Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

MARINE SCIENCE **9693/22**

Paper 2 AS Level Data-handling and Investigative Skills **October/November 2023**

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 **16** pages.

Answer **all** questions.

1 Mangrove forests are important ecosystems.

(a) Explain the term ecosystem.

....

....

....

.... [2]

(b) Fig. 1.1 shows the area of mangrove forest in ten countries and the areas of mangrove forest that are protected and unprotected.

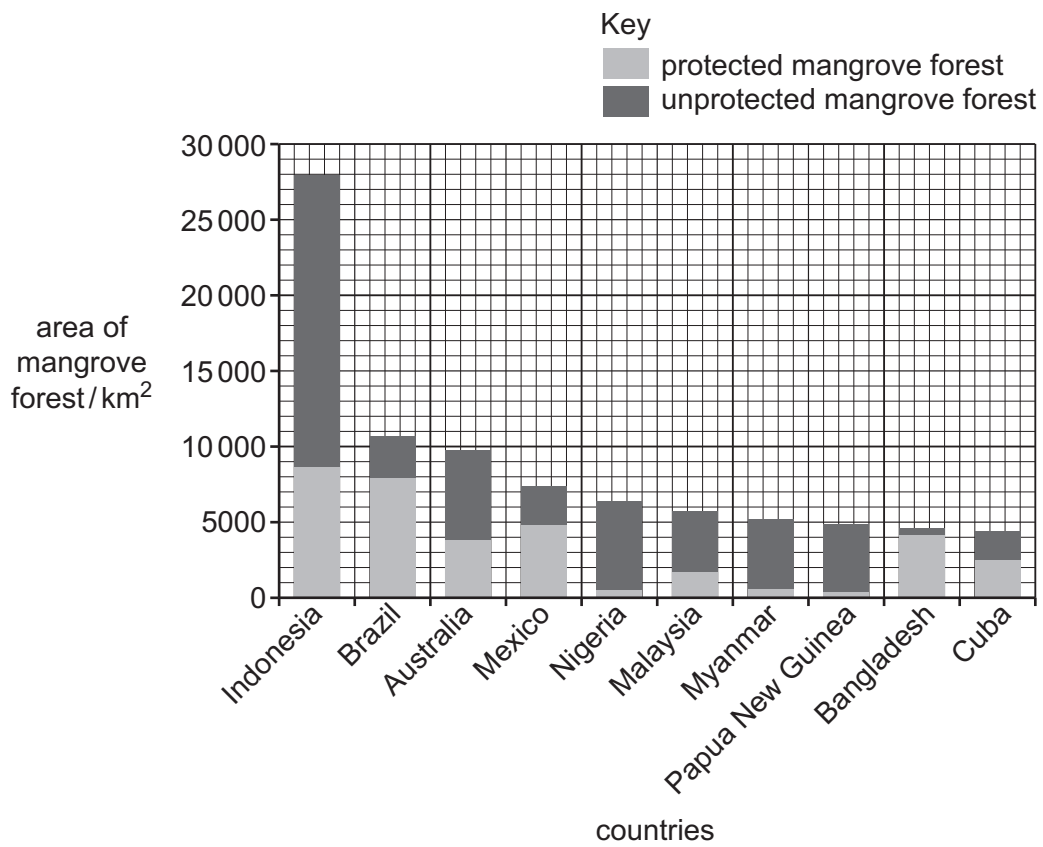**Fig. 1.1**

(i) State the name of the country which protects the greatest percentage of its mangrove forest.

.... [1]

(ii) Calculate the percentage of mangrove forest in Mexico that is protected.

Show your working.

.... % [2]

(iii) State **two** major threats to mangrove forests.

1 ....

2 ....
[2]

(c) Some species of macroalgae grow attached to the roots of mangrove trees.

Scientists planned an investigation to compare the rate of photosynthesis at different light intensities in two of these species of macroalgae.

(i) State the word equation for photosynthesis.

.... [1]

Fig. 1.2 shows their experimental set-up. This closed system is used to fully contain a standardised volume of water which is circulated. An oxygen sensor recorded oxygen concentration in the water. The whole apparatus was submerged into a much larger tank of sea water for the investigation.
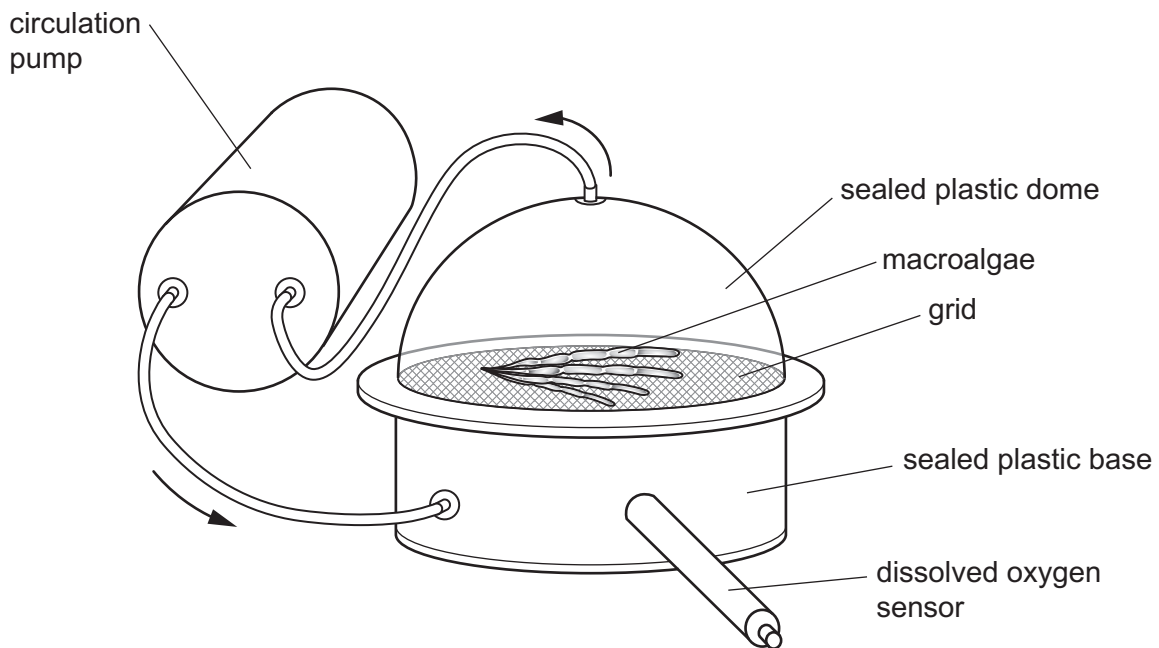

Fig. 1.2

(ii) Identify the dependent variable.

.... [1]

(iii) Suggest **two** variables that should be standardised in this investigation.

1 ....

2 ....

[1]

(iv) Suggest how the light intensity was changed.

....

.... [1]

(v) The scientists allowed the macroalgae to photosynthesise for 8 minutes in the closed system. They then exchanged the water in the closed system with some of the water in the surrounding tank, before beginning to collect results.

Suggest **one** reason the scientists exchanged the water.

....

.... [1]

Table 1.1 shows the results from the investigation.

Table 1.1

light intensity /arbitrary units	oxygen production/μmol mm^{-2}min^{-1}	
	macroalgae species A	macroalgae species B
50	650	210
350	1750	580
600	2410	1530
900	2950	3090
1200	2910	3310

(vi) Plot a graph of the two sets of data in Table 1.1 on the grid below **and** draw an appropriate line for each data set.

Complete the axes for the graph.

oxygen production

/ ....

....
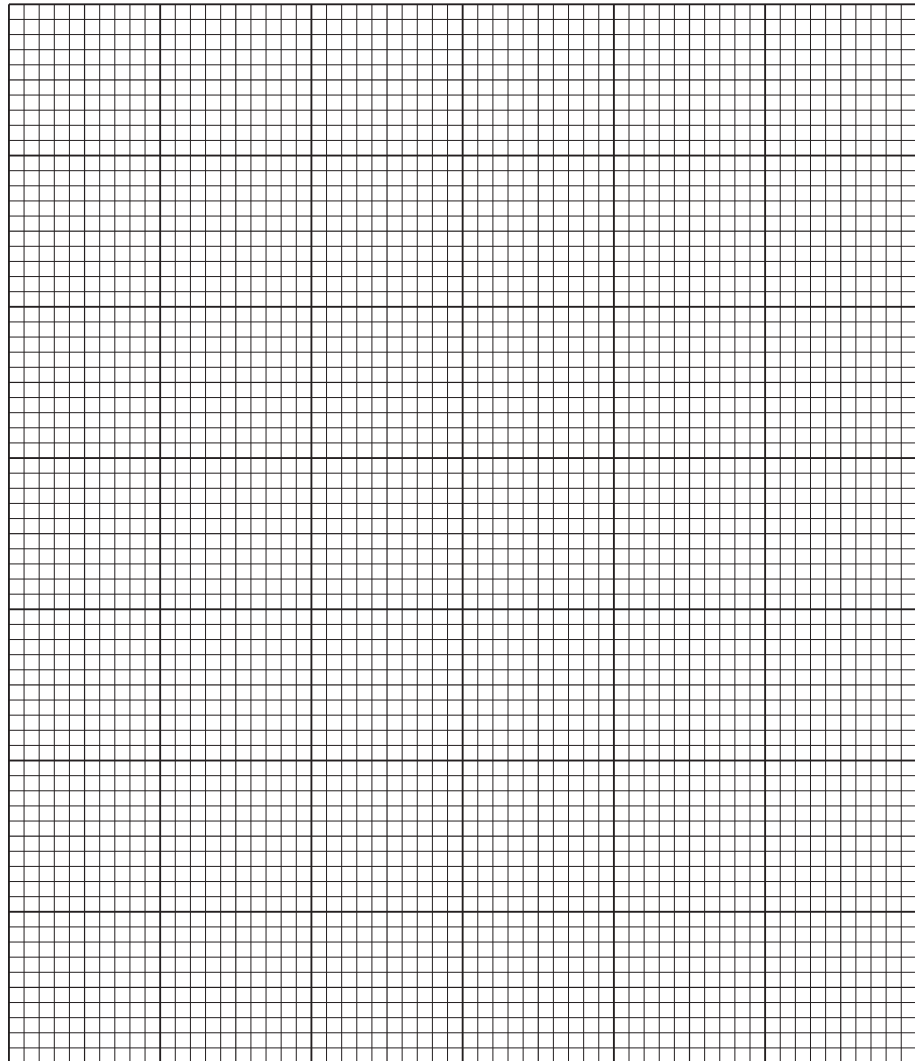
[5]

(vii) The two species of macroalgae used in the investigation are found at different depths on the mangrove tree roots.

Use Table 1.1 to explain the expected depth distribution of the two species of macroalgae on the mangrove tree roots.

....

....

....

....

....

.... [3]

(viii) At a light intensity of zero the oxygen level decreased during the investigation.

Explain this observation.

....

....

....

.... [2]

[Total: 22]

2 A group of students investigated how the distribution of crabs on a rocky shore varied with macroalgae cover.

The students used random sampling to select 10 areas of the shore. They collected data on the percentage cover of macroalgae and the number of crabs in 10 quadrats.

(a) (i) Describe how to collect data using random sampling on a shore.

....

....

....

....

....

.... [3]

(ii) State **one** advantage and **one** disadvantage of using random sampling compared to systematic sampling.

advantage ....

....

disadvantage ....

....
[2]

(b) State the null hypothesis for this investigation.

....

.... [1]

(c) The students ranked the percentage cover of macroalgae and the number of crabs in each quadrat. Their results are shown in Table 2.1.

Table 2.1

quadrat number	percentage cover of macroalgae	rank of percentage cover of macroalgae	number of crabs	rank of number of crabs	difference (*D*)	*D²*
1	100	10	21	8	2	4
2	15	2	6	3	1	1
3	30	3	1	1	2	4
4	70	....	20	....	....	....
5	95	....	25	....	....	....
6	45	4	11	4	0	0
7	80	....	22	....	....	....
8	10	1	2	2	1	1
9	70	....	19	....	....	....
10	55	5	12	5	0	0

Complete Table 2.1.

[2]

(d) The formula for Spearman's rank correlation is:

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

where $\sum$ = sum of (total)

n = number of pairs of items in the sample

D = difference in rank between pairs of measurements.

Use this formula to calculate Spearman's rank correlation for the data in Table 2.1.

Show your working.

Give your answer to an appropriate number of significant figures.

.... [4]

(e) Discuss the extent to which these results show that the percentage of algae cover affects the number of crabs present.

....

....

....

.... [2]

[Total: 14]

3 Fig. 3.1 shows a red snapper, a fish commonly harvested for human food from coral reefs.

Fig. 3.1

(a) Make a large drawing of the red snapper in Fig. 3.1.

Do **not** include the scales.

[4]

(b) On your diagram label the following features:

- operculum
- pectoral fin.

[2]

(c) (i) Describe **one** method that could be used to estimate the population of red snapper on a coral reef.

....

....

....

....

....

....

....

.... [4]

(ii) Scientists investigated the population of red snapper on a coral reef every month for six months.

Draw a results table for this investigation.

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

[1]

(iii) State **two** biotic factors that affect the population of red snapper on a coral reef.

1 ....

2 ....

[2]

(d) Scientists investigated the effect of an artificial reef on the populations of six fish species. The area did not contain any natural reefs.

They collected data using fish traps from an artificial reef and from an area 150 m away from the artificial reef, which had no reef.

The number of fish caught in each area over 8 hours was recorded.

Table 3.1 shows the results.

Table 3.1

fish species	number of fish caught	
	artificial reef	no reef
P	2	1
Q	6	1
R	137	8
S	45	0
T	129	2
U	0	1

The scientists made the statement:

'The artificial reef has increased the biodiversity of the area.'

(i) Discuss the extent to which the data supports this statement.

....

....

....

....

....

.... [3]

(ii) The artificial reef was built 750 m offshore.

Discuss the possible effects of the artificial reef on the shore.

....

....

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....

....

.... [3]

[Total: 19]

4 In 2016 scientists located a previously unknown coral reef near the mouth of the Amazon River.

Fig. 4.1 shows the location of the mouth of the Amazon River, the coral reef locations, and the extent of the spread of river water as it enters the ocean.
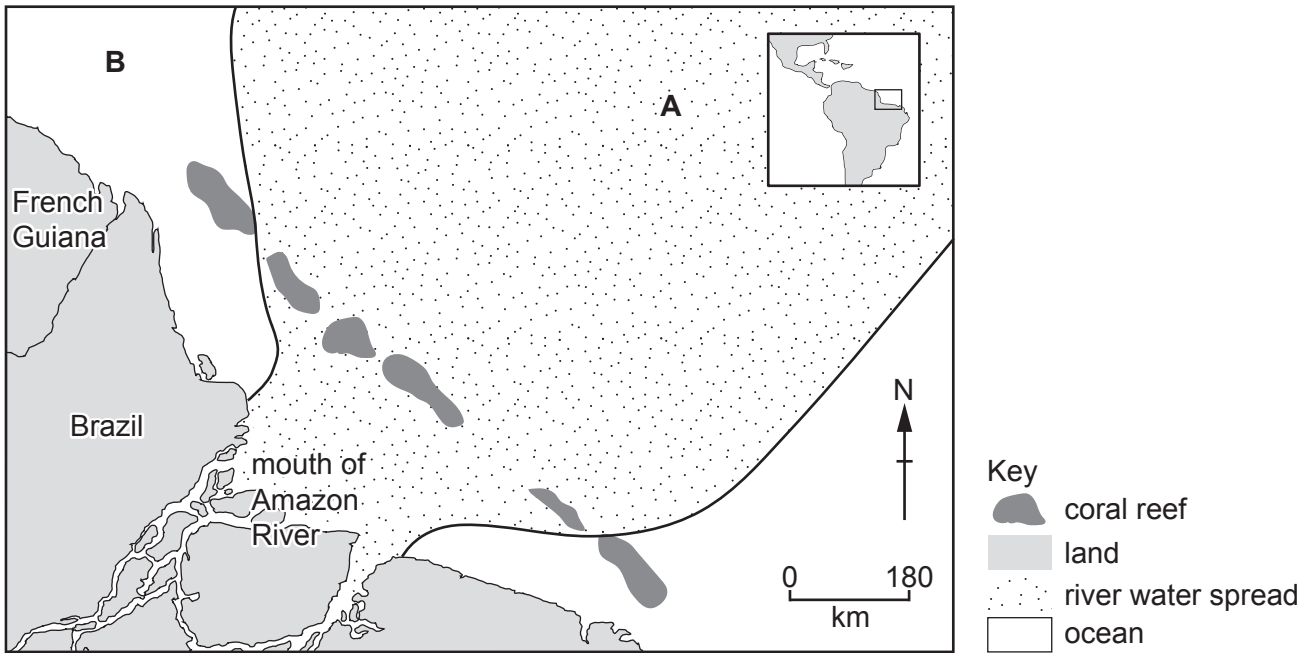

Fig. 4.1

(a) Suggest **and** explain **two** reasons why scientists did not expect coral reefs to grow below the river water spread.

1 ....

....

2 ....

....

[4]

(b) Data were collected on temperature, salinity and dissolved oxygen from the surface down to the benthic region at location **A** and location **B**, which are shown on Fig. 4.1.

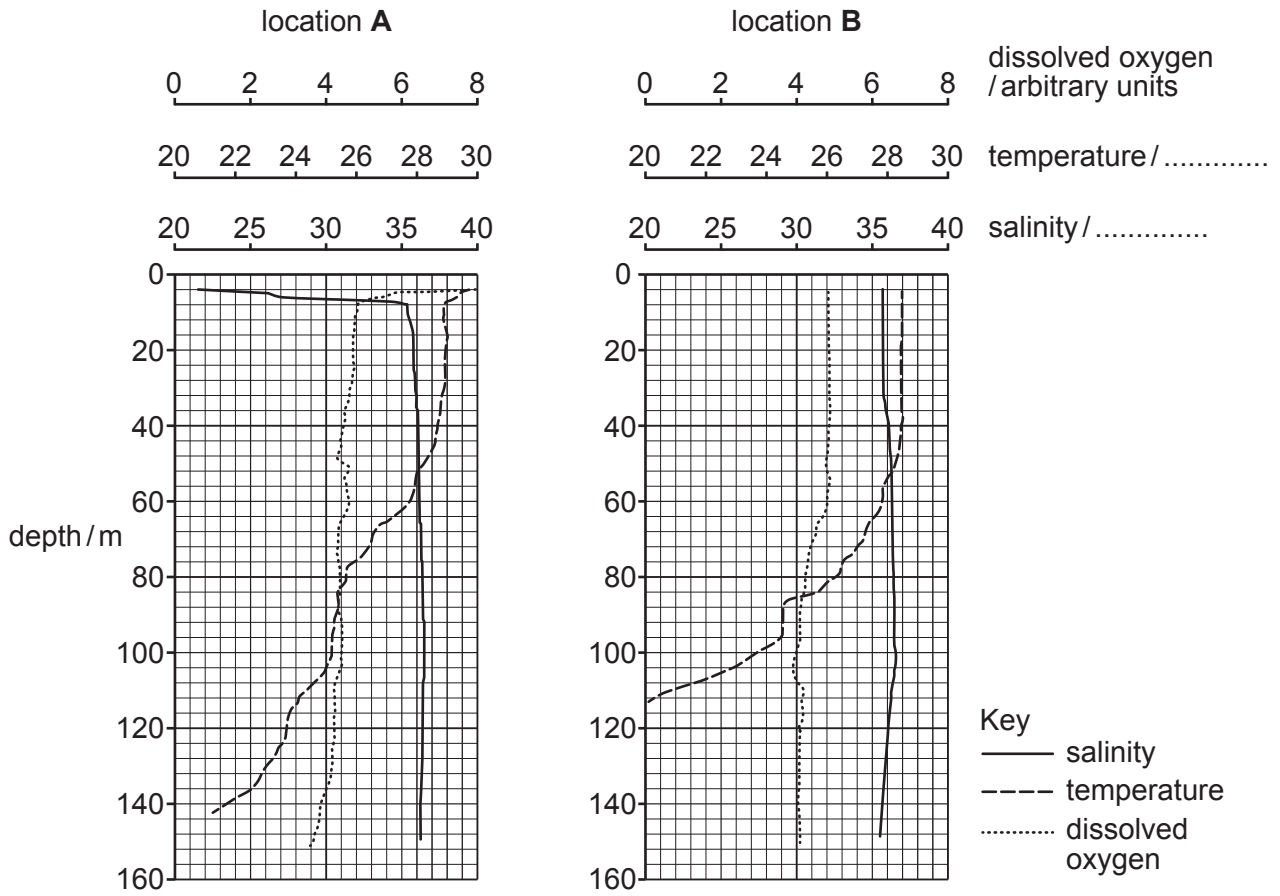Fig. 4.2 shows the data collected from these two locations.

Fig. 4.2

(i) Add the units for temperature **and** salinity to Fig. 4.2. [1]

(ii) Use Fig. 4.2 to describe **and** explain the change in salinity with increasing depth at location **A**.

....

....

....

....

....

....

.... [4]

(iii) Use Fig. 4.2 to compare **and** explain the change in the dissolved oxygen levels between location **A** and location **B**.

....

....

....

....

....

.... [3]

(iv) Suggest why the coral reef was **not** covered in sediment.

....

....

....

.... [2]

(c) (i) The scientists found zooxanthellae in mutualistic symbiosis with the coral polyps.

Explain the terms mutualism and symbiosis.

mutualism ....

....

symbiosis ....

....

[2]

(ii) Suggest why the coral polyps in the reef shown in Fig. 4.1 contain fewer zooxanthellae than in most coral reefs.

....

.... [1]

(iii) Explain how the coral polyps obtain enough nutrients when they contain few zooxanthellae.

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.... [3]

[Total: 20]