Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2048827915

MARINE SCIENCE **9693/21**

Paper 2 AS Level Data-handling and Investigative Skills **May/June 2022**

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 **24** pages. Any blank pages are indicated.

[Turn over

Answer **all** questions.

1 Artificial reefs are widely used to regenerate coral reef ecosystems.

Artificial reefs can be made using 3D printing technology. This technology makes exact copies of the shape and structure of real coral skeletons.

Fig. 1.1 shows an artificial coral skeleton made using this technology.

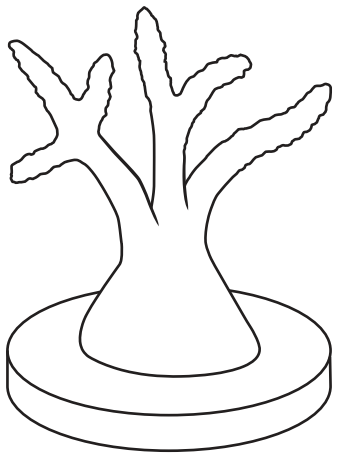

Fig. 1.1

(a) Scientists investigated how damselfish (small reef fish) behave when introduced to artificial coral skeletons made of different types of material.

Four different types of material were used, **A–D**, in addition to natural coral as a control.

Individual damselfish were introduced to tanks containing all five types of coral skeletons.

A total of 44 fish were used. They were able to move freely between the different types of coral skeleton, and the time spent associating with each was recorded.

(i) Suggest **two** variables that the scientists need to control to obtain reliable results.

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[2]

(ii) Fig. 1.2 shows the percentage of time the damselfish spent associating with each type of coral skeleton.

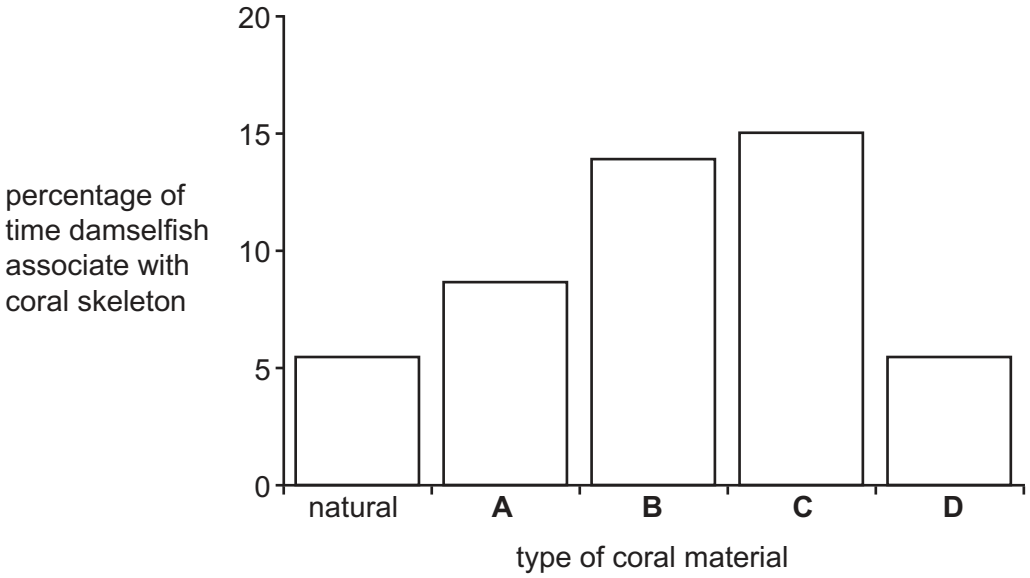

Fig. 1.2

State a conclusion regarding the behaviour of the fish around the coral skeletons.

Use the information in Fig. 1.2 to support your answer.

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(iii) Suggest reasons why small reef fish such as damselfish are dependent on coral for their survival.

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(b) Scientists then investigated the settlement and growth of coral polyp larvae on artificial coral skeletons.

Equal numbers of coral polyp larvae were introduced into separate tanks containing each type of artificial coral skeleton.

The percentage of larvae attached to each type of coral skeleton was recorded over a 14-day period, and the growth rate of those that attached was calculated.

Fig. 1.3 shows the percentage of larvae attached to each type of coral skeleton material.

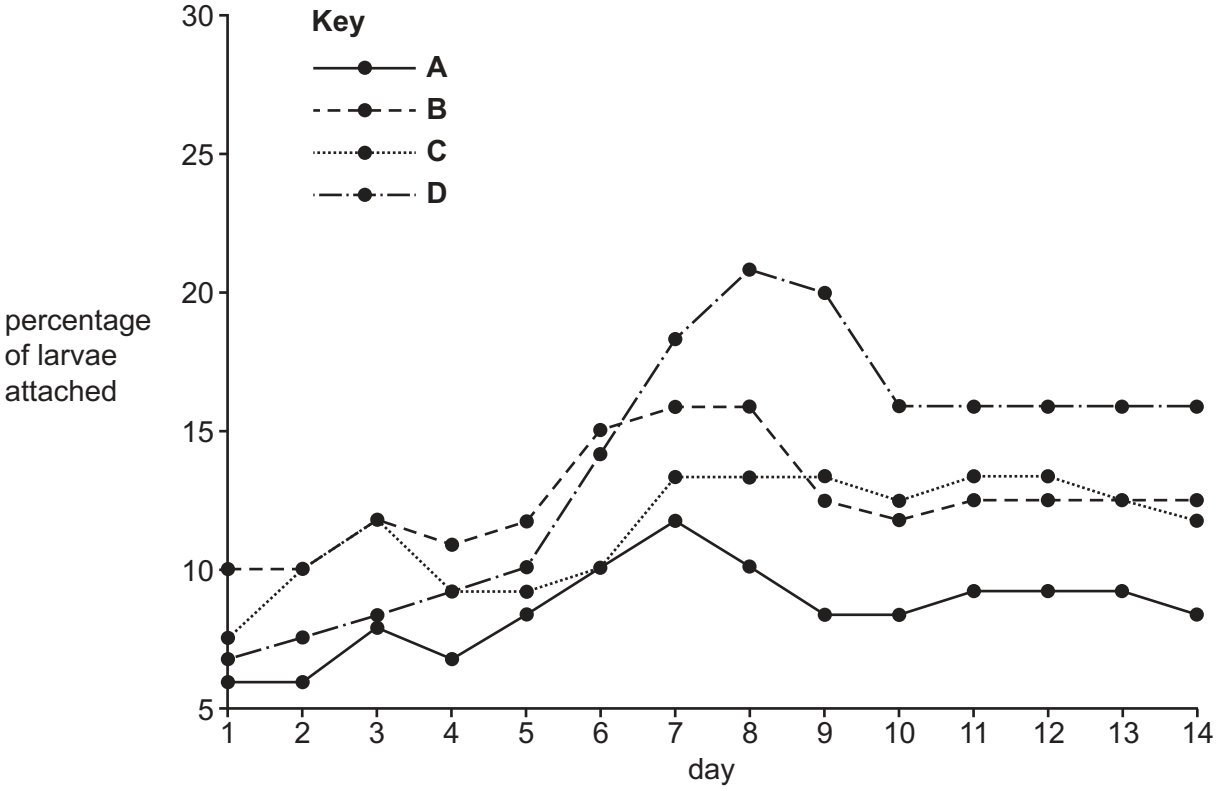

Fig. 1.3

Table 1.1 shows the mean growth rate of attached coral polyp larvae.

Table 1.1

coral skeleton material	mean growth rate of coral polyp larvae / mm^2 per week
A	0.078
B	0.201
C	0.211
D	0.162

Discuss which of the materials **A–D** is best to use for the growth of coral polyp larvae.

Use the results shown in Fig. 1.3 **and** Table 1.1 to support your answer.

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(c) The scientists concluded that 3D-printed coral skeletons can be used for regenerating coral reef ecosystems.

Evaluate the extent to which the results from this investigation support this conclusion.

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(d) Fig. 1.4 shows a damselfish similar to those used in the investigation.

Fig. 1.4

(i) Make a large drawing of the damselfish in the space below.

[4]

(ii) Label the caudal fin and the dorsal fin on your drawing. [1]

[Total: 18]

2 A student investigates the properties of water of different salinities.

(a) Describe how the student makes water samples of different salinities.

Include the equipment they should use.

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(b) The student investigates the effect of salinity on the freezing point of water.

They use a freezer to freeze each of their water samples.

The temperature of the freezer can be adjusted to within 0.1 °C, down to –20 °C.

(i) Suggest how the student could use the freezer to obtain reliable results.

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(ii) The student designed Table 2.1 for recording their results.

Table 2.1

salinity of sample	temperature / °C

Suggest **two** improvements that could be made to Table 2.1.

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[2]

(iii) Predict the relationship between salinity and freezing point that the student would find in this investigation.

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(iv) State the factors that cause the salinity of sea water to change.

Describe how the salinity will change for each factor.

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(c) The student investigates the density of their water samples at each salinity.

(i) State how the density of the samples can be measured.

Include the correct units for calculating the density.

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(ii) Use the axes below to sketch the relationship you would expect to find between salinity and density.

[2]

(iii) Explain the significance of different salinities of sea water having different densities.

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[Total: 18]

3 Rockpools are a common feature of rocky shores.

A student investigated the relationship between the size of a rockpool and the diversity of the macroalgae (seaweeds) that live in it.

They used the following hypothesis:

'The larger the rockpool volume the greater the diversity of macroalgae.'

They spent a day on a rocky shore surveying 35 rockpools.

The approximate size of each rockpool was recorded by measuring its volume in arbitrary units.

The number of species of macroalgae present was counted in each rockpool.

Fig. 3.1 shows the results of their survey.

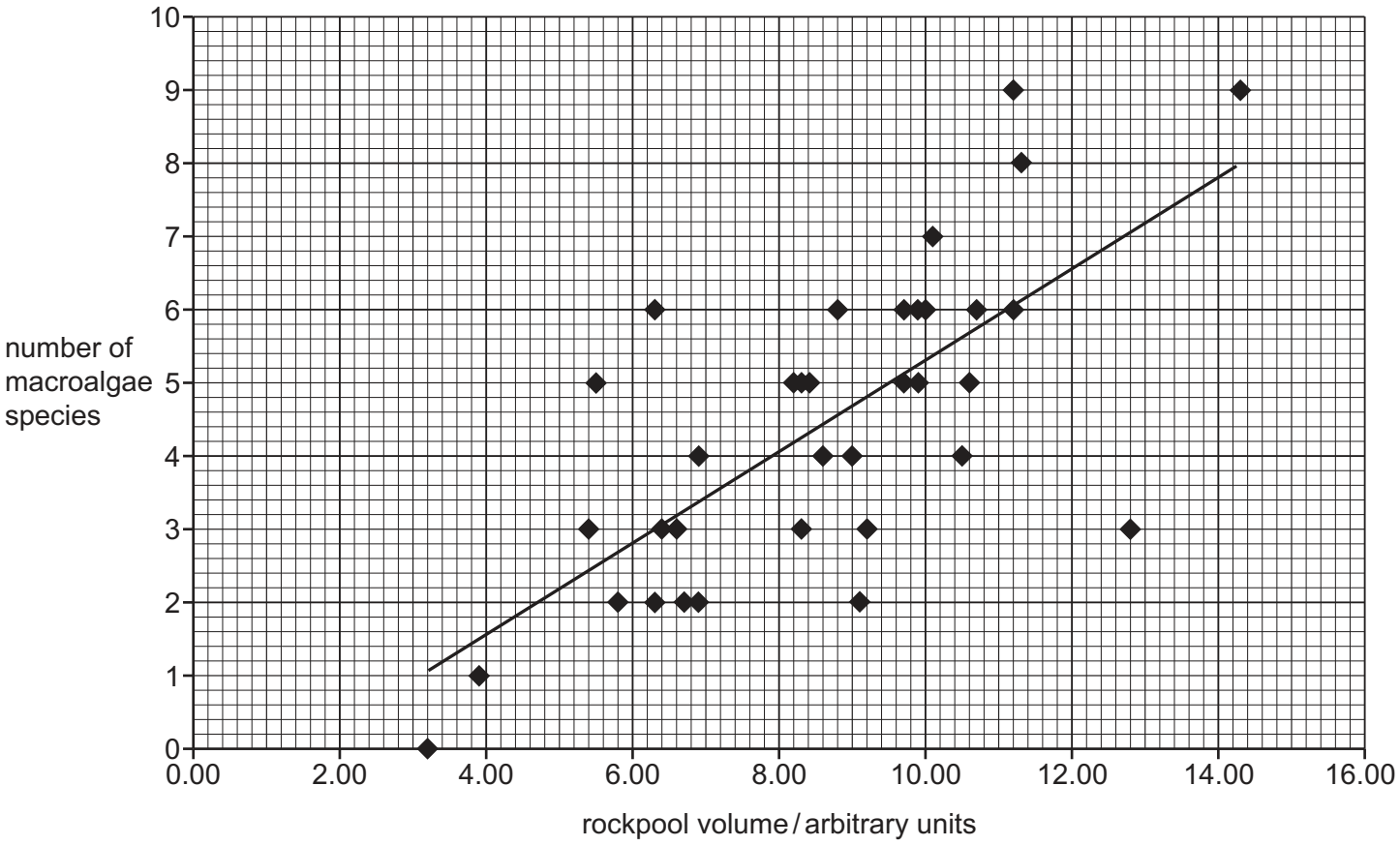

Fig. 3.1

(a) Identify any correlation within the data in Fig. 3.1.

Use the data to support your answer.

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(b) The student gathered additional information about two rockpools of different sizes. They chose the largest rockpool and one of the smaller rockpools. They identified the species and recorded the abundance of each species.

The results are shown in Table 3.1.

Table 3.1

species of macroalgae	abundance	
	largest rockpool	smaller rockpool
Corallina officinalis	11	5
Ulva lactuca	8	4
Fucus spiralis	9	0
Fucus serratus	4	0
Chondrus crispus	7	3
Cladophora rupestris	5	2
Bryopsis plumosa	2	0
Codium tomentosum	1	0
Pelvetia canaliculata	7	5
Total of all species	54	19

They used Simpson's index of diversity to compare the diversity of the two rockpools.

The equation for Simpson's index of diversity is:

$$D = 1 - \left(\Sigma\left(\frac{n}{N}\right)^2\right)$$

Where Σ = sum of (total)
n = number of individuals of each **different** species
N = the total number of individuals of **all** the species

(i) Table 3.2 shows the data for the smaller rockpool.

The values for $\frac{n}{N}$ and $\left(\frac{n}{N}\right)^2$ have already been calculated.

Table 3.2

species	value of n	value of N	value of $\frac{n}{N}$	value of $\left(\frac{n}{N}\right)^2$
Corallina officinalis	5	19	0.2632	0.0693
Ulva lactuca	4	19	0.2105	0.0443
Chondrus crispus	3	19	0.1579	0.0249
Cladophora rupestris	2	19	0.1053	0.0111
Pelvetia canaliculata	5	19	0.2632	0.0693

Use the data in Table 3.2 to calculate *D* for the smaller rockpool.

State your answer for *D* to 2 significant figures.

$\Sigma\left(\frac{n}{N}\right)^2$ = ...

D = ...

[3]

(ii) The student's hypothesis was:

'The larger the rockpool volume the greater the diversity of macroalgae.'

The student calculated the value for *D* for the largest rockpool as 0.86.

Use this value for *D* for the largest rockpool and the value for *D* calculated in **(b)(i)** for the smaller rockpool to decide whether their hypothesis is supported.

Explain your answer.

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(c) Another student stated that the hypothesis was **not** supported.

Suggest reasons for this conclusion.

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[Total: 12]

4 Fig. 4.1 shows an atoll in the Indian Ocean. Atolls typically consist of a reef enclosing a central lagoon.

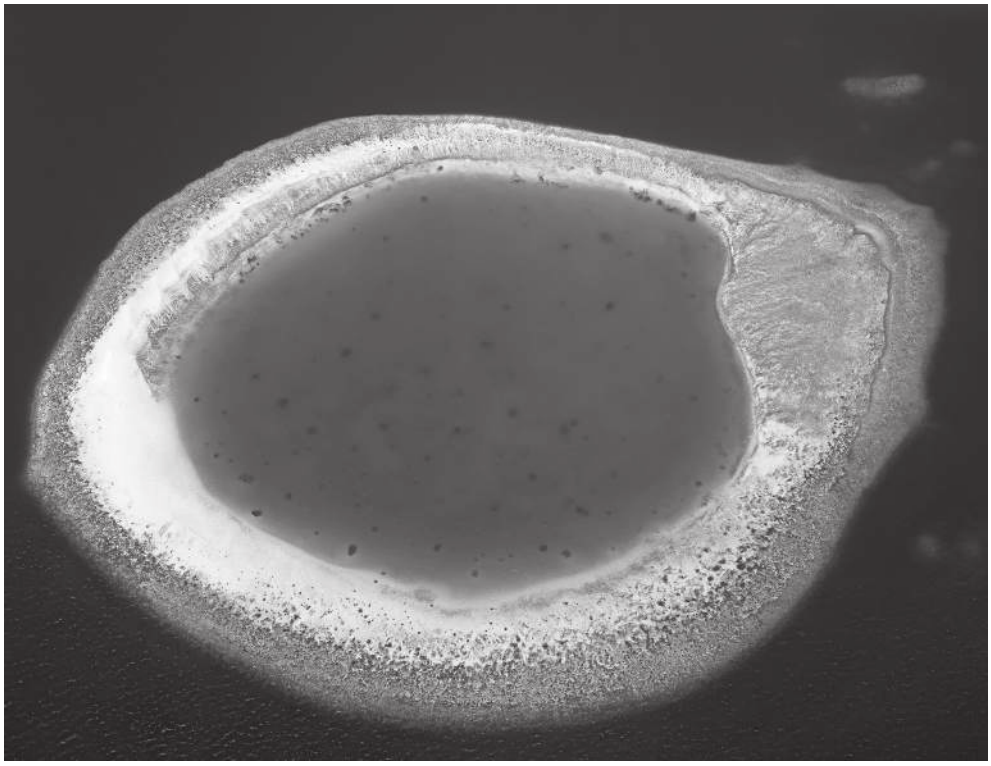

Fig. 4.1

This atoll is mostly submerged at high tide. As the tide level falls, parts of the reef rim become exposed, largely isolating the central lagoon.

Scientists collected data on the tidal height for 15 days, both in the central lagoon, and offshore in the surrounding ocean.

The results of this investigation are shown in Fig. 4.2.

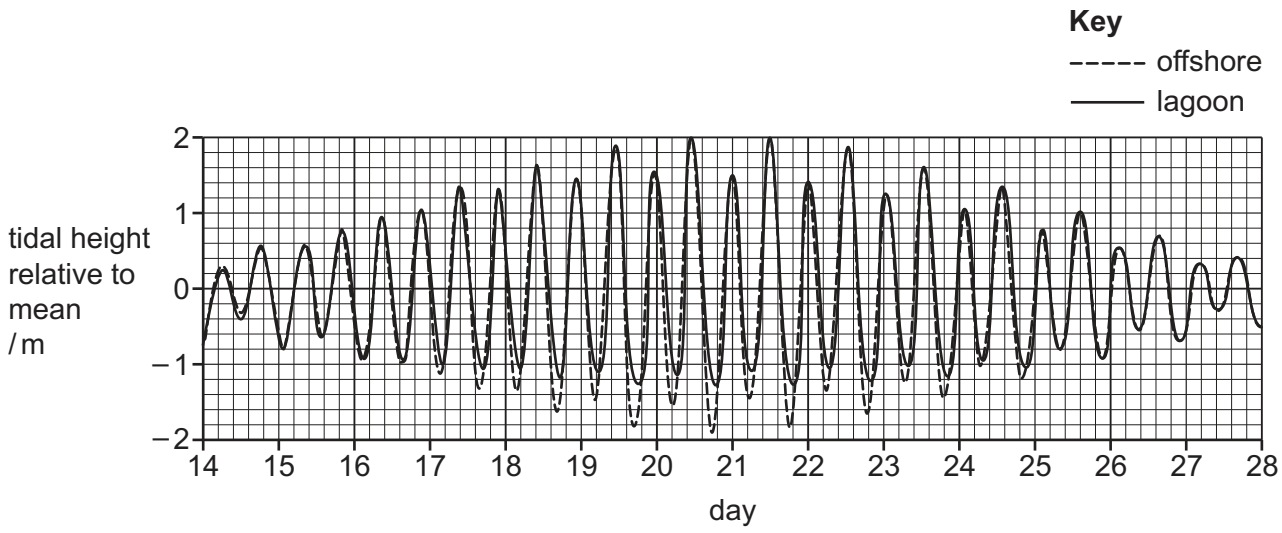

Fig. 4.2

(a) (i) Use Fig. 4.2 to determine the maximum tidal range recorded during the investigation.

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(ii) Explain why the tidal range changes.

Use the data in Fig. 4.2 to support your answer.

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(b) Fig. 4.3 shows the tidal cycle data over one 18-hour period during the investigation.

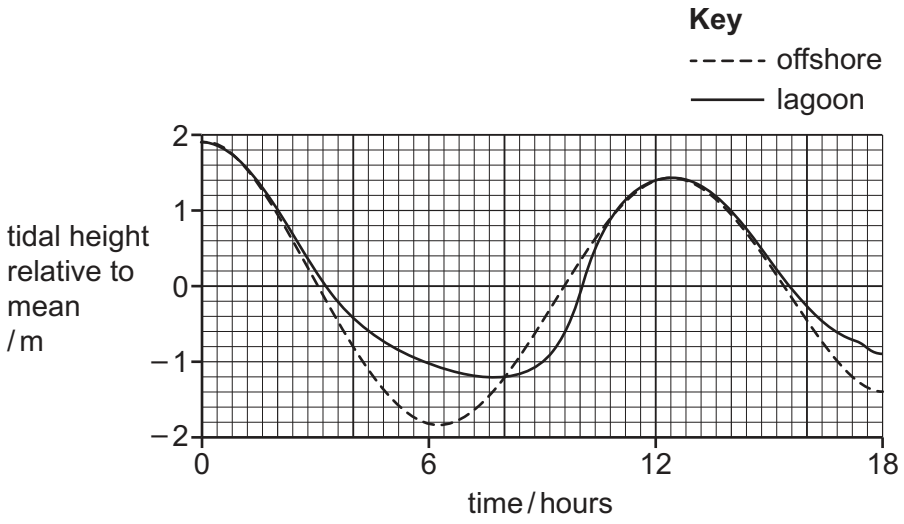

Fig. 4.3

Compare the tidal cycle of the lagoon with the tidal cycle offshore, explaining any differences.

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(c) Suggest how changes in the tidal cycle may affect biotic and abiotic factors in the lagoon.

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[Total: 12]

5 Bioluminescence occurs when organisms emit light from a chemical reaction in their tissues.

It is used by various marine organisms including dinoflagellates, such as those shown in Fig. 5.1.

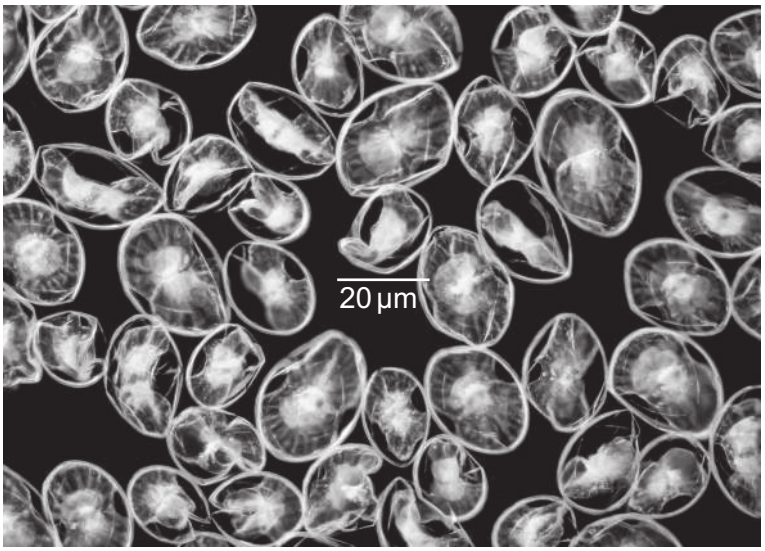

Fig. 5.1

An investigation was carried out to test whether bioluminescence in dinoflagellates could help them to avoid predation by zooplankton, such as copepods.

Dinoflagellates were kept in tanks of sea water. They were exposed to different concentrations of copepodamide, a chemical released into water by copepods, over a period of 48 hours.

The light production was measured after 1 hour, 12 hours and 48 hours. The results were used to calculate the relative increase in light production.

(a) (i) Suggest **one** advantage of using a chemical stimulus such as copepodamide, rather than live copepods.

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(ii) Suggest **one** other variable that would need to be standardised throughout this investigation.

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(b) The results of the investigation after 48 hours are shown in Table 5.1.

Table 5.1

concentration of copepodamide / arbitrary units	percentage increase in light production after 48 hours
0	0
2	120
4	165
6	205
8	230
10	250

The results obtained after 1 hour and 12 hours have been plotted on Fig. 5.2.

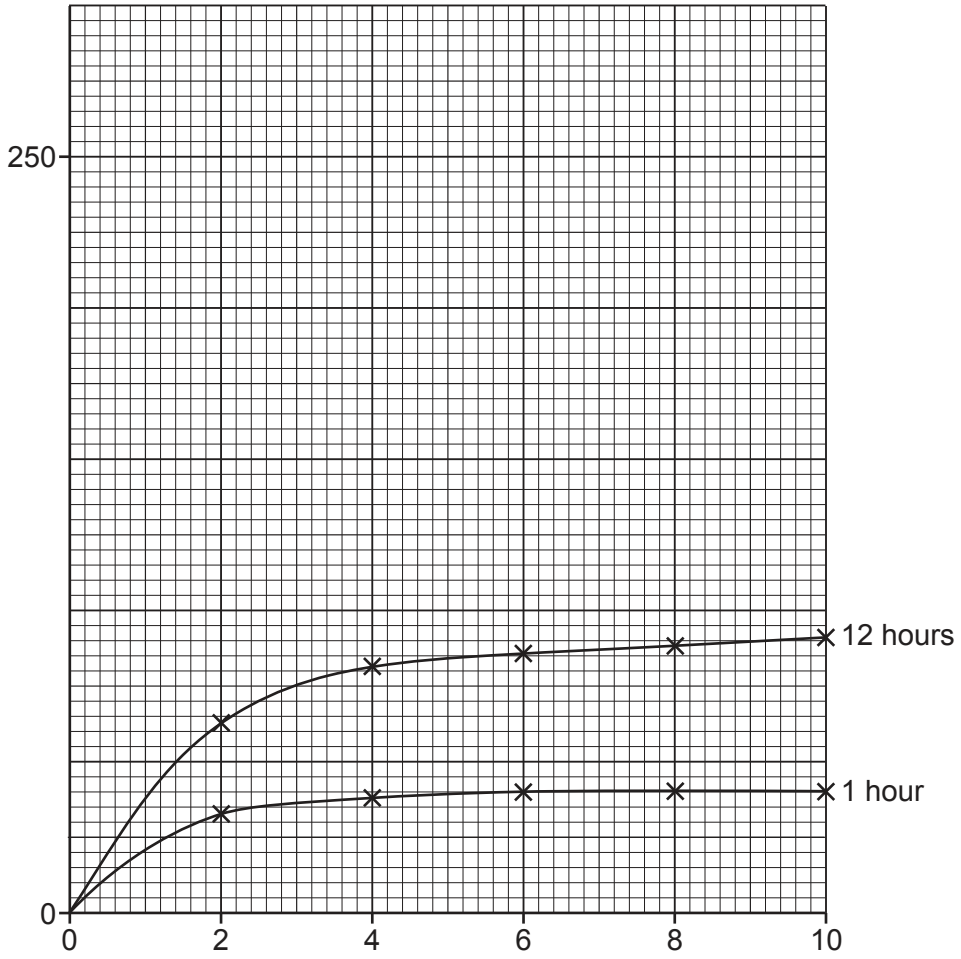

Fig. 5.2

(i) Plot the values from Table 5.1 for percentage increase in light production after 48 hours on Fig. 5.2.

Complete the scale for the y-axis and the labels for both axes. Two scale values have been added for you.

Draw a line of best fit to indicate the overall trend for the data you have plotted.

[4]

(ii) Describe the relationship between copepodamide concentration and percentage increase in light production as shown in Fig. 5.2.

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(iii) Discuss whether the data in Table 5.1 and Fig. 5.2 support the idea that dinoflagellates use bioluminescence to avoid predation.

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(c) The scientists investigated the feeding behaviour of live copepods in the presence of different types of dinoflagellates.

Copepods were given food samples containing either non-bioluminescent or bioluminescent dinoflagellates, and alternative prey species.

food sample **A** non-bioluminescent dinoflagellates and alternative prey species

food sample **B** bioluminescent dinoflagellates and alternative prey species

food sample **C** bioluminescent dinoflagellates, alternative prey species and copepodamide added

They measured the percentage of dinoflagellates being consumed by the copepods, compared to alternative prey species.

Fig. 5.3 shows their results.

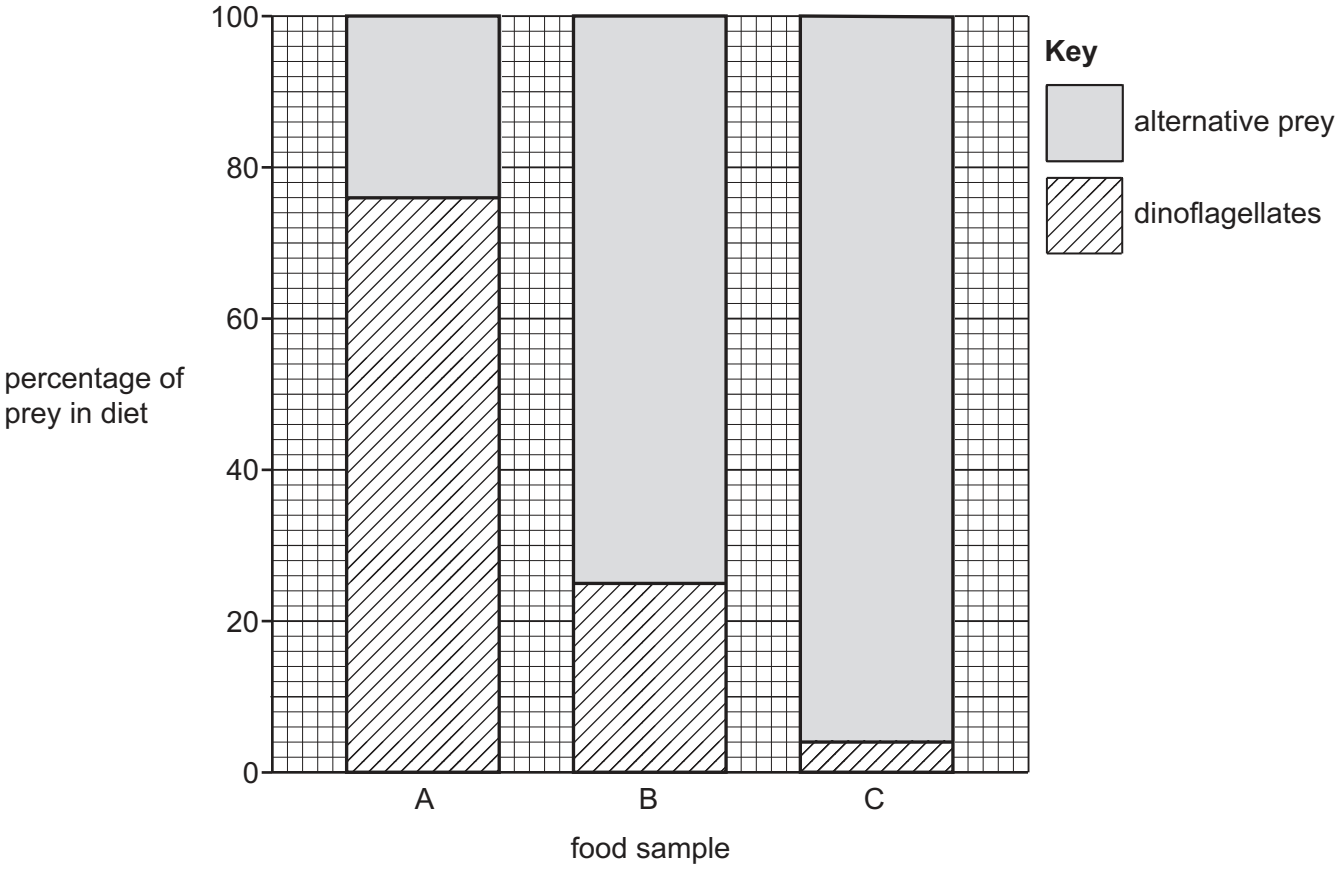

Fig. 5.3

The scientists concluded that the data in Fig. 5.3 proves that bioluminescence in dinoflagellates does help them avoid predation.

Discuss the extent to which the data support this conclusion.

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[Total: 15]

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