Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

9847453759

MARINE SCIENCE **9693/43**

Paper 4 A 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 **20** pages. Any blank pages are indicated.

[Turn over

Answer **all** questions.

1 Desalination plants are industrial factories that produce fresh water from sea water.

Fig. 1.1 shows a photograph of a desalination plant.

Fig. 1.1

Desalination plants are thought to be harmful to seagrass beds due to the release of highly saline water into the sea.

(a) Fig. 1.2 is a diagram of a cell from a seagrass leaf.

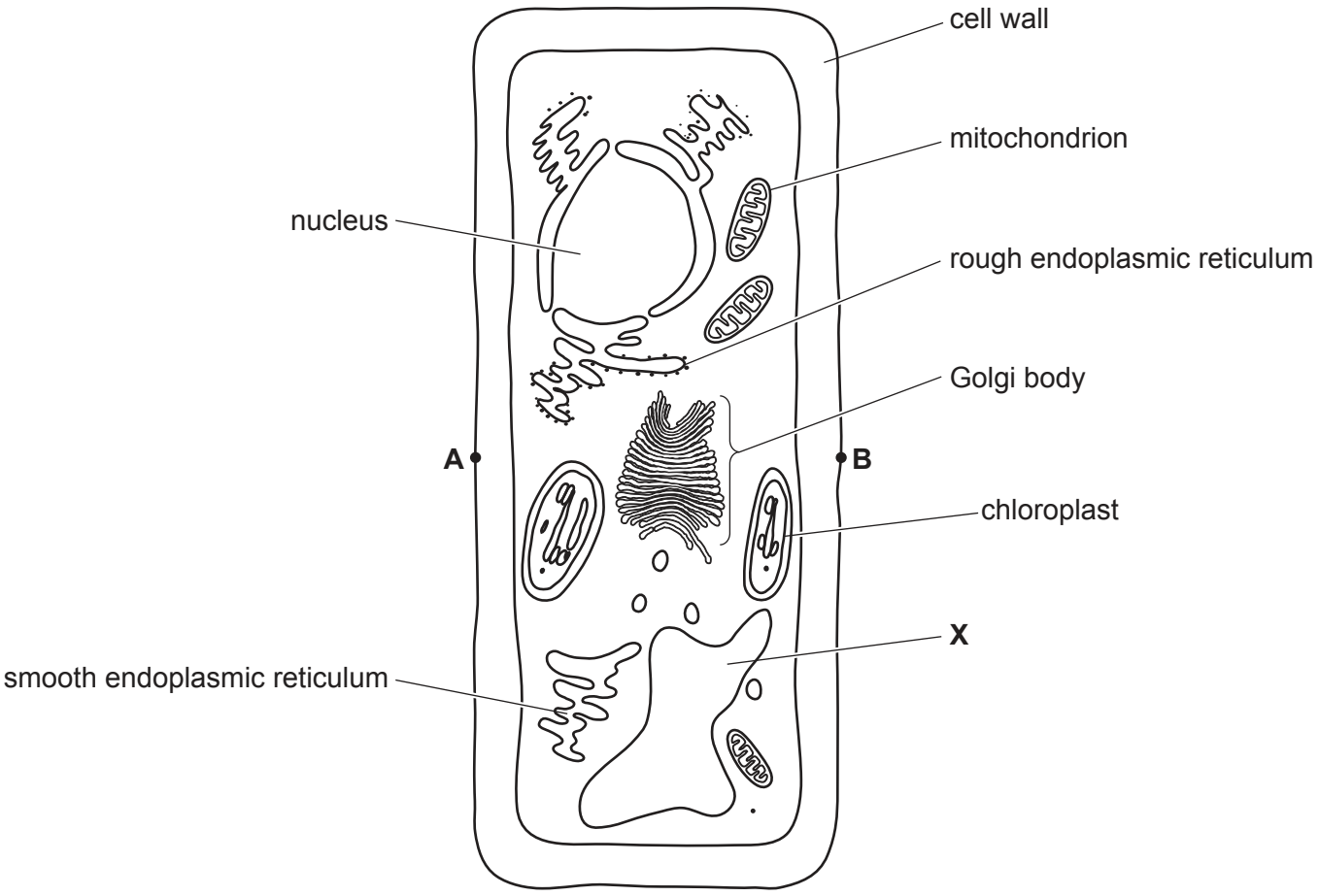

Fig. 1.2

(i) Name the organelle labelled **X** and state its function.

name .....

function .....

.....

[2]

(ii) The diagram has a magnification of × 30 000.

Calculate the actual width of the seagrass cell between **A** and **B** on the diagram.

Show your working.

State the unit.

.....

[3]

(b) Scientists investigated the possible impact of desalination plants on seagrasses. They grew seagrass in water of different salinities and measured:

- the percentage water content of the seagrass cells
- the water potential of the seagrass cells.

The percentage water content of the seagrass cells and the water potential of the seagrass cells were measured at the start, after four weeks and after six weeks. Water potential was measured in kilopascals, kPa.

The results are shown in Fig. 1.3 and Fig. 1.4.

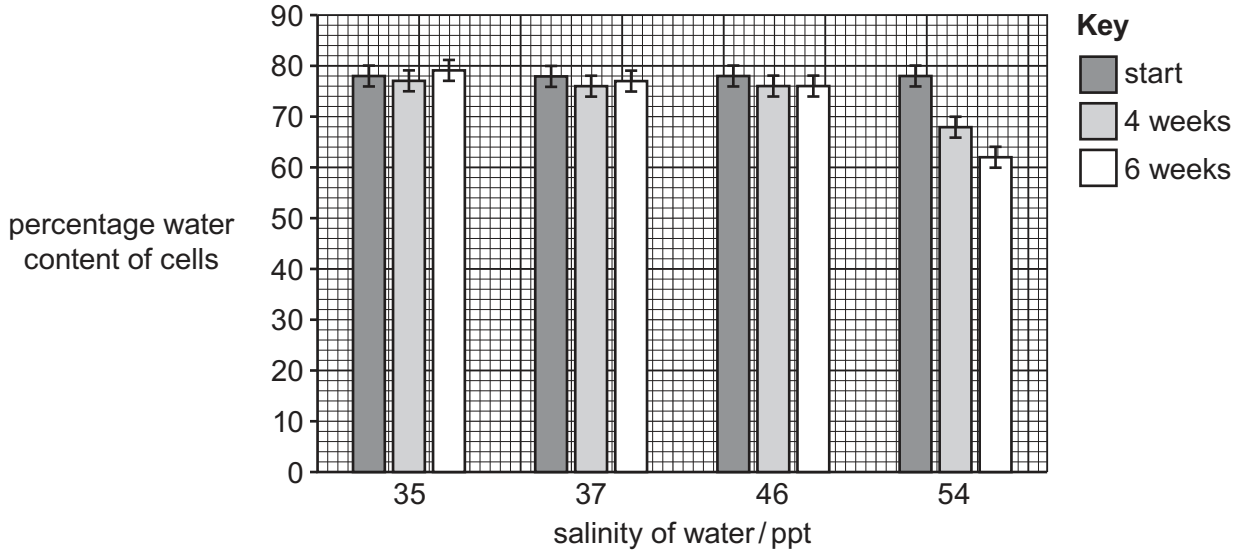

Fig. 1.3

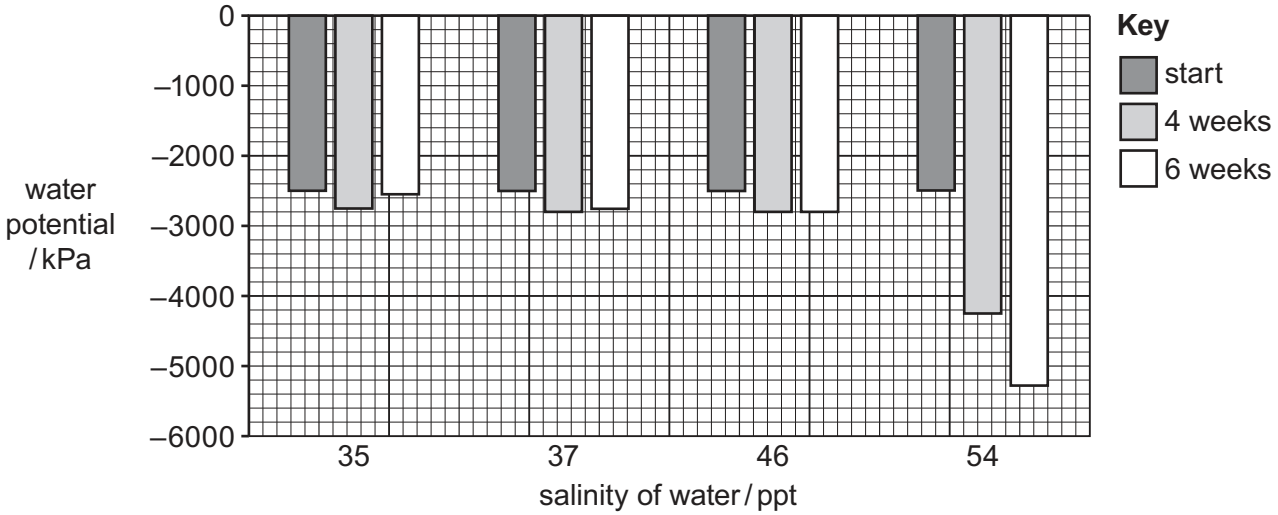

Fig. 1.4

(i) Use the data in **Fig. 1.3** to describe the effect of growing the seagrass in water of different salinities.

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(ii) Use the data in Fig. 1.3 **and** Fig. 1.4 to explain the changes in water potential over time when the seagrass is placed into water of 54 ppt salinity.

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(c) Desalination plants also release toxic heavy metal ions into the sea water.

Explain why the release of heavy metal ions is harmful for top predator organisms in ecosystems.

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..... [3]

[Total: 14]

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2 Organisms require oxygen for aerobic respiration.

(a) Complete the balanced chemical symbol equation for aerobic respiration.

$6O_2$ + ... ⟶ ..... + ...
[2]

(b) Fish obtain oxygen from water by using either pumped ventilation or ram ventilation of their gills.

The rate of oxygen consumption of a tilapia fish using pumped ventilation was determined.

The fish was placed into a tank of water for two hours and the change in oxygen concentration in the water was recorded. The water was enclosed in the tank so no oxygen could diffuse in from the air.

The mass of the tilapia was 0.6 kg.

The mass of oxygen consumed by the tilapia in two hours was 525 mg.

Calculate the rate of oxygen consumption per kilogram of fish per hour.

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

..... $mg\,kg^{-1}\,hr^{-1}$ [2]

(c) Scientists investigated how swimming speed affects the ventilation rate and rate of oxygen consumption of salmon.

The ventilation rate was measured as the number of times the operculum opened in a minute.

A salmon was placed into a transparent plastic tube as shown in Fig. 2.1.

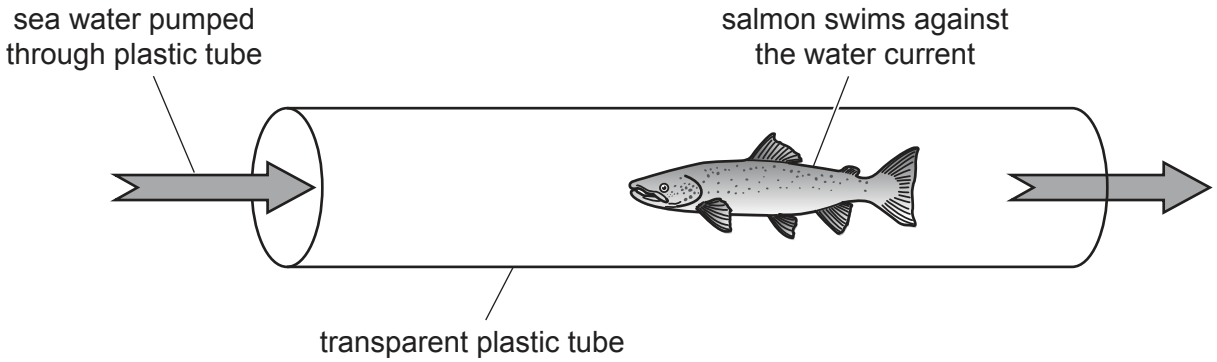


Fig. 2.1

The salmon swam against the water current in the tank. The ventilation rate of the salmon and the rate of oxygen consumption by the salmon were determined at different water current speeds.

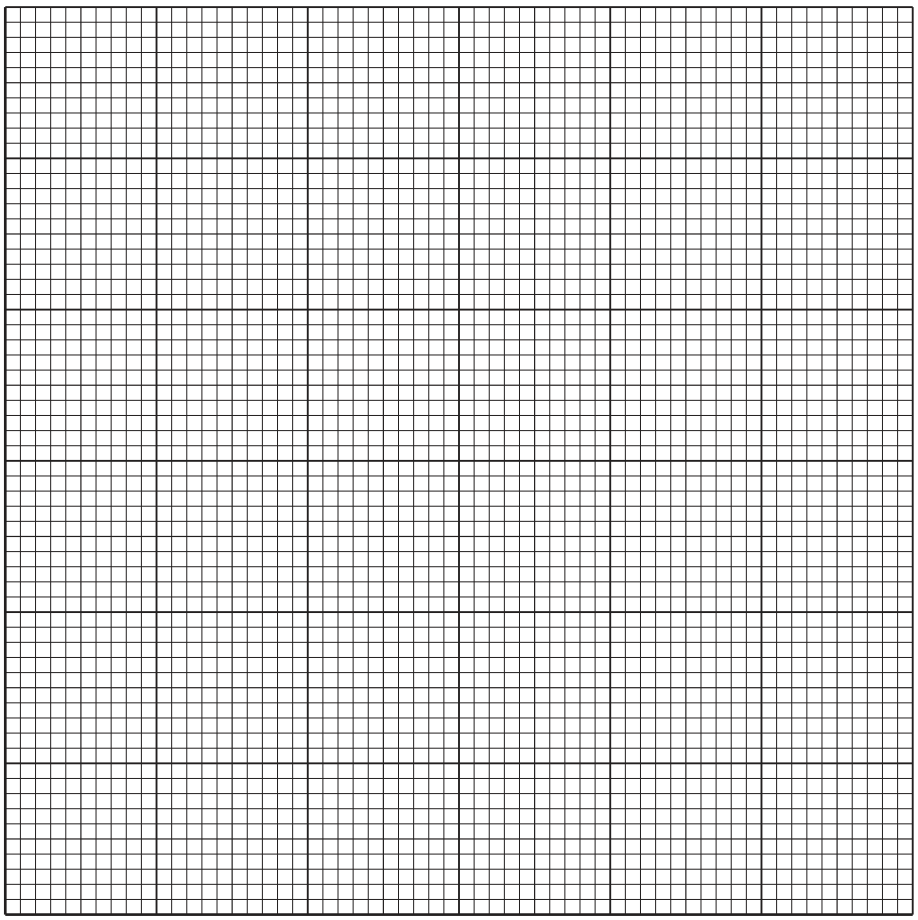
The results are shown in Table 2.1.

Table 2.1

water current speed / $cm\,s^{-1}$	rate of oxygen consumption / $mg\,kg^{-1}\,hr^{-1}$	ventilation rate / operculum openings per minute
0	112	42
5	116	45
10	117	47
15	120	49
20	105	0
25	107	0
30	109	0

(i) Draw a graph of the rate of oxygen consumption **and** the ventilation rate of the salmon at the different water current speeds shown in Table 2.1.

Join your points with straight ruled lines.



[6]

(ii) Describe the effect of increasing water current speed on the rate of oxygen consumption **and** ventilation rate of the salmon.

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..... [2]

(iii) The salmon swims at the same speed as the water current speed.

Use the information in Table 2.1 and your graph in **(c)(i)** to suggest explanations for the effect of the water current speed on the rate of oxygen consumption **and** ventilation rate of the salmon.

You should refer to ram ventilation **and** pumped ventilation in your answer.

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..... [4]

[Total: 16]

3 Salmon are grown commercially around coastal areas using extensive aquaculture systems called salmon farms.

(a) Outline the process of salmon aquaculture in extensive systems.

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(b) Scientists investigated the escape of salmon from salmon farms into the wild.

Farmed salmon are fed food pellets that contain a dye. The dye accumulates in the body tissues of the salmon.

Salmon were caught by rod-and-line from rivers and areas of sea close to a salmon farm.

Salmon that had escaped from the salmon farm were identified by the presence of the dye in their body tissues.

Fig. 3.1 shows the percentage of female salmon caught that had escaped from the salmon farm from 2000 to 2005.

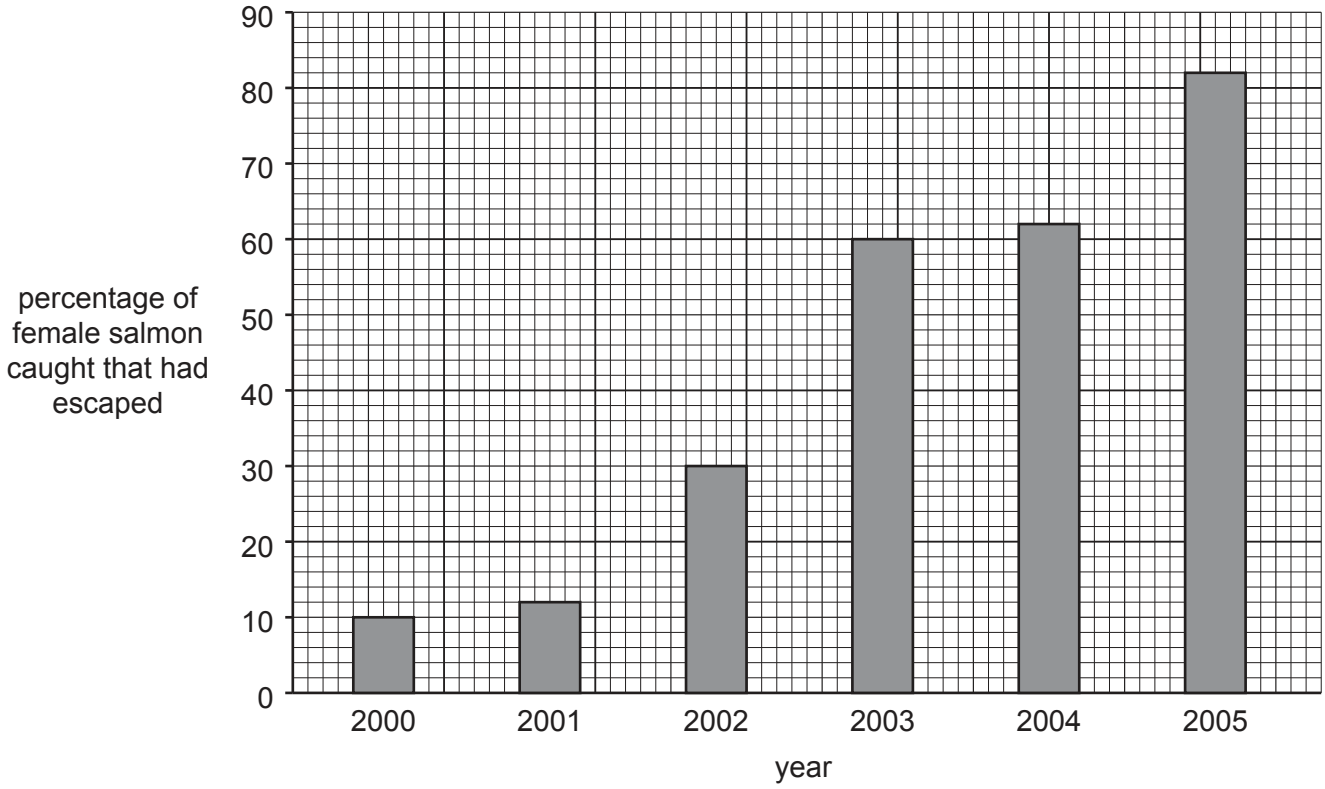

Fig. 3.1

(i) In 2005, a total of 53 female salmon were caught.

Use Fig. 3.1 to calculate the number of female salmon caught that had escaped from the salmon farm.

..... [1]

(ii) Suggest why the percentage of female salmon caught that had escaped increased from 2000 to 2005.

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..... [2]

(c) In the wild, salmon lay eggs in the upstream areas of rivers. They lay the eggs in nests called redds. In 2005, the scientists investigated the presence of eggs produced by escaped salmon in rivers near the salmon farm.

The scientists also took samples of the fertilised eggs and determined the percentage that hatched and developed into fish fry.

They identified the eggs from female salmon that had escaped by the presence of the food dye. They also measured the range of concentration of dye in the eggs from each redd.

The results are shown in Table 3.1.

Table 3.1

redds	number of redds	percentage of eggs that developed into fish fry	range of dye concentration in eggs
redds with eggs containing dye	9	83	3.6% to 55%
redds with eggs not containing dye	11	98	N/A

(i) Suggest a reason for the range of dye concentration in the eggs laid by the escaped salmon.

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..... [1]

(ii) Discuss the impacts of the escaped salmon on the wild salmon populations.

Use the information in Fig. 3.1 **and** Table 3.1 to support your answer.

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(iii) Suggest why the information in Table 3.1 may be insufficient to make a firm conclusion on the impact of escaped salmon on wild salmon populations.

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[Total: 14]

4 Mangrove forests are areas of environmental importance. Replanting mangroves has been suggested as a method to increase the biodiversity of the areas they are grown in.

(a) Fig. 4.1 shows a section through a leaf from a holly mangrove bush.

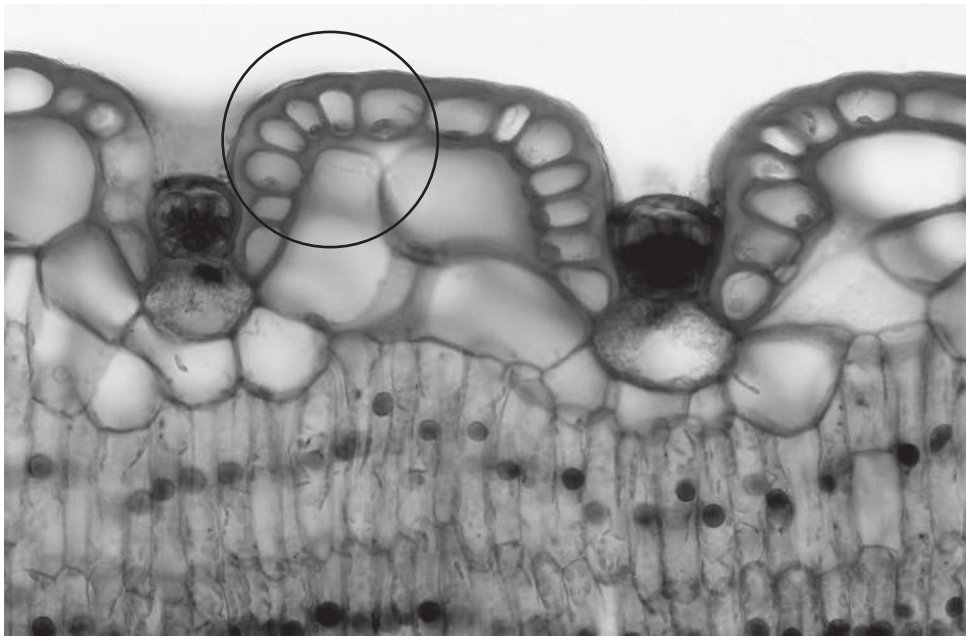

Fig. 4.1

Make a large drawing of the part of the mangrove leaf in the circle in Fig. 4.1.

Do **not** label your drawing.

[4]

(b) A student investigated if the size of mangrove forests affects biodiversity.

The student collected data from different-sized areas of mangrove forest. The student then carried out a Spearman's rank correlation coefficient test to test the null hypothesis. The null hypothesis was that there was no correlation between the area of mangrove forest and Simpson's index of diversity of organisms.

Table 4.1 shows the results.

Table 4.1

area of mangrove forest / km^2	rank of area of forest (r_1)	Simpson's index of diversity	rank of Simpson's index of diversity (r_2)	D (r_1–r_2)	D^2
0.02	8	0.44	7	1	1
0.04	5.5	0.56	5	0.5	0.25
0.02		0.34	10		
0.11	1	0.82	1	0	0
0.02		0.38	8		
0.05	4	0.61	3	1	1
0.06	3	0.58	4	–1	1
0.09	2	0.75	2	0	0
0.01	10	0.35	9	1	1
0.04	5.5	0.54	6	–0.5	0.25
					ΣD^2 = ...

(i) Complete Table 4.1 to calculate the value of ΣD^2.

[2]

(ii) Use your answer to **(b)(i)** and the formula to calculate the Spearman's rank correlation coefficient, r_s.

Give your answer to **three** decimal places.

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

Σ = sum of (total)

n = number of pairs of items in the sample

D = difference in rank between each pair of measurements

..... [2]

(iii) Table 4.2 is a critical values table for Spearman's rank correlation coefficient.

Table 4.2

number of paired items, *n*	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

Use your answer to **(b)(ii)** and Table 4.2 to evaluate the null hypothesis.

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..... [3]

(iv) Suggest why the size of the area of mangrove forest affects the Simpson's index of diversity.

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..... [2]

(c) In a further study in a coastal area of Indonesia, local people were asked to complete a questionnaire about how willing they were to take part in replanting mangroves. The results of the questionnaire are shown in Table 4.3.

Table 4.3

question	percentage of people with response / %				
	strongly disagree	**disagree**	**unsure**	**agree**	**strongly agree**
Are you willing to participate in mangrove replanting in the area?	12	12	0	40	36
Do you currently volunteer to help mangrove replanting?	38	42	8	7	5
Should you have appropriate pay if you participate in the mangrove replanting?	9	18	3	44	26
Do you have skills in mangrove replanting?	35	28	5	18	14

Use the results of the questionnaire in Table 4.3 to discuss how a government could successfully engage local communities in replanting mangrove forests.

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[Total: 16]

5 The rate of photosynthesis of producer organisms can be affected by many abiotic and biotic factors.

(a) The light-dependent stage of photosynthesis occurs in the lamellae of chloroplasts.

(i) Give the **two** products of the light-dependent stage that are used in the light-independent stage.

1 .....

2 .....
[2]

(ii) Fig. 5.1 shows the absorption spectra for the photosynthetic pigments extracted from two different species of alga, species **A** and species **B**.

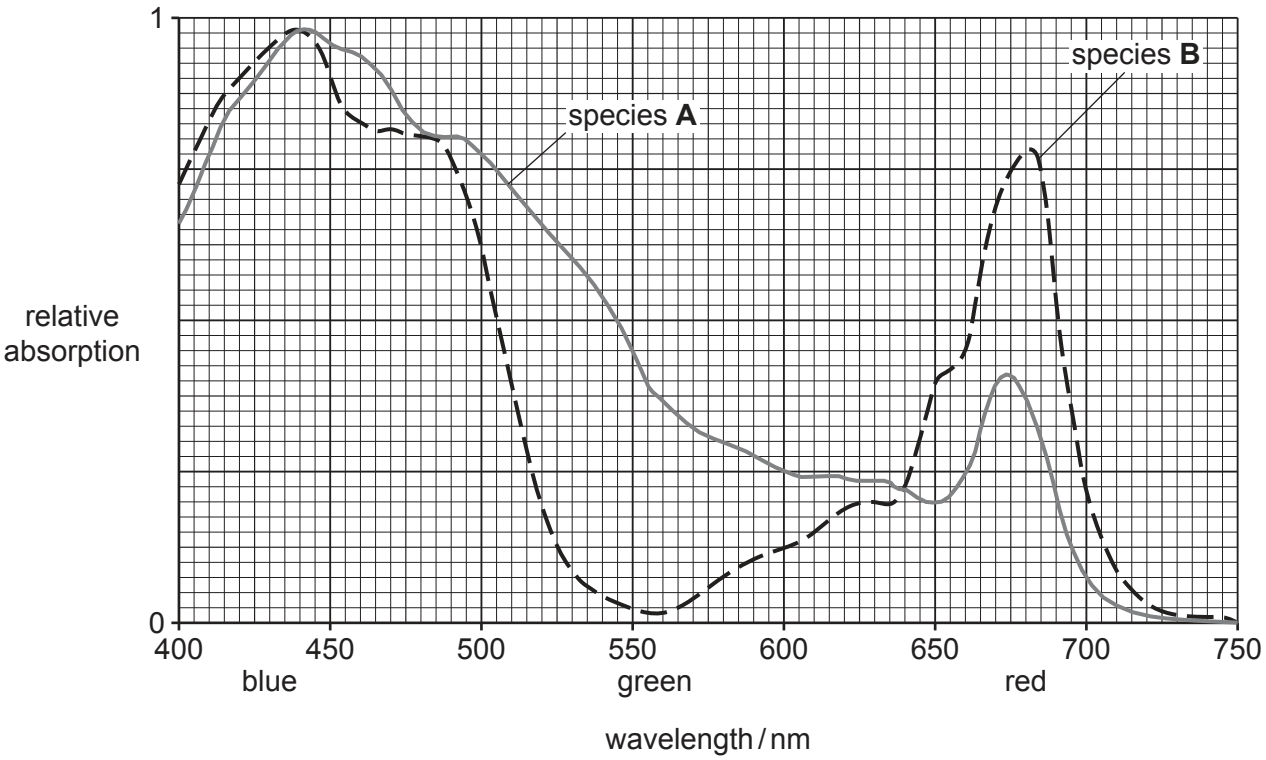

Fig. 5.1

Use Fig. 5.1 to explain which one of the two species of alga is adapted to live in deeper water.

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..... [2]

(b) Atrazine is a weedkiller used in agriculture in some parts of the world. Atrazine is a toxic chemical that inhibits the light-dependent stage of photosynthesis.

There have been concerns that atrazine can cause pollution due to its being washed into rivers and coastal waters.

Plan a laboratory investigation that you could do to investigate the effect of changing the concentration of weedkiller on the rate of photosynthesis of an aquatic plant.

You are provided with a 1% stock solution of atrazine.

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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[Total: 15]