GradeMax

* 0000800000001 * DFD

Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 3 3 0 7 5 7 5 4 0 6 *

BIOLOGY **9700/54**

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 **16** pages. Any blank pages are indicated.

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1 *Beta vulgaris vulgaris*, as shown in Fig. 1.1, is a food crop with a swollen, edible root known as beetroot.

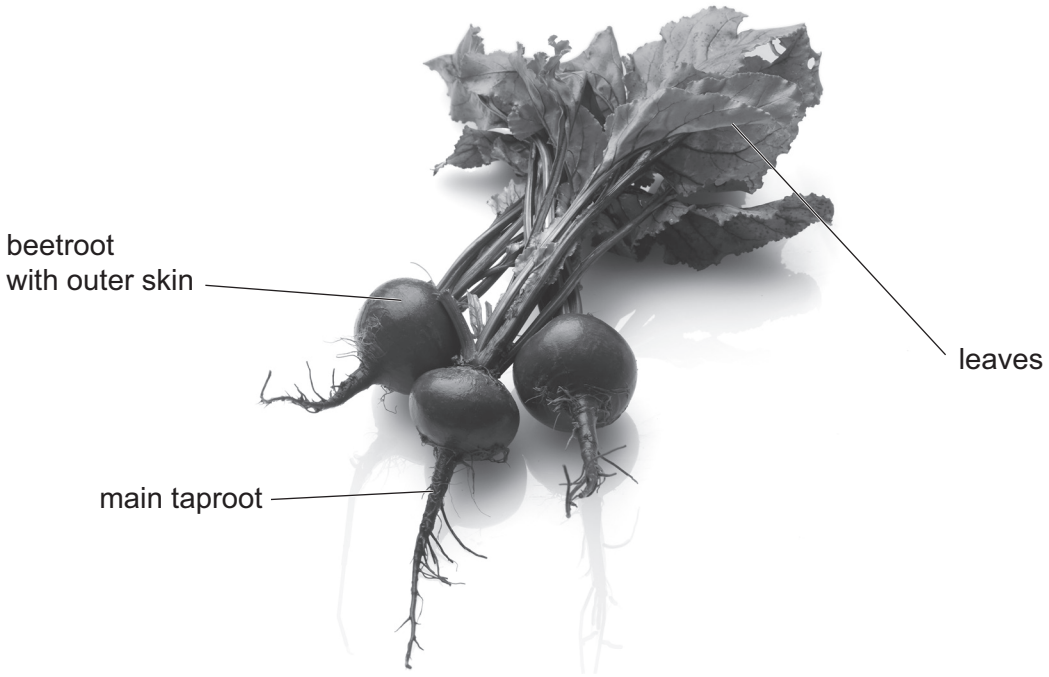


Fig. 1.1

A student determined the concentration of a sucrose solution that has the same water potential as the cells of the beetroot.

The student used distilled water and a stock solution of 2.0 mol dm^{-3} sucrose to prepare a range of sucrose solutions.

Each sucrose solution was prepared using proportional dilution and had a final volume of 30 cm^3.

(a) Complete Table 1.1 to show how the concentrations were made.

Table 1.1

final concentration of sucrose solution / mol dm^{-3}	volume of distilled water / cm^3	volume of 2.0 mol dm^{-3} stock sucrose solution / cm^3
2.0	0.0	30.0
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
0.0	30.0	0.0

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(b) Describe a method the student could use to collect the data needed to determine the concentration of a sucrose solution that has the same water potential as the cells of the beetroot.

The student was supplied with the sucrose solutions prepared in **1(a)** and standard laboratory equipment.

Do **not** include details of how the student:

- prepared the sucrose solutions in **1(a)**
- would use the data collected to determine the concentration of a sucrose solution that has the same water potential as the cells of the beetroot.

Your method should be set out in a logical order and be detailed enough to allow another person to follow it.

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(c) The student calculated the mean percentage change in mass of the beetroot for each concentration of sucrose solution.

(i) The student plotted these calculated values to obtain a line graph.

Complete Fig. 1.2 by:

- labelling the axes
- sketching the line that the student obtained.



Fig. 1.2

[2]

(ii) Explain how the student used the completed line graph in Fig. 1.2 to estimate the concentration of sucrose solution that has the same water potential as the cells of the beetroot.

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..... [1]

(iii) The cells of the beetroot contain a red pigment which can leak out into the solution when the tissue is cut. The student noticed that each sucrose solution was coloured red at the end of the investigation.

Suggest **one** improvement the student could make to the method to reduce the amount of red pigment in each sucrose solution.

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Question 2 starts on page 6.

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2 The buff-tailed bumblebee, *Bombus terrestris*, is an insect that uses its tongue to feed on the nectar and pollen of flowers.

Buff-tailed bumblebees can feed on the nectar and pollen of flowers by either gripping (holding) onto flower petals or by hovering (flying) in front of the flowers.

Fig. 2.1 shows the buff-tailed bumblebee.

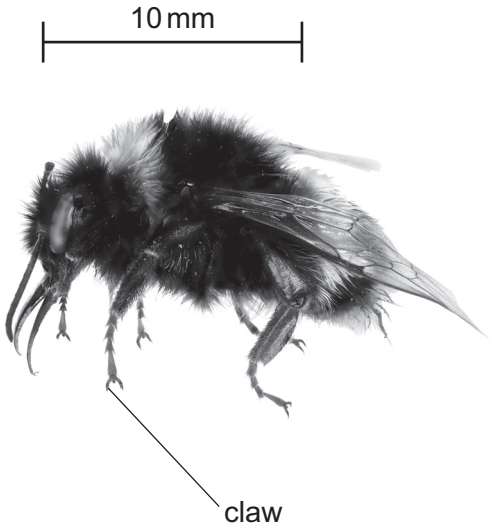


Fig. 2.1

The buff-tailed bumblebee has adaptations, such as claws, to help it to grip on to flower petals to obtain nectar and pollen.

Fig. 2.2 shows the buff-tailed bumblebee using its claws to grip on to the flower petals as the bee feeds.



Fig. 2.2

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Fig. 2.3 is a magnified image of the claw of a bee.

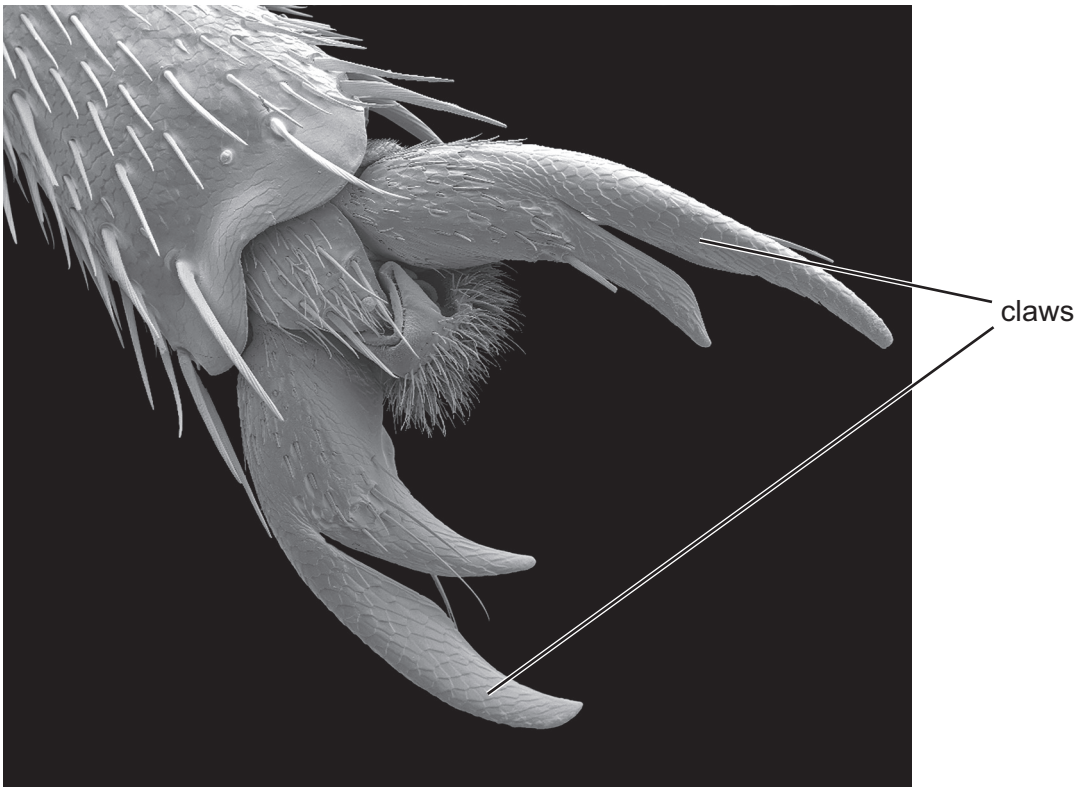


Fig. 2.3

(a) Suggest a method that can be used to measure the image length of the longest part of the curved claw in Fig. 2.3.

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(b) The surfaces of flower petals of different plant species have different textures.

Fig. 2.4 shows a scanning electron micrograph of a rough surface of a flower petal.

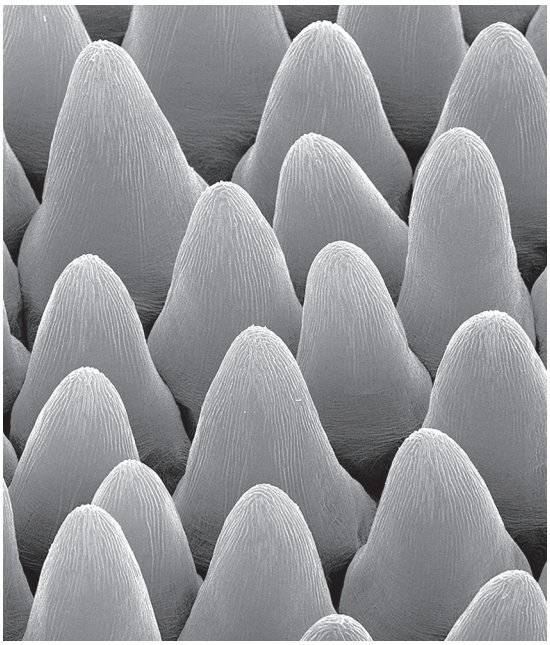


Fig. 2.4

Fig. 2.5 shows a scanning electron micrograph of a smoother surface of a flower petal.

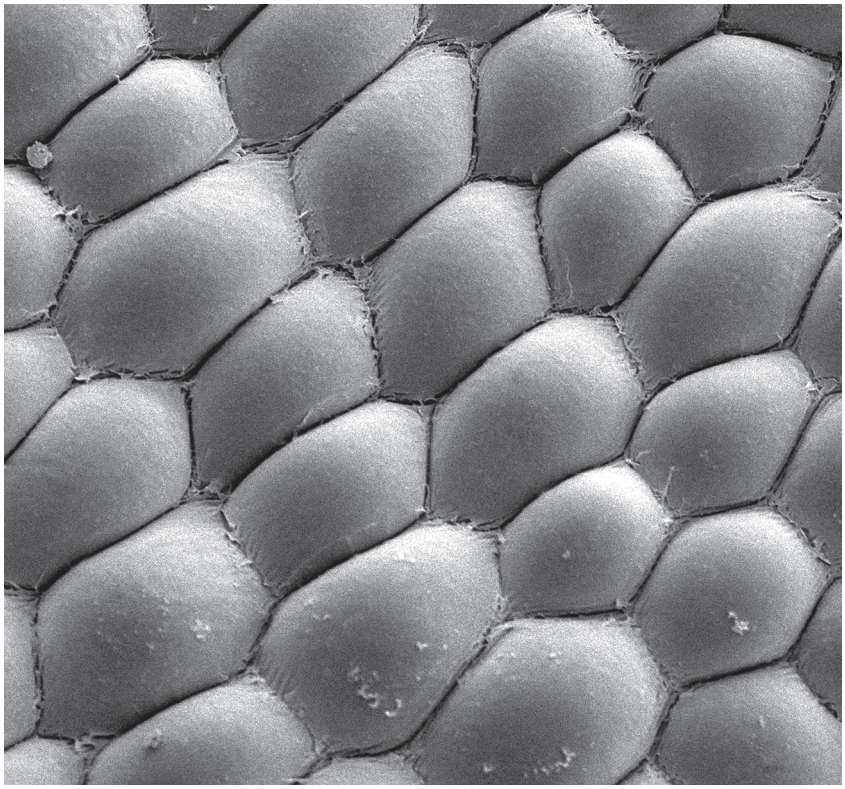


Fig. 2.5

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A scientist made an artificial flower apparatus, as shown in Fig. 2.6.

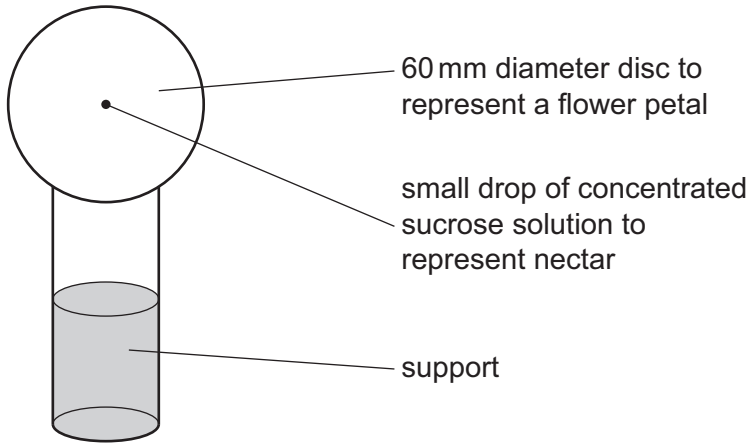


Fig. 2.6

To model flower petals with different levels of roughness, the scientist used different discs.

Each disc was made using particles of different diameters attached to the surface of the disc, as shown in Table 2.1.

Table 2.1

mean particle diameter on the disc / μm	level of roughness
5	smooth ↓ rough
9	
12	
16	
30	
53	

(i) The diameter of each disc was standardised as 60 mm.

Identify **one** other variable the scientist should standardise when making the discs.

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(ii) The scientist investigated if the level of roughness of the discs affects whether buff-tailed bumblebees grip on to the disc or hover when they feed (feeding visit) from the small drop of concentrated sucrose solution.

For each disc, the scientist:

- recorded the number of feeding visits when the buff-tailed bumblebees gripped on to the disc
- recorded the number of feeding visits when the buff-tailed bumblebees hovered in front of the disc
- calculated the percentage of feeding visits when the buff-tailed bumblebees gripped on to the disc.

State the **independent** variable in this investigation.

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..... [1]

(iii) For the disc with a mean particle diameter of 16 μm, the scientist calculated that the buff-tailed bumblebees gripped on to the disc for 79% of their feeding visits.

The total number of feeding visits was 117.

Calculate the number of feeding visits when the buff-tailed bumblebees hovered in front of the disc.

Give your answer to the nearest whole number.

number of feeding visits when the buff-tailed bumblebees hovered = ... [1]

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(iv) Fig. 2.7 shows the results of the investigation.

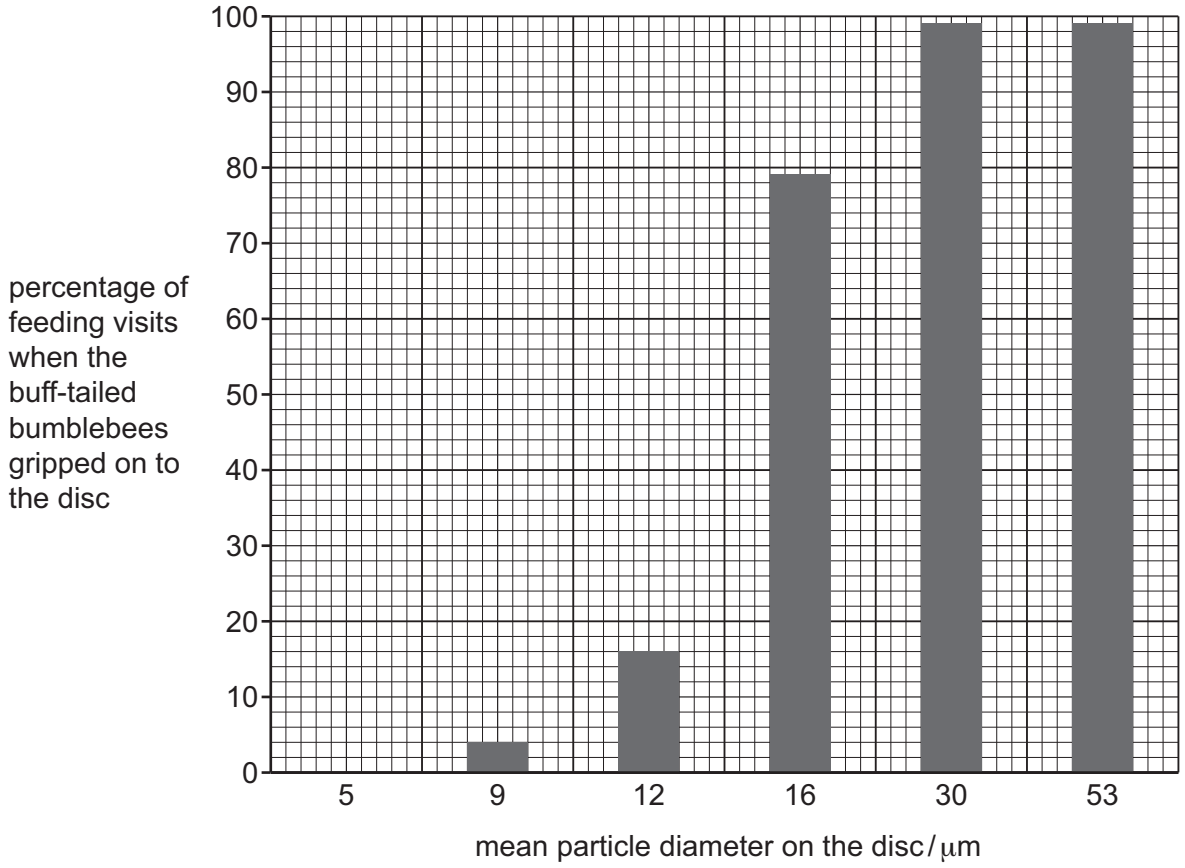


Fig. 2.7

State **two** conclusions that can be made from the results in Fig. 2.7.

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(c) A student used the Spearman's rank correlation to analyse the data in Fig. 2.7.

The student stated the null hypothesis as:

There is no correlation between the mean particle diameter on the disc and the percentage of feeding visits when the buff-tailed bumblebees gripped on to the disc.

The formula for Spearman's rank correlation (r_s) is:

$$r_s = 1 - \left(\frac{6 \times \Sigma D^2}{n^3 - n}\right)$$

key to symbols:
D = difference in rank between each pair of measurements

n = number of pairs of items in the sample

(i) Complete Table 2.2 to calculate ΣD^2.

Table 2.2

mean particle diameter on the disc / μm	rank of mean particle diameter on the disc	percentage of feeding visits when the buff-tailed bumblebees gripped on to the disc	rank of percentage of feeding visits when the buff-tailed bumblebees gripped on to the disc	Difference in rank, D	D^2
5	1	0			
9	2	4			
12	3	16			
16	4	79			
30	5	99			
53	6	99			
				$\Sigma D^2 =$	

[2]

(ii) Use the calculated value for ΣD^2 from Table 2.2 to calculate r_s.

$r_s =$ ..... [1]

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(iii) Table 2.3 shows the critical values of r_s at the 0.05 probability level.

Table 2.3

n	5	6	7	8	9	10	11	12
critical value of r_s	0.90	0.83	0.71	0.64	0.60	0.56	0.54	0.50

Use the data from Table 2.3 to explain why the student rejected the null hypothesis.

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3 **(a)** Pectin is a polysaccharide found in plant cell walls. Pectinase is an enzyme that hydrolyses pectin.

A student investigated the use of pectinase to extract more juice from different types of fruit.

The student:

- removed the outer skin and cut each type of fruit into small pieces
- placed each type of fruit into a separate beaker with 5 cm^3 of 1% pectinase solution
- incubated the mixture at 60 °C for 10 minutes
- passed the contents of the beaker through a filter funnel into a measuring cylinder
- measured the volume of juice extracted from each type of fruit.

Table 3.1 shows the results.

Table 3.1

type of fruit	volume of juice extracted / cm^3			
	sample 1	sample 2	sample 3	mean of samples
apple	16	17	17	.....
orange	30	37	33	.....
pineapple	41	44	45	.....
grapes	17	15	11	.....

(i) Complete Table 3.1 by calculating the means. [1]

(ii) The independent variable is the type of fruit and the dependent variable is the volume of juice extracted.

Complete Table 3.2 to show the type of variable and the type of data.

Table 3.2

	type of variable	type of data
type of fruit		
volume of juice extracted		

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(iii) State **two** changes the student should make to their method to improve the quality of their results.

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(b) The student wanted to determine the quantity of pectin in the cell walls of different types of fruit.

Suggest why the student could **not** use the experiment in **3(a)** to determine the quantity of pectin in the cell walls of different types of fruit.

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