Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

MARINE SCIENCE **9693/23**

Paper 2 AS Level Data-handling and Investigative Skills **May/June 2024**

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 **20** pages. Any blank pages are indicated.

[Turn over

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Answer **all** questions.

1 When sea water temperature increases, coral polyps release zooxanthellae. Either the polyps release whole zooxanthellae which are healthy, or the polyps partially digest and release zooxanthellae which are damaged.

A scientist carried out an investigation to test the hypothesis:

Increased temperature will increase the number of healthy and damaged zooxanthellae released by coral polyps.

An aquarium was prepared with a light supply and constantly flowing sea water at 27 °C, and a supply of air was bubbled through the sea water. A coral colony was placed into the aquarium. The sea water was filtered to collect all the zooxanthellae released by the coral polyps.

Three sea water samples were taken from the aquarium each day. The samples were examined under a microscope to count the number of zooxanthellae that were healthy or damaged.

Results were collected for five days.

The sea water temperature was then gradually increased to 30 °C over a two-day period with sampling of the sea water continuing.

The corals were kept at 30 °C for a further six days with sampling of the sea water continuing.

(a) (i) Explain why light **and** air were supplied to the aquarium.

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..... [4]

(ii) Identify the independent **and** dependent variable.

independent variable .....

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dependent variable .....

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[2]

(b) Table 1.1 shows the results collected for day 13.

Table 1.1

sample number	number of healthy cells	number of damaged cells
1	460	1420
2	1840	1560
3	640	1620
mean	.....	.....

(i) Identify the anomalous result in Table 1.1 by drawing a circle around it. [1]

(ii) Calculate the means for healthy cells **and** for damaged cells. Do **not** include the anomalous result.

Write your answers in Table 1.1. [2]

(iii) Fig. 1.1 shows the daily mean number of zooxanthellae released that are healthy or damaged and the sea water temperature.

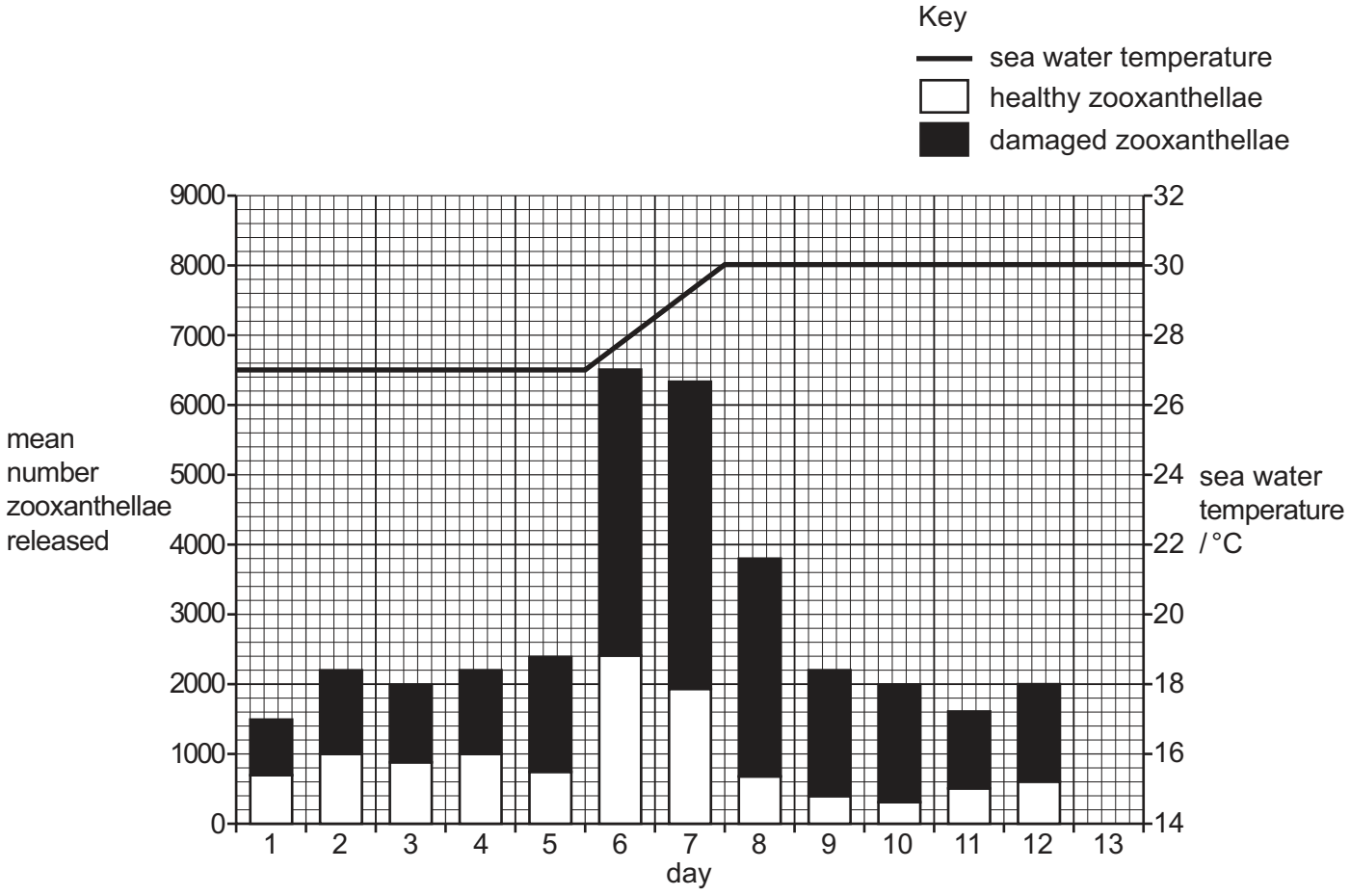

Fig. 1.1

On Fig. 1.1, plot the calculated daily means for day 13 using your answers from **(b)(ii)**. [2]

(iv) Discuss the extent to which the results of the investigation support the hypothesis the scientist was testing.

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..... [2]

(c) On day 4, the number of zooxanthellae released was 0.04% of the total zooxanthellae held in one coral polyp.

Calculate the number of zooxanthellae living in one coral polyp.

Show your working.

..... [2]

[Total: 15]

2 **(a)** Fig. 2.1 shows a plaice, *Pleuronectes platessa*. This is a bony fish that lives in the benthic zone.

Fig. 2.1

(i) Make a large drawing of the fish in Fig. 2.1.

Do **not** draw the markings.

[4]

(ii) On your drawing in **(a)(i)**, label the following features:

- lateral line
- operculum
- pelvic fin.

[3]

(iii) The larvae of plaice live in the zooplankton community.

When they reach a length of 2.5 cm, they settle on the sea bed and during their development their organs migrate to one side of their body.

Suggest why adult plaice **do not** have a swim bladder but the larvae **do** have a swim bladder.

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..... [2]

(b) Skate are fish that also live in the benthic zone.

Fig. 2.2 shows some of the anatomy of a skate.

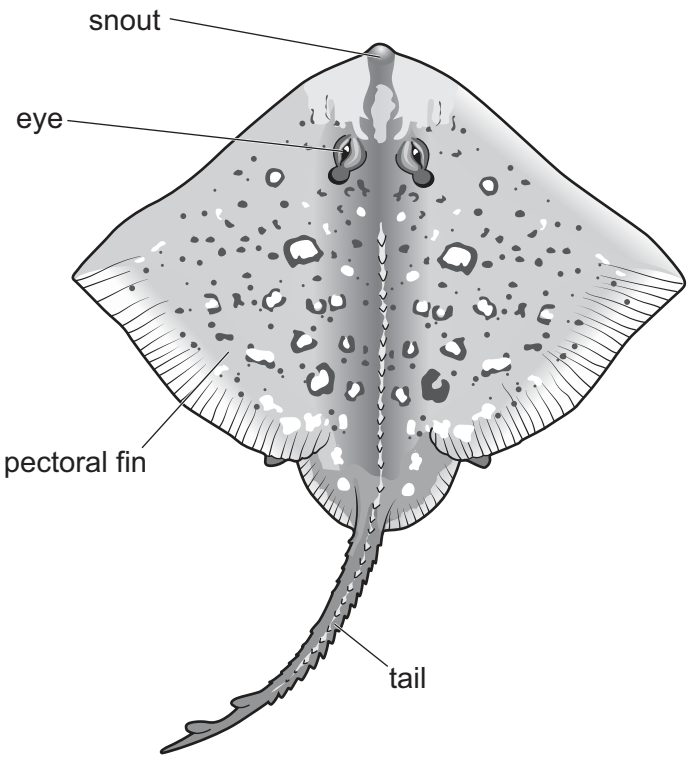
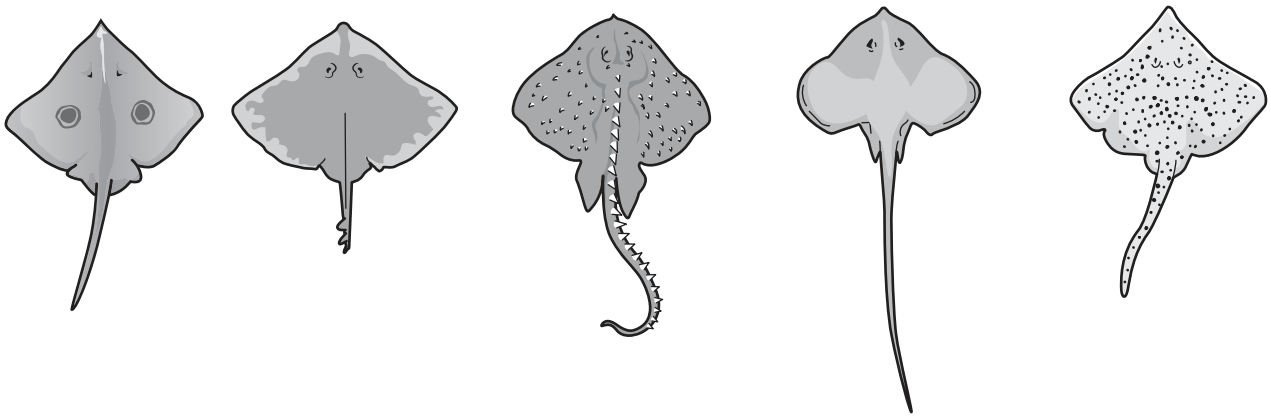


Fig. 2.2

Fig. 2.3 shows five species of skate, **A**, **B**, **C**, **D** and **E**.



A **B** **C** **D** **E**

NOT TO SCALE

Fig. 2.3

Use the dichotomous key **and** Fig. 2.3 to identify the two species (**A**, **B**, **C**, **D** or **E**) that belong to the same genus.

1 Sharp snout ..... go to 2

Rounded snout ..... go to 3

2 One large spot on each pectoral fin ..... *Beringraja binoculata*

Small spots all over the body ..... *Dipturus laevis*

3 A row of thorns from the head down the body ..... *Amblyraja radiata*

No thorns on the body ..... go to 4

4 Tail longer than the body ..... *Fenestraja ishiyamai*

Tail shorter than the body ..... *Dipturus chinensis*

Species ..... and species ..... are from the same genus. [2]

(c) Flounder are bony fish and skate are cartilaginous fish.

Cartilaginous fish do not have a swim bladder, while most bony fish do have a swim bladder.

State **two** other ways in which bony fish are different from cartilaginous fish.

1 .....

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2 .....

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[2]

[Total: 13]

3 **(a)** A scientist used the mark-release-recapture technique to estimate the population size, *N*, of a species of herbivorous sea urchin on a coral reef.

Table 3.1 shows the data the scientist collected.

Table 3.1

	n_1	n_2	m_2
herbivorous sea urchin	128	97	64

Where:

n_1 = number of individuals captured and marked in the first sample

n_2 = number of individuals (both marked and unmarked) captured in the second sample

and m_2 = the number of marked individuals recaptured in the second sample.

Use the formula for the Lincoln index to calculate the population, *N*, of sea urchins.

$$N = \frac{n_1 \times n_2}{m_2}$$

Show your working.

..... [2]

(b) The scientist investigated factors that allow coral polyps to recolonise an eroded coral reef. The scientist measured coral cover, algae cover, and the population density of herbivorous sea urchins on three recovering coral reefs.

(i) Describe a systematic sampling method that the scientist could use to measure the mean population density of juvenile coral polyps.

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..... [5]

(ii) Fig. 3.1 shows the relationship between percentage algae cover and the population density of juvenile coral polyps.

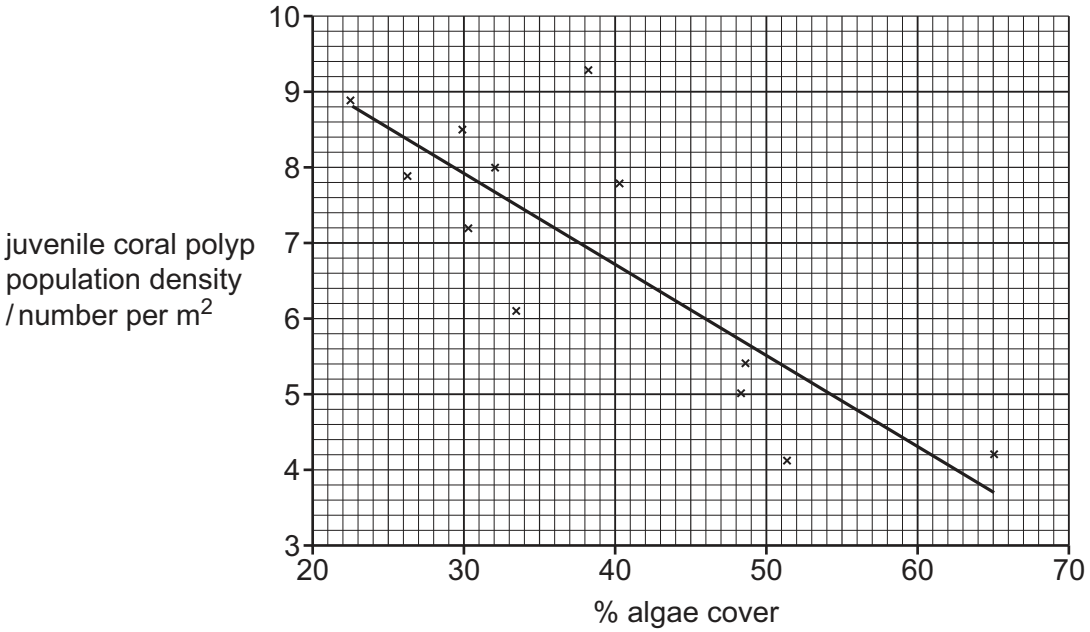

Fig. 3.1

Humans harvest herbivorous sea urchins for food.

Use evidence from Fig. 3.1 to explain why removal of herbivorous sea urchins from eroded coral reefs is a reason for a decline in coral reef recovery.

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..... [3]

(c) Many species of sea urchin are herbivores, but some are omnivores.

Suggest why a large population of omnivorous sea urchins may not help eroded reefs to recover.

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..... [1]

[Total: 11]

4 **(a)** Fig. 4.1 shows the mean rate of photosynthesis each month and the water temperature throughout the year in a bay of an ocean in the northern hemisphere.

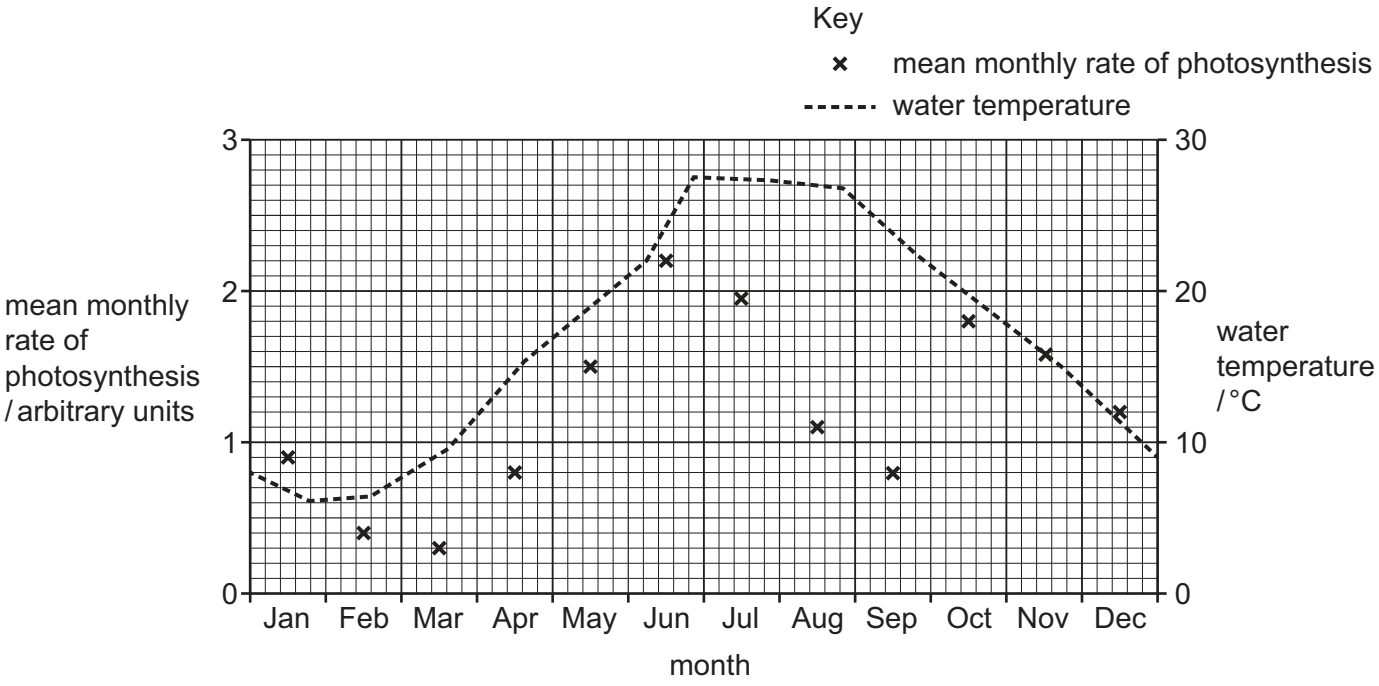

Fig. 4.1

(i) Use Fig. 4.1 to describe the relationship between water temperature and the rate of photosynthesis.

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..... [2]

(ii) Sketch a line on Fig. 4.2 to suggest what would happen to the primary consumer population over the period of this year.

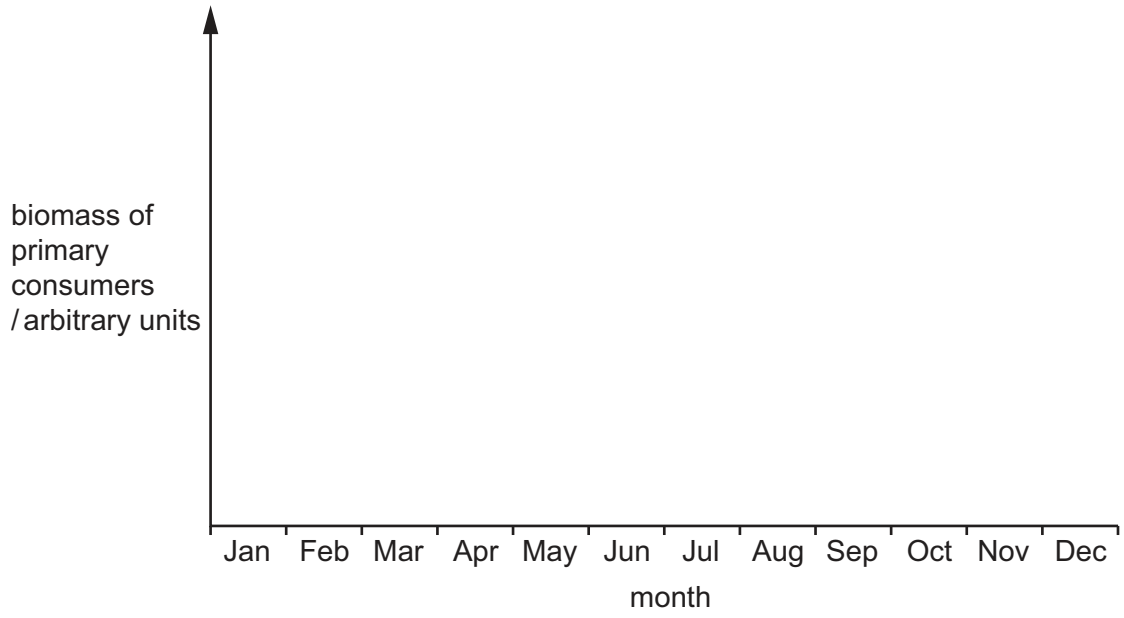

Fig. 4.2

[2]

(b) Fig. 4.3 shows a flooding river discharging into the bay during winter.

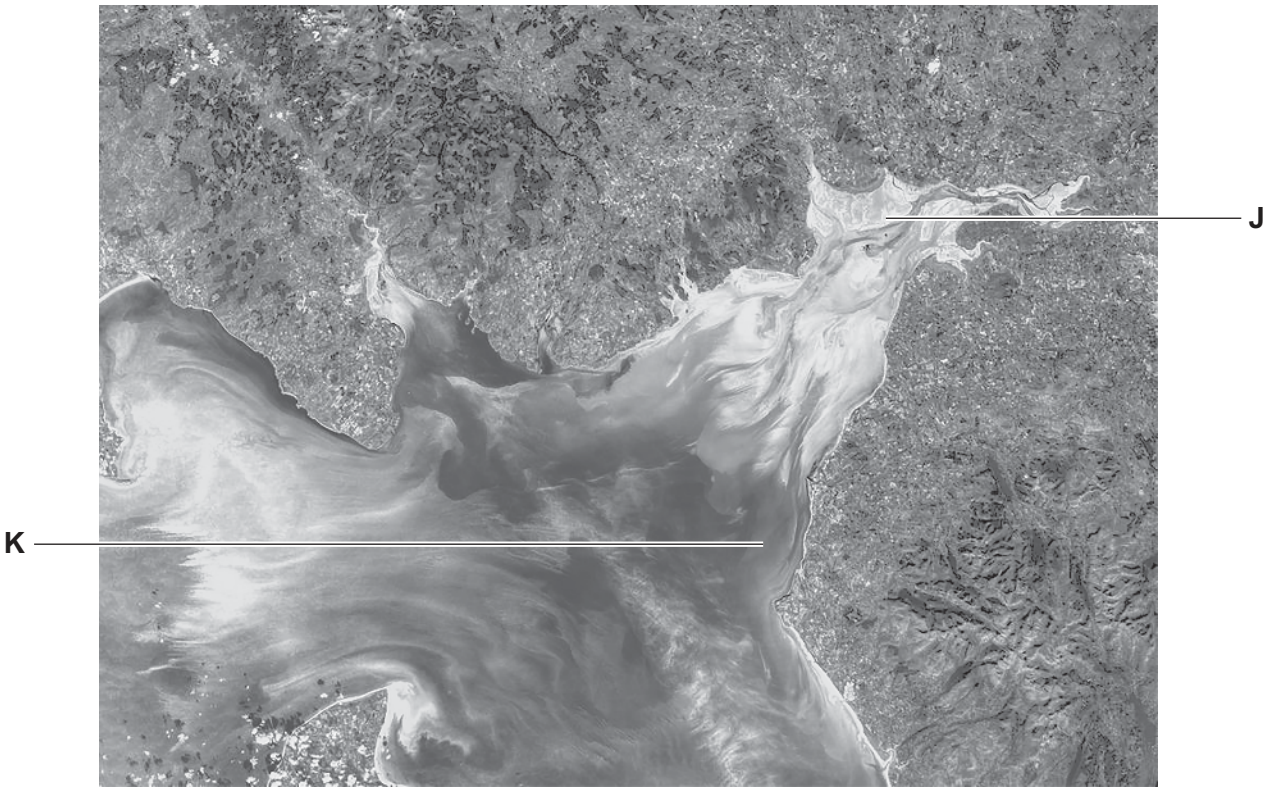

Fig. 4.3

Discuss how abiotic factors in the water at point **J** differ to point **K**.

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..... [5]

(c) Table 4.1 shows the mean concentration of some nutrient ions in the bay in January and in August.

Table 4.1

nutrient	mean concentration in bay in January / parts per million	mean concentration in bay in August / parts per million	percentage change in nutrient ions January to August
CO_3^{2-}	31	26	–16
NO_3^-	0.92	0.31	–67
Mg^{2+}	1400	1300	–5.0
PO_4^{3-}	0.14	0.05	

(i) Calculate the percentage change in phosphate ions (PO_4^{3-}) between January and August.

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

Show your working.

..... % [3]

(ii) Suggest reasons for the increase **and** decrease in phosphate ion levels in the bay during the year.

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..... [4]

(iii) Discuss the impact of a large decrease in the concentration of nitrate ions (NO_3^-) on the productivity of food webs in the bay.

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..... [3]

(d) A scientist took a sample of a small macroalga from the bay.

An experiment was set up in a laboratory to investigate the effect of light intensity on the rate of photosynthesis of the alga.

(i) State **one** key variable to standardise.

..... [1]

(ii) Suggest a laboratory method the scientist could use to investigate the effect of light intensity on the rate of photosynthesis of the alga.

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..... [5]

(iii) Draw a table to record the results. Include units.

Do **not** write in any results.

[3]

[Total: 28]

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5 Latitude describes a north or south position of a point on the Earth's surface. Fig. 5.1 shows the equator is at zero degrees latitude, while the north pole is at 90° north, and the south pole is at 90° south.

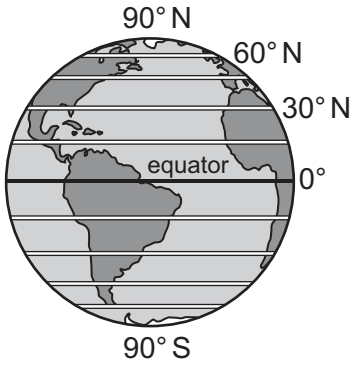

Fig. 5.1

Razor clams are benthic, bivalve molluscs, living on the continental shelf. There are many species of razor clam across the globe.

A scientist investigated if the species diversity of razor clams was affected by latitude. Fig. 5.2 shows the results.

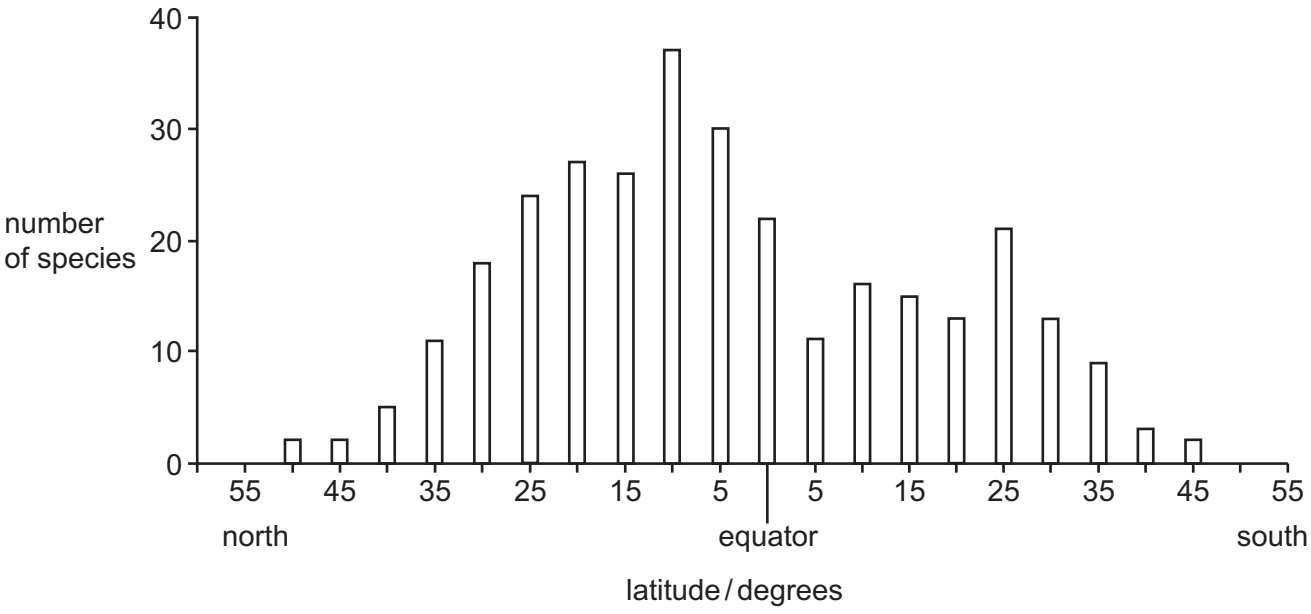

Fig. 5.2

(a) Use Fig. 5.2 to outline the effect of latitude on species diversity of razor clams.

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..... [3]

(b) A variety of other factors were measured.

Spearman's rank correlation was used to calculate the correlation, r_s, between each factor and the species diversity of razor clams. The results are shown in Table 5.1.

Table 5.1

factor	Spearman's rank correlation	
	northern hemisphere	southern hemisphere
mean sea surface temperature / °C	0.87	0.61
range of sea surface temperature / °C	–0.83	0.39
primary productivity / mg carbon m^{-2} day^{-1}	–0.54	0.03
ocean area / km^2	0.60	0.46
coastline length / km	–0.37	0.27
continental shelf area / km^2	–0.11	0.41

(i) State the variable in the southern hemisphere which shows the strongest Spearman's rank correlation.

..... [1]

(ii) State the variable in the northern hemisphere which shows the weakest Spearman's rank correlation.

..... [1]

(iii) Describe the relationship between the range of sea surface temperatures in the northern hemisphere and razor clam species diversity.

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..... [1]

(iv) Evaluate if the correlation data for razor clam species diversity and primary productivity show a causal relationship.

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..... [2]

[Total: 8]