UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2308899973

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

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.

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1	
2	
Total	

This document consists of **8** printed pages.

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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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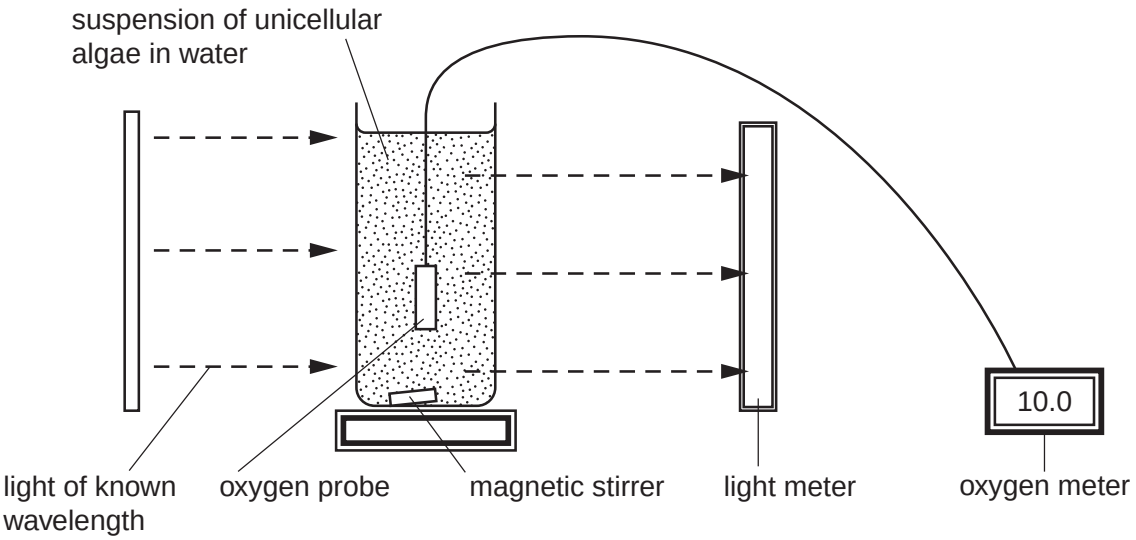

Fig. 1.1

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.

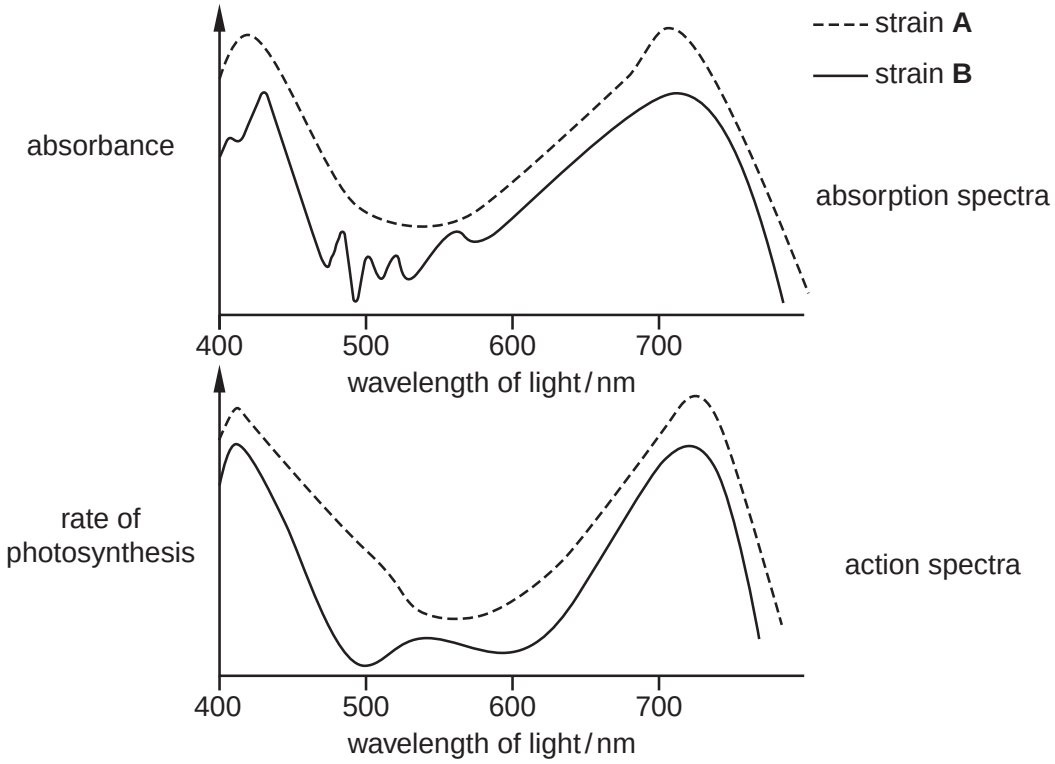

Fig. 1.2

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

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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.

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..... [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.

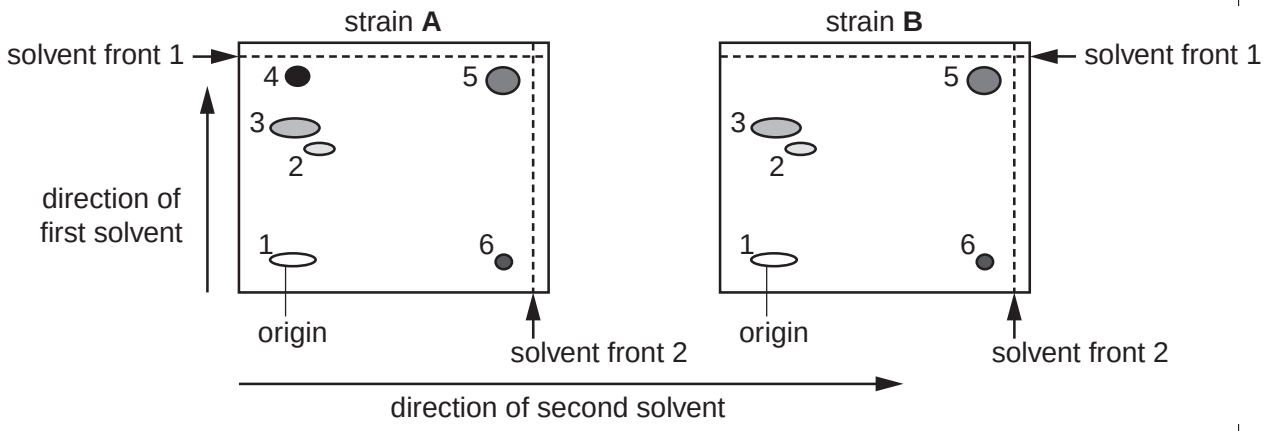

Fig. 1.3

(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.

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

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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)**.

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..... [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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[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:

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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.

Table 2.1 shows the results of the three crosses.

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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.

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..... [1]

(d) The student used the chi-squared test (χ^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.

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..... [1]

(ii) Complete Table 2.2 to calculate the value of χ^2 for the results of **cross 3**.
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	$\frac{(O - E)^2}{E}$
grey bodies long wings	15		
grey bodies short wings	19		
ebony bodies long wings	13		
ebony bodies short wings	17		
		χ^2 =	

[3]

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

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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.

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..... [1]

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

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[Total: 10]