Cambridge Assessment International Education

# Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*7468530014*

**MARINE SCIENCE** **9693/43**

Paper 4 A Level Data-handling and Investigative Skills **May/June 2022**

**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.

Answer **all** questions.

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

A group of students investigated the effect of a desalination plant on the salinity of sea water and the percentage cover of the seabed with seagrass.

They measured the salinity of the sea water and percentage cover of the seabed with seagrass every 5 m from the desalination plant over a total distance of 30 m.

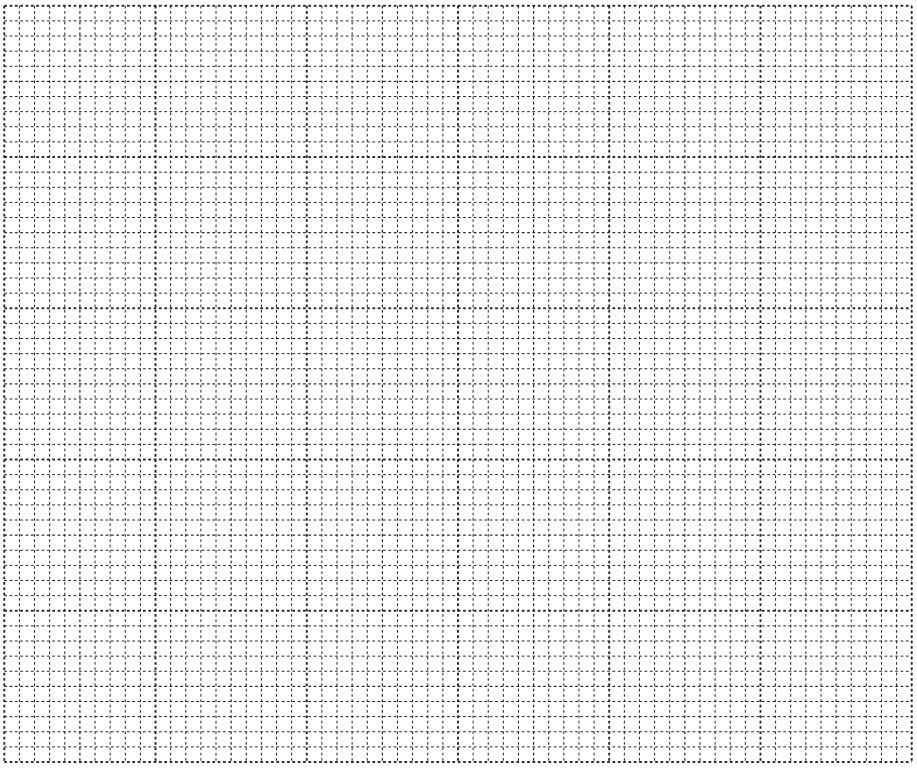
The results are shown in Table 1.1.

**Table 1.1**

| distance from desalination plant / m | salinity of sea water / ppt | percentage cover of seabed with seagrass |
|---|---|---|
| 5 | 45 | 25 |
| 10 | 41 | 27 |
| 15 | 34 | 58 |
| 20 | 33 | 85 |
| 25 | 32 | 95 |
| 30 | 32 | 95 |

**(a) (i)** Draw a graph to show how the salinity of the sea water and percentage cover of the seabed with seagrass change with distance from the desalination plant.

Join your points with ruled, straight lines.



[5]

**(ii)** Use your graph and Table 1.1 to suggest an explanation for the distribution of the seagrass.

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**(b)** Outline how salmon perform osmoregulation in regions of high salinity.

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[Total: 10]

**2** The effect of mercury from untreated sewage released into the ocean was investigated.

Table 2.1 shows the mean concentrations of mercury in the body tissues of species of fish with different diets that live in areas where untreated sewage is released.

**Table 2.1**

| diet of fish | mean concentration of mercury in body tissues of fish / $\mu g\,g^{-1}$ |
|---|---|
| plants | 72 |
| small invertebrates | 122 |
| plants and invertebrates | 97 |
| small fish | 382 |
| mixed small and large fish | 453 |
| dead fish | 597 |

**(a)** Use Table 2.1 to suggest an explanation for the different mean concentrations of mercury in the body tissues of fish with different diets.

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**(b)** **(i)** Tuna have a diet of mixed small and large fish. Many health authorities advise pregnant women to eat no more than 340 g of tuna each week.

Use Table 2.1 to calculate the mass of mercury found in 340 g of tuna.

Give your answer to three significant figures.

..... μg [2]

**(ii)** Suggest why pregnant women are advised to restrict the amount of tuna in their diet.

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[Total: 8]

**3** A student investigated the rate of respiration of a species of coral. The coral was a species that contained zooxanthellae.

A piece of the coral was placed into a tank filled with one cubic decimetre of sea water.

The concentration of oxygen dissolved in the water was measured every five minutes for 25 minutes.

The coral was kept in darkness throughout the experiment.

The results are shown in Fig. 3.1.

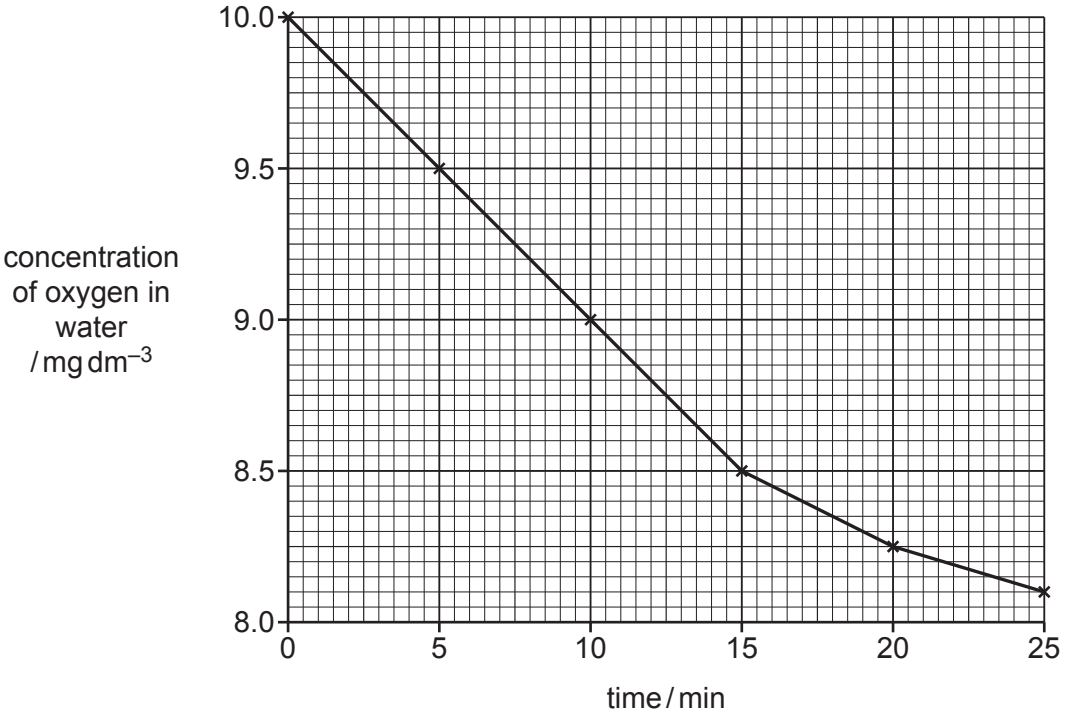


**Fig. 3.1**

**(a) (i)** Give the balanced chemical (symbol) equation for aerobic respiration.

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**(ii)** Explain why the experiment was carried out in darkness.

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**(iii)** Use Fig. 3.1 to calculate the mean rate of change of oxygen concentration over the first 15 minutes of the experiment.

Show your working and state the correct unit.

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**(b)** In a second investigation, a pump was used to circulate the water over the coral polyps.

The rate of oxygen uptake by the coral polyps was measured at different speeds of water current.

The results are shown in Fig. 3.2.

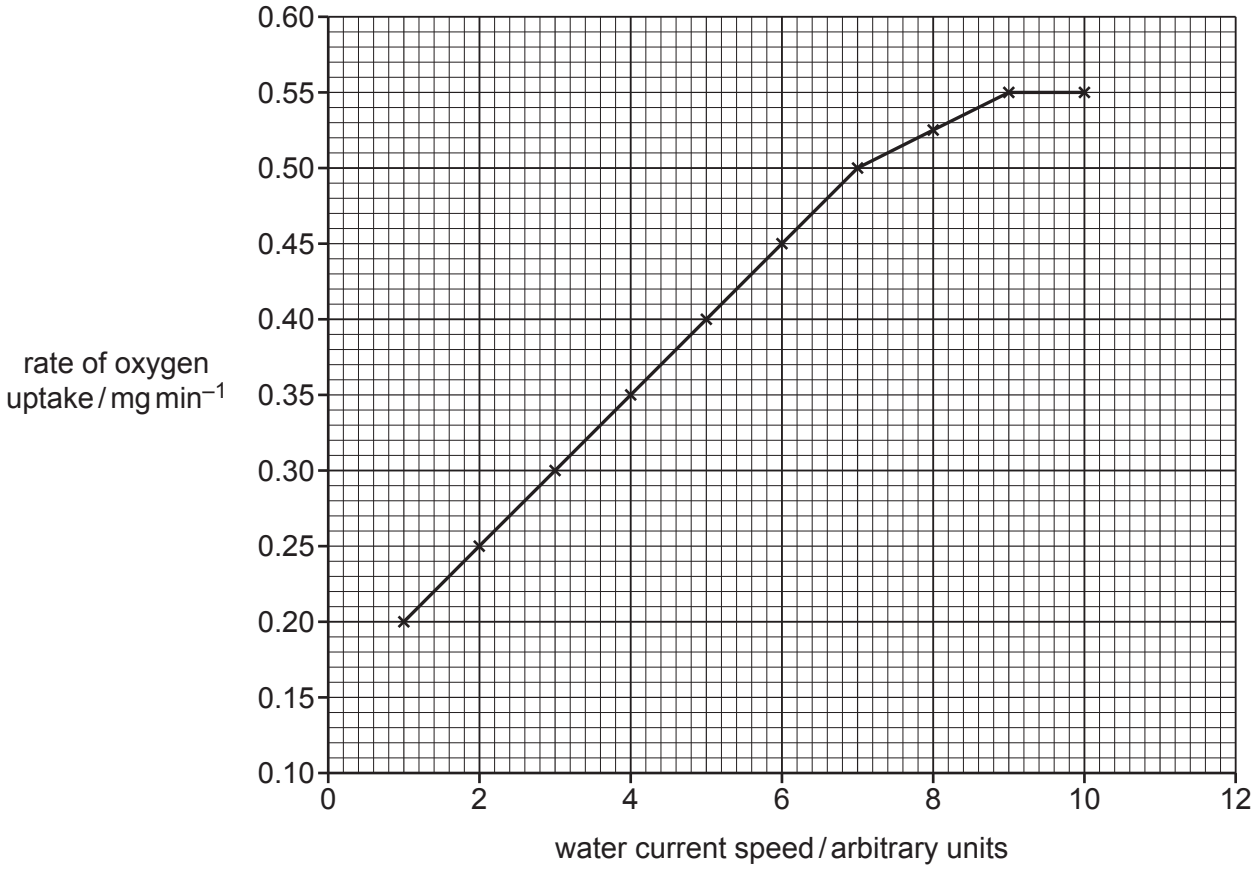


**Fig. 3.2**

**(i)** Describe the effect of increasing water current speed on the rate of oxygen uptake.

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**(ii)** Suggest reasons for the effect of increasing water current speed on the rate of oxygen uptake.

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**(c)** Coral polyps use simple diffusion for gaseous exchange.

Agar cubes that contain alkali and indicator solution can be used as a model for diffusion.

The agar cubes can be placed into hydrochloric acid.

As the hydrochloric acid diffuses into the agar, it neutralises the alkali and changes the indicator from pink to colourless. This is shown in Fig. 3.3.

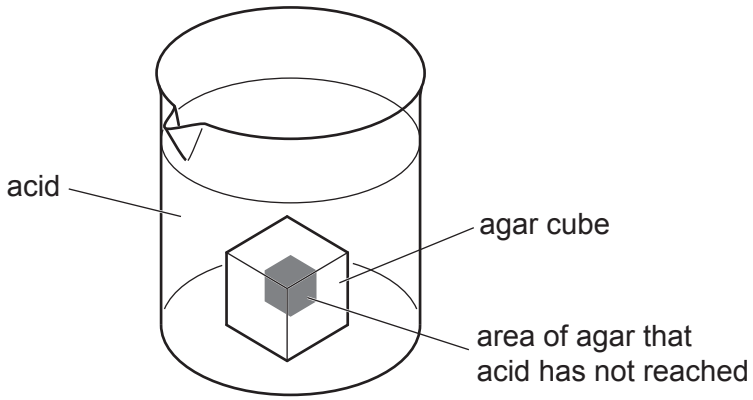


**Fig. 3.3**

The time taken for the agar to turn colourless when placed into hydrochloric acid is a measure of the rate of diffusion of acid to the centre of the agar cubes.

Plan an investigation into the effect of temperature on diffusion of hydrochloric acid into agar cubes.

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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[Total: 24]

**4** Increasing ocean acidification may be a threat to marine biodiversity.

**(a) (i)** Describe how carbon dioxide reacts with water to reduce the pH and availability of carbonate ions.

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**(ii)** Explain the impact of acidification on shelled organisms.

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**(b)** Fig. 4.1 shows the changes in atmospheric carbon dioxide concentration and ocean pH around Hawaii.

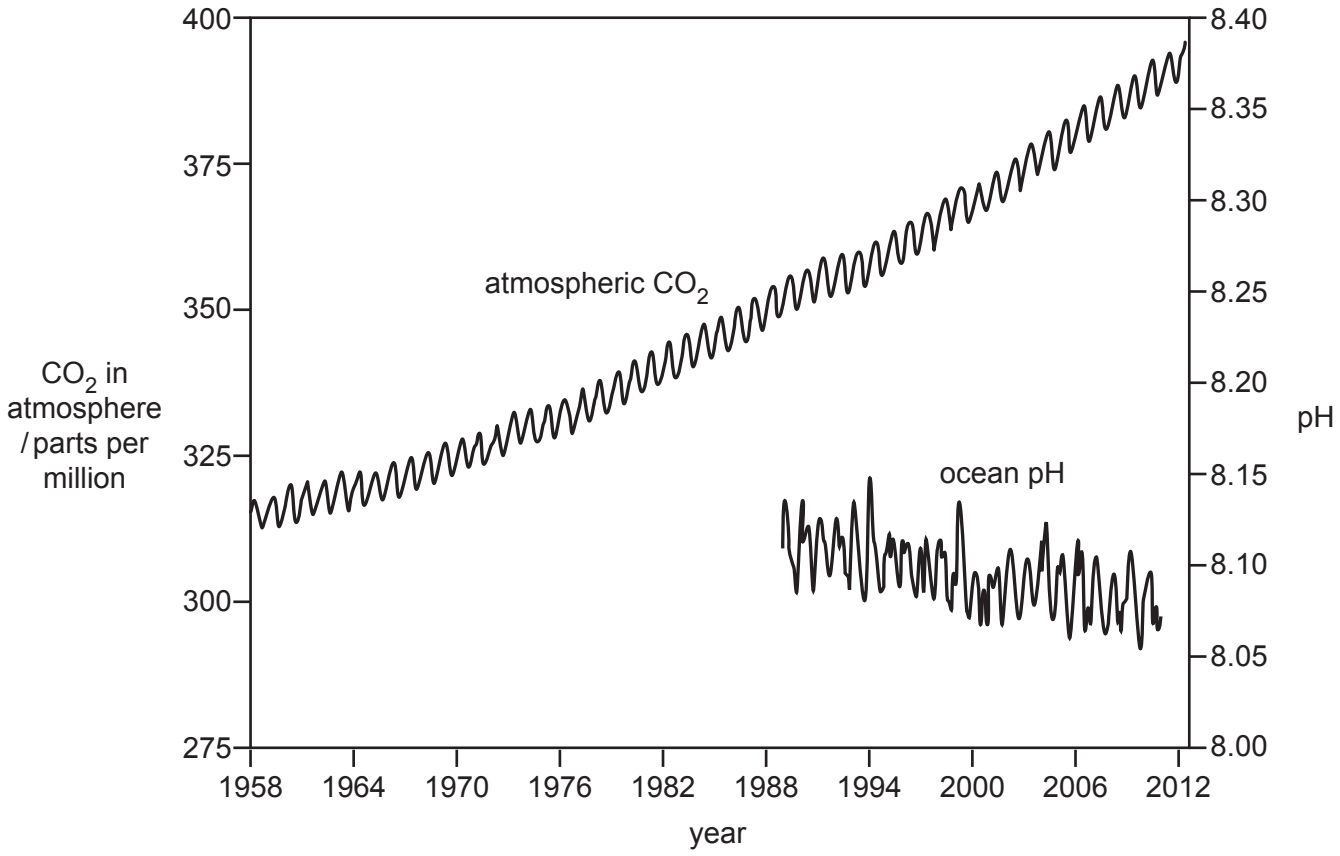


**Fig. 4.1**

Discuss the extent to which the data in Fig. 4.1 support the theory that fossil fuel use by humans is causing ocean acidification.

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**(c)** Scientists have suggested that conservation of kelp forests may help to reduce the impact of ocean acidification.

They measured the light intensity and pH of water at a depth of two metres in a kelp forest around the coast of Norway during the summer months.

The results are shown in Fig. 4.2.

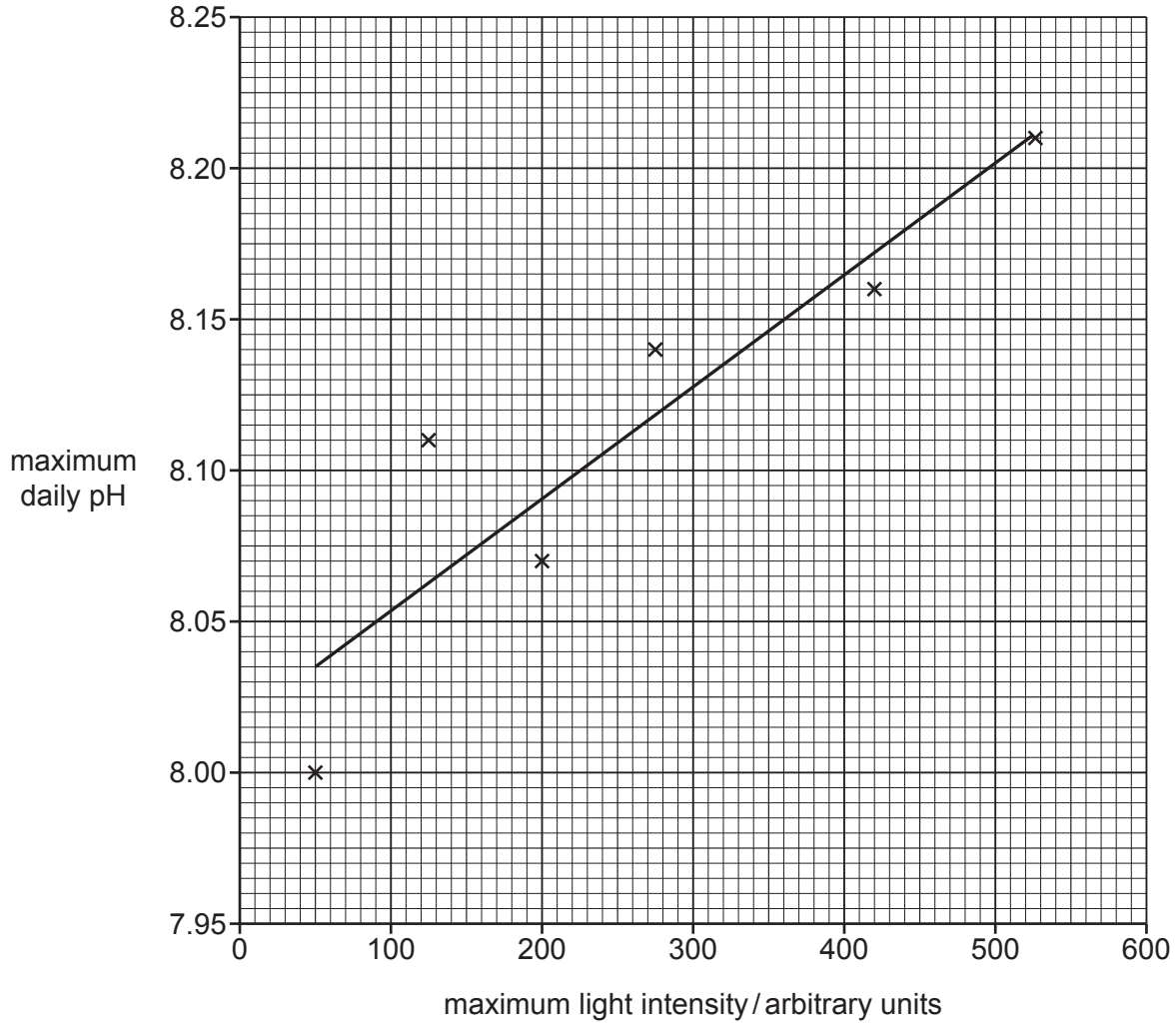


**Fig. 4.2**

**(i)** Use your knowledge of photosynthesis to explain why the maximum daily pH was affected by the maximum light intensity.

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..... [2]

**(ii)** The investigation was carried out in the Arctic Ocean during the summer months.

Discuss whether the investigation supports the use of kelp forests in reducing global ocean acidification.

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**(iii)** Fig. 4.3 shows a light micrograph of cells in the surface of a kelp frond.

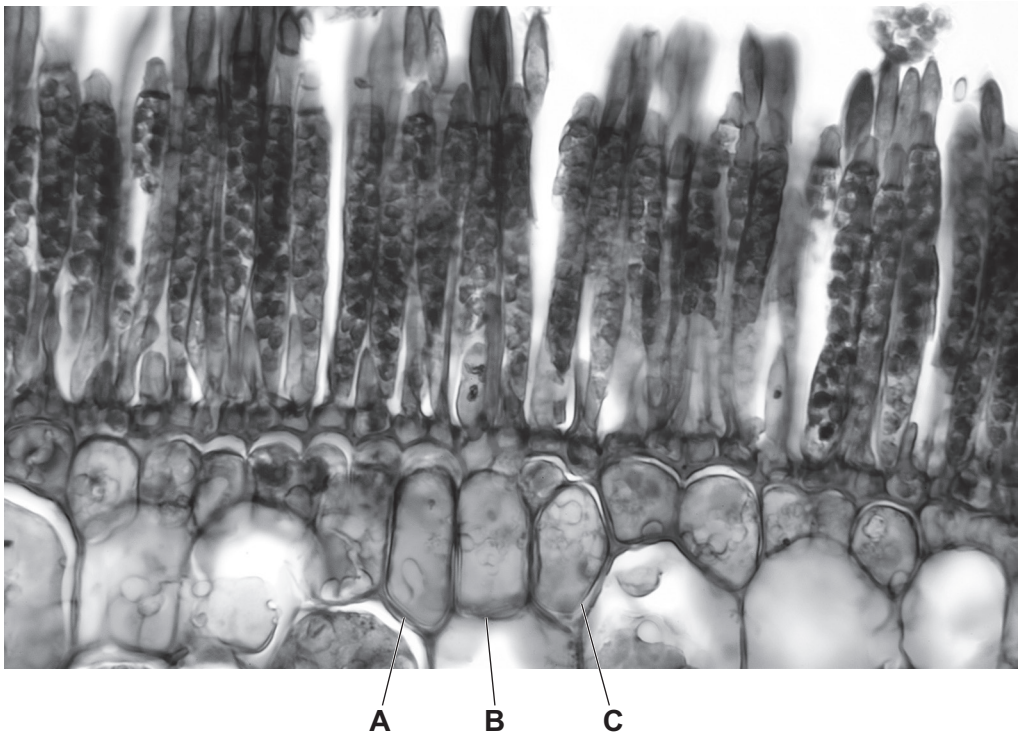


**Fig. 4.3**

Draw the group of cells **A**, **B** and **C** as shown in Fig. 4.3 in the space below.

Do **not** label your diagram.

[3]

[Total: 17]

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**5** Lionfish are a species of carnivorous fish naturally found in the Pacific Ocean near Indonesia.

Lionfish are now found in the western Atlantic Ocean and Caribbean Sea and are classed as an invasive species.

**(a)** State what is meant by an invasive species, as defined by the IUCN.

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..... [1]

**(b)** Fig. 5.1 shows the change in population of lionfish between 2004 and 2010 on an area of coral reef near the Bahamas in the western Atlantic Ocean.

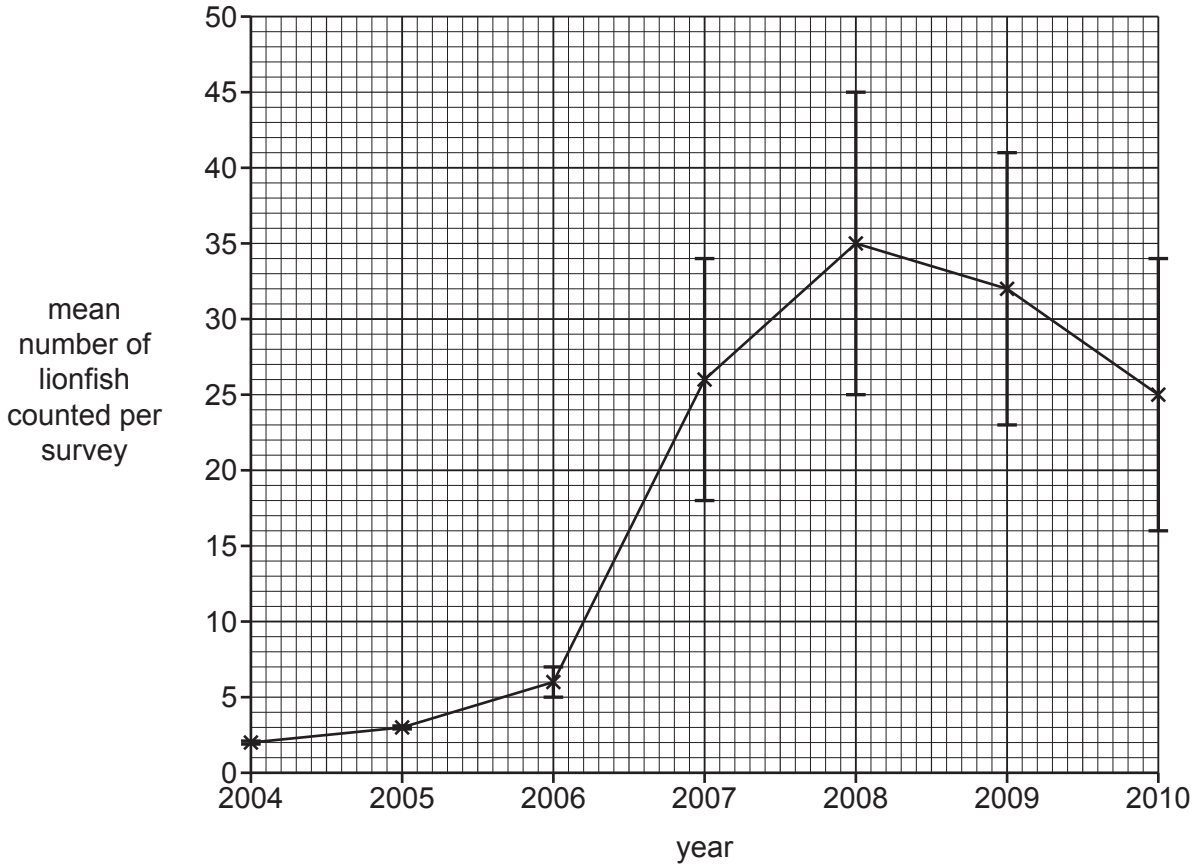


**Fig. 5.1**

**(i)** Suggest explanations for the changes in population of lionfish on this coral reef between 2004 and 2010 shown in Fig. 5.1.

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**(ii)** Fig. 5.1 has error bars that represent the standard deviation.

Explain what the standard deviations in Fig. 5.1 show about the data.

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..... [2]

**(c)** Fig. 5.2 shows the percentage change in abundance of other species of fish and algae growing on the same coral reef between 2004 and 2010.

The species of fish were classed as:

- small fish species that are prey of lionfish
- small fish species that are not prey of lionfish
- large fish species that are competitors of lionfish
- large fish species that are not competitors of lionfish

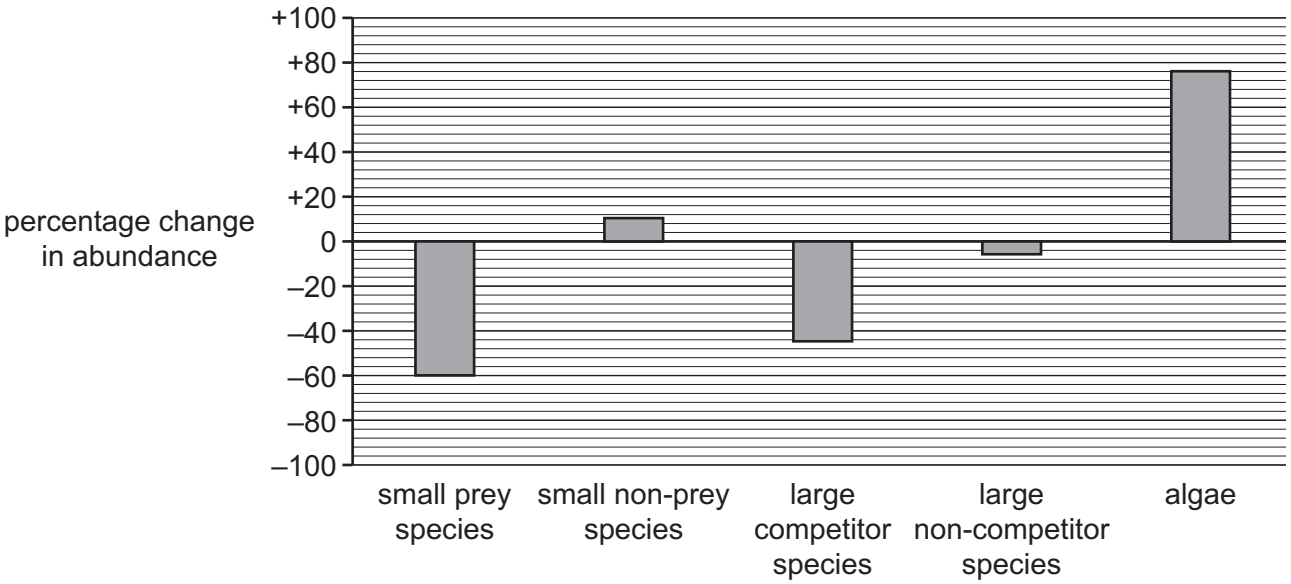


**Fig. 5.2**

Discuss the change in abundance of the different species of fish and algae shown in Fig. 5.2.

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**(d)** Scientists investigated the effect of removing lionfish on the population of damselfish on a reef.

Divers physically removed lionfish from an area of reef each week for a period of six months. The population of damselfish on the reef was then recorded.

The population of damselfish on an area of identical reef where lionfish were **not** removed was also recorded.

Both reefs had the same initial populations of damselfish.

The scientists carried out a chi-squared test to see if removing the lionfish caused a change in the population of damselfish.

They made the following null hypothesis:

**Removing the lionfish did not affect the number of damselfish on the reef.**

The results are shown in Table 5.1.

**Table 5.1**

| reef area | number of damselfish (*O*) | expected number of damselfish (*E*) | $(O-E)$ | $(O-E)^2$ | $\frac{(O-E)^2}{E}$ |
|---|---|---|---|---|---|
| lionfish removed | 420 | 390 | 30 | 900 | 2.308 |
| no lionfish removed | 360 | 390 | | | |

**(i)** Complete Table 5.1. [1]

**(ii)** Use the formula to calculate the chi-squared value for the results.

$$\text{chi-squared} = \Sigma \frac{(O-E)^2}{E}$$

$\Sigma$ = sum of (total)

*O* = observed values

*E* = expected values

..... [1]

**(iii)** Table 5.2 is a probability table of critical values for chi-squared.

**Table 5.2**

| degrees of freedom | *p* value | | | | |
|---|---|---|---|---|---|
| | **0.900** | **0.500** | **0.100** | **0.050** | **0.010** |
| 1 | 0.016 | 0.455 | 2.706 | 3.841 | 6.635 |
| 2 | 0.211 | 1.386 | 4.605 | 5.991 | 9.210 |
| 3 | 0.584 | 2.366 | 6.251 | 7.815 | 11.345 |
| 4 | 1.064 | 3.357 | 7.779 | 9.488 | 13.277 |

Use your calculated value from **(d)(ii)**, and Table 5.2, to decide whether to accept or reject the null hypothesis.

Justify your decision.

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**(iv)** Explain why international cooperation and legislation are required to conserve species.

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[Total: 16]

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