EUNOIA JUNIOR COLLEGE
JC2 Preliminary Examinations 2024
General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME								
CIVICS GROUP	**2**	**3**	**-**			REGISTRATION NUMBER		

BIOLOGY

9744/04

Paper 4 Practical

22 August 2024

2 hours 30 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and registration number on all the work you hand in.
Give details of the practical shift and laboratory, where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use stapler, paper clips, highlighters, glue or correction fluid/tape.

Answer **all** questions in the spaces provided in the Question Paper.

The use of an approved scientific calculator is expected, where appropriate. You may lose marks if you do not show your working or if you do not use appropriate units.

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

Shift
Laboratory

For Examiner's Use	
1	
2	
3	
Total	**55**

This document consists of **21** printed pages and **3** blank pages.

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Answer **all** questions.

1 You will be investigating the effect of salt concentration on the movement of water in potatoes.

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	volume / cm^3
P	5 lengths of potato	none	–
W	distilled water	none	150
S	1 mol dm^{-3} salt solution	none	150

It is recommended that you wear suitable eye protection.

(a) You will need to make different concentrations of salt solution using simple dilution of the 1.00 mol dm^{-3} salt solution, **S**.

You will need to prepare 40 cm^3 of each concentration.

Table 1.2 shows two of the concentrations you will use.

Decide which other concentrations of salt solution you will use.

(i) Complete Table 1.2 to show how you will prepare the other concentrations.

Table 1.2

final concentration of salt solution / mol dm^{-3}	volume of **S** / cm^3	volume of distilled water, **W** / cm^3
1.00	40	0
0.00	0	40

[2]

Carry out step 1 to step 11.

step 1 Prepare the concentrations of salt solution, as shown in Table 1.2, in the beakers provided.

step 2 Cut 10 discs of potato for each of the concentrations prepared in step 1.

Each disc should be approximately 3 mm thick.

step 3 Place 10 discs in a line as shown in Fig. 1.1.

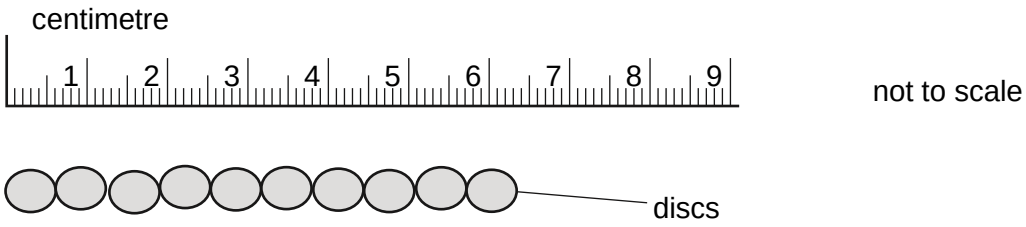

Fig. 1.1

step 4 Measure the total length of the 10 discs and record this value in **1(a)(ii)**.

step 5 Put the 10 discs into the beaker containing 1 mol dm^{-3} salt solution.

step 6 Repeat step 3 to step 5 with the other discs and the salt solutions you prepared in step 1.

step 7 Start timing and leave for 30 minutes. Use this time to continue with other parts of Question 1.

step 8 After 30 minutes (step 7), discard the 1 mol dm^{-3} salt solution from around the discs and tip the discs onto some paper towel.

step 9 Place the 10 discs in a line as in Fig. 1.1 and measure their total length. Record this value in **1(a)(ii)**.

step 10 Repeat step 8 and step 9 for the other salt concentrations.

step 11 Calculate the **change** in length for each line of 10 discs.

(ii) Record your results in an appropriate table, including raw results **and** processed results.

[5]

(iii) Explain your results for the 0.0 mol dm^{-3} salt solution (distilled water).

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…… [2]

(iv) Suggest why a line of 10 discs was measured instead of a single disc.

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…… [1]

(v) Identify **one** significant source of error in this investigation.

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…… [1]

(vi) Use your results to estimate a salt concentration where there is **no net movement** of water into or out of the potato.

salt concentration ..... mol dm^{-3} [1]

(vii) Describe **two** improvements to your procedure that would make the estimate in **1(a)(vi)** more accurate.

a. ……

……

b. ……

……

[2]

(b) The salt content of unprocessed food was measured.

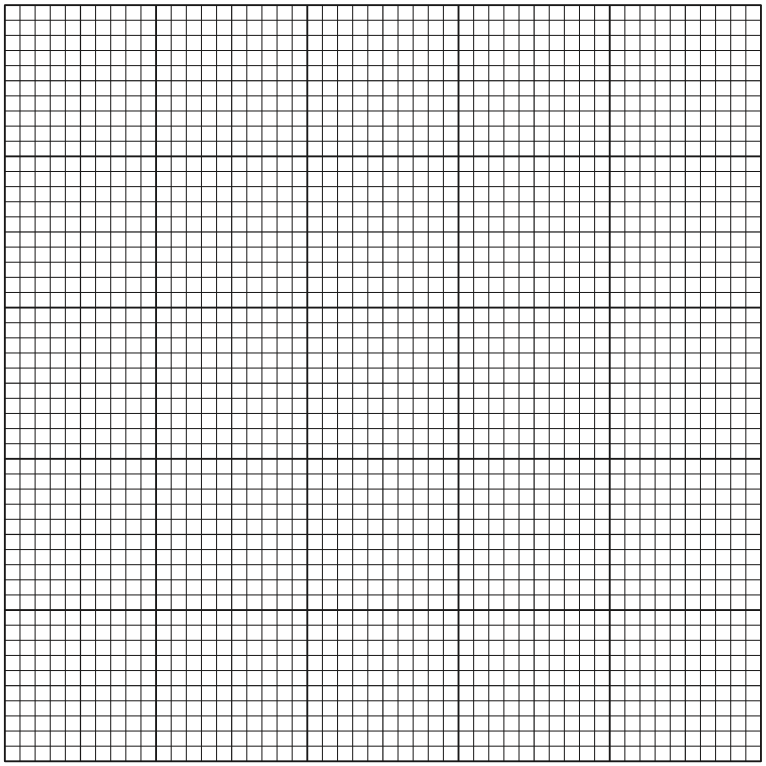
The values are shown in Table 1.3.

Table 1.3

food type	salt content of unprocessed food / mg per 100 g food
potatoes (P)	10.0
tuna (T)	40.0
bran (B)	25.0
chicken (C)	50.0
salmon (S)	95.0

(i) Plot a bar chart of the data shown in Table 1.3 on the grid in Fig. 1.2.

Use a sharp pencil.



[4]

Fig. 1.2

The salt content of the same foods that had been processed was also measured.

The values are shown in Table 1.4.

Table 1.4

food type	salt content of processed food / mg per 100 g food
potatoes (P)	200.0
tuna (T)	300.0
bran (B)	1000.5
chicken (C)	350.5
salmon (S)	1800.0

(ii) Calculate the percentage increase in salt content when salmon is processed.

Show your working and write your answer to **two** significant figures.

increase in salt content ..... % [2]

[Total: 20]

2 Hydrogencarbonate indicator is a water-soluble solution that can act as a source of carbon dioxide for aquatic photosynthetic organisms. The solution changes colour depending on the concentration of carbon dioxide in the solution. These colours are related to different pH values, as shown in Table 2.1.

Table 2.1

colour of hydrogencarbonate indicator solution	pH	concentration of carbon dioxide in the solution
yellow	7.6	↑ increasing carbon dioxide concentration
yellow-orange	7.8	
orange	8.0	
orange-red	8.2	
red	8.4	atmospheric concentration
red-magenta	8.6	↓ decreasing carbon dioxide concentration
magenta	8.8	
magenta-purple	9.0	
purple	9.2	

Chlorella vulgaris is a protoctist that is single-celled, aquatic and photosynthetic. It can be immobilised in alginate beads.

Alginate beads with immobilised *C. vulgaris* can be used to measure the rate of photosynthesis.

(a) A student noticed that a colour change occurred, from red to magenta, when the alginate beads with immobilised *C. vulgaris* were left in a container of hydrogencarbonate indicator solution and exposed to light.

Explain why this colour change occurred.

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…… [2]

(b) The student used the alginate beads with immobilised *C. vulgaris* in hydrogencarbonate indicator solution to investigate the rate of photosynthesis in different light intensities.

Fig. 2.1 shows some of the apparatus and reagents the student used.

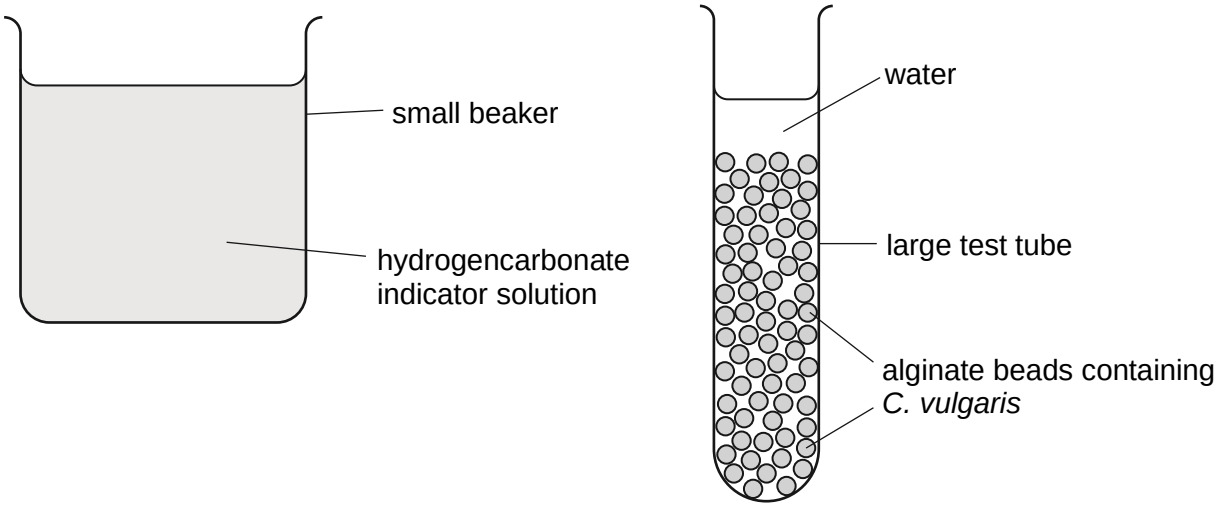

Fig. 2.1

(i) Identify the **independent** variable in this investigation.

..... [1]

(ii) The student was provided with a supply of alginate beads containing immobilised *C. vulgaris*.

Plan an investigation to determine the effect of light intensity on the rate of photosynthesis of *C. vulgaris* using hydrogencarbonate indicator and the experimental set-up in Fig. 2.1.

Your plan should:

- have a clear and helpful structure such that the method you use is able to be repeated by anyone reading it
- a description of the method used including the scientific reasoning behind the method
- be illustrated by relevant diagram(s), if necessary
- identify the key variables
- describe the method so that the results are as accurate and repeatable as possible
- include the layout of results tables and graphs with clear headings and labels
- use the correct technical and scientific forms
- include reference to safety measures to minimise the any risks associated with the proposed experiment.

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(c) The student set up a large test-tube containing alginate beads with immobilised *C. vulgaris* in hydrogencarbonate indicator solution at **pH 8.4** (red).

The student kept this set-up in the dark for 12 hours.

Predict and explain the results that will be observed after 12 hours in the dark.

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…… [2]

(d) Some scientists wanted to culture cells of *C. vulgaris* on a large scale for use as a biofuel.

To determine the optimal growing conditions for *C. vulgaris*, the scientists needed to determine the number of cells per cm^3 of suspension to monitor the population growth.

They tried two methods to determine the number of cells per cm^3 of suspension.

The first method used a Secchi stick, as shown in Fig. 2.2.

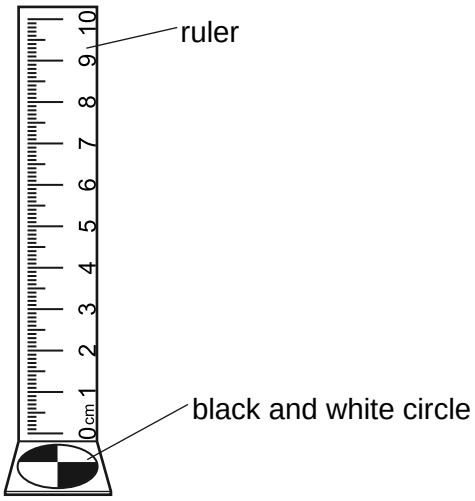

Fig. 2.2

The Secchi stick is lowered into the suspension of cells until the black and white circle is not able to be seen from above.

The depth in cm is recorded from the ruler, as shown in Fig 2.3.

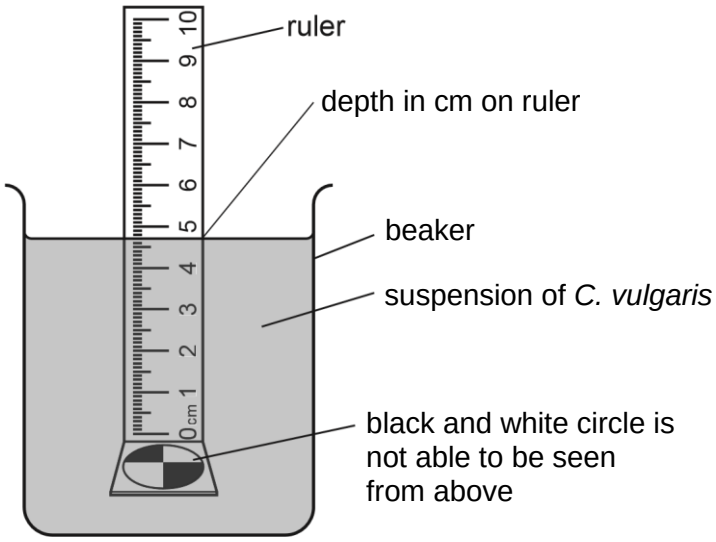

Fig. 2.3

The $\log_{10}$ (l g) of the number of cells is determined from a graph of $\log_{10}$ of cells counted per cm^3 suspension against Secchi depth (cm), as shown in Fig 2.4.

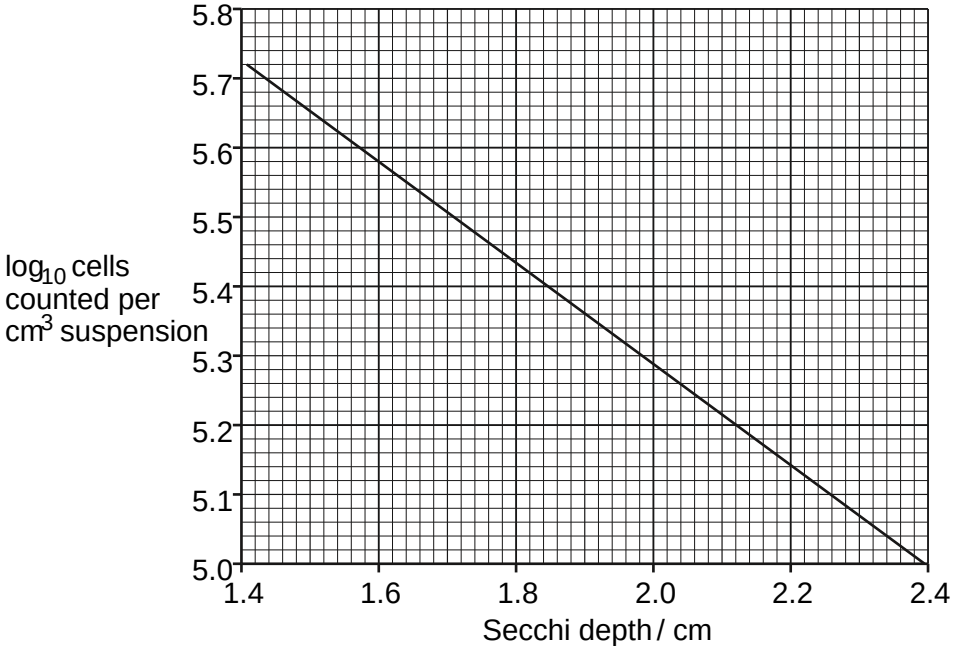

Fig. 2.4

(i) When the scientists inserted the Secchi stick into a sample from their cell suspension, the circle (on the Secchi stick) was not able to be seen at a depth of **1.9 cm**.

Using the graph in Fig. 2.4, calculate the actual number of cells per cm^3 of suspension.

Show your working and give your answer to the nearest 1000 cells.

number of cells per cm^3 of suspension ..... [2]

The second method used a counting chamber to determine the number of cells per cm^3 of suspension.

Fig. 2.5 shows a section of a counting chamber with cells present, as viewed using the high power of a light microscope.

The depth of the 1 mm · 1 mm counting chamber is **0.1 mm**.

The scientists counted the number of cells in several sections of a counting chamber.

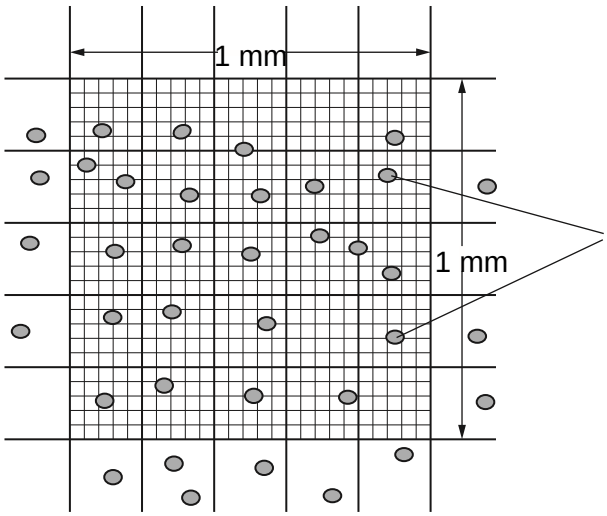

Fig. 2.5

(ii) Count the number of cells in the 1 mm · 1 mm section of the counting chamber shown in Fig. 2.5.

Use your answer to calculate the number of cells per cm^3 of the suspension.

Show all your working.

number of cells per cm^3 of suspension ..... [2]

(iii) The scientists decided that using the Secchi stick was a less accurate method for determining the number of cells per cm^3 of suspension.

Give **one** reason why using the Secchi stick is less accurate than using a counting chamber.

.....

..... [1]

[Total: 18]

3 **L1** is a slide of a stained transverse section through a plant stem.

You are not expected to be familiar with this specimen.

(a) Select a field of view so that you can observe a vascular bundle on **L1**.

Use a sharp pencil for drawing.

You are expected to draw the correct shape and proportions of the different tissues.

(i) Draw a large plan diagram of a vascular bundle on **L1**.

Use **one** ruled label line and label to identify the xylem.

[5]

(b) Fig. 3.1 is a photomicrograph of a stained transverse section through a stem of a different type of plant.

You are not expected to be familiar with this specimen.

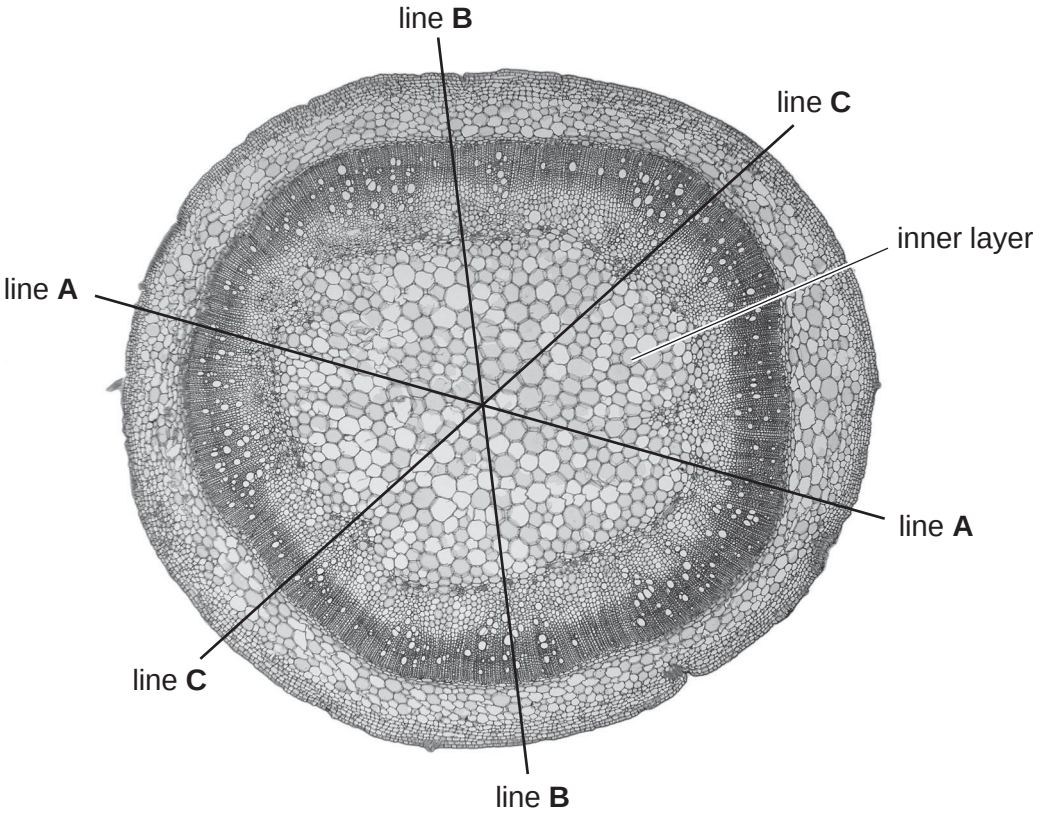

Fig. 3.1

Use line **A**, line **B** and line **C** to determine:

- the mean actual diameter of the inner layer (pith).

Show all the steps in your working.

mean actual diameter of inner layer ..... [3]

(c) Fig. 3.2 is a photomicrograph of the same stem section that is in Fig. 3.1.

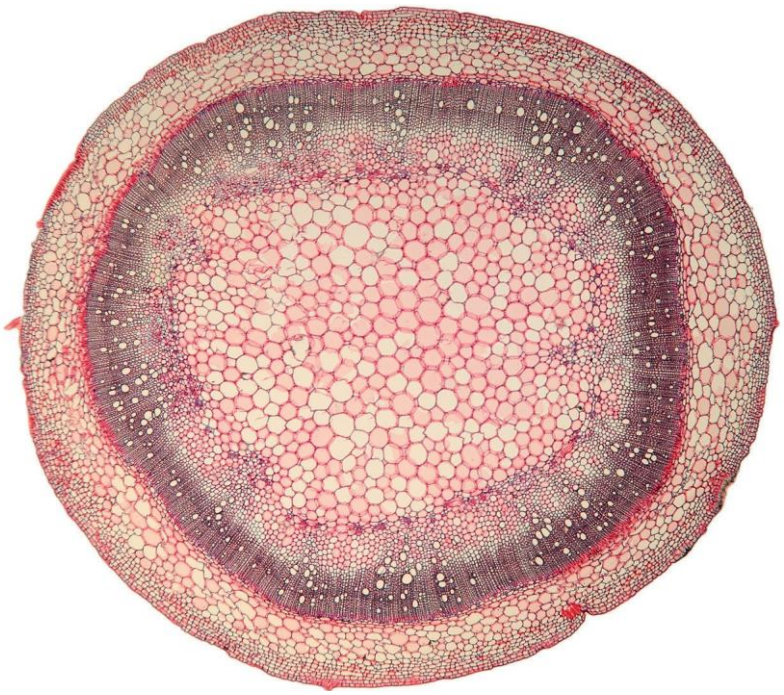

Fig. 3.2

Identify the observable differences between the stem section in Fig. 3.2 and the stem section on **L1**.

Record **two** observable differences in Table 3.1.

Table 3.1

feature	Fig. 3.2	L1

[2]

(d) In plants, the growth regulator, auxin, is synthesised in the stem tip and moves away from the tip. The movement of auxin through plant tissues was investigated using bean seedlings as shown in Fig. 3.3.

The following procedure was used.

- Stems were cut into 60 mm lengths.
- Agar blocks containing radioactive auxin were placed on the apical surfaces of two groups of stem lengths.
- The basal ends of the stem lengths were placed on agar blocks without any auxin to provide support.

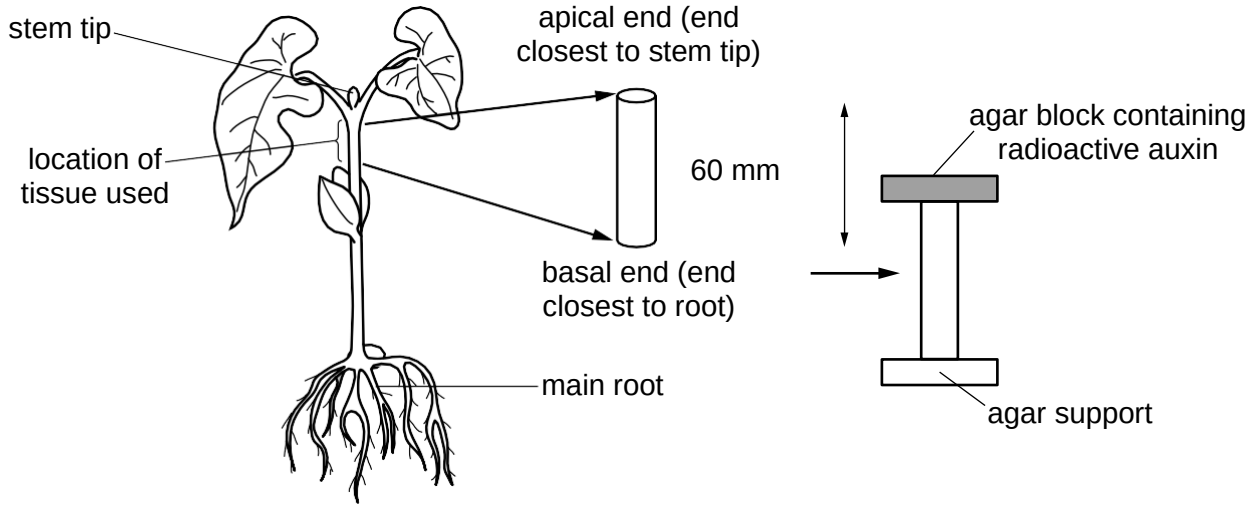

Fig. 3.3

- After 10 minutes, the agar blocks at the apical ends were removed.
- One group of stem lengths was placed in air and the other group in an atmosphere of nitrogen.
- Both groups were left in light for 30 minutes after removing the agar blocks.
- The position of the radioactivity was located.

Fig. 3.4 shows the results of the investigation.

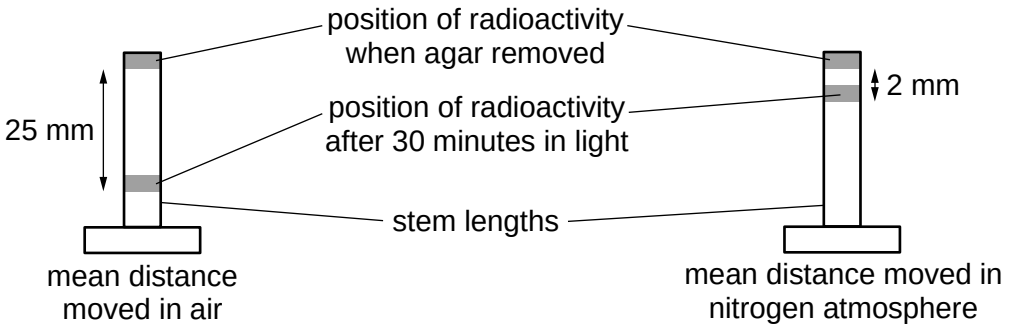

Fig. 3.4

(i) Suggest **one** conclusion that can be made from these results.

……..…

…….. [1]

(ii) Calculate the rate in mm h^{-1} of movement of auxin for the setup placed in air.

[1]

A similar investigation was carried out to test the hypothesis:

The rate of movement of auxin will be faster in plants grown in the light than plants grown in the dark.

Table 3.2 shows the results of this investigation.

Table 3.2

plants grown in light										**plants grown in the dark**									
sample number										sample number									
1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
rate of movement / mm h^{-1}																			
56	61	66	52	50	68	76	51	55	64	45	52	42	35	55	38	32	37	45	51
mean ± standard deviation *(s)* = 59.9 ± 8.5										mean ± standard deviation *(s)* = 43.2 ± 7.7									

(iv) Describe how the following evidence from Table 3.2 supports the hypothesis.

Mean

……..……

…….. [1]

standard deviation

……..……

…….. [1]

(v) A *t*-test was carried out to see if the difference in the rates of movement of auxin in plants grown in the light and plants grown in the dark was significant.

Suggest a null hypothesis for this statistical test.

……

…… [1]

(vi) Explain how the student should use the value for *t* to find out if the difference in the rates of movement of auxin is significant.

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…… [2]

[Total: 17]

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