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General Certificate of Education Advanced Level

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*2308966973*

**BIOLOGY** **9700/51**

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**

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|---|---|
| 1 | |
| 2 | |
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**1** Photosynthesis was investigated in a species of unicellular alga using the apparatus shown in Fig. 1.1.

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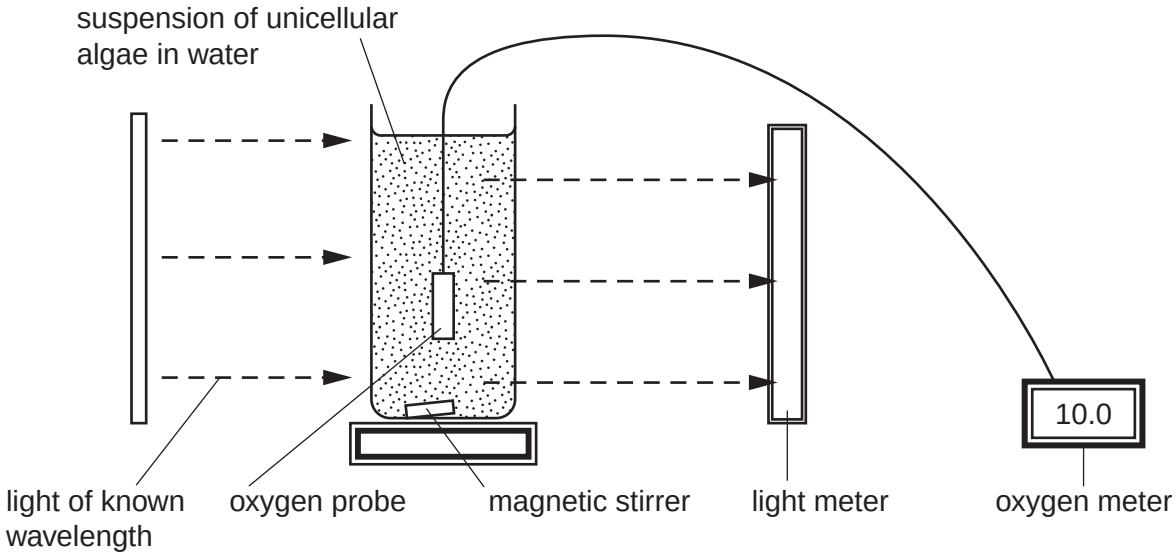



**Fig. 1.1**

Two different strains of the species of alga were tested using a range of different wavelengths of light.

- Light of known wavelength was passed through the tube containing algae for two hours.
- The light transmission through the suspension and the oxygen concentration were then measured.

The results were used to plot the absorption spectrum and the action spectrum for each strain of alga.

Fig.1.2 shows these spectra.

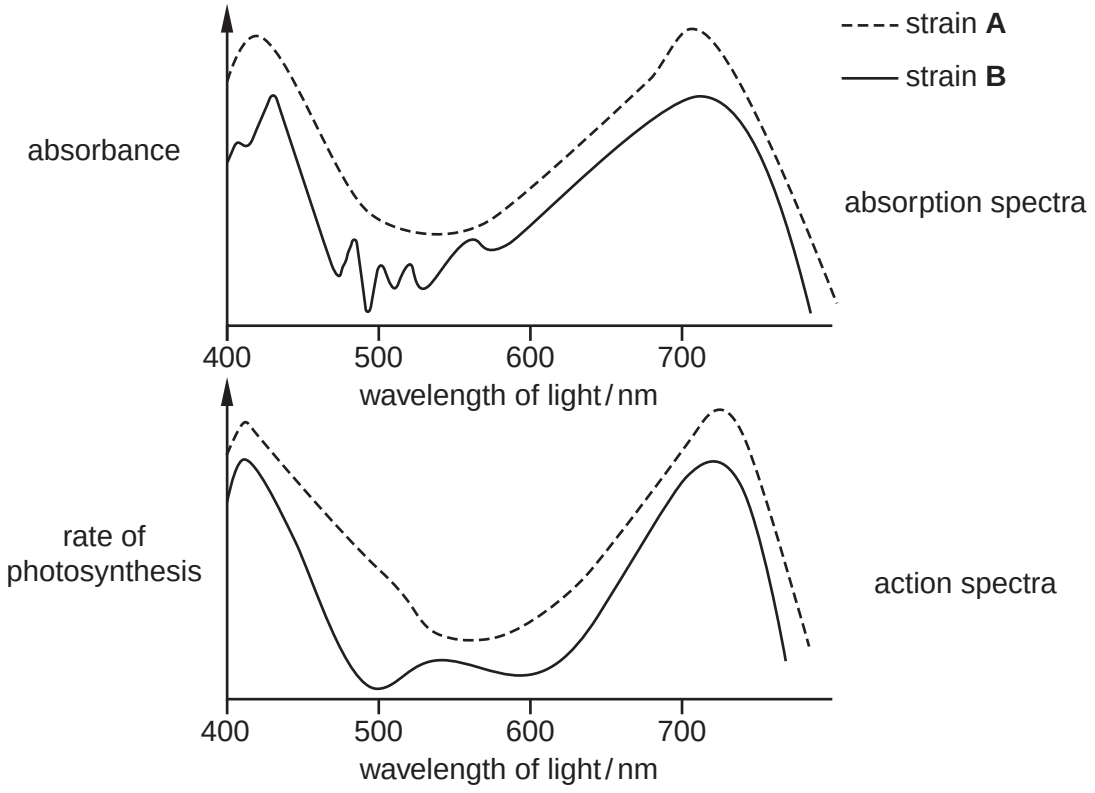



**Fig. 1.2**

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**(a) (i)** State the two dependent variables in this investigation.

1. .....

2. .....[2]

**(ii)** Apart from temperature and pH, which have little effect, state two variables that should be standardised during this investigation.

1. .....

2. .....[2]

**(b) (i)** Water with no suspended algae transmits 100% of the light. State how the data to plot the absorption spectrum was obtained.

.....

..... [1]

**(ii)** State the data which would be used to plot the action spectrum.

..... [1]

The photosynthetic pigments of the algae were extracted and were separated by two-way chromatography.
The pigments were first separated by one solvent and then separated again by a second solvent at right angles to the first solvent.
Fig. 1.3. shows the results for the two different strains.

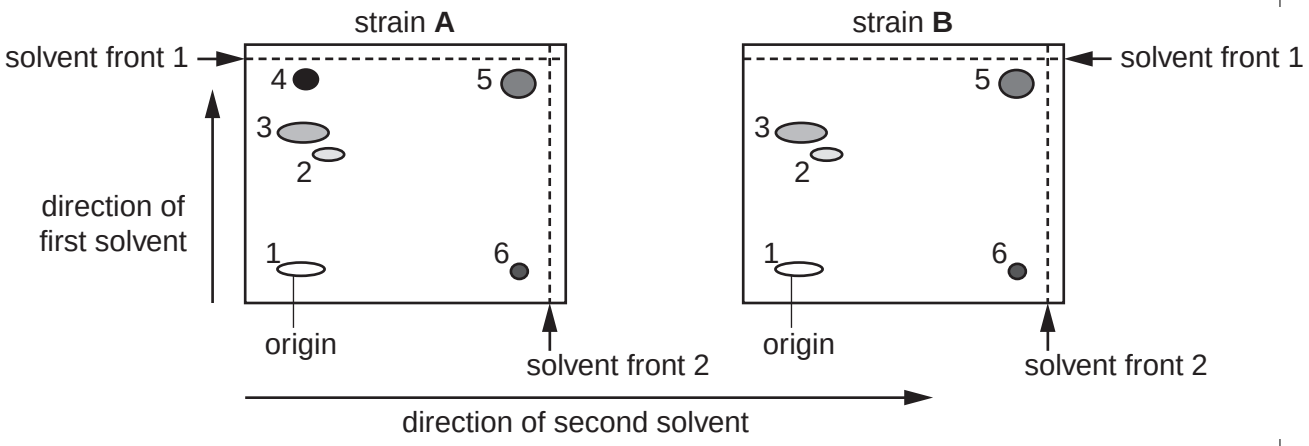



**Fig. 1.3**

**(c)** Using the information in Fig.1.3, suggest why using two different solvents gives a better separation of these pigments than just using one solvent.

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..... [2]

**(d)** Outline a procedure that a student could use to extract the photosynthetic pigments and obtain these chromatograms.

*For Examiner's Use*

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..... [8]

**(e)** Different photosynthetic pigments absorb different wavelengths of light.

*For Examiner's Use*

Table 1.1 shows some information about the pigments, **P**, **Q**, **R**, **S** and **T**, found in these unicellular algae, including the wavelength of light at which maximum light absorption occurs.

**Table 1.1**

| pigment | wavelength of light / nm | Rf value | |
|---|---|---|---|
| | | solvent 1 | solvent 2 |
| **P** | 620 | 0.20 | 0.89 |
| **Q** | 545 and 547 | 0.60 | 0.29 |
| **R** | 420 and 660 | 0.65 | 0.11 |
| **S** | 490 | 0.91 | 0.19 |
| **T** | 430 and 645 | 0.82 | 0.92 |

$$\text{Rf} = \frac{\text{distance moved by pigment}}{\text{distance moved by solvent front}}$$

One of the strains of algae lacks one of the pigments.

Using the information in Table 1.1, Fig. 1.2 **and** Fig. 1.3:

**(i)** identify the strain of alga that lacks one of these pigments and state the letter of the missing pigment

..... [1]

**(ii)** state the evidence that supports your answer to **(i)**.

.....

.....

.....

..... [2]

**(iii)** In water, the shorter the wavelength of light, the deeper it travels.

Suggest why it is an advantage to have the pigment that you identified in **(i)**.

.....

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.....

..... [1]

[Total: 20]

**2** A student carried out some investigations into the inheritance of body colour and wing length in the fruit fly, *Drosophila melanogaster*, to test the hypothesis:

*For Examiner's Use*

The inheritance of body colour and wing length in fruit flies is controlled by two genes on separate chromosomes.

The student carried out three genetic crosses.

To carry out each cross the following procedure was used:

- male and virgin female adult fruit flies were placed into a breeding unit containing a culture medium for their larvae
- after mating and egg laying, the adult fruit flies were removed
- newly emerged adult fruit flies were sexed by observing the shape of the last abdominal segment.

**(a)** Suggest **one** factor that might affect the rate of development of the fruit flies from egg to adult. State **one** method by which it might be controlled.

*factor* .....

*method of control* .....

..... [2]

**(b)** Adult fruit flies are about 2.5 mm long. Suggest how the student might have observed the last abdominal segment in order to sex them.

..... [1]

The three crosses the student carried out were:

**cross 1** pure breeding fruit flies with grey bodies and long wings × pure breeding flies with ebony bodies and short wings

**cross 2** the offspring of cross 1 (offspring 1) were crossed with each other

**cross 3** offspring 1 × pure breeding flies with ebony bodies and short wings

- male and female pupae were transferred to separate breeding units
- the number of newly emerged adult flies in each phenotype was counted.

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Table 2.1 shows the results of the three crosses.

*For Examiner's Use*

**Table 2.1**

| cross | parental phenotypes | | total number of offspring | number of offspring of each phenotypes |
|---|---|---|---|---|
| **1** | pure breeding grey body long wings | × pure breeding ebony body short wings | 62 | 62 grey body long wings |
| **2** | offspring 1 grey body long wings | × offspring 1 grey body long wings | 75 | 42 grey body long wings; 13 ebony body long wings; 15 grey body short wings; 5 ebony body short wings |
| **3** | offspring 1 grey body long wings | × pure breeding ebony body short wings | 64 | 15 grey body long wings; 13 ebony body long wings; 19 grey body short wings; 17 ebony body short wings |

**(c)** The student concluded that the results of **cross 2** showed that the two genes were on separate chromosomes. State the evidence for this conclusion.

.....

..... [1]

**(d)** The student used the chi-squared test ($\chi^2$ test) to analyse the results for **cross 3**. The student predicted that the numbers of fruit flies with each phenotype in this cross should be in the ratio 1 : 1 : 1 : 1.

**(i)** State the null hypothesis for this test.

.....

..... [1]

**(ii)** Complete Table 2.2 to calculate the value of $\chi^2$ for the results of **cross 3**.
The equation for the calculation of $\chi^2$ is:

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

O = Observed result

E = Expected result

**Table 2.2**

| offspring phenotype | O | E | $\frac{(O - E)^2}{E}$ |
|---|---|---|---|
| grey bodies long wings | 15 | | |
| grey bodies short wings | 19 | | |
| ebony bodies long wings | 13 | | |
| ebony bodies short wings | 17 | | |
| | | $\chi^2$ = | |

[3]

Table 2.3 shows some critical values for chi-squared at four different probability levels.

*For Examiner's Use*

**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 |
| 4 | 7.78 | 9.49 | 13.28 | 18.46 |

**(iii)** State why the student should look for the critical value at 3 degrees of freedom in this investigation.

.....

..... [1]

**(iv)** State the conclusion from the $\chi^2$ value calculated in part **(ii)**.

..... [1]

[Total: 10]

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*9210675572*

**BIOLOGY** **9700/52**

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

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

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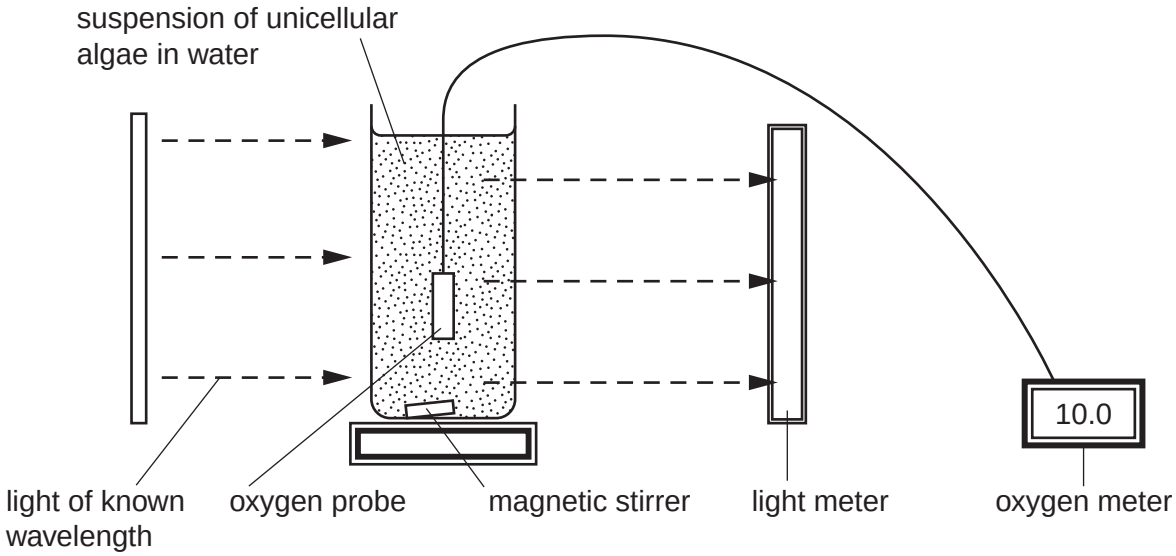



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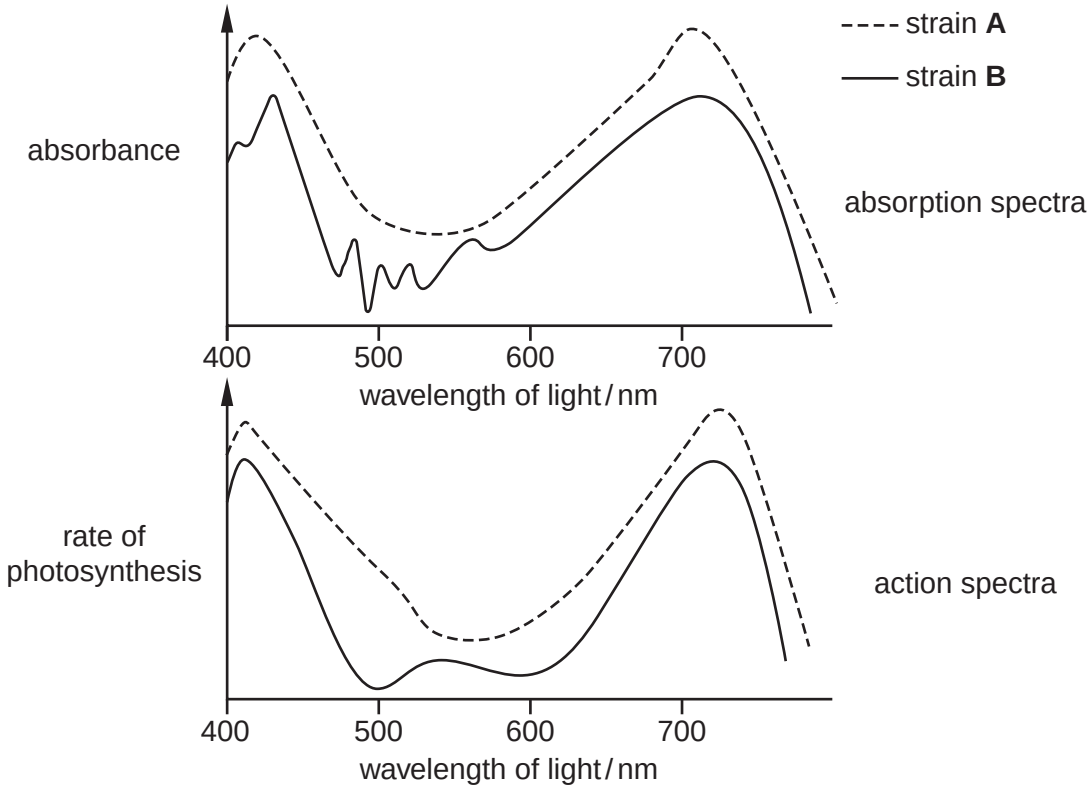



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For Examiner's Use

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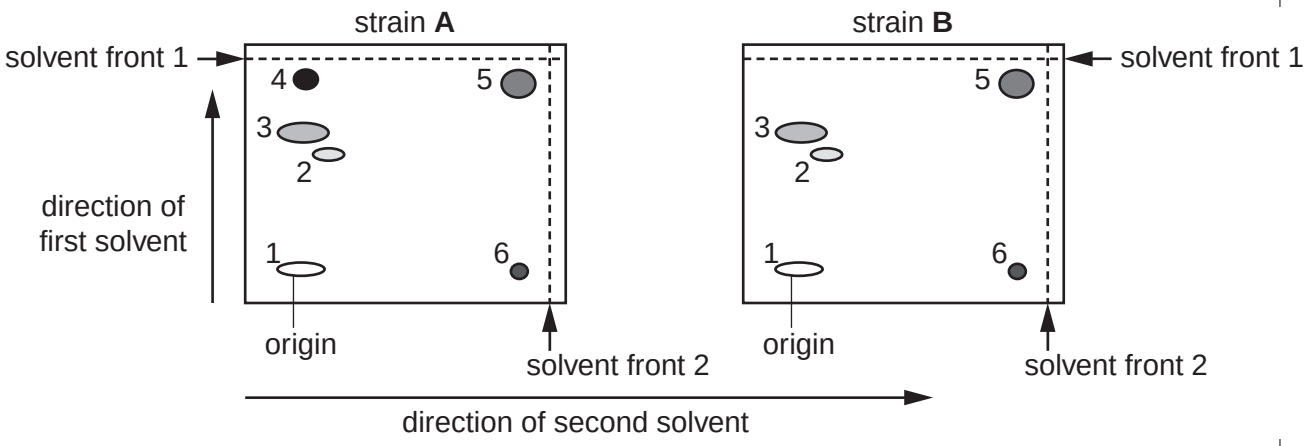



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*For Examiner's Use*

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*factor* .....

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**(iii)** State why the student should look for the critical value at 3 degrees of freedom in this investigation.

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**(iv)** State the conclusion from the $\chi^2$ value calculated in part **(ii)**.

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**BIOLOGY** **9700/53**

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

**1 hour 15 minutes**

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**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.

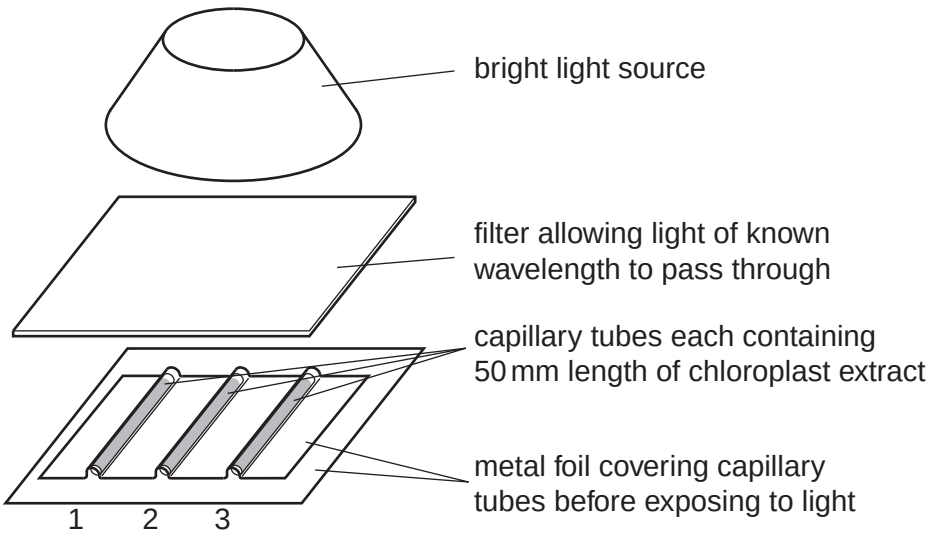



**Fig. 1.1**

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

*For Examiner's Use*

1. .....

2. .....
[2]

**(ii)** State the dependent variable in this investigation.

.....

..... [1]

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

.....

..... [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.

.....

..... [1]

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Table 1.1 shows the student's results.

For Examiner's Use

**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:

*For Examiner's Use*

- **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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..... [7]

Fig. 1.2 shows the chromatograms obtained by the student.

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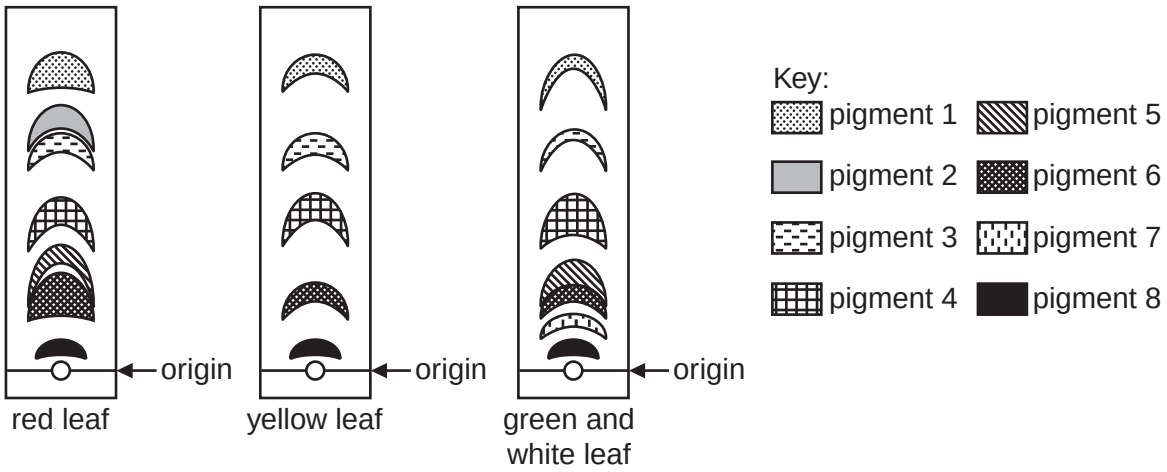



**Fig. 1.2**

**(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**

For Examiner's Use

**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

- '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.

.....

.....

.....

**(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 ($\chi^2$ 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.

.....

..... [1]

For Examiner's Use

**(ii)** Complete Table 2.2 to calculate the value of $\chi^2$ for the results of cross 1.

The equation for the calculation of $\chi^2$ 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 | | |
| | | $\chi^2$ = | |

[3]

Table 2.3 shows some critical values for $\chi^2$ 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.

.....

..... [1]

**(iv)** State the conclusion from the $\chi^2$ value calculated in **(ii)**.

.....

..... [1]

**(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.

.....

..... [1]

Total: [10]

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