Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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3265335577

BIOLOGY **9700/53**

Paper 5 Planning, Analysis and Evaluation **May/June 2023**

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.

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1 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 1.1.

Table 1.1

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. 1.1 shows some of the apparatus and reagents the student used.

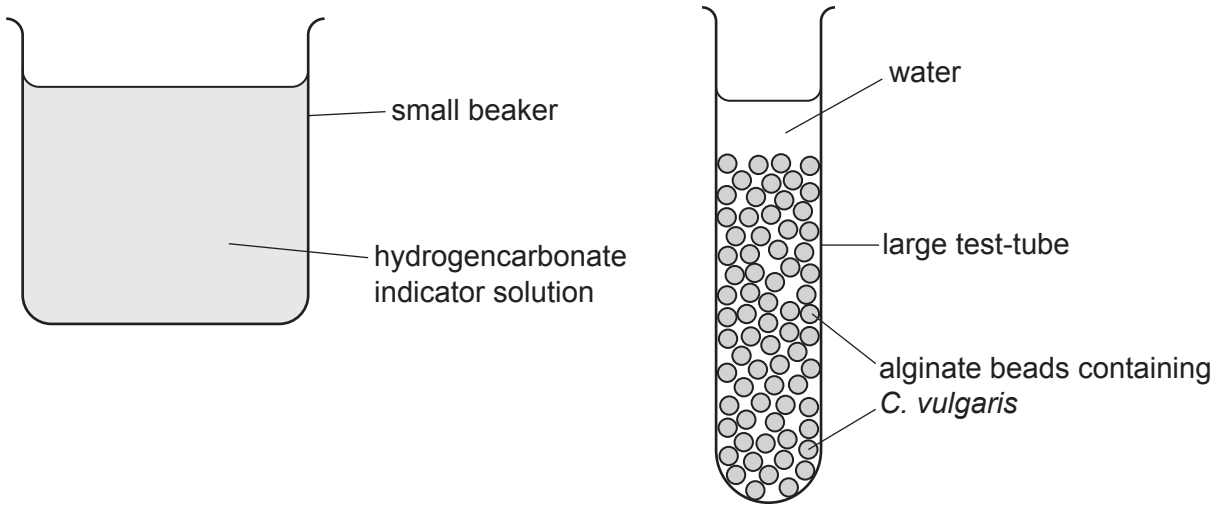


Fig. 1.1

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

..... [1]

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

Describe a method the student could use to collect data 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. 1.1.

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

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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. 1.2.

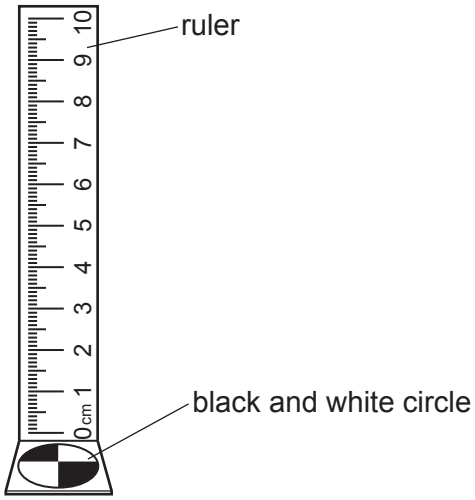


Fig. 1.2

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 1.3.

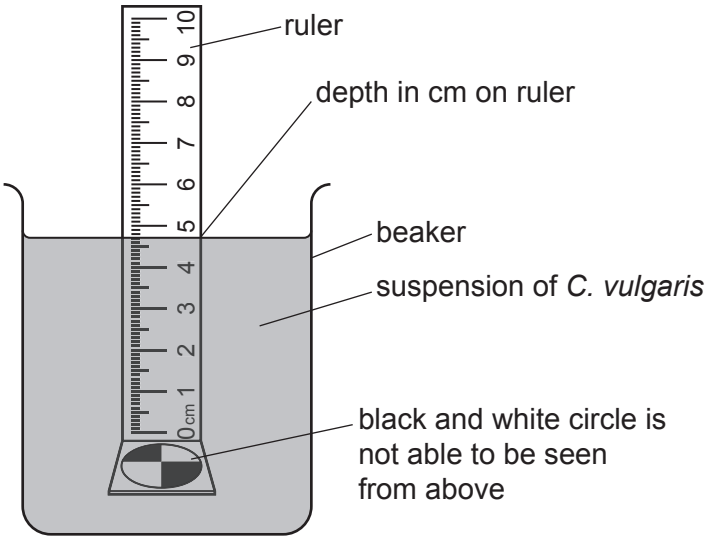


Fig. 1.3

The $\log_{10}$ (lg) 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 1.4.

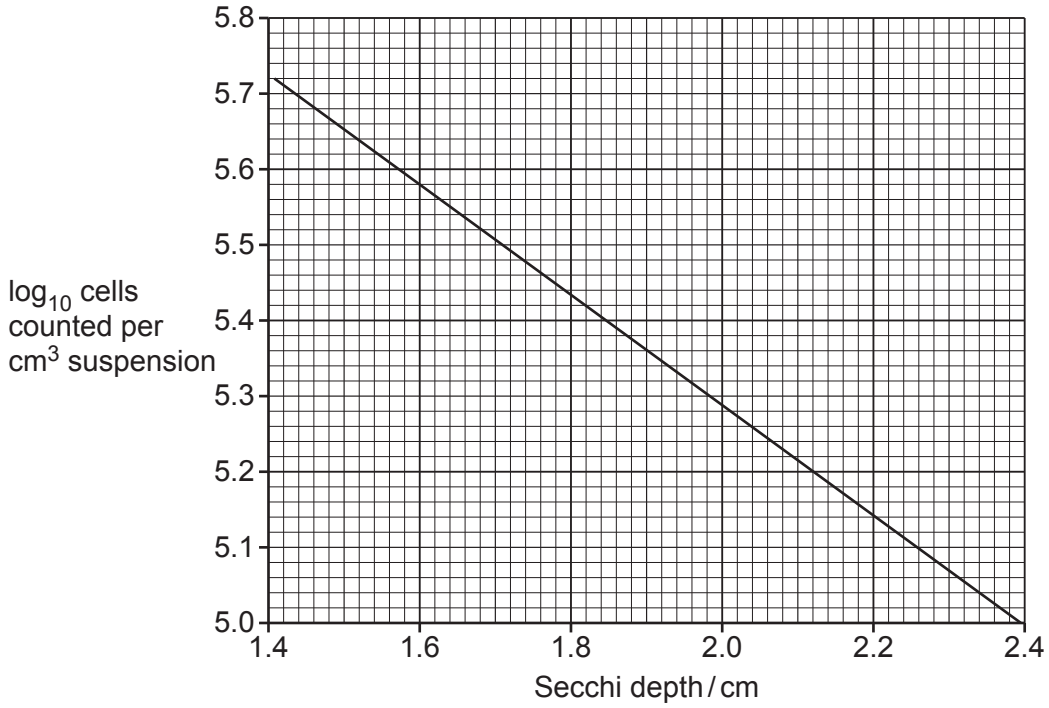


Fig. 1.4

(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. 1.4, 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]

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

Fig. 1.5 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.

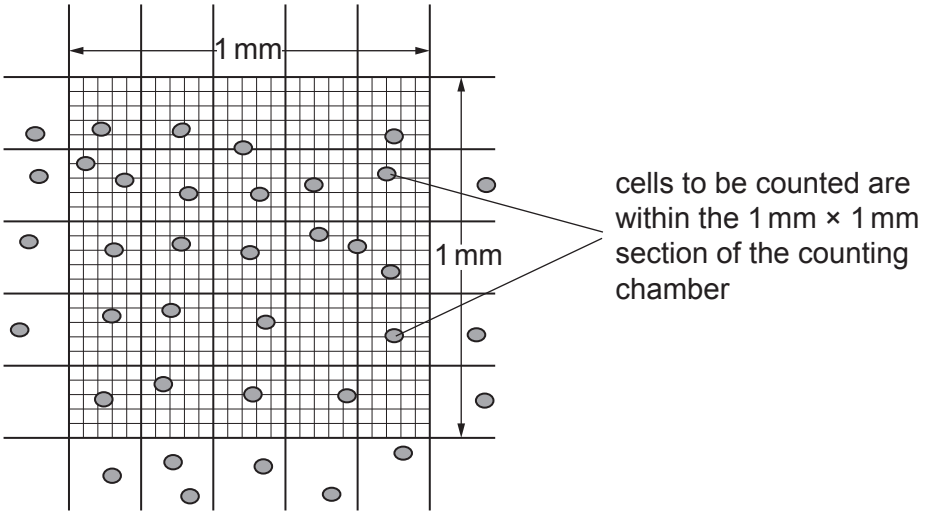


Fig. 1.5

(ii) Count the number of cells in the 1 mm × 1 mm section of the counting chamber shown in Fig. 1.5.

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 ..... [3]

(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 **two** reasons why using the Secchi stick is less accurate than using a counting chamber.

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..... [2]

[Total: 20]

2 Lichens consist of protoctists and fungi living in close association. Both types of organism benefit from this association. Lichens are found in a large range of habitats, including on the trunks of trees.

Fig. 2.1 shows an example of a lichen, the salted shield lichen, *Parmelia saxatilis*, on the trunk of a tree.

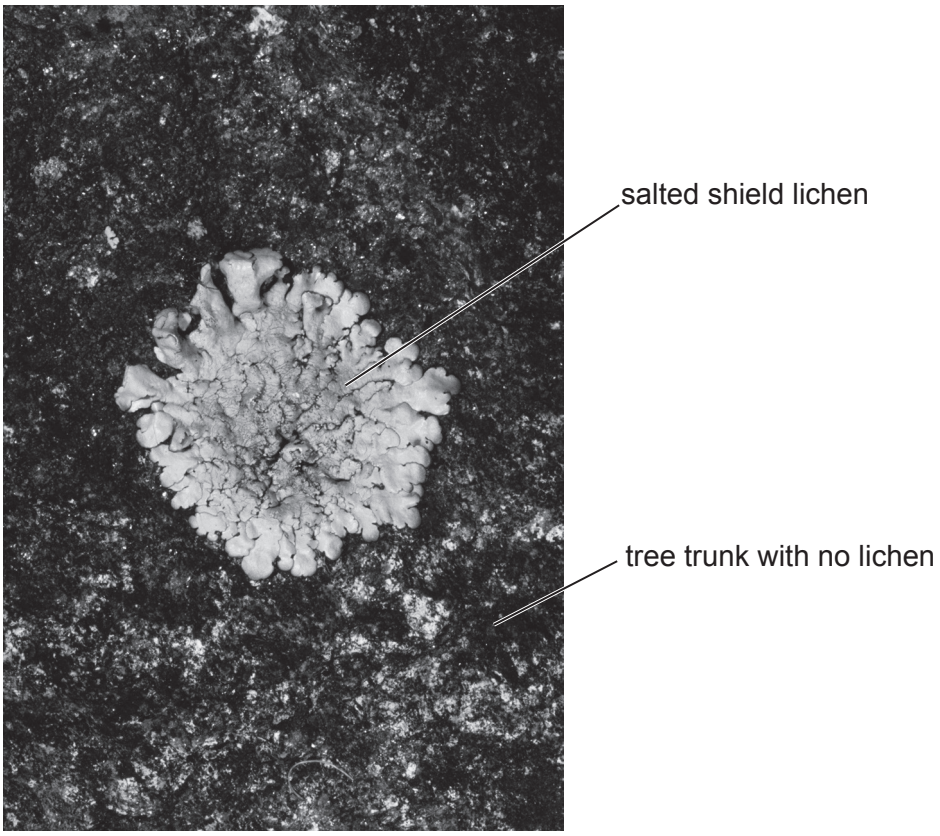


Fig. 2.1

The red deer, *Cervus elaphus*, is found in many parts of the world including north-west Europe. Red deer are found in a large range of habitats, including mixed woodlands. Mixed woodlands contain many different tree species.

Fig. 2.2 shows a male red deer.



Fig. 2.2

Red deer have increased in numbers in the mountainous regions of Scotland in north-west Europe since the 1960s.

Scientists think that grazing of plants by red deer has affected the abundance of certain lichens found growing on the trunks of trees in mixed woodlands.

To investigate this, the scientists excluded red deer from certain mixed woodland areas (exclosures) in 1995, allowing the exclosures to remain ungrazed.

In 2013, the scientists compared the abundance of the salted shield lichen in the exclosures and in the grazed areas.

The scientists used the grid shown in Fig. 2.3 to determine the abundance of the salted shield lichen on the tree trunks.

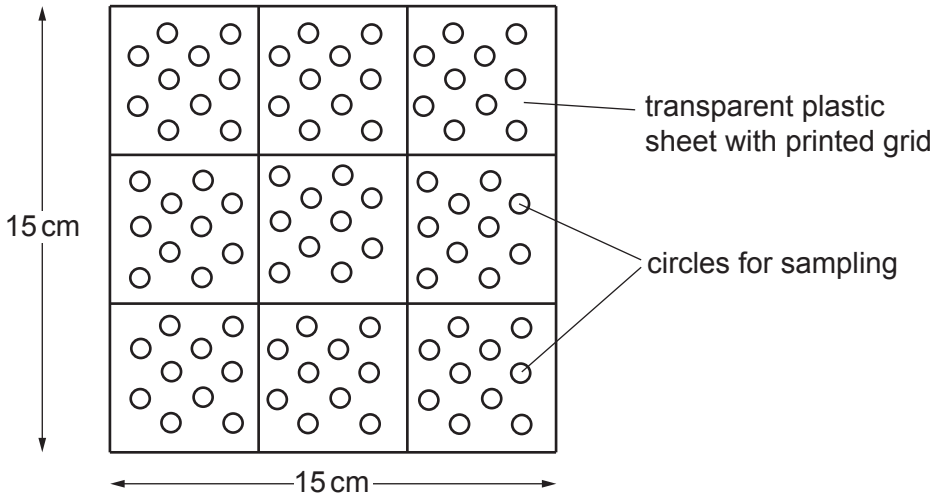


Fig. 2.3

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For each tree sampled:

- The grid was placed against the tree trunk at three different heights: base, middle and upper.
- The scientists counted the number of circles that contained the salted shield lichen.
- The number of circles that contained the salted shield lichen was used to calculate the percentage cover of salted shield lichen on the tree.

This study was carried out over the course of the three months (June, July and August) in the summer of 2013 in the exclosures and the grazed areas.

(a) (i) Suggest **two** variables that the scientists should have standardised in this investigation.

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(ii) State **one** risk **and** the safety precaution that the scientists should take when measuring the abundance of salted shield lichen on the tree trunks.

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(b) The scientists calculated a percentage cover for the salted shield lichen as **63.3%** on one of the trees, using the grid in Fig. 2.3.

Calculate how many circles on the grid contained salted shield lichen.

Show your working and give your answer to the nearest whole number.

number of circles with salted shield lichen = ... [2]

(c) The scientists performed a *t*-test to compare the abundance of the salted shield lichen in the exclosures and the grazed areas.

(i) State a null hypothesis for the *t*-test.

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..... [1]

Table 2.1 shows the mean results and values of *t* the scientists obtained.

Table 2.1

position of grid on tree trunk	mean percentage cover in exclosures	mean percentage cover in grazed areas	*t*	significance at $p = 0.05$
base	1.7	3.2	0.730	not significant
middle	3.4	9.8	2.117	significant
upper	8.5	22.0	2.071	significant

(ii) State **one** conclusion that can be made from the data in Table 2.1.

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(iii) State **two** improvements the scientists could make to their study to determine the effect of grazing of red deer on the abundance of salted shield lichen in mixed woodland areas.

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[Total: 10]

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