Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

BIOLOGY **9700/52**

Paper 5 Planning, Analysis and Evaluation **May/June 2025**

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.

[Turn over

1 Phosphatases are enzymes that catalyse the removal of phosphate from other molecules, releasing inorganic phosphate (P_i). A phosphatase can be extracted from mung bean seedlings, *Vigna radiata*.

Fig. 1.1 shows mung bean seedlings.

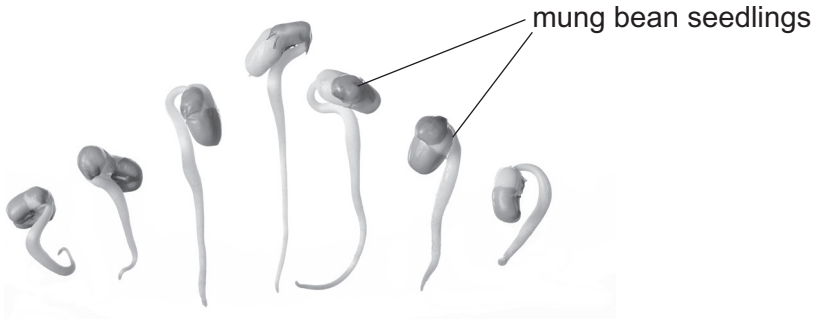

Fig. 1.1

A student found a published method to extract phosphatase from mung bean seedlings.

- Use a pestle and mortar to grind mung bean seedlings, with a small volume of distilled water, to make a paste.
- Add distilled water to the paste to make a mixture with a total volume of 50 cm^3.
- Filter the mixture and put the filtrate into a clean centrifuge tube.
- Centrifuge the filtrate until a solid pellet is formed, as shown in Fig. 1.2.
- Pour the liquid extract containing phosphatase into a clean test-tube.

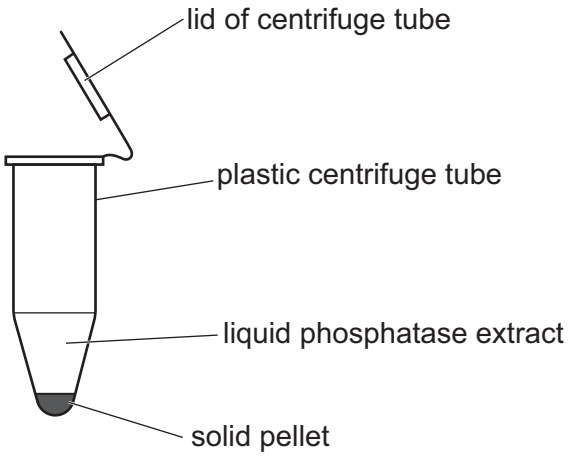

Fig. 1.2

(a) State **two** other variables that should be standardised in the published method so that extracts with the same concentration of phosphatase can be produced.

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(b) The student read that the optimum pH for phosphatase extracted from mung bean seedlings is less than pH 7.0.

The student decided to investigate phosphatase activity, using the substrate phenolphthalein phosphate (PPP).

In the first four steps of the method, the student:

- mixed 5 cm^3 of pH 6.0 buffer solution with 1 cm^3 of a 1.0% solution of PPP in a test-tube
- added 1 cm^3 of the phosphatase extract to the test-tube and started a timer
- incubated the test-tube for 10 minutes in a water-bath at 30 °C
- stopped the enzyme reaction after 10 minutes, by adding 5 cm^3 of 10.0% solution of sodium carbonate. Sodium carbonate solution is alkaline.

(i) The buffered PPP solution and the phosphatase extract were mixed and then placed in the water-bath. The student identified this as a source of error in the method.

Explain why this is a source of error **and** state how you would modify the method to remove this source of error.

explanation

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modification

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[2]

(ii) Suggest how the addition of 10.0% solution of sodium carbonate stops the enzyme reaction.

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(c) The phosphatase catalyses the removal of inorganic phosphate from PPP as shown by:

$$\text{PPP} \xrightarrow{\text{phosphatase}} \text{phenolphthalein + inorganic phosphate}$$

The 10.0% solution of sodium carbonate added at the end of the experiment also causes any phenolphthalein to turn pink. The intensity of the pink colour is an indication of the concentration of phenolphthalein.

To estimate the concentration of phenolphthalein produced by the reaction, the student decided to make a proportional dilution using a 2.0% stock solution of phenolphthalein.

The student made 50 cm^3 of each diluted solution.

Describe a method the student could use to make a proportional dilution of the 2.0% stock solution of phenolphthalein to get a range of concentrations.

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(d) Describe how the student could use the dilutions from **(c)** and a colorimeter to estimate the concentration of phenolphthalein in a reaction mixture.

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(e) The student decided to determine the optimum pH for phosphatase extract from the mung bean seedlings.

Describe a method the student could use to determine the optimum pH for phosphatase.

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

Details of how to extract phosphatase from the mung bean seedlings **and** how to make the dilutions of phenolphthalein solutions should **not** be included.

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(f) The student investigated the effect of a competitive inhibitor on the activity of a phosphatase.

Fig. 1.3 shows a graph of the initial rates of enzyme reaction against PPP concentration for the enzyme with no inhibitor and the enzyme with inhibitor.

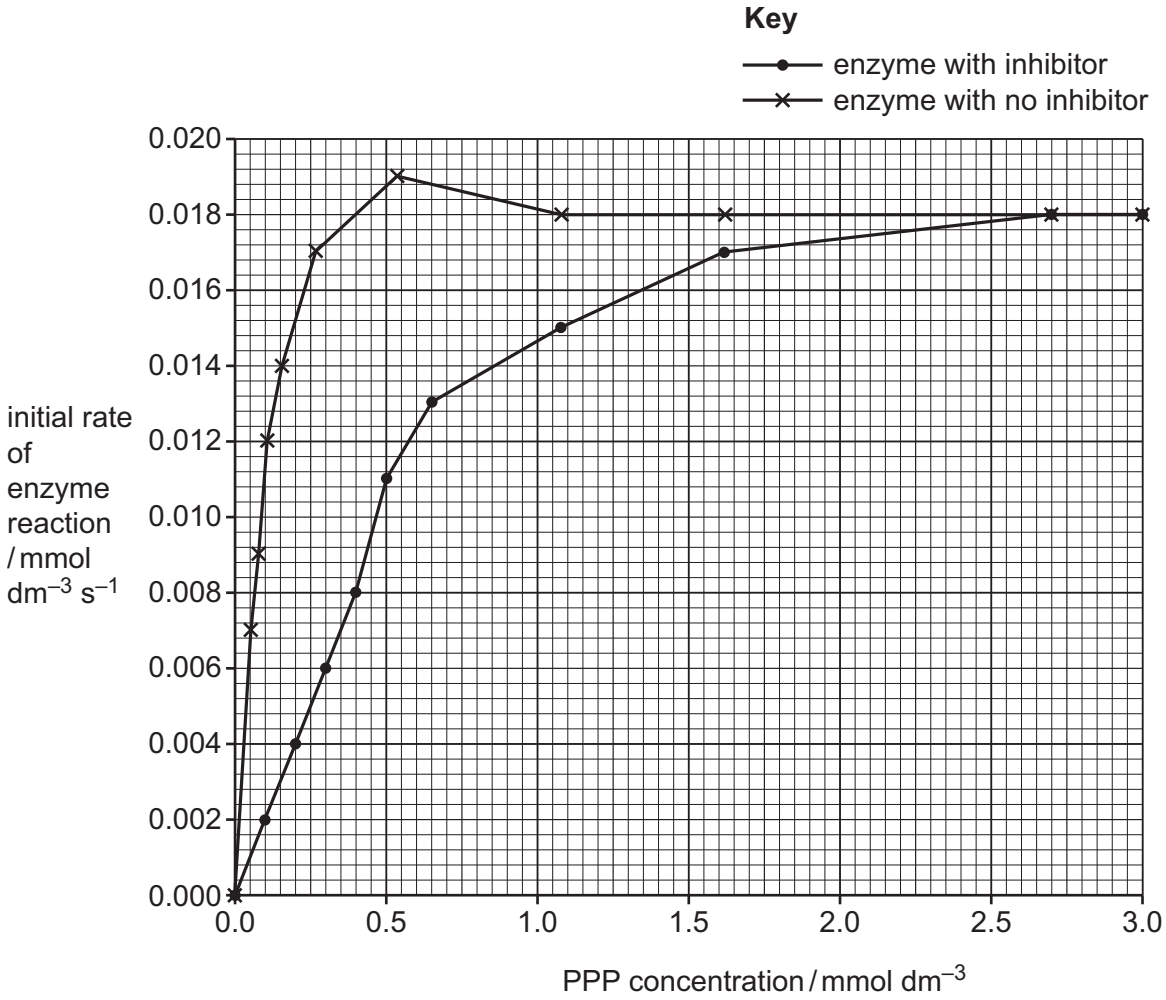

Fig. 1.3

(i) One of the data plots in Fig. 1.3 is anomalous.

Circle the anomalous data plot in Fig. 1.3 **and** explain why you think it is anomalous.

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(ii) Use Fig. 1.3 to determine the Michaelis–Menten constant (K_m) for the enzyme with no inhibitor and for the enzyme with inhibitor.

Include the correct units in your answers.

K_m for the enzyme with no inhibitor = ...

K_m for the enzyme with inhibitor = ...
[1]

(iii) Calculate the percentage increase in the K_m that occurs in the presence of the inhibitor.

Show your working.

percentage increase = ... % [2]

[Total: 20]

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2 Sponges are immobile, aquatic animals that live on rocks and sediment at the bottom of salt water environments.

Fig. 2.1 shows an example of a sponge, growing on the seabed, in a marine habitat.

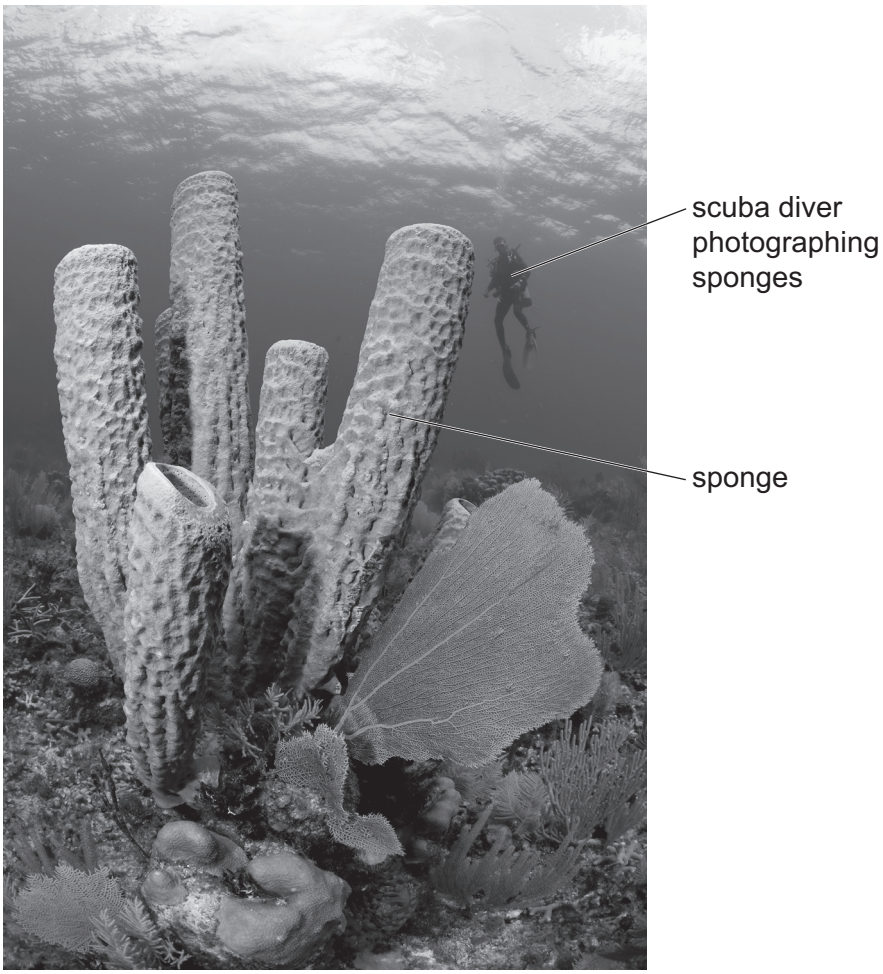

Fig. 2.1

There are many different species of sponge. Most species of sponge are sensitive to environmental stress. Human activity causes some environmental stress.

Scientists sampled the marine habitats along a length of coastline in Algeciras Bay in southern Spain to study the species diversity of sponges.

The scientists selected 12 sampling stations, **A** to **L**, as shown in Fig. 2.2. The scientists noted the land use or human activity along the coast next to each sampling station.

Key to diagram:

sampling station	type of land use or human activity
A	natural habitat
B	natural habitat
C	tourist beach
D	housing
E	shipping port
F	tourist beach
G	thermal power station
H	oil industry
I	ship building and repairs
J	tourist boats
K	tourist boats
L	natural habitat

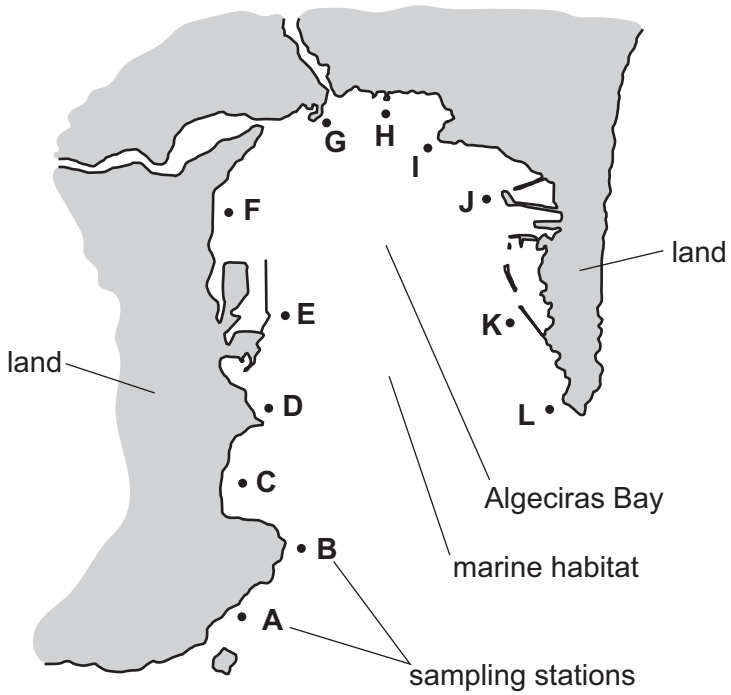

Fig. 2.2

The sampling stations were chosen to compare the effects of land use or human activity on the species diversity of sponges in the bay.

At each marine sampling station, the scientists:

- placed permanent line transects, 50 m in length, on the seabed
- photographed all sponges sighted at a distance of 1 m either side of the transect
- sampled each transect for the same length of time
- sampled each transect four times a year.

(a) The scientists standardised some variables.

State **two other** variables that the scientists should standardise in this investigation.

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(b) The scientists compared the species diversity of sponges between different sampling stations using an index of diversity known as beta diversity.

The higher the beta diversity index, the higher the species diversity at a sampling station.

Fig. 2.3 shows a graph of the beta diversity index for each sampling station.

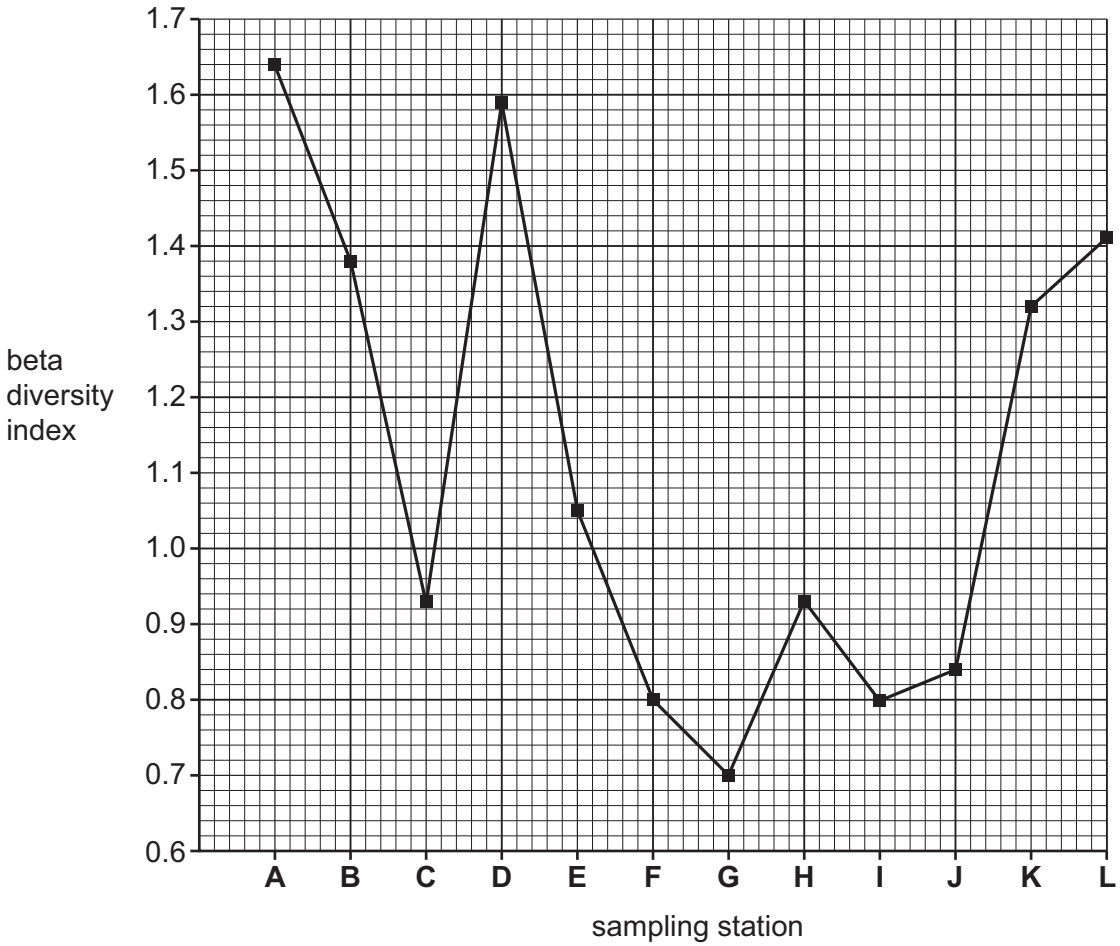

Fig. 2.3

A simplified formula for beta diversity is shown:

$$\text{beta diversity} = \frac{n}{\bar{x} - 1}$$

Key to symbols:

n = the number of sponge species recorded at a sampling station

$\bar{x}$ = the mean number of sponge species across all sampling stations

At sampling station **A**, 37 sponge species were recorded (n = 37).

Use Fig. 2.3 and the formula for beta diversity to calculate the mean number of sponge species across all sampling stations ($\bar{x}$).

Show your working. Write your answer to the nearest whole number.

mean number of sponge species across all sampling stations ($\bar{x}$) = ... [2]

(c) (i) A student concluded that the species diversity of sponges was higher in the sampling stations where there was less human activity.

Using the information in Fig. 2.2 and in Fig. 2.3, evaluate this conclusion.

Use the values in Fig. 2.3 to support your answer.

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..... [3]

(ii) Use the information in Fig. 2.2 and in Fig. 2.3 to state **two other** conclusions about the species diversity of sponges in Algeciras Bay.

Use the values in Fig. 2.3 to support your answer.

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[Total: 10]