



Cambridge International AS & A Level

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MARINE SCIENCE

9693/21

Paper 2 AS Level Data-handling and Investigative Skills

October/November 2025

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.

Answer **all** questions.

- 1 A student investigates how salinity affects the freezing point of a solution.

The student has access to a laboratory with the following equipment:

- electronic balance (can record masses to the nearest 0.01 g)
- measuring cylinders (10 cm^3 and 100 cm^3)
- beakers (100 cm^3)
- large test-tubes
- thermometers
- stirring rods
- freezer

- (a) The student uses some of the equipment to prepare **five** solutions of different salinity, using pure water and dry salt.

Describe a method for the student to use to prepare the **five** solutions.

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..... [4]



(b) The student has access to a freezer set to -25°C with a glass door.

Describe a method to reliably record the freezing point for the five solutions.
Equipment from the list may be chosen.

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..... [3]

(c) Draw a results table for this investigation to show the final results.

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

Include units where appropriate.

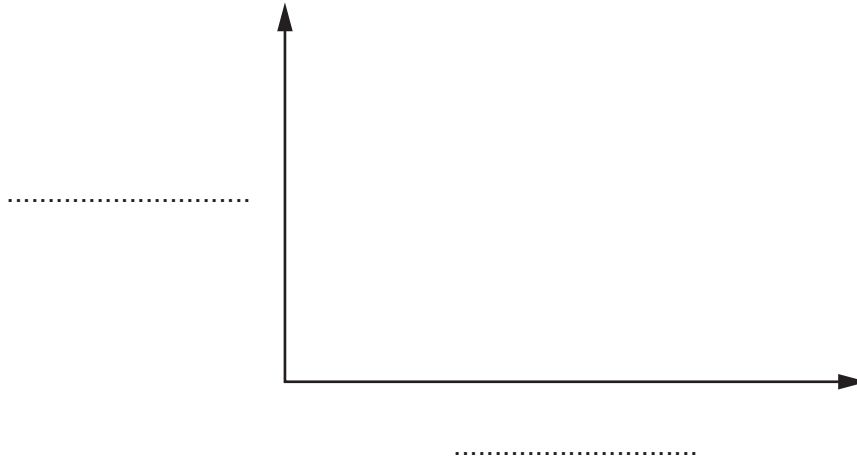
[2]





- (d) Use the axes below to sketch the relationship you would expect to find between salinity and freezing point.

Label the axes.



[1]

[Total: 10]





- 2 Scientists investigated the relationship between corals and their symbionts.

They investigated if nitrogen and phosphorus are provided by the symbiont to the coral.

- (a) (i) State **and** explain the type of symbiotic relationship between coral polyps and zooxanthellae.

type of symbiotic relationship

explanation

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[3]

- (ii) State **one** function of phosphorus in corals.

..... [1]

- (iii) Describe how the structure of coral polyps enables them to obtain nutrients from fish larvae.

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..... [2]



- (b) The scientists investigated the growth of one species of coral in sea water with different concentrations of nitrate ions (NO_3^-) and phosphate ions (PO_4^{3-}).

Two tanks of sea water were used:

- tank one was maintained at a normal concentration of nitrate and phosphate ions
- tank two was maintained at a low concentration of nitrate and phosphate ions.

Ten samples of the coral were placed into each tank.

The tanks contained no other organisms. The sea water was constantly filtered to remove any small particles and food sources.

The scientists measured the growth of coral in both tanks for six months.

- (i) Identify the independent variable and the dependent variable in this investigation.

independent variable

.....

dependent variable

.....

[2]

- (ii) Use the information given above to identify **one** variable that was standardised.

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..... [1]

- (iii) Suggest **two other** variables **not** described above that need to be standardised to ensure the data collected is valid.

1

2

[2]



(c) Table 2.1 shows the mean data the scientists collected.

Table 2.1

time/months	mean percentage change in mass of the corals	
	normal concentration of nitrate and phosphate ions	low concentration of nitrate and phosphate ions
0	0	0
1	15	24
2	33	32
3	54	35
4	91	41
5	158	62
6	212	80

- (i) The graph in Fig. 2.1 shows the mean percentage change in mass of the corals in the **normal** concentration of nitrate and phosphate ions. A line of best fit has been drawn to show the trend.

Complete the scale **and** the labels for **both** axes. One scale value has already been added.

Plot the values from Table 2.1 for the mean percentage change in mass of the corals in the **low** concentration of nitrate and phosphate ions on Fig. 2.1.

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



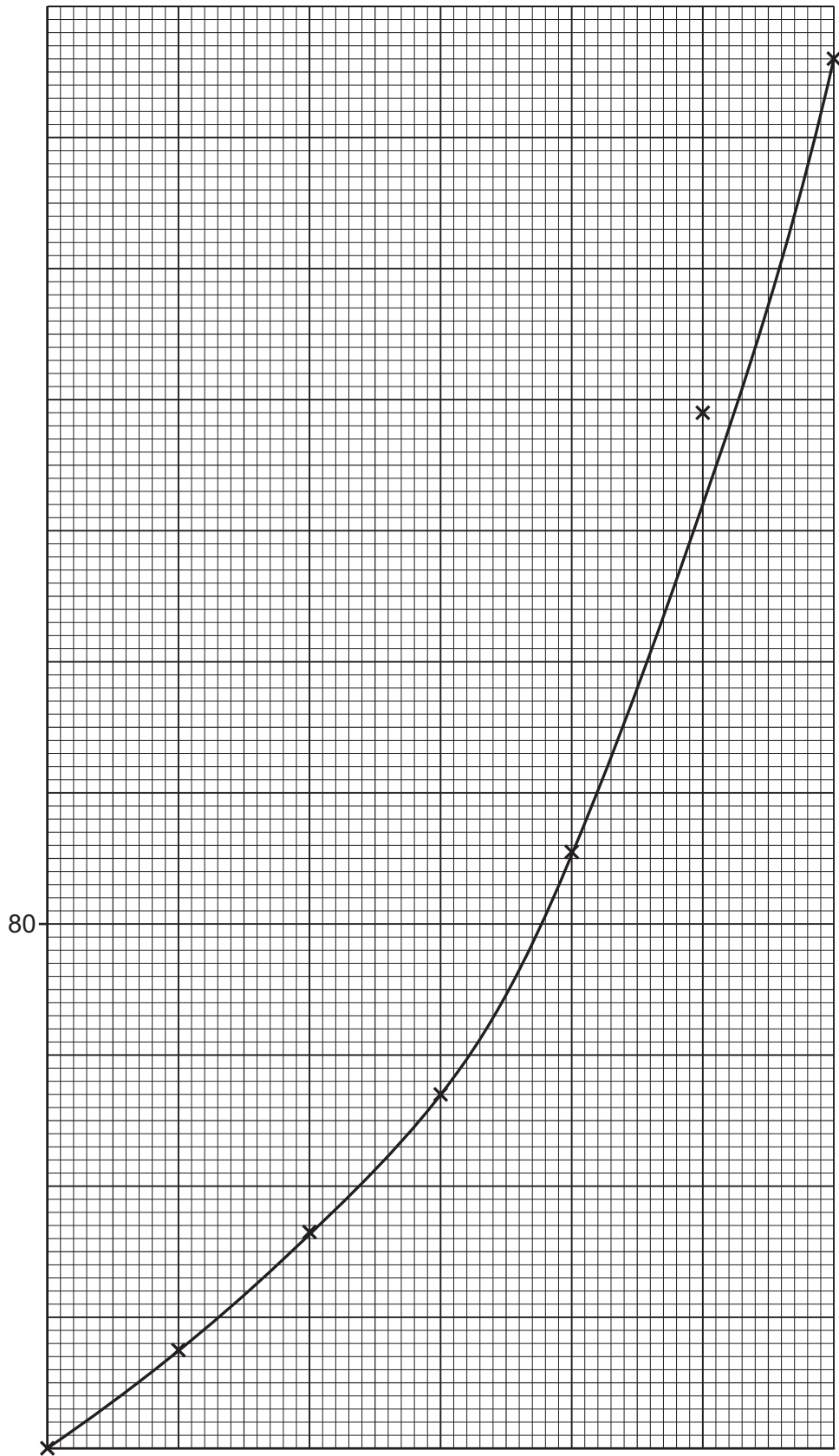


Fig. 2.1



- (ii) Compare the growth rates of the corals in normal concentrations **and** in low concentrations of nitrate and phosphate ions shown in Table 2.1.

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..... [2]

- (d) In further investigations, the scientists found that the growth of the coral was linked to digestion of some of the symbionts hosted in the coral tissues.

The number of zooxanthellae per cm² in the coral tissue:

- remained constant in the tank with the normal concentration of nitrate and phosphate ions
- decreased in the tank with the low concentration of nitrate and phosphate ions.

The colour of the coral is due to the presence of zooxanthellae.

The coral in the sea water with the low concentration of nitrate and phosphate ions gradually changed to white during the investigation.

Suggest reasons for the change in appearance **and** growth of the coral in the sea water with the low concentration of nitrate and phosphate ions.

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..... [5]



(e) A student formed the following conclusion based on the results.

'Zooxanthellae are essential for all corals to obtain nutrients and grow faster.'

Use the information provided throughout **Question 2** to evaluate this conclusion.

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..... [3]

[Total: 25]





3 Organisms are classified in a taxonomic hierarchy.

(a) Complete the taxonomic hierarchy to show the correct position of the levels of classification.

Use the words from the box.

class	family	genus	kingdom	phylum
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taxonomic hierarchy
domain
order
species

[1]



(b) Fig. 3.1 shows a jellyfish which is in the phylum cnidaria.

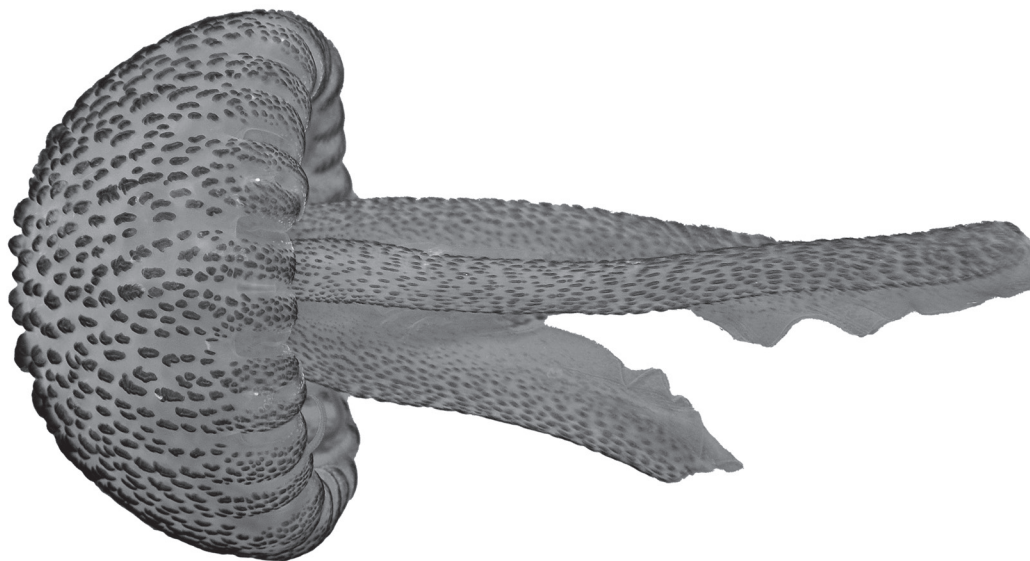


Fig. 3.1

Make a large drawing of the jellyfish shown in Fig. 3.1.

Do **not** include the markings.

Do **not** label your drawing.



(c) Scientists investigated the biodiversity of jellyfish in the ocean.

They recorded the number of species of jellyfish found at different depths.

Fig. 3.2 shows the results.

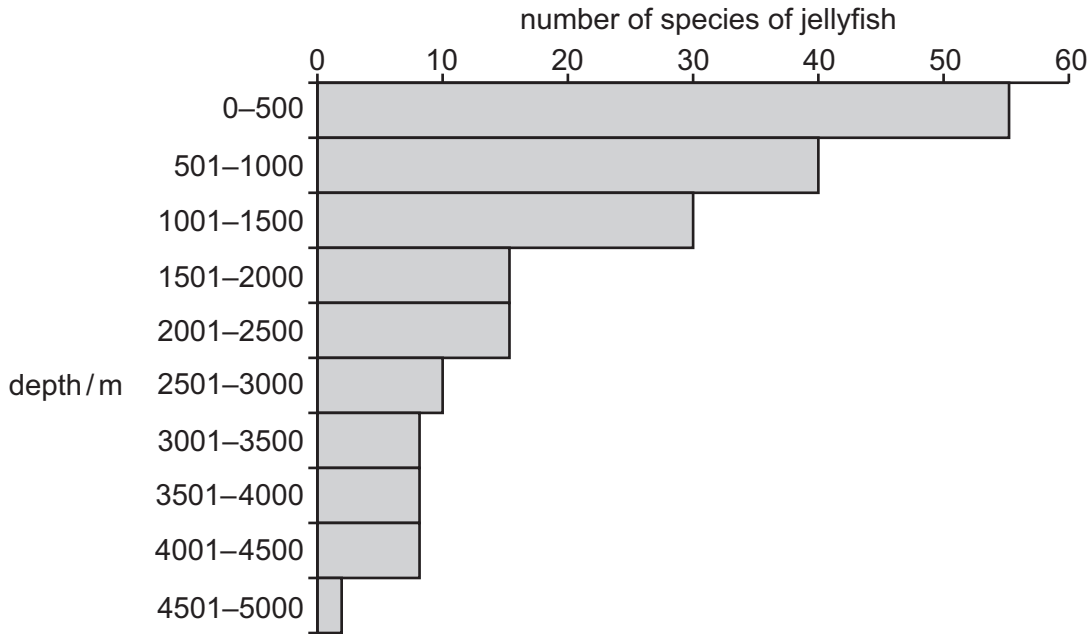


Fig. 3.2

(i) Use Fig. 3.2 to describe the change in species diversity of jellyfish as depth increases.

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..... [2]

(ii) Explain the distribution of jellyfish species at depths between 0m and 1500m of the ocean.

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..... [3]





- (iii) The thermocline in the ocean at the time the results were recorded was at a depth of approximately 30 m.

Describe how a thermocline forms.

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- (iv) The scientists only counted the number of jellyfish species present.

State what other measurement is needed to improve the measurement of species diversity.

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..... [1]

- (v) Species diversity is one measure of biodiversity.

Describe **two** other levels of measuring biodiversity.

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..... [4]

[Total: 17]



- 4 Scientists investigated the effect of marine protected areas (MPAs) on a species of fish which feeds on seagrass.

They investigated similar habitats in three areas (**A**, **B** and **C**) outside an MPA and three areas (**D**, **E** and **F**) inside an MPA.

The fish were observed for the same length of time at each site.

The scientists recorded:

- the number of bites observed per minute per fish
- the surface area of seagrass eaten by the fish.

Fig. 4.1 shows the results.

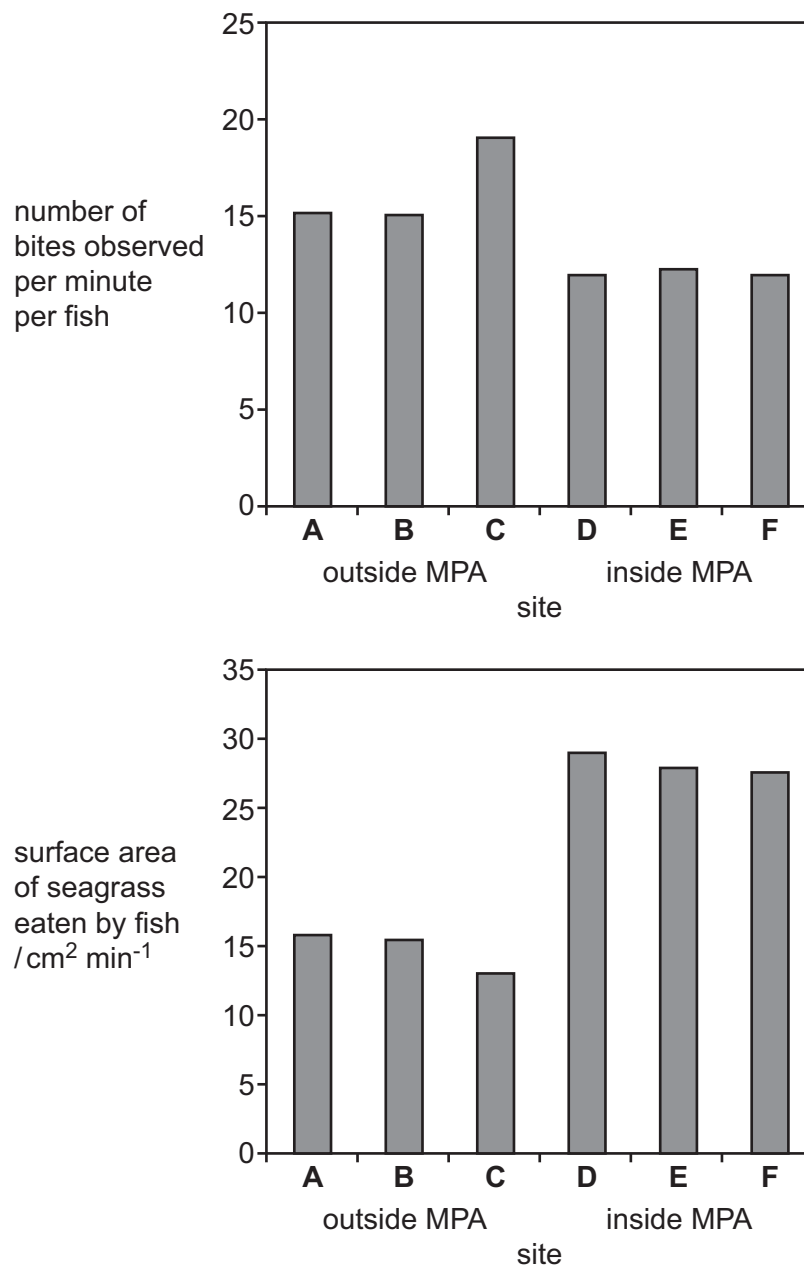


Fig. 4.1





(a) Use the data shown in Fig. 4.1 to describe the results in **both** graphs.

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..... [3]



(b) Fig. 4.2 shows the number of fish and mean length of the fish in each area.

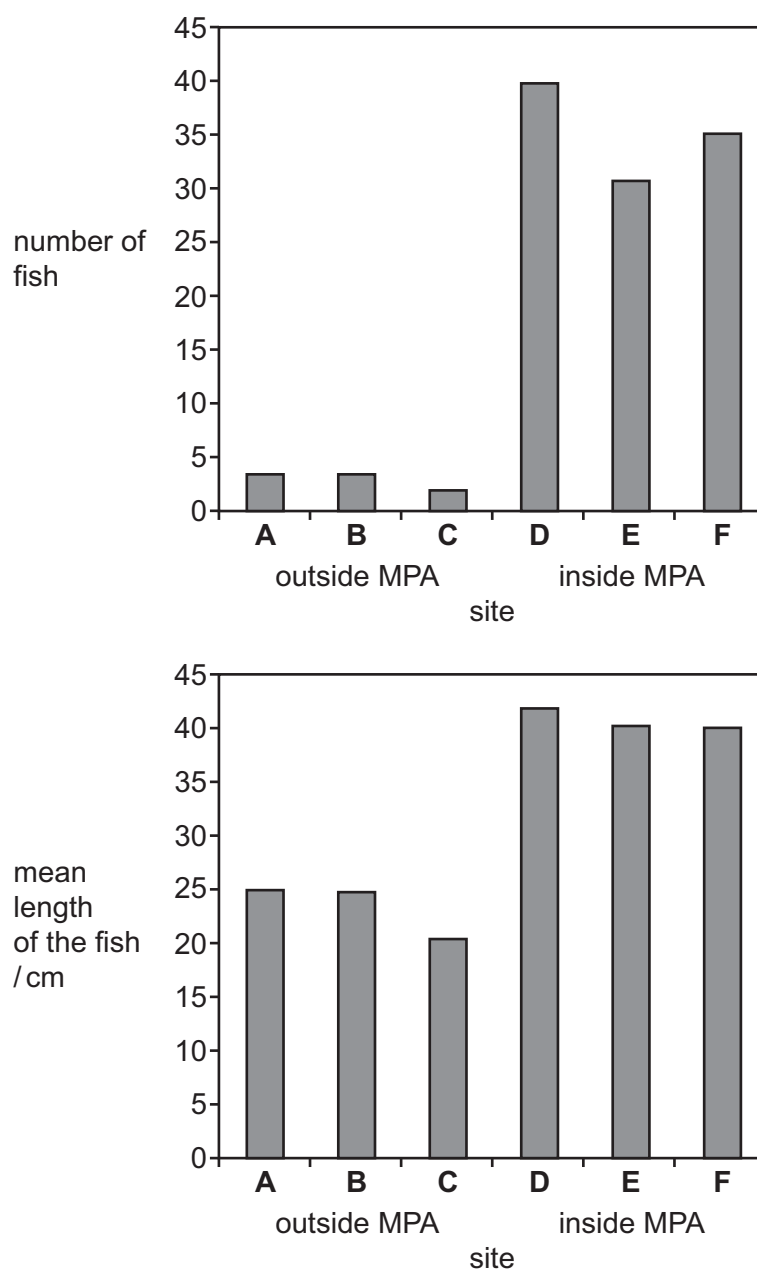


Fig. 4.2

Use **both** graphs in Fig. 4.2 to describe the impact of the MPA on the total biomass of fish.

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..... [4]



(c) Fig. 4.3 shows the behaviour of the fish at the six sites.

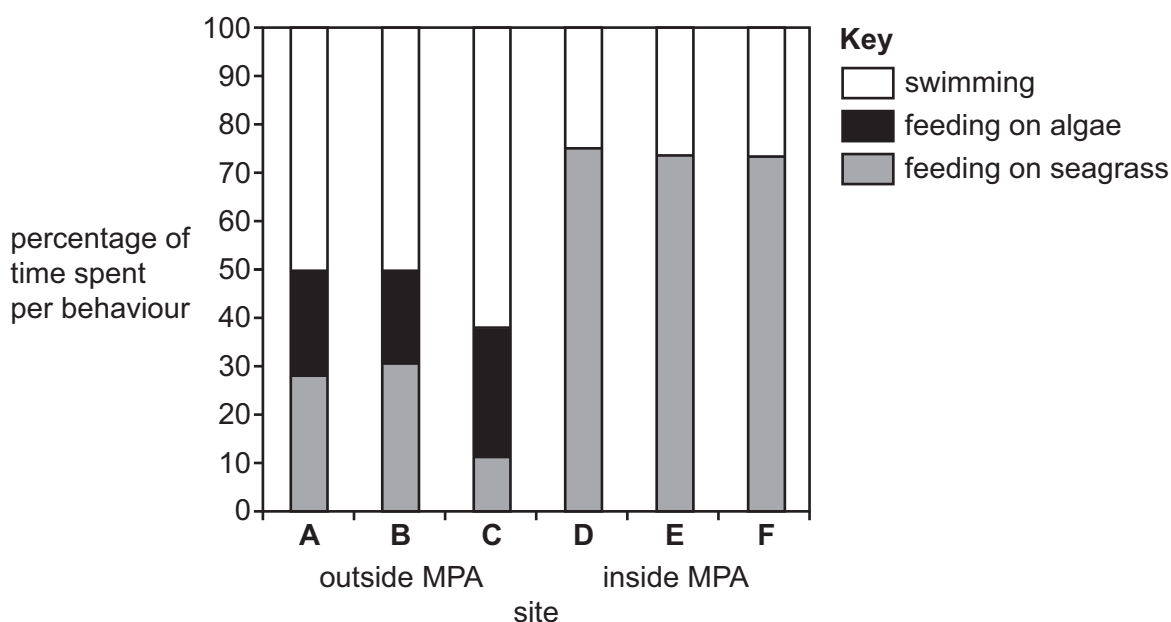


Fig. 4.3

Use the information in Fig. 4.3 to describe the behaviour of the fish outside the MPA compared to the behaviour of the fish inside the MPA.

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..... [3]

(d) Use the information provided throughout **Question 4** to explain the difference in the growth of the fish outside the MPA compared to the growth of the fish inside the MPA.

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..... [2]

[Total: 12]



5 Scientists studied the biodiversity at eight locations in the Arabian Sea.

The scientists used a net to catch species in the benthic zone.

(a) Describe what is meant by the benthic zone.

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..... [1]

At each location the nets were pulled at a constant speed for one hour.

Four of the locations sampled were at a depth of 200 m.

The other four locations sampled were at a depth of 1000 m.

Table 5.1 shows the depth and total catch at each location.

Table 5.1

location number	depth / m	total catch / kg
1	200	169
2	200	122
3	200	34
4	200	582
5	1000	75
6	1000	453
7	1000	256
8	1000	120

(b) Use the data shown in Table 5.1 to describe if there is a relationship between depth and total catch.

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..... [2]



- (c) The scientists identified the species present in each catch and the number of individuals of each species.

They used this data to calculate Simpson's index of diversity using the equation:

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

Σ = sum of (total)

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

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

- (i) Use the data provided to complete Table 5.2 for **location 1**.

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

Table 5.2

species	location 1		
	n	$\frac{n}{N}$	$\left(\frac{n}{N} \right)^2$
P	27	0.278	0.077
Q	23		
R	18	0.186	0.034
S	16	0.165	0.027
T	13	0.134	0.018
N	97		
		Σ	

[4]

- (ii) Use your answer to (c)(i) to calculate Simpson's index of diversity for **location 1**.

.....
[1]



(d) Table 5.3 shows the Simpson's index of diversity calculated for each other location sampled.

Table 5.3

location number	depth / m	total catch / kg	Simpson's index of diversity
1	200	169	
2	200	122	0.88
3	200	34	0.92
4	200	582	0.68
5	1000	75	0.91
6	1000	453	0.71
7	1000	256	0.78
8	1000	120	0.91

Compare the biodiversity for the catches shown in Table 5.3.

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..... [3]

[Total: 11]







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