Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6200056094

MARINE SCIENCE **9693/43**

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

Answer **all** questions.

1 Fig. 1.1 shows a diagram of a section of a cell surface membrane.

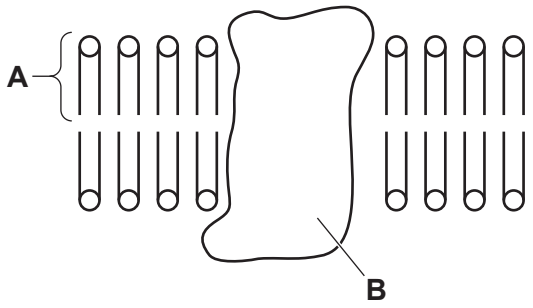

Fig. 1.1

(a) Name the structures labelled **A** and **B**.

A .....

B .....
[2]

(b) Cells taken from a mussel were placed into a potassium chloride solution.

The mass of potassium ions absorbed by the mussel cells was measured every five minutes for one hour.

The experiment was repeated in the presence of cyanide, a chemical that stops respiration.

The results are shown in Fig. 1.2.

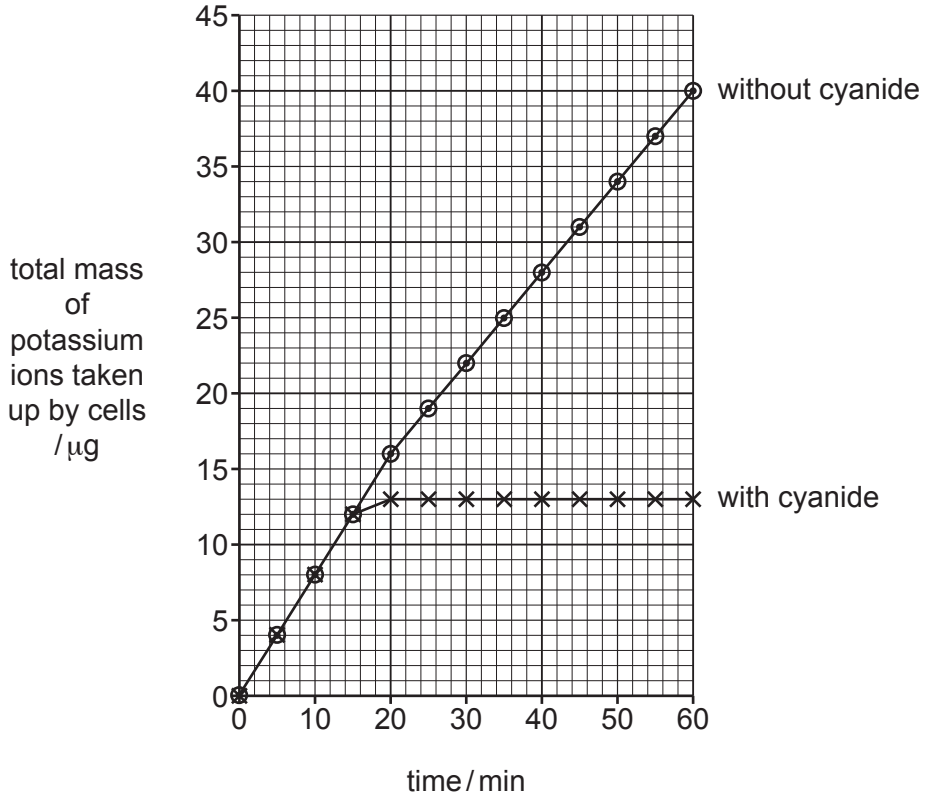

Fig. 1.2

(i) Calculate the mean rate of absorption of potassium ions without cyanide over the first 20 minutes.

State the unit.

Show your working.

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[3]

(ii) Compare the uptake of potassium ions by the mussel cells without cyanide with the uptake of potassium ions with cyanide.

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(iii) Use the information in Fig. 1.2 to explain how the mussel cells absorb potassium ions.

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[Total: 11]

2 **(a)** Scientists compared the sustainability of three different fishing methods for an Indian Ocean fishery.

Table 2.1 shows the catch data for the different methods over one year.

Table 2.1

fishing method	total fishing time for all boats / days	total mass of catch / kg	catch per unit effort / kg day^{-1}
purse seine	3140	105 234	33.510
rod-and-line	4100	30 677	7.480
spear fishing	111	516	

(i) Calculate the catch per unit effort for spear fishing using the following formula.

$$\text{catch per unit effort (CPUE)} = \frac{\text{total mass of catch}}{\text{total fishing time for all boats}}$$

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

..... kg day^{-1} [2]

(ii) The scientists suggested that the data in Table 2.1 show that rod-and-line fishing is more sustainable than purse seine fishing.

Discuss the scientists' suggestion, using the information in Table 2.1.

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(b) The scientists investigated the type of fish caught by purse seine, and by rod-and-line.

500 fish were sampled from catches taken by purse seine, and 500 from catches by rod-and-line.

Three factors were compared:

- length of fish
- number of different species of fish
- proportion of juvenile fish in the catches.

The results are shown in Table 2.2.

Table 2.2

fishing method	length of fish / cm			number of different species in catch	percentage of juvenile fish in catch (%)
	mean length	standard deviation	standard error		
purse seine	18	25	1.12	23	82
rod-and-line	75	11		9	35

The scientists calculated the mean lengths of the fish. They also calculated the 95% confidence intervals to compare the mean lengths of the fish caught by the two methods.

(i) Give a null hypothesis to compare the mean lengths of fish caught by purse seine with fish caught by rod-and-line.

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..... [1]

(ii) Use the formula to calculate the standard error of the mean length of fish caught by rod-and-line.

$$S_M = \frac{s}{\sqrt{n}}$$

S_M = standard error

s = standard deviation

n = sample size

..... cm [1]

(iii) Use your answer to **(b)(ii)** to calculate the 95% confidence intervals for the mean length of fish caught by rod-and-line.

$$95\%\ \text{confidence interval (95\% CI)} = \bar{x} \pm (2 \times S_M)$$

where $\bar{x}$ = mean

S_M = standard error

..... to ..... [1]

(iv) The 95% confidence interval for the mean length of fish caught by purse seine is 15.76 cm to 20.24 cm.

Use your answer to **(b)(iii)** to comment on the difference between the length of the fish caught by purse seine and the length of the fish caught by rod-and-line.

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(v) Use the information in Table 2.2 to discuss the impact of purse seine fishing on fish stocks compared with rod-and-line fishing.

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(c) State **three** restrictions that a government could place on purse seine fishing that would ensure that the fishery is exploited sustainably.

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[3]

[Total: 17]

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3 An area of coral reef had been damaged by pollution from agricultural run-off containing fertiliser over a number of years.

In 1990 the percentage of this coral reef covered with live, unbleached coral was measured.

In 1995, this coral reef was placed inside a marine protected area (MPA). The use of fertiliser by local agriculture was banned.

The percentage of coral reef covered with live, unbleached coral, and the Simpson's index of diversity for the coral reef were measured every five years.

The results are shown in Table 3.1.

Table 3.1

year	percentage of reef covered with live, unbleached coral	Simpson's index of diversity
1990	37	0.43
1995	35	0.41
2000	41	0.42
2005	45	0.48
2010	62	0.51
2015	85	0.57

(a) Explain how fertiliser in agricultural run-off can damage coral reefs.

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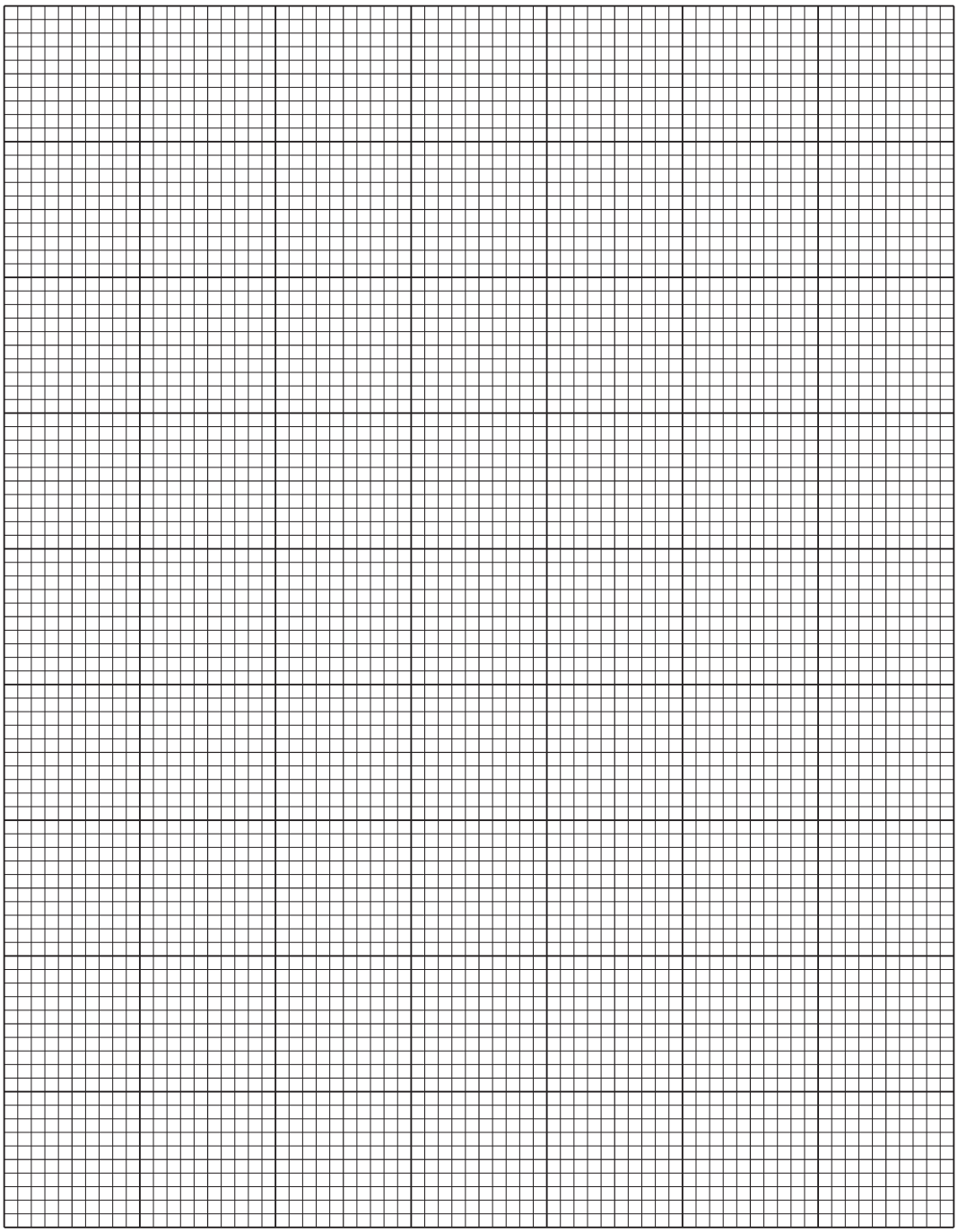
(b) (i) Plot a graph to show the percentage of reef covered with live, unbleached coral, **and** the values for Simpson's index of diversity, between 1990 and 2015.



[5]

(ii) Suggest why Simpson's index of diversity changed between 1995 and 2015.

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(iii) Explain **one** reason why it is **not** possible to be certain that the recovery of the coral reef was caused by the banning of fertiliser use.

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[Total: 14]

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4 Killifish are a euryhaline species of fish.

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

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(b) Killifish have cells called ionocytes in their gills that are involved in osmoregulation.

Ionocyte cells have large numbers of mitochondria.

Fig. 4.1 shows an electron micrograph of a mitochondrion.

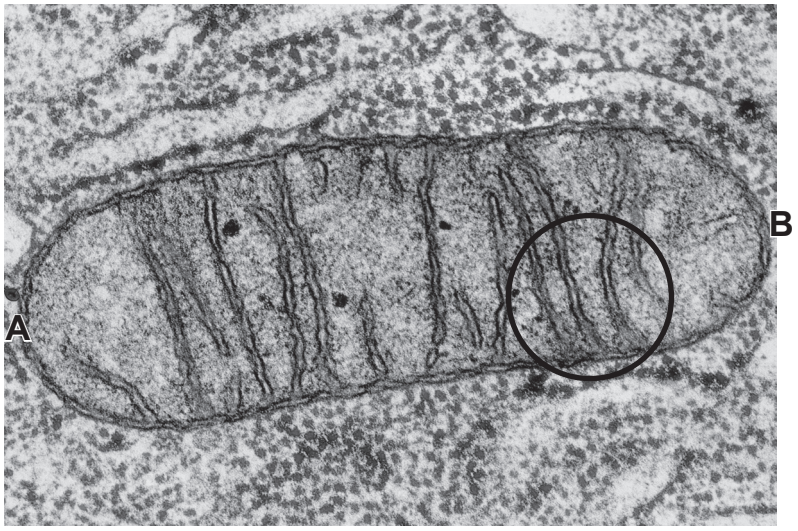

Fig. 4.1

(i) The electron micrograph has a magnification of ×14 000.

Calculate the actual length of the mitochondrion in Fig. 4.1 between **A** and **B**.

Give your answer in micrometres (μm).

Show your working.

..... μm [2]

(ii) Make a large drawing of the part of the mitochondrion shown in the circle in Fig. 4.1.

Do **not** label your drawing.

[4]

(c) Scientists investigated the effect of salinity on the rate of oxygen consumption by killifish.

Three tanks of water with salinities of 0 ppt, 11 ppt and 35 ppt were set up.

Five killifish were placed into each tank.

The fish were left for one week to acclimatise.

The scientists then measured:

- the mean rate of oxygen consumption by each group of fish
- the mean gill surface area of each group of fish
- the mean density of the ionocytes in the gills of each group of fish.

The results are shown in Fig. 4.2 and Table 4.1.

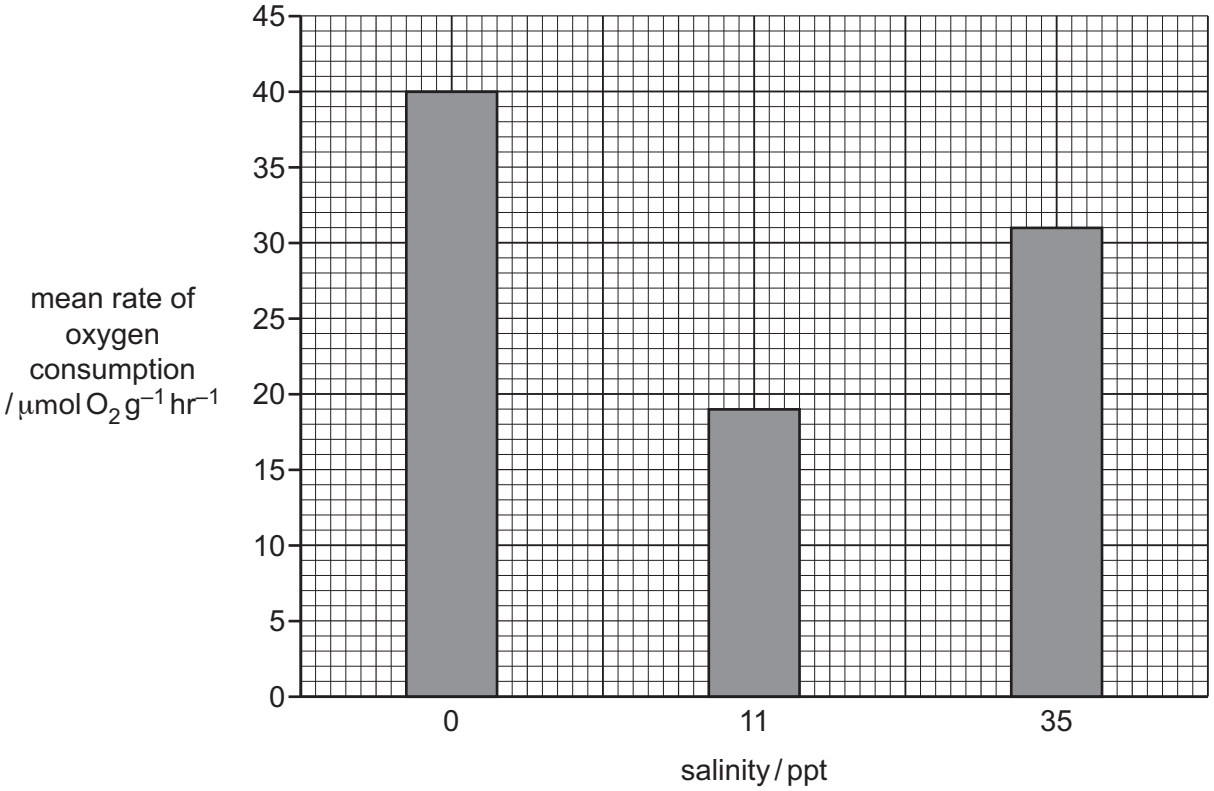

Fig. 4.2

Table 4.1

salinity / ppt	mean gill surface area / $\mu m^2 g^{-1}$	mean ionocyte density / number of cells per μm^2
0	62 000 000	320
11	78 000 000	127
35	82 000 000	235

(i) The scientists first measured the mean gill surface area of each group of fish.

Suggest why the scientists then calculated the mean gill surface area per gram of fish.

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(ii) Describe the effect of increasing salinity on the rate of oxygen consumption by the killifish.

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(iii) Discuss the effects of increasing salinity on the gill surface area **and** density of ionocyte cells.

Use information in Fig. 4.2 and Table 4.1 in your answer.

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[Total: 14]

5 Copepods are marine zooplankton. They are crustaceans that have a complex life cycle.

(a) Explain the advantages of having a complex life cycle.

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(b) Algae grow on the surfaces of microplastics when microplastics are left in ocean surface water for over one month. The presence of the algae causes some animals to mistake the microplastic for food.

Scientists measured the consumption of microplastic particles by copepod larvae, adult female copepods and adult male copepods.

They counted the number of these consumed microplastic particles that were:

- new, with no algae growing on them
- two months old, with algae growing on them.

The results are shown in Fig. 5.1.

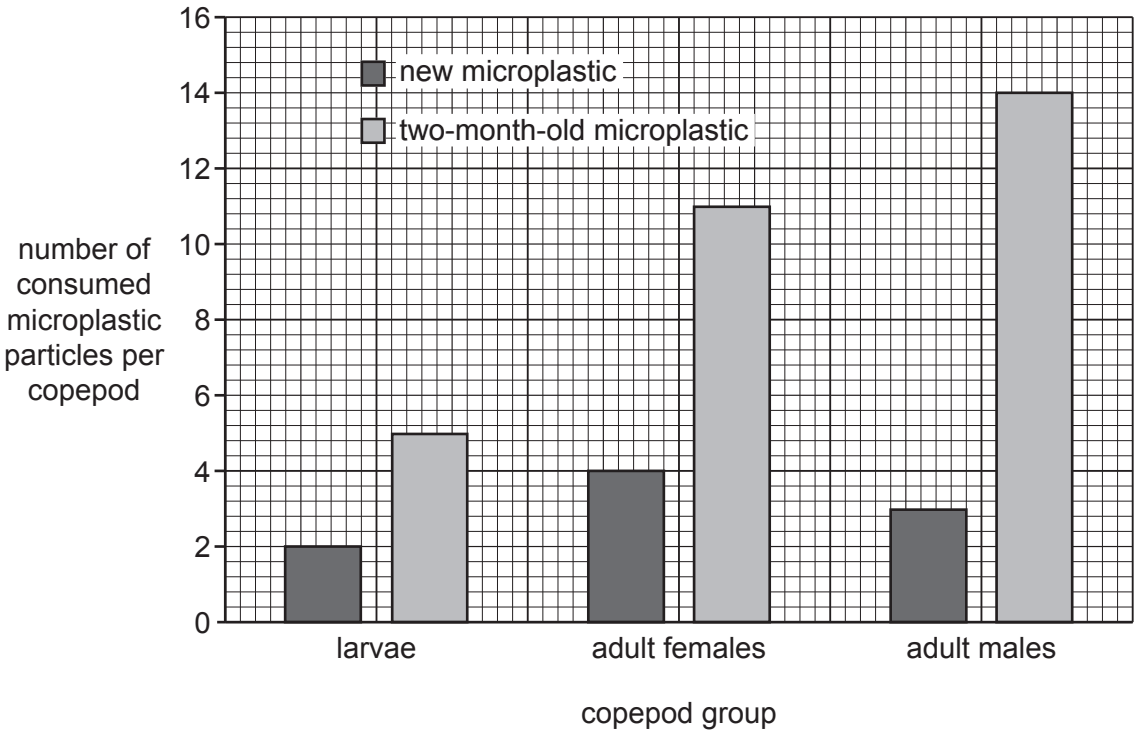

Fig. 5.1

(i) Describe the effect of age of the microplastics on their consumption by the different groups of copepod.

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(ii) Salmon are grown for human consumption, using aquaculture in sea cages.

Waste food from the salmon aquaculture is broken down by microorganisms, causing algal blooms.

Copepods are small enough to swim into salmon cages and are eaten by salmon.

Use this information and the information in Fig. 5.1 to suggest why the presence of microplastics in the waters around salmon aquaculture systems poses a threat to humans.

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(iii) Plastic sheets placed into sea water gradually break down to form microplastics. As the plastic sheet breaks down, its area decreases.

Temperature and wave action are two of the factors that affect the breakdown of plastic sheets into microplastics.

Plan a laboratory-based investigation that you could do to investigate the effect of water temperature on the rate of breakdown of plastic sheets.

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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