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 **October/November 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 **24** pages. Any blank pages are indicated.

[Turn over

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Answer **all** questions.

1 Photosynthesis by organisms in the epipelagic zone of the oceans produces carbon-containing substances. Some of this carbon is transported to the mesopelagic zone and bathypelagic zone by the vertical movement of organisms.

Fig. 1.1 shows the positions of these zones.

NOT TO SCALE

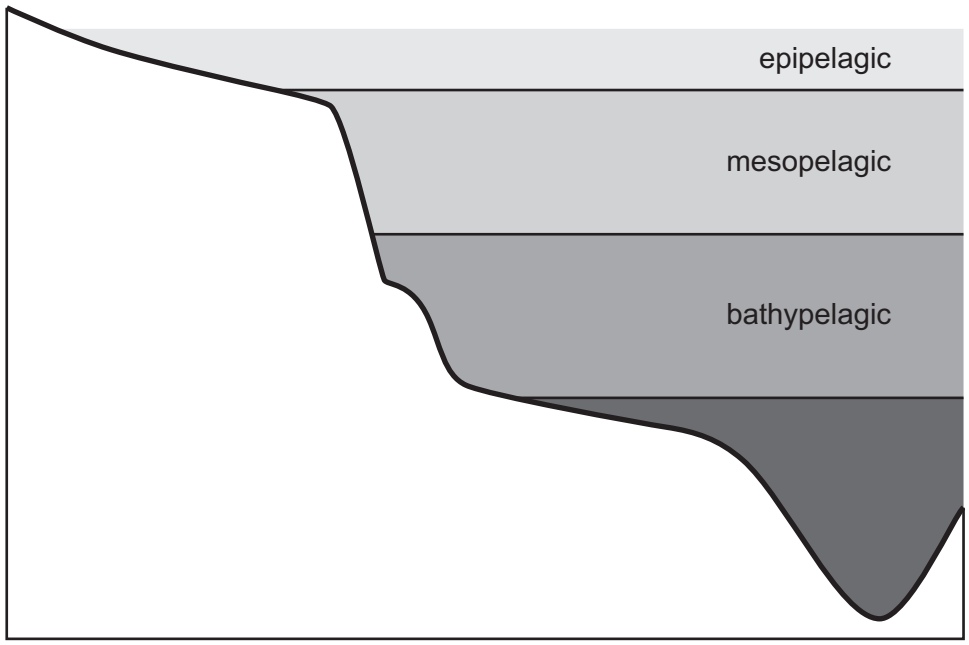

Fig. 1.1

(a) Sketch a line on the axes in Fig. 1.2 to show the light intensity in the epipelagic, mesopelagic and bathypelagic zones shown in Fig. 1.1.

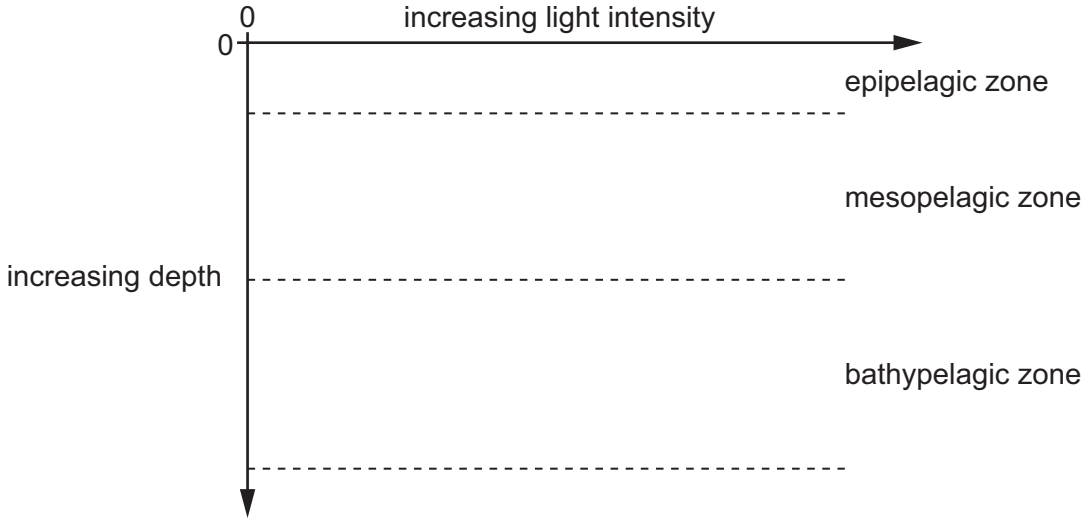

Fig. 1.2

[2]

(b) Phytoplankton carry out photosynthesis to obtain nutrition.

(i) State the word equation for photosynthesis.

..... [1]

(ii) Name **one** other process used by producers to obtain nutrition.

..... [1]

(c) Scientists investigated the effect of light intensity on the rate of photosynthesis in phytoplankton.

Phytoplankton absorb light during photosynthesis. The greater the rate of photosynthesis, the faster the growth of the population.

The greater the population of phytoplankton in a container, the less light is transmitted through the container.

The percentage of light passing through the container can be measured using a light sensor as shown in Fig. 1.3.

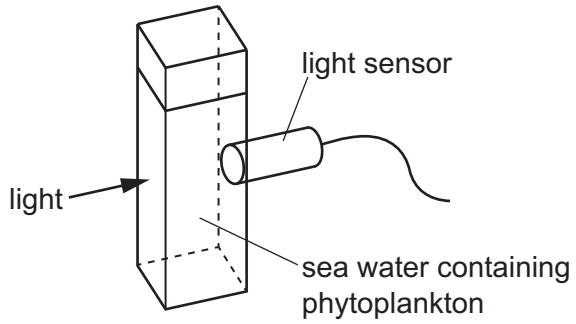

Fig. 1.3

(i) Identify the independent and dependent variables.

independent variable .....

dependent variable .....

[1]

(ii) Complete Table 1.1 to identify **two** key variables to standardise, **and** describe how these can be standardised in this investigation.

Table 1.1

key variable	how to standardise

[3]

(iii) Using the equipment shown in Fig. 1.3, outline a safe method that can be used to investigate the effect of light intensity on the rate of photosynthesis of the phytoplankton.

Do **not** include how to standardise key variables in your answer.

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..... [4]

[Total: 12]

2 Scientists investigated food webs in the open ocean. Organisms were captured, and their trophic level was identified. The total biomass of organisms at each trophic level was then calculated.

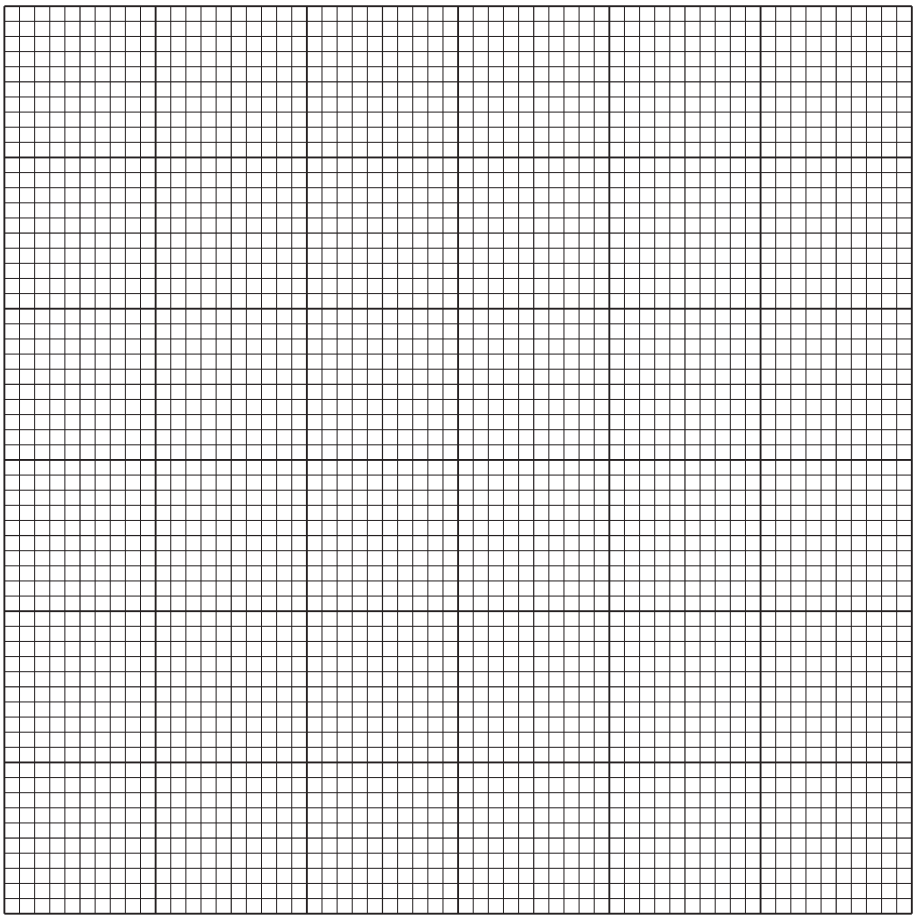
The results are shown in Table 2.1.

Table 2.1

trophic level	total biomass / arbitrary units
1	3.8
2	4.6
3	3.4
4	2.1
5	0.5

(a) Construct a pyramid of biomass for the data shown in Table 2.1.

Draw your pyramid **to scale**, **and label** the trophic levels.



[4]

(b) Suggest an explanation for the difference in total biomass between trophic levels 1 and 2.

.....

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..... [2]

(c) The efficiency of biomass transfer is a measure of the proportion of biomass transferred from a lower trophic level to a higher one.

The biomass transfer efficiency between trophic levels 3 and 4 is 61.8%.

Calculate the percentage biomass transfer efficiency between trophic levels 4 and 5.

..... % [1]

(d) Suggest reasons for the difference in the biomass transfer efficiency between trophic levels 3 and 4 and the biomass transfer efficiency between trophic levels 4 and 5.

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..... [2]

(e) Explain how nutrients leave ocean food chains and become available to producers again.

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..... [2]

[Total: 11]

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3 Scientists collected a series of measurements from a ship travelling across the Atlantic Ocean from locations 1 to 12. They recorded the temperature, concentration of nitrate ions (NO_3^-) and abundance of phytoplankton at five depths from each of the 12 locations shown in Fig. 3.1.

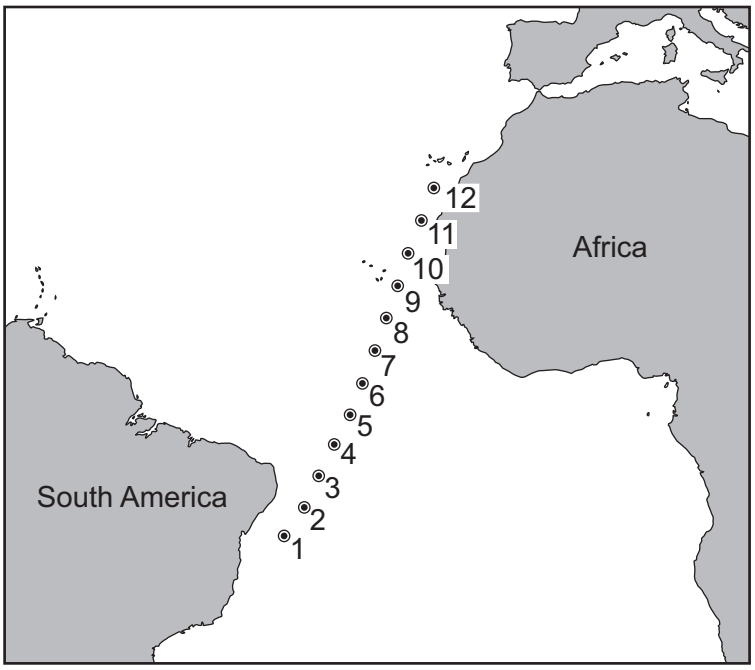

Fig. 3.1

(a) State the type of sampling used by the scientists, **and** describe the benefits of this method.

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.....

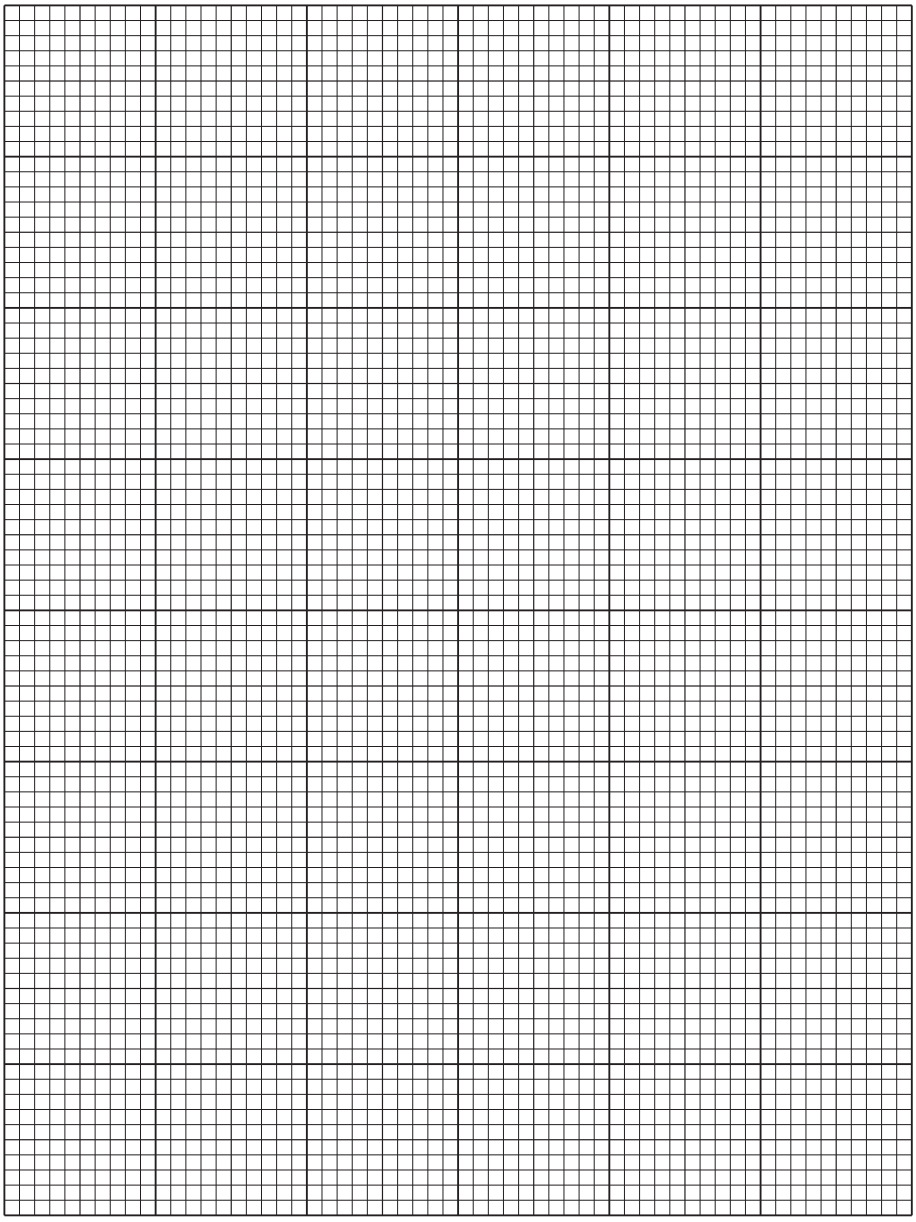
..... [3]

(b) Table 3.1 shows the temperatures recorded at location 4.

Table 3.1

depth / m	temperature / °C
50	28
60	25
75	20
80	15
170	12

Plot the information shown in Table 3.1 as a line graph.



[4]

(c) Fig. 3.2 shows the analysis of some of the data that the scientists collected at each location.

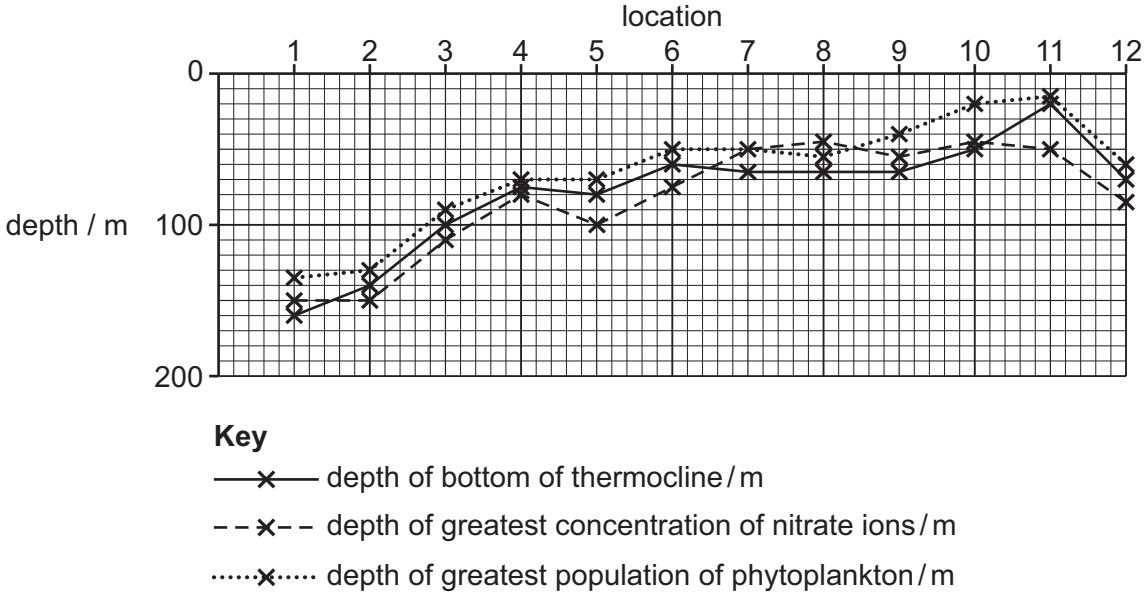


Fig. 3.2

Use the information shown in Table 3.1 **and** Fig. 3.2 **and** your own knowledge to discuss the reasons for the distribution of phytoplankton.

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..... [3]

[Total: 10]

4 **(a)** Scientists investigated the thickness of the shells of sea snails around two underwater vents, test sites **A** and **B**. The vents release carbon dioxide.

Carbon dioxide from the vents decreases the pH of the surrounding sea water to a distance of approximately 20 m from the vent.

The scientists collected five samples of one species of sea snail from a location near to each vent. They measured the thickness of the shell of each sea snail. They also measured the protein content of the algae the snails feed on. They calculated the mean values for each of these measurements.

This was repeated at another location more than 20 m away from each vent.

Table 4.1 shows the results of the investigation.

Table 4.1

test site	location	pH of sea water	mean thickness of snail shell / μm	dry mass mean percentage protein content of algae
A	near vent	7.8	9.6	17.0
	away from vent	8.1	7.8	14.2
B	near vent	7.8	6.6	20.5
	away from vent	8.1	6.2	15.2

(i) Suggest how the pH of the water from each site was measured.

.....

..... [1]

(ii) Explain why samples were also collected over 20 m away from the vent.

.....

..... [1]

(iii) Suggest **two** abiotic factors that are similar at both locations for each test site.

1 .....

2 .....

[2]

(b) Table 4.1 shows the dry mass mean percentage protein content of the algae.

(i) State the names of **two** other **organic** nutrients that would make up a large percentage of the remaining dry mass of the algae.

1 .....

2 .....

[2]

(ii) Evaluate the extent to which the data in Table 4.1 support the idea that sea water of lower pH increases the nutritional content of algae.

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..... [2]

(iii) Evaluate the extent to which the data in Table 4.1 support the idea that the thickness of the snail shell increases with a higher protein content of the algae.

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..... [2]

[Total: 10]

5 **(a)** Fig. 5.1 shows a brittle star which belongs to the echinoderm phylum.

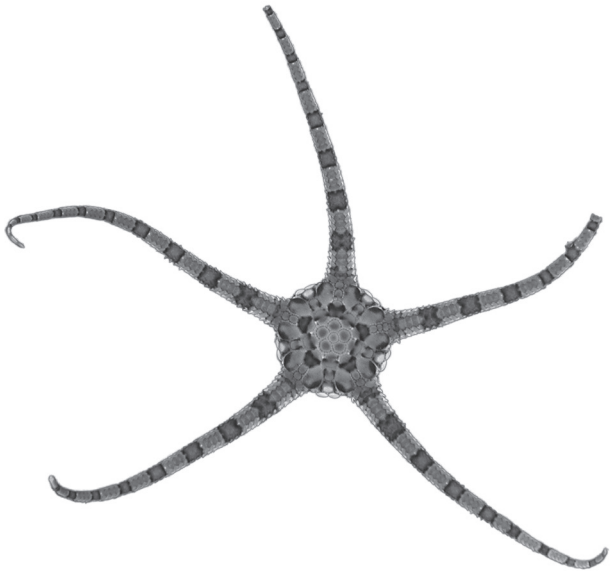


Fig. 5.1

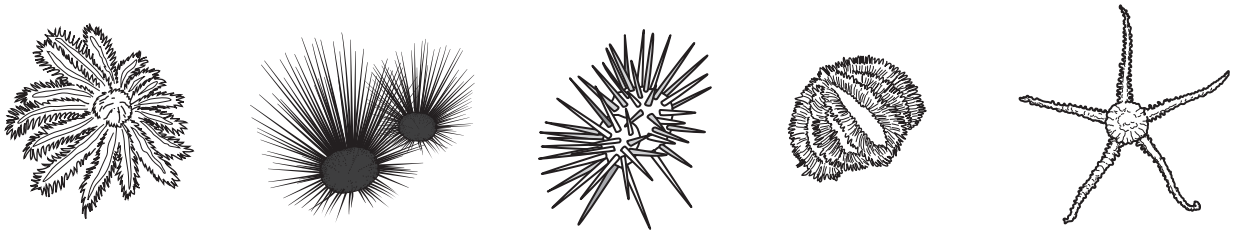
Make a large drawing of the brittle star shown in Fig. 5.1.

Do **not** include the markings on the arms.

[4]

(b) Sea urchins and starfish also belong to the echinoderm phylum.

Fig. 5.2 shows five species of echinoderm.



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

Fig. 5.2

Use the key below to identify species **A** and **B**.

1	disc-shaped body with arms	2
	body does not have arms	3
2	body has 5 arms	*Ophiura albida*
	body has 12–23 arms	*Acanthaster planci*
3	body has many spines which are longer than diameter of the body	4
	body has many spines which are shorter than diameter of the body	*Mespilia globulus*
4	spines are thin and dark in colour	*Diadema setosum*
	spines are thick and light in colour	*Echinometra mathaei*

species **A**: .....

species **B**: .....

[2]

(c) Collector urchins feed on seagrass and macroalgae.

Collector urchins are prey for octopus.

Pufferfish consume collector urchins.

Tiger sharks are predators of octopus and pufferfish.

Draw a food web for the organisms described above.

[2]

(d) Collector urchins are often seen coated with debris such as gravel.

Suggest why this may be an advantage to their survival.

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..... [2]

[Total: 10]

6 A survey was carried out to estimate the total population of the shark *Carcharias taurus* in the coastal waters off south-east Australia.

Scientists attached numbered tags to a dorsal fin of the sharks.

(a) Label **one** dorsal fin on the diagram of a *Carcharias taurus* in Fig. 6.1.

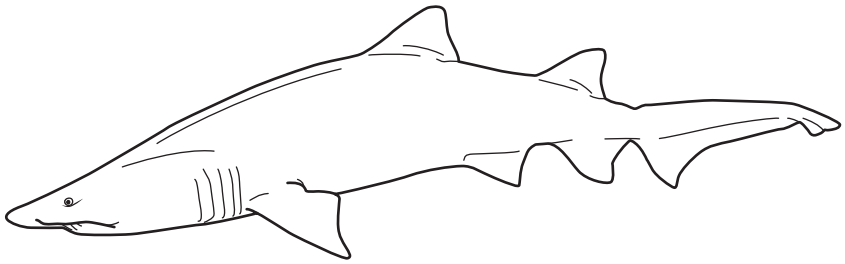

Fig. 6.1

[1]

(b) *Carcharias taurus* are cartilaginous fish.

State **two** features of cartilaginous fish that are **not** features of bony fish.

1 .....

.....

2 .....

.....

[2]

(c) The scientists used the mark–release–recapture method to estimate the population of *Carcharias taurus* off the south-east coast of Australia.

The data collected are shown in Table 6.1.

Table 6.1

	number
sharks captured and marked in first sample (n_1)	152
sharks captured in second sample (both marked and unmarked) (n_2)	185
marked sharks recaptured in second sample (m_2)	44

The equation for the Lincoln index is shown.

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

Use the data in Table 6.1 **and** the equation to estimate the population of *Carcharias taurus* in the area surveyed.

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

Show your working.

.....

[3]

(d) *Carcharias taurus* is known as the grey nurse shark in Australia, the sand tiger shark in the USA and the spotted ragged-tooth shark in South Africa.

Explain the importance of using the binomial system of species nomenclature.

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..... [2]

(e) Scientists in the USA studied the growth rate of *Carcharias taurus* and found that its growth rate decreased over time as shown in Table 6.2.

Table 6.2

age in years	rate of growth / cm year^{-1}
0 to 2	25 to 30
2 to 4	20 to 25
4 to 6	15 to 20
6 to 8	10 to 15
> 8	5 to 10

When a *Carcharias taurus* is born, it is around 1 m long.

Calculate the approximate length of a 5-year-old *Carcharias taurus*, using the data in Table 6.2.

State the units.

Show your working.

.....

[3]

[Total: 11]

7 **(a)** A major earthquake resulted in the formation of a tsunami.

The earthquake occurred at the plate boundary shown in Fig. 7.1.

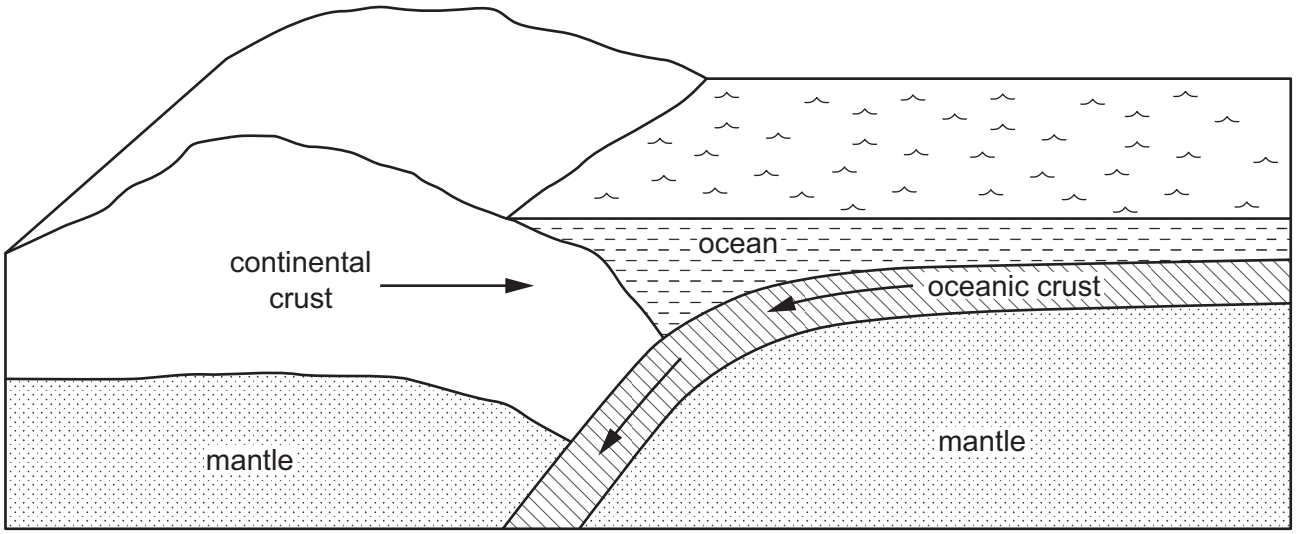

Fig. 7.1

(i) Explain why the earthquake occurred at the plate boundary shown in Fig. 7.1.

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..... [3]

(ii) Explain how the earthquake formed a tsunami.

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..... [2]

(b) Table 7.1 shows the height of the tsunami at fishing ports along the coast close to the centre of the earthquake.

Table 7.1

coastal location	maximum tsunami height / m
1	9.9
2	8.1
3	18.9
4	14.6
5	34.7

(i) Suggest why the height of the tsunami varied so much, using ideas about the geomorphology of coastlines.

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..... [2]

(ii) Explain how the tsunami caused weathering **and** erosion along the coastline.

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..... [2]

(iii) Suggest possible impacts of the tsunami on a sandy shore, other than weathering and erosion.

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..... [2]

[Total: 11]

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