Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

8580821456

MARINE SCIENCE **9693/23**

Paper 2 AS Level Data-handling and Investigative Skills **May/June 2022**

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.

DC (EF) 324620/1

Answer **all** questions.

1 Fig. 1.1 shows a species of brown macroalga (seaweed) from a rocky shore.

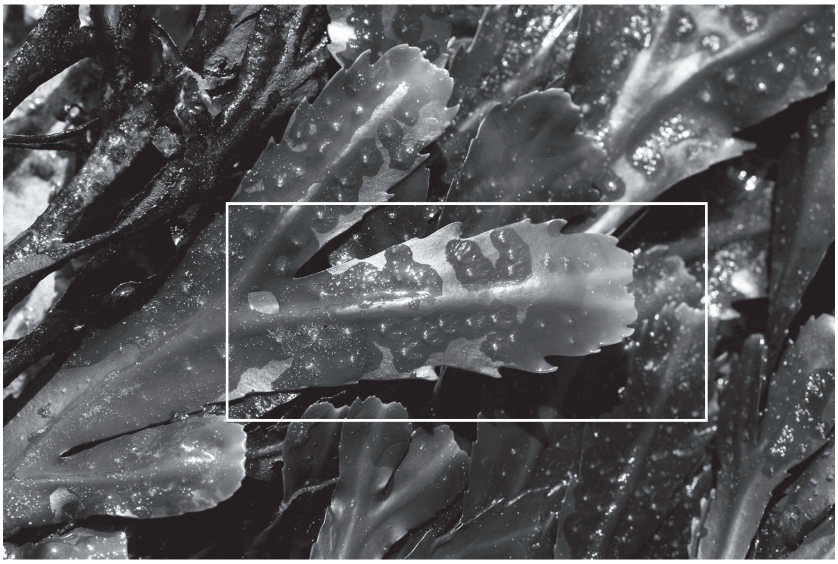

Fig. 1.1

(a) **(i)** Use the key below to identify the species of seaweed shown in Fig. 1.1.

1	Fronds lie flat	go to 2
	Fronds twisted into spirals	*Fucus spiralis*
2	Large air bladders present	go to 3
	No large air bladders present	go to 4
3	Air bladders wider than width of frond	*Ascophyllum nodosum*
	Air bladders narrower than width of frond	*Fucus vesiculosus*
4	Smooth edge to frond	*Fucus ceranoides*
	Frond edge serrated, not smooth	*Fucus serratus*

.... [1]

(ii) Use your answer to **(a)(i)** to identify the genus this species belongs to.

.... [1]

(b) Make a large drawing of a frond from the seaweed in Fig. 1.1. Only draw the frond shown inside the white box.

Do **not** label your diagram.

[4]

(c) Some macroalgae, such as kelp, are of significant economic importance.

Fig. 1.2 shows the annual harvest of kelp along the Mexican Pacific coast from 1958 to 2002.

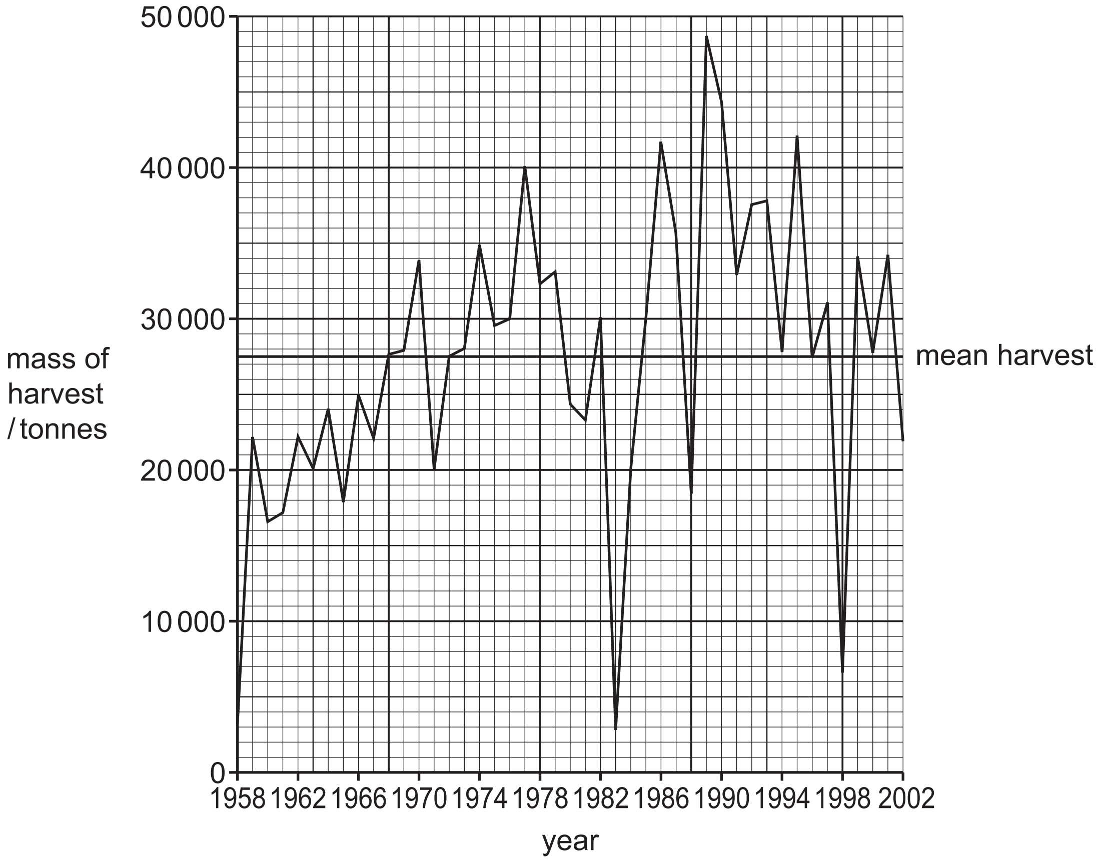

Fig. 1.2

(i) Use Fig. 1.2 to state the size of the mean harvest **and** explain how it is calculated.

....

....

....

....

.... [3]

(ii) Calculate the harvest in 1998 as a percentage of the mean harvest.

Show your working.

.... % [2]

(iii) Suggest an economic impact of the harvest size in 1998.

....

.... [1]

(iv) The sea temperature was significantly higher than normal in 1983 and 1998.

Explain why this may have affected the size of the kelp harvest.

....

....

....

....

....

....

.... [3]

(v) Harvest size can be used to compare the population size of kelp in any given year.

Suggest **one** reason why this might **not** be a reliable method for this comparison.

....

.... [1]

[Total: 16]

2 Fig. 2.1 shows the solubility of oxygen at different temperatures and pressures in sea water at the mean ocean salinity of 35‰.

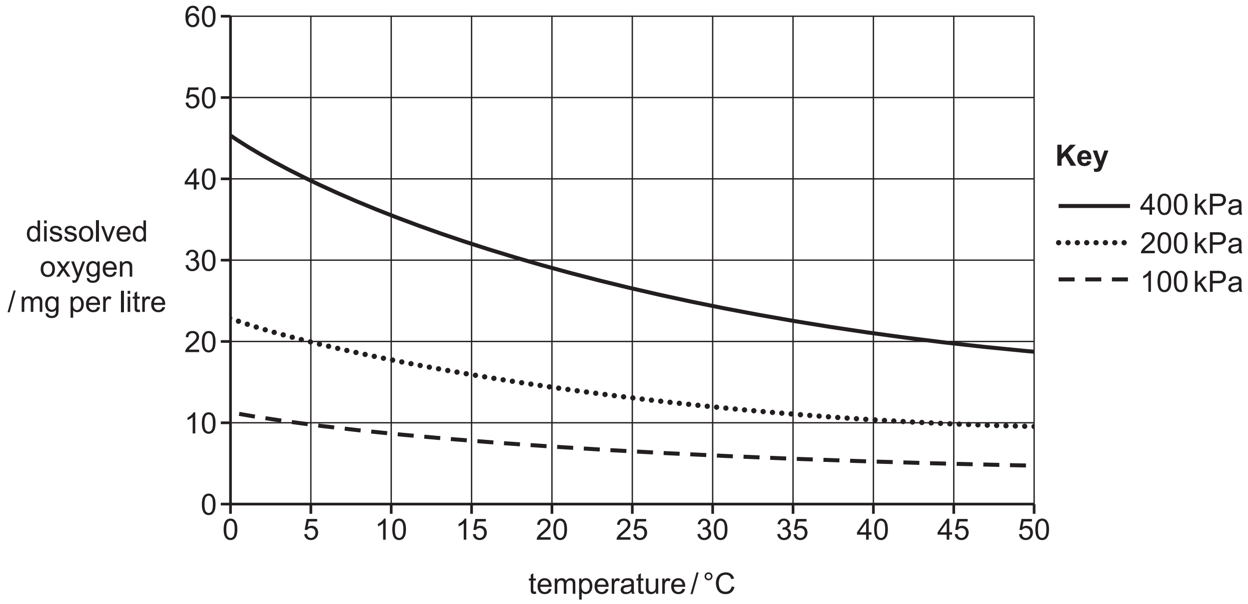

Fig. 2.1

(a) Use Fig. 2.1 to describe the relationship between:

dissolved oxygen and temperature ....

....

dissolved oxygen and pressure ....

....
[2]

(b) The mean temperature of the world's oceans is 17 °C.

Using Fig. 2.1, estimate the mean dissolved oxygen concentration when the water pressure is 200 kPa.

Include the correct unit.

.... [2]

(c) Fig. 2.2 shows the concentration of oxygen at different depths at two locations, one in the Atlantic Ocean and one in the Pacific Ocean.

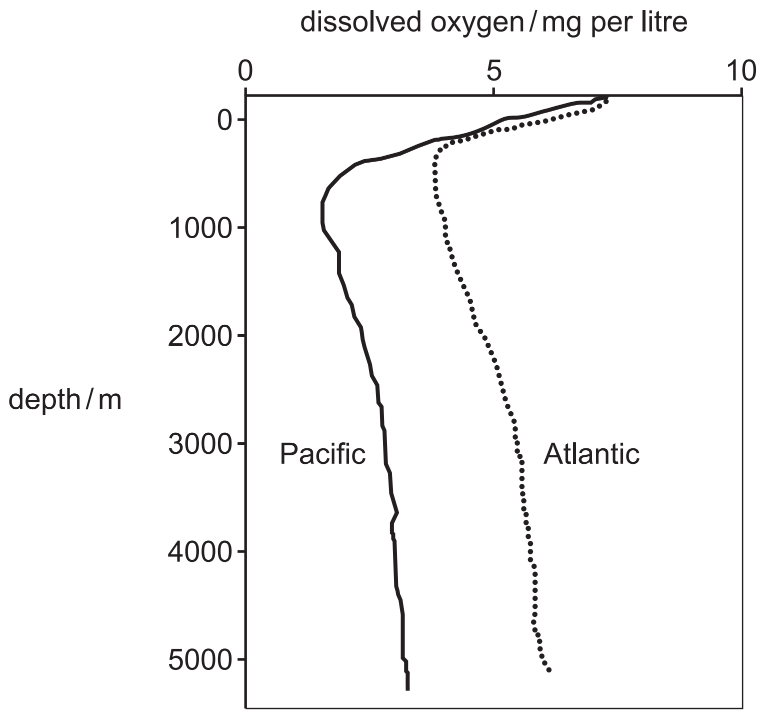

Fig. 2.2

(i) Describe **and** explain the similarities between the lines for the two oceans in Fig. 2.2.

....

....

....

....

....

.... [3]

(ii) Describe **and** explain the differences between the lines for the two oceans in Fig. 2.2.

....

....

....

....

....

.... [3]

[Total: 10]

BLANK PAGE

3 A student investigates the substrate composition of two sandy shores, **A** and **B**.

They collect a sample from each shore for analysis in the laboratory.

They conduct a sediment analysis using the mechanical sieve system shown in Fig. 3.1. This system contains a stack of sieves with different sized holes.

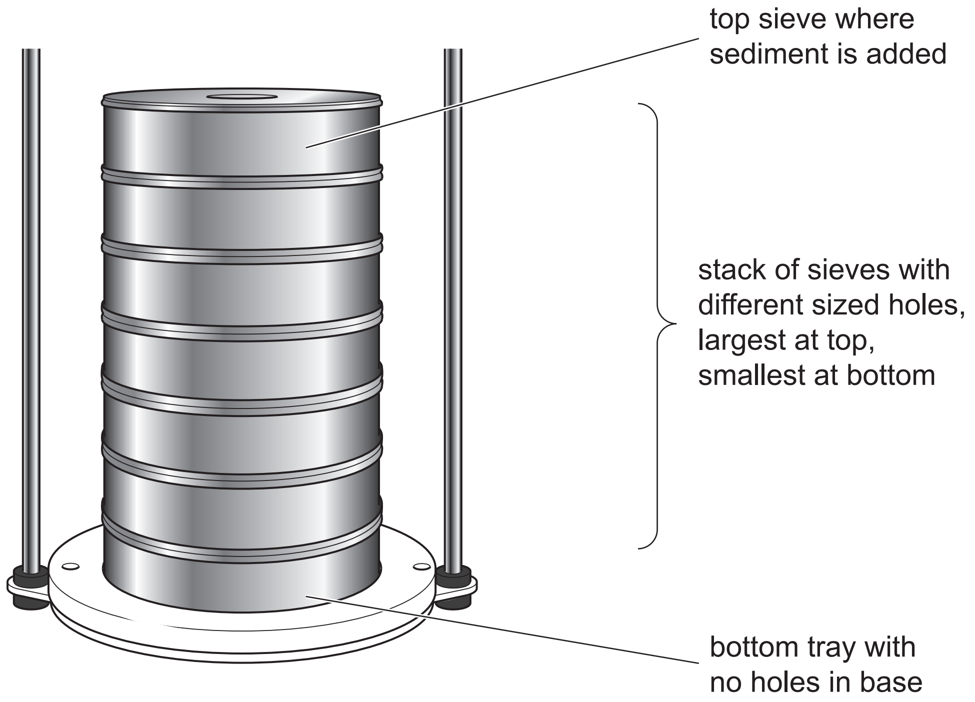

Fig. 3.1

Samples are dried over 48 hours.

A sample of sediment is placed in the top sieve and the machine switched on.

The machine shakes the sieves so that sediments fall through to different levels.

(a) **(i)** Suggest why samples are left to dry for 48 hours before sieving.

....

.... [1]

(ii) The sieve at the top has the largest holes, with each sieve below having progressively smaller holes. The bottom tray has no holes.

Explain how this will allow separation of different sized particles as the machine shakes the sediment through the sieves.

....

....

....

.... [2]

(b) Each sample is shaken for 10 minutes. The mass of the contents of each sieve is measured and the percentage of the total mass calculated.

The results for both samples are shown in Table 3.1.

Table 3.1

sieve	**particle type**	**percentage in sample from shore A**	**percentage in sample from shore B**
1 (top)	gravel or larger	7	5
2	very coarse sand	19	10
3	coarse sand	31	17
4	medium sand	20	
5	fine sand	11	22
6	very fine sand	8	14
7 (bottom)	silt or smaller	4	7

(i) Calculate the percentage of medium sand in the sample from shore **B**.

.... % [1]

(ii) Suggest why the results were converted to percentages, rather than just using the mass of each particle type.

....

.... [1]

(iii) The data for the sample from shore **A** has been plotted on Fig. 3.2.

Use the data in Table 3.1 and your answer from **(b)(i)** to complete the bar graph in Fig. 3.2 for the sample from shore **B**. Complete the scale for the y-axis and the labels for both axes.

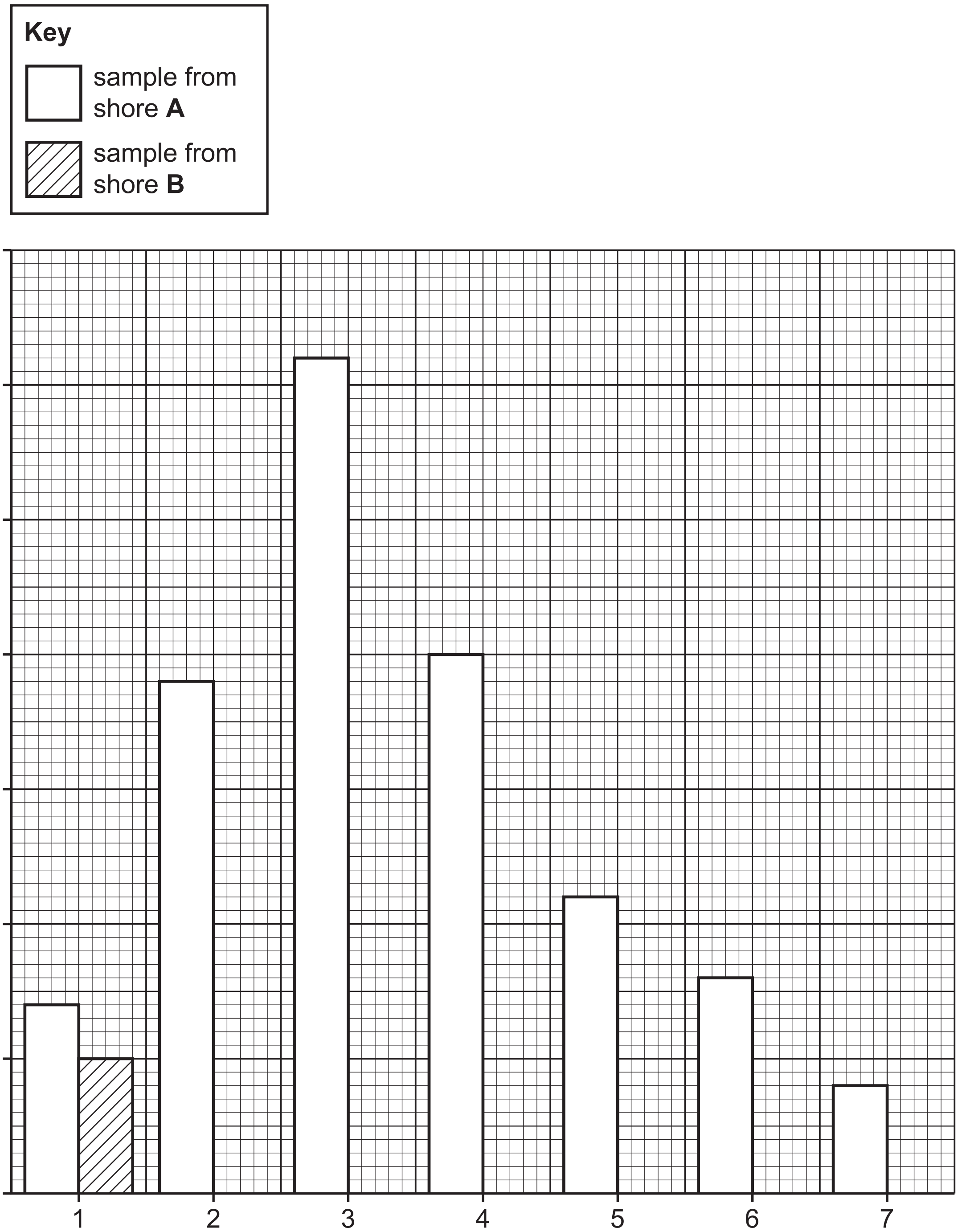

Fig. 3.2

[4]

(c) Fig. 3.3 shows the apparatus used to compare the permeability of samples from shore **A** and shore **B**.

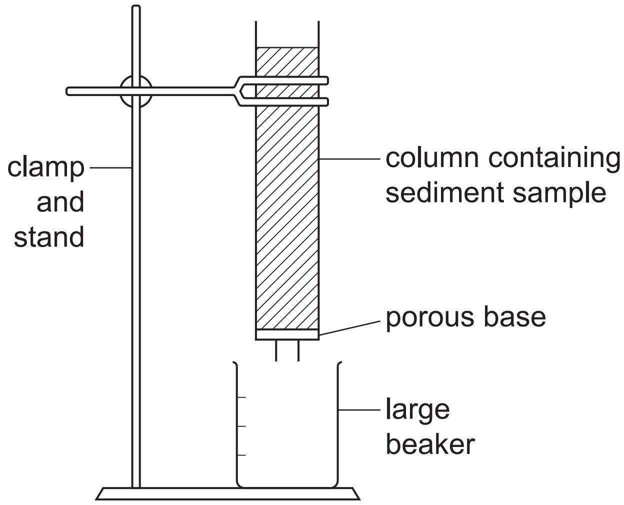

Fig. 3.3

(i) Describe how the students could use the apparatus in Fig. 3.3 to compare the permeability of samples from shore **A** and shore **B**.

You should include any additional apparatus that may be required, and how it would be used to obtain reliable data.

....

....

....

....

....

....

....

....

....

....

....

....

....

.... [5]

(ii) In the space below, construct a table that you could use to record your results. Include headings in the results table.

[2]

(iii) Use the data in Table 3.1 and your bar graph in Fig. 3.2, to predict which of the samples, from shore **A** or shore **B**, would have the greatest permeability.

Explain your answer.

....

....

....

.... [2]

(d) Animals have adaptations to survive on sandy shores.

Suggest **two** reasons why the particle size of sediments on a sandy shore may affect which organisms can survive there.

1 ....

....

2 ....

....

[2]

[Total: 20]

BLANK PAGE

4 *Parma victoriae* is a species of fish living on rocky reefs. They are highly territorial, aggressively defending their territory from other fish.

Scientists investigated the factors affecting the number of aggressive attacks by *P. victoriae*.

Table 4.1 shows the number of aggressive encounters recorded with various types of other fish. The food source and population density of each species (measured as mean number of fish per 500 m^2) is also shown.

Table 4.1

species of fish	food source	population density of species / mean number per 500 m^2	number of aggressive encounters with *P. victoriae*
Caesioperca rasor	zooplankton	84.0	12
Cheilodactylus nigripes	carnivore	6.6	4
Dactylosargus arctidens	herbivore	0.6	3
Meuschenia flavolineata	herbivore	16.2	41
Meuschenia freycineti	herbivore	1.2	2
Meuschenia hippocrepis	herbivore	8.4	29
Parma victoriae	herbivore	30.4	61
Penicipelta vittiger	herbivore	8.6	18
Pseudolabrus tetricus	carnivore	27.1	3
Scorpis aequipinnis	omnivore	10.8	11
Upeneichthys lineatus	carnivore	5.8	2

(a) Use Table 4.1 to state the number of aggressive encounters due to intra-specific competition.

Explain your answer.

....

....

....

.... [2]

(b) One scientist suggested the following hypothesis:

'The greater the density of a species' population, the greater the number of aggressive encounters with *Parma victoriae*.'

The research data in Table 4.1 were then analysed.

A scatter graph using data from Table 4.1 was plotted as shown in Fig. 4.1.

Scatter graphs allow scientists to look for correlations between variables.

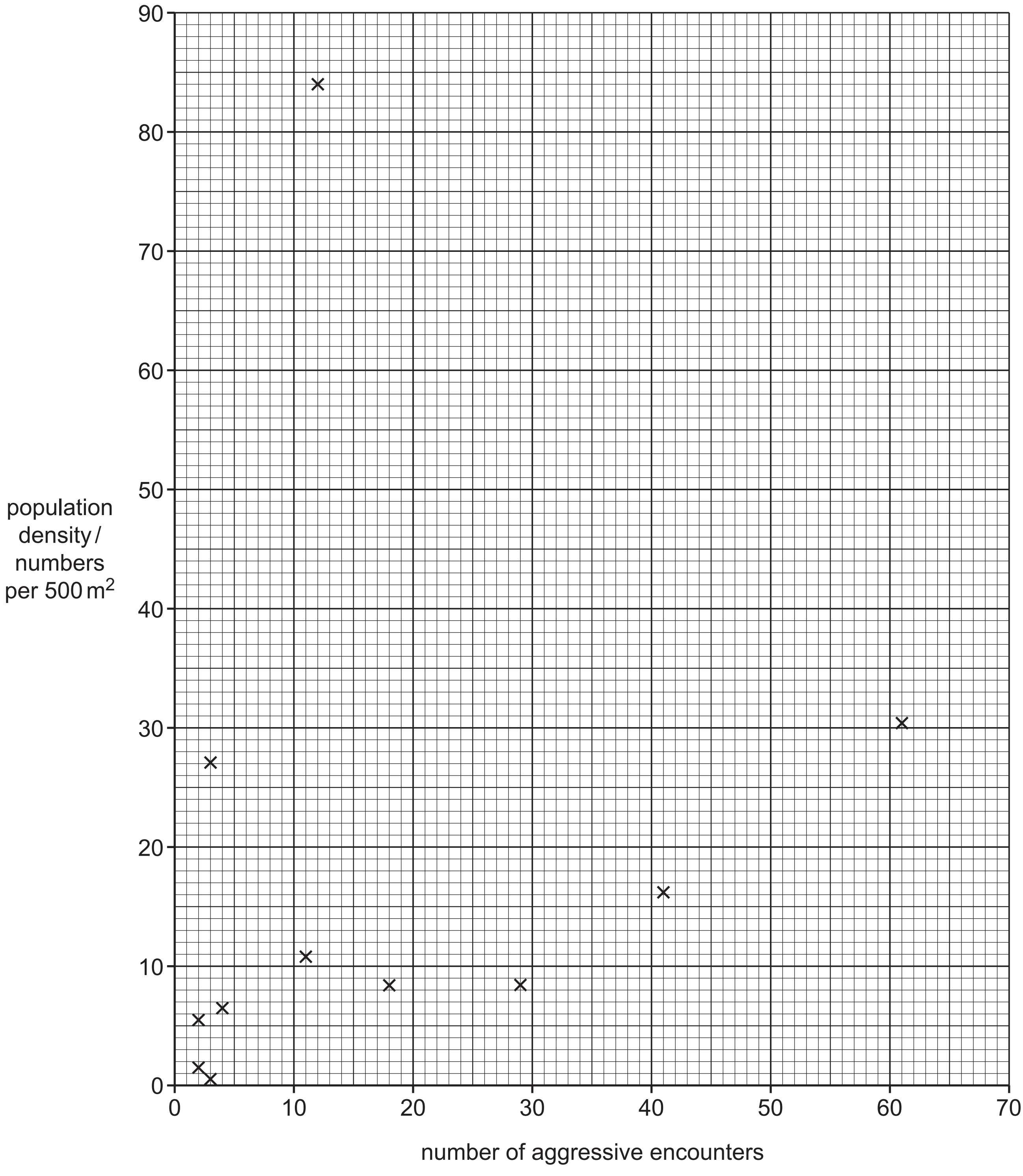

Fig. 4.1

(i) The scientist decided that a firm conclusion could not be drawn from the data.

Use the data in Fig. 4.1 to explain the scientist's decision.

....

....

....

.... [2]

(ii) To analyse the data further the scientists used Spearman's rank correlation (r_s) to decide if there was a correlation between the two variables.

Explain why they chose Spearman's rank correlation to analyse the data further.

....

....

....

.... [2]

(iii) The calculation for Spearman's rank correlation (r_s) uses the following equation:

$$r_s = 1 - \left(\frac{6 \times \sum D^2}{n^3 - n}\right)$$

where,

$\sum$ = sum of (total)
n = number of pairs of items in the sample
D = difference in rank between each pair of measurements

Table 4.2 shows the scientists' calculations of D and D^2.

Table 4.2

species	**population density**		**aggressive encounters**			
	number per 500 m^2	**rank**	**number**	**rank**	***D***	***D*^{2}**
Caesioperca rasor	84.0	1	12	5	4	16
Cheilodactylus nigripes	6.60	8	4	7	1	1
Dactylosargus arctidens	0.600	11	3	8.5	2.5	6.25
Meuschenia flavolineata	16.2	4	41	2	2	4
Meuschenia freycineti	1.20	10	2	10.5	0.5	0.25
Meuschenia hippocrepis	8.40	7	29	3	4	16
Parma victoriae	30.4	2	61	1	1	1
Penicipelta vittiger	8.60	6	18	4	2	4
Pseudolabrus tetricus	27.1	3	3	8.5	5.5	30.3
Scorpis aequipinnis	10.8	5	11	6	1	1
Upeneichthys lineatus	5.80	9	2	10.5	1.5	2.25

Use the information in Table 4.2 and the equation to calculate a value for r_s.

Show your working.

Give your answer to 3 significant figures.

r_s = ... [5]

(iv) What does your calculated value for r_s tell you about the original hypothesis?

....

.... [1]

(c) Suggest what other factors, apart from population density, may be affecting the number of aggressive encounters by *P. victoriae*.

....

....

....

....

....

.... [4]

[Total: 16]

5 A mid-ocean ridge is a tectonic feature found in the Earth's crust in the larger oceans.

(a) (i) Name the type of plate boundary usually found at a mid-ocean ridge.

....

.... [1]

(ii) Explain how the ocean floor forms at this plate boundary.

....

....

....

....

....

.... [3]

(b) A magnetometer is a scientific instrument that is used to survey the magnetic polarity of rocks on the ocean floor.

A survey ship towed a magnetometer in a straight line for 100 km as it passed across a mid-ocean ridge.

The direction of travel was perpendicular (at right angles) to the position of the mid-ocean ridge, as shown in Fig. 5.1.

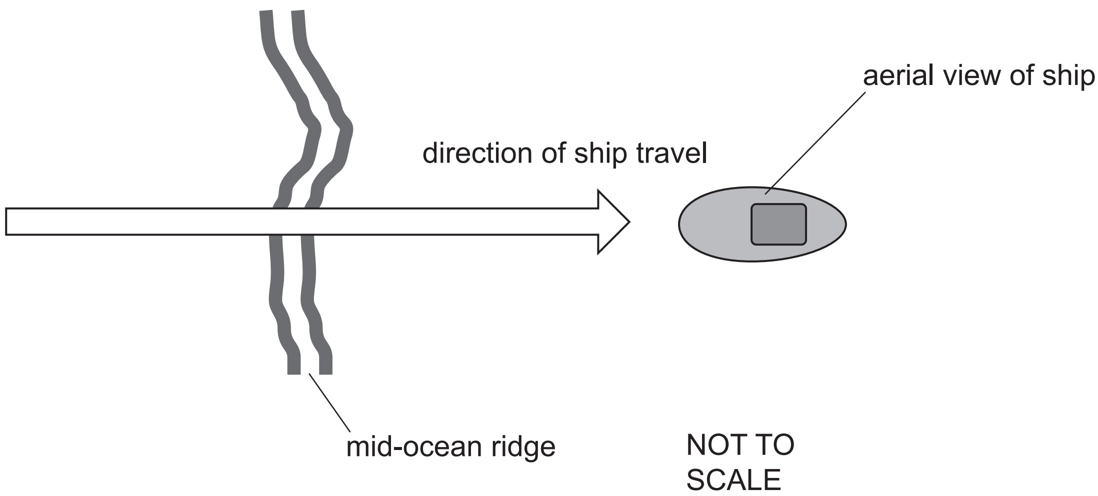

Fig. 5.1

Fig. 5.2 shows the data that was collected.

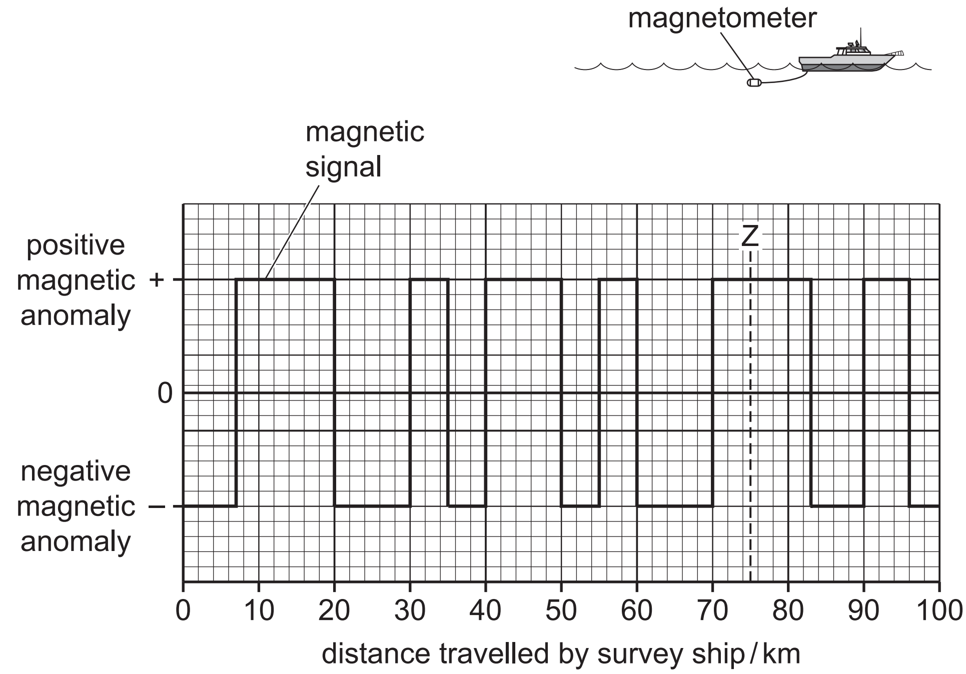

Fig. 5.2

(i) Explain the pattern shown by the data in Fig. 5.2.

....

....

....

.... [2]

(ii) Suggest how many kilometres the boat had travelled before it was directly over the centre of the mid-ocean ridge.

Explain your answer.

....

....

....

.... [2]

(iii) The ocean floor at this mid-ocean ridge is spreading at a rate of 0.02 m per year. Use this information to estimate the age of rocks at point Z.

.... [1]

(c) Research suggests a link between ocean floor spreading and the carbon cycle, as the formation of rock will act as a sink for carbon.

Fig. 5.3 on page 23 shows data for atmospheric carbon dioxide concentration in parts per million (ppm), the total global length of mid-ocean ridge plate boundaries, and the mean rate of ocean floor spreading.

Discuss whether the data shown in Fig. 5.3 support the idea that there is a link between ocean floor spreading and the carbon cycle.

Explain your answer.

....

....

....

....

....

....

....

....

....

.... [4]

[Total: 13]

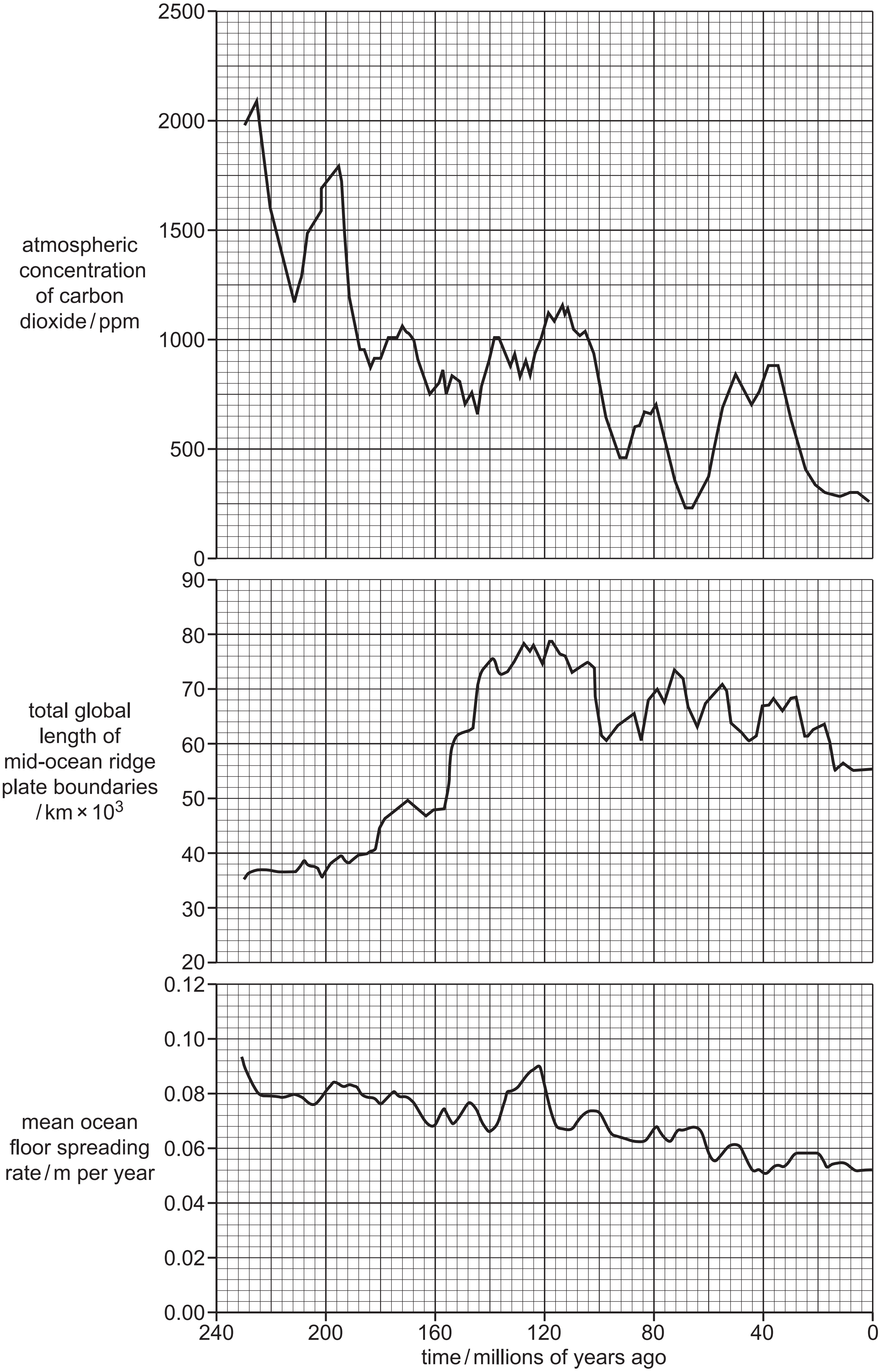
2500
2000
1500
1000
500
0
atmospheric concentration of carbon dioxide / ppm
90
80
70
60
50
40
30
20
total global length of mid-ocean ridge plate boundaries / km × 10³
0.12
0.10
0.08
0.06
0.04
0.02
0.00
mean ocean floor spreading rate / m per year
240
200
160
120
80
40
0
time / millions of years ago

Fig. 5.3

BLANK PAGE