Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

BIOLOGY **9700/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2020**

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. Blank pages are indicated.

[Turn over

1 *Chlorella* is a green, single-celled protoctist that is photosynthetic. Some students immobilised cells from a culture of this protoctist using the same method as used for immobilising enzymes.

(a) Outline how the students could immobilise cells of *Chlorella*.

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The students used the respirometer shown in Fig. 1.1 to measure oxygen uptake by the immobilised *Chlorella* cells.

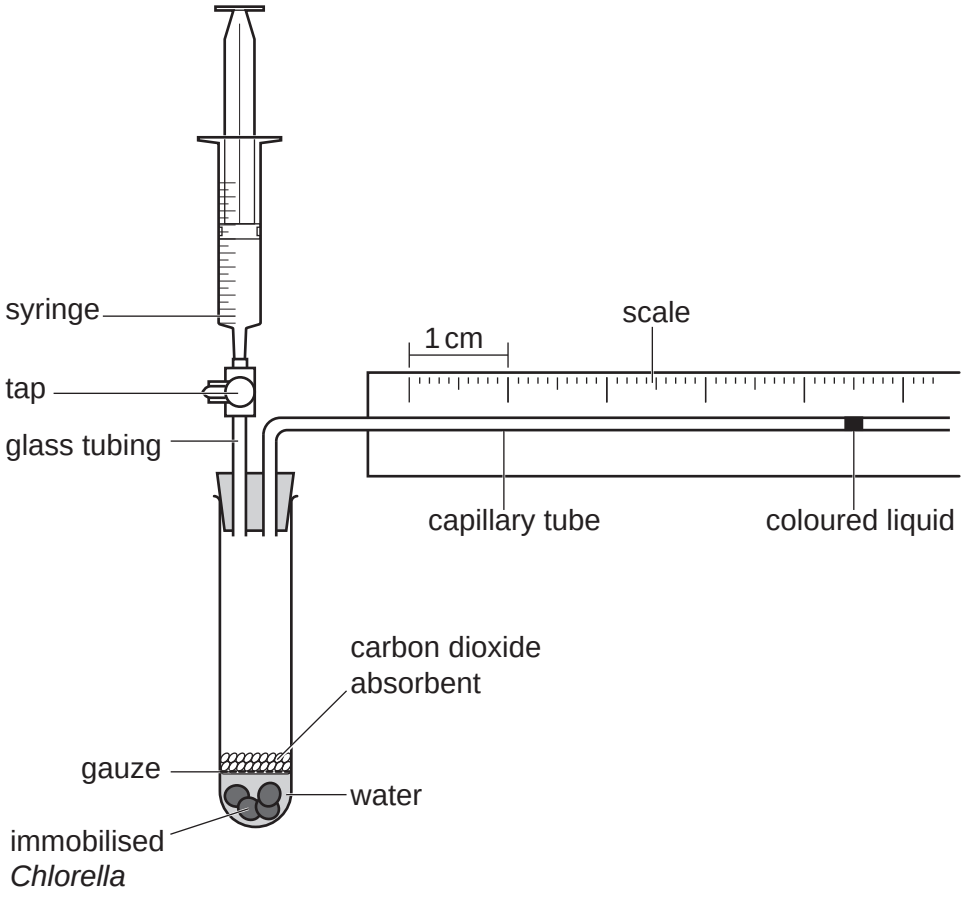

Fig. 1.1

The students used the respirometer to test the hypothesis:

> The volume of oxygen taken up by respiration in immobilised *Chlorella* increases with an increase in temperature.

(b) (i) State the independent variable and the dependent variable in this investigation.

independent variable .....

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dependent variable .....

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[2]

(ii) The students decided to measure oxygen uptake for 5 minutes using a range of temperatures from 10 °C to 50 °C.

Discuss whether the range of temperatures used by the students was suitable for their investigation.

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(iii) Describe a method by which the students could set up the respirometer **and** use it to test their hypothesis:

The volume of oxygen taken up by respiration in immobilised *Chlorella* increases with an increase in temperature.

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

Details of immobilising *Chlorella* are **not** required.

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(c) The students calculated the oxygen uptake for each temperature.

Their results are shown in Table 1.1.

Table 1.1

temperature / °C	10	20	30	40	50
oxygen uptake / mm^3	200	400	800	750	680

(i) Outline how the students calculated the volume of oxygen uptake.

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(ii) State **and** explain **two** conclusions about the trends shown by these results.

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[2]

[Total: 18]

2 **(a)** The cotton bollworm, *Helicoverpa armigera*, is an insect pest of cotton.

The adult cotton bollworm is a moth. The adult female moth lays eggs on cotton plants. The eggs hatch into larvae. The larvae feed on cotton plants by boring holes into the base of flower buds and developing fruits, causing extensive damage and reduction in yield.

Fig. 2.1 shows a mature cotton fruit (cotton boll) from an uninfested plant.

Fig. 2.2 shows a cotton bollworm inside a developing cotton boll.

Fig. 2.1

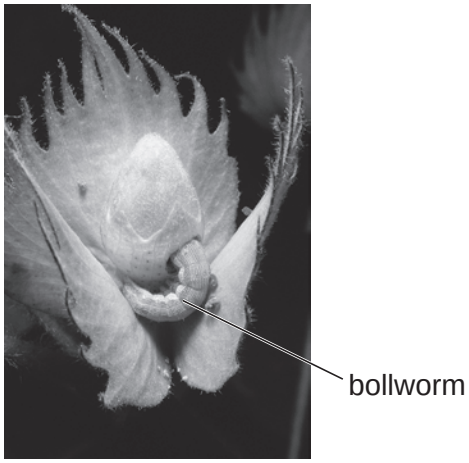

Fig. 2.2

A gene, *cry*, from the bacterium *Bacillus thuringiensis* (Bt), can be inserted into the cotton genome to produce Bt cotton.

- The protein coded by *cry* is toxic to some insects.
- This toxicity gives cotton plants some resistance to cotton bollworm.

Bt cotton was first approved for commercial use in China in 1997. By 2001, Bt cotton had been planted extensively in northern China.

A long-term study on the effect of planting Bt cotton on the occurrence of *H. armigera* was carried out at an experimental field station in northern China from 1998 to 2007.

Two varieties of Bt cotton, v1 and v2, and two varieties of non-Bt cotton, v3 and v4, were used.

A number of fields, covering over 2000 hectares, were divided into standard sized plots. Bt cotton or non-Bt cotton were planted in randomised plots.

Fig. 2.3 shows **one** possible arrangement of the plots in **one** field.

v3	v1	v1	v3
v4	v2	v4	v1
v2	v4	v2	v3

Fig. 2.3

- Sampling was carried out every 4 days during the breeding season of *H. armigera*.
- Five fields were selected at random and a total of 100 plants in each plot were examined.
- The total number of eggs and larvae on each plant was counted.

(i) State **two** ways in which the design of the field study contributes to the validity of the results.

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[2]

(ii) Suggest **two** variables which **cannot** be standardised in this field study.

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[2]

(b) Table 2.1 shows the results of this study.

Table 2.1

year	density of eggs / mean number of eggs per 100 plants		density of larvae / mean number of larvae per 100 plants	
	Bt cotton (v1 + v2)	non-Bt cotton (v3 + v4)	Bt cotton (v1 + v2)	non-Bt cotton (v3 + v4)
1998	810	920	18	500
1999	995	930	18	340
2000	620	595	72	237
2001	730	782	12	240
2002	200	180	15	173
2003	52	50	24	61
2004	6	5	15	54
2005	120	120	27	75
2006	422	420	33	144
2007	195	190	8	8

(i) The researchers decided to calculate the standard error for each of the mean values shown in Table 2.1.

State why they decided to calculate standard error.

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(ii) The *t*-test could be used to find out if the difference in the mean number of larvae on Bt cotton and non-Bt cotton in each year is significant.

Explain why the *t*-test could be used to analyse the data in Table 2.1.

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(iii) A trend is a change over time.

Describe **three** trends shown by the data in Table 2.1.

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Question 2 continues on page 10

(c) *H. armigera* is a pest on a variety of other crop plants in Asia such as peanuts, soya and rice.

Another long-term field study was carried out to investigate the effect of growing Bt cotton on the density of the larvae of *H. armigera* on other crop plants growing in the same region of northern China.

Table 2.2 shows the results of this study.

Table 2.2

	year	mean population density per year of larvae on other crop plants / number per hectare
before the commercial use of Bt cotton	1992 to 1996	5865
after the commercial use of Bt cotton	1997 to 2001	2011
	2002 to 2006	761

(i) State **one** variable that should be standardised in this field study.

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(ii) Suggest **one** conclusion about the effect of Bt cotton on *H. armigera* that could account for the results in Table 2.2.

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[Total: 12]

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