Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8065773579

BIOLOGY **9700/51**

Paper 5 Planning, Analysis and Evaluation **October/November 2023**

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.

DC (SL) 333651

1 Fruits in the diet can be a source of vitamins, such as vitamin C and vitamin A, which are important in maintaining good health.

Vitamin A is a group of molecules that includes retinol and retinal.

Vitamin C is an organic acid known as ascorbic acid.

Ripening occurs in fruit when molecular changes cause an increase in sugar content, colour changes and softening of the fruit, over time.

Ascorbic acid is found in plant cells. The fruits of many plants have high concentrations of ascorbic acid.

A student planned to investigate how ascorbic acid concentration changes with ripeness in the fruit of the apple tree, *Malus domestica*.

The fruit of *M. domestica* (apples) are shown in Fig. 1.1.

Fig. 1.1

(a) The student removed an apple that was 5 cm in diameter from a tree. The student measured the sugar content of the apple, which was low. This indicated that the apple was at the early stages of ripening (unripe).

For the investigation, the student decided to select apples from trees when each apple was 5 cm in diameter.

The student assumed that the ripeness of each apple would increase each day after it had been picked from a tree.

(i) Suggest why the diameter of the apples selected may **not** give accurate estimates of ripeness.

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.... [1]

(ii) Describe an improvement to the method for selecting the apples that would give more accurate estimates of ripeness.

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.... [1]

(b) The student researched how ascorbic acid concentration changes with ripeness in the fruit of other species.

Based on this research, the student predicted that ascorbic acid concentration in apples will:

- be lowest in unripe apples when they are first picked from the tree
- increase over several days and peak in partially ripe apples
- decrease slightly in later days as the apples become fully ripe.

Sketch a line graph below, including labelled axes, to show the predicted results.

[2]

(c) The student used the redox indicator DCPIP to investigate how ascorbic acid concentration changes as the apples ripen.

The student tested the ascorbic acid concentration of the apples at intervals from the time they were taken from the tree until the apples were fully ripe.

For each test, the student prepared an apple extract solution and reacted this with a DCPIP solution of standardised concentration.

(i) The student was provided with a 0.01 $mol\,dm^{-3}$ stock solution of DCPIP.

After preliminary research, the student decided to dilute the stock solution to prepare a 0.0005 $mol\,dm^{-3}$ DCPIP solution to use in the experiment.

The student used two steps to dilute the stock solution to the 0.0005 $mol\,dm^{-3}$ DCPIP solution.

Complete the description of the two steps for the dilution by adding the correct values to the sentences.

step 1

The student mixed 10 cm^3 of 0.01 $mol\,dm^{-3}$ DCPIP stock solution with .... cm^3 of distilled water to produce solution **A**. Solution **A** had a concentration of 0.001 $mol\,dm^{-3}$.

step 2

The student then mixed .... cm^3 of solution **A** with 50 cm^3 of distilled water to produce the 0.0005 $mol\,dm^{-3}$ DCPIP solution.

[2]

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(ii) DCPIP changes colour from blue to colourless when it is reduced by ascorbic acid.

- The volume of DCPIP that can be reduced by ascorbic acid is a measure of the concentration of ascorbic acid present in a solution.
- When all the ascorbic acid present in a solution has reacted with DCPIP, any more DCPIP that is added will remain blue.

The student had access to standard laboratory equipment and a burette.

DCPIP solution can be added to a burette and released one drop at a time by turning a tap.

Fig. 1.2 shows a burette set up for this investigation.

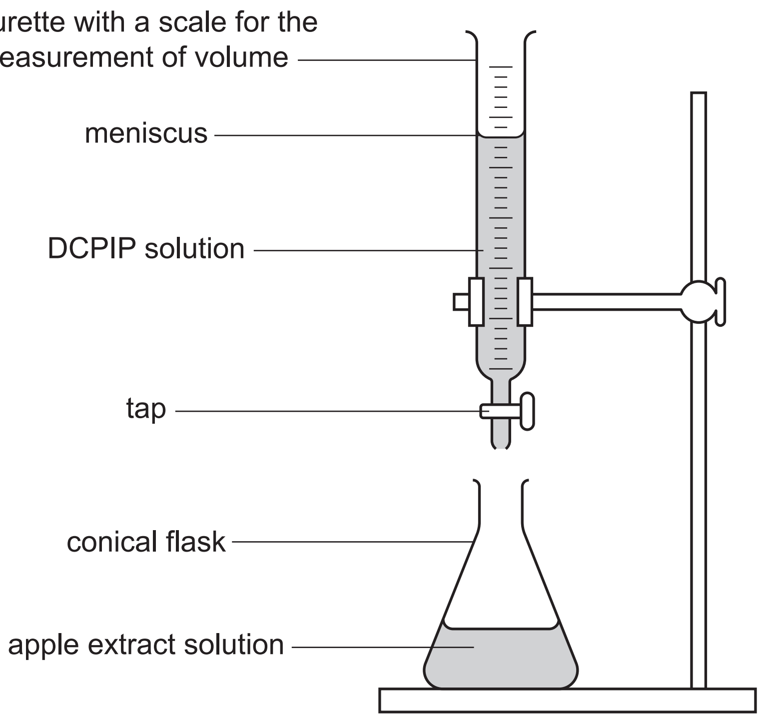

Fig. 1.2

Describe a method the student could use to:

- prepare apple extract solutions from the fruit
- collect the results needed to show the changes in ascorbic acid concentrations as the apples ripen, using DCPIP.

The description of your method should be set out in a logical way and be detailed enough for another person to follow.

You should **not** repeat the details from **(c)(i)** describing how to dilute the 0.01 $mol\,dm^{-3}$ stock solution of DCPIP.

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(d) After recording the results, the student decided that Pearson's linear correlation was a more appropriate test to use than Spearman's rank correlation to test whether ripeness and ascorbic acid concentration were correlated.

Suggest **two** reasons why Pearson's linear correlation was the more appropriate statistical test.

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.... [2]

(e) Many fruits are a good source of β-carotene, which can be converted in the human body to vitamin A.

The student investigated the β-carotene content of apples.

The student measured the β-carotene concentration in ripe apples and the ripe fruit of four other species.

Fig. 1.3 shows the results.

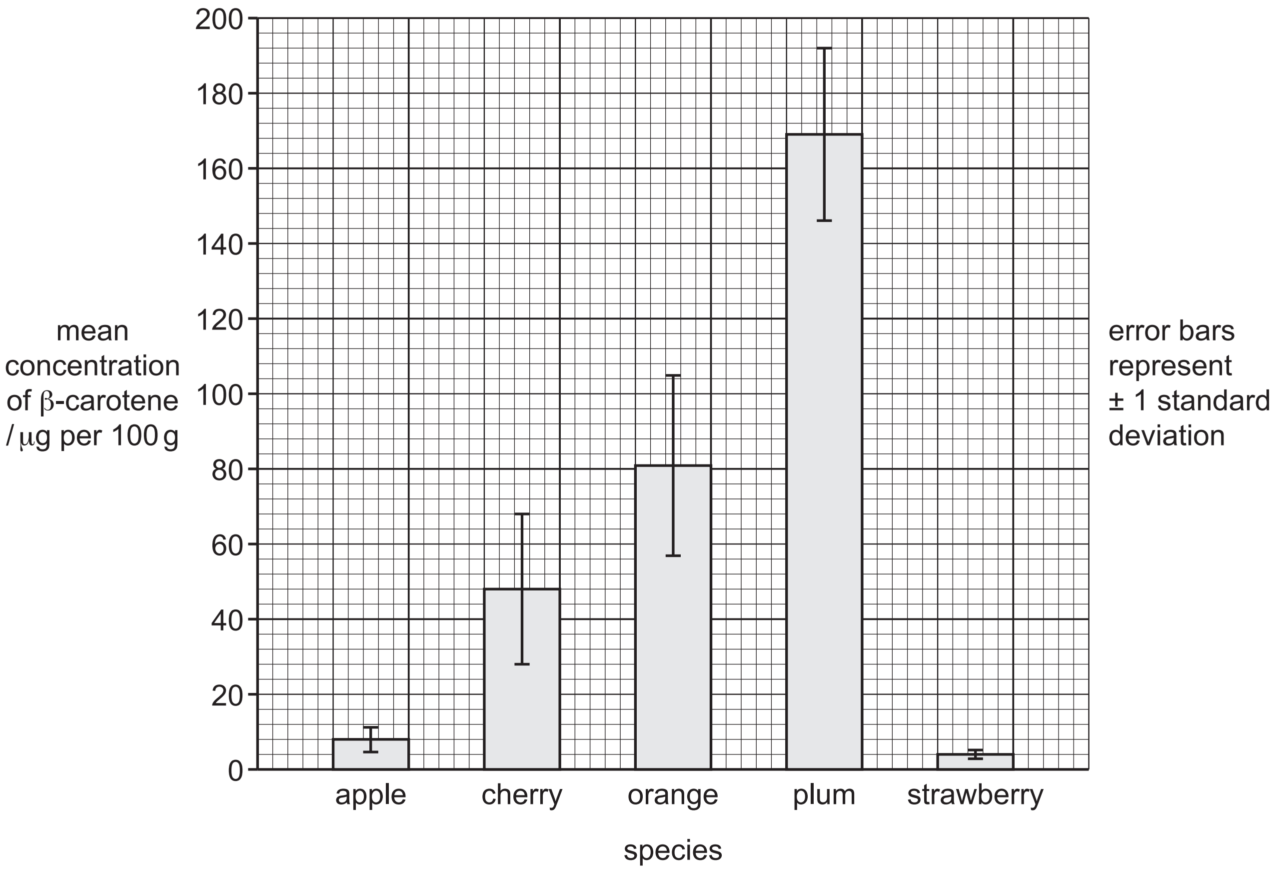

Fig. 1.3

The student concluded that apples are **not** a good dietary source of vitamin A.

Use the data in Fig. 1.3 to evaluate this conclusion.

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.... [3]

[Total: 20]

2 Trypsin is a protease enzyme. A student compared the activity of trypsin from two different species: the Atlantic salmon, *Salmo salar*, and the domestic pig, *Sus scrofa domesticus*.

Fig. 2.1 shows an Atlantic salmon and Fig. 2.2 shows domestic pigs.

Fig. 2.1

Fig. 2.2

Atlantic salmon are fish and are ectothermic, which means that the internal body temperature fluctuates with the surrounding environmental temperature.

The water temperature in the habitat of Atlantic salmon can decrease to –0.5 °C.

Domestic pigs are mammals and maintain an internal body temperature of approximately 38 °C.

The student was provided with trypsin from Atlantic salmon, trypsin from domestic pigs and cubes of gelatine. Gelatine is made from the protein collagen.

The student measured the time taken for the trypsin from each animal species to break down the gelatine cubes at 20 °C.

The student:

- used 10 cm^3 of 5% trypsin solution from each animal species
- placed each trypsin solution in separate test-tubes, maintained at 20 °C in a water-bath
- placed a gelatine cube in each test-tube of trypsin solution
- recorded the time taken to break down the gelatine cube in each test-tube.

The student repeated this 12 times for each type of trypsin.

(a) **(i)** Identify the independent variable **and** the dependent variable in this experiment.

independent variable ....

dependent variable ....
[2]

(ii) The student standardised the temperature of the water-bath, the volume of the trypsin solution and the concentration of the trypsin solution.

State **one** other variable that the student should standardise in this experiment.

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.... [1]

(b) The results of the experiment are shown in Table 2.1.

Table 2.1

replicate	time taken to break down gelatine cube / seconds	
	Atlantic salmon	**domestic pigs**
1	125	130
2	121	127
3	128	134
4	119	128
5	132	135
6	125	130
7	131	132
8	127	128
9	126	128
10	131	137
11	131	133
12	129	131
mean	127.1	
standard deviation (s)	4.1	

(i) Use the data in Table 2.1 to calculate the mean time taken for trypsin from domestic pigs to break down the gelatine cube.

mean = ... seconds [1]

(ii) The formula for calculating standard deviation is:

$$s = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}}$$

Key to symbols
x = observation
$\bar{x}$ = mean
n = sample size (number of observations)

The student calculated $\sum(x-\bar{x})^2$ as **110.92** for the domestic pigs.

Use the calculated value of $\sum(x-\bar{x})^2$ and the data in Table 2.1 to complete the calculation of the standard deviation for domestic pigs.

s = ... seconds [1]

(iii) The student used a *t*-test to analyse the data.

The null hypothesis for this *t*-test was:

There is no difference between the time taken for trypsin from Atlantic salmon and trypsin from domestic pigs to break down a gelatine cube at 20 °C.

The calculated value of *t* was **2.663**.

The student compared **2.663** to the values in Table 2.2.

Table 2.2

degrees of freedom	probability level (*p*)			
	0.10	**0.05**	**0.01**	**0.001**
20	1.725	2.086	2.845	3.850
21	1.721	2.080	2.831	3.819
22	1.717	2.074	2.819	3.792
23	1.714	2.069	2.807	3.767
24	1.711	2.064	2.797	3.745

Using Table 2.1, Table 2.2 and the calculated value of *t* of **2.663**, state **and** explain what the student can conclude about the results.

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(iv) Suggest explanations for the difference between the activity of the enzyme trypsin in Atlantic salmon and the activity of trypsin in domestic pigs.

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[Total: 10]

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