Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8693396902

BIOLOGY **9700/52**

Paper 5 Planning, Analysis and Evaluation **February/March 2024**

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 **16** pages.

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1 Onions are vegetables that are harvested from the plant *Allium cepa*. In many countries, small onions are used to make pickled onions. Pickled onions can be stored for a long time because the growth of microorganisms is prevented.

Pickled onions are made using this method.

- Remove the dry outer layer from small onions.
- Place the onions in a sodium chloride solution for several hours.
- Remove the sodium chloride solution and place the onions in a solution of ethanoic acid (vinegar).

Fig. 1.1 shows a container of pickled onions and some fresh onions that have **not** been pickled.

Fig. 1.1

(a) Some students decided to investigate how placing small onions in different concentrations of sodium chloride solution affects the mass of the onions.

(i) Identify the **independent** variable in this investigation.

.... [1]

(ii) The students were given a 20.0% stock solution of sodium chloride. The students decided to use the stock solution to make sodium chloride solutions with concentrations of 0.0%, 1.0%, 5.0%, 10.0%, 15.0% and 20.0%.

The students made 140 cm^3 of these solutions in separate beakers.

Complete Table 1.1 to show how **140 cm^3** of these solutions could be made by **proportional** dilution of the 20.0% stock solution of sodium chloride.

Table 1.1

percentage concentration of sodium chloride solution	volume of 20.0% sodium chloride solution / cm^3	volume of .... / cm^3
0.0		
1.0		
5.0		
10.0		
15.0		
20.0		

[2]

(b) The students carried out this procedure.

- The dry outer layer was removed from 30 small onions.
- Five of the small onions were placed into each of the six beakers containing the sodium chloride solutions prepared by the students.
- The onions were left in the sodium chloride solutions for **2 hours**.
- The mean percentage change in mass of the five small onions in each beaker was calculated.

The students then repeated the whole procedure using a new set of 30 small onions. This time the onions were left in the sodium chloride solutions for **48 hours**.

Fig. 1.2 shows the results of the investigation.

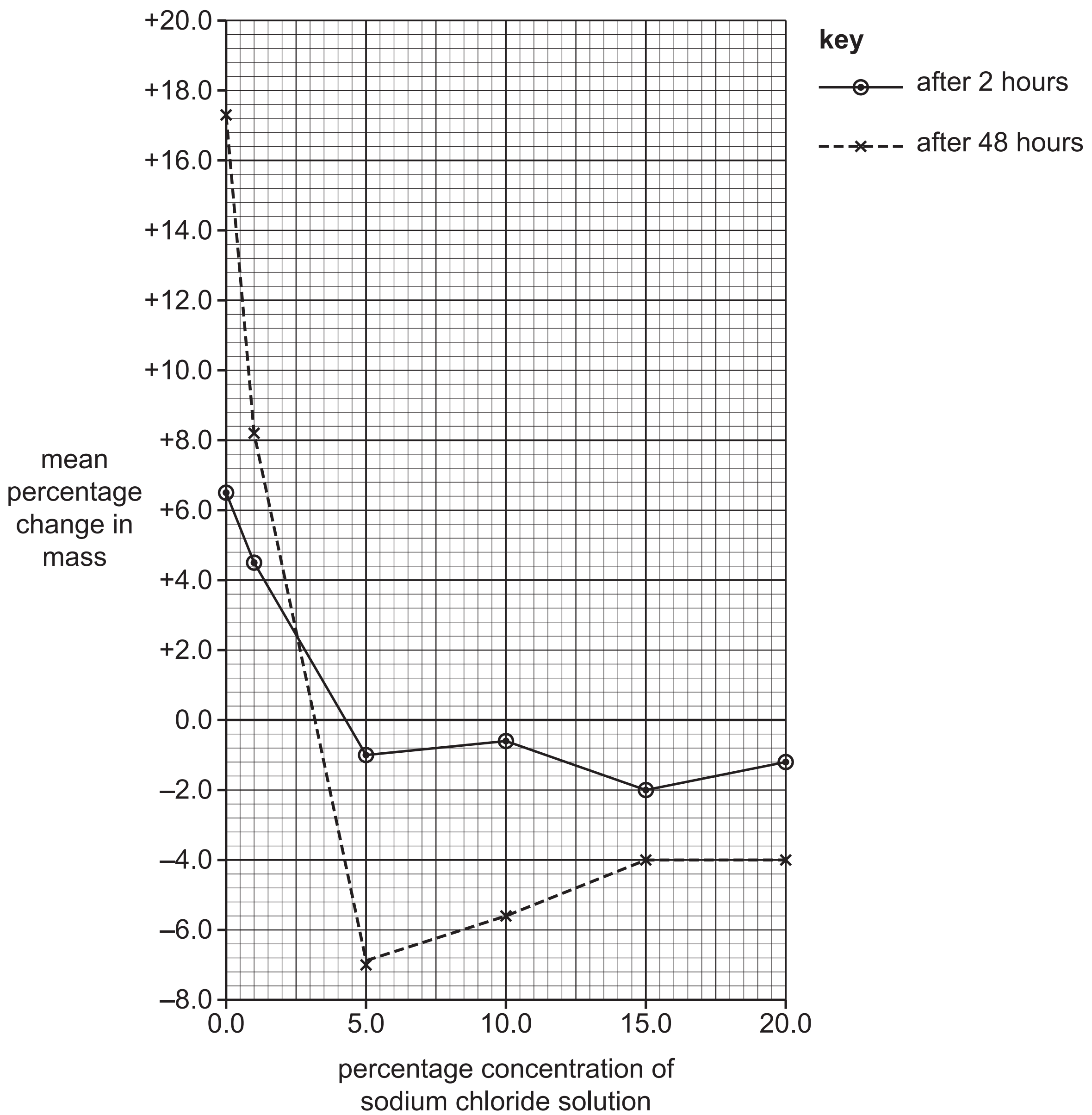

Fig. 1.2

(i) Explain why the students calculated the percentage change in mass of the onions.

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.... [1]

(ii) One of the students concluded that:

> The water potential of the onion cells is the same as the water potential of a 4.2% sodium chloride solution.

With reference to the information provided, including the results shown in Fig. 1.2, suggest reasons why this conclusion should **not** be accepted.

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.... [4]

(c) The turnip, *Brassica rapa*, is a root vegetable. Turnips are grown in many parts of the world.

Fig. 1.3 shows freshly harvested turnips with the leaves still attached.

Fig. 1.3

A student decided to investigate the effect of temperature on the rate of osmosis in turnips.

In an initial test, the student removed the outer layer from a turnip and cut the turnip into small blocks. The student placed one of the turnip blocks into a beaker of distilled water, as shown in Fig. 1.4. Water entered the block by osmosis.

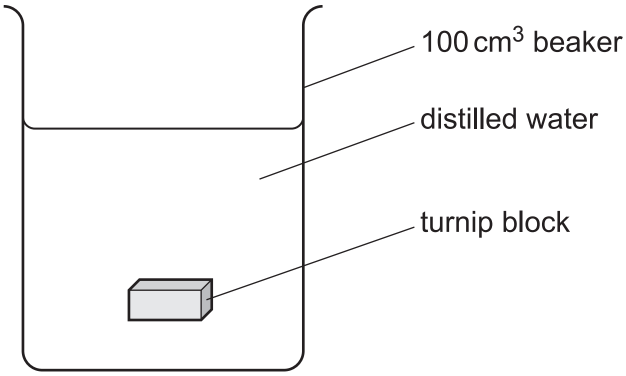

Fig. 1.4

(i) The student was provided with additional turnips and standard laboratory apparatus.

Describe a method that the student could use to investigate the effect of increasing the **temperature**, over a range from 10 °C to 50 °C, on the **rate of osmosis** in turnip blocks.

Do **not** include the risk assessment or how to calculate the rate of osmosis from the results.

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

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.... [6]

(ii) Complete the sketch graph shown in Fig. 1.5 to predict the effect of increasing the temperature, over a range from 10 °C to 50 °C, on the rate of osmosis in turnips.

Include axis labels with units in your answer.

Fig. 1.5

[2]

(iii) Suggest **one** hazard of your method in **(c)(i)**, the risk associated with the hazard and the precaution that would need to be taken.

hazard ....

....

risk ....

....

precaution ....

....

[1]

[Total: 17]

2 *Drosophila melanogaster* is a small fruit fly that is often used in research on genetics.

Wild fruit flies normally have dark red eyes due to the presence of a brown pigment, ommochrome, and a bright red pigment, drosopterin.

Fig. 2.1 shows an adult female fruit fly and an adult male fruit fly.

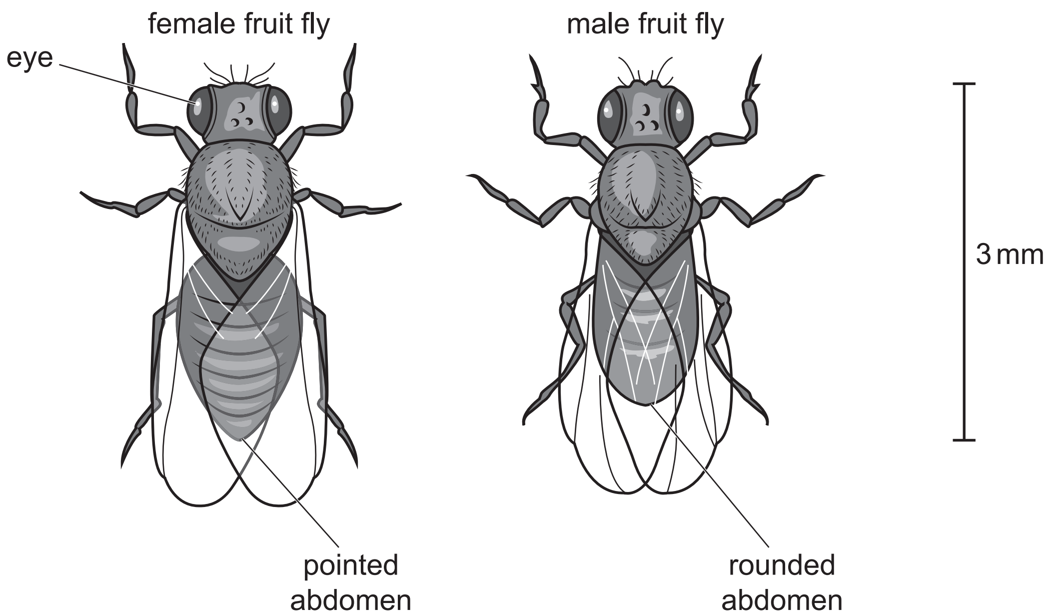

Fig. 2.1

A biologist carried out an investigation to determine the roles of two genes that are involved in the determination of eye colour in adult fruit flies. Both genes have two alleles.

Earlier research by other scientists suggested that:

- the synthesis of the brown pigment ommochrome depends on the gene **B/b**
- the synthesis of the bright red pigment drosopterin depends on the gene **R/r**.

The biologist obtained the parent fruit flies shown in Table 2.1.

Table 2.1

parent fruit flies	genotype	phenotype
female	BBrr	brown eyes
male	bbRR	bright red eyes

The biologist carried out the procedure shown in Fig. 2.2 to cross the parent fruit flies and obtain first generation offspring.

Some agar jelly containing nutrients and water was placed in the bottom of several specimen tubes.

↓

On day 1, four adult female fruit flies with brown eyes and four adult male fruit flies with bright red eyes were placed in each specimen tube.

↓

A piece of cotton wool was placed in the top of each specimen tube.

↓

The specimen tubes were left in a warm room for several days. During this time, the parent fruit flies reproduced and laid fertilised eggs on the agar jelly. The fertilised eggs hatched into larvae that fed on the agar jelly.

↓

On day 7, the parent fruit flies were removed from each specimen tube.

↓

By day 12, the first generation of adult fruit flies had developed from the larvae and were ready for crossing to produce the second generation.

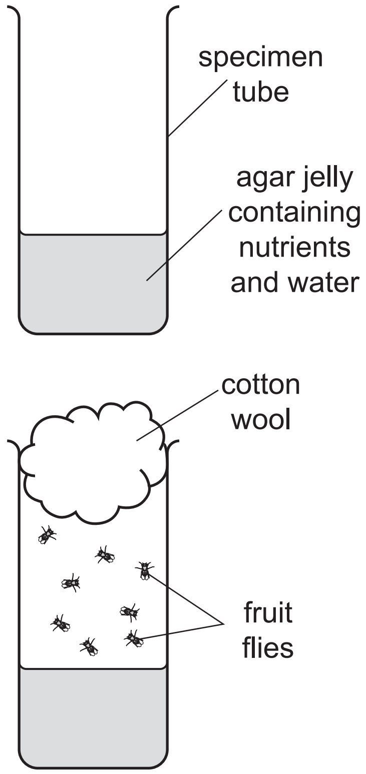

Fig. 2.2

(a) Suggest a reason why the biologist removed the parent fruit flies from the specimen tubes on day 7.

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.... [1]

The biologist wanted to cross the first generation of fruit flies with one another to produce the second generation of fruit flies.

The first generation of adult fruit flies in the specimen tubes on day 12 were a mixture of females and males and had **not** yet mated.

The biologist crossed the first generation of fruit flies with one another by:

- preparing fresh specimen tubes in which to produce the second generation of fruit flies
- using a chemical to anaesthetise the first generation of adult fruit flies so that they were temporarily unable to move
- separating the adult female fruit flies and adult male fruit flies
- placing four adult female fruit flies **and** four adult male fruit flies into each of the fresh specimen tubes.

(b) Suggest a method that the biologist could use to separate anaesthetised adult **female** fruit flies and anaesthetised adult **male** fruit flies **and** place four of each into a fresh specimen tube.

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.... [1]

(c) The biologist expected the cross to result in a phenotypic offspring ratio of 9 : 3 : 3 : 1 in the second generation.

Table 2.2 shows the results of this cross.

Table 2.2

offspring phenotype (second generation)	expected phenotypic ratio	observed number
dark red eyes	9	691
brown eyes	3	260
bright red eyes	3	225
white eyes	1	72
total		1248

The biologist used the chi-squared (χ^2) test to compare the observed and expected results for this cross.

(i) State the null hypothesis for this chi-squared (χ^2) test.

....

.... [1]

(ii) The equation for the calculation of χ^2 is:

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

key to symbols:

O = observed result
E = expected result
Σ = sum of

Complete Table 2.3 to calculate the value of χ^2 for the results of this cross shown in Table 2.2.

Give the value of χ^2 to **four** significant figures.

Table 2.3

offspring phenotype (second generation)	O	E	$O - E$	$(O - E)^2$	$\frac{(O-E)^2}{E}$
dark red eyes	691				
brown eyes	260				
bright red eyes	225				
white eyes	72				
total	1248				

χ^2 = ...

[3]

(iii) The biologist compared the calculated value of χ^2 to the critical values at different probability values shown in Table 2.4.

Table 2.4

degrees of freedom	**probability (p)**					
	0.95	**0.90**	**0.50**	**0.10**	**0.05**	**0.01**
2	0.103	0.211	1.386	4.605	5.991	9.210
3	0.352	0.584	2.366	6.251	7.815	11.345
4	0.711	1.064	3.357	7.779	9.488	13.277

Using Table 2.4 and the calculated value of χ^2 in **(c)(ii)**, explain whether the null hypothesis should be accepted or rejected.

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.... [2]

(d) More recent research has shown that gene **B/b** and gene **R/r** code for polypeptides in carrier proteins. These carrier proteins are found in organelle membranes of the pigment cells of the eyes of adult fruit flies.

- Gene **B/b** codes for a polypeptide in the tryptophan carrier protein. Tryptophan is an amino acid.
- Gene **R/r** codes for a polypeptide in the guanine carrier protein.

Fig. 2.3 shows how the dark red eye colour of wild fruit flies is produced in organelles in pigment cells of the eyes.

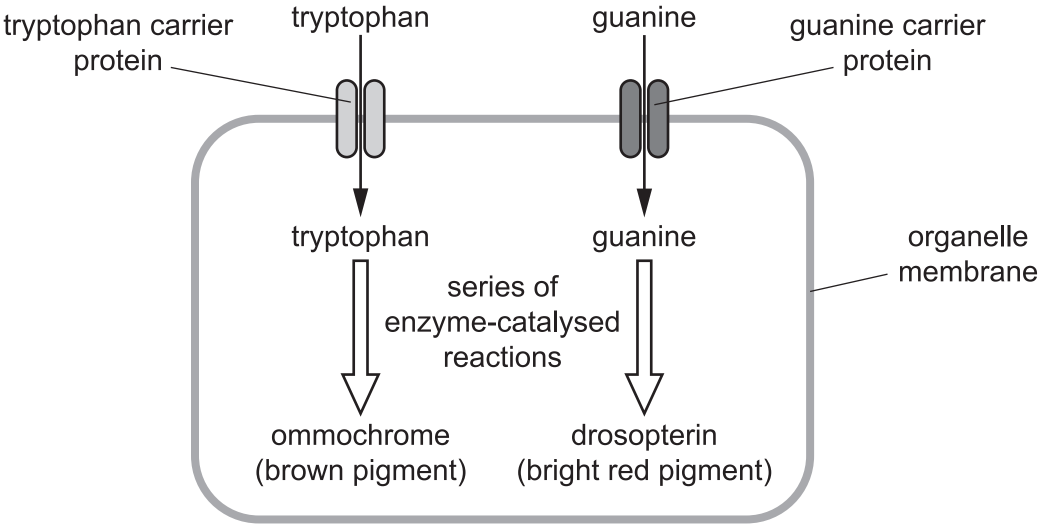

Fig. 2.3

The biologist decided to analyse all the pigments present in the eyes of the second generation of fruit flies.

The biologist started by extracting eye pigments from the adult fruit flies with **dark red eyes** and from the adult fruit flies with **white eyes**. The biologist then added a small volume of each liquid extract to chromatography paper and separated the pigments present by chromatography.

Fig. 2.4 shows the chromatography paper at the end of the procedure when viewed using visible light and ultraviolet light.

Pigment 1 and pigment 3 were visible only when viewed under ultraviolet light. Under visible light, pigment 2 was yellow and pigment 4 was bright red.

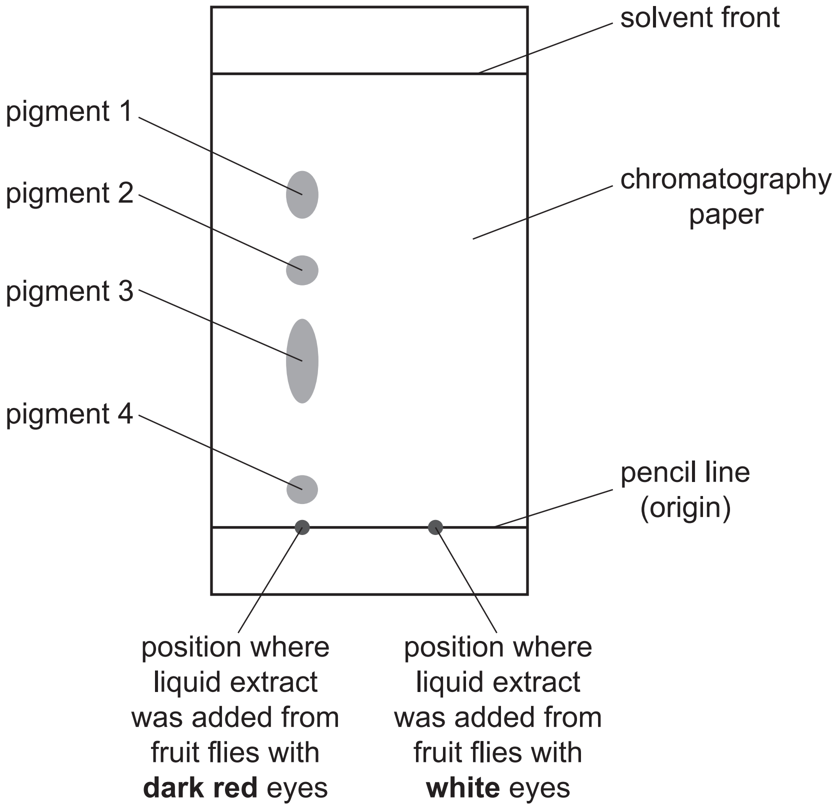

Fig. 2.4

The biologist calculated R_f values for each pigment on the chromatography paper. The biologist used the R_f values to confirm the identity of the pigments using a published source.

(i) The formula for the calculation of R_f is:

$$R_f = \frac{\text{distance moved by pigment}}{\text{distance from origin to solvent front}}$$

When measuring the distance moved by the pigment, the distance to the centre of the pigment should be measured.

Use Fig. 2.4 to calculate the R_f value of **pigment 1**.

R_f = ... [1]

(ii) State the conclusions that can be made from the results of the fruit fly breeding experiment in **(c) and** from the chromatography results.

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.... [4]

[Total: 13]