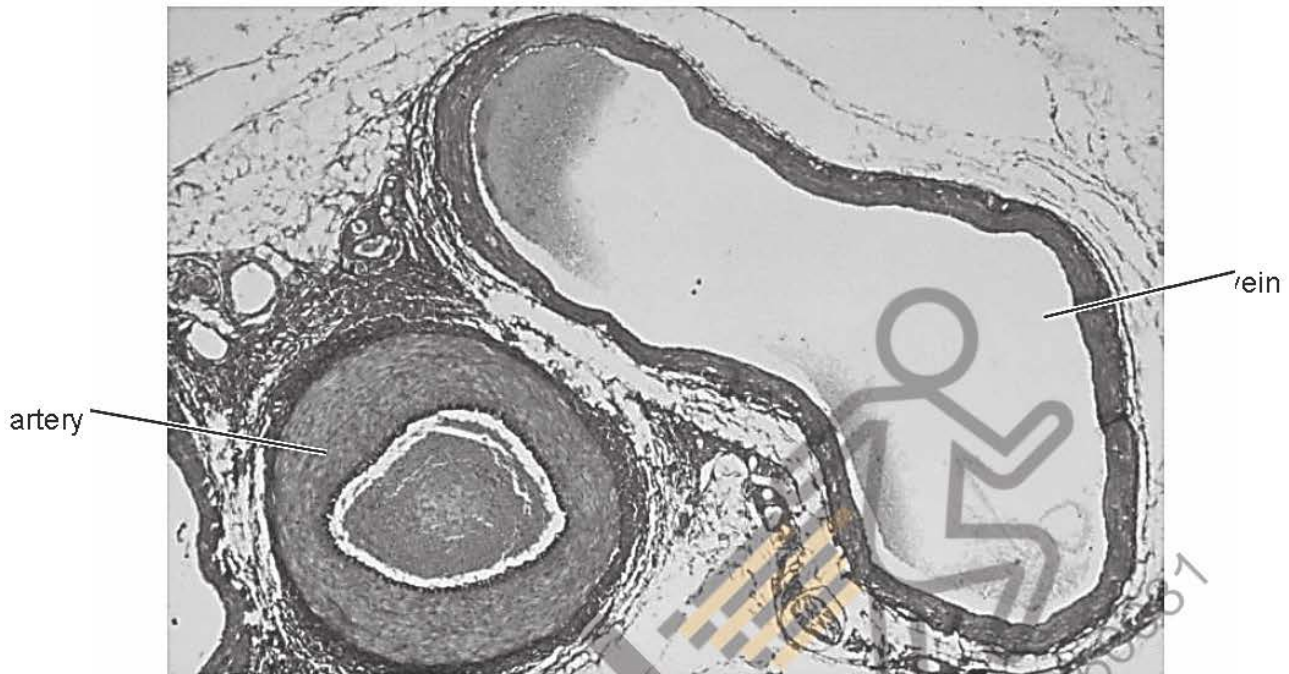


Fig. 2.2

x 125

- (i) Make a line drawing of the artery **only** as shown in Fig. 2.2. Show the layers present clearly.

Label the lumen of the artery on your drawing.

- lines: clear, single, unbroken with no shading [1]
- size: drawing occupies at least half of the space provided [1]
- layers: clear distinction of at least four layers of arterial wall. [1]
- correctly labelled structure (lumen) [1]

[4]

The diameter of the blood vessel in Fig. 2.2, shown by line XY, can be calculated using:

diameter = $\frac{\text{measured}}{\text{magnificati}}$

- (ii) Measure, in mm, the length of line $\hat{XY}$ on Fig. 2.2.

measured length of XY **99 [1]** mm [1]

- (iii) Use the information above and your answer to (ii) to calculate the diameter shown by line XY, in mm.

Show your working. Give your answer to one decimal place.

$$\text{diameter} = 99 \text{ mm} / 125$$

$$= 0.792 \text{ mm}$$

diameter **0.8 [1]** mm [1]

- (iv) The length of XY is not the most accurate measurement of the diameter of the blood vessel in Fig. 2.2.

Suggest how you could determine a more accurate measurement of the diameter.

- Take multiple / more than one readings for diameter across different positions [1]
- Calculate average length/diameter of the blood vessel [1]

[2]

- (iv) State two visible differences between the artery and the vein shown in Fig. 2.2.

feature	artery	vein
shape	round and regular	oval and irregular
wall	thick	thin
detail of layers	wavy inner layer / two or more layers	smooth inner layer / single layer
lumen	small w.r.t diameter of artery	large w.r.t diameter of vein

any difference [1]

[2]

[Total: 19]



Class:	Candidate Name:	Candidate Index Number:
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	EDGEFIELD SECONDARY SCHOOL		O
	2025 PRELIMINARY EXAMINATION		Syllabus
	Secondary 4		
	BIOLOGY	6093/03	
Paper 3 Practical		August 2025	
Candidates answer on the Question Paper		1 hour 50 minutes	

READ THESE INSTRUCTIONS FIRST Write your name, class and index number in the boxes above. Write in dark blue or black ink on both sides of the paper. You may use a soft pencil for any diagrams, graphs, tables or rough working. Do not use staples, paper clips, glue or correction fluid. Answer all questions Write your answer in the spaces provided on the question paper. 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.

FOR EXAMINER'S USE	My target grade/mark _____
TOTAL	/40
_____ Parent's signature	

This document consists of **11** printed pages.

You are advised to read the whole question before you start.

1 Part 1

Rice contains starch. Amylase is an enzyme that catalyses the breakdown of starch to form reducing sugars.

You are to investigate the effect of amylase on cooked rice.

You are provided with:

- 2 boiling tubes each containing 15 g cooked white rice labelled **W** and **A** respectively
- distilled water
- test-tube rack and holder
- 30 cm³ of 1% amylase solution in a small beaker labelled **amylase solution**
- empty 250 cm³ beaker labelled **40°C**
- supply of hot water at approximately **40°C**
- 2 test-tubes
- 2 plastic droppers
- 25 cm³ measuring cylinder
- stopwatch
- paper towels
- marker pen

Carry out Step 1 to Step 9

- | | |
|--------|--|
| Step 1 | Label one empty test-tube W10 and label the other empty test-tube A10 . |
| Step 2 | Label one of the boiling tubes containing rice W and the other boiling tube containing rice A . |
| Step 3 | Put both boiling tubes containing rice in the empty beaker labelled 40°C . |
| Step 4 | Collect a suitable volume of warm water from the 40°C water bath to fill the beaker labelled 40°C . |
| Step 5 | Use the measuring cylinder to add 20 cm ³ of distilled water to the rice in the boiling tube labelled W . |
| Step 6 | Use the measuring cylinder to add 20 cm ³ of amylase solution to the rice in the boiling tube labelled A . |
| Step 7 | Start the stopwatch and leave the boiling tubes of rice in the 40°C beaker for 10 minutes. While waiting, prepare a boiling water bath for step 14, 15 and 16. |

3

- Step 8 After 10 minutes, use a clean dropper to remove 2 cm³ of the liquid surrounding the rice in boiling tube **W**. Put the 2 cm³ of liquid into test-tube **W10**.
- Step 9 Repeat step 8 with boiling tube **A** and test-tube **A10**. Leave the test-tubes **W10** and **A10** aside for now. Both test-tubes will be used in Step 16 later.

Continue with **Part 2**.

Part 2

You will:

- Prepare a range of known concentrations of reducing sugar by serial dilution of the 2.0 % reducing sugar solution, **R**.
- Carry out the Benedict's test on the known concentrations of reducing sugar and the solutions in test-tubes **W10** and **A10** collected in steps 8 and 9.
- Use the results to estimate the concentration of reducing sugar in the solution in test-tube **A10**.

You are provided with:

- 25 cm³ of 2.0 % reducing sugar solution labelled **R**
- distilled water
- 5 boiling tubes
- 2 10 cm³ syringe
- 6 test-tubes
- Benedict's solution
- empty 250 cm³ beaker to use for boiling water
- bunsen burner
- tripod stand and wire gauze
- stopwatch

Step 10 Label five boiling tubes **1** to **5**.

Step 11 Use the distilled water and the 2.0 % reducing sugar solution, **R**, to make five different concentrations in the labelled boiling tubes, as shown in Table 1.1.

You are advised to use the syringes provided.

Table 1.1

boiling tube	concentration of reducing sugar solution / %	volume of distilled water / cm ³	volume of 2.0 % reducing sugar solution R / cm ³
1	0.2	9.0	1.0
2	0.5	7.5	2.5
3	1.0	5.0	5.0
4	1.5	2.5	7.5
5	2.0	0.0	10.0

- Step 12** Prepare a boiling water bath for step 13.
- Step 13** Label five test-tubes **1** to **5**. Follow steps 14-15 to carry out the Benedict's test on each of the concentrations of reducing sugar solution. **Test each solution separately.**
- Step 14** For each concentration of reducing sugar solution prepared in step 11, use a plastic dropper to measure out 2.0 cm^3 of the solution and add it into the respective test-tube. Perform Benedict's test.
- Step 15** Record in **(a)(i)** the time taken for the first appearance of any colour change. Record the time taken to the **nearest second**.
If there is no colour change after 120 seconds, record as '> 120'.
- (a) (i)** Record your results in an appropriate table. [3]

Step 16 Carry out the Benedict's test on the solution in test-tubes **A10** and **W10** from step 9.

Record in **(a)(ii)** the time taken for the first appearance of any colour change.

If there is no colour change after 120 seconds, record as '> 120'.

- (ii)** State the time taken for the first appearance of any colour change in step 16.

time taken for **A10** s

time taken for **W10** s [2]

- (iii) Based on the results in **(a)(i)**, give an estimate of the concentration of reducing sugar in test-tube **A10**.

..... [1]

- (iv) State **one** key variable that was kept constant in this investigation and explain why it was important to keep it constant.

key variable

.....
 explanation

..... [2]

- (v) State the purpose of boiling tube **W** that contains distilled water and cooked rice.

..... [1]

- (vi) Describe **two** significant sources of error when carrying out this investigation and state how you would improve the procedure to minimise the error.

source of error 1

.....
 improvement

.....
 source of error 2

.....
 improvement

..... [4]

- (b) Some students investigated the effect of temperature on the rate of amylase activity. They measured the mass of reducing sugars produced in five minutes, at different temperatures.

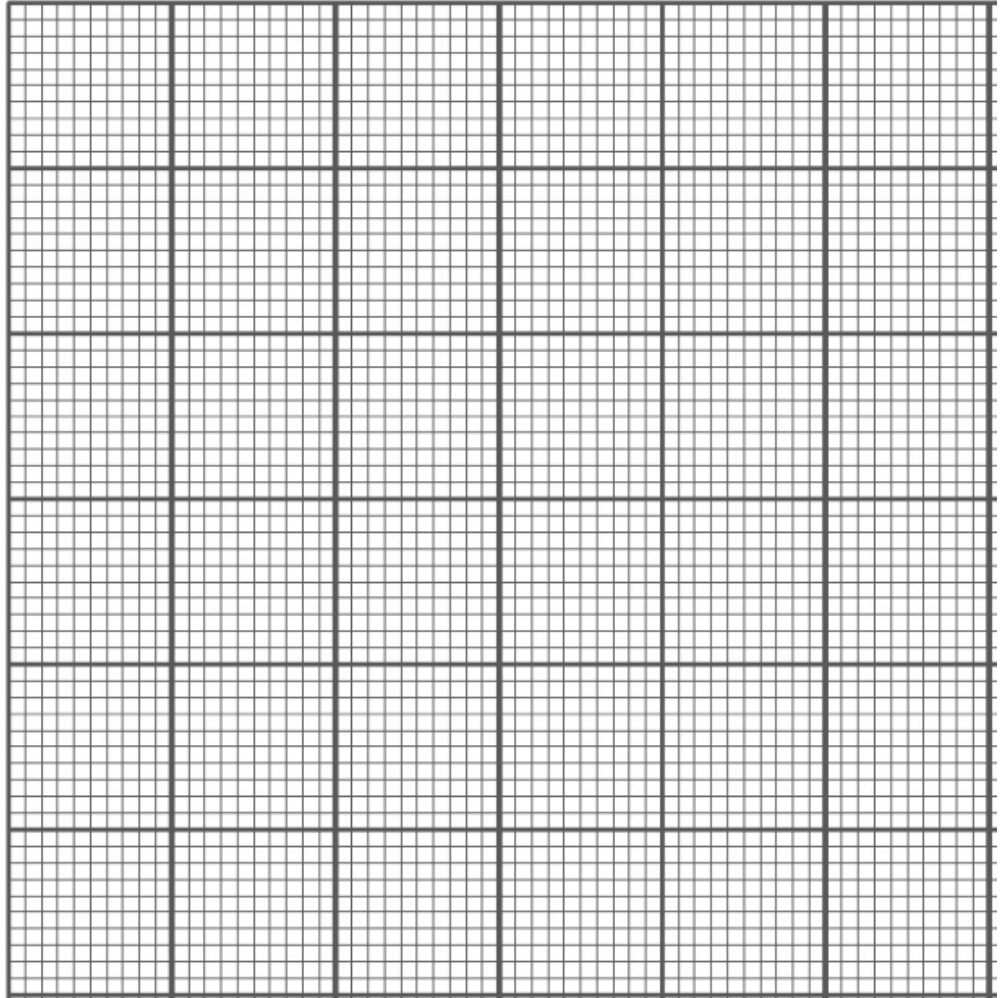
The results of this investigation are given in Table 1.2.

Table 1.2

temperature / °C	mass of reducing sugars produced in five minutes / mg
5.0	6.0
10.0	12.0
20.0	28.0
30.0	41.0
35.0	45.0
40.0	35.0
45.0	22.0
55.0	4.0

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

Use a sharp pencil.



[4]

Fig 1.2

- (ii) Based on the graph drawn, describe the effect of temperature on the activity of amylase.

.....

.....

.....

.....

[2]

- (iii)** Use the graph to estimate the rate of amylase activity, in mg / min, at a temperature of 42 °C. Show your working in the space below.

(c) pH is another factor that affects amylase action.

[6]

[Total: 27]

- 2 The species *Musa acuminata* produces banana fruits. Fig. 2.1 shows a cross-section of a banana.



magnification 1.5X

Fig. 2.1

- (a) (i) Make a large drawing of the cross-section of the banana fruit as shown in Fig. 2.1.

[3]

- (ii) Draw a straight line on the photograph joining the lines labelled **A** and **B** to show the diameter of the banana in Fig. 2.1. Measure line **AB** and record the measurement.

diameter of the banana [1]

- (iii) Indicate on your drawing in **a(i)** to show the diameter of the drawing of the banana and record the measurement.

diameter of the drawing of the banana [1]

- (iv) The magnification of the photographed specimen in Fig. 2.1 is **1.5X**.

Calculate the magnification of your drawing in comparison with the actual banana shown in the photograph. Show your working.

magnification [2]

- (b) You are provided with part of a banana on a white tile.

- Cut a transverse section of the banana, approximately 1 cm thick.
- Lay this banana section flat on a white tile, with the freshly cut surface facing upwards.
- Completely cover the cut surface with iodine solution and leave this for five minutes.
- After five minutes, pick up the banana section with forceps. Use distilled water to carefully rinse off the excess iodine solution.

- (i) Label your drawing in **a(i)**, to describe the effect of iodine solution on the different tissues.

[2]

- (ii) State what you can conclude from your observations.

.....
 [1]

- (iii) The farmer sprays insecticide on the banana plants to improve his crop-yield of bananas.

Explain how this has an impact on the biodiversity of his fields.

.....

 [3]

[Total: 13]

END OF THE PAPER





Class:	Candidate Name:	Candidate Index Number:
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EDGEFIELD SECONDARY SCHOOL O
2025 PRELIMINARY EXAMINATION Syllabus
Secondary 4

BIOLOGY

6093/03

Paper 3 Practical

August 2025

Candidates answer on the Question Paper

1 hour 50 minutes

READ THESE INSTRUCTIONS FIRST

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 Write in dark blue or black ink on both sides of the paper.
 You may use a soft pencil for any diagrams, graphs, tables or rough working.
 Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions

Write your answer in the spaces provided on the question paper.

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.

FOR EXAMINER'S USE	My target grade/mark _____
TOTAL /40	_____ Parent's signature

This document consists of **11** printed pages.

You are advised to read the whole question before you start.

1 Part 1

Rice contains starch. Amylase is an enzyme that catalyses the breakdown of starch to form reducing sugars.

You are to investigate the effect of amylase on cooked rice.

You are provided with:

- 2 boiling tubes each containing 15 g cooked white rice labelled as **W** and **A**.
- distilled water
- test-tube rack & holder
- 30 cm³ of 1% amylase solution in a small beaker labelled **amylase solution**
- empty 250 cm³ beaker labelled **40°C**
- supply of hot water at approximately **40°C**
- 2 test-tubes
- 2 plastic droppers
- 25 cm³ measuring cylinder
- stopwatch
- paper towels
- marker pen

Carry out Step 1 to Step 9

- Step 1 Label one empty test-tube **W10** and label the other empty test-tube **A10**.
- Step 2 Label one of the boiling tubes containing rice **W** and the other boiling tube containing rice **A**.
- Step 3 Put both boiling tubes containing rice in the empty beaker labelled **40°C**.
- Step 4 Collect a suitable volume of warm water from the 40°C water bath to fill the beaker labelled **40°C**.
- Step 5 Use the measuring cylinder to add 20 cm³ of distilled water to the rice in the boiling tube labelled **W**.
- Step 6 Use the measuring cylinder to add 20 cm³ of amylase solution to the rice in the boiling tube labelled **A**.
- Step 7 Start the stopwatch and leave the boiling tubes of rice in the 40°C beaker for 10 minutes. While waiting, prepare a boiling water bath for step 14, 15 and 16.

- Step 8 After 10 minutes, use a clean dropper to remove 2 cm³ of the liquid surrounding the rice in boiling tube **W**. Put the 2 cm³ of liquid into test-tube **W10**.
- Step 9 Repeat step 8 with boiling tube **A** and test-tube **A10**. Leave the test-tubes **W10** and **A10** aside for now. Both test-tubes will be used in Step 16 later.

Continue with **Part 2**.



Part 2

You will:

- Prepare a range of known concentrations of reducing sugar by serial dilution of the 2.0 % reducing sugar solution, **R**.
- Carry out the Benedict's test on the known concentrations of reducing sugar and the solutions in test-tubes **W10** and **A10** collected in steps 8 and 9.
- Use the results to estimate the concentration of reducing sugar in the solution in test-tube **A10**.

You are provided with:

- 25 cm³ of 2.0 % reducing sugar solution labelled **R**
- 1 bottle of distilled water
- 5 boiling tubes
- 2 10 cm³ syringe
- 6 test-tubes
- Benedict's solution
- a beaker to use for boiling water
- bunsen burner
- tripod stand and wire gauze

Step 10 Label five boiling tubes **1** to **5**.

Step 11 Use the distilled water and the 2.0 % reducing sugar solution, **R**, to make five different concentrations in the labelled boiling tubes, as shown in Table 1.1.

You are advised to use the syringes provided.

Table 1.1

boiling tube	concentration of reducing sugar solution / %	volume of distilled water / cm ³	volume of 2.0 % reducing sugar solution R / cm ³
1	0.2	9.0	1.0
2	0.5	7.5	2.5
3	1.0	5.0	5.0
4	1.5	2.5	7.5
5	2.0	0.0	10.0

- Step 12** Prepare a boiling water bath for step 13.
- Step 13** Label five test-tubes **1** to **5**. Follow steps 14-15 to carry out the Benedict's test on each of the concentrations of reducing sugar solution. **Test each solution separately.**
- Step 14** For each concentration of reducing sugar solution prepared in step 15, use a plastic dropper to measure out 2.0 cm³ of the solution and add it into the respective test-tube. Perform Benedict's test.
- Step 15** Record in **(a)(i)** the time taken for the first appearance of any colour change. Record the time taken to the **nearest second**. If there is no colour change after 120 seconds, record as '> 120'.
- (a) (i)** Record your results in an appropriate table. [3]

Test tube	concentration of reducing sugar / %	time taken / s
1	0.2	
2	0.5	
3	1.0	
4	1.5	
5	2.0	

Headings and variables – “concentration of reducing sugar / %” on the left + “time taken/ s” on the right most column and no units in body of table;

Precision – readings for all 5 concentrations recorded (0.2, 0.5, 1.0, 1.5 and 2.0)+ results recorded to nearest whole second

Trend – time recorded for first colour change shows a decreasing trend as conc of reducing sugar increases

- Step 16** Carry out the Benedict's test on the solution in test-tubes **A10** and **W10** from step 9.
- Record in **(a)(ii)** the time taken for the first appearance of any colour change.
- If there is no colour change after 120 seconds, record as '> 120'.
- (ii)** State the time taken for the first appearance of any colour change in step 16.

time taken for **A10** Between readings for test tube 4 and 5 s

 > 120

time taken for **W10** s [2]

- (iii) Based on the results in (a)(i), give an estimate of the concentration of reducing sugar in test-tube **A10**.

Any value between 1.5 and 2.0%

ECF awarded based on answer in (ii)

[1]

- (iv) State **one** key variable that was kept constant in this investigation and explain why it was important to keep it constant.

Constant variable	Importance
Mass of rice/ type of rice	To keep the conc of starch constant
Volume/ Conc of Benedict's solution used	Same concentration of BS molecules to react with the test sample
TOTAL volume of solutions used in creating standards is kept the same	Using the same volume ensures that the test conditions are uniform across different samples. This allows for <u>consistent and reliable comparison of results.</u>

1m for constant variable

1m for explanation of importance

Marker's comments

Well done. A few mentioned keeping pH level constant which we cannot verify during the experiment.

- (v) State the purpose of boiling tube **W** that contains distilled water and cooked rice.

As a control to compare or show what would happen if no amylase were present OR

To show that the colour change was due to amylase

[1]

- (vi) Describe **two** significant sources of error when carrying out this investigation and state how you would improve the procedure to minimise the error.

Source of error	Improvement
1. Difficulty in judging when first colour change occurs; Deciding when the colour change occurs is subjective. Example: iodine test	1. Prepare a white card to compare when colour change occurs/ 2. record final colour change instead of time taken/ 3. use a colour chart/ 4. use a colorimeter

Determination of the intensity of blue-black coloration is subjective.	Explanation: to provide a more objective way of determining the final colour change.
Inconsistencies in volume of sample and Benedict's solution as a plastic dropper was used	Use an instrument with higher precision e.g. syringe instead of plastic droppers (accept measuring cylinder)
Inconsistencies in volume of sample and Benedict's solution as a plastic dropper was used	To use a 5 cm ³ syringe to measure the volume instead.
10 cm ³ syringes were used to measure 1.0 cm ³ volumes of sugar solution leading to inaccurate dilutions.	To use a syringe of higher accuracy. i.e a 1 cm ³ syringe to measure smaller volumes.
Temperature not maintained at 40 degrees celsius.	Use a thermometer and maintain temperature by adding hot water whenever temperature falls below 40.

Common answers that were rejected:

1. Bubbles in the syringe -> candidates are expected to remove the bubbles by inverting the syringe
2. Only two droppers provided -> candidates were given deionised water and were expected to wash between uses.
3. Invert syringe and tap to remove bubbles -> human error, candidates were expected to do that.

Markers comments

Source of error should either affect the preparation of IV (concentration) or the measuring of the DV. some students mention sources of errors that are not significant such as the evaporation of water in test tube A10 (however, since A10 is in a test tube, the rate of evaporation would be low).

Use of 25 cm³ measuring cylinder to measure 20 cm³ is appropriate and should not be used as a source of error.

Reject: use same dropper as candidates are expected to rinse their droppers in between use.

1m for each correct source of error

1m for each correct improvement

- (b) Some students investigated the effect of temperature on the rate of amylase activity. They measured the mass of reducing sugars produced in five minutes, at different temperatures.

The results of this investigation are given in Table 1.2.

Table 1.2

temperature / °C	mass of reducing sugars produced in five minutes / mg
5.0	6.0
10.0	12.0
20.0	28.0
30.0	41.0
35.0	45.0
40.0	35.0
45.0	22.0
55.0	4.0

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

Use a sharp pencil.

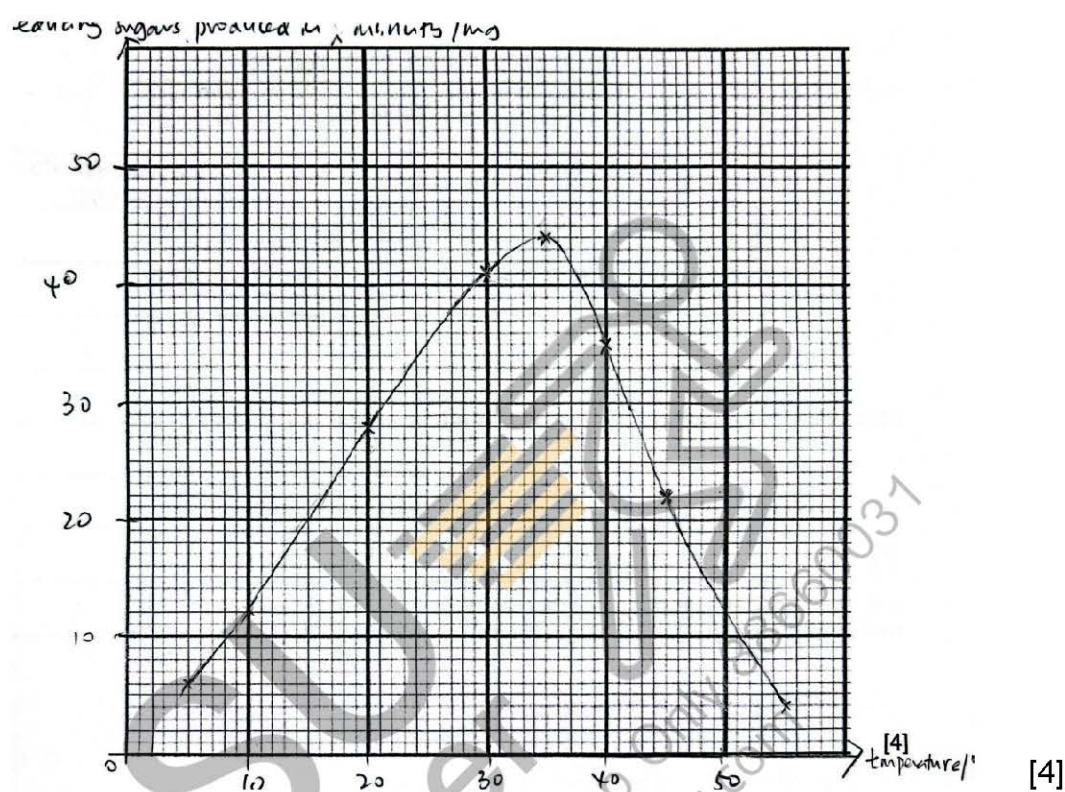


Fig 1.2

- (ii) Based on the graph drawn, describe the effect of temperature on the activity of amylase.

activity of amylase/ mass of reducing sugar produced increased from 6.0 g to 45.0 g as temperature increases from 5.0 °C to 35.0 °C [1m]

then decreased to 8.0 g as temperature increases 35.0 °C to 55.0 °C [1m]

OR

Correct data quoted from the graph [1m]

Trend [1m]

Marker's comments

Students often quoted the table's data instead of data from the graph.

- (iii) Use the graph to estimate the rate of amylase activity, in mg / min, at a temperature of 42 °C. Show your working in the space below.

correct reading ~30 mg from graph; [1m]

correct answer calculated ($30/5 = 6$ mg per minute) [1m] (accept both whole number and 1 d.p) (ECF awarded)

Marker's comments

Missing working line to indicate reading of graph at 42 °C (dotted line).

Many tried to find the gradient of the graph, since the X axis is not time but temperature, this method will not work.

..... mg / min [2]

- (c) pH is another factor that affects amylase action.

Plan an investigation to find out the optimum pH of the salivary amylase.

Independent variable: [1m (IV)]
pH

Dependent variable: [1m (DV)]

Time taken for mixture to change colour in Benedict's test

OR Time taken for iodine solution to be brown

[R] mass of reducing sugars produced (unable to measure in the school lab)

Constant variables:

(any 2, specific values must be stated in the Procedure) [1m (CV)]

- Concentration of starch / amylase solution
- Volume of starch / amylase solution
- Temperature
- Time taken for incubation

Procedure:

1. Use a 5 cm³ syringe to place 2 cm³ of 10% starch solution into a test tube.
2. Use a 5 cm³ syringe to add 2 cm³ of pH 2 buffer solution into the test tube and mix well.
3. Use a 1 cm³ syringe to add 1 cm³ of 1% amylase solution into the test tube and mix well.
4. Start the stopwatch and leave the test tube in a 40°C water bath for 10 minutes.
5. After 10 minutes, use a 5 cm³ syringe to remove 2 cm³ of the mixture and perform the Benedict's test.
6. Use the stopwatch and record the time taken for the first appearance of any colour change.
7. Repeat Steps 1 - 6 with buffer solutions of pH 4, 6, 8, 10 and 12.

[1m (5D.P.)] - 5 data points

[1m (P)] use of buffer solutions with different pH, correct syringes and stopwatch

How Observation leads to Conclusion: [1m (OC)]

Optimum pH of amylase would be when the time taken for colour change is the shortest.

Marker's Comments:

Generally well-answered. Common mistakes include:

- Measuring mass of reducing sugar as the dependent variable
- Not stating the correct syringes to be used for the required volume
- Predicting optimum pH as the conclusion

[6]

[Total: 27]

- 2 The species *Musa acuminata* produces banana fruits. Fig. 2.1 shows a cross-section of a banana.



magnification 1.5X

Fig. 2.1

- (a) (i) Make a large drawing of the cross-section of the banana fruit as shown in Fig. 2.1.

S/T: Size and Title – occupies at least half of the space provided [1m]

A: Accuracy and Proportion [1m]

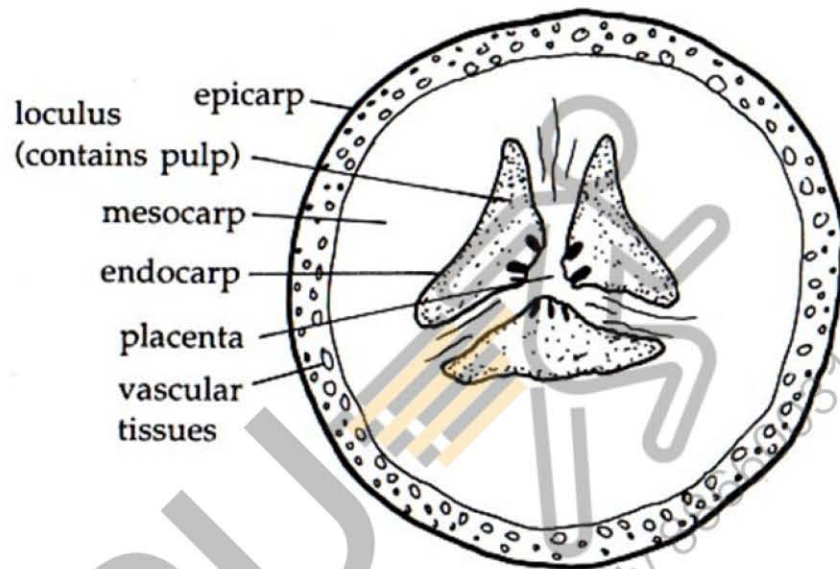
- 3 layers shown and relative thickness shown with an irregular central region
- shape corresponds to specimen

L: Clean and sharp pencil lines [1m]

Marker's Comments:

[3]

Most did not draw in the detailed structure of the vascular tissues.
Most did not draw the outline of the layer with the vascular tissues.



- (ii) Draw a straight line on the photograph joining the lines labelled **A** and **B** to show the diameter of the banana in Fig. 2.1. Measure line **AB** and record the measurement.

diameter of the banana **6.5 cm (+/- 0.1 cm) OR**
65 mm (+/- 1 mm) [1]

Marker's Comments:
Generally well-answered.

- (iii) Indicate on your drawing in **a(i)** to show the diameter of the drawing of the banana and record the measurement.

diameter of the drawing of the banana [1]

Marker's Comments:
Generally well-answered.

- (iv) The magnification of the photographed specimen in Fig. 2.1 is **1.5X**.

Calculate the magnification of your drawing in comparison with the actual banana shown in the photograph. Show your working.

$$\text{magnification} = \frac{\text{diameter of drawing}}{\text{diameter of photo} \div 1.5} \text{ [1] correct working}$$

= correct final answer in correct accuracy and inclusion of magnification [1]

magnification [2]

Marker's Comments:

Poorly-answered. Most did not include working statement.

(b) You are provided with part of a banana on a white tile.

- Cut a transverse section of the banana, approximately 1 cm thick.
- Lay this banana section flat on a white tile, with the freshly cut surface facing upwards.
- Completely cover the cut surface with iodine solution and leave this for five minutes.
- After five minutes, pick up the banana section with forceps. Use distilled water to carefully rinse off the excess iodine solution.

(i) Label and predict the effect of iodine solution on the banana tissues. [1]

middle layer is blue black [1] Reject: Banana skin turns blue black

Marker's Comments:

Fairly-answered. Some predicted that starch was present in the vascular bundles.

(ii) Explain your prediction.

Starch is present in the middle layer but absent in inner region [1]

Marker's Comments:

Generally well-answered. Weak responses include:

- Starch is transported by /stored in phloem
- Starch is absent because banana does not contain chlorophyll, hence it does not undergo photosynthesis to produce glucose. [1]

(iii) The farmer sprays insecticide on the banana plants to improve his crop-yield of bananas.

Explain how this has an impact on the biodiversity of his fields.

- disrupts food chains / web OR imbalance in ecosystem [1]
- reduction in numbers of non-insect organisms or species / less biodiversity [1]
- bioaccumulation of insecticide in food chains [1]
- top predators killed [1]
- less pollination [1]

[4]

Marker's Comments:

Fairly-answered. Some weak responses made associations to genetic engineering - insect-resistant gene instead.

[Total: 13]

END OF THE PAPER





Name:

Register no:

Class:



NGEE ANN SECONDARY SCHOOL



PRELIMINARY EXAMINATION

BIOLOGY

6093/03

Paper 3 Practical Test

18 August 2025

Candidates answer on the Question Paper.

1 h 50 min

Additional Materials: Nil

READ THESE INSTRUCTIONS FIRST

1. Write your name, register number and class in the spaces at the top of this page.

Write in dark blue or black ink.

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

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

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.

For Examiner's Use

Question	Marks
1	/25
2	/7
3	/8
Total	/40

Check by student: _____ Date: _____

This document consists **11** of printed pages and **1** blank page.

You are advised to read the whole question before you start.

- 1** Mammals have different adaptations which help them to maintain their body temperature in different climates. Boiling tubes containing hot water can be used as a model of an animal's body to investigate the heat loss.

You are going to investigate how different adaptations affect temperature loss by setting up a simulation.

You are provided with:

- three boiling tubes
- boiling tube rack
- retort stand
- large glass beaker
- large plastic beaker
- cotton wool
- tissue
- rubber bands
- dropper
- three thermometers
- stop-watch
- ruler
- marker pen
- supply of hot water

Read the procedure on pages 2, 3 and 4, and prepare a table to record your results in the space provided in part **1(a)** before beginning your investigation.

You should exercise caution when using hot water.

Step 1 Label three boiling tubes as **A**, **B** and **C** with a marker.

Step 2 Draw a line 5 cm from the top of each boiling tube. This will indicate the level to which hot water will be filled in the boiling tubes.

- Step 3 Arrange the cotton wool around boiling tube **A** in the beaker shown in Fig 1.1.

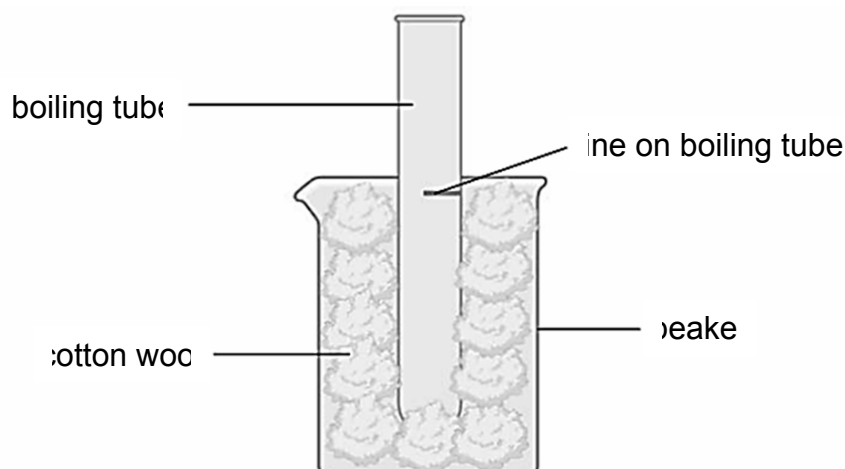


Fig. 1.1

- Step 4 Wrap tissue paper around boiling tube **B** and secure it with rubber bands. Support boiling tube **B** using a retort stand as shown in Fig. 1.2.

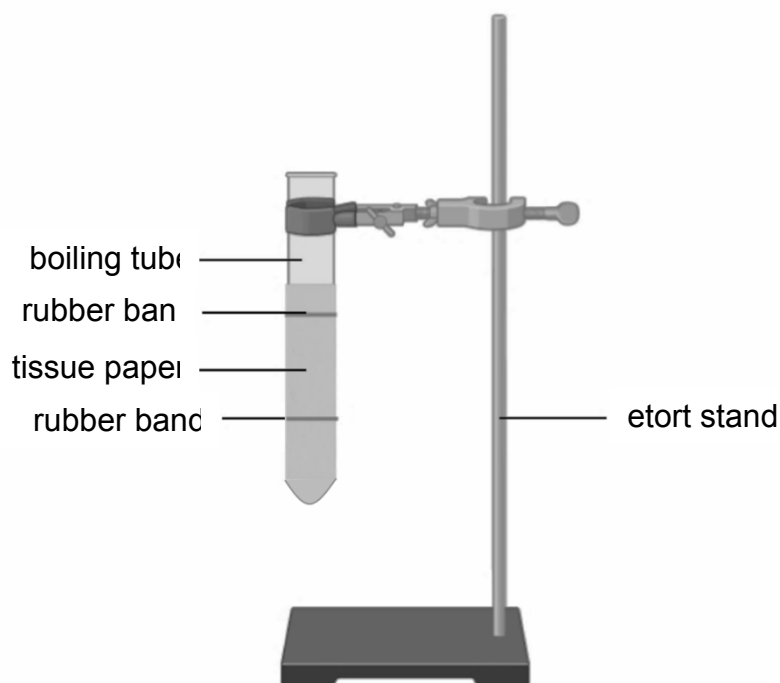
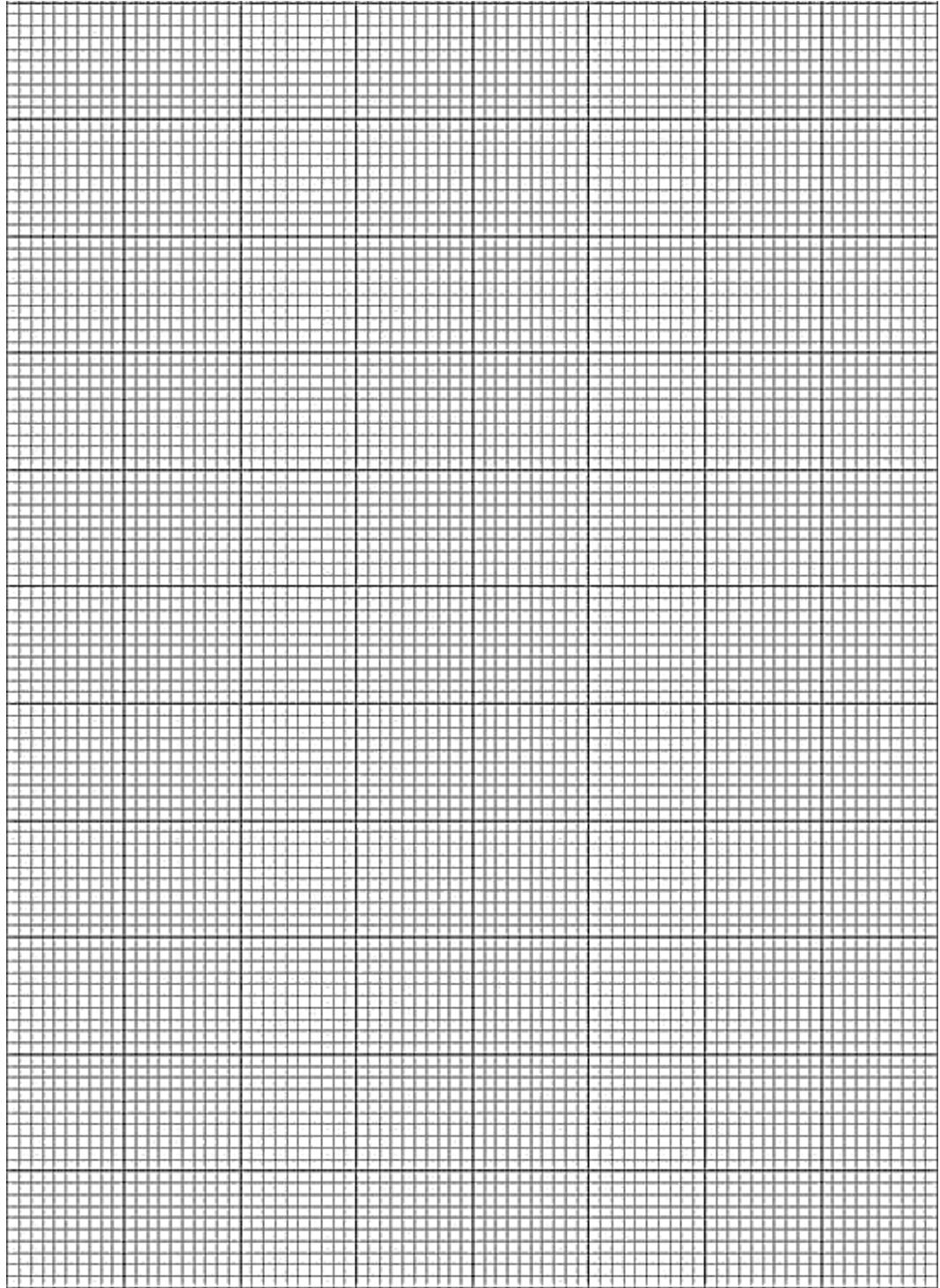


Fig. 1.2

- Step 5 Support boiling tube **C** in a boiling tube rack.
- Step 6 When you are ready, collect hot water using the plastic beaker provided from the hot water point.
- Step 7 Using the dropper, drip hot water onto the tissue paper around boiling tube **B** to completely moisten it.

- Step 8 Add hot water to each of your boiling tubes up to the lines that you have marked.
- Step 9 Place the thermometers in each set-up and start the stop-watch. Immediately record the temperature of the water in each boiling tube.
- Step 10 Record the temperature of the water in each boiling tube at two-minute intervals for 12 minutes.
- (a)** Present all your results in a table in the space provided.

- (b) Use the grid provided to plot three best fit graphs to show the effect of different adaptations on temperature loss over a period of 12 minutes. [6]



[6]

- (c) From the graph, calculate the rate of temperature loss in boiling tube **A** at 3 min. Show your working in the space provided below. Give your answer to three significant figures.

Rate of temperature loss in boiling tube **A** at 3 min =
[3]

- (d) State **one** similarity and **one** difference about the heat loss between boiling tubes **A**, **B** and **C** as shown in your graph.

.....

[2]

- (e) Suggest what adaptation is simulated by boiling tube **B**.

.....[1]

- (f) Suggest and explain two ways to improve this investigation to make the results more reliable and accurate.

improvement	explanation

[2]

- (g)** Humpback whales are large aquatic mammals that maintain a constant body temperature of 38°C . They spend part of the year in cold water around the North or South poles and part of the year in warm water around the equator.

Design an investigation that you could carry out to discover the effect of different surrounding water temperatures on the loss of heat from the humpback whale.

.....[5]

[Total: 25]

- 2 Bacteria can be grown on agar jelly in a Petri dish. When they grow and multiply, the clear agar jelly becomes cloudy.

Beta-lactam antibiotics are a broad class of antibiotics which can prevent the growth of bacteria by inhibiting the synthesis of the cell wall. Discs of filter paper dipped in an antibiotic solution can be placed on the surface of the agar. If the area around a disc remains clear, the antibiotic has prevented the growth of the bacteria. The larger the clear area, the more effective the antibiotic is.

A student investigated the effect of distilled water (**E**) and four different Beta-lactam antibiotics (**F**, **G**, **H** and **J**) on some bacteria using the method described. She set up three identical Petri dishes and measured the diameter of the clear areas around the filter paper discs after a few days. There was no clear area around disc **E** in any of the Petri dishes. Fig. 2.1 shows the results for Petri dish 3.

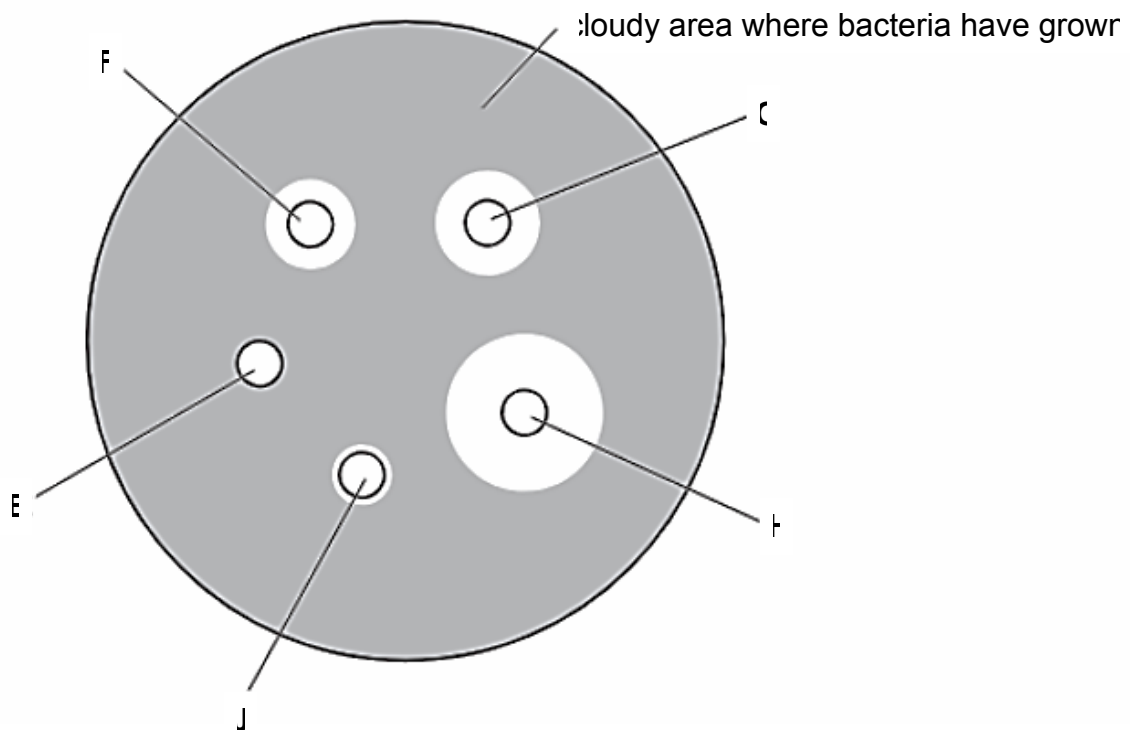


Fig. 2.1

Most of the measurements for the clear areas around the discs with antibiotics **F**, **G**, **H** and **J** are shown in Table 2.1.

Table 2.1

antibiotic	diameter of clear area / mm			
	Petri dish 1	Petri dish 2	Petri dish 3	mean
F	12	6	12	10.0
G	15	14	14	14.3
H	20	21	21	

J	8	8	8	8.0
----------	----------	----------	----------	------------

(a) Calculate the mean diameter of the clear areas around the discs with antibiotic **H**. Write the calculated value in Table 2.1.
[1]

(b) State which antibiotic was most effective at preventing growth of the bacteria.

.....[1]

(c) The student realised that one of their measured diameters was anomalous. Circle the anomalous measurement in Table 2.1 and suggest what the student should do about it.

.....

.....[2]

(d) **F**, **G**, **H** and **J** are beta-lactam antibiotics which can prevent the growth of bacteria by inhibiting the synthesis of the cell wall. Explain why this inhibition can be harmful to bacterial cells.

.....

.....[2]

(e) Suggest why these antibiotics only target bacterial cells and not human cells.

.....

.....[1]

[Total: 7]

- 3 Fig. 3.1 is a photomicrograph of a section through a kidney showing some kidney tubules.

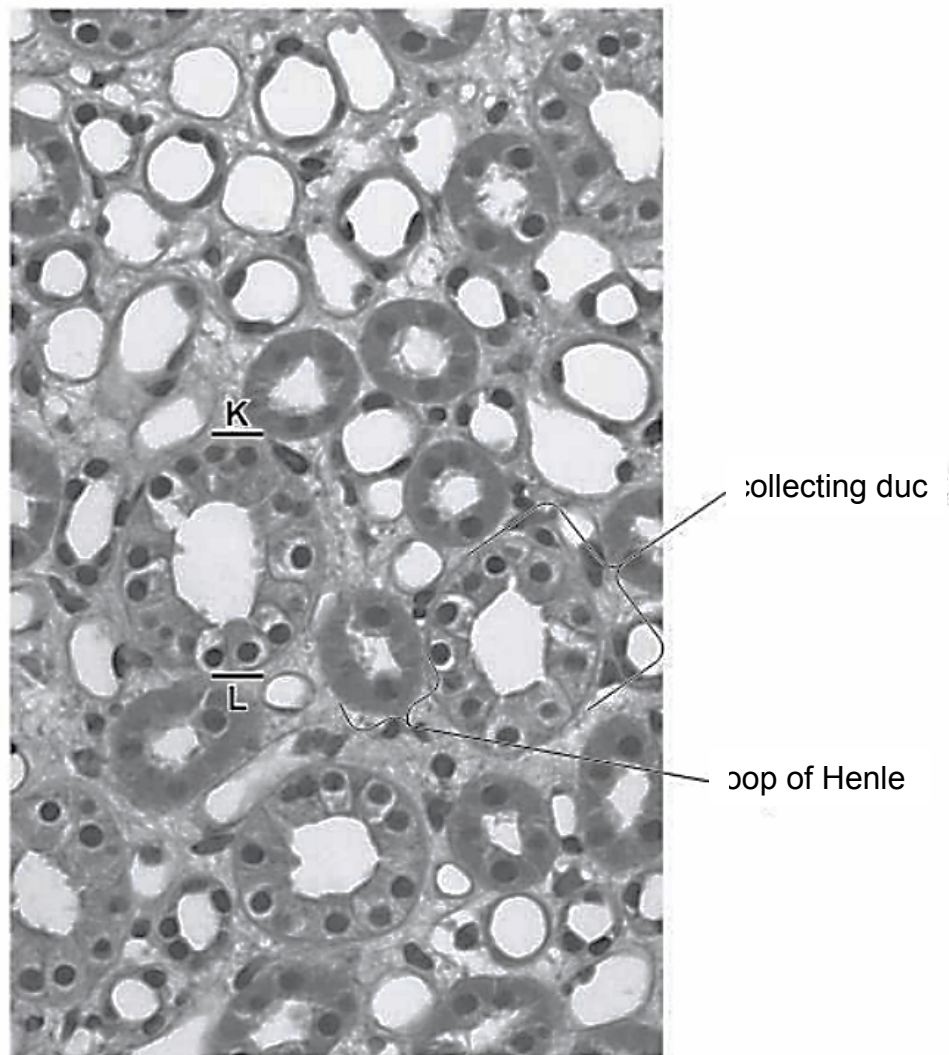


Fig. 3.1

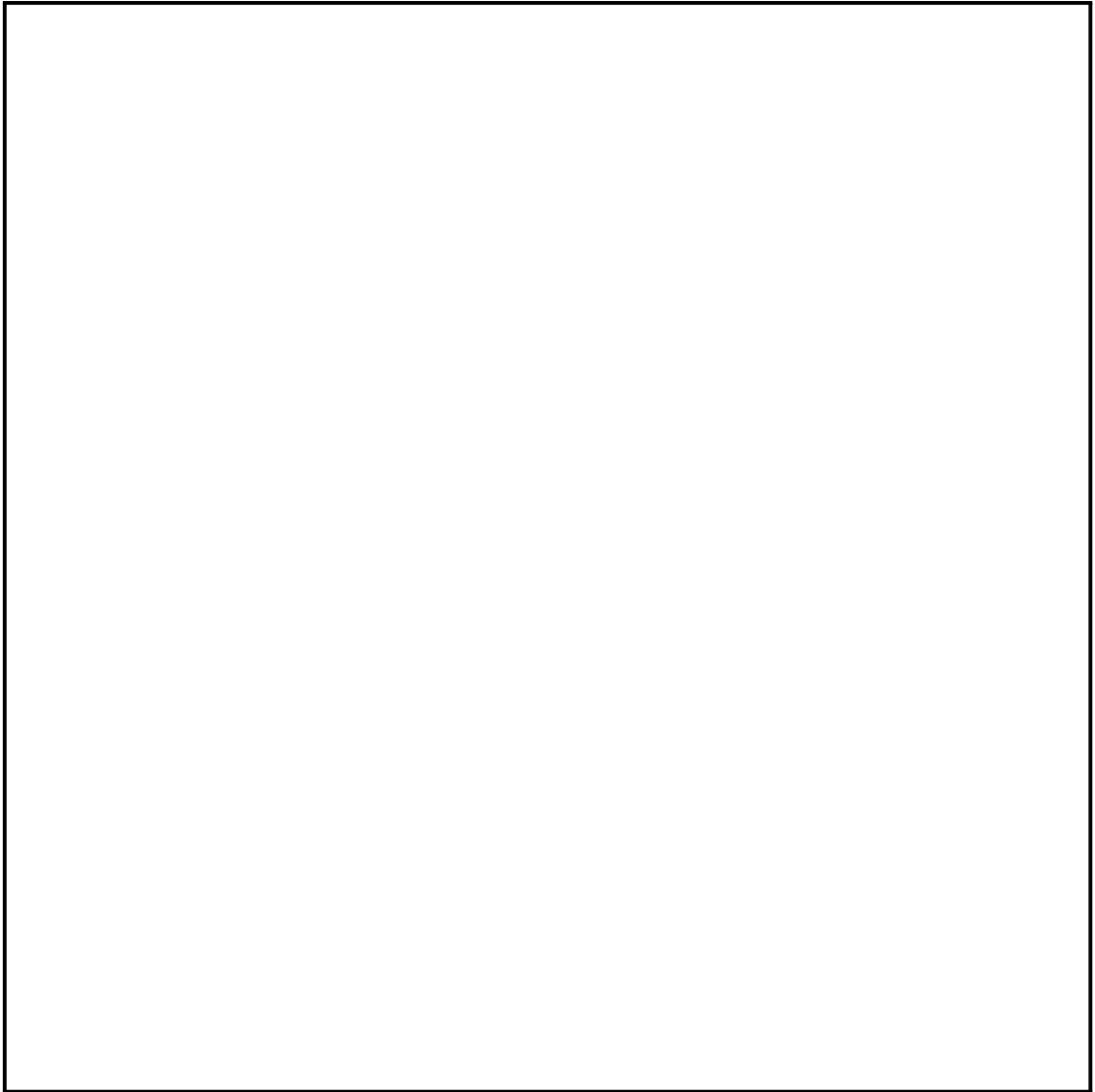
- (a) **K** and **L** indicate the diameter of a collecting duct. Draw a straight line to join **K** and **L** in the photomicrograph. Measure the length of the line and record it.

Length:[1]

- (b) The actual distance between **K** and **L** is 0.06 mm. Calculate the magnification of the photomicrograph and record it to the nearest whole number. Show your working.

Magnification x[2]

- (c) In the space below make a large drawing of the collecting duct and loop of Henle that are labelled in Fig. 3.1. Draw them as they appear in the photomicrograph. Identify and label any visible structures in the cells.



[5]

[Total: 8]

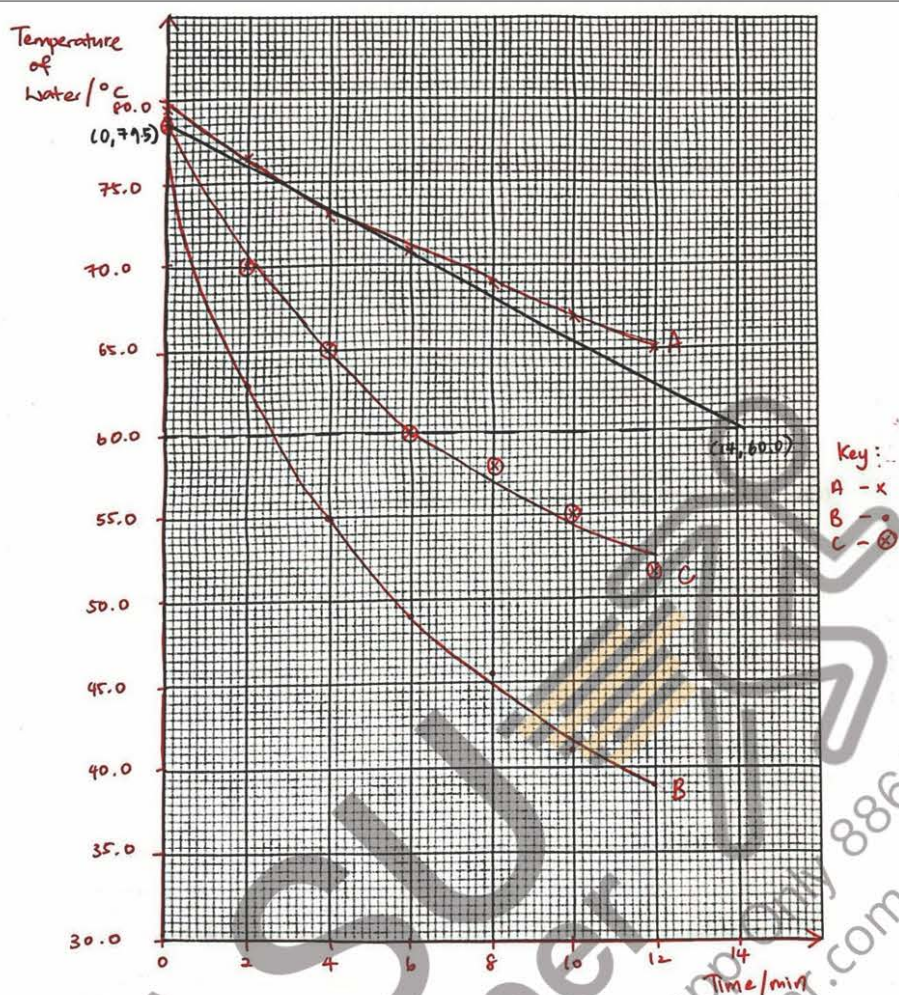
– End of Paper –



SECONDARY 4 PRELIMS 2025

BIOLOGY 6093/03

Qn	Marking points	Marks																																			
1(a)	1 column for time/min + time from 0 min to 12 min; (R: no reading for 0 min)	[1]																																			
	1 column for temperature of boiling tube A/ C + temperatures lower for each successive reading ;	[1]																																			
	1 column for temperature of boiling tube B/ C + temperatures lower for each successive reading ;	[1]																																			
	1 column for temperature of boiling tube C/ C + temperatures lower for each successive reading ;	[1]																																			
	Trend: temperature drop overall wet tissues (B) > without insulation (C) > with insulation (A) + each temperature recorded as xx.0 or xx.5 ;	[1]																																			
	Starting temperature of boiling tubes should be similar (within 2.5 C) and around (60-75 C) ;	[1]																																			
<u>Sample table</u>																																					
<table><tr><th rowspan="2">Time/min</th><th colspan="3">Temperature of water in the boiling tube/ C</th></tr><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>0</td><td></td><td></td><td></td></tr><tr><td>2</td><td></td><td></td><td></td></tr><tr><td>4</td><td></td><td></td><td></td></tr><tr><td>6</td><td></td><td></td><td></td></tr><tr><td>8</td><td></td><td></td><td></td></tr><tr><td>10</td><td></td><td></td><td></td></tr><tr><td>12</td><td></td><td></td><td></td></tr></table>			Time/min	Temperature of water in the boiling tube/ C			A	B	C	0				2				4				6				8				10				12			
Time/min	Temperature of water in the boiling tube/ C																																				
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<u>Sample answer</u>																																					
<table><tr><th rowspan="2">Time/min</th><th colspan="3">Temperature of water in the boiling tube/ C</th></tr><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>0</td><td>79.5</td><td>79.0</td><td>78.5</td></tr><tr><td>2</td><td>76.5</td><td>63.0</td><td>70.0</td></tr><tr><td>4</td><td>73.0</td><td>55.0</td><td>65.0</td></tr><tr><td>6</td><td>71.0</td><td>49.0</td><td>60.0</td></tr><tr><td>8</td><td>69.0</td><td>45.5</td><td>58.0</td></tr><tr><td>10</td><td>67.0</td><td>41.0</td><td>55.0</td></tr><tr><td>12</td><td>65.0</td><td>39.0</td><td>51.0</td></tr></table>			Time/min	Temperature of water in the boiling tube/ C			A	B	C	0	79.5	79.0	78.5	2	76.5	63.0	70.0	4	73.0	55.0	65.0	6	71.0	49.0	60.0	8	69.0	45.5	58.0	10	67.0	41.0	55.0	12	65.0	39.0	51.0
Time/min	Temperature of water in the boiling tube/ C																																				
	A	B	C																																		
0	79.5	79.0	78.5																																		
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8	69.0	45.5	58.0																																		
10	67.0	41.0	55.0																																		
12	65.0	39.0	51.0																																		
1(b)																																					



[1]

[1]

[1]

[3 – 1m for each curve]

Axes correctly orientated Temperature of water (°C) on Y-axis, time (min) on X-axis + fully labelled;
 Scales to fill at least half printed grid and linear;
 Plots clear and correct;
 Best fit curves cleanly drawn through most plots or plots neatly joined by ruled lines;

1(c)

Draw a tangent line at 3 min on the graph for boiling tube A;
 Workings (calculation of gradient);
 Correct final ans + units (°C/min)

$$\text{E.g. Rate of temperature loss at 3 min} = (79.5 - 60.0) / (14 - 0) \\ = 1.39 \text{ } ^\circ\text{C/min}$$

[1]

[1]

[1]

1(d)

Similarity:

All boiling tubes show a decrease in temperature/total heat loss increases + with time AW

[1]

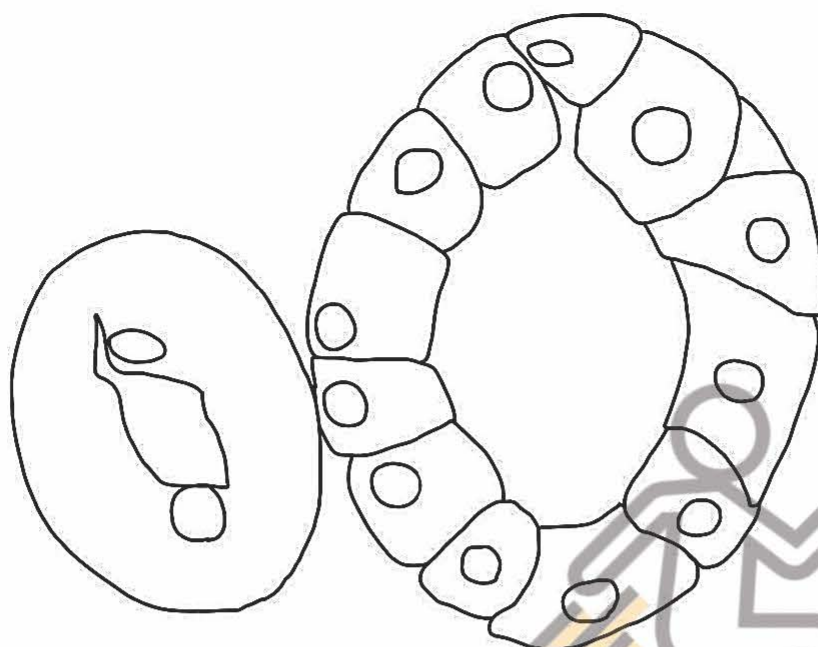
All boiling tubes show a faster decrease in temperature at the start / slower decrease in temperature at the end

[1]

	Difference: <table> <tr> <th>Boiling tube A</th><th>Boiling tube B</th><th>Boiling tube C</th></tr> <tr> <td>Rate of temperature/heat loss decrease is slowest.</td><td>Rate of temperature/heat loss decrease is fastest</td><td>Rate of temperature/heat loss decreases faster than A/slower than B</td></tr> <tr> <td>Overall least heat loss / smallest temperature decrease</td><td>Overall greatest heat loss / most temperature decrease</td><td>Overall heat loss between boiling tube A and B</td></tr> </table> Any 2 points at least 1 similarity and 1 difference Ecf given based on results from (a)	Boiling tube A	Boiling tube B	Boiling tube C	Rate of temperature/heat loss decrease is slowest.	Rate of temperature/heat loss decrease is fastest	Rate of temperature/heat loss decreases faster than A/slower than B	Overall least heat loss / smallest temperature decrease	Overall greatest heat loss / most temperature decrease	Overall heat loss between boiling tube A and B	[1] [1]
Boiling tube A	Boiling tube B	Boiling tube C									
Rate of temperature/heat loss decrease is slowest.	Rate of temperature/heat loss decrease is fastest	Rate of temperature/heat loss decreases faster than A/slower than B									
Overall least heat loss / smallest temperature decrease	Overall greatest heat loss / most temperature decrease	Overall heat loss between boiling tube A and B									
1(e)	Sweating	[1]									
1(f)	Imp – repeat/replicate (at least 2 times more); Exp – identify error/anomaly or calculate mean/average / improve reliability of results; (R: improve accuracy) Imp – use hotter water at the start; Exp – greater difference in temperature of water and room/heat loss more pronounced; Imp – water at same temperature in all tubes at the start; Exp – same amount of heat available to be lost; Imp – use datalogger with 3 temperature probes/sensors attached to take temperature of the water Exp – temperature of water in tube B and C will be slightly lower than actual as there is a lag time while taking measurements / allows temperature of water in the 3 boiling tubes to taken simultaneously (R: conduct experiment separately, use three different stopwatches, have three different people pour water into the boiling tubes at the same time → does not eliminate the lack of accuracy of data collection) Imp – similar external conditions for all tubes/same room temperature/use screen/prevent draughts; (A: turn off fans/ lid/rubber bung on the test-tubes) Exp – prevent (variable) external conditions influencing the rate of heat loss /AW; - Examples: ○ Imp – turn off fans in the lab ○ Exp – evaporation of water on the tissue around boiling tube B will cause rate of heat loss to be	[2]									

	<u>faster than actual</u> in the presence of wind ○ Imp – cover the boiling tubes with a lid/rubber bung ○ Exp – evaporation of water causes <u>rate of heat loss to be faster than actual</u> (R: use a fixed volume of water in each boiling tube) [Any 2 pairs of answers for 2 marks]	
1(g)	<u>independent variable</u> <u>Temperature of water bath</u> in the 500cm³ beaker [stated explicitly] <u>range of at least five external temperatures eg 10, 20, 30, 40, 50 °C (some values must be above and some below 38 °C) + controlled using thermostatically controlled water bath / temp controlled by added hot or cold water; [stated implicitly in the procedure]</u> (R: placing an actual humpback whale into a pool of water) <u>dependent variable</u> <u>Temperature of water in boiling tubes</u> [stated explicitly] <u>Measure/Record the temperature of the water in the boiling tubes in 2 minute intervals for 12 minutes</u> [stated implicitly in procedure] <u>variables kept constant (any 2)</u> Same start temperature of boiling tube water; Same volume of water in each boiling tube + either draw line / fixed volume; (R: ridiculous volumes for boiling tube e.g. too low - 5cm³, too high - 50cm³) Same volume of water in the water bath beakers <u>method</u> 1. <u>Prepare 5 water baths of temperature 10, 20, 30, 40, 50 °C</u> 2. Prepare 5 test-tubes of water with a line drawn 5 cm below the top of each test-tube (A: same volume of water in test-tube) 3. Place one test-tube into every water bath.	2m for stated variables; [2m for all variables clearly identified, 1m for only 2 out of 3 variables identified, 0m for all others] 3m for method [1m is allocated for 5 or more replicates, 1m is

	4. Add 38°C water to each of the test-tube to the lines marked. 5. Start the stopwatch and immediately measure the temperature of the water in each test-tube. 6. Measure and record the temperature of water in each test-tube every 2 min for 12 min. 7. Repeat step 1 to 6 twice to obtain average temperature of water in each test-tube 8. Plot a graph of temperature of water in each test-tube against time. 9. Compare the heat loss for each external temperature. The decrease in temperature shows the greatest effect of surrounding water temperature on the whale's body temperature. [students are allowed to cite steps in the given procedure that are similar to decrease the burden of writing]	allocated for a feasible procedure + 38°C starting temp. of water in boiling tube, 1m allocated for data collection and analysis of data / possible trend]
2(a)	20.7 ; (R: if missing 1 dp)	[1]
2(b)	H	[1]
2(c)	Circle petri dish 2 + antibiotic F / 6 mm measurement;	[1]
	Exclude it from the mean / repeat experiment;	[1]
2(d)	When <u>water molecules enters</u> the cell + <u>osmosis</u> ;	[1]
	Cell <u>expands/swells and burst/dies</u>	[1]
2(e)	Human cells have <u>no cell wall</u>	[1]
3(a)	line drawn + correct measurement 31–33 mm / 3.1-3.3 cm + units;	[1]
3(b)	candidate answer + 0.06 (mm);	[1]
	correct magnification + whole number only;	[1]
3(c)		



[1]

[1]

[1]

[1]

[1]

(a) sharp pencil + continuous outer lines + no shading + most of given space used;

(b) shape of both oval / taller than wide + loop of Henle smaller than collecting duct + size of drawing ;

(c) only collecting duct and loop of Henle drawn touching + delimited + correct orientation;

(d) 2 nuclei in loop of Henle + 11 / 12 nuclei in collecting duct, separated in different cells;

(e) Labelling of any one nucleus and cell membrane (A: cytoplasm)





Paya Lebar Methodist Girls' School (Secondary)
Preliminary Examination 2025
Secondary 4 Express / G3

CANDIDATE
NAME

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CLASS

4	.	
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INDEX NUMBER

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BIOLOGY

6093/03

Paper 3 Practical Test

18 August 2025

1 hour 50 minutes

READ THESE INSTRUCTIONS FIRST

Write your name and index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, 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 are given in brackets [] at the end of each question or part question.

⚠ WARNING ⚠

PLMGS(Sec) operates a zero tolerance policy in relation to Cheating in Graded Assessments

This is a graded assessment. No part of this assessment should be leaked to students who have yet to sit for the assessment.

Any student who gives information or attempts to obtain unfair assistance to questions in a graded assessment is considered to be cheating or is attempting to cheat.

She will face serious consequences.

For Examiner's Use

1	
2	
Total	40

This document consists of **13** printed pages.

You are advised to read the whole question before you start.

- 1** Amylase is an enzyme that catalyses the breakdown of starch into reducing sugars.

Amylase is produced by seeds during germination.

You are provided with extract **U**, which is made from germinating seeds.

You are going to estimate the concentration of amylase in seed extract **U** by comparing it to known concentrations of amylase.

Read all the instructions but DO NOT CARRY THEM OUT until you have drawn a table for your results in the space provided in 1(a)(ii).

You should use the eye protection provided while you are carrying out the practical work.

Step 1 Label four small containers, **A**, **B**, **C** and **D**.

Step 2 Use a syringe to add the volumes of **2% amylase** and **distilled water** shown in Table 1.1 to each labelled container.

Table 1.1

container	volume of 2% amylase solution / cm ³	volume of distilled water / cm ³	final percentage of concentration of amylase solution
A	10.0	0.0	2.0
B	7.5	2.5	1.5
C	5.0	5.0	1.0
D	2.5	7.5	

- (a) (i)** Complete Table 1.1. by determining the final percentage concentration of amylase solution for container **D**.

..... % [1]

- Step 3 Label five test-tubes **A**, **B**, **C**, **D** and **U**.
- Step 4 Use a syringe to add 3cm³ of **starch** suspension to each labelled test-tubes.
- Step 5 Prepare two white tile by using a dropper to put drops of iodine solution in five columns labelled **A**, **B**, **C**, **D** and **U**, as shown in Fig. 1.1. There should be 8 drops of iodine solution in each column.

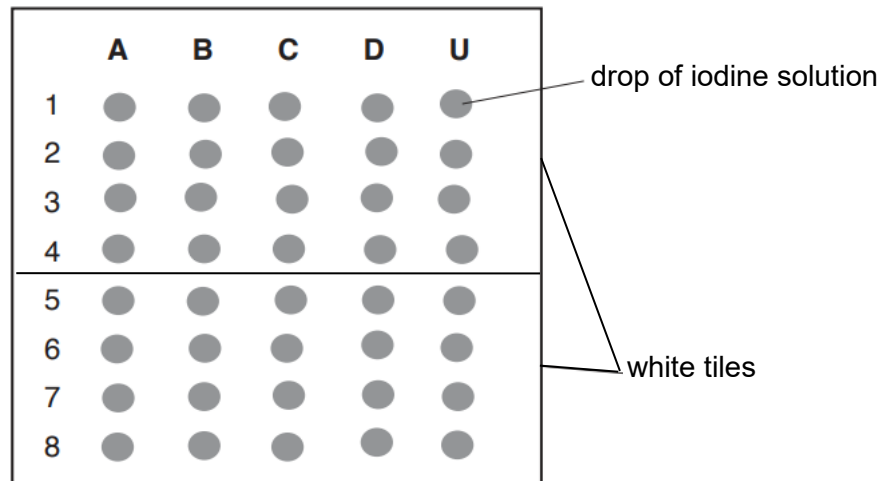


Fig. 1.1

- Step 6 Use a clean syringe to add 1cm³ of amylase solution from container **A** to test-tube **A** and shake gently to mix.
- Step 7 Clean the syringe using water in the beaker labelled '**for washing**'. Repeat step 6 using containers **B**, **C**, **D** and **U** and test-tubes **B**, **C**, **D** and **U**.
- Step 8 Start the stopwatch.
- Step 9 After **two** minutes use a clean dropper to remove one drop of solution from test-tube **A** and add it to the first drop of iodine solution, **A1**, on white tile. Observe any colour change.
- Step 10 Repeat step 9 using:
- the contents of test-tube **B** and iodine solution drop **B1**
 - the contents of test-tube **C** and iodine solution drop **C1**
 - the contents of test-tube **D** and iodine solution drop **D1**
 - the contents of test-tube **U** and iodine solution drop **U1**
- Step 11 After **one** minute, repeat step 9 and 10 using iodine solution drop **A2**, **B2**, **C2**, **D2** and **U2**.

[Turn over

Step 12 Continue to test the contents of the test-tubes at one-minute intervals until a drop of the mixtures in the test-tubes have been added to all eight rows of iodine solution drops on the white tile.

Step 13 Observe the colour of each drop of iodine solution on the white tile and determine the time at which the starch in each test-tube was broken down.

In your table in **1(a)(ii)**, record the time taken for the starch to be broken down.

If starch was still present in row **8** record the time taken as **>8**.

(ii) Prepare a table to record your results.

[4]

(iii) Explain how you decided when all of the starch had been broken down in step 13.

.....

..... [1]

- (iv) Estimate the concentration of amylase in seed extract **U** using your results in **1(a)(ii)**.

State the evidence that support your choice.

estimated amylase concentration of **U**

evidence

..... [1]

- (v) Describe how you would test for the presence of reducing sugars.

State the results for a positive test.

procedure

.....

.....

.....

positive test result

..... [3]

[Turn over

- (b)** Seeds contain starch as a store of energy. Amylase in the seeds catalyses the breakdown of the stored starch into reducing sugars. Seeds use the reducing sugars to provide some of the energy required for germination.

By grinding the seeds to obtain seed extract, plan an investigation to find out how temperature affects the activity of amylase in germinating seeds.

[6]

- (c) A scientist investigated how the activity of amylase in a seed changed as it germinated.

She measured the activity of amylase in a germinating seed over a period of 18 days.

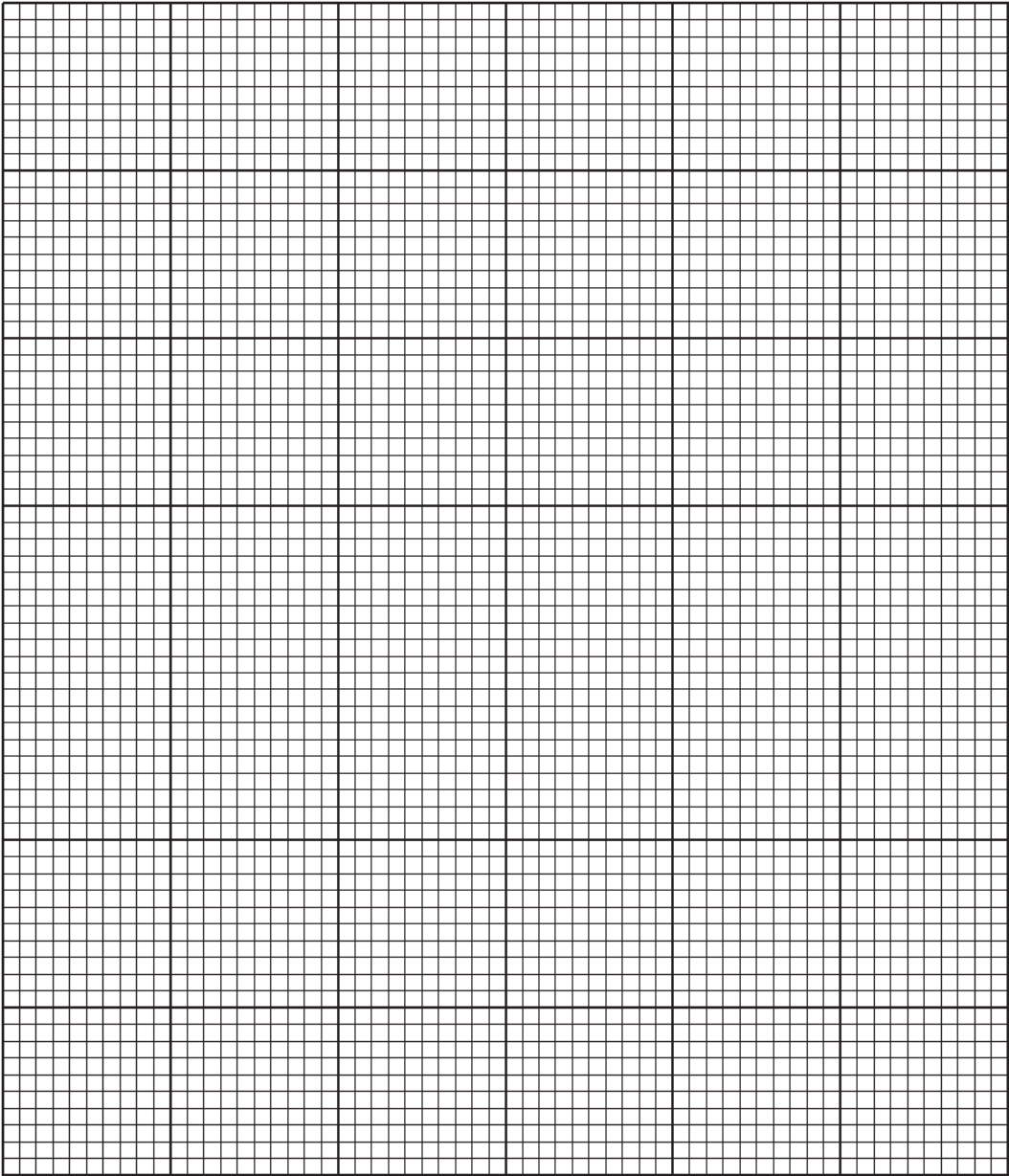
The results are shown in Table 1.2.

Table 1.2

time / days	activity of amylase / arbitrary units
0	0
3	0
6	40
9	240
12	240
15	120
18	65

[Turn over

- (i) Plot a line graph of the data in Table 1.2.



[4]

- (ii) With reference to Table 1.2, describe the results as shown in your graph.

.....

.....

.....

..... [2]

- (d) (i) The data in Table 1.2 did not enable the scientist to determine precisely when the amylase was most active.

Explain why.

.....

..... [1]

- (ii) Suggest what further data is needed to be able to determine exactly when amylase was most active.

.....

..... [1]

[Turn over

- (e) Fig. 1.2 shows a photograph of two winged seeds from a plant.

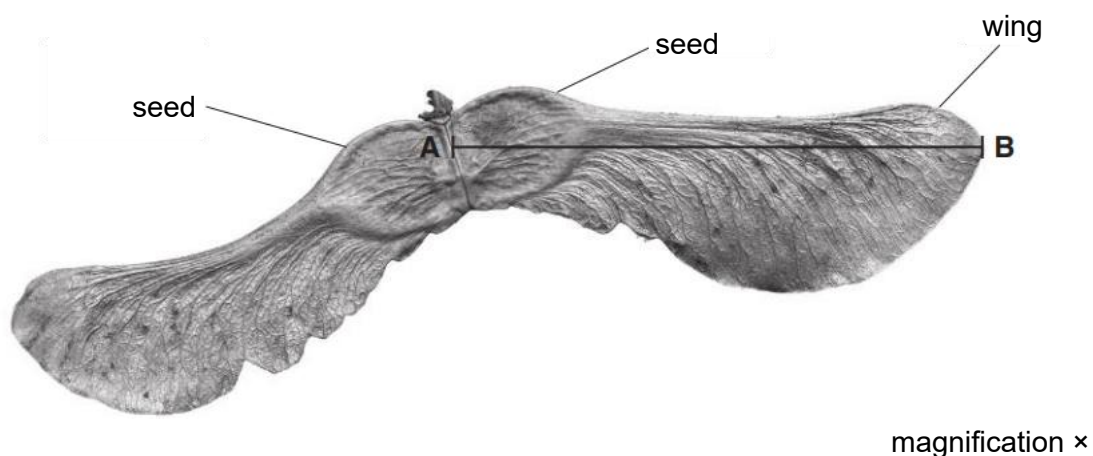


Fig. 1.2

- (i) Make a large drawing of the two winged seeds shown in Fig. 1.2.

Do not label your drawing.

[4]

- (ii) Measure the length of line **AB** on the winged seeds on Fig. 1.2.

length of line **AB**mm

- (iii) Use the magnification shown in Fig. 1.2 to calculate the actual seed length to two significant figures.

Show your working.

[2]

[Total: 30 marks]

- 2 (a) Warm blooded animals need to maintain a constant internal body temperature.

You are going to investigate heat loss from the outer surface of the bodies of two animals.

You are provided with a large test-tube and a small test-tube to represent the two animals.

The large test-tube has a lower surface area to volume ratio.

The small test-tube has a higher surface area to volume ratio.

- Step 1 Place the two test-tubes in a rack.
- Step 2 Raise your hand to ask for hot water.
- Step 3 Use a dropper to fill the large test-tube with hot water to 5cm from the top. Fill the small test-tube to the same depth as the large test-tube.

Caution: the test-tubes will be hot.

- Step 4 Immediately measure the temperature of the water in each test-tube and record your measurements in Table 2.1.

After 2 minutes, measure the temperature of the water in each test-tube again and record your measurements in Table 2.1.

Measure the temperature of the water in each test-tube every 2 minutes for 10 minutes and record your measurements in Table 2.1.

[Turn over

- (a) Record your results in Table 2.1.

Table 2.1

time / minutes	temperature / °C	
	large test-tube	small test-tube
0		
2		
4		
6		
8		
10		

[2]

- (b) (i) Suggest and explain two ways to improve this method to make the results more reliable.

improvement 1

.....

explanation

.....

improvement 2

.....

explanation

..... [4]

- (ii) With reference to Table 2.1, describe what you can conclude about heat loss in large and small animals.

.....

.....

..... [1]

- (c) Penguins are animals that need to maintain a constant body temperature. They can be found living in cold climates near the South Pole as well as in the warmer climate of New Zealand.

With reference to Table 2.1, suggest and explain

- (i) the difference in the size of the penguins found in these two areas;

size

.....

explanation

.....

..... [2]

- (ii) why penguins stand very close together in groups when external temperatures are very low.

.....

.....

..... [1]

[Total: 10 marks]

End of Paper





Secondary 4 Preliminary Exam Paper 3_2025

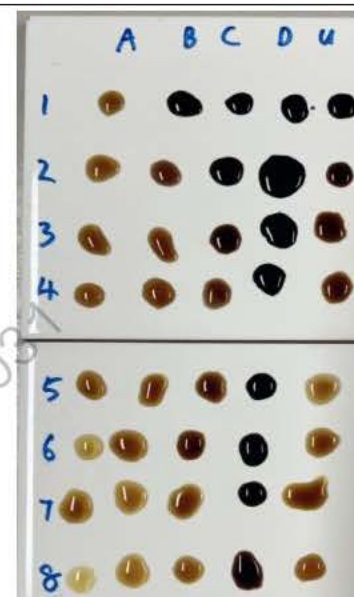
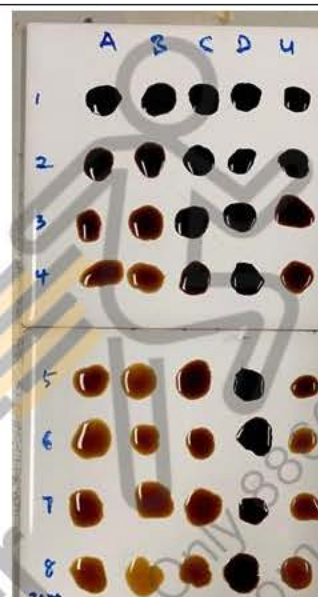
Biology 6093/ P3

Mark Scheme

Question		Answer	Mark	Remarks
1(a)	(i)	0.5(%) Award 1: if 0.5 is writing in the working space but not in the table.	1	
1(a)	(ii)	1. suitable table with minimum two columns ; 2. suitable headings; Column 1: container / test-tube / beaker / final percentage concentration of amylase Reject: mixture / set-up / solution / column / sample Column 2: time taken for starch to be broken down / min Reject: m / s or seconds 3. five results recorded + in whole number; Reject: results recorded in decimal 4. trend: A takes shortest time + D takes longest time;	4	e.g. container / test tube or percentage concentration amylase AND time / minutes;

Sample of results:

container	final percentage of concentration of amylase solution	time taken for starch to be broken down / min
A	2.0	3
B	1.5	5
C	1.0	6
D	0.5	> 8
U	1.5	5



1(a)	(iii)	Iodine solution / mixture remaining yellow -brown / did not change to blue black;	1	
1(a)	(iv)	Accept <u>1.5%</u> to <u>2.0%</u> + estimate matches time taken in the results; E.g.: 1.5% because the time taken is the same as B Or 1.75% because the time taken is between A and B; Reject: if unit is not written or written wrongly;	1	
1(a)	(v)	1. add 2cm ³ Benedict's reagent / solution to 2cm ³ of test sample; Accept: any equal volume of Benedict's solution and test sample; 2. place the test-tube in a <u>boiling</u> water-bath; Reject: hot water-bath 3. suitable colour change: green / yellow / orange / red / Ignore: brick-red precipitate;	3	

1(b)	1. allow time for seeds to germinate before grinding seeds to obtain seed extract; <i>independent variable:</i> 2. at least 5 different temperatures + range from cold to hot with equal intervals, min. range: 20C to 70C; 3. method of maintaining a constant temperature, e.g. using a water bath with a thermometer / thermostatically controlled water-bath / adding ice or hot water to obtain desired temperature / Ignore: using a water-bath (without mention of thermometer) <u>Method 1 (starch to disappear):</u> 4. use of iodine solution + on <u>white tile</u> + using a dropper; 5. test at regular time interval + using a stopwatch; 6. record time taken for iodine solution to turn from blue black to yellowish brown; <u>Method 2 (reducing sugar to appear)</u> 7. test with Benedict's + specify equal volume of seed extract and volume of Benedict's reagent; 8. record the colour change + green: traces of reducing sugar & red precipitate: large amount of reducing sugar; OR time taken for reducing sugar to appear + using a stopwatch;	6 max 5 mark for this part if students didn't use <u>seed extract</u> in planning the procedure / adding amylase and / or starch / Common mistakes: - Many students did not understand the preamble of the question, i.e. amylase in the seeds breakdown <u>stored</u> starch; Many students wrote 'add amylase in the seed extract'. - Many students did not include instruments used in the procedure. - MP4: mark will not be awarded if iodine solution is added into the test-tube, instead of conduction iodine test by dropping seed extract on a white tile; - MP8 mark will be awarded for qualitative test (i.e. colour change of Benedict's tes) or quantitative
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	9. and 10. <i>max for two from variables kept constant;;</i> age / type / species, of seed time for incubation or germination growing conditions equilibrium time volume / mass, of extract / seeds concentration / volume of seed extract / amylase volume / concentration of Benedict's solution pH / use of buffers 11. (at least) two more repeats / three trials + (if time is recorded) calculate average time / to increase the reliability of the results; 12. Control set-up + describe how to set up a control 13. Analysis of observation + aim of experiment;	test (i.e record the time taken for reducing sugar to appear)
	1. [MP1] Allow 3 days for seeds to germinate before grinding seeds to obtain seed extract; 2. [constant variable] Using a syringe, add 3cm³ of seed extract into 5 test-tubes labelled A,B,C, D and E. 3. [constant variable & MP4, iodine test] Prepare a white tile by using a dropper to put 3 drops of iodine solution in five columns. There should be 8 drops of iodine solution in each column. 4. [MP2] Prepare a water-bath of 5 different temperatures, 0 C,20 C,40 C,60 C and 80 C.	MP2: • using a water bath with a thermometer • thermostatically controlled water-bath • adding ice or hot water to obtain desired temperature • using a water-bath (without mention of thermometer)

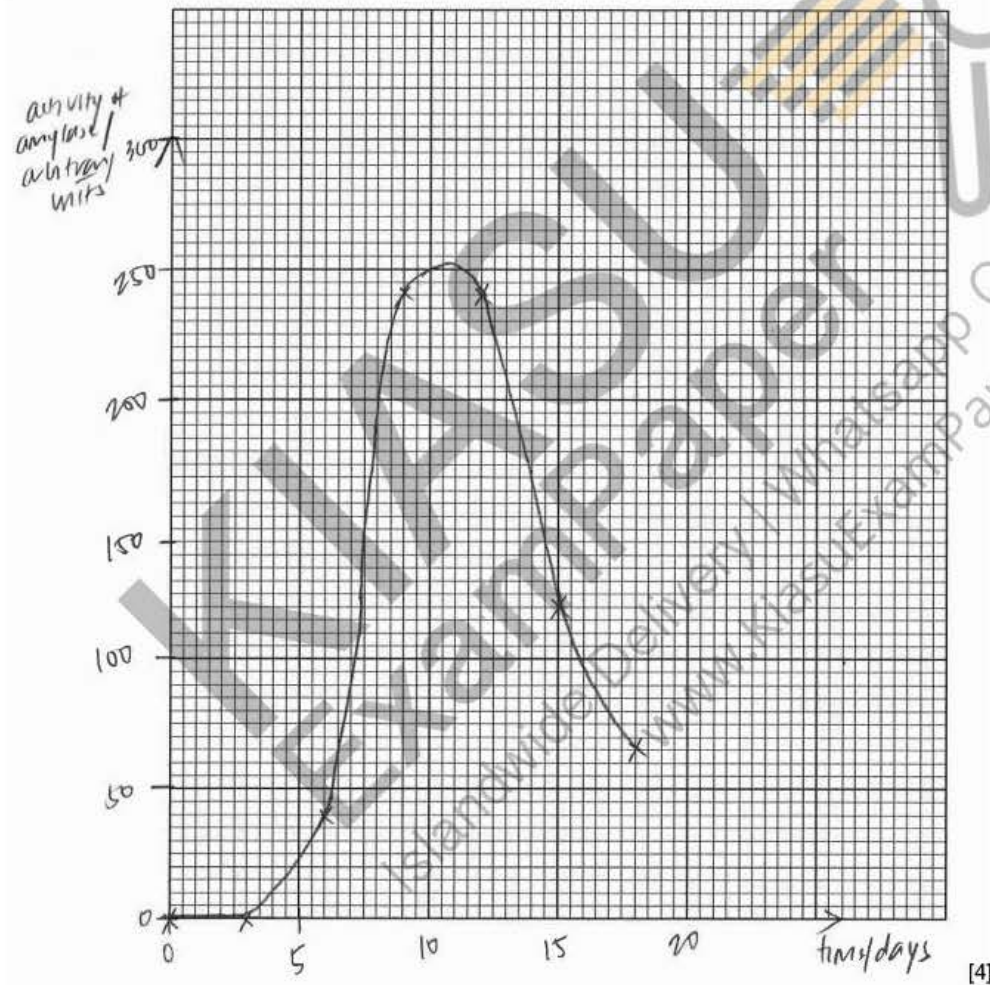
	5. [MP3] Place a thermometer in each water-bath, add cold water/ ice or hot water to maintain the temperature. 6. Place test-tube A in OC water-bath and start the stopwatch immediately. 7. [constant variable: incubation time & MP5] After 2 minutes, use a clean dropper to remove one drop of solution / seed extract from test-tube A and add it to the first drop of iodine solution, A1, on white tile. 8. Observe the colour change. 9. [MP5] Continue to test the contents of the test-tubes at one-minute intervals until a drop of the mixtures in test-tube A have been added to all eight rows of iodine solution drops on white tile. 10. Observe the colour change. 11. [MP6] Record the time taken for iodine solution to turn from blue-black to yellowish brown. 12. Repeat steps 5 to 9 with test-tubes B in 20C water-bath, C in 40C water-bath, D in 60C water-bath and E in 80C water-bath. 13. [MP11] Repeat the experiment twice + calculate the average time taken for starch to be broken down, average time = total time for 3 experiments / 3; Accept: repeat the experiment to increase the reliability of the results 14. [MP12] To prepare a control set-up, labelled 5 test-tubes A1, B1, C1, D1 and E1. Using a syringe, add 3cm³ of distilled water in each test-tube. 15. [MP13] The shorter the time taken for starch to be broken down, the higher the activity of amylase in germinating seeds.	Award MP6 only answer clear describe 'observe the colour change of iodine solution from blue-black to yellowish brown' MP6 will not be awarded for simply stating 'observe the colour change'
	1. [MP1] Allow 3 days for seeds to germinate before grinding seeds to obtain seed extract;	

2. [constant variable] Using a syringe, add 3cm³ of seed extract into 5 test-tubes labelled A,B,C, D and E. 3. [MP2] Prepare a water-bath of 5 different temperatures, 0 C,20 C,40 C,60 C and 80 C. 4. [MP3] Place a thermometer in each water-bath, add cold water/ ice or hot water to maintain the temperature. 5. Place test-tube A in OC water-bath and start the stopwatch immediately. 6. [constant variable: incubation time] After 2 minutes, remove test-tube A from OC water bath. 7. [MP7, Benedict's test] Using a syringe, add 3cm³ of Benedict's solution into test-tube A. Place the test-tube into a boiling water-bath. 8. [MP8, Benedict's test] Using a stopwatch, measure and record the time taken for the colour change of Benedict's solution from blue to green/ orange or red; 9. Repeat steps 5 to 9 with test-tubes B in 20C water-bath, C in 40C water-bath, D in 60C water-bath and E in 80C water-bath. 10. [MP11] Repeat the experiment twice + calculate the average time taken for reducing sugar to appear , average time = total time for 3 experiments / 3; Accept: repeat the experiment to increase the reliability of the results; 11. [MP12] To prepare a control set-up, labelled 5 test-tubes A1, B1, C1, D1 and E1. Add 3cm³ of distilled water in each test-tube, instead of 3cm of seed extract; 12. [MP13] The shorter time taken for reducing sugar to appear, the higher the activity amylase in germinating seeds.	Award MP8 ref colour change of Benedict's solution to amount of reducing sugar, e.g. green: traces of reducing sugar, red: large amount of reducing sugar
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1(e)	(i)	A: axes labelled and units; S: even scale to fill more than half of printed grid + (y-axis) > 240 au; P: plot all four points correctly; L: line of best fit / trend line;	4	
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Sample:



1(c)	(ii)	Any 2 from: - from day 0 to day 9, the activity of amylase increases from 0a.u. to 240a.u. OR day 0 to day 3, the activity of amylase is 0a.u; - between days 9 and 12 + correct data value of candidates line of best fit; - from day 12 to day 18, the activity of amylases decreases from 240 a.u to 65a.u.	max: 2	Max 1 mark awarded: - Range of days quoted correctly (i.e. day 0 to day 9 + day 12 to day 18) but data for activity of amylase not quoted / incorrect unit; E.g. from day 0 to day 9, the activity of amylases increases + from day 12 to day 18, the activity of amylases decreases; - Range of days / data for activity of amylase quoted incorrectly, e.g. using symbol '·' Eg. from days 0-3, there is no amylases activity; - Incomplete range of days quoted; E.g. from day 12 onwards / beyond day 12, activity of amylases decreases from 240a.u. to 65a.u; 0 mark awarded:
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				1. Range of days AND data for activity of amylases not quoted / quoted wrongly; E.g. from day 0 to day 3, activity of amylase remains constant. From day 3 to day 12, activity of amylase increases. From day 12 to day 15, activity of amylase decreases;
1(d)	(i)	No highest / maximum / peak activity of amylase measured and recorded; Accept: data when the amylase is most active is missing [or] values at <u>day 9 and day 12</u> are the same + <u>240 a.u.</u>; Ignore: there are 2 days (without specifying which day) where the activity of amylase is the same [or] the scientist only measured and recorded the enzyme activity <u>every 3 days</u>; Accept: the intervals between the measurements of activity of amylase were recorded / between the days were too large; [or] there are no measurements / readings of activity of amylases every day / between day 9 and day 12; Ignore: the scientist missed days between 9 and 12 (without clear ref. To measurements / reading of activity of amylase);	1	Ignore: the greatest value should be between day 9 and day 12 Note: the answer did not make clear reference to the data in Table 1.2. The question did not required student to 'guess' which day was when enzyme was the most active

1(d)	(ii)	<u>measure</u> and <u>record</u> the activity of amylase <u>every day / daily</u> / using a smaller / narrower intervals (instead of every 3 days); Accept: read + how data is read Accept: <u>measure</u> and record on day 10 and day 11;	1	Ignore: take / find out / record / collect (without measuring) the activity of amylase
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1(e)	(i)	1. outline: smooth and continuous line, no shading; 2. size: $\geq 130\text{mm}$ wide + correct proportion by vision; 3. detail 1: two seeds drawn with dividing line and appropriate shape 4. detail 2: at least 2 notches drawn on lower left wing edge and one or two notches on the right;	4	
Sample: (i) Make a large drawing of the two winged seeds shown in Fig. 1.2. Do not label your drawing. 				
1(e)	(ii)	1. length of line AB: 70 ± 1 (mm); 2. actual length: 18 mm; (in 2 significant figure)	2	MP1: correct measurement MP2: correct calculation – allow ecf
[Total: 30 marks]				

2(a)	1. 6 sets temperature recorded for large test-tube and small test-tube, one in each box of table + temperature recorded in 0.0 or 0.5 2. decrease in temperature in both test-tubes + smaller test-tube has larger change than large test-tube;	2	
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Sample:

time / minutes	temperature / °C	
	large test-tube	small test-tube
0	68.0	67.0
2	61.0	57.0
4	58.0	54.0
6	55.0	50.0
8	52.0	47.0
10	50.0	45.0

2(b)	(ii)	Any 2 pairs from: <i>improvement</i>: repeat the same experiment twice / thrice; <i>explanation</i>: (to increase the <u>reliability</u> of the results) by calculating the average / mean <u>temperature</u> [or] to identify errors; Ignore: take / calculate average measurements (with no clear ref. To mean temperature) <i>improvement</i>: ensure the same initial temperature for both test-tubes; <i>explanation</i>: same amount of <u>heat available</u> to be lost; <i>improvement</i>: use two different thermometers / use digital thermometer to measure temperature / use stopwatch to time the 2-minute interval / to measure temperature / conduct the experiment 1 test-tube at a time <i>explanation</i>: (to increase the <u>reliability</u> of the results / measurements) as having 2 thermometers / 2 stopwatch <u>minimises the delay</u> in reading the measurements / temperatures recorded + <u>minimise heat loss while readings were taken</u> Accept: delay / not measuring at exact 2 minutes interval + leading to temperature recoded is lower than expected;	max: 4	Only answers with clear and detailed explanation will be awarded. Simply explaining by 'reducing heat loss' is insufficient to be awarded 1 mark for explanation. Many students make reference to accuracy of readings instead of reliability of readings. Any answer made reference to accuracy will be ignored. As the investigation focuses on the consistency of readings in minutes (i.e. reliability), not the true value of reading at a specific time (i.e accuracy);
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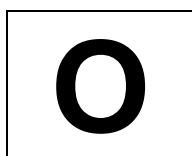
		Ignore: to increase the accuracy (without making ref. To 'delay' and 'heat loss') 7. <i>improvement</i>: similar external conditions for both test-tubes / same room temperature / use screen to cover the test-tubes; 8. <i>explanation</i>: prevent variable external conditions influencing the rate of heat loss / to prevent heat loss via opening of test-tube, through convection; Reject: using a styrofoam cup / insulate the test-tube to prevent heat loss to the surrounding Ignore: prevent evaporation of water; 9. <i>improvement</i>: use same volume of water in both test-tubes at the start / use hotter water at the start; 10. <i>explanation</i>: same amount of heat <u>available</u> to be lost (at the start) 11. <i>improvement</i>: use a measuring cylinder to add the same volume of water into each test-tube; 12. <i>Explanation</i>: to minimise heat loss as it is faster to add hot water than using a dropper; Ignore: to increase the accuracy (without making ref. To 'delay' and 'heat loss') 13. <i>improvement</i>: use hotter water at the start;		
--	--	---	--	--

		14. explanation : greater difference in temperature of water and room / heat loss more pronounced;		
2(b)	(ii)	(large animal) lesser heat loss + (small animal) higher heat loss + QF	1	
2(c)	(i)	Either 1. size: lower surface area : volume ratio animals at South Poles / cold climates 2. explanation: less heat loss / more heat retained; Or 3. size: larger animals at the South Pole / cold climate; 4. explanation: reduced rate of heat loss / less heat loss / more heat retained / lower surface area : volume ratio Accept: penguins in warmer climate / New Zealand needs to lose heat faster / to prevent overheating Note: when penguins are land in warm weather in New Zealand during summer time	max:2	
2(c)	(ii)	reduces / slows heat loss / retain more heat + reduce surface area to volume ratio; Accept: reduced exposed surface area to cold air in the surrounding	1	Only answer made clear reference to surface area to volume ratio will be awarded, as stated in the

		Or by standing close together, the penguins reduces surface area exposed to cold air + reduces surface area to volume ratio + reduces heat loss; Ignore: trap air + poor conductor of heat	question 'with reference to Table 2.1'
[Total: 10 marks]			

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**SEMBAWANG SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2025
SECONDARY FOUR EXPRESS**



CANDIDATE
NAME

CLASS

INDEX
NUMBER

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BIOLOGY

Paper 3 PRACTICAL

6093/03

06 August 2025

Paper 3

1 hour 50 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.

You may use an HB pencil for any diagrams, graphs, tables or rough working.

Write in dark blue or black pen.

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

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.

FOR EXAMINER'S USE	
Qn 1	
Qn 2	
TOTAL	40

This document consists of **12** printed pages and **2** blank pages.

1 You are advised to read the whole question before you start.

Amylase is an enzyme that catalyses the digestion of starch to maltose.

You will investigate the effect of the concentration of amylase on the time taken to completely digest starch to maltose.

- (a)** Describe and explain how reducing the concentration of amylase is expected to affect the time taken to completely digest starch to maltose.

.....

.....

.....

.....

..... [2]

You are provided with:

- 0.1% stock amylase solution **A**, in a container labelled **A**
- deionised water **W**, in a beaker labelled **W**
- starch solution **S**, in a container labelled **S**
- iodine solution in a container labelled **iodine**
- five capped 50 cm³ containers
- five test tubes
- test-tube rack
- two 10.0 cm³ syringes
- two 5.0 cm³ syringes
- five droppers
- stop-watch
- one white tile
- marker
- paper towels
- gloves
- safety goggles

Amylase solution A is an irritant and iodine solution is a stain. Suitable eye protection should be worn. If A or iodine solution comes into contact with your skin, wash it off immediately under a tap.

Part 1 Follow this procedure to prepare different concentrations of amylase solution.

You are required to prepare three dilutions of sodium chloride solution using 0.1% amylase solution, **A**, and deionised water.

The final volume of each solution that you prepare must be 20 cm³.

(b) Complete Table 1.1 to show how you will prepare the three dilutions: 0.075%, 0.05%, 0.025%. The volume of stock amylase, **A** and deionised water, **W**, in 0.0% and 10% solutions have been included in the table for your reference.

You may use the space for working.

Table 1.1

concentrate of amylase solution / %	volume of A / cm ³	volume of W / cm ³	total volume of solution / cm ³
0.100	20.0	0.0	20.0
0.075			
0.050	10.0		
0.025			
0.000	0.0	20.0	20.0

[2]

Read steps **1–12** before starting the investigation.

Proceed as follows.

Step 1 Prepare the concentrations of amylase solution as shown in Table 1.1, in the capped containers provided.

Step 2 Label test-tubes **0.100**, **0.075**, **0.050**, **0.025**, **0**. Put each labelled test-tube into the test tube rack.

- Step 3 Label the white tile as shown in Fig. 1.1. The numbers indicate the sampling times in seconds.

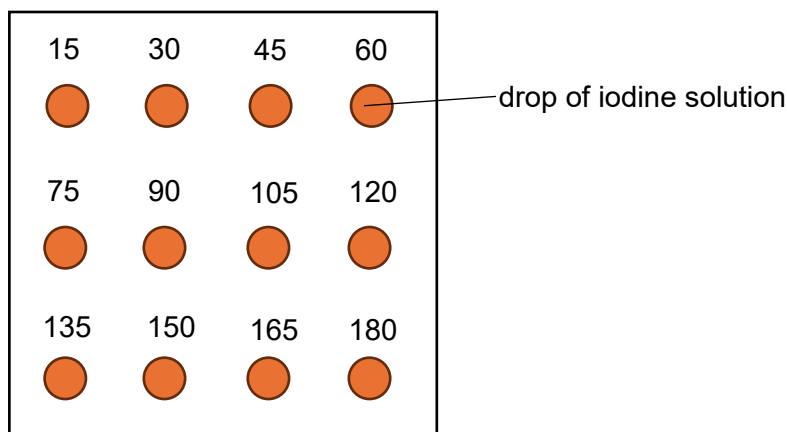


Fig. 1.1

- Step 4 Put one drop of iodine solution on the white tile under each labelled sampling time as shown in Fig. 1.1.

Part 2 Follow these steps to investigate the effect of different concentrations of amylase on time taken for starch to be digested into maltose.

Iodine solution turns from an orange brown colour to a blue-black colour when starch is present.

The course of the reaction can be monitored by sampling at intervals and using iodine solution to test for the presence of starch. The end-point is when all the starch has been digested by amylase.

At the end-point, the colour of the iodine solution may be slightly different to the colour of the original iodine solution and there may be some specks of blue black. These specks of blue black can be ignored.

- Step 5 Use a 5.0 cm³ syringe to put 5.0 cm³ of **S** into each of the labelled test-tubes.
- Step 6 Use another 5.0 cm³ syringe to put 5.0 cm³ of 0.1% amylase solution into the test-tube labelled with this concentration. Start timing immediately.
- Step 7 Use a dropper to mix the amylase solution and draw up some of the mixture.
- Step 8 After 15 seconds, and every 15 seconds from then on, drop one drop of mixture from the test-tube into the drop of iodine solution on the while tile that corresponds to the correct sampling time.
- Step 9 If the dropper runs out of mixture you may draw up more from the test-tube. Continue testing further drops of the mixture from the test-tube, as described in step 9, **until the end-point** is reached. If the end-point has **not** been reached within 180 seconds, do **not** test further samples from the test-tube.
- Step 10 Record, in **(c)**, the time taken to reach the end-point. If the end-point has **not** been reached after 180 seconds, record the result as 'more than 180'.

- Step 11 Rinse the white tile with running water from a tap and wipe dry with a paper towel. If the labels are no longer visible, you will need to label the white tile again, as shown in Fig 1.1.
- Step 12 Prepare the tile with fresh supply of iodine by repeating step 4.
- Step 13 Repeat steps **6–11** with each of the other concentrations of amylase that you prepared in step **1**. Ensure that you wash the syringe used in step **6** before every transfer.

(c) Present all of your results in a table in the space provided.

[4]

- (d)** Suggest why washing the syringe in step 6 is mandatory but would not be necessary if the experiment were to be carried out with increasing concentration of amylase solution (i.e from 0.0% to 0.100%)

.....

.....

.....

.....

..... [2]

- (e) Suggest one limitation in accurately measuring the time to the end-point.
Suggest an improvement to the method that will increase the accuracy of the measuring the time to the end-point.

limitation

.....

improvement

.....

..... [2]

- (f) Identify **two** possible significant sources of error in the procedure that you have followed.
Describe how you would minimise each source of error that you have identified.

source of error	how you would minimise the source of error
.....	
.....	
.....	
.....	
.....	
.....	
.....	

[4]

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- (g) A teacher suggested that more accurate results can be obtained by adding amylase directly into a mixture of starch and very diluted iodine shown in Fig 1.2.

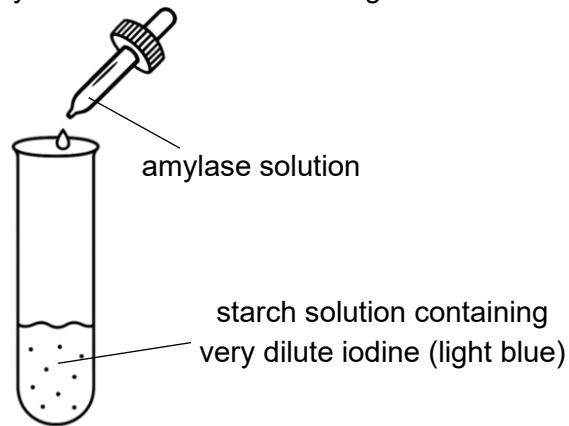


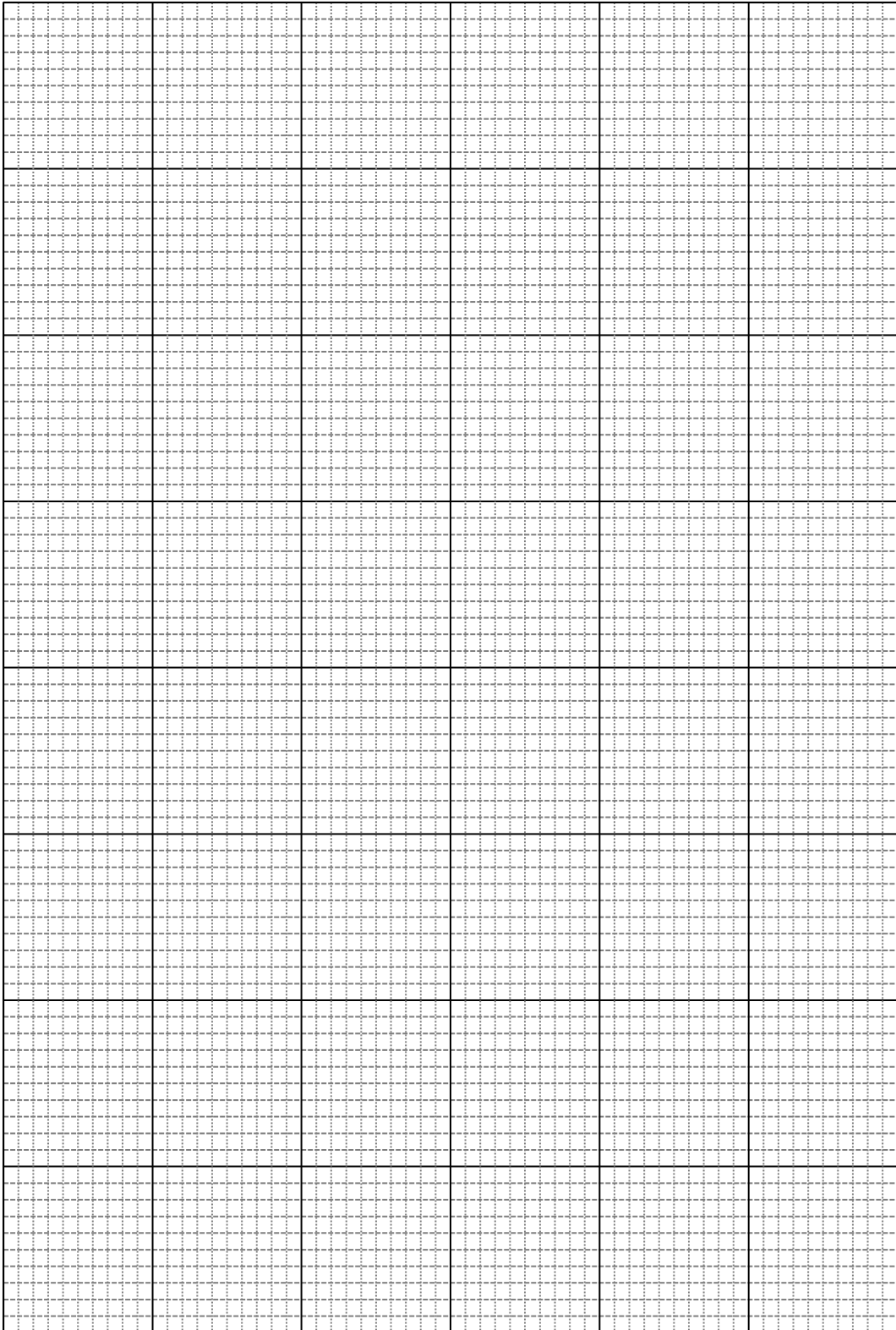
Fig. 1.2

A student performed the experiment using various concentration of amylase solution and measured the time it takes for the mixture to become colourless. The result is shown in Table 1.2.

Table 1.2

concentration of amylase / %	time taken for mixture to turn colourless / s
0.10	30
0.08	45
0.06	65
0.04	95
0.02	150

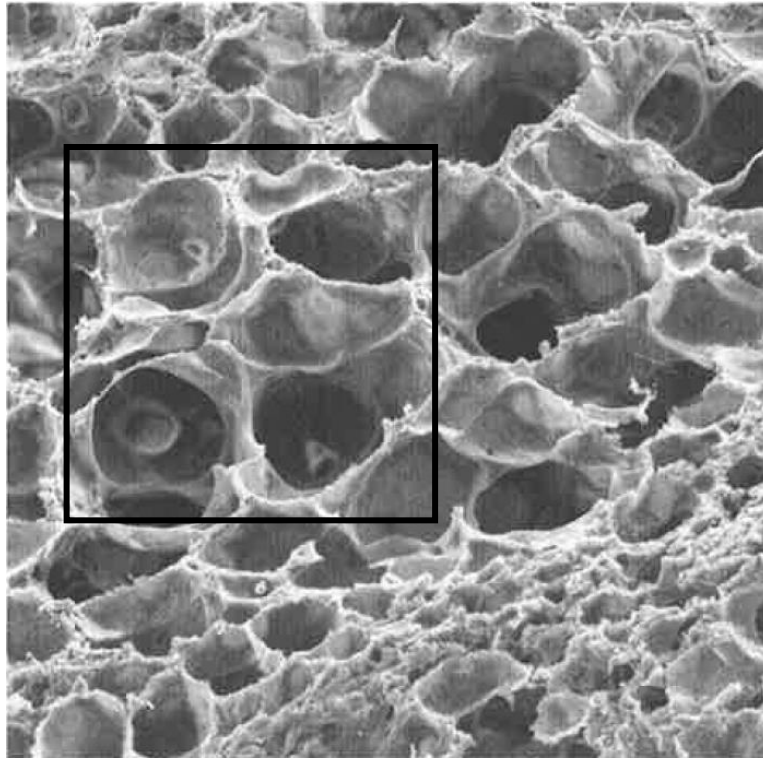
Using the grid, plot a graph to show the effect of different concentration of amylase solution on the time taken for mixture to turn colourless.



[4]

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- 2 Fig 2.1 is a pictogram of the alveoli in the lungs of a person who has never smoked.



magnification: $\times 300$

Fig. 2.1

- (a) Make a large drawing of the five alveoli in the square. Label one bronchiole.

- (b) Using **only** the information visible in Fig 2.1, explain how **two** structural features of alveoli are adapted for gas exchange.

.....

.....

.....

.....

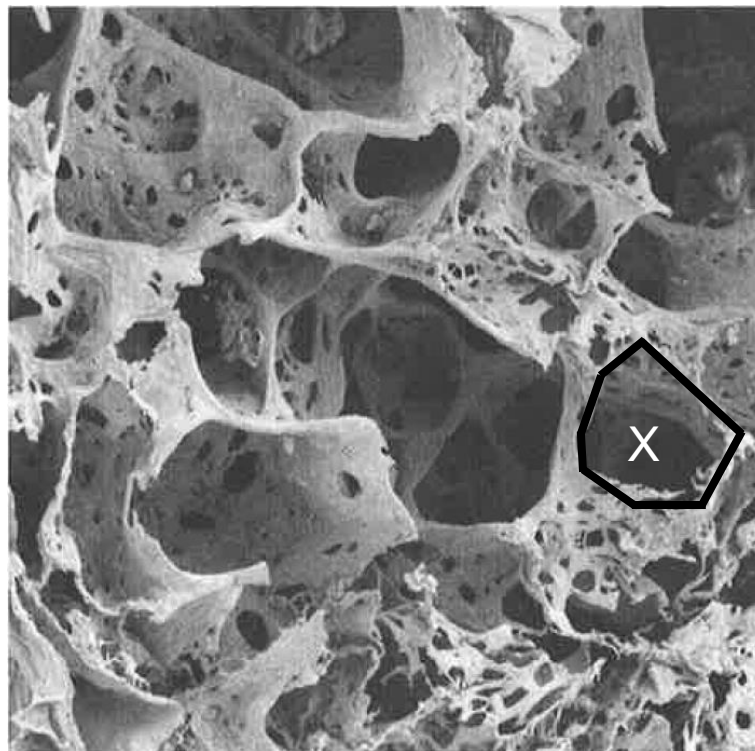
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.....

.....

..... [4]

- (c) Fig. 2.2 is a photomicrograph of a damaged alveoli in the lungs of a long-term smoker.



magnification: $\times 300$

Fig. 2.2

- (i) Using the outline on Fig 2.2, measure the circumference of alveolus **X** in Fig. 2.2.

circumference of **X**: mm [1]

- (ii) Suggest how accuracy of the measurement can be improved.

.....
 [1]

- (iii) The magnification of Fig. 2.2 is $\times 300$, find the actual circumference of alveolus **X**.

Show your working and give your answer in micrometre (μm) to one decimal place.
 $1 \mu\text{m} = 0.001 \text{ mm}$.

actual circumference of **X**: μm [2]

- (d) Compare Fig. 3.2 with Fig. 3.1. State **two** visible changes in the alveoli of a long-term smoker.

.....

 [2]

[Total: 14]

End of Paper





Paper 3

- 1 (a) ACE**
Time taken to digest starch to maltose will be longer [1]. Lower concentration means lesser active sites [1] for starch to bind to form enzyme-substrate complex.
- (b) PDO**
All volume of A and total volume calculated correctly [1]
All volume of VV calculated correctly [1]
[if dp is incorrect here do not give the dp mark in (c)]
- (c) PDO**
Appropriate headers and unit [1]
Concentration and time in appropriate dp [1 also covers this in (b) so as not to double penalise]
MNO
All 5 concentrations recorded with increasing time [1]
Time taken for 0.1, 0.0075 and 0.0650 ± 15 of supervisor result, 0% must be more than 180 second [1]
- (d) ACE**
Higher concentration of solution would easily **add more enzyme** OR **[contaminate]** to the lower concentration [1]. However, going from more diluted solution, amount of enzyme introduce will be negligible [1].
- (e) ACE**
Timing to test of complete digestion is in 15 seconds interval [1]
Do more testing at shorter interval [1] such as every 10 seconds
- (f) ACE**
Volume of each drop of iodine is not constant [1], use a syringe to add iodine on the tile [1]
Some drops of iodine are more spread out than others [1], drop iodine into small well on pallet rather than a flat surface [1].
End-point is not clear [1] have a reference colour range acceptable for end point and picture reference of specks of blue black [1]
[Max 4]
- (g) PDO**
Label [1]
Scale [1]
Correct point plotted [1]
Line of best fit drawn [1]
- (h) P**
Independent variable is the pH of each mixture.
Prepare starch solution in very diluted iodine of different pH. pH of each mixture which is the independent variable should be 5.0, 6.0, 7.0, 8.0, 9.0, 10.0 and 11.0. [1]
Add acid to water to lower its pH or add hydroxide to the liquid to make it more alkaline[1].
Factors to be kept constant are surrounding temperature, concentration of amylase, volume of starch solution, concentration of amylase solution. [1]
Measure the time it takes for the mixture to become colourless [1].

	Award two marks for any two of the following: <i>data use to reach a conclusion:</i> Plot a graph of time taken for mixture to become colourless against pH [1] Turning point of the curve is the optimum pH. [1] <i>reliability:</i> Repeat it 5 more time and calculate the mean time taken. [1] [Max: 6]
2	(a) MNO Larger [1] Continuous line and no shading [1] 5 alveoli proportionately drawn [1] Bronchiole labelled [1] (b) ACE Numerous / curved [1] increase surface area for gas exchange [1] Thin wall [1] shorter distance for gas molecules to diffuse [1] (c) MNO 69 mm $\pm$ 2 mm ACE (i) use a string to trace the outline of the alveolus [1] and measure the length of the string traced (ii) (i) Answer $\div$ 300 [1] $\times$ 1000 = Answer μm [1] (d) ACE Partition walls of alveoli in smoker lungs are porous [1] Partition walls between alveoli of smoker lung has broken down [1] Less alveoli [1]

