Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

0940876115

MARINE SCIENCE **9693/41**

Paper 4 A Level Data-handling and Investigative Skills **May/June 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 **20** pages. Any blank pages are indicated.

[Turn over

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Answer **all** questions.

1 Fig. 1.1 shows a diagram of a cell from the leaf of a species of seagrass.

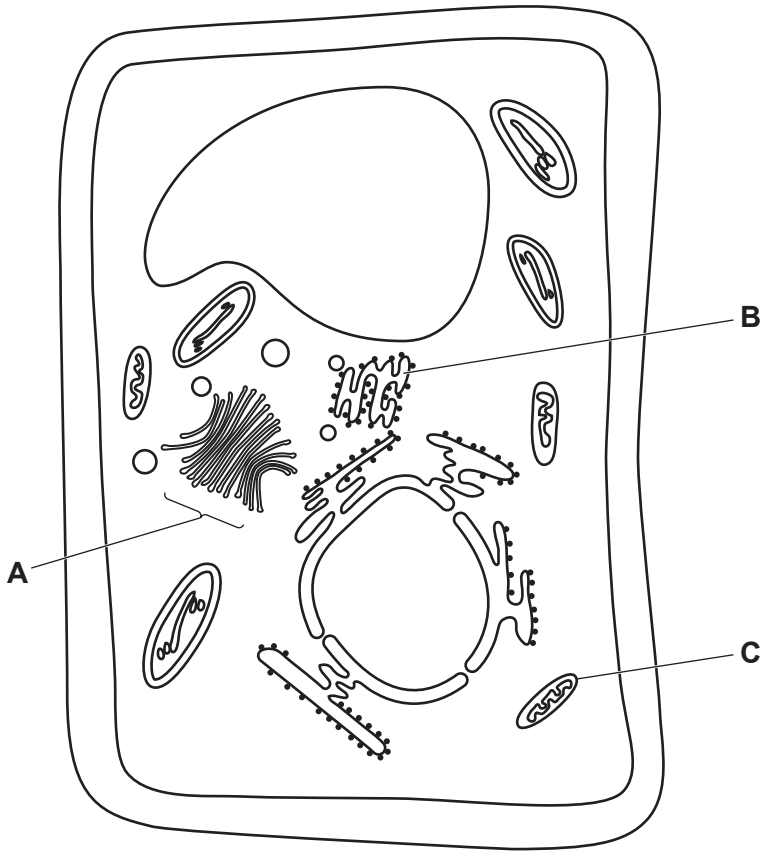

Fig. 1.1

(a) (i) Give the names of the structures labelled **A** and **B**.

A .....

B .....
[2]

(ii) The magnification of the diagram is × 5000.

Calculate the maximum length of the structure labelled **C**.

Show your working.

State the unit.

.....
[3]

(b) The effect of salinity on the growth of seagrass leaves was investigated.

Seagrass plants were placed in different salinities for two weeks.

The increase in length of 9 leaves at each of the salinities was measured.

The mean rate of leaf growth per day was then calculated.

The results are shown in Fig. 1.2.

The error bars represent ± 1 standard deviation.

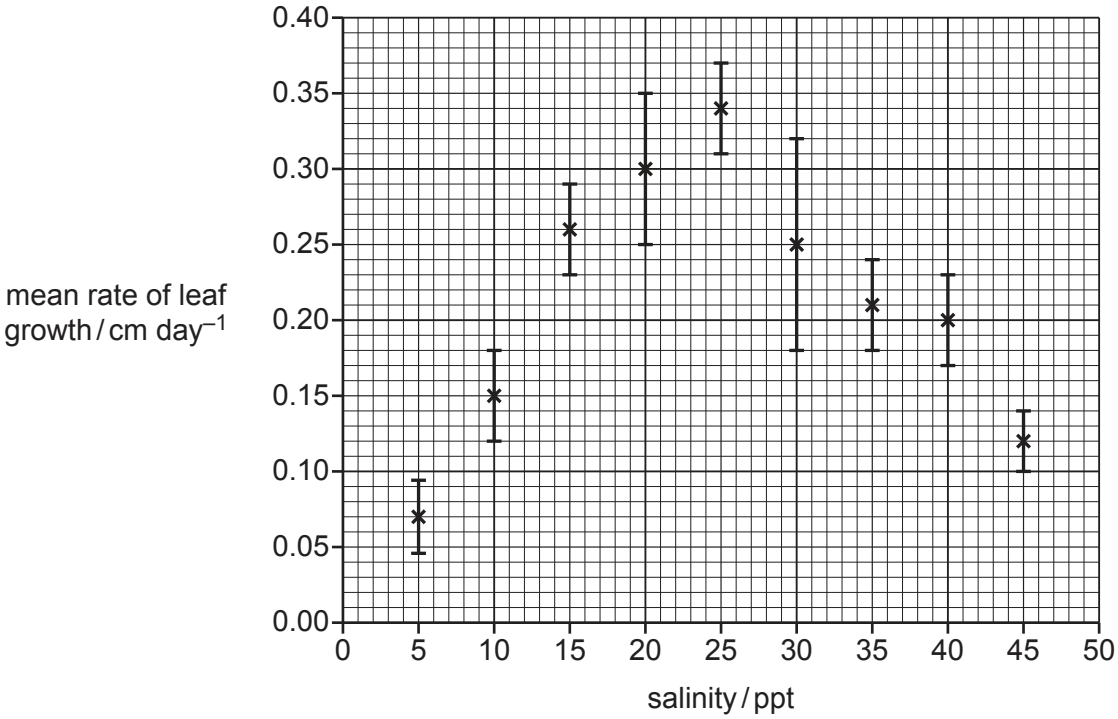

Fig. 1.2

(i) Describe the effect of increasing salinity on the mean rate of leaf growth per day.

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..... [2]

(ii) A student concluded that the results show that the optimum salinity for growth of the seagrass is 25 ppt.

Use the data in Fig. 1.2 to discuss whether their conclusion is correct.

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(iii) Desalination plants are used to produce fresh water from sea water.

Use the information in Fig. 1.2, and your own knowledge, to explain why outflow from a desalination plant might harm seagrass growth.

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..... [4]

[Total: 14]

2 Photosynthesis occurs in chloroplasts.

(a) Fig. 2.1 shows an electron micrograph of a chloroplast.

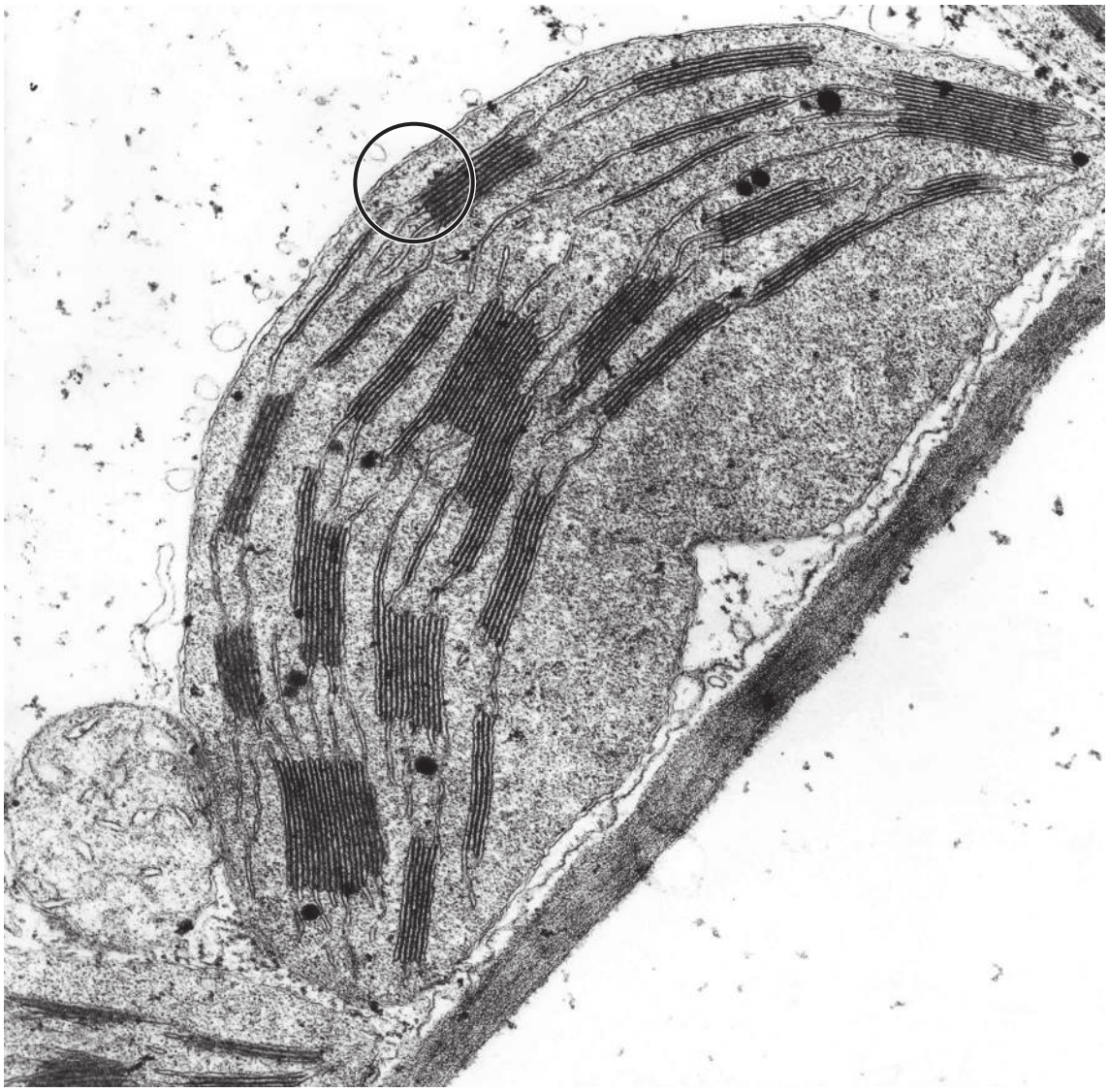

Fig. 2.1

(i) On Fig. 2.1, label the part of the chloroplast where the light-independent stage occurs with the letter X and a label line. [1]

(ii) Make a large drawing of the part of the chloroplast shown in the circle in Fig. 2.1.

Do **not** label your drawing.

[4]

(b) A scientist investigated the effect of different colours of light on the rate of photosynthesis of a species of seaweed.

Normally, NADP is reduced in the light-dependent stage of photosynthesis. In this experiment, a chemical called DCPIP was reduced instead of NADP.

DCPIP is normally blue and becomes colourless when it gains electrons and is reduced.

The scientist used the following method.

- Chloroplasts were extracted and suspended in a solution of saline. Equal volumes of the chloroplast suspension were placed into five test-tubes.
- An equal volume of DCPIP was added to each test-tube. A sixth test-tube containing DCPIP with no chloroplasts was also set up.
- One test-tube containing chloroplasts was wrapped in foil to block light. Each of the other tubes containing chloroplasts were wrapped with coloured cellophane to allow different colours of light to pass through.
- The test-tubes were all exposed to light and the times taken for the DCPIP to become colourless were recorded.
- The experiment was replicated three more times and the mean times taken for the DCPIP to become colourless were calculated.

The results are shown in Table 2.1.

Table 2.1

conditions	mean time taken for the DCPIP to become colourless / s
wrapped in foil	no change
red light	257
blue light	235
green light	758
white light	
no chloroplasts	no change

(i) The times taken for each of the replicates exposed to white light were:

175 s, 183 s, 181 s, 174 s

Calculate the mean time taken for the DCPIP to become colourless when exposed to white light.

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

..... s [2]

(ii) Suggest why the scientist included a test-tube wrapped with foil to block light.

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..... [1]

(iii) Suggest why the scientist included a test-tube with no chloroplasts.

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..... [1]

(iv) Explain the effects of red light, blue light and green light on the mean time taken for the DCPIP to become colourless.

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(v) Many deep-water algae contain accessory pigments in their chloroplasts.

Name **one** of these accessory pigments **and** use the results of the investigation to suggest an explanation for its presence in deep-water algae.

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..... [3]

[Total: 16]

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3 Fig. 3.1 shows tubeworms, *Riftia*, near a hydrothermal vent.

Fig. 3.1

(a) Describe the relationship between *Riftia* and *Endoriftia*.

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..... [3]

(b) Scientists investigated the effects of hydrogen sulfide concentration and water pressure on carbon dioxide uptake from water inside *Riftia*.

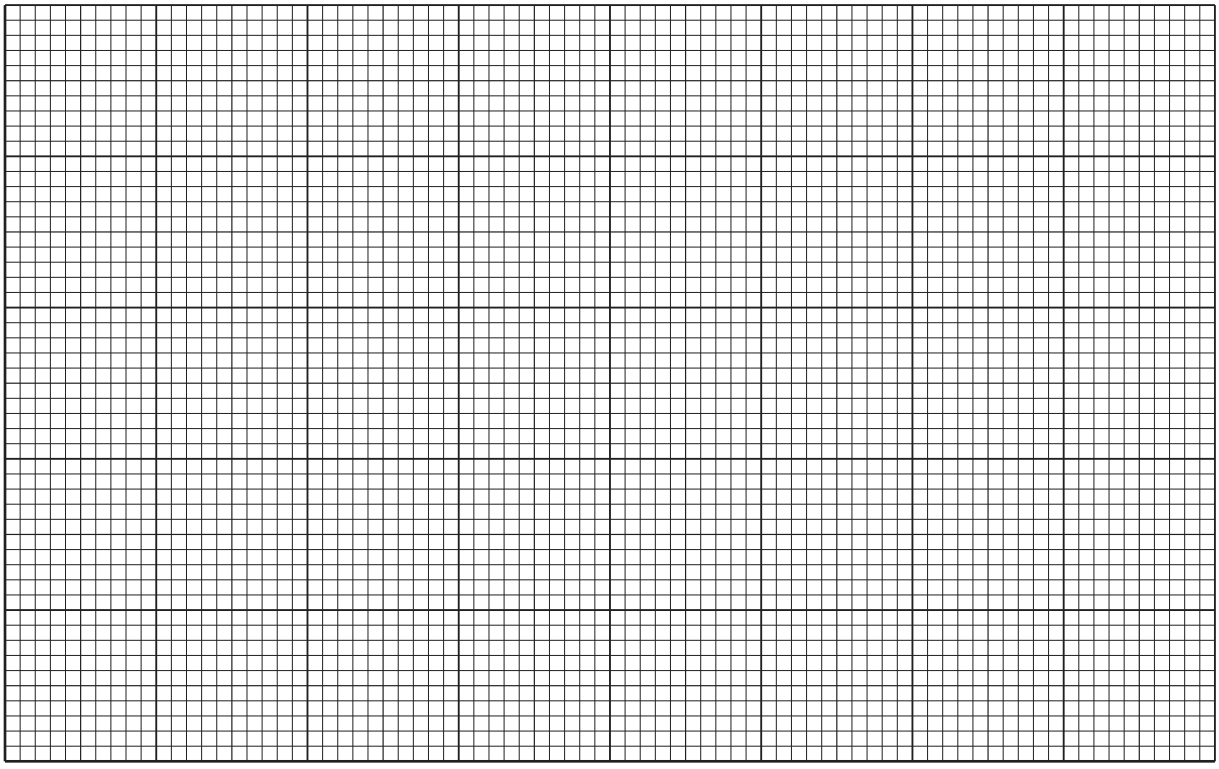
They measured the mean mass of carbon dioxide removed from the water after 60 minutes.

The results are shown in Table 3.1.

Table 3.1

hydrogen sulfide concentration / μmol dm^{-3}	water pressure	mean mass of carbon dioxide removed after 60 minutes / μmol
35	low	1.5
35	high	1.5
65	low	1.8
65	high	1.8
250	low	1.8
250	high	2.2

(i) Draw a bar chart to show the effect of increased hydrogen sulfide concentrations at low and high water pressures on the mean mass of carbon dioxide removed.



[5]

(ii) Discuss the effects of changing the concentration of hydrogen sulfide and water pressure on the mean mass of carbon dioxide removed from the water inside *Riftia*.

Use Table 3.1 and **(b)(i)** to support your answer.

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[Total: 12]

4 Aquaculture is used to produce large quantities of seafood.

(a) Describe how salmon are grown to maturity in sea cages, using extensive aquaculture.

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(b) Table 4.1 shows the estimated environmental impacts of aquaculture of different species.

Biotic depletion is a measure of the mass of wild organisms that are lost due to the aquaculture method.

Table 4.1

species	relative environmental impact per 1000 kg of product			
	phosphate released into ocean / kg	CO_2 released / kg	land loss / km^2	biotic depletion / kg
mussels	–20	2000	0.10	10
salmon	70	100	100	2100
shrimp	80	15 000	1500	1000
seaweed	–70	–150	0.15	2

(i) Calculate the mass of phosphate released by the production of 400 kg of shrimp.

..... kg [1]

(ii) A salmon farmer claimed that salmon aquaculture is better for the environment compared with shrimp aquaculture.

Use Table 4.1 to discuss the farmer's claim.

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(iii) Integrated multi-trophic aquaculture is a method of aquaculture where several species of organism are grown together.

Integrated multi-trophic aquaculture may reduce the negative impacts of aquaculture on the environment.

Use Table 4.1 to suggest why growing mussels and seaweed in a salmon aquaculture system would reduce negative environmental impacts.

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[Total: 12]

5 **(a)** Describe how microplastics are formed.

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(b) A scientist investigated the effect of human population density near coastal areas on the number of microplastic particles in the sand of 12 beaches.

The scientist made the following null hypothesis:

There is no correlation between human population density and the number of microplastic particles.

They carried out a Spearman's rank correlation test on their data. Table 5.1 shows some of their calculations.

Table 5.1

human population density / people per km^2	r_1, rank of human population density	number of microplastic particles per 250 cm^3 sand	r_2, rank of number of microplastic particles	D $(r_1 - r_2)$	D^2
0	1	5	1	0	0
5	2	7	3	–1	1
10	3.5	19	6	–2.5	6.25
15	5	6	2	3	9
155	11	85	11	0	0
75	8.5	75	9.5	–1	1
65	7	25	7	0	0
75	.....	65	8	.....	.....
10	3.5	11	4.5	–1	1
20	6	11	4.5	1.5	2.25
120	10	75	9.5	0.5	0.25
175	12	115	12	0	0
				$\sum D^2$ =	.....

(i) Complete Table 5.1 by determining the missing values.

Write your answers in Table 5.1. [2]

(ii) Use the formula to calculate the Spearman's rank correlation coefficient for the data in Table 5.1.

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

r_S = Spearman's rank correlation coefficient

$\sum$ = sum of (total)

D = difference in rank between each pair of measurements

n = number of pairs of items in the sample

r_S = ... [1]

(iii) Table 5.2 is a critical values table for Spearman's rank correlation coefficient.

Table 5.2

number of pairs, n	r_S (p < 0.05)
5	1.000
6	0.886
7	0.786
8	0.738
9	0.700
10	0.648
11	0.618
12	0.587
13	0.560
14	0.538
15	0.521

Use your calculated value from **(b)(ii)**, and Table 5.2, to assess whether the null hypothesis can be accepted or rejected.

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(c) Use the information in this question to suggest why regularly eating mussels from shores near areas with high human population density may be harmful to humans.

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[Total: 10]

6 Oysters have a complex life cycle with a larval stage and an adult stage. The larvae live in the open water until they settle on a substrate and mature into adults.

It has been suggested that ocean acidification might affect the settling of oyster larvae onto substrates.

Plan an ethical, laboratory investigation that you could do to investigate the effect of changing the pH on the settling of oyster larvae onto a substrate.

Your plan should:

- include a clear statement of the hypothesis
- identify the independent, dependent and standardised variables
- include full details of the method so that another person can follow it
- describe how you would analyse your results
- be safe and ethical.

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