H

NANYANG JUNIOR COLLEGE
PRELIMINARY EXAMINATIONS
Higher 2

CANDIDATE NAME

CLASS

BIOLOGY **9744/04**

Paper 4 Practical **22 August 2024**

Candidates answer on the Question Paper

Additional Materials: As listed in the Confidential Instructions **2 hour 30 minutes**

READ THESE INSTRUCTIONS FIRST

Write your name and CT on all the work you hand in.
Give details of the practical shift and laboratory, where appropriate in the boxes provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO NOT WRITE IN ANY BARCODES.

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.

Shift
Laboratory

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	
1	
2	
Total	

This document consists of **19** printed pages and **0** blank pages.

[Turn over

Answer **all** the questions.

1 **J1** is a slide of a stained transverse section through a plant leaf.

(a) (i) Draw a large plan diagram of the whole section on **J1**. Use a sharp pencil. Use **one** ruled label line and label to identify the epidermis.

[5]

(ii) The leaf section on **J1** is from a plant that lives at high altitudes in very cold conditions. In the winter the ground is often frozen and plants are unable to take up water.

Suggest **one** observable feature of the leaf section on **J1** which enables it to survive these conditions.

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[1]

(iii) Observe the cells in the epidermis of the section on **J1**.

Select a line of four adjacent cells that make up this tissue.

Each cell must touch at least one of the other cells.

- Make a large drawing of this line of **four** cells.
- Use **one** ruled label line and label to identify the cell wall of **one** cell.

[5]

(b) Fig. 1.1 is a photomicrograph of a stained transversed section through a different type of leaf from **J1**.

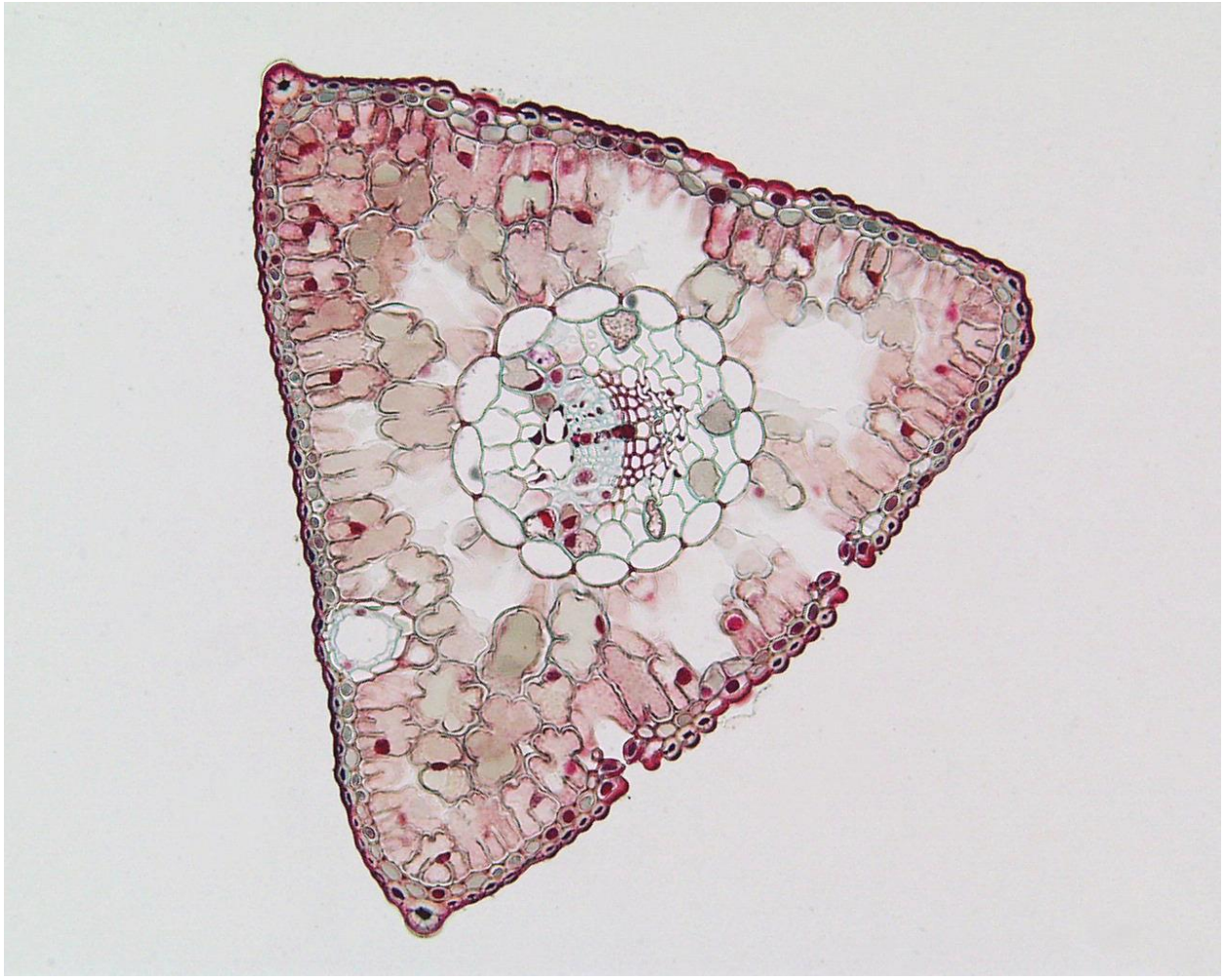

Fig. 1.1

Identify three observable differences between the leaf section on **J1** and the leaf section in Fig. 1.1. Record these three observable differences in Table 1.1.

Table 1.1

Feature	J1	Fig 1.1

[3]

(c) Fig. 1.2 is the same photomicrograph as that in Fig. 1.1, with the line **X – Y** drawn across its width.

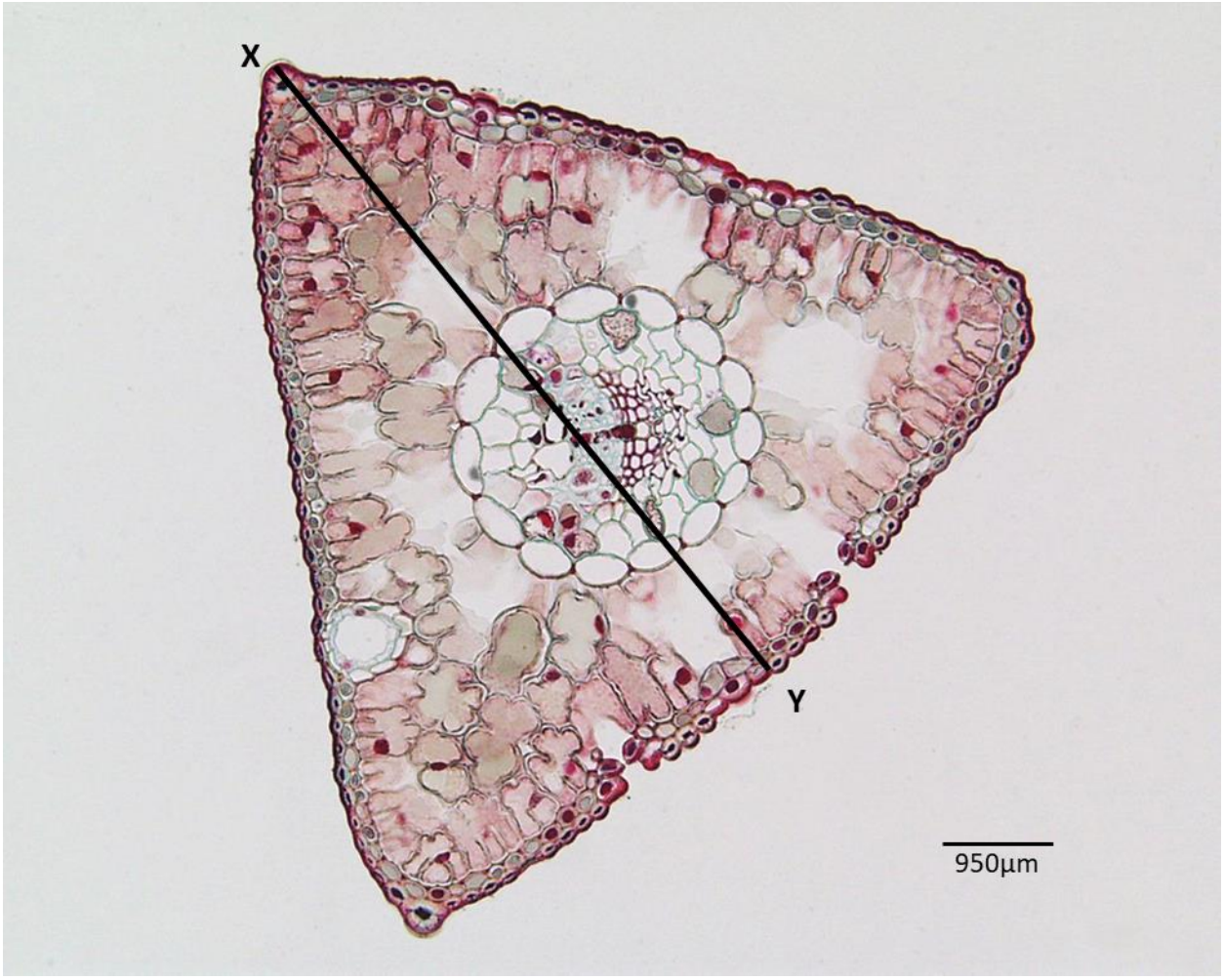

Fig. 1.2

In Fig. 1.2 the line **X – Y** is drawn across the width of the leaf. Use the line X – Y and the scale bar to calculate the actual width of the leaf.

Show your working.

actual width of leaf = …….. [4]

Several studies have suggested that shifts in stomatal densities in pine leaves can be attributed to rising atmospheric carbon dioxide concentrations and climate change.

A student decided to investigate the differences by observing 6 pine leaves from the *Pinus* genus under a light microscope.

Table 1.2 shows the student's results.

Table 1.2

	P. taeda	*P. ponderosa*
Mean stomatal density	114.64 ± 10.51	52.11 ± 3.35

The formula for t-test is:

$$t = \frac{\left|\bar{x}_1 - \bar{x}_2\right|}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}} \qquad v = n_1 + n_2 - 2$$

Key to symbols

s = standard deviation
$\bar{x}$ = mean
n = sample size (number of observations)
v = degrees of freedom

(i) Complete the calculation to find the value of t for the stomatal densities. Show your working.

t = $\dfrac{-}{\sqrt{\dfrac{\quad}{6} + \dfrac{\quad}{6}}}$

= $\dfrac{\quad}{4.50}$

t = _____ [3]

Table 1.2 shows the critical values for the *t*-test.

Table 1.2

Degrees of freedom	Significance level					
	20% (0.20)	10% (0.10)	5% (0.05)	2% (0.02)	1% (0.01)	0.1% (0.001)
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.598
3	1.638	2.353	3.182	4.541	5.841	12.941
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.859
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.405
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.767
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.043	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
40	1.303	1.684	2.021	2.423	2.704	3.551
60	1.296	1.671	2.000	2.390	2.660	3.460
120	1.289	1.658	1.980	2.158	2.617	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.291

(ii) State and explain the meaning of the results.

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[2]

[Total: 23]

2 You are required to investigate the effect of concentration of hydrochloric acid (independent variable) on the rate of diffusion.
The investigation involves placing agar cubes containing an indicator into dilute hydrochloric acid. As the acid diffuses into the agar cubes the indicator changes colour.

You are provided with the materials shown in Table 2.1.

Table 2.1

labelled	contents	hazard	volume / cm^3
H	1.0 mol dm^{-3} hydrochloric acid	irritant	100
A	agar	none	–
W	distilled water	none	60

It is recommended that you wear suitable eye protection.

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

You must not touch the agar with your hands. Use the blunt forceps and paper towel to handle the agar.

You will need to carry out a trial test (step 1 to step 4) before you start your investigation.

Read step 1 to step 4 before proceeding.

1. Cut 3 cubes from the agar, **A**, as shown in Fig. 2.1. Each cube should be approximately 5 mm × 5 mm x 5 mm but they must all have the same dimensions. Cut the cubes from **A** on the white tile provided.

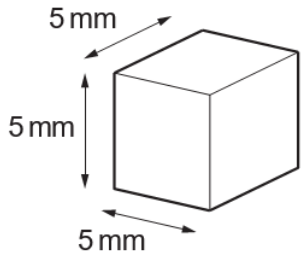

Fig. 2.1

2. Put 10 cm^3 of 1.0 mol dm^{-3} hydrochloric acid, **H**, into a beaker.

3. Put the 3 cubes you cut in step 1 into the beaker containing **H**, using blunt forceps. Start timing.

   As the acid diffuses into the agar cubes they change colour. The end-point is reached when the blue-green colour disappears and the **whole cube** has changed colour from blue-green to pink.

   Putting the beaker on the white card provided may help you to see the colour changes more clearly.

4. Measure the time taken for each cube to reach the end-point and record the times in **(a)(i)**. If any cube remains blue-green after 3 minutes, record as 'more than 180'.

(a) **(i)** Record your results in an appropriate table.

[2]

(ii) Calculate the mean time taken for the cubes to reach the end-point.

mean time = ... [1]

The student investigated the effect of concentration of hydrochloric acid on the rate of diffusion and suggested the hypothesis:

> Lowering the concentration of hydrochloric acid below 1.0 mol dm^{-3} will have no effect on the rate of diffusion of acid into the agar cubes.

You will need to use simple (proportional) dilution of the 1.0 mol dm^{-3} hydrochloric acid, **H**, to prepare four further concentrations of hydrochloric acid.

You need to prepare 10.0 cm^3 of each concentration.

(iii) Draw a table to show how you will prepare these concentrations.

Table 2.2

volume of 1.0 mol dm^{-3} hydrochloric acid / cm^3	volume of distilled water, **W** / cm^3	final concentration of hydrochloric acid / mol dm^{-3}

[2]

Read step 5 to step 10 before proceeding.

5. Prepare the concentrations of hydrochloric acid, as shown in Table 2.2, in the containers provided.

6. Cut three cubes, each approximately 5 mm × 5 mm × 5 mm, from **A**. Cut the cubes on the white tile provided.

7. Put the 3 cubes into the container containing 1.0 mol dm^{-3} hydrochloric acid, **H**, and immediately start timing. Do **not** stir.

8. Measure the time taken for each cube to reach the end-point and record the times in **(a)(iv)**. If any cube remains blue-green after 3 minutes record as 'more than 180'.

9. Repeat step 6 to step 8 for each of the other concentrations of hydrochloric acid you have prepared.

10. Calculate the mean time taken for each concentration and record the mean times in **(a)(iv).**

(iv) Record your results and mean times in an appropriate table.

[3]

(v) Using your mean times, calculate the rate of diffusion when the concentration of hydrochloric acid is 1.0 mol dm^{-3} **and** in the lowest concentration of hydrochloric acid you have investigated.

rate in 1.0 mol dm^{-3} hydrochloric acid .....s^{-1}

rate in the lowest concentration .....s^{-1}

[1]

The student's hypothesis stated that:

Lowering the concentration of hydrochloric acid below 1.0 mol dm^{-3} will have no effect on the rate of diffusion of acid into the agar cubes.

(vi) State whether you **support** or **reject** this hypothesis.
Explain how your results provide evidence for this decision.

support or reject

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explanation

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[1]

(vii) Explain **two** significant sources of error in this investigation.

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[4]

(viii) Describe **two** modifications to this investigation which would improve the confidence in your results.

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[2]

(b) A scientist carried out an experiment to investigate whether a chemical, **C**, extracted from the flowers of a plant, was able to inhibit the reproduction of pathogenic bacteria.

The scientist prepared 5 Petri dishes containing agar (agar plates) which had each been inoculated with a different type of pathogenic bacterium.

A filter paper disc, soaked in chemical **C**, was put onto each agar plate. Chemical **C** diffused from the filter paper disc into the agar. The agar plates were incubated at 25 °C to allow the bacteria in the agar to reproduce.

A clear zone, called a zone of inhibition, is observed around the filter paper disc if the chemical is effective at preventing bacteria from reproducing, as shown in Fig. 2.2.

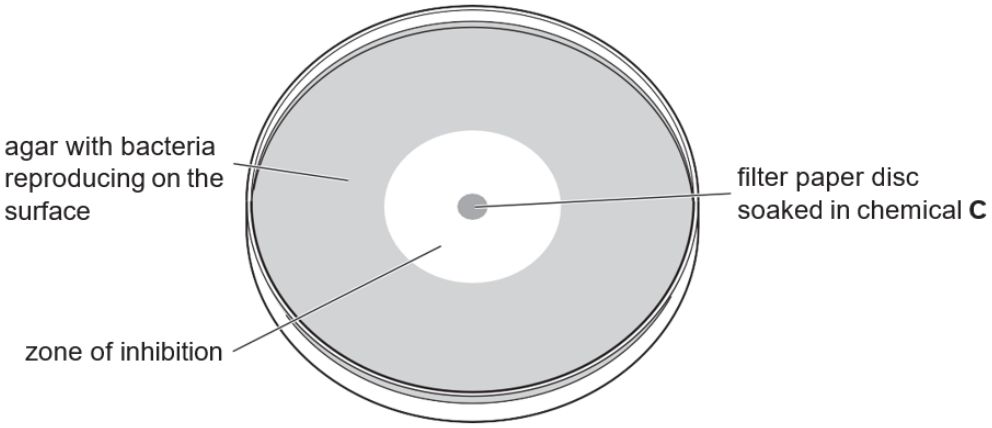

Fig. 2.2

The scientist measured the diameter of the zone of inhibition produced in the agar for each of the 5 different types of pathogenic bacterium.

The results are shown in Table 2.3.

Table 2.3

type of pathogenic bacterium	diameter of zone of inhibition / mm
P	7.0
Q	24.0
R	18.0
S	15.5
T	19.0

(i) Draw a bar chart of the data in Table 2.3 on the grid in Fig. 2.3.
Each bar should be separated for each type of pathogenic bacterium.

Use a sharp pencil for drawing bar charts.

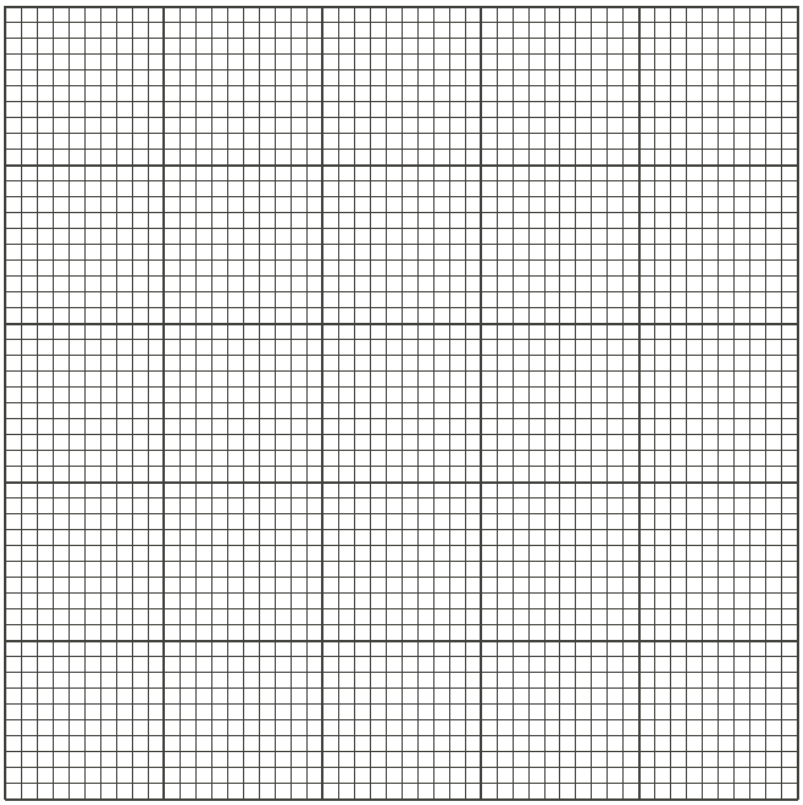

Fig. 2.3

[4]

(ii) Suggest how chemical **C** may act as an antibiotic.

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[2]

(c) Due to the increasing problem of antibiotic resistance, the scientist wanted to learn more about the effects of chemical **C**. He wanted to find out the most effective concentration of chemical **C** that can inhibit the growth of this bacterium, which is determined by the size of the zone of inhibition.

Bacterium will be spread onto the agar plate and incubated at 25°C to produce an evenly distributed growth of the bacteria (a bacterial lawn).

Design an experiment to determine the **lowest concentration** of chemical **C** that will give the largest zone of inhibition.

You are required to decide on an appropriate dilution method.

In your plan you **must** use:

- prepared agar plates with bacteria lawn
- $30cm^3$ 100mg cm^{-3} chemical C
- $100cm^3$ distilled water
- 5mm filter paper disc

You may select from the following apparatus and plan to use appropriate additional apparatus:

- sterile swabs and forceps
- disinfectant solution
- normal laboratory glassware, e.g. test-tubes, boiling tubes, beakers, measuring cylinders,
- graduated pipettes, glass rods, etc.
- incubator
- autoclave (a pressurised oven for heating sterilizing apparatus and materials)
- Bunsen burner
- Parafilm
- ruler
- syringes
- timer, e.g. stopwatch

Your plan should:

- have a clear and helpful structure such that the method you use is able to be repeated by anyone reading it
- be illustrated by relevant diagrams, if necessary
- identify the dependent variable and the independent variable
- identify the variables you will need to control
- use the correct technical and scientific terms
- indicate how the results will be recorded and analysed
- indicate the safety measures to minimize the risks

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