Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME	
CENTRE NUMBER	CANDIDATE NUMBER

5839121393

BIOLOGY **9700/53**

Paper 5 Planning, Analysis and Evaluation **October/November 2016**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

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.

This document consists of **9** printed pages and **3** blank pages.

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CAMBRIDGE International Examinations

1 **(a)** The opening and closing of stomata involves the movement of potassium ions into and out of guard cells in response to environmental factors, for example light and water stress.

This movement of potassium ions is influenced by the concentration of calcium ions in the cytoplasm of guard cells. When plants are water stressed, abscisic acid (ABA) release causes the concentration of calcium ions in the cytoplasm to increase. The increase in calcium ions causes a series of changes resulting in the loss of potassium ions, so the stomata close in light.

A student investigated the effect of calcium chloride in overcoming the effect of light on stomata.

The student was provided with:
- 500 cm^3 of 1.0 mmol dm^{-3} buffered calcium chloride ($CaCl_2$) solution
- freshly picked leaves from a plant that had been kept in light for 2 hours so that all the stomata were open.

The student soaked three epidermal strips of leaves in each of a range of calcium chloride solutions for 3 hours and recorded the number of closed stomata. An epidermal strip is made by peeling the epidermis from a leaf as a single layer.

(i) Identify the independent and dependent variables in this investigation.

independent variable .....

.....

dependent variable .....

.....[2]

(ii) The student used the 1.0 mmol dm^{-3} $CaCl_2$ solution provided to prepare 50 cm^3 of four other concentrations by reducing the concentration by half each time.

State the method that the student used to make these four concentrations.

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.....[1]

(b) **(i)** Suggest a hypothesis that the student could test about the effect of $CaCl_2$ on the opening and closing of stomata.

.....

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.....[1]

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(ii) Describe a method the student could use to investigate the effect of different concentrations of $CaCl_2$ solution on the closing of stomata.

Your method should be detailed enough for another person to follow and should **not** include the details of how to dilute the 1.0 mmol dm^{-3} solution of $CaCl_2$.

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(c) The student also tested the hypothesis:

The stomata on the upper epidermis of a leaf and the stomata on the lower epidermis respond differently to ABA.

- Young leaves that had just expanded were removed from seedling plants and cut into strips 5 mm wide and 10 mm long.
- The upper and lower epidermis were removed from five leaf strips and put into the same concentration of buffered ABA solution.
- This process was repeated for each different concentration of ABA solution.
- These were left in a constant environment and supplied with carbon dioxide-free air for two hours.
- The diameter of each stomatal aperture was measured using an eyepiece graticule.
- The eyepiece graticule was calibrated using a stage micrometer at ×400 and the stomata measured at the same magnification using the same microscope.
- 10 randomly selected stomata on each of 5 epidermal strips from the lower and upper epidermis were measured at each ABA concentration.

(i) State two ways in which the method of measuring the diameter of the stomata has been standardised.

1. .....

2. .....[1]

Fig. 1.1 shows stomata at different stages of opening.

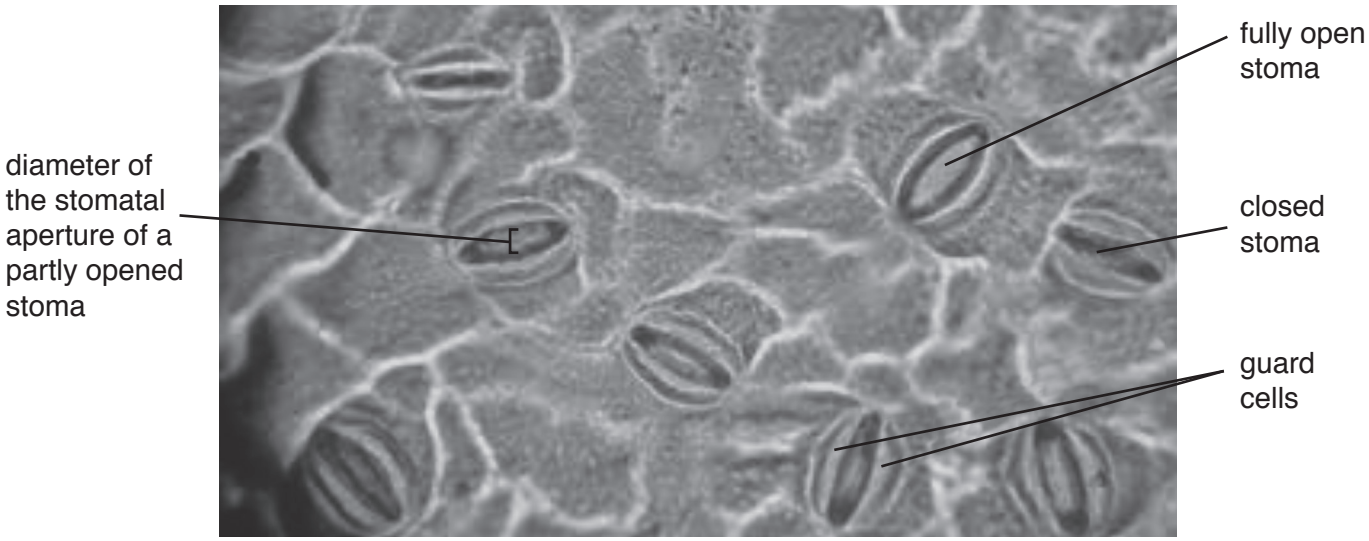

Fig. 1.1

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(ii) Fig. 1.2 shows the eyepiece graticule and stage micrometer used by the student.

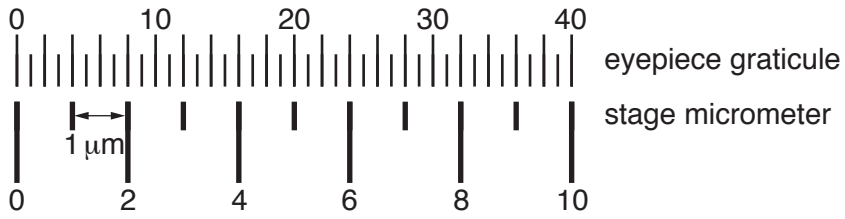

Fig. 1.2

The diameter of a stomatal aperture was 3 eyepiece units.

Calculate the actual size of the aperture.

..... μm [1]

(d) Fig. 1.3 shows the results of the experiment. The 95% confidence limits are shown for each mean stomatal aperture.

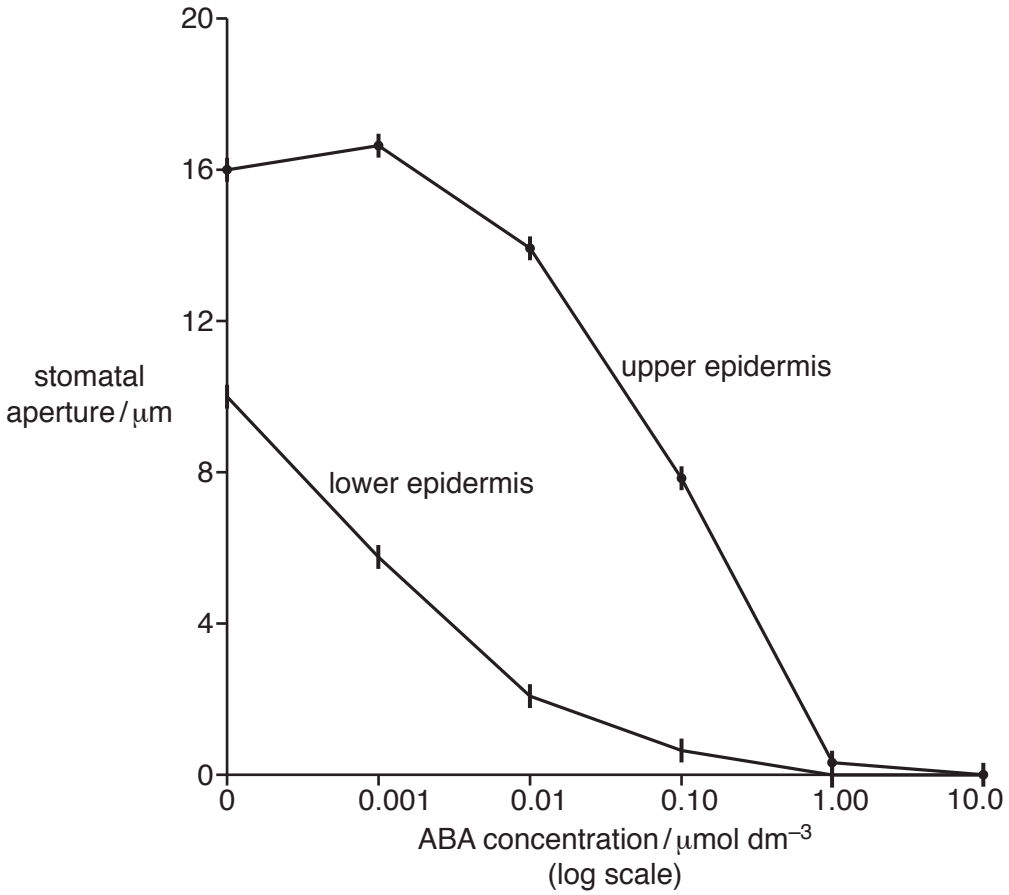

Fig. 1.3

(i) State **one** piece of evidence in Fig. 1.3 that supports the student's hypothesis that:

The stomata on the upper epidermis of a leaf and the stomata on the lower epidermis respond differently to ABA.

.....

.....[1]

(ii) The confidence limit of each of the mean values plotted on Fig. 1.3 is 95%.
State what this tells you about each mean value.

.....

.....[1]

(iii) State a statistical test that could be used to find out if the difference in the stomatal aperture at different concentrations of ABA is significant.

Give a reason for your choice.

test .....

reason .....[2]

(e) The experimental procedure carried out by the student was considered to have given data that could be trusted to support the hypothesis:

The stomata on the upper epidermis of a leaf and the stomata on the lower epidermis respond differently to ABA.

Describe the aspects of the experimental procedure which ensure that the data can be trusted.

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[Total:19]

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2 A common weed in barley fields is couch grass. A laboratory investigation was carried out to study the effect of couch grass on the yield of barley.

Barley was grown in standard sized pots in a glasshouse. The number of barley plants per pot was constant. The supply of water and mineral salts, the light and the temperature were controlled automatically. Six replicates of each of four different experiments were carried out.

experiment 1: Couch grass and barley were sown together at the same time.

experiment 2: Couch grass was sown 14 days before the barley.

experiment 3: Barley sown 14 days before the couch grass.

experiment 4: Barley grown alone.

The yield of barley from each of the different experiments was measured.

The results showed that the yield of barley from experiments 1, 3 and 4 were the same.
The results from experiment 2 showed a significant decrease in the yield of barley in comparison to the others.

(a) One hypothesis to explain the results of these experiments is:

Older couch grass roots produce a substance that inhibits the growth of younger barley roots.

(i) Outline how this hypothesis could be tested.

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.....[4]

(ii) Suggest **one other** hypothesis that could explain the results of experiment 2.

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.....[1]

(iii) Suggest a null hypothesis that could be used in a statistical test to compare the yield of barley with the control.

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.....[1]

(b) In a second investigation the biodiversity in two fields of barley was studied.

Barley was planted at the same density in each field and left to grow until it reached maturity.

In one of the fields pesticides (herbicides and insecticides) were used to manage pests. In the other field pesticides were not used.

When the barley was mature, a standard sampling method was used to estimate the number of each different type of organism found in each field. These numbers were used to calculate the species diversity of each field using the formula for Simpson's Index of Diversity (*D*).

$$D = 1 - \left(\sum\left(\frac{n}{N}\right)^2\right)$$

n = number of individuals of each type present in the sample
N = the total number of all individuals of all types
$\sum$ = the sum of

Table 2.1 shows the results of this investigation and some of the calculations for Simpson's Index of Diversity.

Table 2.1

type of organism	mean number of individuals in 10 m^2 samples from fields using pesticides	$\left(\frac{n}{N}\right)^2$	mean number of individuals in 10 m^2 samples from fields without pesticides	$\left(\frac{n}{N}\right)^2$
dicotyledons	3	0.004	60	0.021
monocotyledons	15	0.102	120	0.084
ground beetles	20		45	
butterflies and moths	4	0.007	35	0.007
bees	0	0.000	95	0.053
small mammals	3	0.004	23	0.003
birds	2	0.002	36	0.008
total	47		414	

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(i) Complete Table 2.1 **and** use the data to calculate *D* for both fields of barley.

In fields using pesticides *D* = ...

In fields without pesticides *D* = ...[3]

(ii) State what the results of this investigation show about the effect of pesticides on the plants and animals studied.

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.....[2]

[Total:11]

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