Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME						
CENTRE NUMBER						
CANDIDATE NUMBER						

9015892676

BIOLOGY **9700/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2023**

1 hour 15 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 30.
- The number of marks for each question or part question is shown in brackets [ ].

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

DC (CE/CB) 316126/2

1 Catalase is an enzyme that is found in many plant cells and animal cells. Catalase breaks down hydrogen peroxide, which is a waste product from cell metabolism.

Fig. 1.1 shows the breakdown of hydrogen peroxide by catalase.

$$\underset{\text{hydrogen peroxide}}{2\,H_2O_2} \xrightarrow{\text{catalase}} \underset{\text{water}}{2\,H_2O} + \underset{\text{oxygen}}{O_2}$$

Fig. 1.1

A student decided to investigate how catalase activity varies along the length of a carrot root.

Fig. 1.2 shows a photograph of some carrots.

Fig. 1.2

The student extracted catalase from different parts of the carrot root tissue.

- Carrot root tissue was mixed with a small volume of pH7 buffer and some fine sand.
- The mixture was ground with a pestle and mortar.
- The mixture was placed into a centrifuge tube and spun in a variable speed centrifuge for a few minutes.
- This caused the mixture to be separated into a solid pellet at the bottom of the centrifuge tube and a liquid carrot extract at the top, as shown in Fig. 1.3.
- The liquid carrot extract was poured into a clean test-tube. This liquid contained catalase.

Fig. 1.3 shows a centrifuge and centrifuge tube with its contents, after spinning in the centrifuge for a few minutes.

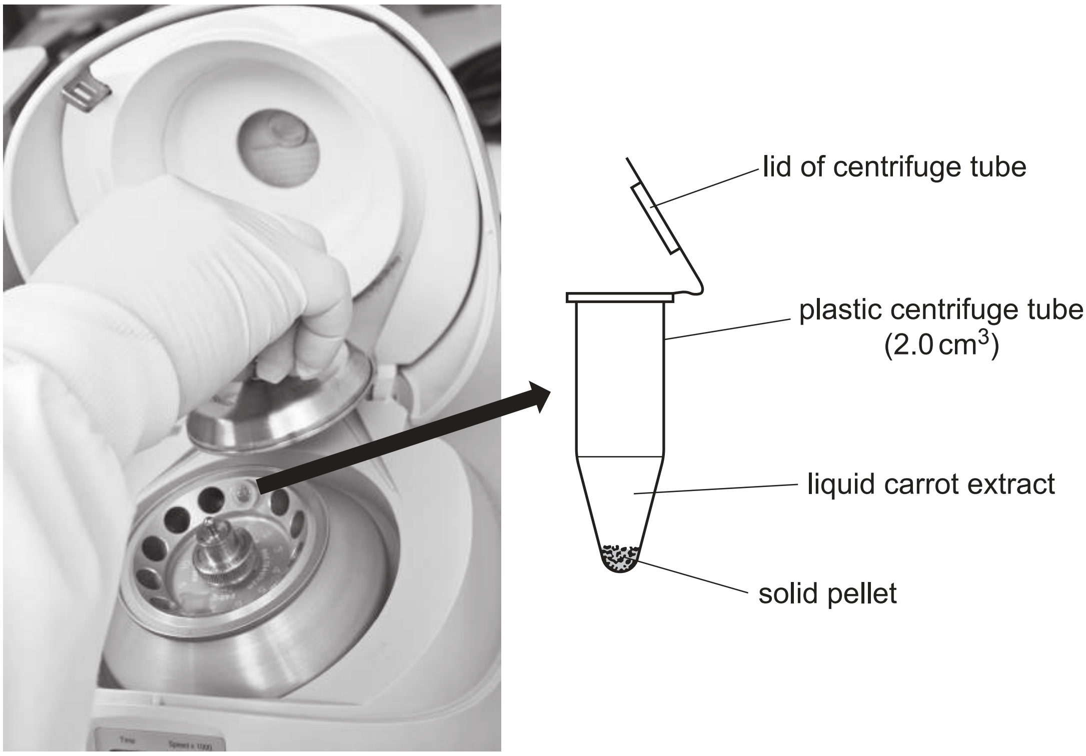

Fig. 1.3

(a) State **one** variable that should be standardised in the procedure to obtain the liquid carrot extract, **other than** the carrot tissue, fine sand and apparatus used.

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The student carried out these steps to investigate the activity of catalase in the different samples of carrot root tissue.

- A disc of filter paper of 5 mm diameter was dipped into the liquid carrot extract using forceps.
- The filter paper disc was placed at the bottom of a beaker of 1% hydrogen peroxide solution using forceps.
- The time taken for the filter paper disc to rise to the surface of the hydrogen peroxide solution was measured.

Fig. 1.4 shows the apparatus used to measure the time taken for the filter paper disc to rise.

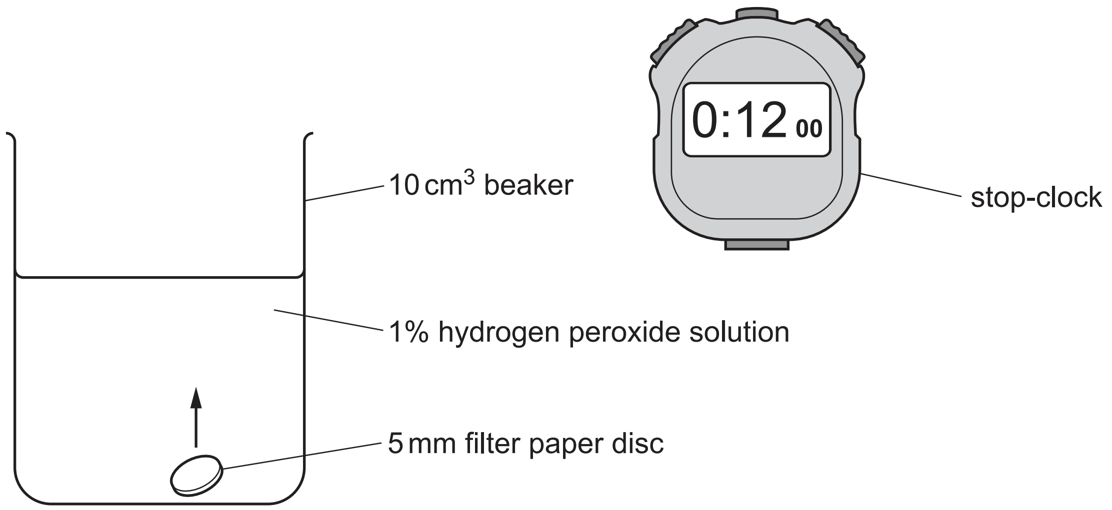

Fig. 1.4

(b) State the relationship between the time taken for the filter paper disc to rise to the surface of the hydrogen peroxide solution and the catalase activity of the liquid carrot extract.

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The student decided to investigate how catalase activity varies along the length of the carrot root.

Fig. 1.5 shows a carrot.

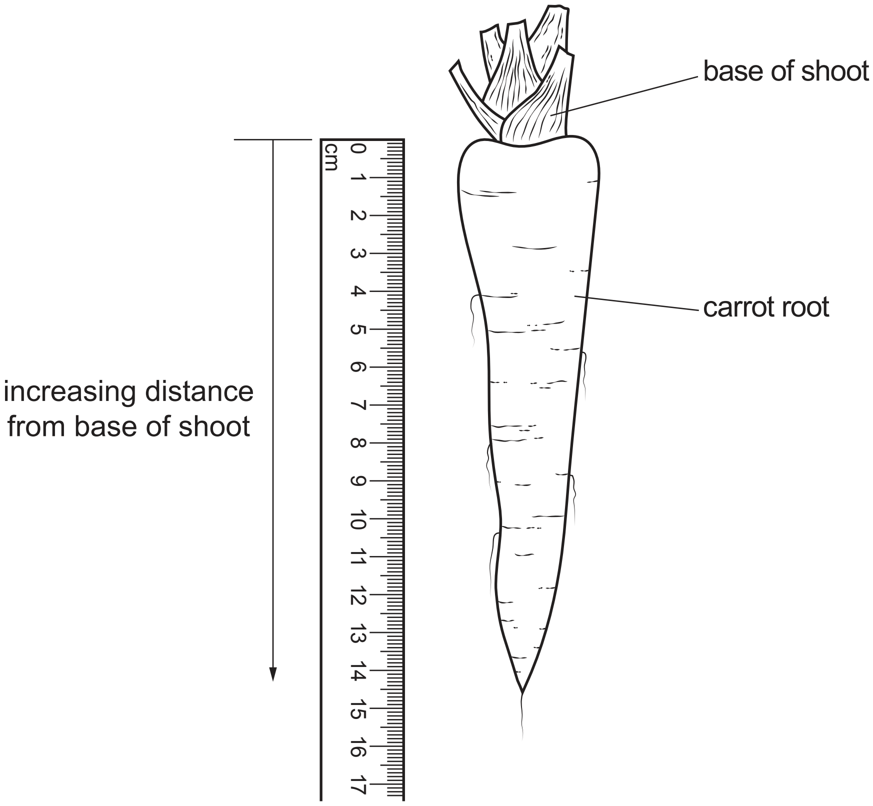

Fig. 1.5

(c) The student made the prediction:

As the distance from the base of the shoot increases, the catalase activity of carrot root tissue increases.

(i) Identify the **independent** variable in this investigation.

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(ii) Describe a method that the student could use to test the prediction that:

As the distance from the base of the shoot increases, the catalase activity of carrot root tissue increases.

Your method should be set out in a logical order and be detailed enough to allow another person to follow it.

Details of how to use the centrifuge to prepare the liquid carrot extract should **not** be included.

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(d) In a different investigation, the student determined the effect of hydrogen peroxide concentration on the activity of catalase in yeast.

- $5\,cm^3$ hydrogen peroxide solution was placed in a test-tube at 25 °C.
- 0.2 g dried yeast was added to the test-tube, so that the yeast cells formed a suspension in the hydrogen peroxide solution.
- A gas syringe was quickly connected to the test-tube using a bung and delivery tube, as shown in Fig. 1.6.
- The volume of gas collected after one minute was measured.

Fig. 1.6 shows the apparatus used by the student.

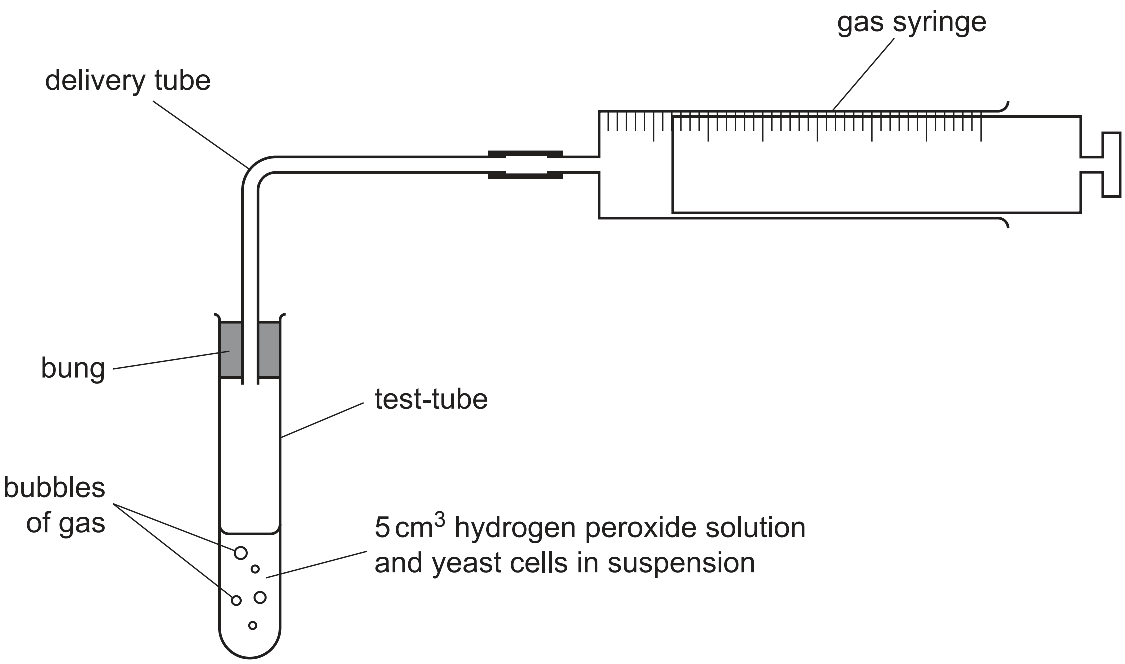

Fig. 1.6

(i) Identify the **dependent** variable in this investigation.

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(ii) To investigate the effect of hydrogen peroxide concentration on the activity of catalase in yeast, the student first prepared a range of known concentrations of hydrogen peroxide.

The student was given a 6.0% stock solution of hydrogen peroxide. The student decided to use the stock solution to make hydrogen peroxide solutions with concentrations of 3.0%, 3.6%, 4.8% and 5.4%.

The student made 50 cm^3 of each solution.

Complete Table 1.1 to show how these solutions could be made by **proportional dilution** of the 6.0% stock solution of hydrogen peroxide.

Table 1.1

percentage concentration of hydrogen peroxide	**volume of stock solution / cm^3**	**volume of .... / cm^3**
3.0		
3.6		
4.8		
5.4		

[2]

Use this space for your working.

(iii) Fig. 1.7 shows the results of the investigation.

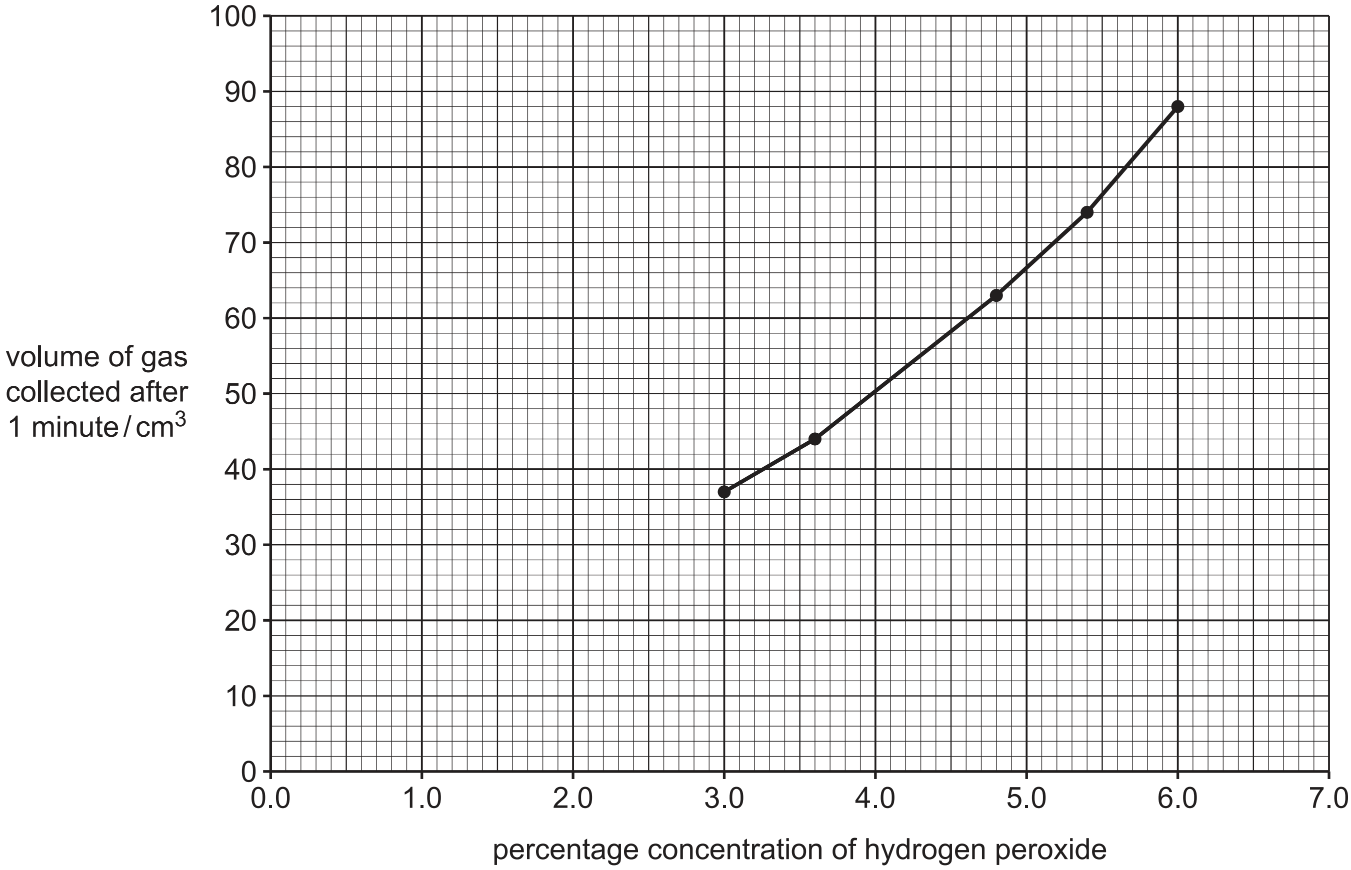

Fig. 1.7

The student made two conclusions:

- As the concentration of hydrogen peroxide increases, the volume of oxygen produced after one minute increases.
- The V_{max} of catalase is 88 cm^3.

Use the information shown in Fig. 1.7 to evaluate these conclusions.

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.... [3]

[Total: 15]

2 Sea trout, *Salmo trutta*, are found in rivers and coastal seawaters in many regions of the world.

Sea trout lay their eggs in rivers and the young fish remain in this freshwater environment. After living for 1–8 years in freshwater rivers, sea trout migrate to the sea. Adult sea trout feed in coastal seawater regions, usually no more than 80 km from their home river.

Fish farms that produce Atlantic salmon, *Salmo salar*, may be located in the coastal seawater regions where wild sea trout are also found.

Fig. 2.1 shows one cage at a fish farm.

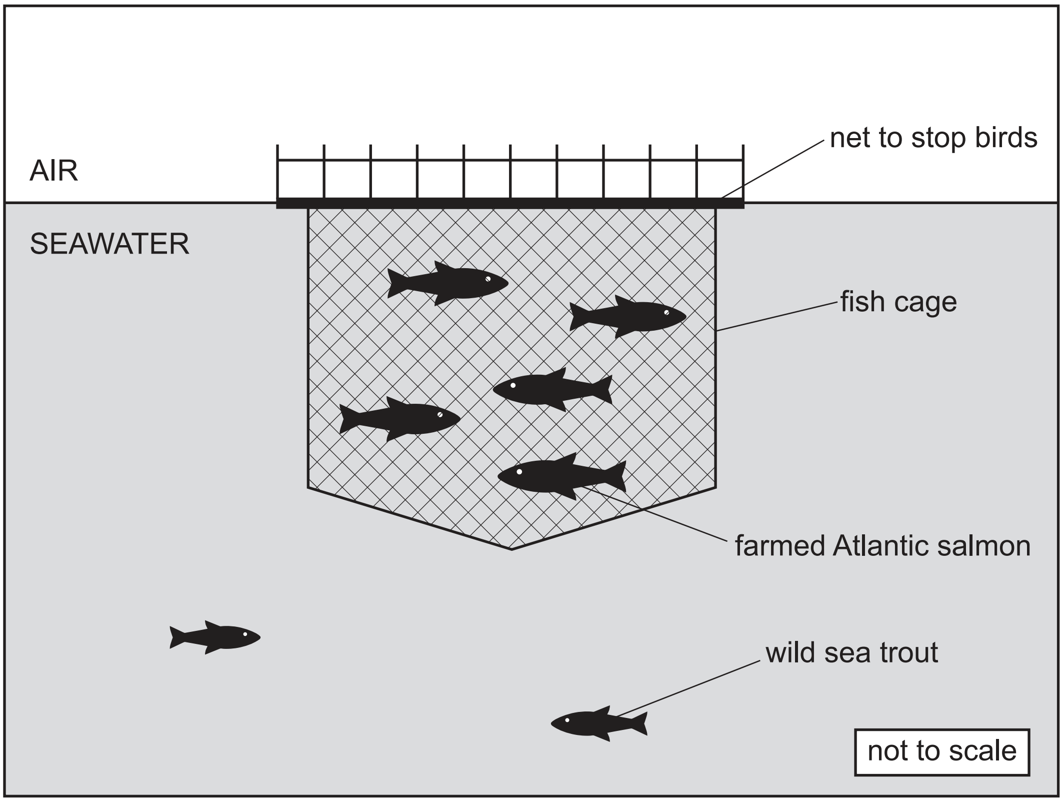

Fig. 2.1

The increase of fish farming is thought to have caused more infections by salmon lice, *Lepeophtheirus salmonis*, in wild fish such as sea trout. When sea trout enter coastal seawater regions, they can become infected with salmon lice.

Salmon lice larvae live in seawater and can move freely between fish cages and open seawater. Salmon lice attach to the skin of sea trout and feed on their skin and blood. The resulting tissue damage can sometimes cause the death of sea trout.

Fig. 2.2 shows a sea trout infected with salmon lice.

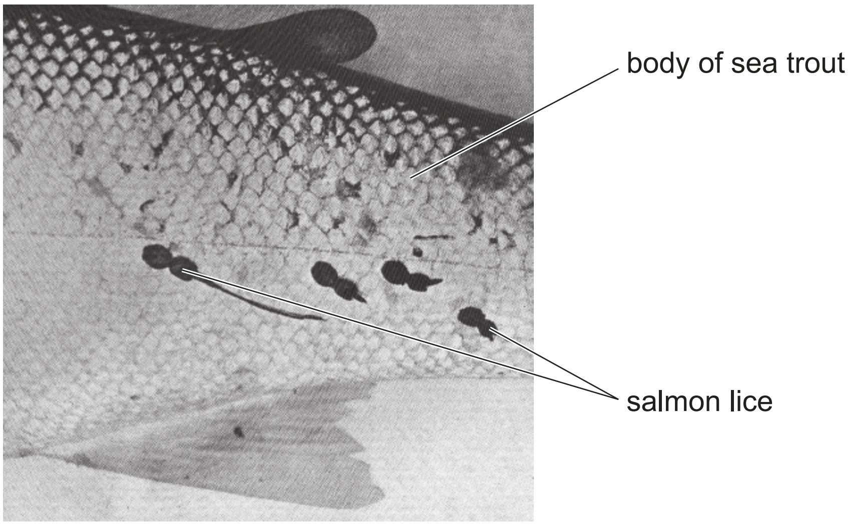

Fig. 2.2

(a) Some scientists found out from a published source that 13 or more attached salmon lice usually cause the death of a sea trout kept in laboratory conditions.

The scientists decided that each **wild** sea trout with 13 or more salmon lice is at risk of physiological stress and potential death.

Outline a laboratory method that could be used to determine the number of salmon lice needed to cause the death of a sea trout.

Suggest a suitable control that could be used to confirm that it is the salmon lice that are causing the death of the sea trout.

method that could be used ....

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suitable control ....

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[3]

(b) The scientists investigated the relationship between fish farming and infections by salmon lice on wild sea trout in coastal seawaters at Shieldaig on the west coast of Scotland in north-west Europe.

Fish farms use a two-year production cycle for Atlantic salmon. After hatching in freshwater tanks, the young salmon are transferred to seawater cages. Atlantic salmon spend two years growing in the seawater cages before they are harvested.

Infections by salmon lice on the farmed salmon are known to be higher in the second year of the two-year production cycle.

The scientists wanted to test the hypothesis:

Infections by salmon lice on wild sea trout in coastal seawaters at Shieldaig will be higher in the second year of the two-year production cycle of the fish farm near Shieldaig.

Electrofishing was used to sample the wild sea trout population in coastal seawater regions near the fish farm.

- A boat was used to travel to the sample location.
- An electric current was applied to the water around the boat. This causes some fish in the area to stop moving temporarily.
- A hand net was used to catch the fish that were not able to move.
- The number of sea trout caught was recorded.
- The number of salmon lice attached to each sea trout was also recorded.
- The fish were then returned to the sea.
- Sampling was repeated once a year for 10 years.

(i) State **one** variable that should be standardised in this procedure, **other than** the boat and the hand net.

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(ii) Electrofishing is more likely to prevent movement in larger fish.

State why this systematic error may give results that are **not** representative of the wild sea trout population.

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(c) The scientists collected data on infections by salmon lice on wild sea trout in coastal seawaters at Shieldaig every year from 2000 to 2009. During this time the fish farm near Shieldaig completed their two-year production cycle five times.

The data are shown in Table 2.1.

Table 2.1

year	year of production cycle	number of sea trout sampled	percentage of sea trout with attached salmon lice	percentage of sea trout with ⩾ 13 attached salmon lice
2000	1	15	13	data not collected
2001	2	87	31	data not collected
2002	1	31	6	3
2003	2	44	20	14
2004	1	15	0	0
2005	2	26	0	0
2006	1	39	8	5
2007	2	30	87	70
2008	1	14	0	0
2009	2	21	33	19

(i) Explain why the scientists calculated the percentages of sea trout with attached salmon lice.

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The scientists then calculated the mean percentage of sea trout with attached salmon lice in the first and second years of the fish farm production cycle.

These means are shown in Table 2.2.

Table 2.2

year of production cycle	mean percentage of sea trout with attached salmon lice	mean percentage of sea trout with ⩾ 13 attached salmon lice
1	6.1	2.6
2	33.2	14.9

The scientists concluded that greater numbers of wild sea trout in coastal seawaters at Shieldaig are at risk of death in the second year than in the first year of the two-year production cycle of the fish farm near Shieldaig.

(ii) Use Table 2.2 to describe the evidence that supports this conclusion.

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(iii) Suggest limitations of the data shown in Table 2.1 and Table 2.2 that reduce confidence in this conclusion.

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(d) The scientists then decided to use published data to investigate the effect of distance from fish farms on infection of wild sea trout by salmon lice in north-west Europe.

- 8 locations in coastal seawater regions of Scotland and 17 locations in coastal seawater regions of Ireland were sampled over several years.
- The number of salmon lice attached to each wild sea trout sampled was recorded.
- For each location, the distance from the nearest fish farm was recorded.

The scientists predicted that the number of attached salmon lice on wild sea trout will decrease as the distance from the nearest fish farm increases.

(i) State a null hypothesis the scientists would make before carrying out statistical analysis.

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The scientists then carried out statistical tests on the data to see if the relationship between the number of attached salmon lice on wild sea trout and the distance from the nearest fish farm was significant.

The probability values (p) from the results of the statistical tests are shown in Table 2.3.

Table 2.3

location	**value of *p***	**significance**
Ireland	0.001	....
Scotland	0.559	....

(ii) Complete Table 2.3 by indicating if the results of the statistical tests are significant **or** not significant. [1]

Fig. 2.3 shows the distance from the nearest fish farm plotted against the mean number of attached salmon lice per wild sea trout.

The error bars in Fig. 2.3 show 95% confidence intervals (95% CI).

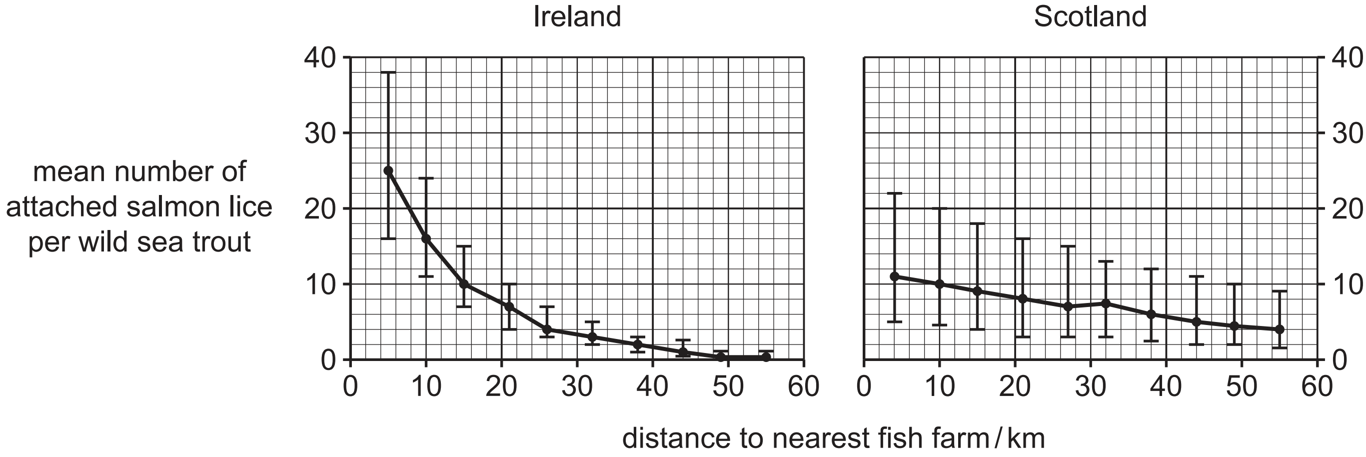

Fig. 2.3

(iii) With reference to Fig. 2.3, state the relationship between the distance from the nearest fish farm and the mean number of attached salmon lice per wild sea trout in the coastal seawater regions of Ireland.

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(iv) With reference to Fig. 2.3, suggest why the scientists calculated the 95% confidence intervals for their data.

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