



Cambridge International AS & A Level

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MARINE SCIENCE

9693/22

Paper 2 AS Level Data-handling and Investigative Skills

May/June 2026

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. Do **not** use correction fluid or tape.
- 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.

Answer **all** questions.

- 1 Figure 1.1 shows some barnacles living on a rocky shore.

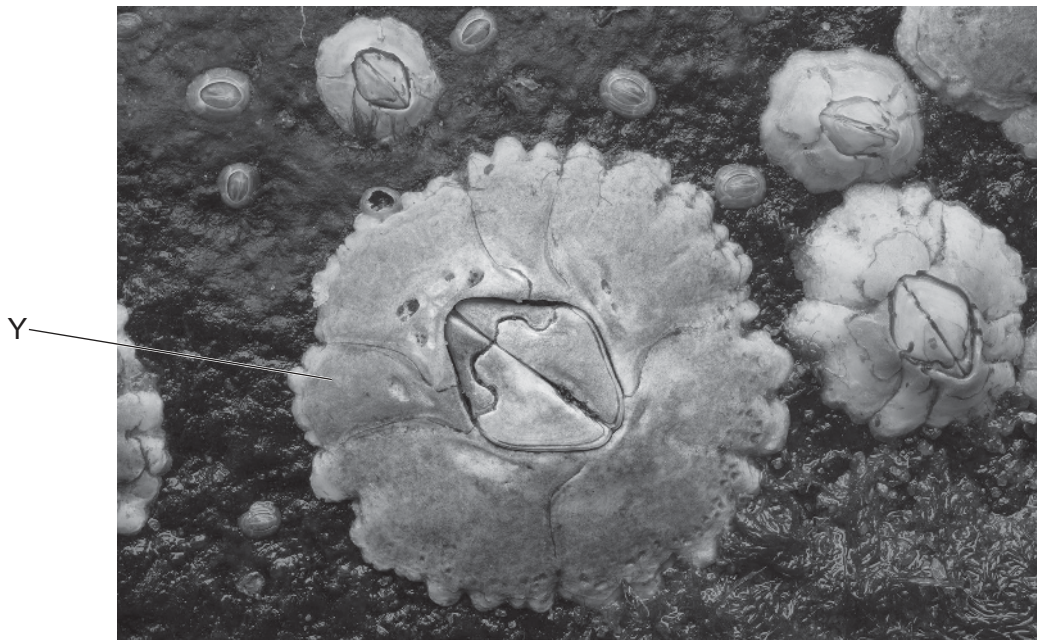


Figure 1.1

- (a) Make a large drawing of the barnacle labelled Y in Figure 1.1.

[4]



- (b) Students compared barnacles living on horizontal and vertical surfaces of the rocky shore shown in Figure 1.2.

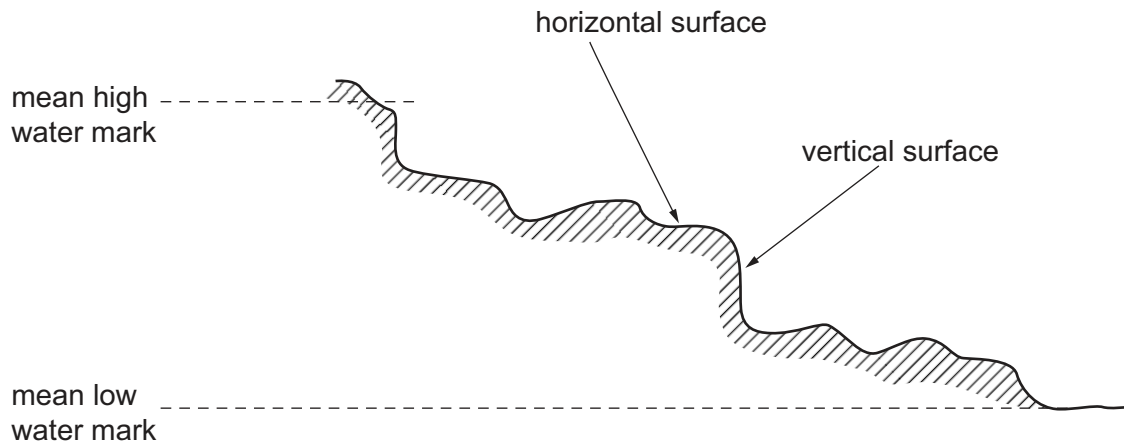


Figure 1.2

Students collected data for the barnacles on each surface:

- mean barnacle diameter
- mean percentage cover (the percentage of the rock covered by barnacles).

To measure the mean diameter, the 20 largest barnacles on each surface were selected.

Table 1.1 shows the mean barnacle diameter and mean percentage cover on each surface.

Table 1.1

	horizontal rock surface	vertical rock surface
mean barnacle diameter / mm	11.7	9.2
mean percentage cover	94	83

- (i) State a null hypothesis for this investigation.

.....
 [1]



- (ii) Describe a method the students could use to estimate the mean percentage cover of barnacles on each surface.

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..... [4]

- (iii) Describe how mean barnacle diameter was calculated for the 20 largest barnacles.

.....

..... [1]

- (iv) Suggest why mean diameter was calculated using **only** the 20 **largest** barnacles.

.....

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..... [2]

- (v) Compare the barnacles on horizontal and vertical rock surfaces, using the data in Table 1.1.

.....

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..... [2]



(vi) Suggest an explanation for the differences you have described in 1(b)(v).

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..... [3]

[Total: 17]





- 2 A student took water samples from the middle of an estuary, at both the surface and the bottom as shown in Figure 2.1.

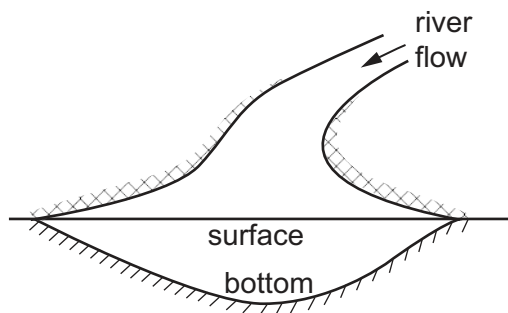


Figure 2.1

They took samples every hour for six hours and measured the mass of salt in each sample. Table 2.1 shows the results.

Table 2.1

time / hours	samples taken from surface of estuary		samples taken from bottom of estuary	
	sample volume /cm ³	mass of salt in sample /g	sample volume /cm ³	mass of salt in sample /g
1	200	5.6	200	7.0
2	200	4.4	200	6.3
3	200	3.4	200	5.8
4	200	2.3	200	5.5
5	200	1.8	200	5.1
6	200	1.6	200	5.1

- (a) (i) State the dependent variable in this investigation.

..... [1]

- (ii) Suggest how the student could find the mass of salt in each water sample.

.....

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.....

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..... [3]



The student used the data collected to calculate the salinity of the water at each time interval. Table 2.2 shows the salinities they calculated.

Table 2.2

time / hours	water salinity at surface of estuary / g dm^{-3}	water salinity at bottom of estuary / g dm^{-3}
1	28.0	35.0
2	22.0	31.5
3		29.0
4	11.5	27.5
5	9.0	25.5
6	8.0	25.5

- (b) (i) Use the data in Table 2.1 to calculate the salinity of water in g dm^{-3} at the surface of the estuary after three hours.

..... g dm^{-3} [2]



- (ii) Use the data in Table 2.2 **and** your answer to 2(b)(i) to plot a graph on Figure 2.2 to show the change in salinity in the estuary over the six hours at the surface of the estuary. The data for the bottom of the estuary has been plotted for you.

Complete the scale **and** labels for the y-axis.

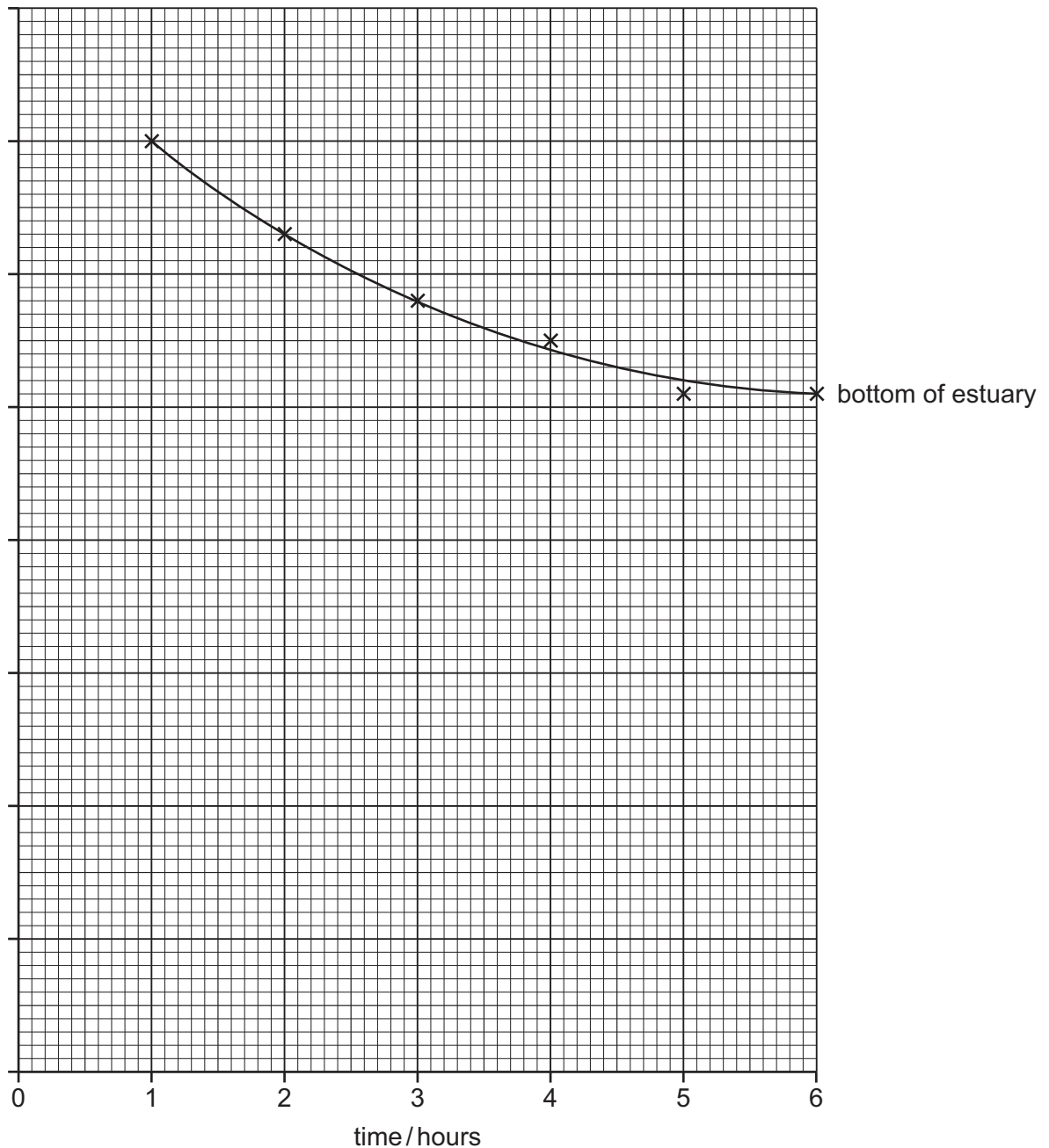


Figure 2.2

[4]





- (iii) Use Table 2.2 to compare the change in salinity shown between the water at the surface of the estuary and water at the bottom of the estuary, over the six-hour period.

.....

.....

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.....

..... [3]

- (iv) Explain why there are differences in salinity between the water at the surface of the estuary and water at the bottom of the estuary over the six-hour period.

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..... [3]

[Total: 16]



- 3 Scientists investigated the relationship between water current speed and the diversity of fish species in three different types of coral reef ecosystem.

The three ecosystems studied were fringing reefs, patch reefs and submerged pinnacle reefs.

Submerged pinnacle reefs are found at depths below 20 m.

Figure 3.1 shows the relative positions of the three types of reef studied.

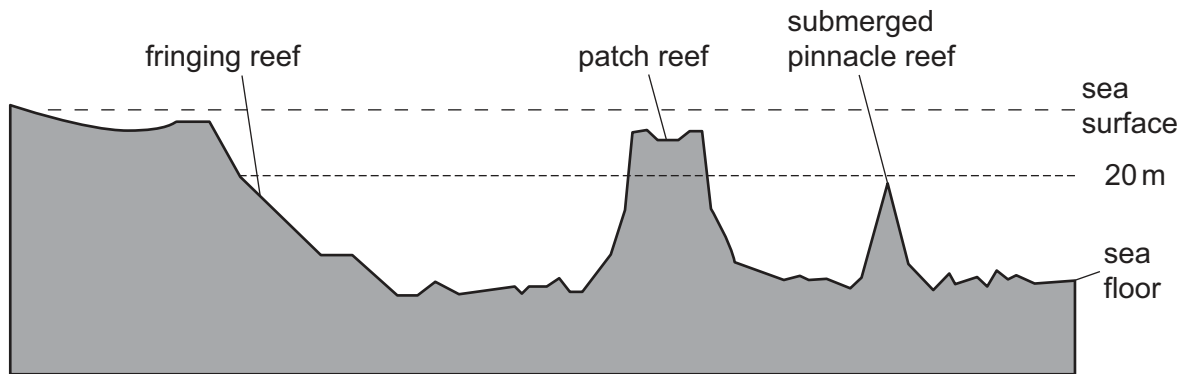


Figure 3.1

- (a) (i) Define the term ecosystem.

.....

.....

.....

..... [2]

- (ii) State **one** difference between a fringing reef and a patch reef.

.....

..... [1]

- (iii) All three reefs provide habitat for both hard corals and soft corals.

State **one** similarity **and one** difference in structure between hard corals and soft corals.

similarity

.....

difference

..... [2]



(b) The scientists investigated the following hypothesis:

Faster water current speed will allow higher diversity of fish species on coral reef ecosystems.

The scientists measured the water current speed and fish species diversity for each type of reef ecosystem.

The diversity of fish species was measured by recording the number of fish species per 150 m² of reef area.

Figure 3.2 shows the results of the investigation.

key

— data collected

– – extrapolated data

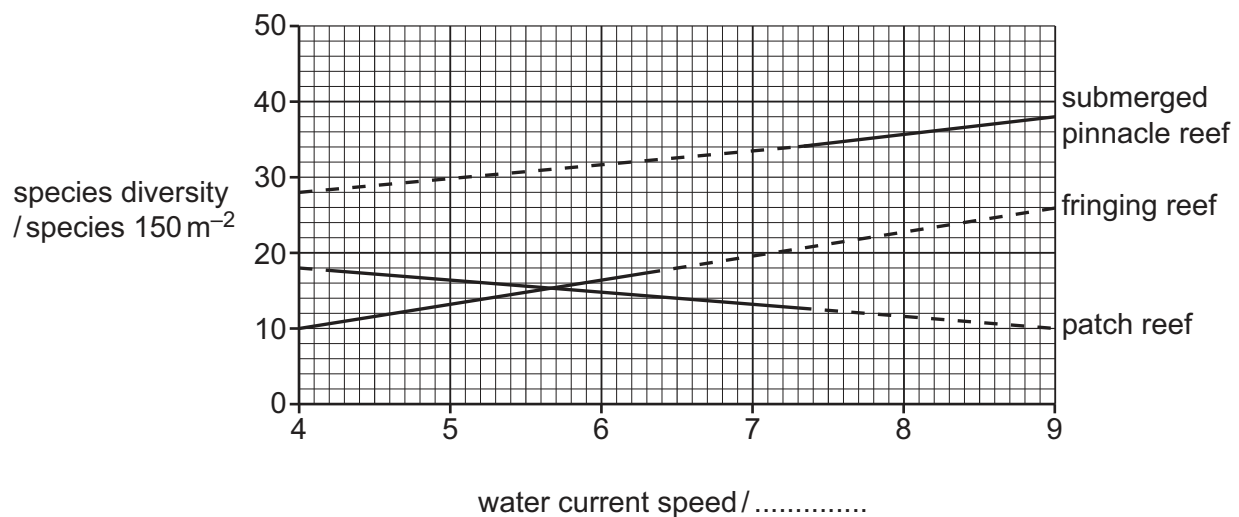


Figure 3.2

- (i) On Figure 3.2, complete the x-axis with a suitable unit. [1]
- (ii) Evaluate the extent to which the data in Figure 3.2 support the scientists' hypothesis.

[4]



- (iii) Simpson's index of diversity (D) could be used to help compare the species diversity at each reef.

Below is the formula for Simpson's index of diversity (D):

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

where

Σ = sum of (total)

n = number of individuals of each **different** species

N = the total number of individuals of **all** the species.

Explain why Simpson's index of diversity may give a better comparison of fish diversity than the data shown in Figure 3.2.

.....
 [1]

- (iv) Draw a table to record the fieldwork data needed for calculating Simpson's index of diversity (D) on **one** reef.

Your table does **not** need to show any calculations.

..... [1]

- (v) Suggest why water current speed may affect fish species diversity on coral reefs.

.....

 [2]

- (c) Name **one** other type of tropical coral reef that could be investigated.

..... [1]





- 4 (a) Figure 4.1 shows a tidal pool in the littoral zone of a shore.



Figure 4.1

- (i) Define the term littoral zone.

.....

.....

.....

..... [2]

- (ii) Tidal pools form due to the rise and fall of the tides.

Explain why tides rise and fall.

.....

.....

.....

..... [2]



- (b) Figure 4.2 shows the temperature changes in one tidal pool over eight hours, for a day in summer and a day in winter.

Days were chosen when the tidal cycle was at a similar starting point at 08:00 hours.

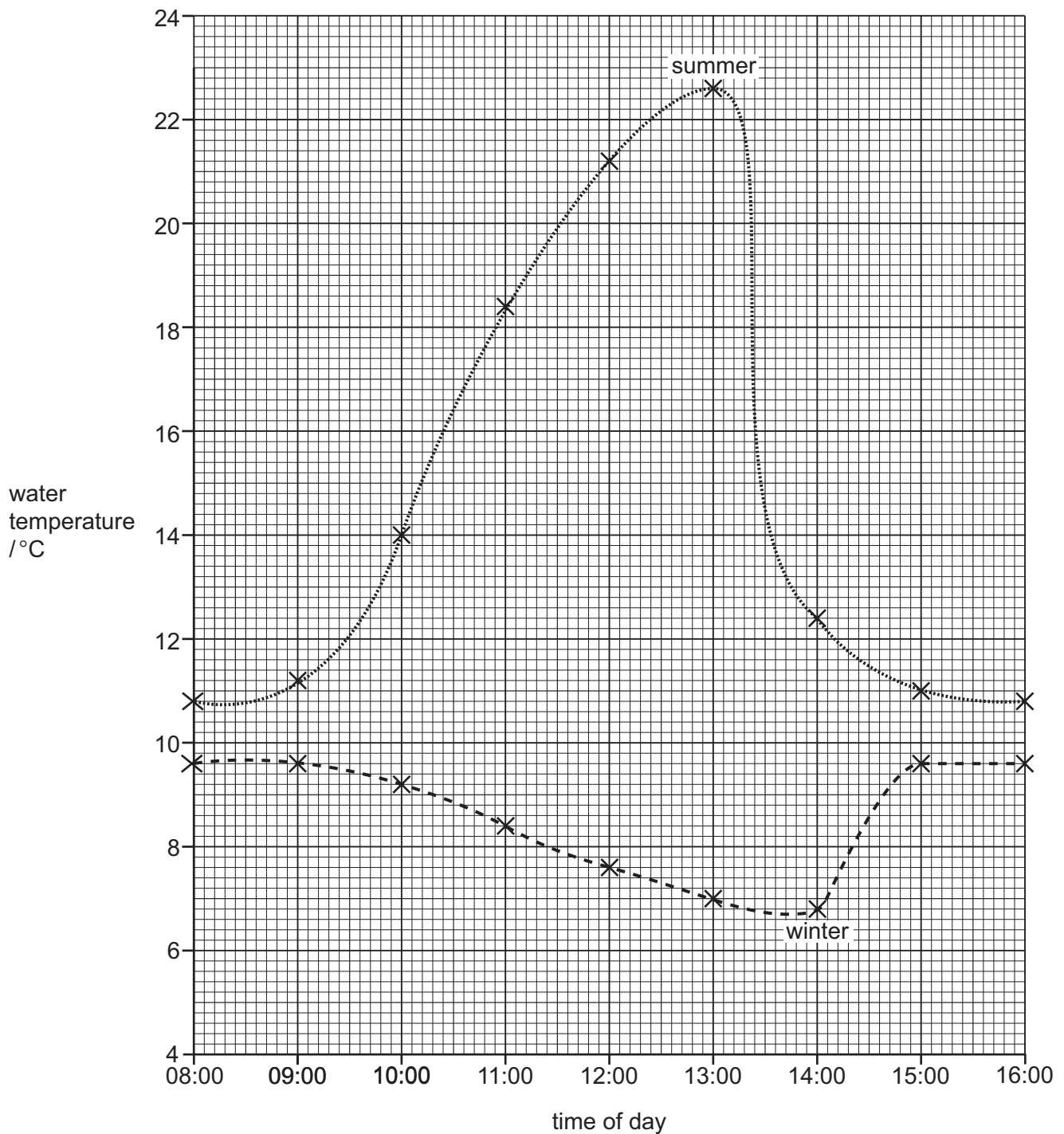


Figure 4.2



(i) Use Figure 4.2 to describe the differences in the data for summer and winter.

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..... [3]

(ii) Explain the differences you have described in **4(b)(i)**.

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..... [2]

(c) (i) Use Figure 4.2 to predict the time at which you would expect the highest salinity in the tidal pool in summer.

..... [1]

(ii) Explain your answer to **4(c)(i)**.

.....

..... [1]



- (d) Figure 4.3 shows changes in the dissolved oxygen concentration for a different tidal pool on a clear summer day.

The graph shows when the pool is exposed or submerged.

- Section **A** – the tidal pool is exposed.
- Section **B** – the tidal pool is submerged.
- Section **C** – the tidal pool is exposed.

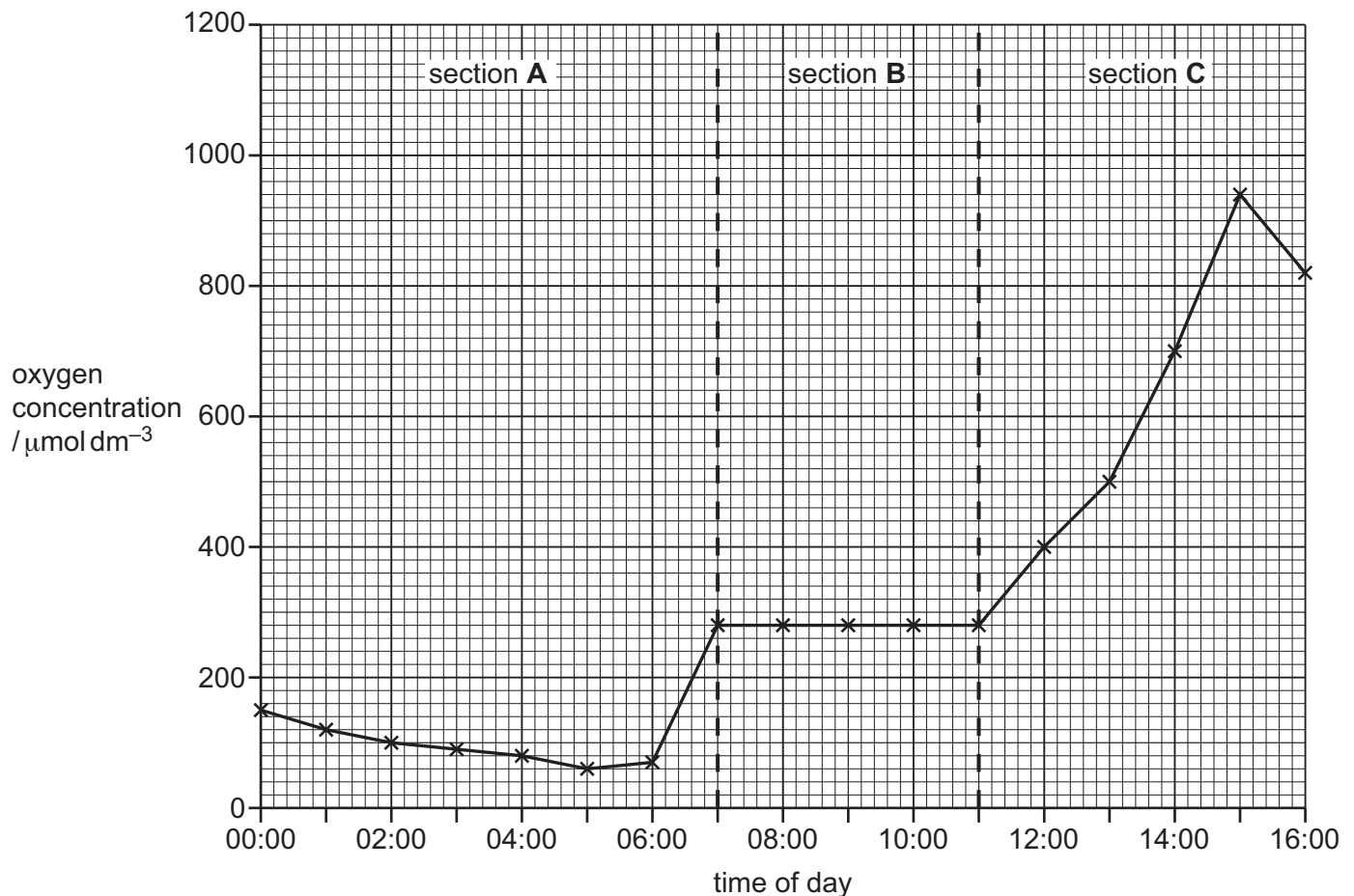


Figure 4.3

- (i) Explain the decrease in concentration of dissolved oxygen in section **A** shown in Figure 4.3.

.....

.....

.....

..... [2]



- (ii) Calculate the maximum percentage increase in oxygen concentration in section **C** of Figure 4.3.

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

..... % [3]

- (iii) Suggest reasons to explain the changes in concentration of dissolved oxygen in section **C** shown in Figure 4.3.

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..... [4]

[Total: 20]



5 (a) Nitrogen is an important nutrient for marine organisms.

(i) State **two** uses of nitrogen in marine organisms.

1

2 [2]

(ii) Nitrogen is often available in the form of nitrate ions.

State the formula of a nitrate ion.

..... [1]

(b) Some species of phytoplankton can convert nitrogen gas into nitrate ions by a process called nitrogen fixation.

The process of nitrogen fixation is inhibited by high concentrations of oxygen.

Figure 5.1 shows the rate of photosynthesis **and** the rate of nitrogen fixation for a species of phytoplankton, species A.

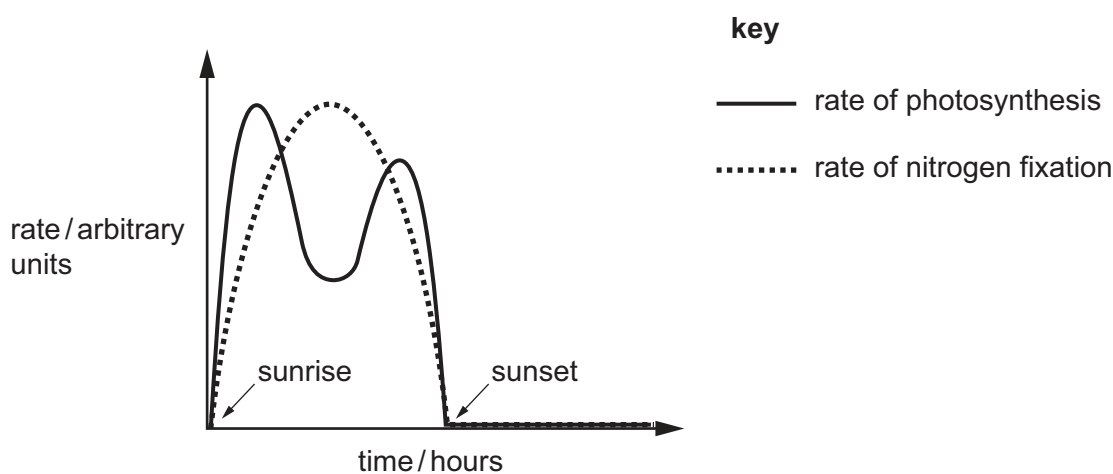


Figure 5.1

(i) State the word equation for photosynthesis.

..... [1]





(ii) Use Figure 5.1 to suggest how species A maximises its productivity.

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..... [3]

[Total: 7]









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