Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

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0123456789

MARINE SCIENCE **9693/04**

Paper 4 A Level Data-handling and Investigative Skills **For examination from 2022**

SPECIMEN PAPER **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. Blank pages are indicated.

Answer **all** questions.

1 Rock lobsters are caught commercially in areas of sea around New Zealand. In 1990, to conserve stocks, the fisheries ministry placed an annual quota on the mass of rock lobsters that could be caught from an area. They monitored the success of the quotas by determining the catch per unit effort (CPUE) each year.

The CPUE was calculated each year by determining the mean mass of rock lobsters caught in a trap.

The results are shown in Table 1.1.

Table 1.1

year	annual quota / tonnes	CPUE / kg trap^{-1}
1980	unlimited catches	1.20
1985	unlimited catches	0.85
1990	400	0.70
1995	300	0.50
2000	250	0.85
2005	250	1.35
2010	275	1.50
2015	300	

(a) (i) In 2015, 230 000 pots were used.

1 tonne = 1000 kg

Calculate the CPUE for 2015.

Give your answer to the appropriate number of significant figures.

Include the unit.

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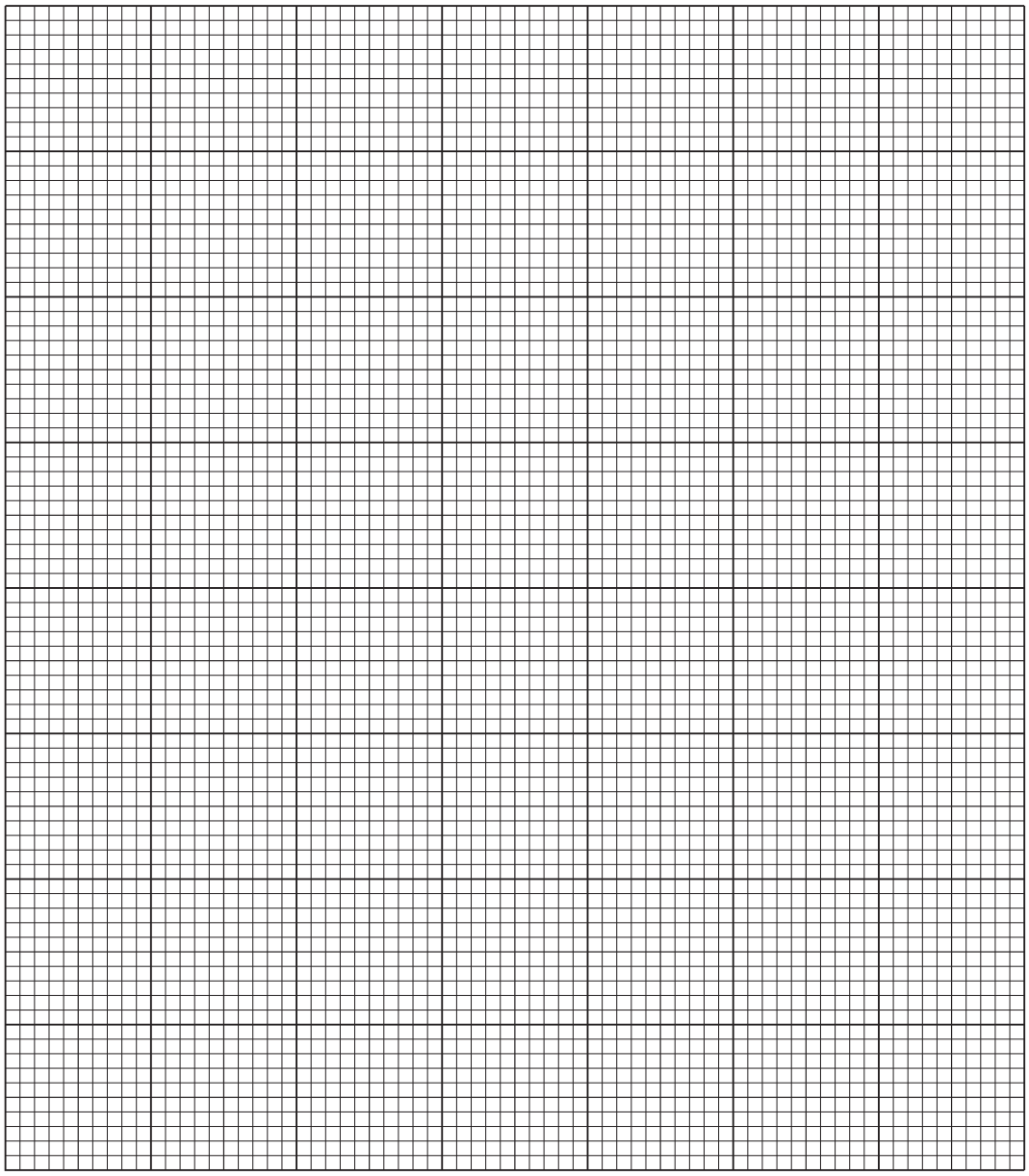
(ii) Plot a graph to show the changes in annual quota and CPUE between 1980 and 2015.

Do **not** plot the annual quota for 1980 and 1985.

Use a sharp pencil.



[5]

(iii) Describe the changes in CPUE between 1980 and 2010.

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(iv) Use the data in Table 1.1 and your graph to discuss the evidence that the use of annual quotas has allowed stocks of rock lobster to recover.

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(b) Describe how consumer-orientated tools can be used to preserve fish stocks.

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[Total: 17]

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2 Rainbow trout, *Oncorhynchus mykiss*, is a species of cold-water fish. Part of their life cycle is spent in fresh water rivers and part is spent in sea water.

Fig. 2.1 shows a rainbow trout.

Fig. 2.1

Rainbow trout use pumped and ram ventilation. They use pumped ventilation when swimming at slow speeds and ram ventilation when swimming at higher speeds.

(a) Outline the process of pumped ventilation.

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(b) Scientists think that rainbow trout may alter the rate of pumped ventilation in response to different temperatures. This may be because temperature affects the rate of cellular respiration.

The rate of ventilation of the rainbow trout can be measured by the rate at which the operculum opens and closes.

Plan an ethical investigation that you could do to investigate the effect of changing the temperature on the rate of ventilation.

Your plan should:

- include a clear statement of the hypothesis
- identify the key variables
- include full details of the method
- describe how you would analyse your results
- be safe and ethical.

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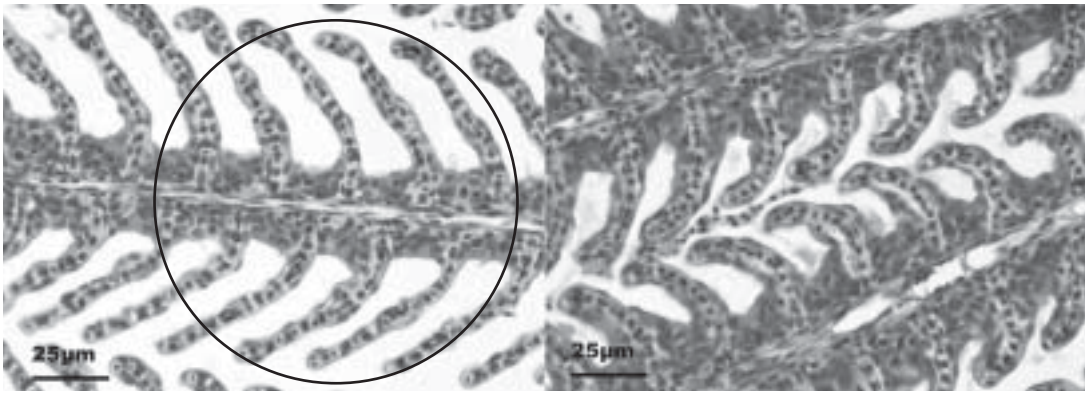
(c) Chemicals called anionic polymers are sometimes added to soil to prevent soil erosion around rivers and estuaries. Scientists investigated the effect of these anionic polymers on the gill lamellae of rainbow trout.

Fig. 2.2 shows light micrographs of the gill lamellae from rainbow trout kept in clean water, **A**, and water containing anionic polymers, **B**.



A **B**

Fig. 2.2

(i) Draw, with a magnification of ×2, the area of gill lamellae within the circle shown in Fig. 2.2. Show the details within only **one** of the lamellae.

Do **not** label your drawing.

Use a sharp pencil.

[4]

(ii) Use the information in Fig. 2.2 to suggest why the anionic polymers may adversely affect trout.

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[Total: 21]

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3 **(a)** Fig. 3.1 shows the mass of carbon dioxide that is removed and released into the atmosphere in one year by some of the processes in the carbon cycle.

All figures are $\times 10^{12}$ kg of carbon dioxide.

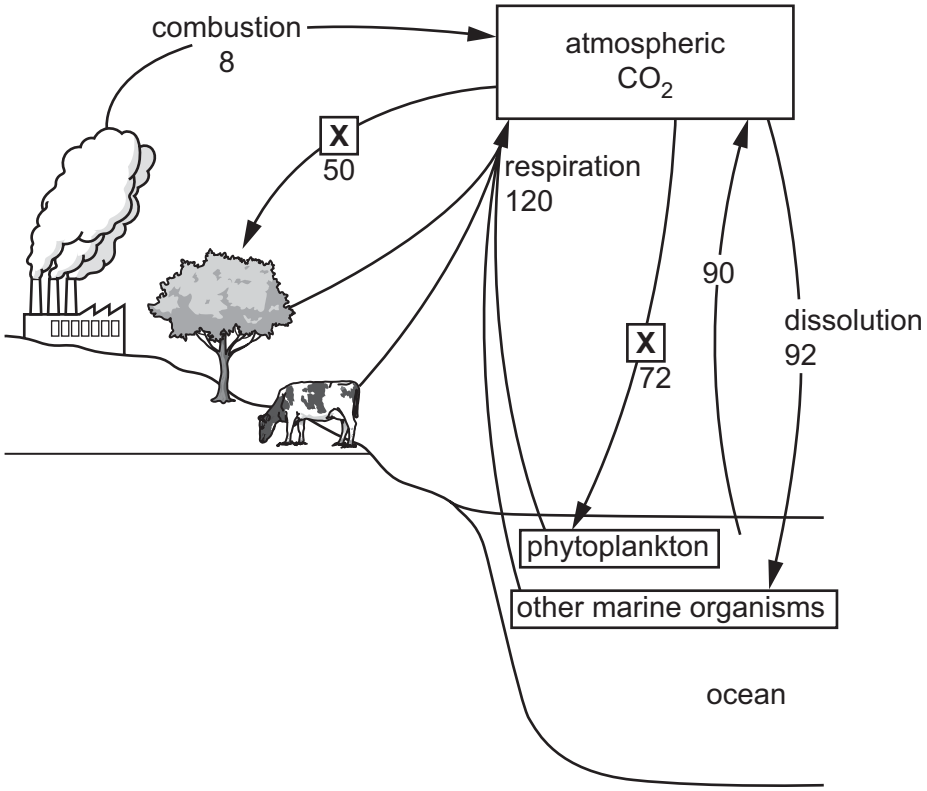

Fig. 3.1

(i) Name the process labelled **X** in Fig. 3.1.

..... [1]

(ii) Use Fig. 3.1 to calculate the percentage change in atmospheric carbon dioxide in one year if the starting mass of atmospheric carbon dioxide is 750×10^{12} kg.

.....% [3]

(iii) With reference to Fig. 3.1, predict **and** explain how increased combustion would affect the pH of sea water.

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..... [2]

(b) A student investigated the effect of pH on the loss of mass of bivalve mollusc shells.

They measured the mass of each shell and made up solutions, each with a different pH. One shell was placed into each solution for three weeks and then its mass measured again.

The student then carried out the Spearman's rank correlation test to determine whether there was a significant correlation between pH and the decrease in mass of the shells.

The results of the experiment, and their rankings, are shown in Table 3.1.

Table 3.1

pH of solution	rank pH	decrease in mass of shell / g	rank decrease mass of shell	D	D^2
1	1	3.35	7	–6	36
2	2	3.37	6	–4	16
3	3	3.10	5	–2	4
4	4	2.71			
5	5	2.71			
6	6	0.42	2	4	16
7	7	0.10	1	6	36
				ΣD^2 =	

Σ = sum of (total)
D = difference in rank between each pair of measurements

(i) Complete Table 3.1. [2]

(ii) State a null hypothesis for this experiment.

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..... [1]

(iii) Use the formula to calculate the Spearman's rank correlation coefficient for the data in Table 3.1.

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

r_S = Spearman's rank correlation coefficient

Σ = sum of (total)

D = difference in rank between each pair of measurements

n = number of pairs of items in the sample

..... [1]

(iv) Table 3.2 is a critical values table for Spearman's rank correlation coefficient.

Table 3.2

number of pairs, *n*	r_S (P < 0.05)
5	1.000
6	0.886
7	0.786
8	0.700
9	0.648
10	0.618
11	0.587

Use your calculated value from **3(b)(iii)**, and Table 3.2, to determine whether there is a significant correlation between pH and decrease in mass of shells.

Justify your conclusion.

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(v) Suggest how the student could modify the experiment to increase confidence in their conclusion.

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..... [2]

[Total: 15]

4 Scientists investigated how temperature and the addition of hydrogen sulfide affected carbon fixation by chemosynthetic bacteria taken from the sea bed.

(a) (i) Explain why chemosynthetic bacteria are important to hydrothermal vent food webs.

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..... [2]

(ii) The equation for one type of chemosynthesis is:

$$12H_2S + 6CO_2 \rightarrow C_6H_{12}O_6 + 6H_2O + 12S$$

Use this equation and your own knowledge to compare this type of chemosynthesis with photosynthesis.

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(b) Samples of bacteria taken from the sea bed were placed into beakers and provided with carbon dioxide. Samples were incubated at 15 °C, 50 °C, 60 °C and 80 °C for 24 hours in the dark. The mean rate of carbon fixation was then determined.

The experiment was repeated with samples that had hydrogen sulfide added.

The results are shown in Fig. 4.1.

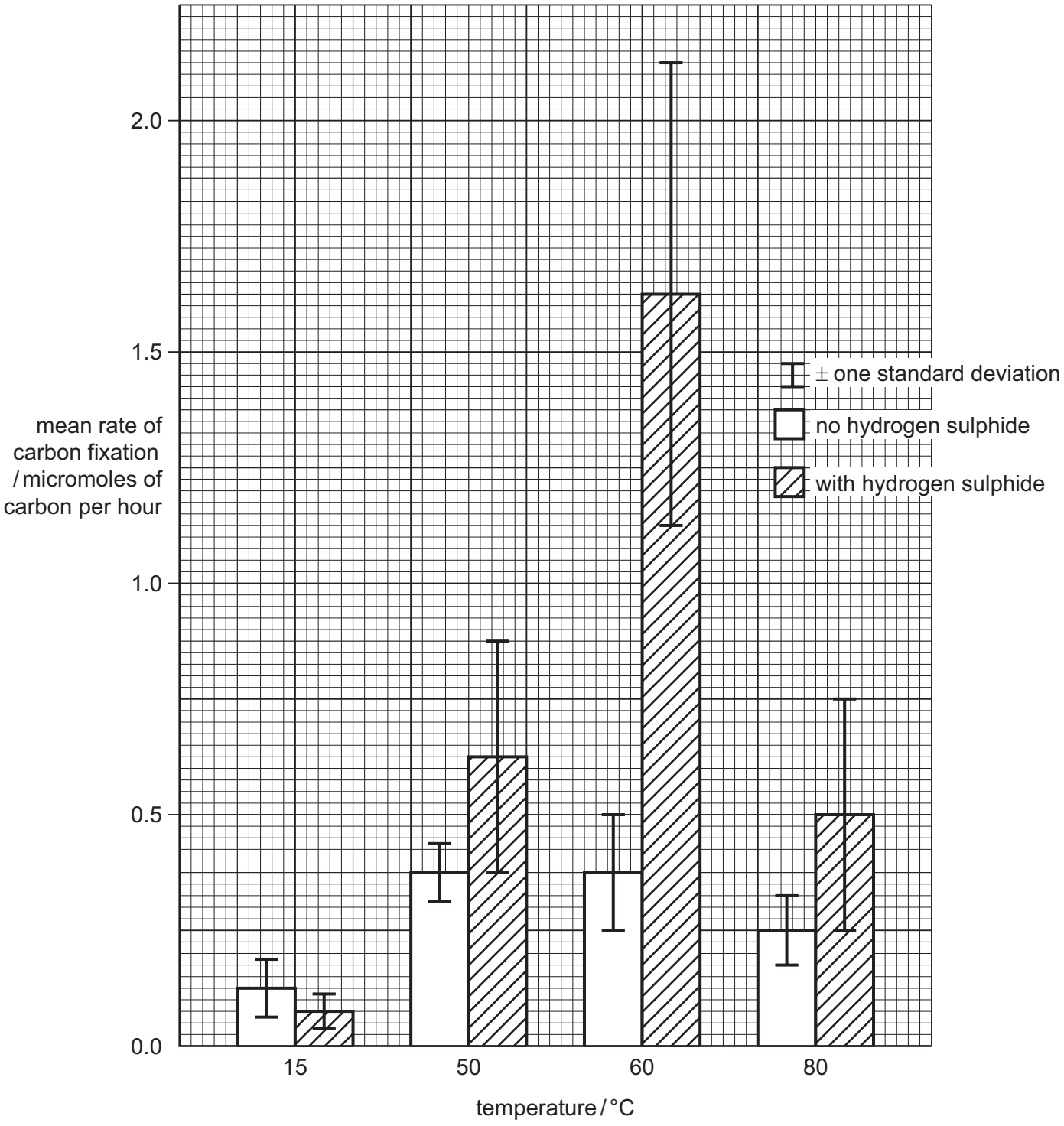

Fig. 4.1

(i) Suggest why the samples were incubated in the dark.

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(ii) Use data from Fig. 4.1 to describe the effect of increasing temperature on the rate of carbon fixation when hydrogen sulfide is added.

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(iii) The scientists added error bars on their graph to represent the standard deviation of the results.

Use Fig. 4.1 to discuss whether the addition of hydrogen sulfide increased the rate of carbon fixation.

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..... [3]

[Total: 13]

[Turn over

5 The effect of different salinities on a killifish, *Fundulus heteroclitus*, was investigated.

Killifish are euryhaline, osmoregulatory fish.

(a) State the meaning of euryhaline and osmoregulator.

euryhaline .....

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osmoregulator .....

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[2]

Fig. 5.1 shows a diagram of an osmoregulatory cell taken from the gill of a killifish that had been placed in water with a salinity of 35 parts per thousand (ppt).

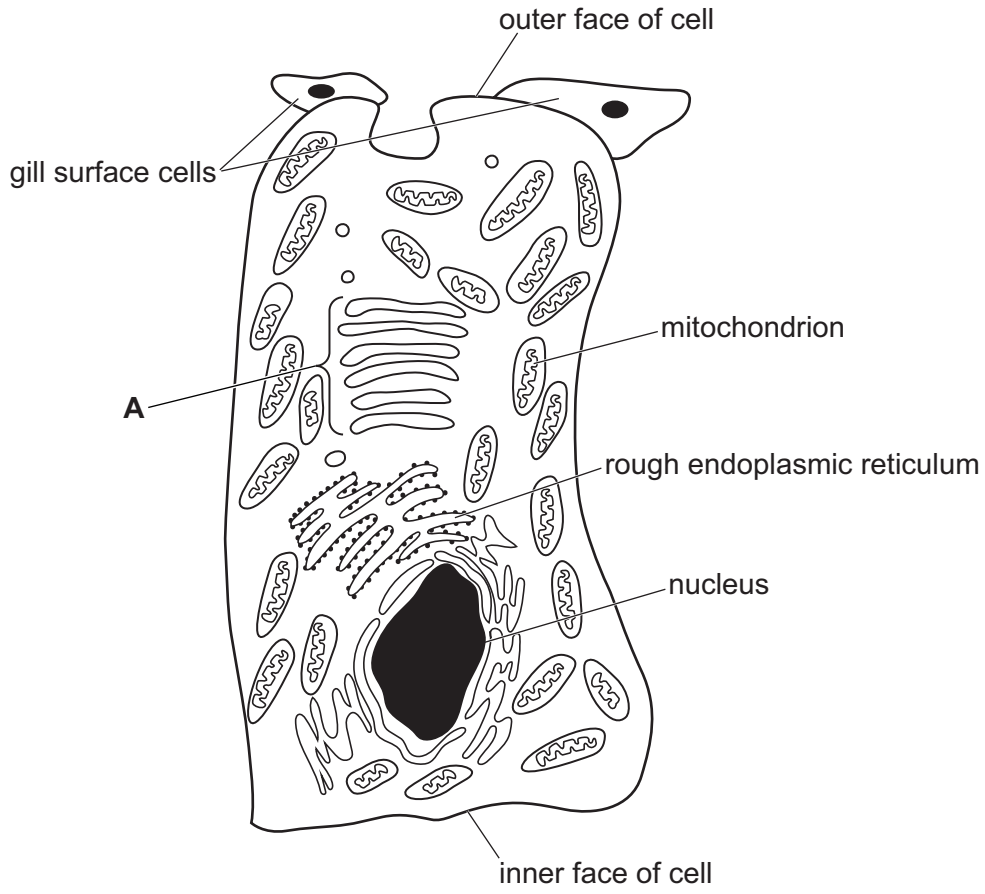

Fig. 5.1

(b) (i) State the name and function of structure **A** in Fig. 5.1.

name .....

function .....

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[2]

(ii) Use the information shown in Fig. 5.1 to suggest how the cell is adapted for its function as an osmoregulatory cell.

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(c) The scientists compared the number of these osmoregulatory cells found in the gills of killifish that had been placed in salinities of 50 ppt, 35 ppt and 15 ppt.

The results are shown in Table 5.1.

Table 5.1

salinity / ppt	osmoregulatory cell density / cells per mm^2
50	320
35	210
15	260

Suggest an explanation for the differences in osmoregulatory cell densities.

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[Total: 9]

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