UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4317720761672

BIOLOGY **9700/53**

Paper 5 Planning, Analysis and Evaluation **October/November 2011**

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 ink.
You may use a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

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.

For Examiner's Use	
1	
2	
Total	

This document consists of **8** printed pages and **4** blank pages.

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[Turn over

1 A student collected leaves from three varieties of the same species of a garden plant that has different coloured leaves.

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Variety A	dark red leaves
Variety B	yellow leaves
Variety C	green and white striped leaves

The student made a chloroplast extract from the leaves of each variety and measured the rate of photosynthesis for each extract in different wavelengths of light.

The following procedure was used:

Extracting the chloroplasts

1 place 10 g of leaves in a mortar with an ice cold phosphate buffer solution

2 place the mortar in an ice bath and crush the leaves using a pestle

3 filter the extract through a fine mesh into a small beaker as quickly as possible

4 completely cover the beaker with metal foil and place in an ice bath.

Measuring the rate of photosynthesis

5 add 1 cm^3 of methylene blue to each chloroplast extract

6 re-cover the extracts and keep in an ice bath

7 collect samples of each extract in capillary tubes and keep covered with metal foil

8 for each extract, remove the metal foil and measure the time taken for the blue colour to disappear in different wavelengths of light.

Fig. 1.1 shows how the apparatus was used to measure the rate of photosynthesis for each extract.

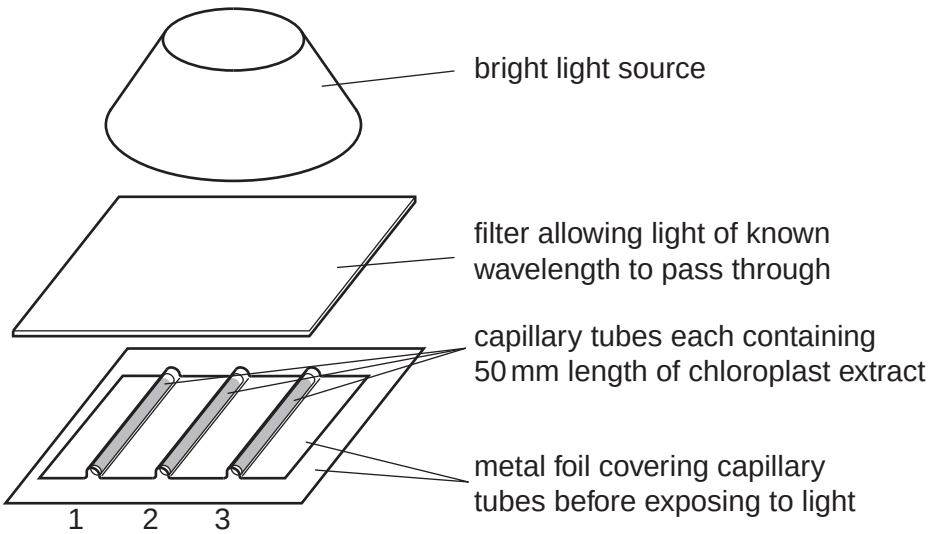


Fig. 1.1

(a) (i) State two independent variables in this investigation.

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1. .....

2. .....
[2]

(ii) State the dependent variable in this investigation.

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..... [1]

(iii) Identify one variable that has been standardised in this investigation.

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..... [1]

(b) State a reason for each of the following procedures:

(i) using a phosphate buffer solution

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..... [1]

(ii) keeping the extract ice cold

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..... [1]

(iii) using a fine mesh to filter the extract.

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..... [1]

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Table 1.1 shows the student's results.

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Table 1.1

wavelength of light / nm	time taken for blue colour to disappear / seconds (s)								
	source of chloroplasts								
	dark red leaf			yellow leaf			green and white striped leaf		
440	9	10	12	28	26	26	13	12	12
500	14	15	13	29	31	33	16	17	15
530	45	44	43	52	45	44	45	43	52
570	32	34	33	34	34	44	34	33	33
650	25	18	17	25	18	16	17	17	18
750	stayed blue after 100 seconds								

Table 1.2 shows the rates of photosynthesis calculated by the student.

Table 1.2

wavelength of light / nm	rate of photosynthesis / s^{-1}		
	source of chloroplasts		
	dark red leaf	yellow leaf	green and white striped leaf
440	0.097	0.038	0.081
500	0.071	0.032	0.063
530	0.023	0.023	
570	0.030	0.029	0.039
650	0.057	0.049	0.058
750	0.000	0.000	0.000

(c) (i) **On Table 1.1** indicate, by placing a circle around each value, **two** results that may be anomalous.

..... [2]

(ii) Complete Table 1.2 by calculating the rate of photosynthesis for the green and white striped leaf at a wavelength of 530 nm. Show your working.

[2]

(d) The student analysed these results and proposed two hypotheses:

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- **There is a pigment in red leaves which is not present in the other leaves.**
- **Yellow leaves do not have a pigment that is found in the other leaves.**

To test these hypotheses the student used chromatography to separate the pigments in the leaves.

(i) Outline a procedure the student could use to extract the leaf pigments and separate them by chromatography.

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Fig. 1.2 shows the chromatograms obtained by the student.

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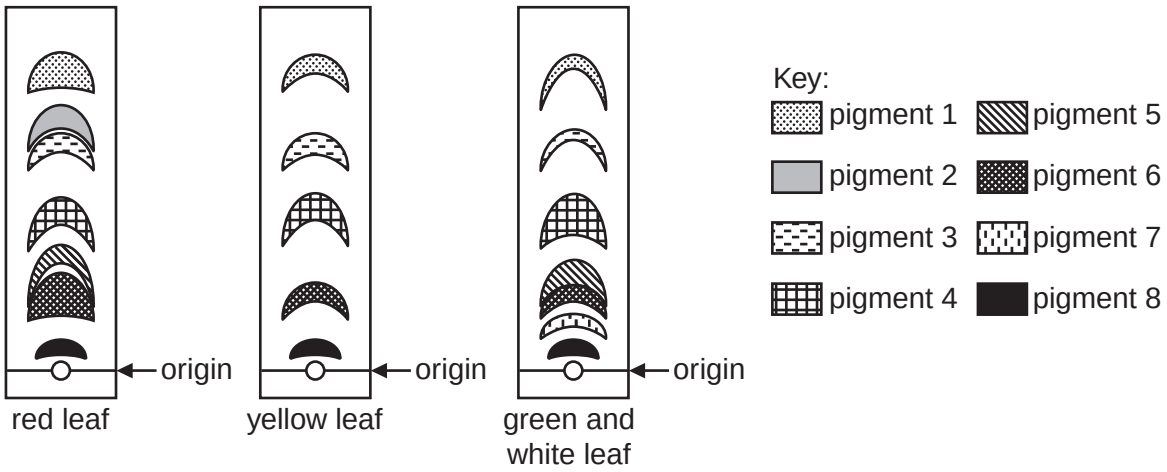


Fig. 1.2

(ii) Use Fig. 1.2 to describe the evidence that supports the student's hypotheses.

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..... [2]

Total: [20]

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Question 2 starts on page 8

2 A variety of domestic cat does not have a tail. This condition is controlled by a single gene with two alleles. These alleles are

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- 'with tail'
- 'without tail'

Table 2.1 shows the results of four crosses between cats with tails and cats without tails Each male was crossed with several females.

Table 2.1

parental phenotype			offspring phenotype			
			male		female	
cross	**male**	**females**	**with tail**	**without tail**	**with tail**	**without tail**
1	without tail	without tail	21	32	19	40
2	with tail	with tail	65	0	70	0
3	with tail	without tail	40	25	25	36
4	without tail	with tail	35	27	38	36

(a) (i) Explain how the results of **crosses 1 and 2** show that the allele 'without tail' is dominant.

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(ii) Explain how the results of **crosses 3 and 4** show that the gene for this condition is **not** sex linked.

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[3]

(b) Based on the results of **cross 1** in Table 2.1 a student decided that:

- the cats without tails are always heterozygous
- the ratio of their offspring 'with tails' and 'without tails' is not as expected for this type of cross.

(i) The student carried out a chi- squared test (χ^2 test) to determine if the offspring ratio in cross 1 differed significantly from that expected of a cross between two heterozygotes.

State **one** reason why the student chose this statistical test.

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..... [1]

(ii) Complete Table 2.2 to calculate the value of χ^2 for the results of cross 1.

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The equation for the calculation of χ^2 is:

$$\chi^2 = \Sigma \frac{(O - E)^2}{E}$$

O = Observed result

E = Expected result

Table 2.2

offspring phenotype	O	E	$\frac{(O - E)^2}{E}$
offspring with tail	40		
offspring without tail	72		
		χ^2 =	

[3]

Table 2.3 shows some critical values for χ^2 at different probability levels.

Table 2.3

degrees of freedom	probability (p)			
	0.10	0.05	0.01	0.001
1	2.71	3.84	6.64	10.83
2	4.61	5.99	9.21	13.82
3	6.25	7.82	11.34	16.27

(iii) State why the student should look for the critical value at 1 degree of freedom in this investigation.

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(iv) State the conclusion from the χ^2 value calculated in **(ii)**.

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(v) Cats without tails are always heterozygous for this gene. Homozygous dominant cats are never born.

Suggest what could account for the effect of the dominant allele in the homozygous condition.

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