Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6637190192

MARINE SCIENCE **9693/42**

Paper 4 A Level Data-handling and Investigative Skills **May/June 2024**

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

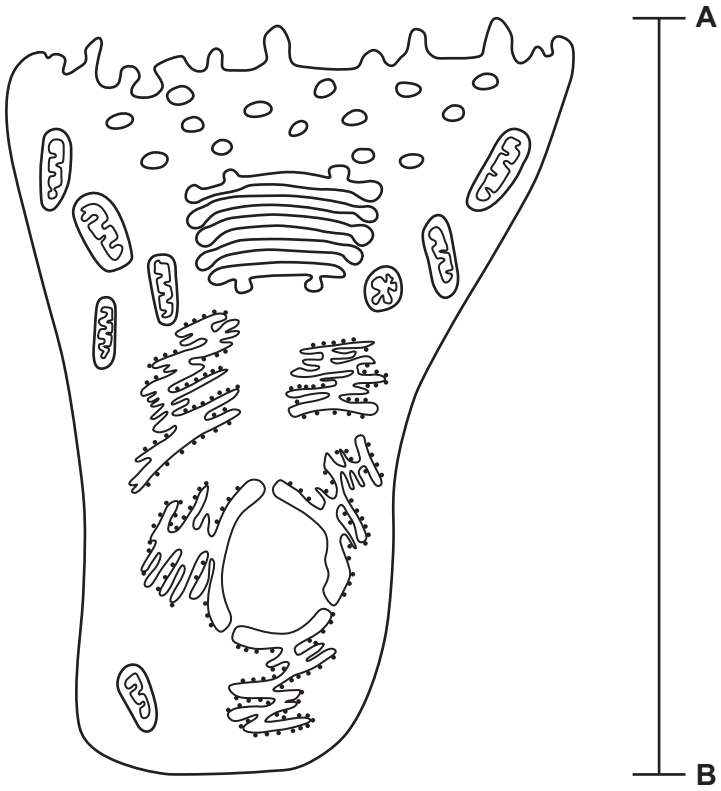
- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **20** pages. Any blank pages are indicated.

Answer **all** questions.

1 The gills of most fish have cells on their surfaces that secrete a thick, slippery fluid called mucus. The cells that secrete mucus are known as goblet cells.

Fig. 1.1 is a diagram of a goblet cell from the gill of a salmon.



×8500

Fig. 1.1

(a) (i) The diagram has a magnification of ×8500.

Calculate the actual length of the goblet cell between **A** and **B** on Fig. 1.1.

Give your answer to **three** significant figures and in micrometres (μm).

Show your working.

..... μm [3]

(ii) Name **two** cell structures **not** present in the goblet cell that would be present in a plant cell.

1 .....

2 .....

[2]

(b) Fig. 1.2 shows an electron micrograph of a mitochondrion.

Make a large drawing of the mitochondrion.

Do **not** label your drawing.

Fig. 1.2

[4]

[Total: 9]

2 Killifish are euryhaline fish that are able to osmoregulate.

(a) (i) State what is meant by the term euryhaline.

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..... [1]

Scientists kept killifish in sea water with a salinity of 35 parts per thousand (ppt) for one week.

The fish were then placed into fresh water.

The scientists measured the rate of breakdown of ATP in gill cells and body skin cells of the killifish over one week. Energy is released when ATP is broken down.

The results are shown in Fig. 2.1.

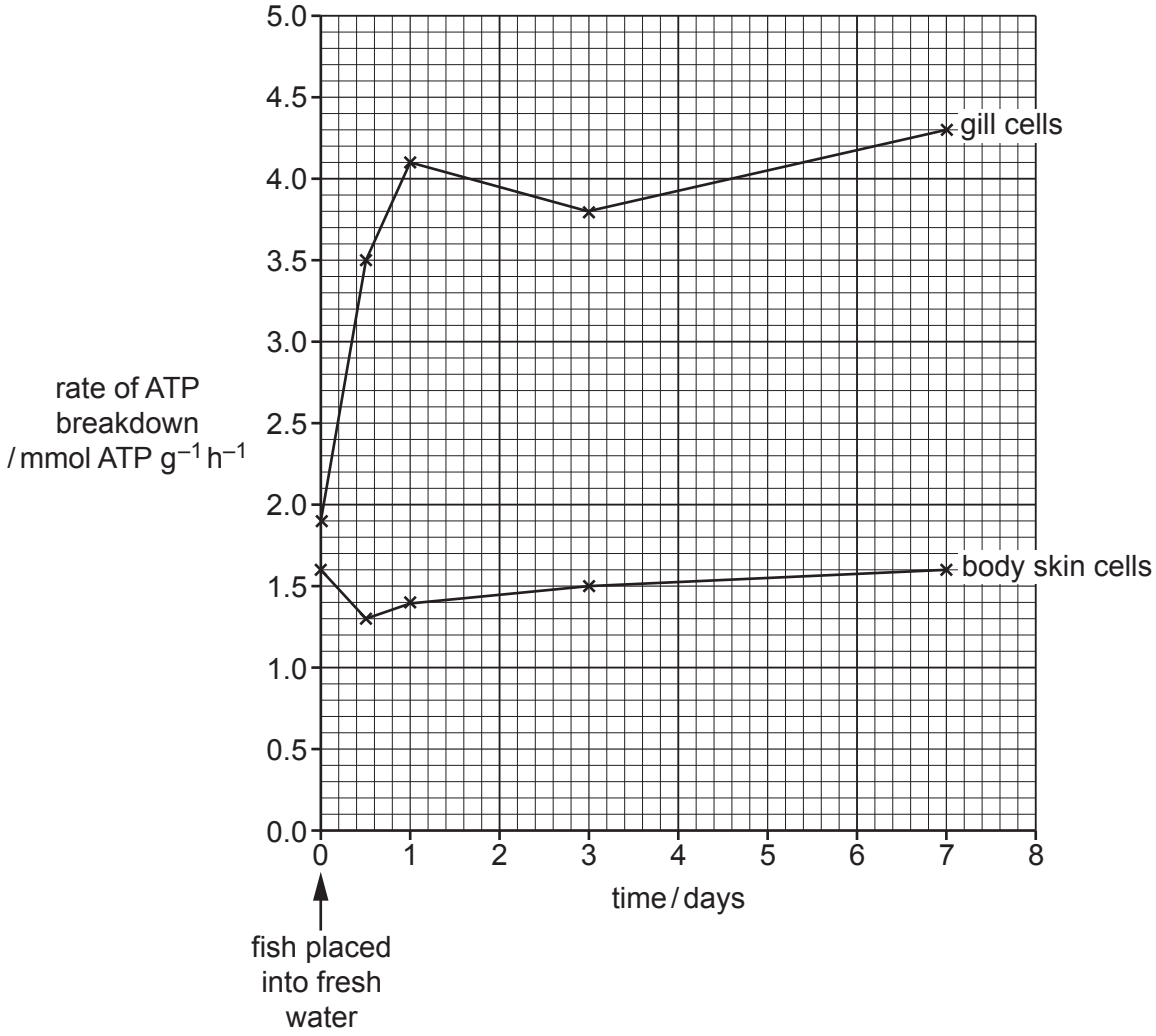

Fig. 2.1

(ii) Describe the change in the rate of breakdown of ATP by the gill cells after placing the fish into fresh water.

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..... [2]

(iii) Suggest an explanation for the change in the rate of breakdown of ATP after placing the killifish into fresh water.

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(iv) Suggest why the scientists investigated the response of body skin cells as well as of gill cells.

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..... [1]

(b) The scientists also investigated the effect of placing mussels into sea water of different salinities.

Two groups of mussels, group **A** and group **B**, were placed into tanks of sea water.

- Group **A** mussels were placed into sea water with a salinity of 35 ppt.
- Group **B** mussels were placed into sea water with a salinity of 15 ppt.
- After 24 hours, the mean volume of water per gram of dry mass of mussel was measured for a sample of mussels from both groups. This was the initial mass.
- Half of the remaining mussels from each group were then placed into tanks with a salinity of 35 ppt.
- The other half of the remaining mussels from each group were placed into tanks with a salinity of 15 ppt.
- After 24 hours, the mean volume of water per gram of dry mass of mussel was measured for all the mussels.

Fig. 2.2 shows the investigation.

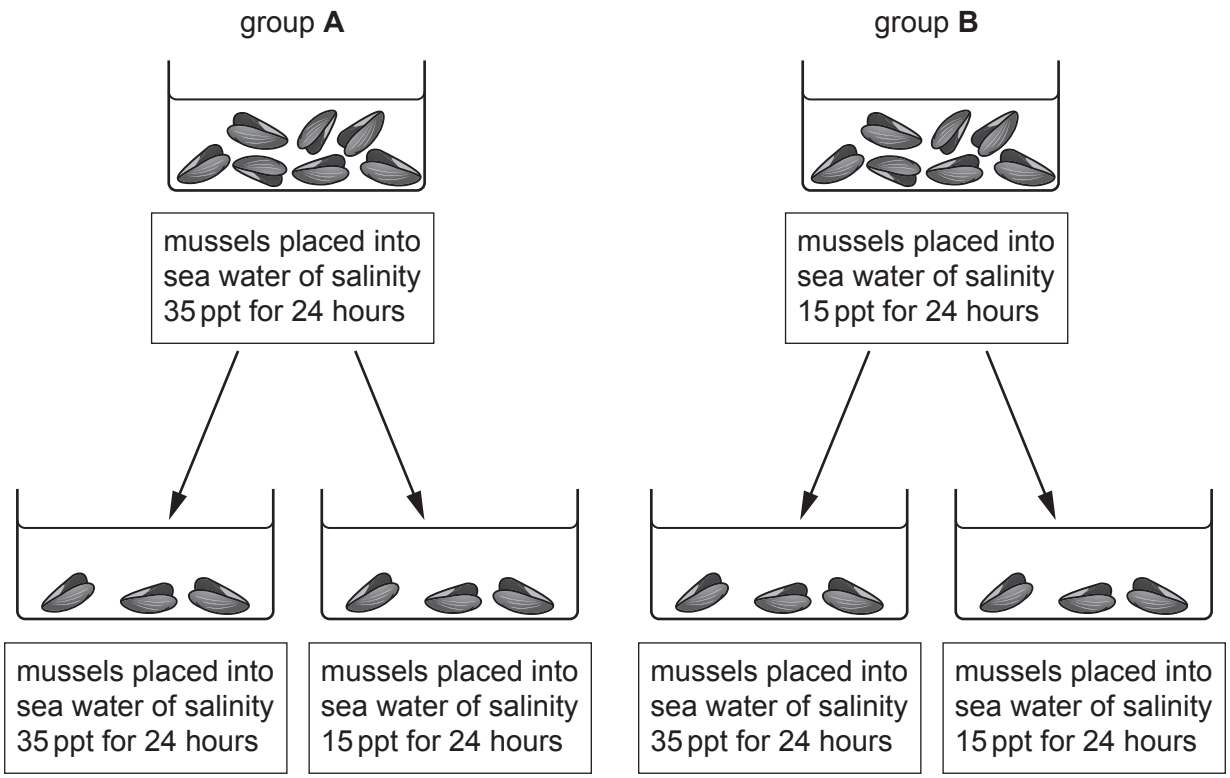

Fig. 2.2

The results of the investigation are shown in Fig. 2.3.

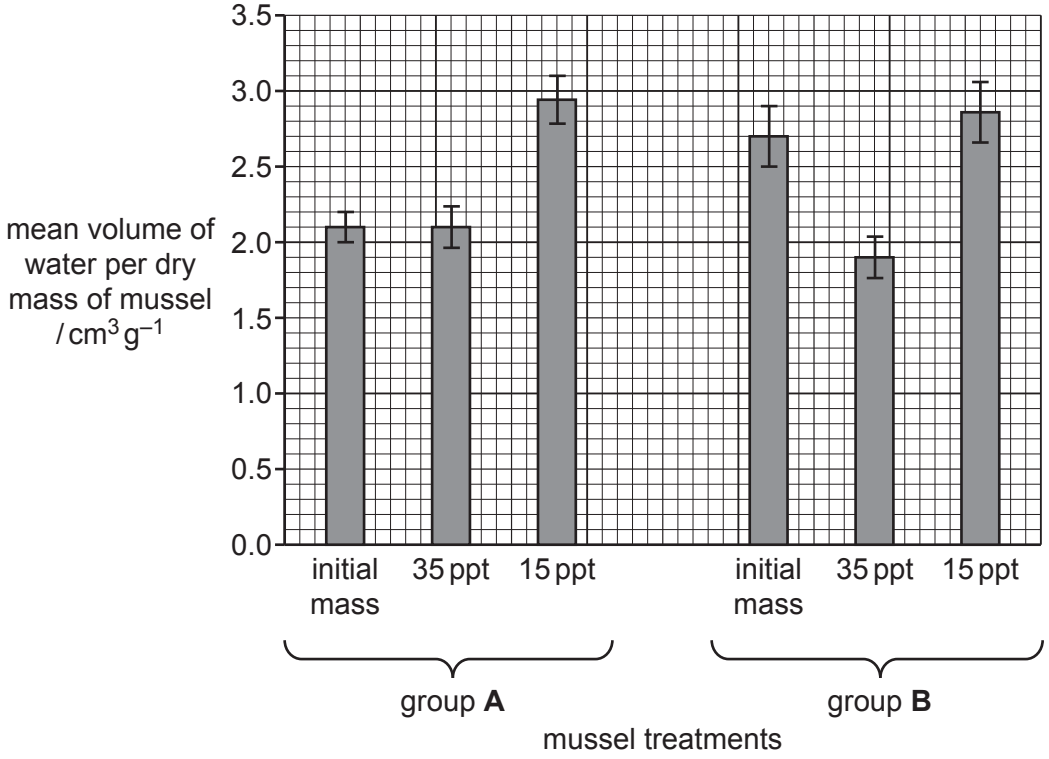

Fig. 2.3

(i) Use Fig. 2.3 to calculate the percentage change in mean volume of water per gram of dry mass of mussel when mussels in group **A** were moved from water with a salinity of 35 ppt to water with a salinity of 15 ppt.

Show your working.

.....% [2]

(ii) Suggest explanations for the results shown in Fig. 2.3.

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..... [4]

[Total: 14]

3 Dublin Bay prawns, *Nephrops* sp., are crustaceans often caught by using bottom trawling.

Fig. 3.1 shows the method of bottom trawling used.

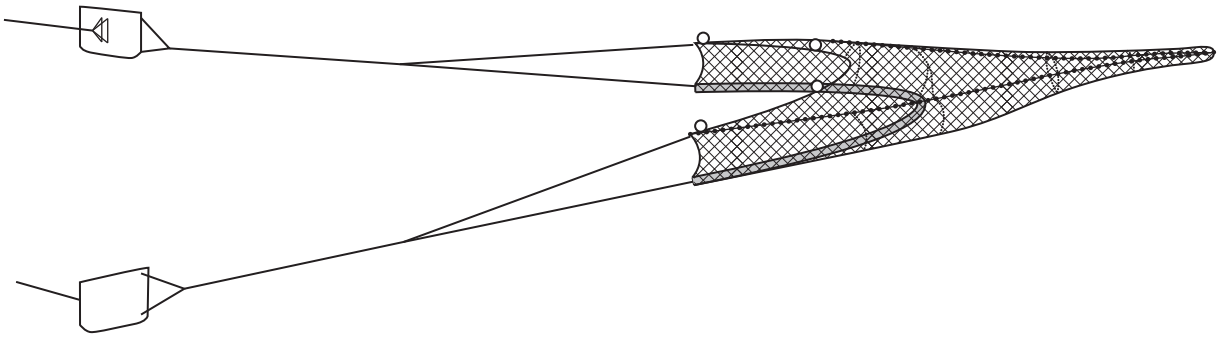

Fig. 3.1

Haddock is a fish that is an important species for fisheries in the north Atlantic Ocean.

The effect of *Nephrops* fishing on haddock populations was investigated in an area of the Atlantic Ocean where *Nephrops* trawling was started in the year 2000.

Between 1990 and 2020, scientists recorded:

- number of haddock per square kilometre
- mean length of female haddock
- percentage of two-year-old female haddock that were sexually mature.

The results are shown in Table 3.1.

Table 3.1

year	number of haddock per square kilometre	mean length of female haddock / cm	percentage of two-year-old female haddock that were sexually mature
1990	100	27	56
1995	120	28	
2000	90	23	65
2005	120	19	
2010	110	17	88
2015	140	16	
2020	130	15	92

(a) (i) Draw a line graph to show the changes in number of haddock per square kilometre **and** mean length of female haddock between 1990 and 2020.

Join your points with straight, ruled lines.

[5]

(ii) Suggest an explanation for the effect of *Nephrops* fishing since 2000 on the change in mean length of female haddock.

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..... [2]

(iii) Some scientists claimed that the modal length of fish would be a better measure of the average length of female fish.

State what information the modal length of female fish would show.

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..... [1]

(iv) Use **all** the information provided to discuss whether *Nephrops* fishing affects the population of haddock.

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..... [4]

(b) The regulations for bottom trawling for *Nephrops* state that the minimum mesh size must be between 7.0 cm and 9.5 cm.

Describe how restrictions on fishing methods can be monitored and enforced.

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..... [3]

[Total: 15]

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4 The effect of a no-take zone on the sustainability of fish populations and the income of fishers (number of people fishing) was investigated in an Indian Ocean fishery near Kenya.

The sustainability of fish stocks was measured by calculating the catch per unit effort (CPUE). A high CPUE was taken as an indicator of a sustainable fish population.

Two similar fishing grounds were compared:

- area **A**: an area with a central no-take zone
- area **B**: an area where no restrictions were placed on fishing.

The CPUE was measured in both areas for a period of eight years.

The results are shown in Fig. 4.1.

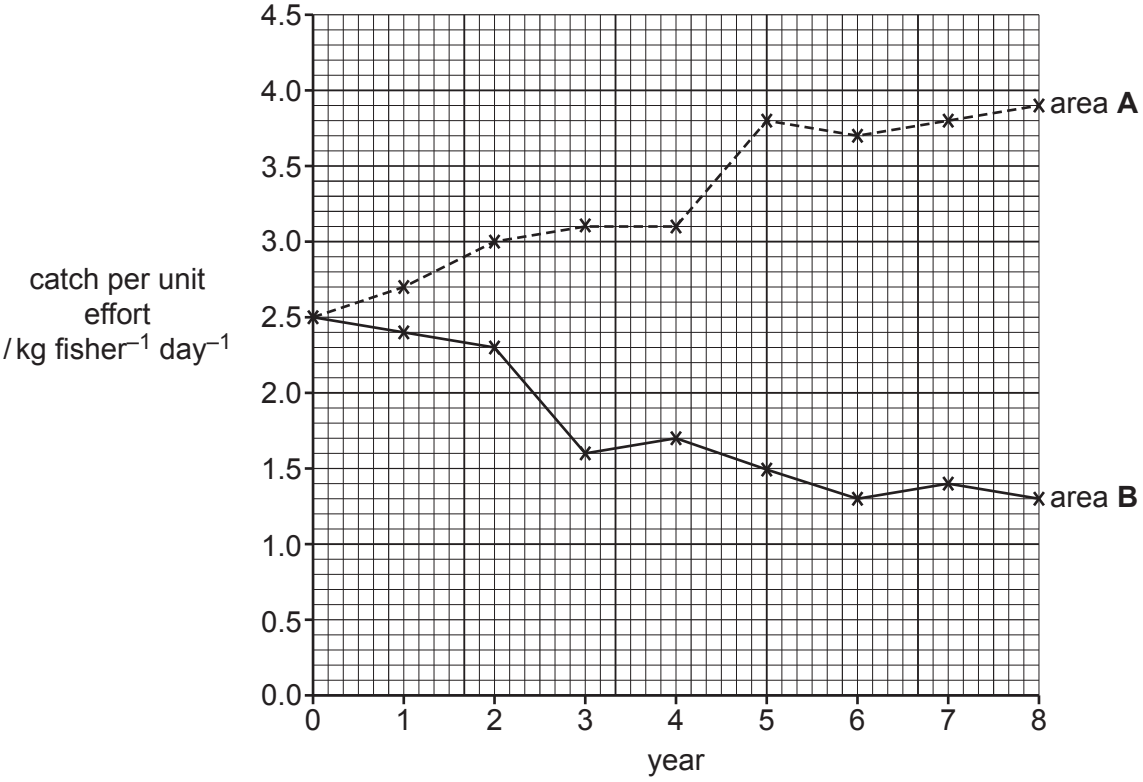

Fig. 4.1

(a) (i) The CPUE was calculated using the following formula:

$$\text{catch per unit effort (CPUE)} = \frac{\text{catch in kg}}{\text{number of days fishing} \times \text{number of fishers}}$$

Evaluate the accuracy of using catch per unit effort as a measure of the sustainability of the fish populations.

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..... [2]

(ii) Use Fig. 4.1 to describe the effects of the no-take zone on the sustainability of fish populations.

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(iii) Suggest explanations for the change in CPUE after the introduction of the no-take zone.

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(b) The effect of the no-take zone on the income of fishers was also investigated.

Table 4.1 shows the mean income of each fisher per month for area **A** with the no-take zone.

Table 4.1

years after restrictions	income / US$ per fisher per month
0	240
1	225
2	250
3	400
4	425
5	410
6	465
7	525
8	520

To see if there is a correlation between the CPUE and the income of the fishers, a Spearman's rank correlation coefficient was calculated.

(i) Give a null hypothesis for the investigation.

.....

..... [1]

Some of the steps of the calculation are shown in Table 4.2.

Table 4.2

year	CPUE /kg per fisher per day	rank CPUE	income /US$ per fisher per month	rank income	*D*	D^2
0	2.5	9	240	8	1	1
1	2.7	8	225	9	–1	1
2	3.0	7	250	7	0	0
3	3.1	5.5	400	6	–0.5	0.25
4	3.1	5.5	425	4	1.5	2.25
5	3.8		410	5		
6	3.7	4	465	3	1	1
7	3.8		525	1		
8	3.9	1	520	2	–1	1

(ii) Complete Table 4.2. [1]

(iii) Use the data in Table 4.2 and the formula below to calculate the Spearman's rank correlation coefficient for the data in Table 4.1.

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

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

Show your working.

..... [2]

(iv) Table 4.3 shows the critical values for Spearman's rank correlation coefficient.

Table 4.3

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

Use your calculated value from **(b)(iii)** and values from Table 4.3 to determine whether there is a significant correlation between the CPUE and income of the fishers.

Justify your conclusion.

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(v) Explain the sociological impacts of restrictions on fishing.

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[Total: 18]

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5 In 2010, the total global output of carbon dioxide from the combustion of fossil fuels was estimated to be 33 000 000 000 kg.

Some scientists have suggested that by 2030 the emission of carbon dioxide from fossil-fuel combustion could increase.

(a) (i) Calculate the predicted mass of carbon dioxide that will be released in 2030 if emissions from fossil-fuel combustion increases by 25%.

State the unit.

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[2]

(ii) Increased carbon dioxide output could lead to global warming.

Give **two** possible consequences of global warming for the marine environment.

1 .....

2 .....
[2]

(iii) Describe how high levels of atmospheric carbon dioxide could reduce pH and carbonate availability in sea water.

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..... [3]

(b) Increasing acidification of water may affect the shell growth of molluscs such as mussels.

Plan a **laboratory-based** investigation that you could do to investigate the effect of changing the pH of sea water on the rate of growth of mussels.

You are provided with standard laboratory apparatus and materials.

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: 19]

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