Cambridge Assessment International Education

# Cambridge International AS & A Level

CANDIDATE NAME

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*1189327790*

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

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 **16** pages. Any blank pages are indicated.

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**1** A group of students investigated two habitats: dense woodland and open grassland.

- Trees are the dominant plants in woodland. The trees form a canopy under which flowering herbs, small shrubs and grasses grow.
- Grasses are the dominant plants in grassland. The grasses and small flowering plants form a continuous ground cover with only a few small shrubs present.

Fig. 1.1 shows photographs of the two areas.



**Fig. 1.1**

The students decided to compare the adaptations for reducing water loss in the plants growing in each area.

The students suggested the following hypothesis:

*The density of stomata will be higher in plants found in the woodland habitat than in the grassland habitat.*

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

independent variable .....

dependent variable ..... [2]

The students collected leaves from a number of different plant species in each area. To study the density of stomata on leaves, impressions of the epidermis can be made using clear varnish.

- One surface of each leaf is painted with a thin layer of varnish.
- The varnish is left to dry.
- Clear sticky tape is applied to the leaf over the varnished area, to make a leaf impression.
- The tape and varnish are removed and stuck to a microscope slide.
- The leaf impression on the slide is viewed using a microscope.

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Fig. 1.2 shows the microscope image of one leaf impression prepared in this way.

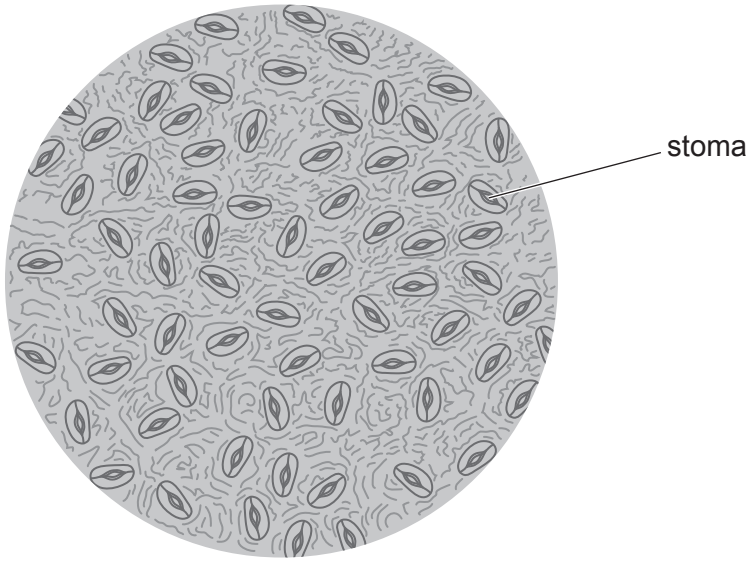



**Fig. 1.2**

**(ii)** State the measurements that the students need to make to determine the stomatal density in Fig. 1.2.

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..... [2]

**(iii)** Calculate the stomatal density in Fig. 1.2.

Space for working.

stomatal density = ..... $mm^{-2}$ [2]

**(iv)** Describe how the students could gather data to compare the stomatal density of plants growing in the woodland and the grassland habitat.

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

You should **not** repeat details of the method for making the leaf impressions.

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**Question 1 continues on page 6.**

**(b)** The students found a published investigation on the effect of light intensity on stomatal density in the species *Lycopersicon esculentum*.

Two plants of *Lycopersicon esculentum* were selected. One was grown in high light intensity and the other was grown in low light intensity.

The results are shown in Table 1.1.

**Table 1.1**

| **leaf number** | **high light intensity** | | | **low light intensity** | | |
|---|---|---|---|---|---|---|
| | number of stomata $\times 10^3$ | | leaf area / $cm^2$ | number of stomata $\times 10^3$ | | leaf area / $cm^2$ |
| | upper surface | lower surface | | upper surface | lower surface | |
| 1 | 1634 | 3131 | 496 | 18 | 1277 | 160 |
| 2 | 1482 | 5072 | 509 | 10 | 906 | 115 |
| 3 | 1865 | 6365 | 637 | 14 | 1398 | 171 |
| **mean** | 1660 | 4856 | 547 | 14 | 1194 | 149 |

**(i)** Calculate the percentage decrease in mean leaf area for leaves grown in low light intensity compared with those grown in high light intensity.

Your answer should be expressed as a whole number.

..... % [1]

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**(ii)** The scientists who carried out the published investigation concluded that:

plants grown in higher light intensity have higher stomatal density **only** on the upper surface of the leaves compared to plants grown in lower light intensity.

Evaluate whether or not the data in Table 1.1 supports this conclusion.

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..... [3]

[Total: 16]

**2** Human immunodeficiency virus (HIV) is an example of a virus that spreads from other animals to humans where it causes disease.

Fig. 2.1 shows a chimpanzee, *Pan troglodytes troglodytes*. Chimpanzees can carry the simian immunodeficiency virus (SIV) which is similar to HIV.

It is thought that chimpanzees who carry antibodies for SIV do not become ill if infected with HIV.

This has been investigated by scientists developing potential vaccines for HIV.



**Fig. 2.1**

Tests were carried out to see if antibodies against SIV present in chimpanzees bind to HIV antigens.

Test strips were prepared which contained several different HIV antigens.

When samples are applied to the test strip a line will appear in the control region. If the sample contains antibodies to the HIV antigens present on the strip, additional lines will also appear.

Samples of chimpanzee faeces were collected from a number of sites in Gabon in central Africa.

The faecal samples were prepared and then applied to the test strips.

**(a) (i)** Suggest why the investigators collected faecal samples from chimpanzees rather than plasma samples.

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..... [1]

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**(ii)** Suggest a method for preparing the faecal samples before applying them to the test strips.

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..... [2]

**(iii)** The scientists collected 608 faecal samples from 224 individual chimpanzees.

Suggest a laboratory method that could be used to identify whether two faecal samples belong to the same individual or not.

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..... [1]

Samples from humans and chimpanzees were applied to the test strips.

1. Plasma samples from humans who are infected with HIV (HIV+)
2. Plasma samples from humans who are not infected with HIV (HIV–)
3. Faecal samples from chimpanzees who are infected with SIV (SIV+)
4. Faecal samples from chimpanzees who are not infected with SIV (SIV–)

The results are shown in Fig. 2.2.

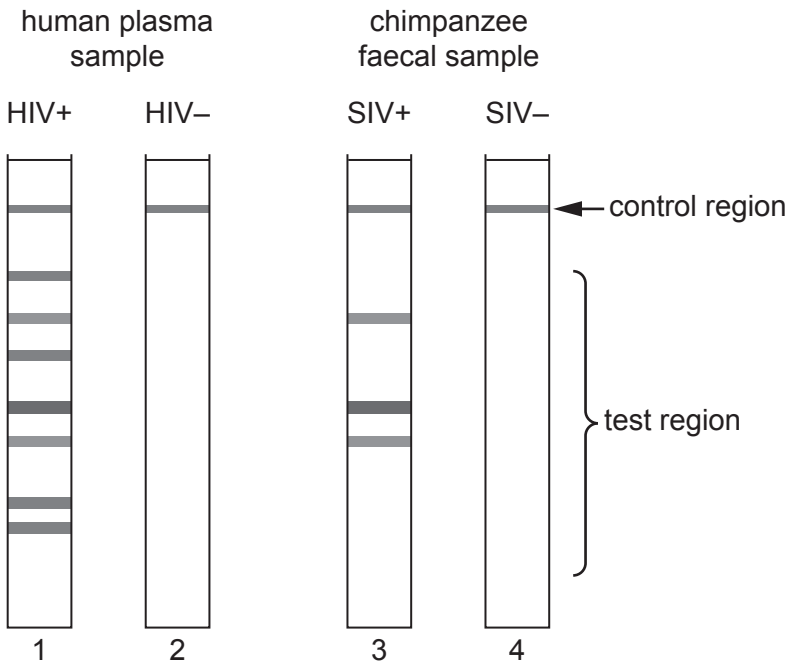



**Fig. 2.2**

**(b)** Suggest conclusions that can be drawn from the results shown in Fig. 2.2.

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..... [3]

**Question 2 continues on page 12.**

**(c)** HIV infection may lead to HIV/AIDS which, if left untreated, may cause death. The effects of SIV infection in chimpanzees are usually less severe.

A group of scientists investigated the effect of SIV infection on the life expectancy of a population of chimpanzees living in the wild.

- The population of 94 chimpanzees was observed for a nine-year period.
- The ages of all the chimpanzees in the population were estimated.
- The chimpanzees were observed each day.
- The numbers of dead and absent chimpanzees were recorded each day.
- Faecal samples of all the chimpanzees in the population were tested for SIV antibodies.

The results of the investigation are summarised in Table 2.1 and Fig. 2.3.

**Table 2.1**

| SIV status | original number of chimpanzees in population | number of chimpanzees who died or disappeared during the study |
|---|---|---|
| SIV– | 77 | 11 |
| SIV+ | 17 | 7 |

The percentage of chimpanzees of each age remaining in the population are represented in Fig. 2.3.

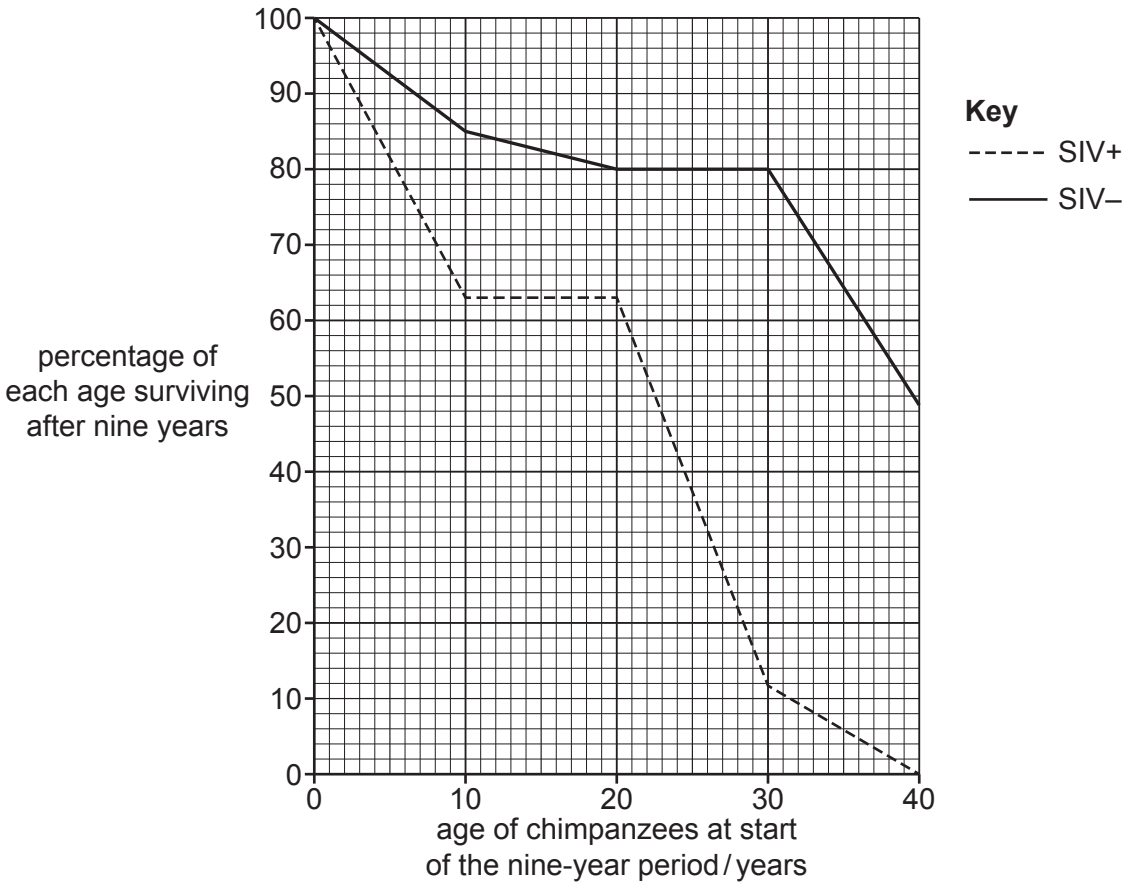



**Fig. 2.3**

**(i)** Fig. 2.3 presents the results of the investigation as the percentage of chimpanzees surviving at each age.

Explain the advantages of presenting the results of this study as percentages.

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..... [2]

The investigators concluded that chimpanzees infected with SIV die at an earlier age than uninfected chimpanzees.

The investigators decided to test their conclusion statistically.

**(ii)** State a null hypothesis the scientists could make before carrying out their statistical test.

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..... [1]

**(iii)** The investigators carried out their statistical analysis and found that they could reject the null hypothesis at $p < 0.05$.

Explain what is meant by the term $\boldsymbol{p < 0.05}$.

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..... [2]

**(iv)** Suggest why the data presented in Fig. 2.3 may not be an accurate representation of the effect of SIV infection on the life expectancy of the chimpanzees.

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[Total: 14]

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# Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*9573633935*

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

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.
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**[Turn over**

**1** Fig. 1.1 **A** shows the root vegetable beetroot, *Beta vulgaris*.

Fig. 1.1 **B** shows a single cell from the beetroot tissue. The vacuole contains the red pigment, betalain.

The pigment molecules are too large to diffuse out of the vacuole.

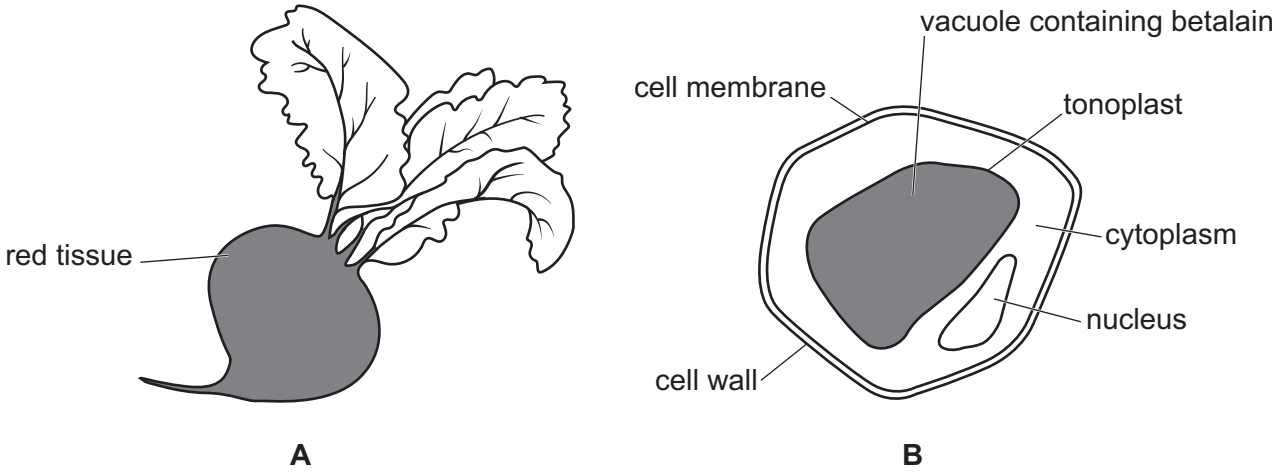



**Fig. 1.1**

When pieces of beetroot are soaked in a solution of calcium hypochlorite, $Ca(ClO)_2$, the beetroot tissue changes from red to white. This is caused by the calcium hypochlorite diffusing into the beetroot cell vacuoles and decolourising the betalain pigment.

Fig. 1.2 shows a cube of beetroot before soaking in the solution of calcium hypochlorite and the halved cube of beetroot after soaking in the solution of calcium hypochlorite.

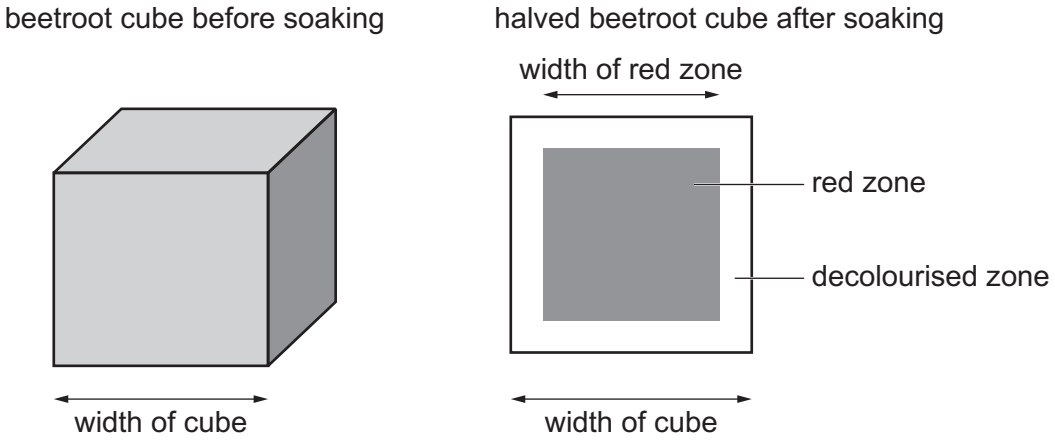



**Fig. 1.2**

In a class experiment:

- Cubes of beetroot of different dimensions were placed in a beaker containing a 10% solution of calcium hypochlorite.
- The cubes were left for 30 minutes.
- The cubes were then cut in half, and the width of the tissue remaining red (the red zone) was measured.

A group of students investigated the effect of changing the surface area:volume ratio on the diffusion of calcium hypochlorite into beetroot cubes. The students used cubes of different sizes and measured the width of the red zone after soaking the beetroot in calcium hypochlorite.

The students suggested the hypothesis:

The width of red tissue remaining in the beetroot after soaking in calcium hypochlorite is inversely proportional to the surface area:volume ratio of the beetroot cubes.

**(a) (i)** Identify the **dependent** variable in this investigation.

.....

..... [1]

**(ii)** Sketch a curve on Fig. 1.3 to show how you expect the width of red tissue to change as the surface area:volume ratio changes if the hypothesis is correct.

Label the axes.



**Fig. 1.3**

[2]

**(b) (i)** Describe a method the students could use to collect the data needed to test their hypothesis.

The students were provided with beetroot tissue, a 10% calcium hypochlorite solution and standard laboratory equipment.

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

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**(ii)** The students decided to calculate the **percentage change in volume** of the red tissue in each cube.

State how the students could calculate the percentage change in volume of the red tissue in each cube.

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..... [2]

**(c)** In a further experiment the students investigated the effect of temperature on the release of betalain pigments from beetroot tissue.

- Cubes of beetroot were cut.
- Beakers containing water were prepared.
- The beakers were placed in water-baths at temperatures between 0 °C and 85 °C.
- The beakers were allowed to equilibrate for 5 minutes.
- The beetroot cubes were added to the beakers.
- After 30 minutes the beetroot cubes were removed.
- Colorimeters, each with a blue-green filter, were used to measure the percentage transmission of light through the fluid remaining in each beaker.

The results of this experiment are shown in Table 1.1.

**Table 1.1**

| **temperature / °C** | **percentage transmission of light** | | | | |
|---|---|---|---|---|---|
| | student 1 | student 2 | student 3 | student 4 | mean |
| 5 | 100 | 97 | 98 | 96 | 97.8 |
| 25 | 83 | 92 | 96 | 86 | |
| 45 | 82 | 73 | 68 | 71 | 70.7 |
| 65 | 26 | 31 | 29 | 17 | 28.7 |
| 85 | 1 | 2 | 1 | 1 | 1.3 |

**(i)** The students decided that two of their results are anomalous. One of the results that they considered anomalous is circled in Table 1.1.

Circle the **other** anomalous result **and** complete Table 1.1 by calculating the mean percentage transmission of light at 25 °C.

[2]

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**(ii)** Describe **two** ways in which the method described in **(c)** could have been improved to give better repeatability between the results of the different students.

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..... [2]

**(iii)** With reference to the data in Table 1.1, state **and** explain the effect that increasing temperature has on the release of betalain from beetroot tissue.

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..... [2]

[Total: 18]

**2** The European badger, *Meles meles*, pictured in Fig. 2.1, is a mammal found in England.

Badgers can contract bovine tuberculosis (bTB) caused by the pathogen, *Mycobacterium bovis*.

- Researchers estimated that 5% of the badger population in England are infected with bTB.
- bTB can be spread between badger populations and other populations of wild animals and farmed animals.
- Herds of dairy cows produce milk for human consumption. If a dairy herd becomes infected with bTB, the pathogen can be transmitted to human populations in milk.
- A variety of measures have been introduced in an attempt to reduce the bTB rate in badgers and so prevent infection of dairy cows.
- These measures include vaccination and the removal of badger populations (culling).



**Fig. 2.1**

**(a)** Suggest how researchers estimated the percentage of the badger population that was infected with bTB.

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..... [3]

**(b)** It is possible that wild badgers infect dairy cows with bTB.

A group of scientists investigated the correlation between bTB infections in badgers and bTB infections in dairy cows.

- 30 study areas in England were identified.
- Each of the areas was approximately 100 $km^2$.
- 10 of the 30 study areas were randomly selected and given the codes **A**–**J**.
- The number of infected cows **and** the number of infected badgers were counted in each area.
- The number of infected badgers was determined by testing for the presence of *Mycobacterium bovis* in tissue samples taken from the badgers.
- The number of infected cows was determined by testing for a response (inflammation) to the introduction of antigenic material into the skin.

Data was collected as shown in Table 2.1.

**Table 2.1**

| data set | areas where counts were made | year when counts were made |
|---|---|---|
| 1 | **A**, **B**, **C**, **E**, **F**, **G**, **H** | 1999 |
| 2 | **D**, **I**, **J** | 2001 |

The scientists expressed their data on the numbers of infected cows and infected badgers as the population **density** of infected cows and infected badgers.

**(i)** Explain what is meant by the term population density **and** suggest why the data was expressed in this way.

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**(ii)** State **three** variables that were **not** standardised in this investigation.

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**(c)** The scientists decided to analyse their data on the occurrence of bTB in cows and badgers statistically.

**(i)** State a null hypothesis for this investigation.

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..... [1]

**(ii)** The scientists plotted a scatter graph of the population density of infected badgers and infected cows as shown in Fig. 2.2.

The scientists drew a line of best fit on the scatter graph.

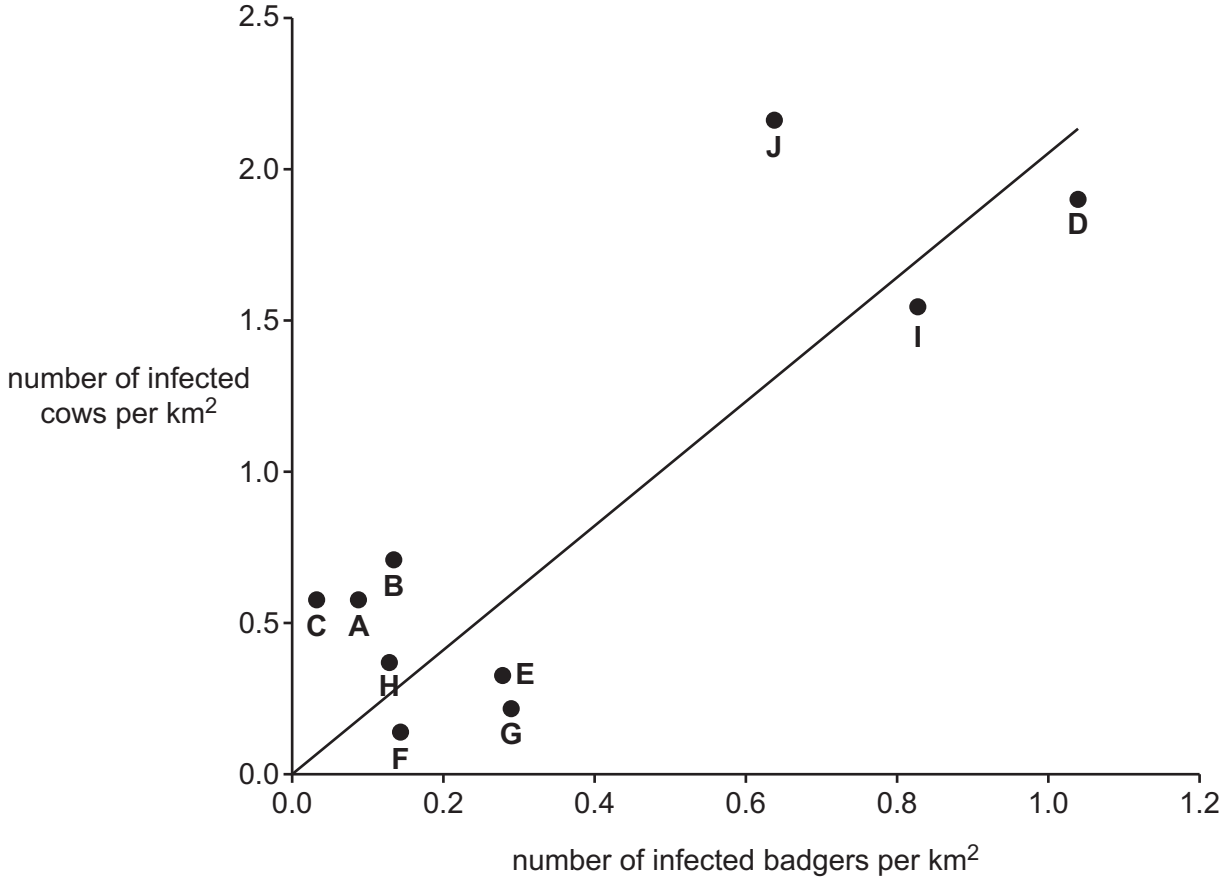



**Fig. 2.2**

The scientists carried out statistical tests on the two data sets combined and on each set separately.

The results of these tests are shown in Table 2.2.

**Table 2.2**

| data set | sampling areas | correlation | significance at p=0.05 |
|---|---|---|---|
| 1 & 2 | **A**, **B**, **C**, **D**, **E**, **F**, **G**, **H**, **I**, **J** | positive | significant |
| 1 | **A**, **B**, **C**, **E**, **F**, **G**, **H** | negative | not significant |
| 2 | **D**, **I**, **J** | negative | not significant |

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Some scientists suggested this information showed a strong positive relationship between the number of infected badgers in an area and the number of infected cows in the same area.

These scientists also suggested that bTB in herds of cows could be reduced by removing badgers through culling.

Evaluate whether or not the data in Fig. 2.2 and Table 2.2 support the suggestions these scientists made.

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[Total: 12]

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# 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.
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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.

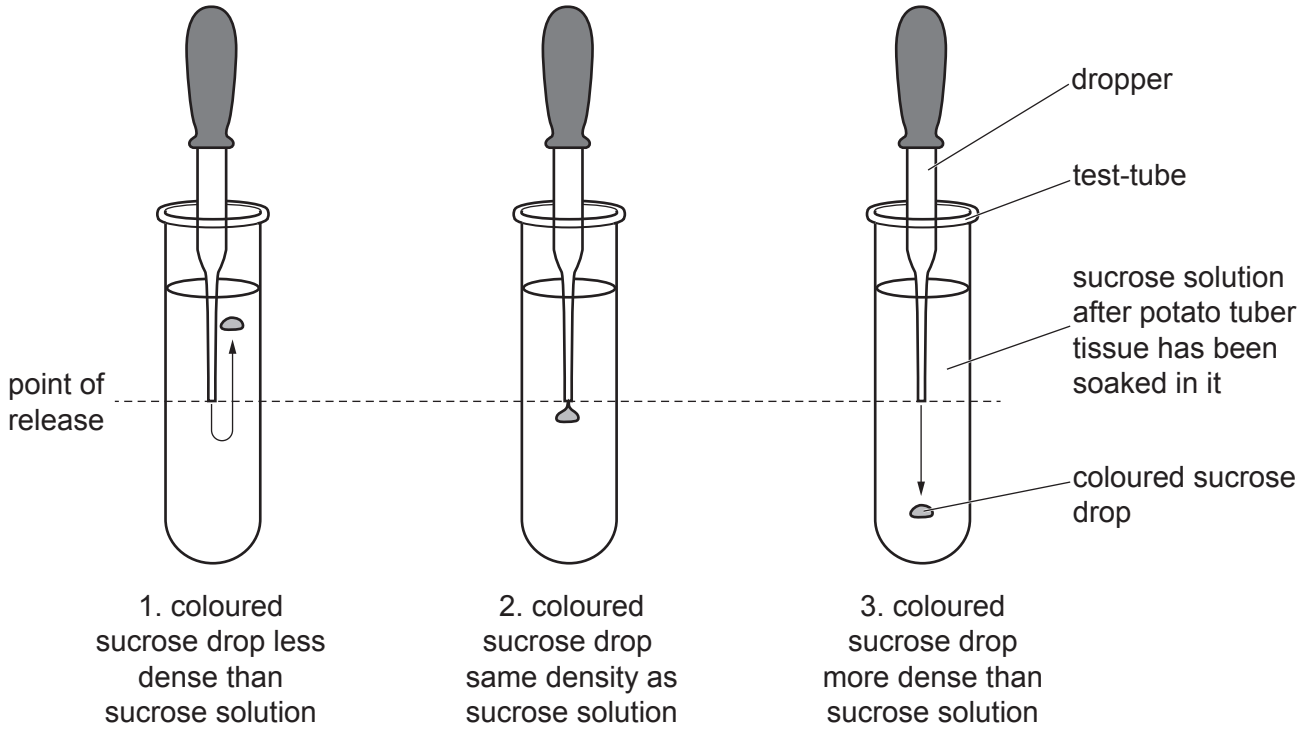



**Fig. 1.1**

**(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 $0.4\,mol\,dm^{-3}$.

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.....

..... [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**.

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..... [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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**(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.

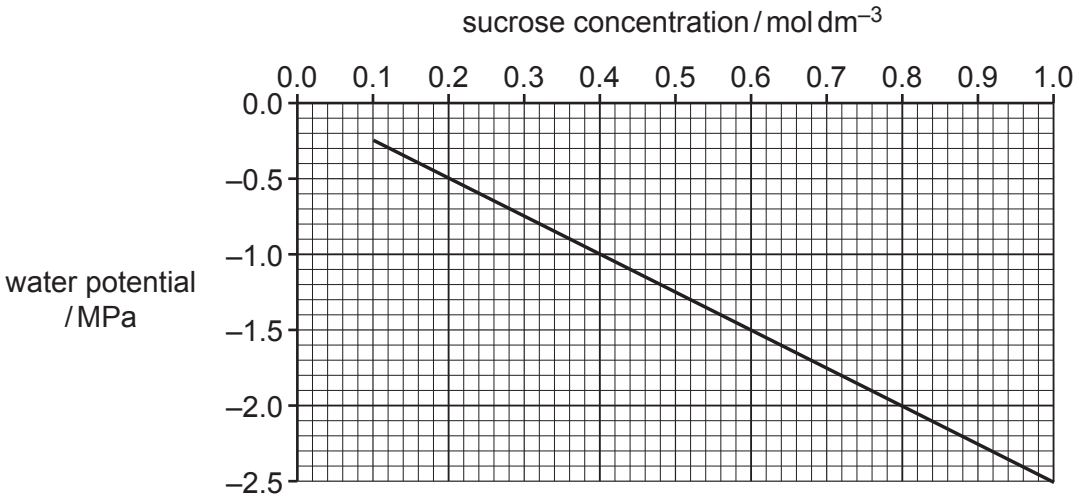



**Fig. 1.2**

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.

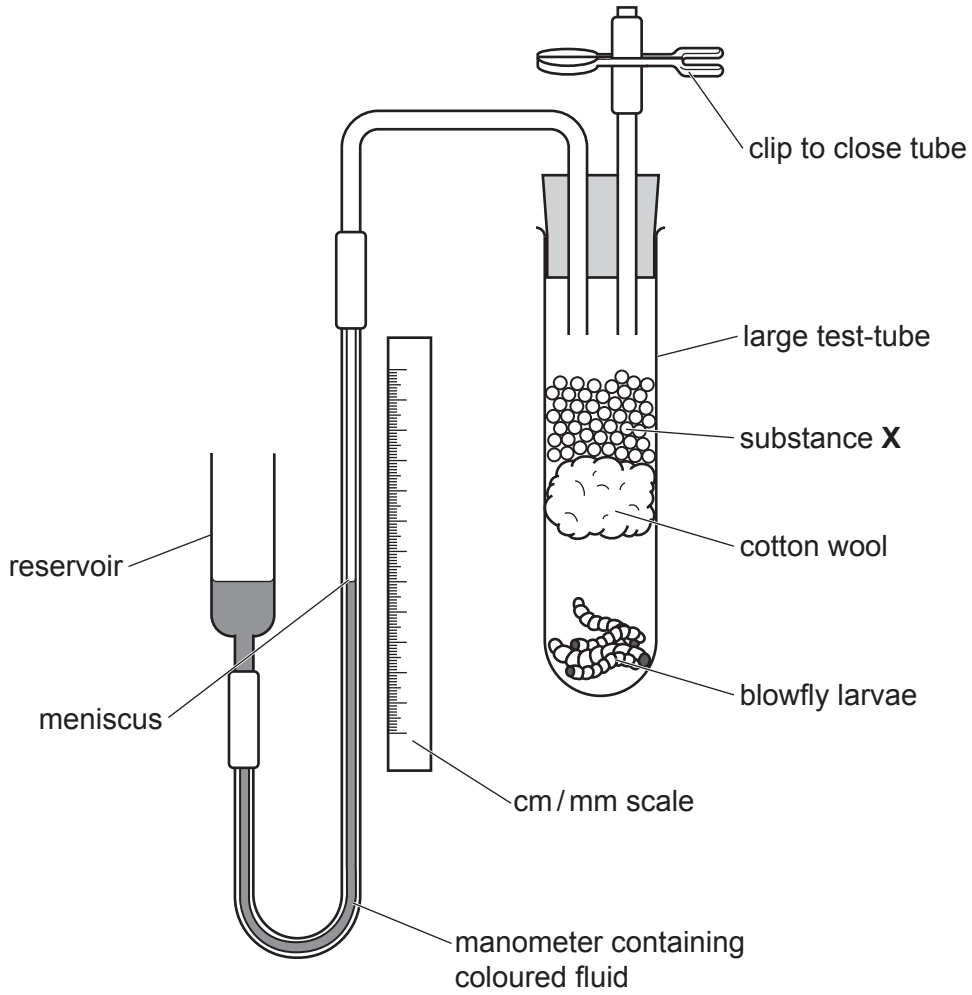



**Fig. 2.1**

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

.....

.....

..... [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.

.....

.....

.....

.....

..... [2]

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

.....

.....

.....

..... [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.

.....

.....

.....

.....

..... [2]

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Fig. 2.2 shows a section of the manometer.

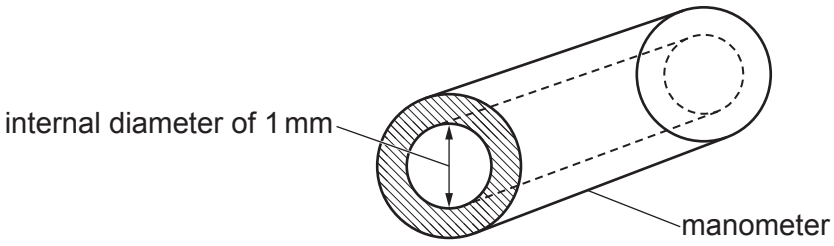



**Fig. 2.2**

**(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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