Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2010066940

BIOLOGY **9700/53**

Paper 5 Planning, Analysis and Evaluation **May/June 2022**

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 **12** pages. Any blank pages are indicated.

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1 There are a variety of methods used to estimate the water potential of plant tissues.

(a) A student decided to estimate the water potential of potato tuber tissue using the method described.

- A number of test-tubes were set up, each containing the same volume of sucrose solution.
- Each test-tube contained a different concentration of sucrose solution.
- Pieces of potato tissue were placed in each test-tube.
- After a period of time, the potato tissue was removed from the test-tubes.

The student then measured the change in density of the sucrose solutions left in each test-tube. The more water present in a sucrose solution, the less dense it is.

- Sucrose solutions of the same concentrations as those of the **original** test-tubes were prepared.
- Each of these sucrose solutions was coloured with methylene blue.
- One drop of the coloured sucrose solution of a known concentration was released into the middle of the test-tube whose sucrose concentration was originally the same as that of the coloured sucrose drop.

The three possible outcomes that the student would see are shown in Fig. 1.1.

1 The drop will rise if the coloured sucrose drop is less dense than the sucrose solution in the test-tube.

2 The drop will remain where it is released if the coloured sucrose drop is similar in density to the sucrose solution in the test-tube.

3 The drop will sink if the coloured sucrose drop is more dense than the sucrose solution in the test-tube.

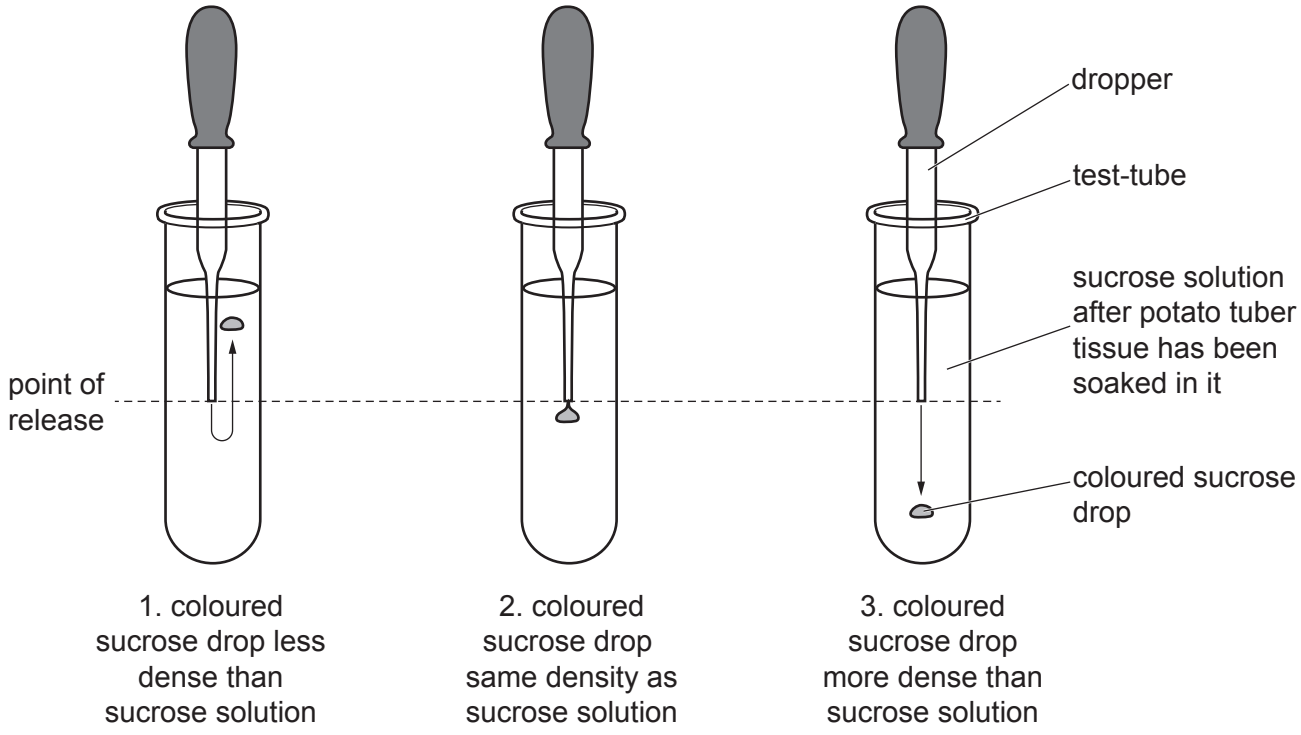


Fig. 1.1

(i) Identify the independent variable in the experiment.

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..... [1]

(ii) Predict the result if the water potential of the potato tissue was **higher** (less negative) than the surrounding sucrose solution.

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..... [1]

(iii) Explain the prediction that you gave in **(a)(ii)**.

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..... [2]

(b) The student then used another method to estimate the water potential of potato tissue.

The student placed pieces of potato tissue in a range of concentrations of sucrose solutions.

The equivalent sucrose concentration was identified as the concentration of the sucrose solution in which the potato tissue did not gain or lose mass.

The equivalent sucrose concentration indicates the water potential of the potato tissue.

(i) The student was given a stock solution of sucrose with a concentration of $1.0\,mol\,dm^{-3}$ from which to make a range of dilutions. The student decided to make $20\,cm^3$ of each concentration of sucrose solution.

Describe how the student prepared $20\,cm^3$ of solution with a concentration of $0.4\,mol\,dm^{-3}$.

.....

.....

..... [1]

(ii) The student carried out a risk assessment before carrying out the experiment to find the equivalent sucrose concentration.

Suggest **one** reason why the student decided the level of risk for this method was **low to medium**.

.....

..... [1]

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(iii) Describe a method, using measurements of mass, that the student could use to determine the equivalent sucrose concentration in the potato tissue.

Do **not** include details of how to make different sucrose solutions or the risk assessment.

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

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..... [6]

(c) The student determined a value of 0.46 mol dm^{-3} for the equivalent sucrose concentration of the potato tissue.

Use Fig. 1.2 to determine the water potential of the potato tissue.

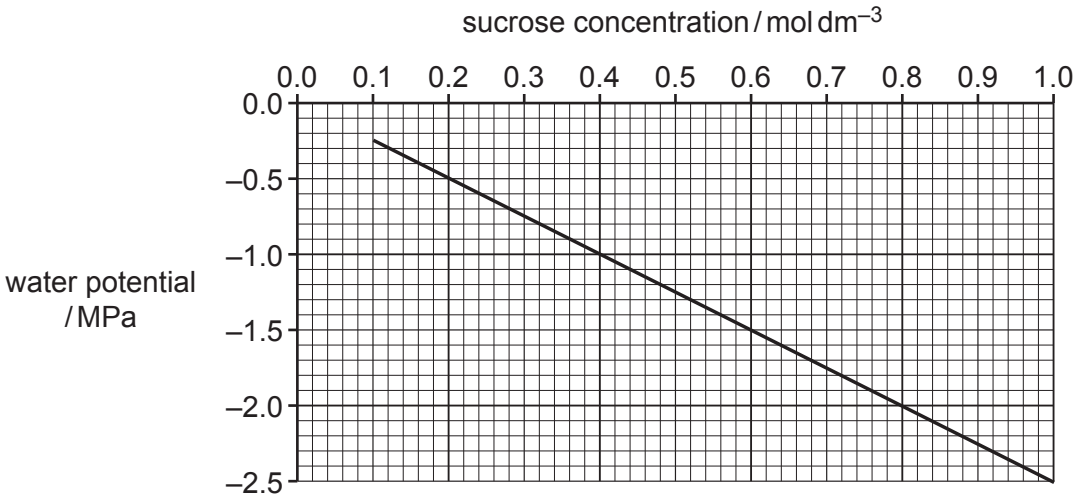


Fig. 1.2

water potential of potato tissue = ... MPa [1]

(d) The student compared two types of potato, Record and Kerr's Pink, to see if there was a significant difference between the water potential of the two potato tissues.

The student decided to carry out a *t*-test.

(i) State **one** condition of the data that allows the student to carry out a *t*-test.

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.....

..... [1]

(ii) State the null hypothesis for the *t*-test that the student carried out.

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.....

..... [1]

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(iii) The student tested 20 samples for each type of potato.

Calculate the number of degrees of freedom (v) for the t-test using the formula given.

$v = n_1 + n_2 - 2$ Key to symbols:

n = sample size (number of observations)

number of degrees of freedom = ... [1]

Table 1.1 shows the critical values for t at 0.05 probability.

Table 1.1

degrees of freedom	36	37	38	39	40	41	42	43	44
critical value at 0.05 probability	2.028	2.026	2.024	2.023	2.021	2.020	2.018	2.017	2.015

(iv) The student calculated t as 1.890.

With reference to Table 1.1 and the calculated value of t, make a conclusion about the water potentials of the two types of potato tissue, Record and Kerr's Pink.

Explain your reasoning.

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..... [3]

[Total: 19]

2 Respiration in blowfly larvae, *Calliphora erythrocephala*, can be studied by determining the respiratory quotient (RQ).

A student used the apparatus set up as shown in Fig. 2.1 to measure oxygen uptake by blowfly larvae during respiration.

Five replicates were carried out.

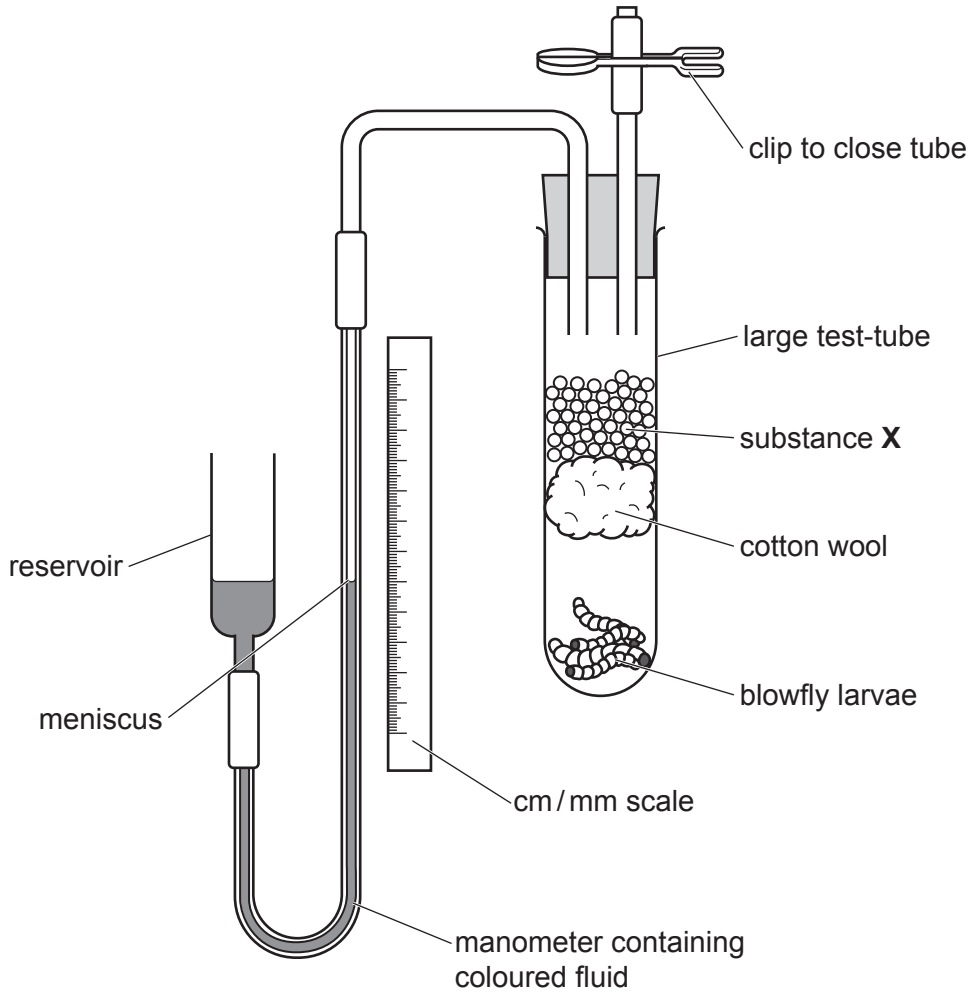


Fig. 2.1

(a) State the role of substance **X** in Fig. 2.1.

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..... [1]

(b) Predict which direction the meniscus in the manometer will move during the experiment.

Explain your answer.

direction .....

explanation .....

.....

..... [1]

(c) To calculate the RQ, the student determined the volume of carbon dioxide produced by the blowfly larvae.

Describe how the apparatus in Fig. 2.1 was modified so that the volume of carbon dioxide produced was determined.

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..... [2]

(d) State **two** variables that should be standardised each time the student carried out the experiments.

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..... [1]

Table 2.1 shows the results and the calculations made by the student.

Table 2.1

replicates	1	2	3	4	5
distance moved by manometer fluid in Fig. 2.1 when measuring oxygen uptake in 10 min / mm	15	48	61	56	68
volume of oxygen taken up / $mm^3\ min^{-1}$	1.18	3.77	4.79	4.40	
volume of carbon dioxide produced / $mm^3\ min^{-1}$	3.30	2.75	3.31	2.83	3.00
respiratory quotient (RQ)	2.80	0.73	0.69	0.64	

(e) The result for replicate 1, ringed in Table 2.1, is anomalous.

Suggest **two** possible causes for this anomaly other than measurement error.

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..... [2]

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Fig. 2.2 shows a section of the manometer.

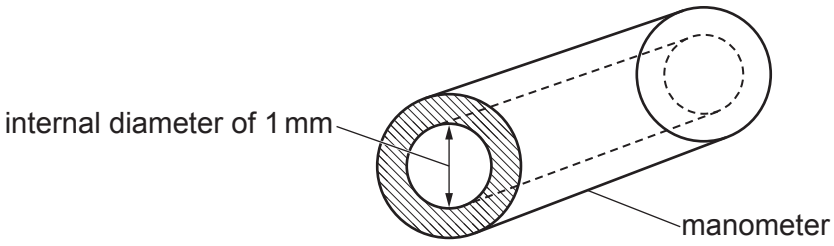


Fig. 2.2

(f) Use the data in Table 2.1 and Fig. 2.2 to calculate the volume of oxygen taken up by the blowfly larvae in **one** minute for replicate 5.

Space for working.

volume of oxygen taken in = ... $mm^3 min^{-1}$ [2]

(g) Use the answer from **(f)** to calculate the respiratory quotient (RQ) for replicate 5.

Space for working.

RQ = ... [2]

[Total: 11]

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