



Cambridge International AS & A Level

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MARINE SCIENCE

9693/21

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 **16** pages.

Answer **all** questions.

- 1 Icebergs form when large chunks of ice break off from glaciers or ice-shelves that extend from land.

In 1986 a large section of ice-shelf broke away from Antarctica. This iceberg was named A23a by scientists. Figure 1.1 shows part of this iceberg.



Figure 1.1

- (a) (i) The top surface of iceberg A23a had an area of 3800 km^2 , and the iceberg had a mean depth of 350 m.

Calculate the total volume of the iceberg in km^3 .

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

..... km^3 [2]

- (ii) A sample of ice collected from the iceberg had a mass of 14.8 kg and a volume of 0.016 m³.

Calculate the density of the sample of ice.

..... kg m⁻³ [2]

- (iii) The iceberg floats.

Use your answer to 1(a)(ii) to predict the density of the surrounding sea water.

..... kg m⁻³ [1]

- (iv) Explain **two** reasons why ice floating is important for marine organisms.

1

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2

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.....

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[4]

(b) Iceberg A23a became attached to the sea bed. It remained in the same position for over 30 years. It began to move away from Antarctica with ocean currents in 2020.

(i) Suggest why the iceberg became detached from the sea bed in 2020.

.....
 [1]

(ii) Describe how ocean currents form.

.....

 [3]

(c) Icebergs contain minerals including iron.

Scientists investigated the effect of dissolved iron ions on the rate of photosynthesis of an aquatic plant in Antarctic sea water.

(i) Identify the independent variable.

independent variable [1]

(ii) Identify the dependent variable **and** how to measure this variable.

dependent variable

how to measure

..... [2]

(iii) Temperature and salinity were standardised variables in the investigation.

Suggest a suitable temperature **and** salinity to use for this investigation.

Identify the units for each of these variables.

standardised variable	suitable value	units
Antarctic sea water temperature		
salinity		

[2]



(d) Icebergs pass through different areas of the ocean.

Scientists investigated how icebergs affected productivity in these areas.

The scientists found that icebergs replenished a significant proportion of dissolved iron ions in sea water.

Chlorophyll is a pigment responsible for capturing light in photosynthesis.

Satellite images showed that the concentration of chlorophyll increased in sea water after icebergs passed by.

The scientists concluded that icebergs increase primary productivity in the oceans.

Use the information in the question **and** your own knowledge to evaluate the scientists' conclusion.

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..... [4]

[Total: 22]

2 Kelp is an important producer in coastal waters.

(a) Figure 2.1 shows a photograph of a typical kelp.

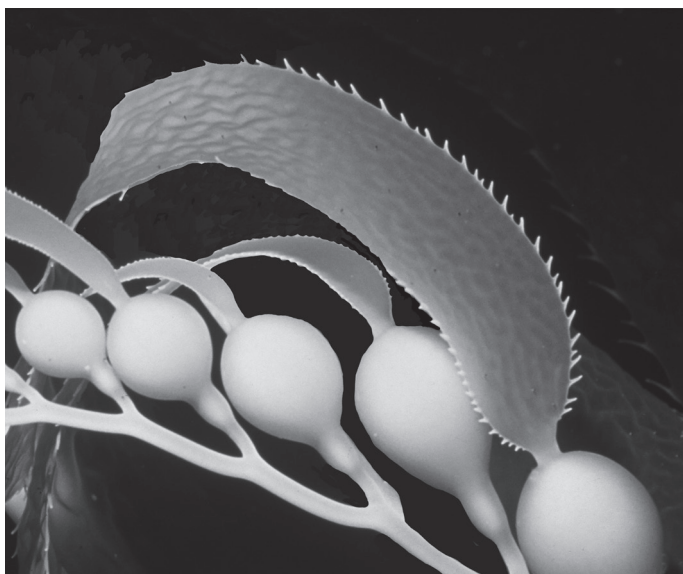


Figure 2.1

(i) Make a large drawing of the kelp shown in Figure 2.1.

(ii) On your diagram, label:

- the stipe
- one blade
- one air bladder.

[4]

[2]



- (b) Scientists investigated the feeding relationships of fish in a kelp forest.

They used several different methods to catch fish. Each method was used for six hours in areas with dense populations of kelp.

The scientists recorded the species, mass and length of each fish captured.

The stomach contents of 10 fish of each species were analysed to identify all the organisms in the stomach.

- (i) Suggest why the scientists used different methods to catch different species of fish.

.....

.....

.....

..... [2]

- (ii) Suggest how the information obtained could be used to construct a food web for the kelp forest ecosystem.

.....

..... [1]

- (iii) Suggest why the food web created from this information may **not** be complete.

.....

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.....

..... [2]

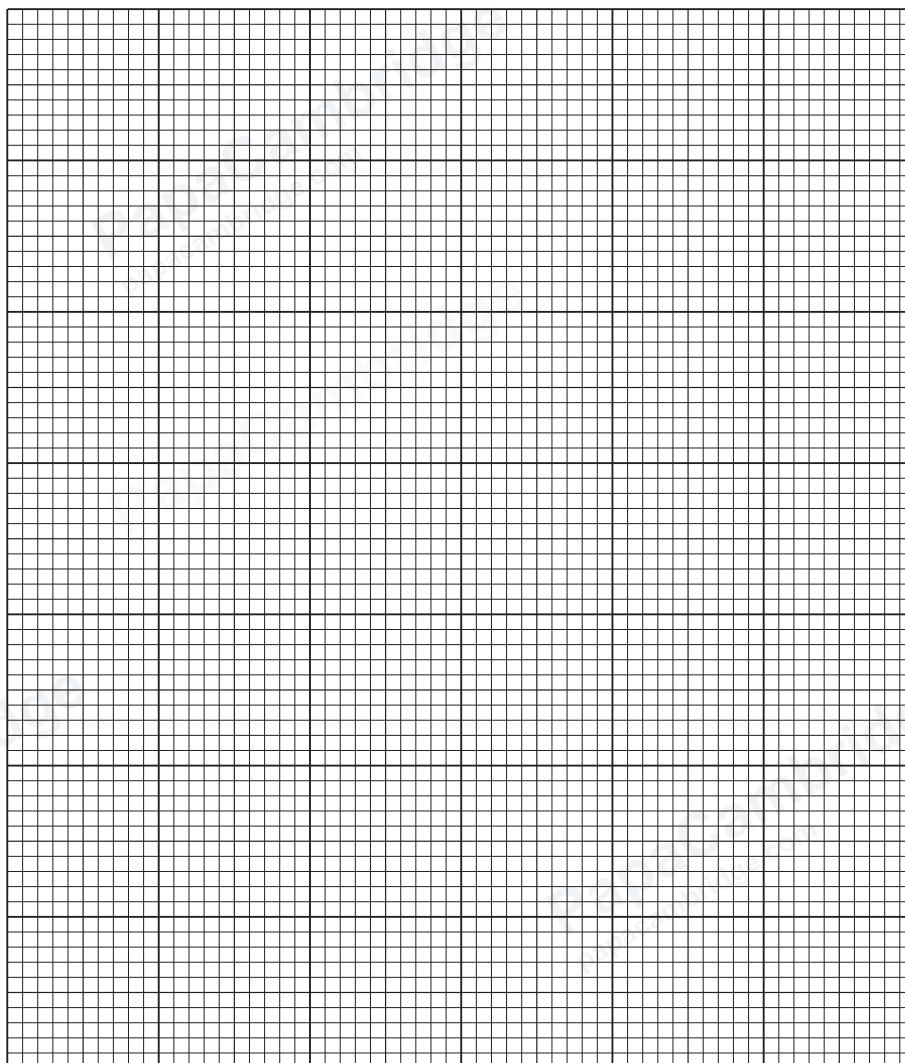
The scientists analysed the abundance of the five most common fish species caught.

Table 2.1 shows the number of fish caught for these five species, **A**, **B**, **C**, **D** and **E**.

Table 2.1

fish species	total number caught
A	20
B	28
C	5
D	66
E	9

(iv) Draw a bar chart to represent the information shown in Table 2.1.



[4]



- (c) Table 2.2 shows the mean mass of each different group of organisms identified in the stomachs of each fish species.

Decapods, isopods, amphipods and gastropods are all small invertebrates.

Table 2.2

fish species	mean mass found in fish stomach/g				
	decapods	isopods	amphipods	gastropods	other fish
A	36	6	1	0	0
B	0	2	0	3	0
C	0	0	1	2	0
D	1	5	2	3	0
E	12	3	1	3	60

- (i) Use the information in Table 2.2 to suggest which species of fish, **A**, **B**, **C**, **D** or **E** is at the highest trophic level. Explain your answer.

species

explanation

.....

[3]

- (ii) An alternative approach to construct a food web could be to use divers to film the feeding relationships in the kelp forest.

Suggest **one** advantage **and one** disadvantage of using divers to film the feeding relationships.

advantage

.....

disadvantage

.....

[2]

[Total: 20]



- 3 Marine animal forests (MAFs) are benthic communities where sessile animals change the environment by creating complex structures allowing other organisms to hide within them.

Coral reefs are examples of MAFs, but other types of MAFs exist in all oceans from shallow seas to deep oceans.

- (a) State the meaning of the terms benthic **and** sessile.

benthic

.....

sessile

.....

[2]

- (b) Scientists investigated the importance of MAFs off the southern coast of Chile.

The scientists sampled small bays along the coast where river water mixes with sea water to form estuaries.

- (i) Describe the change in salinity in the bays from one low tide to the next low tide.

.....

.....

.....

..... [2]

- (ii) Explain the change in salinity in estuaries from one low tide to the next low tide.

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..... [3]



- (c) Scientists completed surveys in the bays using transects from 5 m to 25 m depth as shown in Figure 3.1.

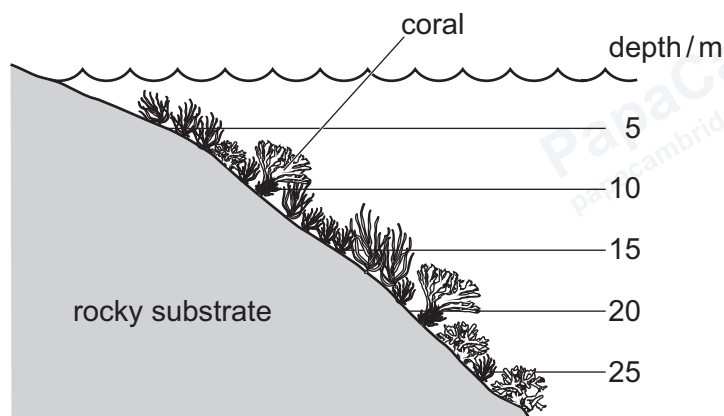


Figure 3.1

The method used by the scientists is described.

- They held a 50 cm x 50 cm quadrat grid against the habitat.
- They took photographs of the habitat and grid.
- They repeated this a total of five times at each depth.
- They repeated the measurements at 5 m depth intervals.
- They recorded the species present in each of the photographs.

- (i) Draw a table the scientists could use to record all their results.

[2]

- (ii) Suggest why the measurements were repeated at the same depth **and** at different depths.

repeats at same depth

.....

repeats at different depths

.....

[2]

- (d) The scientists also recorded the height in cm of each living structure growing from the substrate and recorded the frequency of each range of heights. Figure 3.2 shows their results.

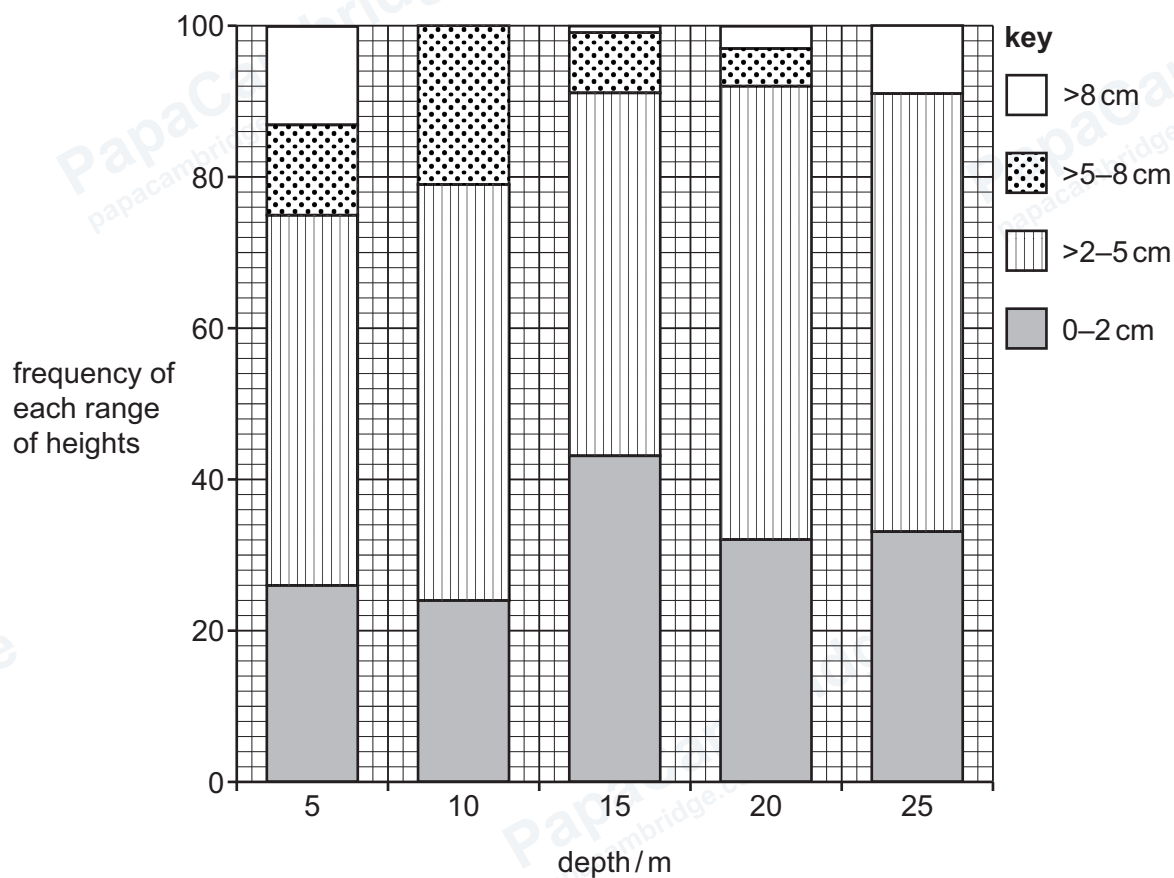


Figure 3.2

- (i) Describe the change in distribution of the living structures of height >8 cm as depth increases.

Use the data shown in Figure 3.2 to support your answer.

.....

.....

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..... [3]



- (ii) Compare the changes in distribution for the living structures of height 0–2 cm **and** >5–8 cm as depth increases.

Use the data shown in Figure 3.2 to support your answer.

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..... [4]

- (iii) Use the information in the question **and** your own knowledge to suggest **three** reasons why 0–5 m depth would have the greatest biodiversity.

1

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2

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3

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[3]

[Total: 21]



- 4 A group of students investigated shore crabs on a beach.

Figure 4.1 shows a shore crab.

A shore crab is a crustacean.



Figure 4.1

- (a) (i) On Figure 4.1, label **two** visible features that are found in typical adult crustaceans. [2]
- (ii) Describe how a dichotomous key can be used to help identify a shore crab from other types of crab.

.....

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.....

..... [2]



(b) The students applied the Lincoln index to estimate the population size of shore crabs.

(i) Describe the method used to obtain the data needed to apply the Lincoln index.

.....

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..... [4]

(ii) Describe **two** limitations of using the method in **4(b)(i)** to estimate the population size of shore crabs.

1

.....

2

..... [2]

- (c) The teacher completed the activity each year with a new group of students.

Table 4.1 shows the results the groups obtained over a period of five years.

Table 4.1

year	population estimate of shore crabs
2021	491
2022	473
2023	459
2024	486
2025	512

Use Table 4.1 to describe how the population estimate of shore crabs has changed from 2021 to 2025.

.....

.....

.....

..... [2]

[Total: 12]

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