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* 0000800000001 * DFD

Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

BIOLOGY **9700/53**

Paper 5 Planning, Analysis and Evaluation **October/November 2025**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 30.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Any blank pages are indicated.

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1 Juglone is a chemical produced by plants in the genus *Juglans*, which includes different species of walnut tree.

Fig. 1.1 shows a black walnut tree.

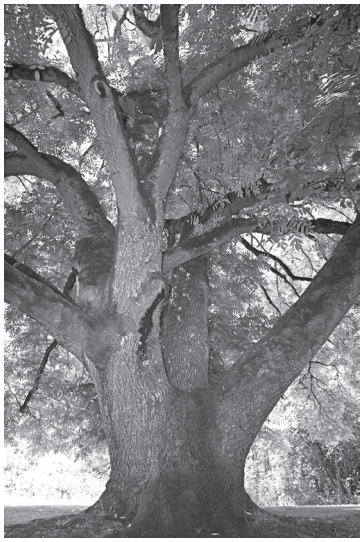

Fig. 1.1

Juglone produced by a black walnut tree can diffuse into the soil surrounding the tree.

Groups of scientists have observed that juglone affects different species of plant growing close to black walnut trees.

Juglone can reduce the percentage of seeds that germinate, delay the start of germination or reduce growth. In some studies, juglone has no effect on germination or growth.

A student planned to investigate the effect of juglone on the cucumber plant, *Cucumis sativus*.

In the investigation, the student:

- placed some damp soil containing juglone in a tray
- added some cucumber seeds to the soil
- placed the container in a suitable environment for germination and growth.

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Fig. 1.2 shows cucumber seedlings (young plants) a few days after germination.



Fig. 1.2

The student planned to compare the effect of exposing cucumber seeds to:

- juglone solution with a concentration of 1.0×10^{-3} mol dm^{-3}, which is a concentration that has been measured in soils surrounding black walnut trees
- a control treatment.

The student planned to determine:

- the percentage of cucumber seeds that germinated in soil
- the growth of each cucumber seedling 10 days after the appearance of the seedling above the soil.

(a) Identify the independent variable in this investigation.

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(b) Juglone solutions are prepared using a mixture of solvents.

The student was provided with:

- a juglone solution with a concentration of $0.1\,\text{mol}\,\text{dm}^{-3}$
- the mixture of solvents.

Using the solution provided, the student prepared a juglone solution with a volume of $500\,\text{cm}^3$ and a concentration of $1.0 \times 10^{-3}\,\text{mol}\,\text{dm}^{-3}$.

The student carried out 1 dilution to prepare the $1.0 \times 10^{-3}\,\text{mol}\,\text{dm}^{-3}$ solution using measuring cylinders.

(i) State the volumes that the student used to carry out the dilution to produce $500\,\text{cm}^3$ of $1.0 \times 10^{-3}\,\text{mol}\,\text{dm}^{-3}$ juglone solution.

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..... [2]

(ii) Outline **one** improvement the student could make to reduce the percentage error while carrying out the dilution.

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..... [1]

(c) **(i)** State a suitable control that the student could use, **and** explain why the student decided to include a control in the investigation.

control .....

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explanation .....

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[2]

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(ii) Describe a method the student could use to investigate the effect of juglone on:

- the percentage of cucumber seeds that germinate
- the growth of each cucumber seedling 10 days after the appearance of the seedling above the soil.

The description of your method should be set out in a logical way and be detailed enough for another person to follow.

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(d) Another student investigated the effect of juglone on a different species of plant called crimson clover, *Trifolium incarnatum*.

The student recorded the number of days required for germination of:

- 10 seeds treated with a juglone solution with a concentration of 1.0×10^{-3} mol dm^{-3}
- 10 seeds not treated with a juglone solution.

(i) The student used the *t*-test to analyse the results. The *t*-test is appropriate for the number of seeds that were used.

Suggest **two other** reasons why the *t*-test is an appropriate statistical test to use for this investigation.

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(ii) The null hypothesis for this *t*-test was:

There is no difference between the time taken for seeds to germinate when treated with juglone and the time taken for seeds to germinate when not treated with juglone.

The calculated value of *t* was **2.090**.

The student compared **2.090** to the values in Table 1.1.

Table 1.1

degrees of freedom	probability level (*p*)			
	0.10	**0.05**	**0.01**	**0.001**
17	1.740	2.110	2.898	3.965
18	1.734	2.101	2.878	3.922
19	1.729	2.093	2.861	3.883
20	1.725	2.086	2.845	3.850
21	1.721	2.080	2.831	3.819

Using Table 1.1 and the calculated value of *t* of **2.090**, state **and** explain what the student can conclude about the results.

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2 Compounds containing nitrite ions (NO_2^-) are present in many foods eaten by humans.

Scientists tested the effect of different concentrations of nitrite ions on the population growth of 5 species of bacterium. All 5 species are pathogenic and can infect the human digestive system.

For each species of bacterium, the scientists placed suspensions of the bacteria in a microwell plate. A microwell plate is a plastic plate containing 96 wells, which are similar to small test-tubes.

In each well, the scientists added:

- a suspension of the bacterial species
- a solution containing nitrite ions
- nutrient broth.

The scientists incubated the microwell plate at 37 °C for 24 hours. After 24 hours, the scientists estimated the number of bacteria in each well by measuring optical density, using a microwell plate reader.

For each species of bacterium, the scientists repeated the experiment with several different concentrations of solution containing nitrite ions.

The scientists determined the lowest nitrite concentration at which no bacterial population growth had occurred after 24 hours.

(a) The scientists standardised temperature, pH (pH 4.8) and time in the investigation.

State **two other** variables that the scientists should standardise in this investigation.

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[2]

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(b) The results of the investigation are shown in Fig. 2.1.

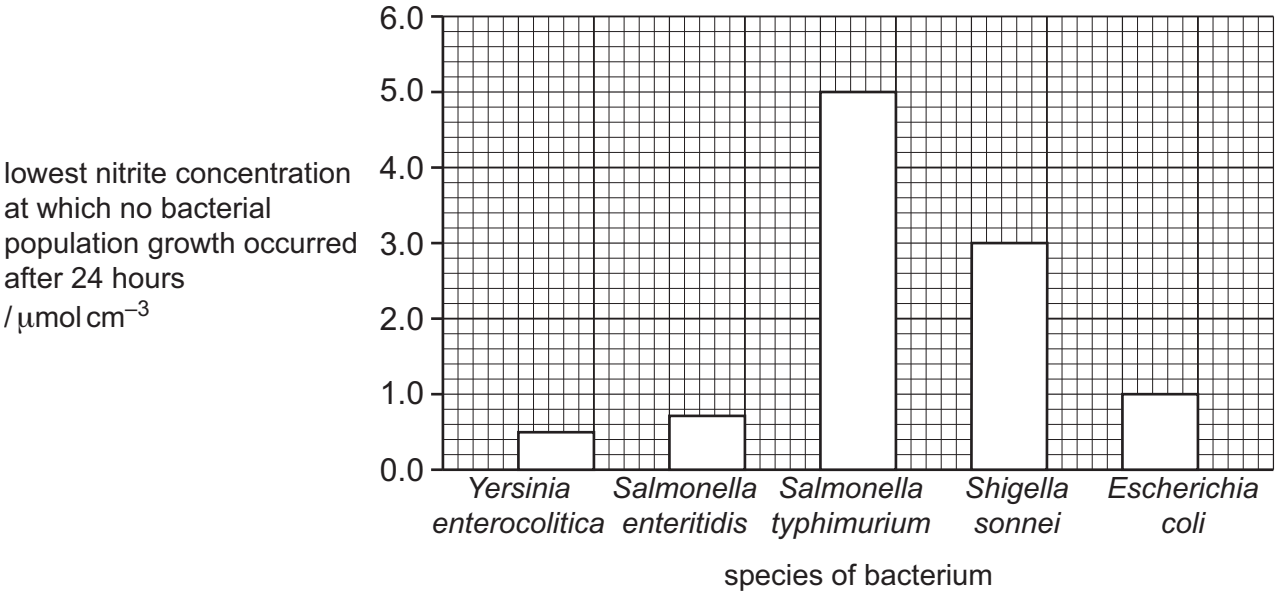

Fig. 2.1

(i) State the type of **data** represented by the species of bacterium and the lowest nitrite concentration in Fig. 2.1.

species of bacterium .....

lowest nitrite concentration .....

[2]

(ii) The 2 species of *Salmonella* shown in Fig. 2.1 are closely related.

Calculate the percentage difference between the results shown in Fig. 2.1 for the 2 species of *Salmonella*.

Show your working.

.....%

[3]

(iii) Use Fig. 2.1 to state:

- the species of bacterium that is most affected by nitrite ions
- the species of bacterium that is least affected by nitrite ions.

most affected .....

least affected .....

[1]

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(c) A student looked at the results and stated:

Consuming a lot of nitrites would improve the health of people because it would help to prevent diseases in the digestive system caused by pathogenic bacteria.

Suggest **four** reasons why this conclusion might **not** be valid.

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