Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1310716870

MARINE SCIENCE **9693/22**

Paper 2 AS Level Data-handling and Investigative Skills **May/June 2023**

1 hour 45 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 75.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **28** pages. Any blank pages are indicated.

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Answer **all** questions.

1 Fig. 1.1 shows the shell of a common dogwhelk, *Nucella lapillus*, which is adapted to live on rocky shores.

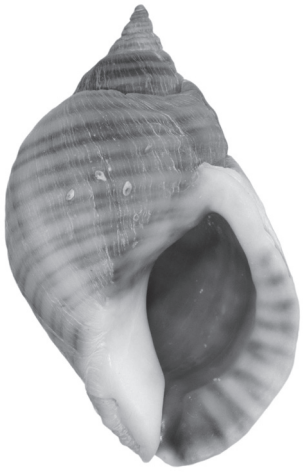

Fig. 1.1

(a) State a mineral that is required for the formation of shells.

..... [1]

(b) Make a large drawing of the shell shown in Fig. 1.1.

Do **not** label your drawing.

[4]

(c) Dogwhelks use a large muscular foot to cling to the rocks on rocky shores.

A scientist investigated the shape of dogwhelk shells on different shore types.

They analysed dogwhelks from an exposed rocky shore with high wave action, and a sheltered rocky shore with low wave action.

100 dogwhelks from each shore were sampled, and the following measurements were recorded:

- total shell length
- shell aperture length.

Fig. 1.2 shows how these measurements were recorded.

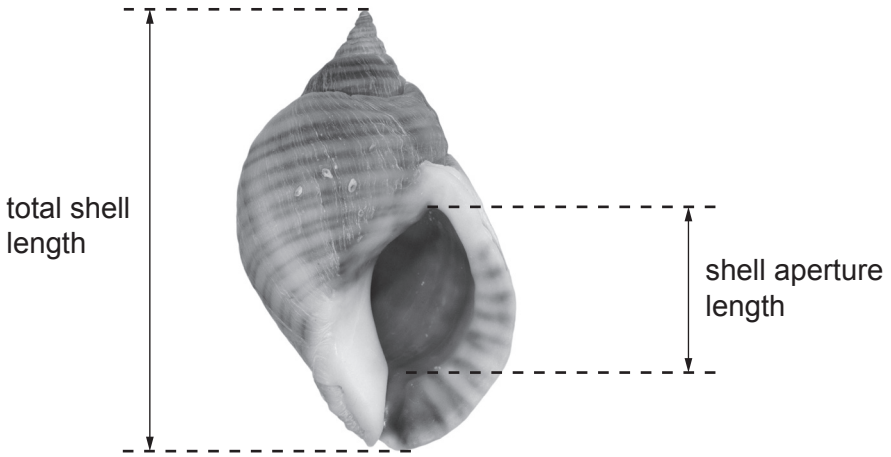

Fig. 1.2

Table 1.1 shows the mean results of the investigation.

Table 1.1

shore type	mean total shell length / mm	mean shell aperture length / mm
exposed rocky shore	24.6	12.5
sheltered rocky shore	26.1	11.9

(i) Describe how the mean total shell lengths were calculated.

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..... [1]

(ii) The scientist calculated the ratio of mean total shell length : mean shell aperture length for the dogwhelks on each shore.

Complete Table 1.2 by calculating the ratio for the sheltered rocky shore.

Table 1.2

shore type	ratio of mean total shell length : mean shell aperture length
exposed rocky shore	1.97 : 1
sheltered rocky shore	

[1]

(iii) Compare the shapes of dogwhelk shells on each shore type, using data from Table 1.1 **and** Table 1.2.

Suggest reasons for any differences.

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(d) During the investigation the scientist noticed that the dogwhelks showed variation in the colour of their shells, some being darker than others.

The scientist also noticed that the darker-shelled individuals were located in more shaded parts of the rocky shore.

They suggested the following hypothesis:

'Lighter-shelled dogwhelks can tolerate higher exposure to sunlight.'

A further investigation was then carried out.

Light and dark dogwhelks on an area of shore were all marked with a small spot of paint on the shell.

The paint fades on exposure to sunlight.

After three days the degree of fading was recorded, using a score of 1 to 10.

Table 1.3 shows the results.

Table 1.3

paint fading score	number of lighter-shelled dogwhelks	number of darker-shelled dogwhelks
1 (least faded)	0	0
2	5	4
3	33	34
4	58	14
5	40	11
6	30	7
7	8	3
8	22	5
9	2	0
10 (most faded)	4	0

Discuss whether the results in Table 1.3 support the scientist's hypothesis.

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..... [3]

(e) Suggest **one** way the scientist ensured their methods were ethical.

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..... [1]

[Total: 15]

2 **(a)** Fig. 2.1 shows apparatus used to investigate the rate of photosynthesis in the laboratory.

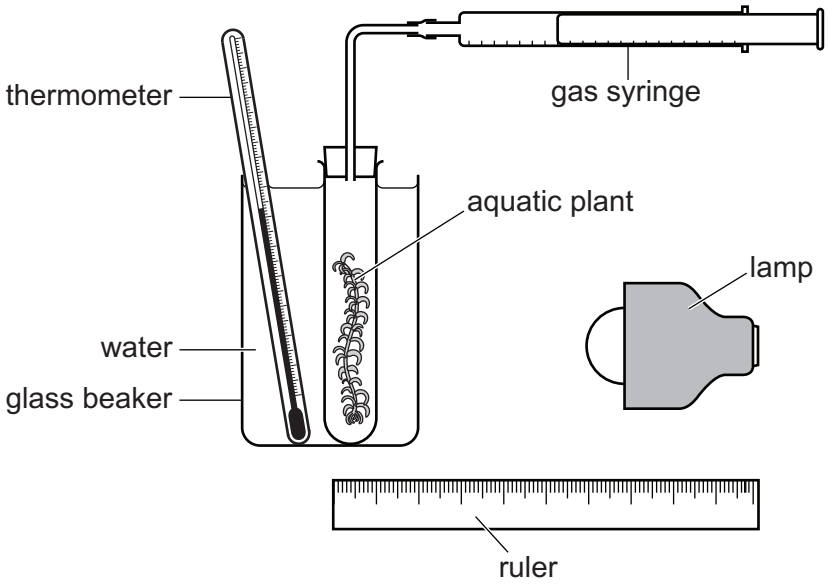

Fig. 2.1

(i) Describe how the apparatus in Fig. 2.1 could be used to measure the rate of photosynthesis at different light intensities.

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..... [5]

(ii) Draw a table that is suitable to record the results of this investigation.

Include units where appropriate.

Include full headings but do **not** write in any results.

[2]

(iii) Describe how the results are used to calculate the **rate** of photosynthesis.

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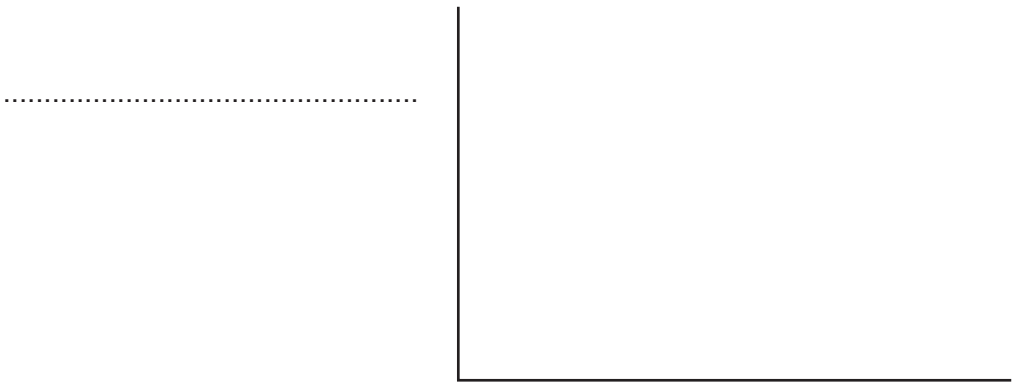
..... [1]

(iv) Sketch on the axes the relationship between light intensity and rate of photosynthesis.

Include labels for both axes.



[2]

(b) The kite diagram in Fig. 2.2 shows the distribution of three species of seaweed (**X**, **Y**, **Z**) on a rocky shore, from the mean high water mark (MHWM) to the mean low water mark (MLWM).

The greater the height of the shaded area, the greater the abundance.

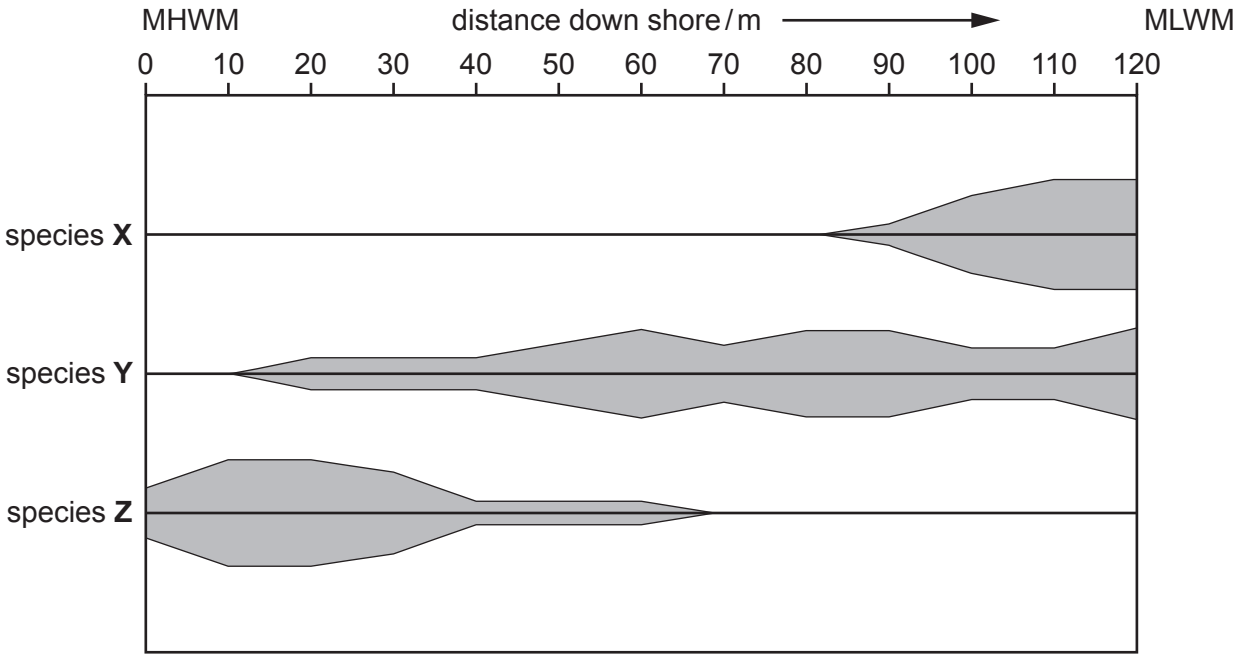


Fig. 2.2

(i) Use Fig. 2.2 to compare the distribution and abundance of species **X**, **Y** and **Z**.

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..... [3]

(ii) Suggest which species is best adapted for photosynthesis at lower light intensities.

Explain your answer.

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(iii) Suggest how species **Z** may be adapted to survive at the mean high water mark.

Explain your answer.

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..... [2]

[Total: 17]

3 **(a)** Nitrates are an important source of nitrogen.

State the importance of nitrogen for marine organisms.

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..... [1]

(b) In October 2017 researchers recorded the following data in an ocean:

- temperature of the sea water
- concentration of nitrate ions (NO_3^-) in the sea water
- rate of uptake of nitrate ions from the sea water.

They took readings every 40 m down to a depth of 200 m.

Table 3.1 shows the recorded temperature of the sea water.

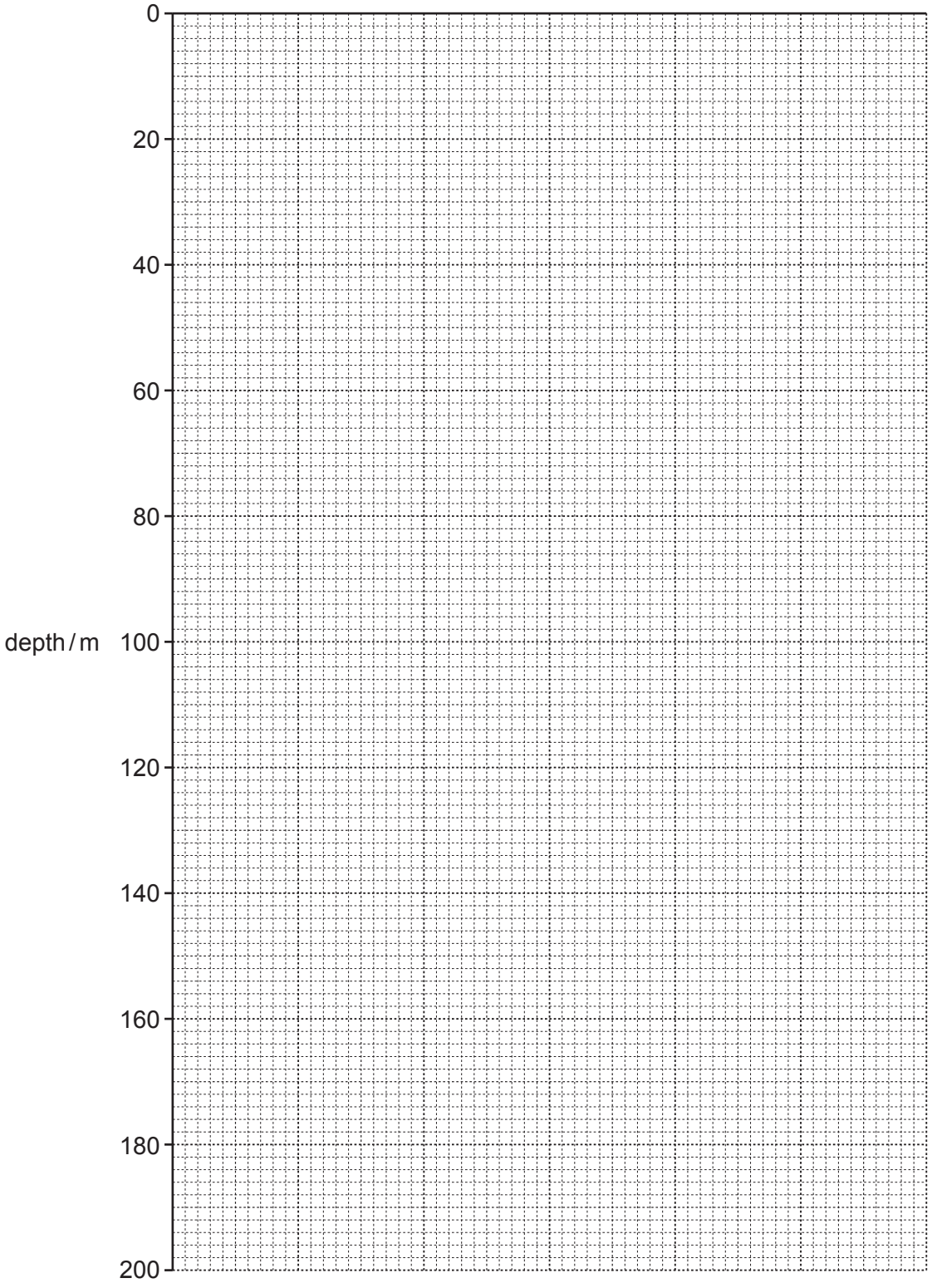
Table 3.1

depth / m	sea water temperature / °C
0	28.4
40	28.2
80	26.5
120	20.1
160	17.5
200	17.0

(i) Use the data in Table 3.1 to complete the graph.

You should:

- label the *x*-axis
- add a scale to the *x*-axis
- plot the data
- draw a line of best fit.



[3]

(ii) Suggest the range of depths where the thermocline is found.

Explain your answer.

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(iii) Suggest a reason why the position of the thermocline may change.

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(c) Fig. 3.1 shows the concentrations of nitrate ions and the rate of uptake of nitrate ions measured by the researchers.

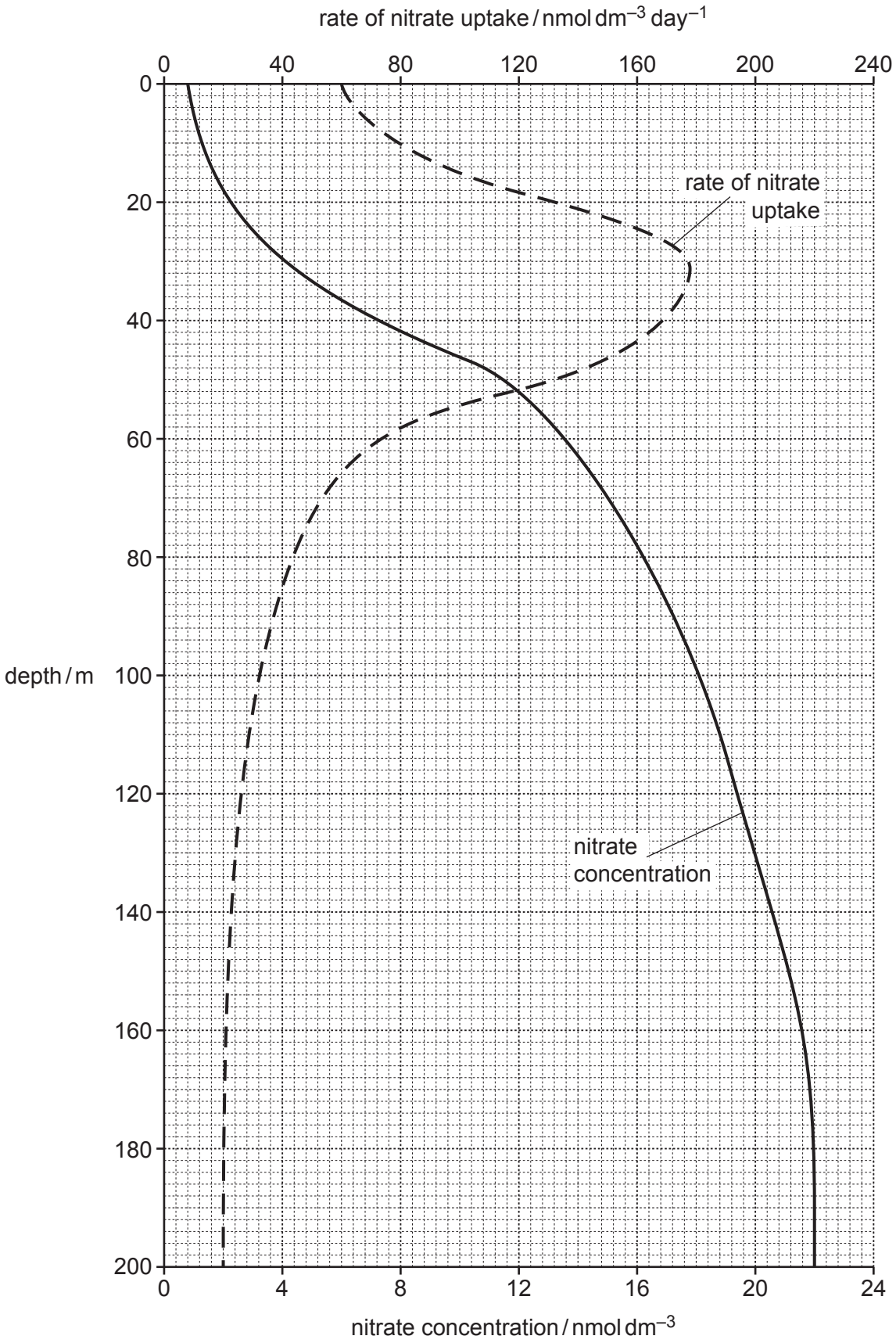

Fig. 3.1

(i) Use your graph in **(b)(i)** and Fig. 3.1 to determine the temperature of the sea water at the maximum rate of nitrate ion uptake.

..... °C [1]

(ii) Describe **and** suggest reasons for the changes in nitrate ion uptake shown in Fig. 3.1.

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..... [3]

(d) An influx of nitrate ions caused an algal bloom, during which the population density of phytoplankton species increased.

Fig. 3.2 shows the population density before and during the algal bloom in the first 20 m of sea water.

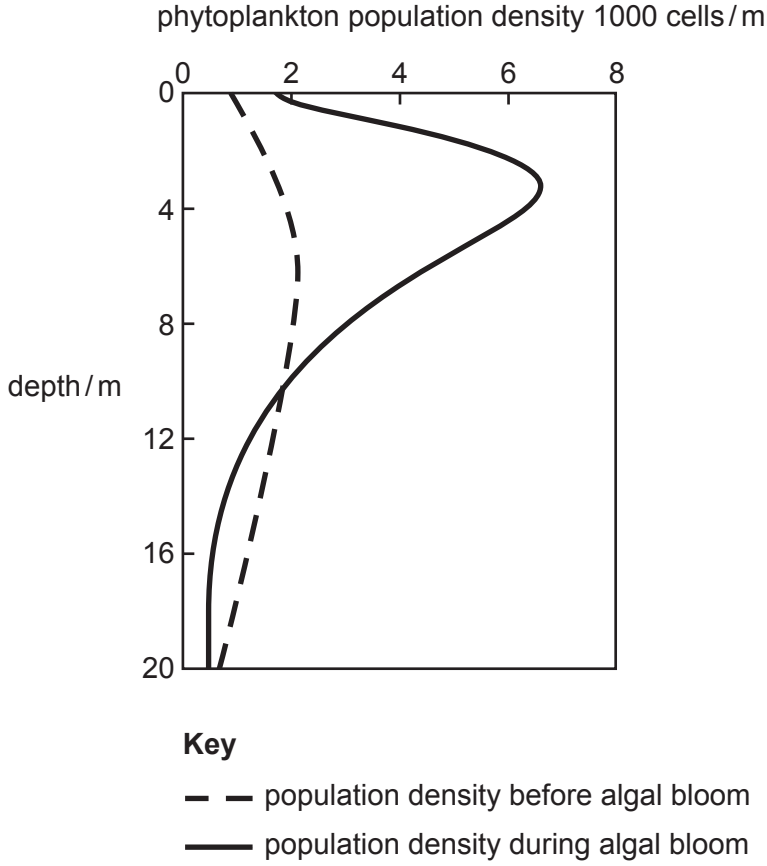

Fig. 3.2

Predict **and** explain the impact of the algal bloom on the trend for the rate of uptake of nitrate ions shown in Fig. 3.1.

Use information from Fig. 3.1 **and** Fig. 3.2 in your answer.

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..... [3]

[Total: 14]

4 Fig. 4.1 shows a boxer crab with two anemones attached to its front claws.

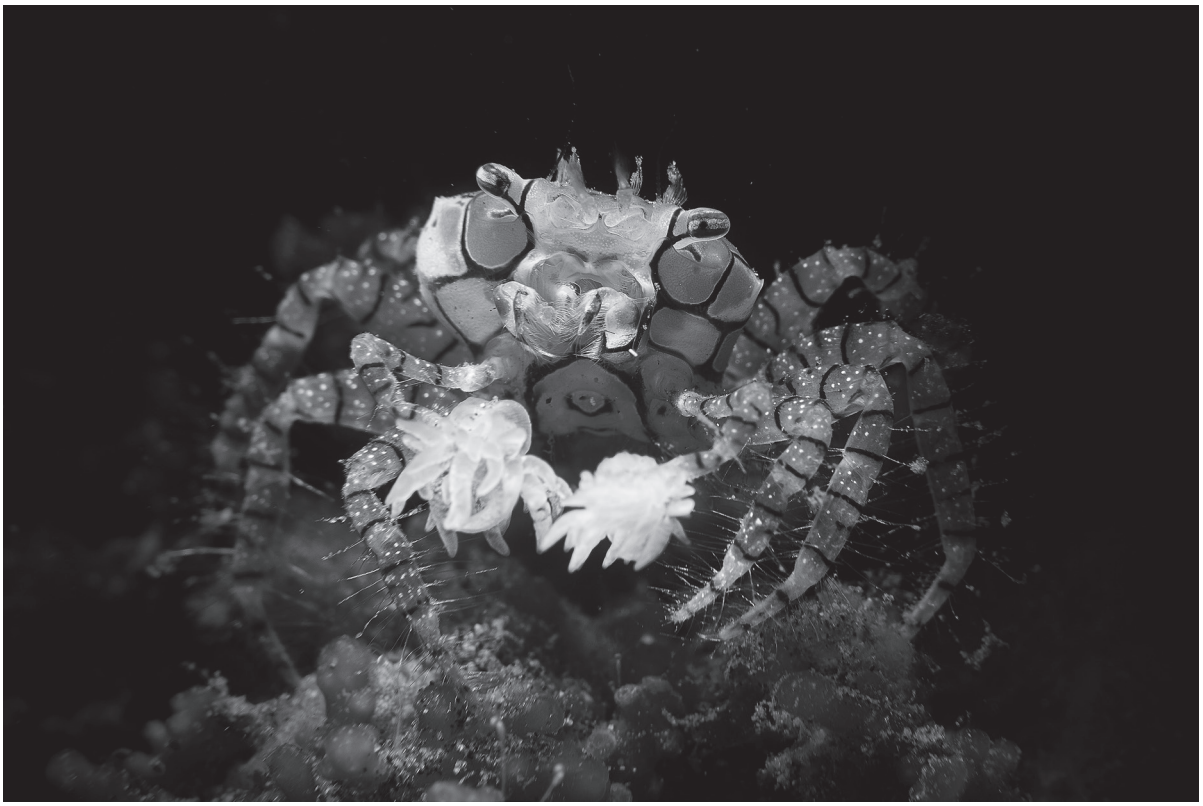

Fig. 4.1

(a) Boxer crabs and anemones show a mutualistic relationship.

Explain why this relationship is an example of mutualism.

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..... [2]

(b) Boxer crabs are crustaceans.

State **one** main feature of a typical adult crustacean.

..... [1]

(c) Anemones belong to the same phylum as corals.

Name this phylum.

..... [1]

(d) Scientists investigated the relationship between the boxer crabs and the anemones.

They measured the size of the anemones on the left and right front claws on 30 crabs.

Fig. 4.2 is a scatter diagram showing the results.

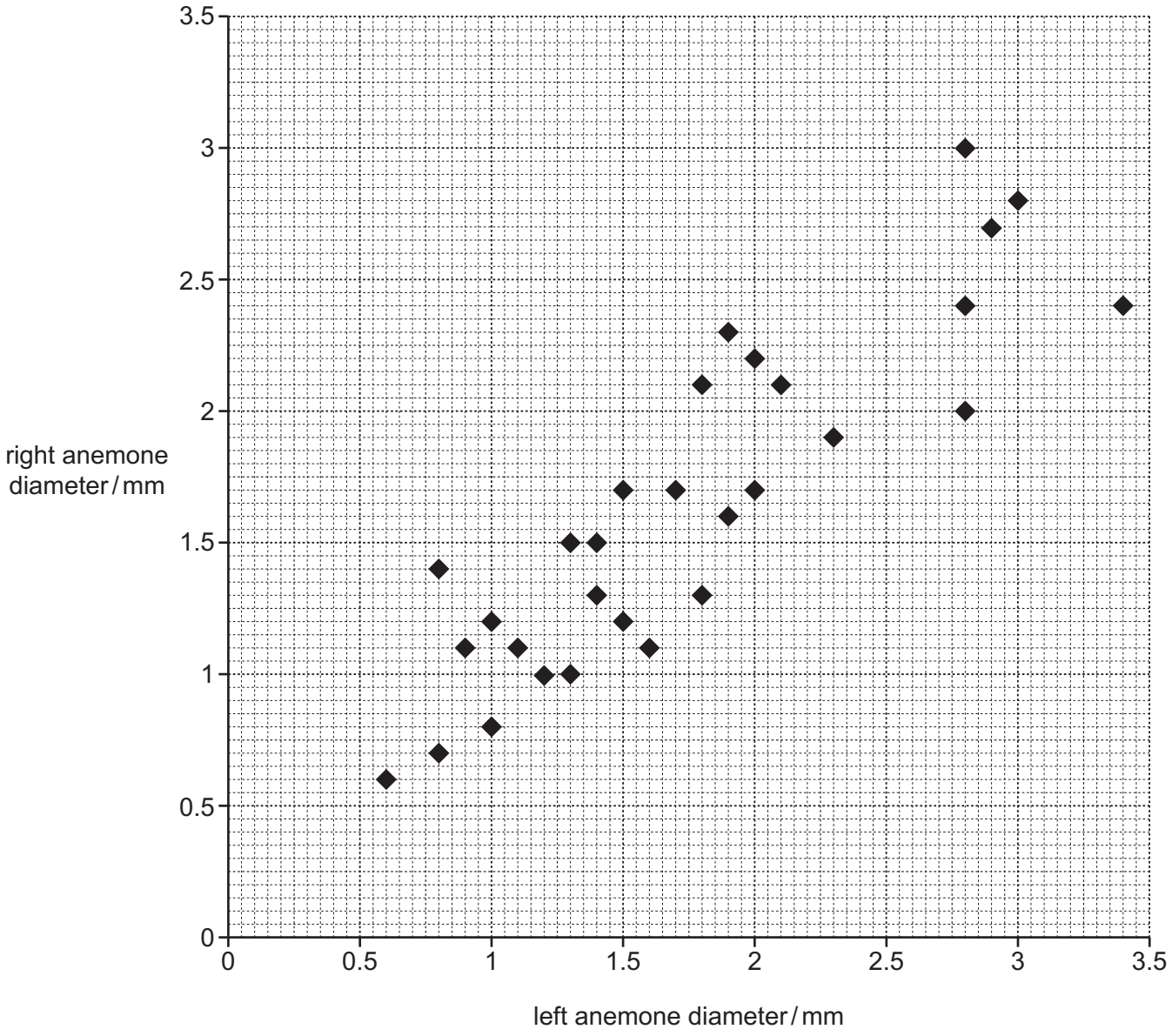

Fig. 4.2

(i) Scientists applied Spearman's rank correlation to the data.

Explain why Spearman's rank correlation is a suitable way to analyse these data.

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..... [2]

(ii) Spearman's rank correlation uses the following equation:

$$r_s = 1 - \left(\frac{6 \times \Sigma D^2}{n^3 - n}\right)$$

A value for ΣD^2 was calculated as 509.0

Complete the calculation for the r_s value using the equation.

Give your answer to **two** significant figures.

Show your working.

..... [3]

(iii) State a conclusion about the correlation between the anemone size on each claw.

Use your calculated value for r_s from **(d)(ii)** to support your answer.

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..... [2]

(e) Scientists hypothesised that the boxer crabs controlled the size of the anemones on their claws.

(i) Suggest a reason why the boxer crabs might need to control the size of the anemones.

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..... [1]

The scientists investigated the growth over a period of 60 days of:

- anemones that were attached to crab claws
- anemones that had never been attached to crab claws
- anemones that had been attached to crab claws but were removed.

Fig. 4.3 shows the results.

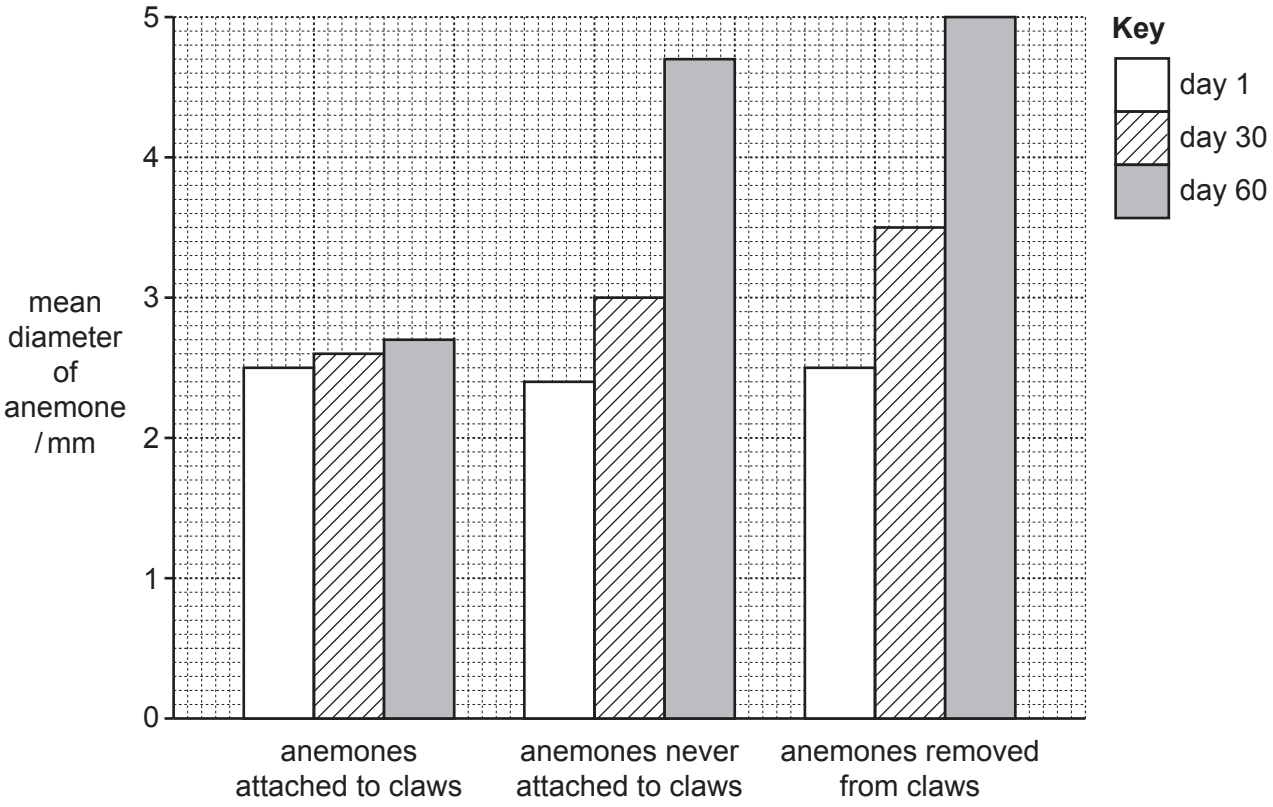

Fig. 4.3

(ii) Discuss whether the data in Fig. 4.3 support the idea that the crabs controlled the size of the anemones.

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[Total: 15]

5 pH is an important abiotic factor in marine ecosystems.

(a) Describe in terms of ions what the pH of a solution measures.

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(b) Describe how Universal Indicator can be used to determine the pH of sea water samples.

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..... [2]

(c) Fig. 5.1 shows the changes in mean global sea water pH from 1990 until 2017.

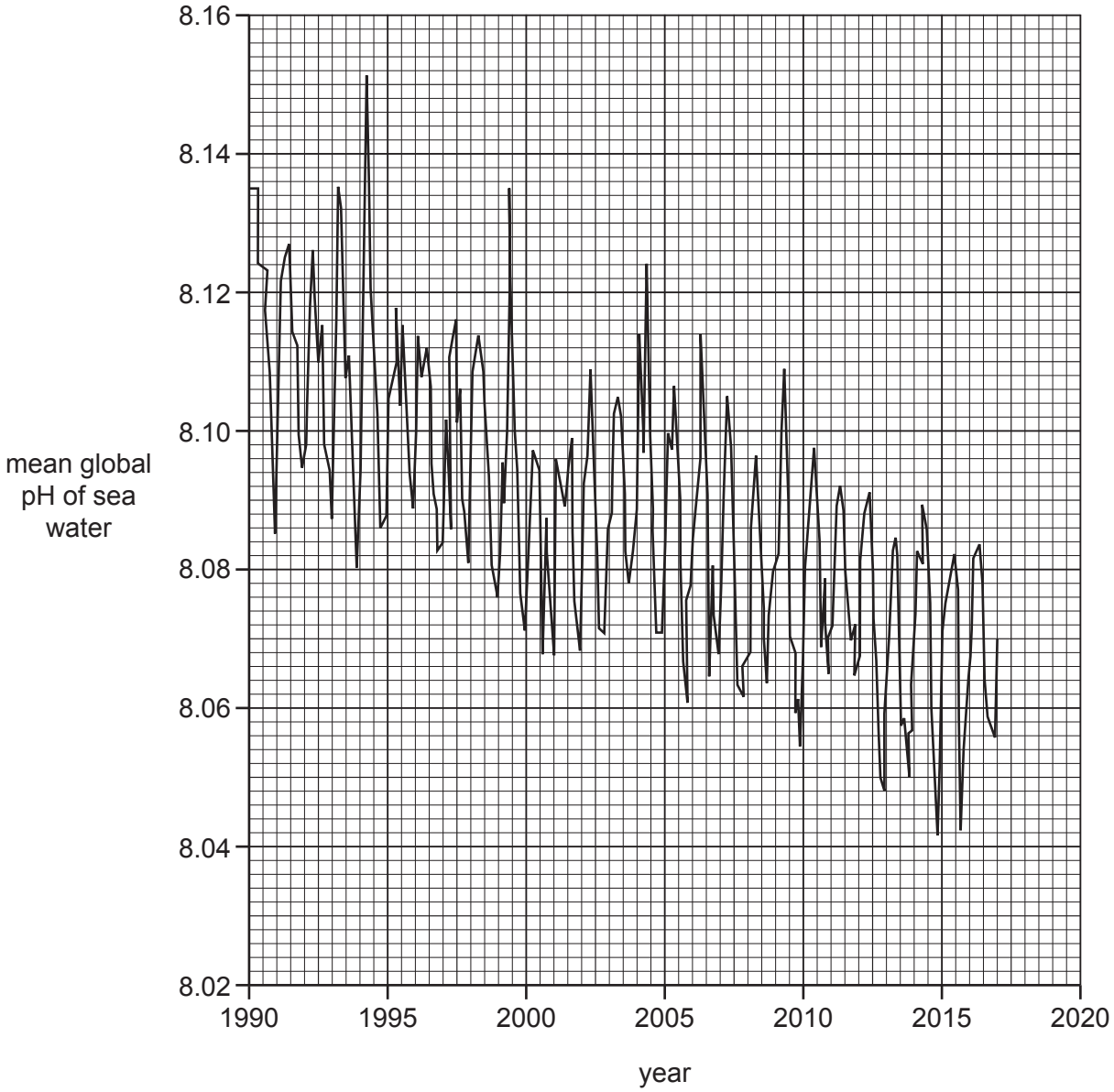

Fig. 5.1

(i) The pH data in Fig. 5.1 were obtained using a pH probe rather than using universal indicator.

Suggest a reason why universal indicator would **not** be suitable for obtaining these data.

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..... [1]

(ii) Calculate the difference in mean global sea water pH between 1990 and 2017.

..... [1]

(d) Scientists investigated the effect of pH on marine organisms from a coral reef.

Two separate tanks of sea water were used: one at an acidified pH and one control tank.

They measured the change in:

- mass of red coral
- area covered by two species of alga
- area covered by two species of sponge.

Fig. 5.2 shows their results.

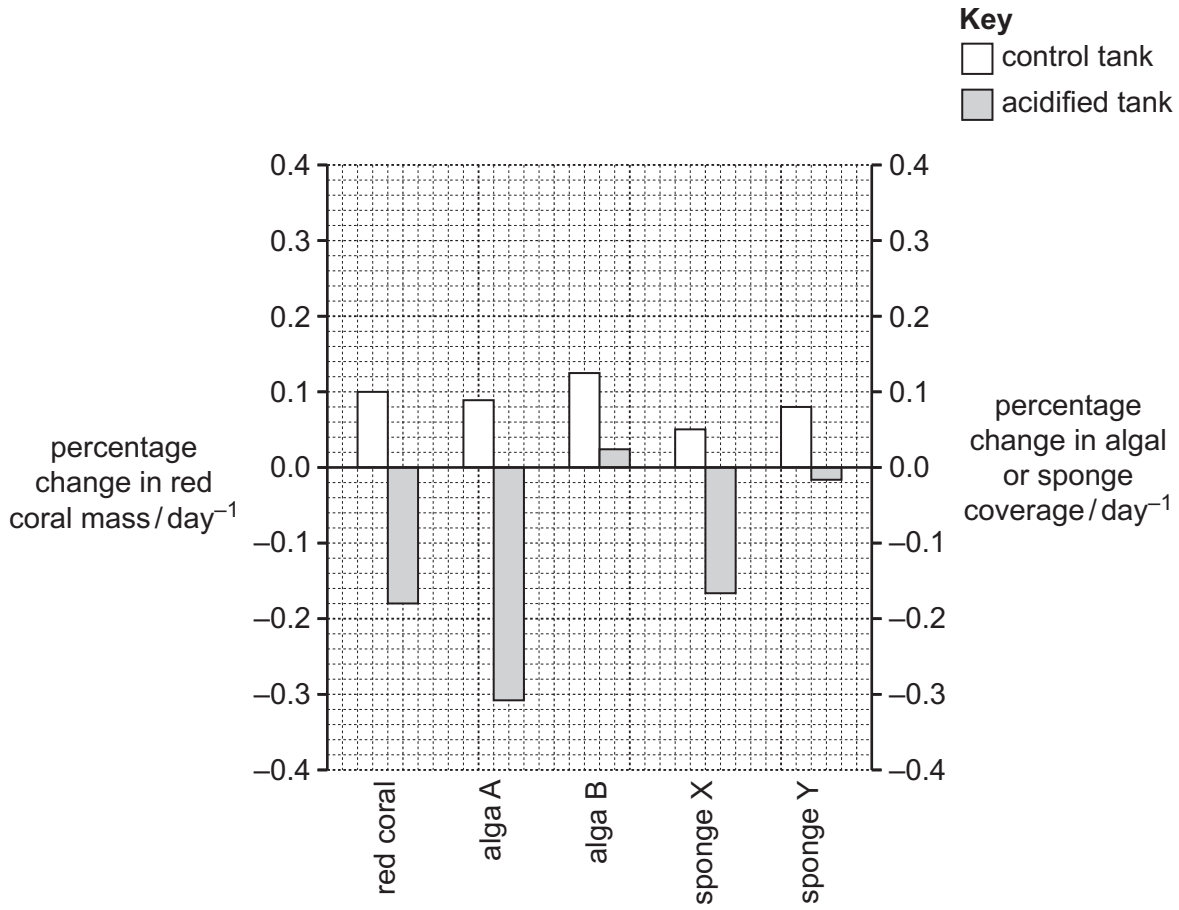

Fig. 5.2

(i) Explain why a control tank is used.

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..... [2]

(ii) The scientists concluded that acidified conditions reduce biodiversity.

Evaluate the extent to which the data support this conclusion.

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(iii) Explain the importance of protecting marine biodiversity for the human population.

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[Total: 14]

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