Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

MARINE SCIENCE **9693/42**

Paper 4 A Level Data-handling and Investigative Skills **May/June 2025**

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.

[Turn over

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Answer **all** questions.

1 **(a)** Fig. 1.1 shows a light micrograph of some leaf cells from an aquatic plant.

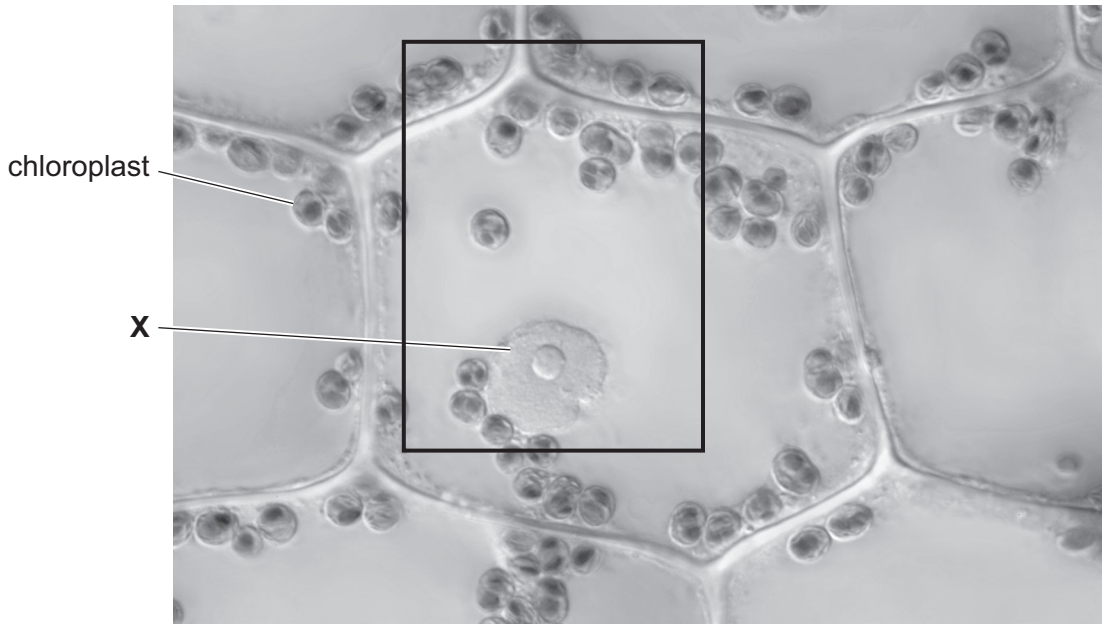

Fig. 1.1

(i) Name the structure labelled **X** in Fig. 1.1.

..... [1]

(ii) Make a large drawing of the part of the micrograph shown in the box in Fig. 1.1.

[4]

(b) Hydrogencarbonate indicator solution is a substance that changes colour depending on the concentration of dissolved carbon dioxide.

Fig. 1.2 shows the colour changes.

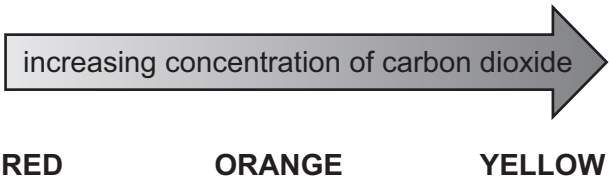

Fig. 1.2

A student compared the effects of changing the colour of light on the rates of photosynthesis of an aquatic plant and a deep-sea macroalga, using the method described.

- Pieces of aquatic plant and macroalga were placed into separate boiling tubes.
- The aquatic plant and macroalga were covered with orange hydrogencarbonate indicator.
- The boiling tubes were placed in front of a lamp producing red light.
- The time taken for the indicator colour to change from orange to red was recorded.
- The experiment was repeated 10 times and the mean times taken were calculated.
- The experiment was repeated with green light, yellow light and blue light.

The results are shown in Fig. 1.3. For the aquatic plant exposed to green light there was **no** colour change, with the colour remaining orange throughout the experiment.

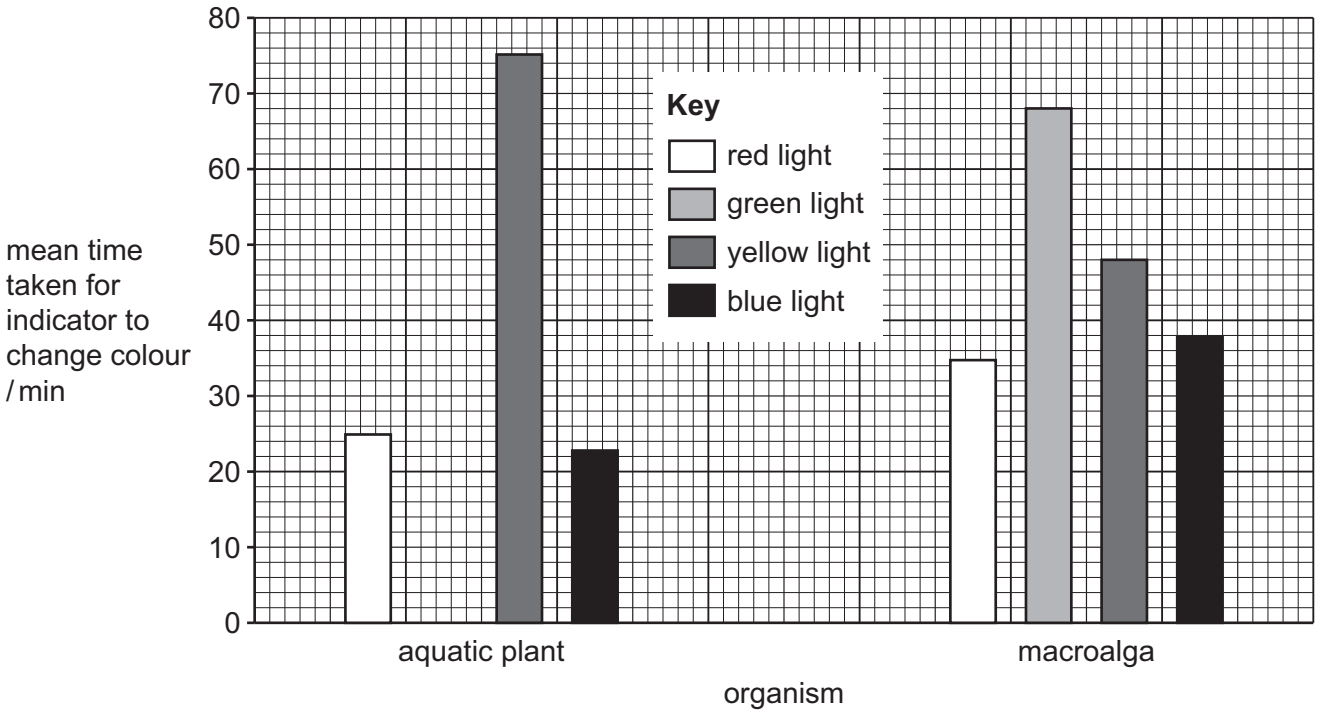

Fig. 1.3

(i) Explain why the indicator solution changed colour from orange to red when the aquatic plant was exposed to blue light.

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(ii) Explain how the results show that the macroalga is better adapted to live in deep water than the aquatic plant.

Use Fig. 1.2 **and** Fig. 1.3 to support your answer.

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(iii) When the aquatic plant was placed in front of the green light for more than two hours, the indicator solution changed to a yellow colour.

Explain why the indicator solution changed to a yellow colour.

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(iv) Suggest why the experiment does **not** give an accurate measurement of the rates of photosynthesis.

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[Total: 14]

2 Lionfish are an invasive species around coral reefs in many parts of the West Atlantic Ocean and Caribbean Sea. Fig. 2.1 shows a photograph of a lionfish.

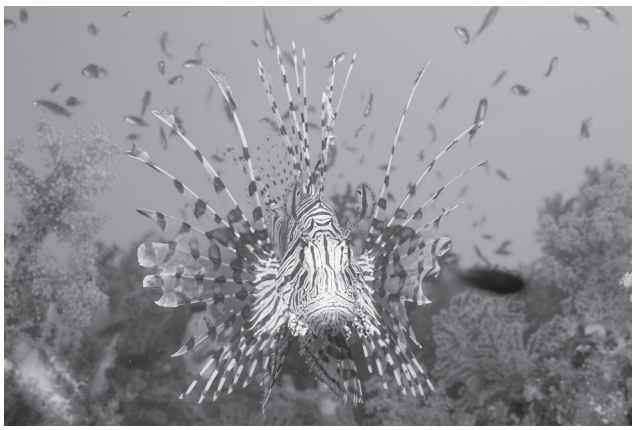

Fig. 2.1

In an area of Mexico, the government developed a conservation project to reduce the impact of lionfish and provide a sustainable lionfish industry for local people.

As part of this conservation project, a fishery was set up to encourage local people to catch lionfish. Lionfish were sold at market and became a major source of income for local people.

(a) The lionfish fishery was set up in 2011. Net fishing for the lionfish was banned. Spearfishing was the only permitted method.

Table 2.1 shows the catches of lionfish from 2011 to 2017.

Table 2.1

year	number of lionfish caught
2011	1017
2012	2515
2013	17250
2014	23121
2015	12022
2016	6032
2017	1035

(i) Suggest **two** reasons why spearfishing was the only method allowed to catch the lionfish.

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[2]

(ii) Calculate the percentage increase of catch from 2011 to 2014.

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

Space for working.

..... % [3]

(b) In 2013, 2014 and 2015 the population densities of lionfish in three reef areas of the fishery were estimated.

(i) Outline **one** method that could be used to estimate the population density of lionfish on a reef.

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(ii) Fig. 2.2 shows the mean population densities of lionfish in the three reef areas during 2013, 2014, and 2015.

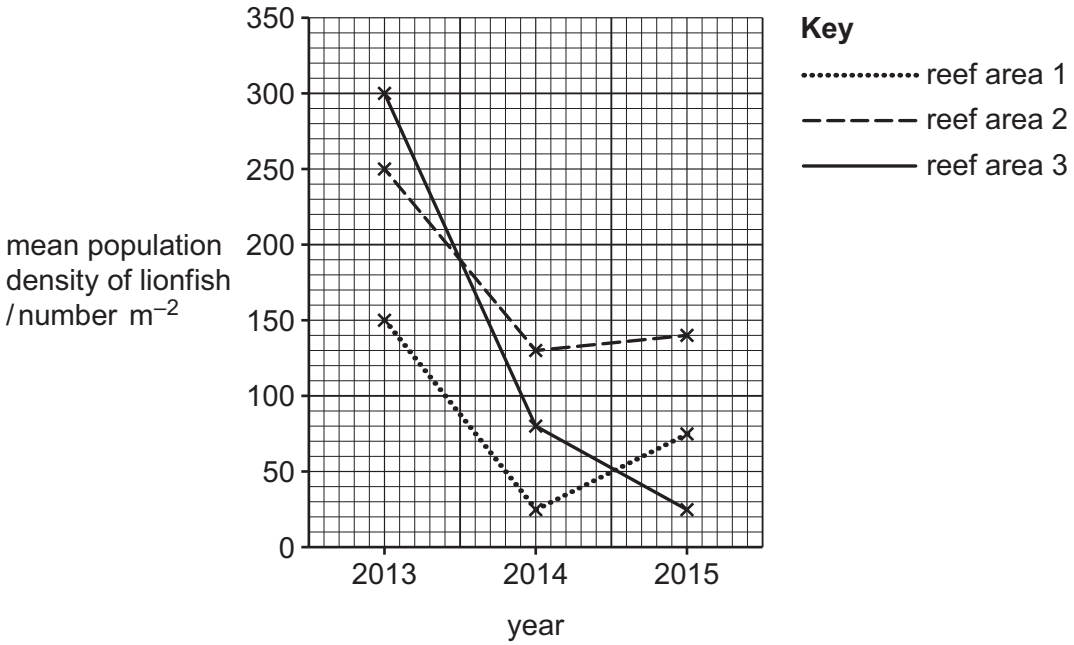

Fig. 2.2

Explain the effects of the conservation project on the changes in population of lionfish in the reef areas.

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(c) Table 2.2 shows the mean price of lionfish at a market in Mexico from 2011 to 2017.

Table 2.2

year	mean price per kilogram / USD ($)
2011	3.8
2012	3.8
2013	2.5
2014	2.4
2015	2.7
2016	4.2
2017	6.8

Evaluate the success of the lionfish fishery as a method of controlling the lionfish population **and** providing an industry for local people.

Use Table 2.1, Fig. 2.2 **and** Table 2.2 to support your answer.

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[Total: 14]

3 Carbon dioxide produced by the combustion of fossil fuels may lead to ocean acidification.

(a) Describe how carbon dioxide reacts with water to increase the acidity.

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(b) Fig. 3.1 shows a photograph of a free-swimming planktonic mollusc, *Limacina helicina*. This shelled species of mollusc is an important part of many Arctic food chains.

Fig. 3.1

Scientists investigated the effect of changing pH on the mass of calcium carbonate deposited into the shells of *Limacina helicina* during larval development.

Three larvae were incubated in each of two tanks of sea water, one at pH 8.1 and the other at pH 7.8. The mass of calcium carbonate deposited into the shells was measured every two hours for six hours.

Fig. 3.2 shows the results.

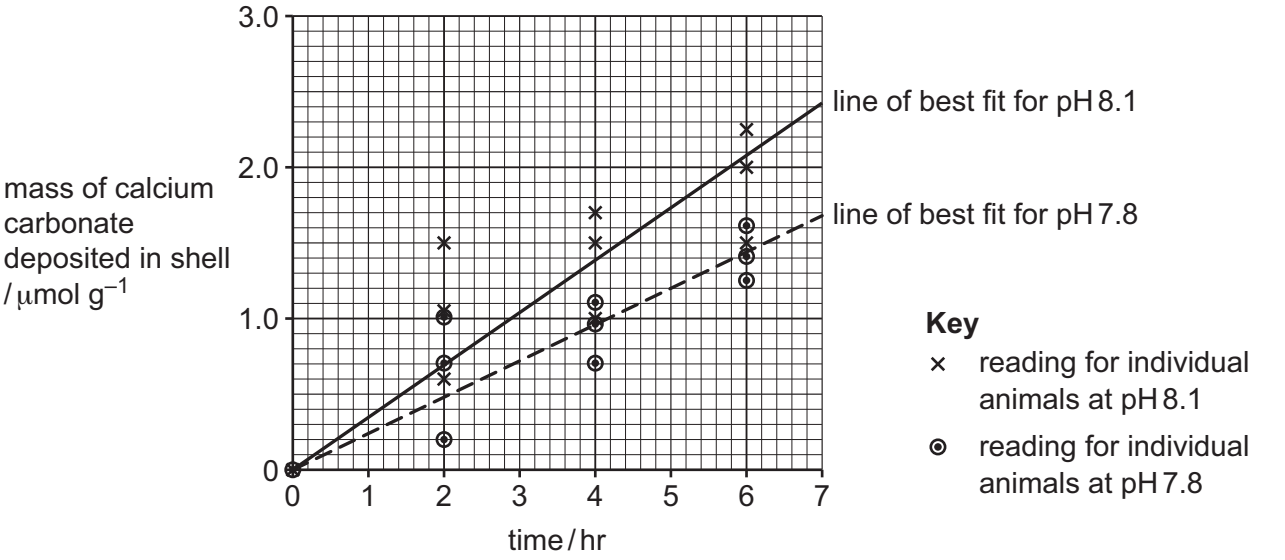

Fig. 3.2

(i) Use the line of best fit in Fig. 3.2 to calculate the mean rate of calcium deposition for the mollusc larvae when placed at pH 7.8.

State the unit.

Show your working.

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[3]

(ii) A pH of 8.1 is the normal pH of water from the Arctic Ocean where *Limacina helicina* is found.

Discuss the possible impact of ocean acidification on Arctic food webs.

Use Fig. 3.2 to support your answer.

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(c) Renewable energy installations such as wind turbines may help to reduce dependency on fossil fuels.

Some scientists are concerned that the noise generated by the building of offshore wind turbines may affect the behaviour of marine mammals such as porpoises.

An offshore wind turbine area was built in an area of the North Sea during 2006. Scientists recorded the number of days over six-month periods that porpoises were seen in the area:

- before construction, in 2005
- during construction, in 2006
- after construction had finished, in 2007.

To see if there was a significant difference in porpoise numbers during these three periods, a chi-squared (χ^2) test was performed. Table 3.1 shows the chi-squared test results.

Table 3.1

year	**number of days that porpoises were detected (*O*)**	**expected number of days that porpoises were detected (*E*)**	**(*O* – *E*)**	**$(O - E)^2$**	**$(O - E)^2 / E$**
2005 (before construction)	56	49	7	49	1.0
2006 (during construction)	54	49	5	25	0.5
2007 (after construction)	36	49			

(i) Complete Table 3.1. [1]

(ii) Use Table 3.1 to calculate the value of chi-squared (χ^2).

Use the formula:

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

where,

χ^2 = chi-squared value

O = observed values

E = expected values

Σ = sum of

..... [1]

(iii) The scientists made the null hypothesis:

'There is no difference in the number of days that the area was visited by porpoises before, during or after construction of the offshore wind turbines.'

Table 3.2 shows the critical values of chi-squared.

Table 3.2

degrees of freedom	probability			
	0.50	**0.10**	**0.05**	**0.01**
1	0.455	2.706	3.841	6.635
2	1.386	4.605	5.991	9.210
3	2.366	6.251	7.815	11.345
4	3.357	7.779	9.488	13.277

Use your answer to **3(c)(ii) and** Table 3.2 to assess the impact of the wind turbines on the porpoises.

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(d) The use of renewable energy could reduce the risk of ocean acidification.

State **two other** benefits of increasing the use of renewable energy installations.

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[2]

[Total: 17]

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4 Turgor pressure is the force exerted by the contents of the cytoplasm of a plant cell when the cell membrane presses outwards against the cell wall.

Turgor pressure is measured in megapascals (MPa).

A student investigated the effect of different concentrations of sucrose on mass and turgor pressure in mangrove roots. Equal-sized pieces of mangrove root were placed into five different sucrose solutions and also placed into pure water.

After six hours, the student calculated the percentage change in mass of the roots and the turgor pressure in the root cells.

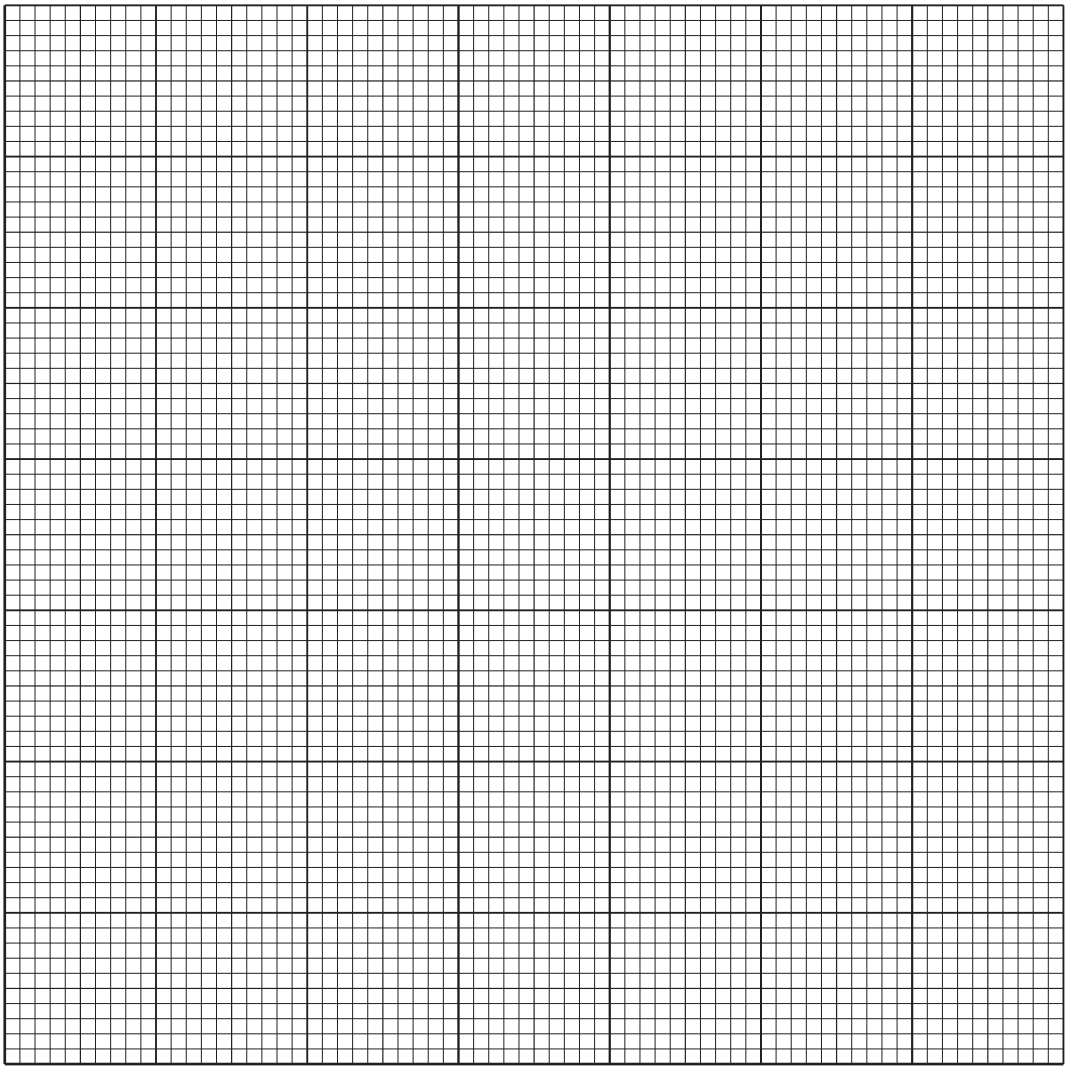
The results are shown in Table 4.1.

Table 4.1

sucrose concentration / mol dm^{-3}	percentage change in mass	turgor pressure / MPa
0.00	+25	0.42
0.25	+15	0.28
0.50	+10	0.14
0.75	–5	0.00
1.00	–10	0.00
1.25	–25	0.00

(a) (i) Draw a line graph to show the percentage change in mass **and** the turgor pressure when the roots were placed in the different concentrations of sucrose.

Join your points with ruled straight lines.



[5]

(ii) Explain the effect of increasing sucrose concentration on the percentage change in mass of the roots.

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(iii) Explain the effect of increasing sucrose concentration on the turgor pressure.

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(b) Reverse osmosis is a method that can be used to produce fresh water from sea water.

Fig. 4.1 is a diagram to show how reverse osmosis works.

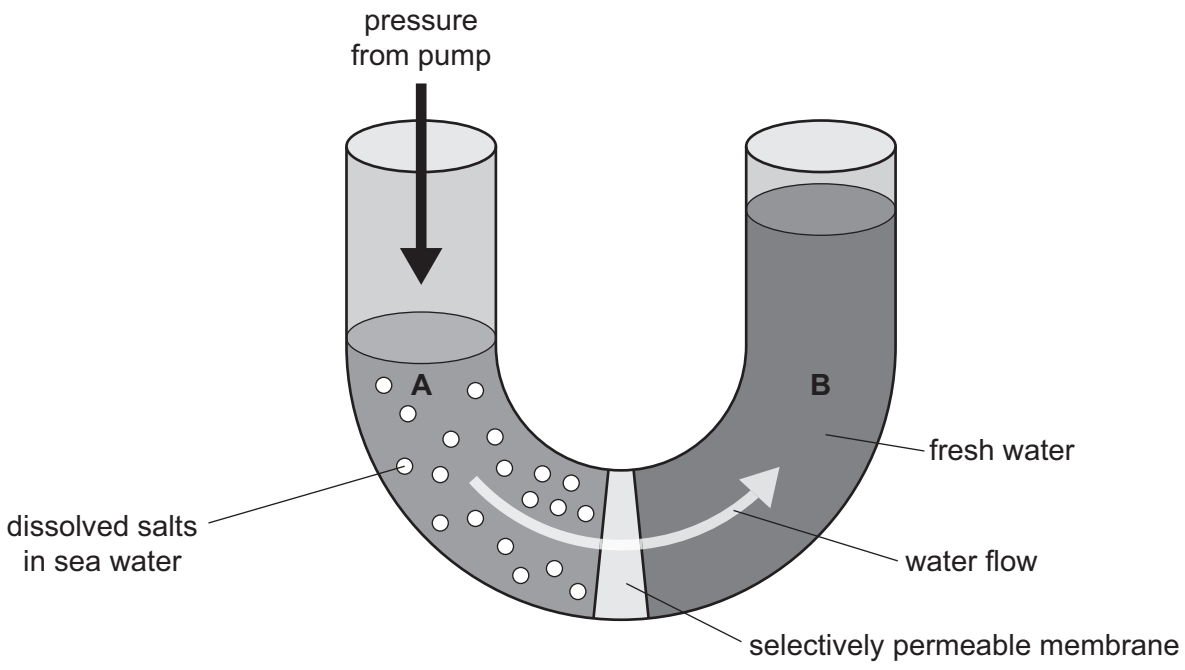

Fig. 4.1

(i) A pump forces sea water under pressure into chamber **A**. Fresh water is produced in chamber **B**.

Explain why pressure is needed to produce the fresh water in chamber **B**.

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(ii) Chamber **A** contains a very concentrated solution of salts after the reverse osmosis process has finished.

Explain why this solution in chamber **A** should **not** be returned to the sea.

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[Total: 15]

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5 Fig. 5.1 is a photograph of a sea trout.

Fig. 5.1

Sea trout use pumped ventilation and ram ventilation for gaseous exchange.

(a) Outline how pumped ventilation differs from ram ventilation.

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(b) The carbon dioxide concentration of surrounding water may affect the rate of pumped ventilation in sea trout.

Plan a **laboratory-based** investigation to see if increasing the carbon dioxide concentration of water changes the rate of pumped ventilation in sea trout.

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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