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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3214706361

MARINE SCIENCE **9693/41**

Paper 4 A Level Data-handling and Investigative Skills **October/November 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.

[Turn over

Answer **all** questions.

1 Fig. 1.1 shows some barnacles and a dogwhelk on a rock.

Fig. 1.1

Adult barnacles are sessile and are often found attached to rocks on rocky shores. Barnacles have a complex life cycle with planktonic larvae.

(a) Explain why a complex life cycle is an advantage for sessile organisms.

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(b) The dogwhelk feeds on barnacles on rocky shores.

Scientists investigated whether the settlement of barnacles on a rocky shore was affected by:

- the presence of dogwhelks
- the quantity of phytoplankton in the sea water next to the shore.

The scientists placed 0.25 m^2 plastic tiles onto four rocky shores:

- one shore with a high quantity of phytoplankton in the sea and with dogwhelks present
- one shore with a high quantity of phytoplankton in the sea and with no dogwhelks present
- one shore with a low quantity of phytoplankton in the sea and with dogwhelks present
- one shore with a low quantity of phytoplankton in the sea and with no dogwhelks present.

All the tiles had a central area which dogwhelks could not access.

Fig. 1.2 shows one of the tiles used.

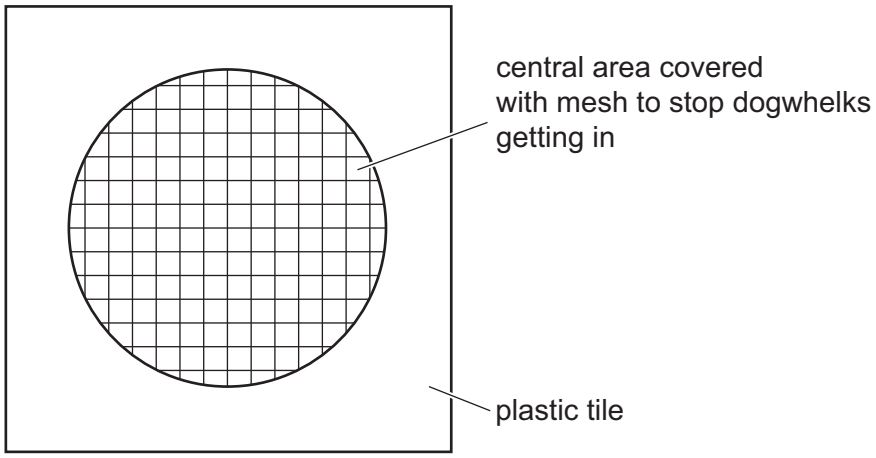

Fig. 1.2

The plastic tiles were examined after two months. The population densities of the barnacles growing in the central area which dogwhelks could not access were calculated.

(i) The central area of one plastic tile had 12 barnacles settled in an area of 0.0225 m^2.

Calculate the population density of barnacles for this plastic tile as the number of barnacles per m^2.

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

..... per m^2 [2]

Fig. 1.3 shows the population density of barnacles that had settled on the plastic tiles on all four rocky shores.

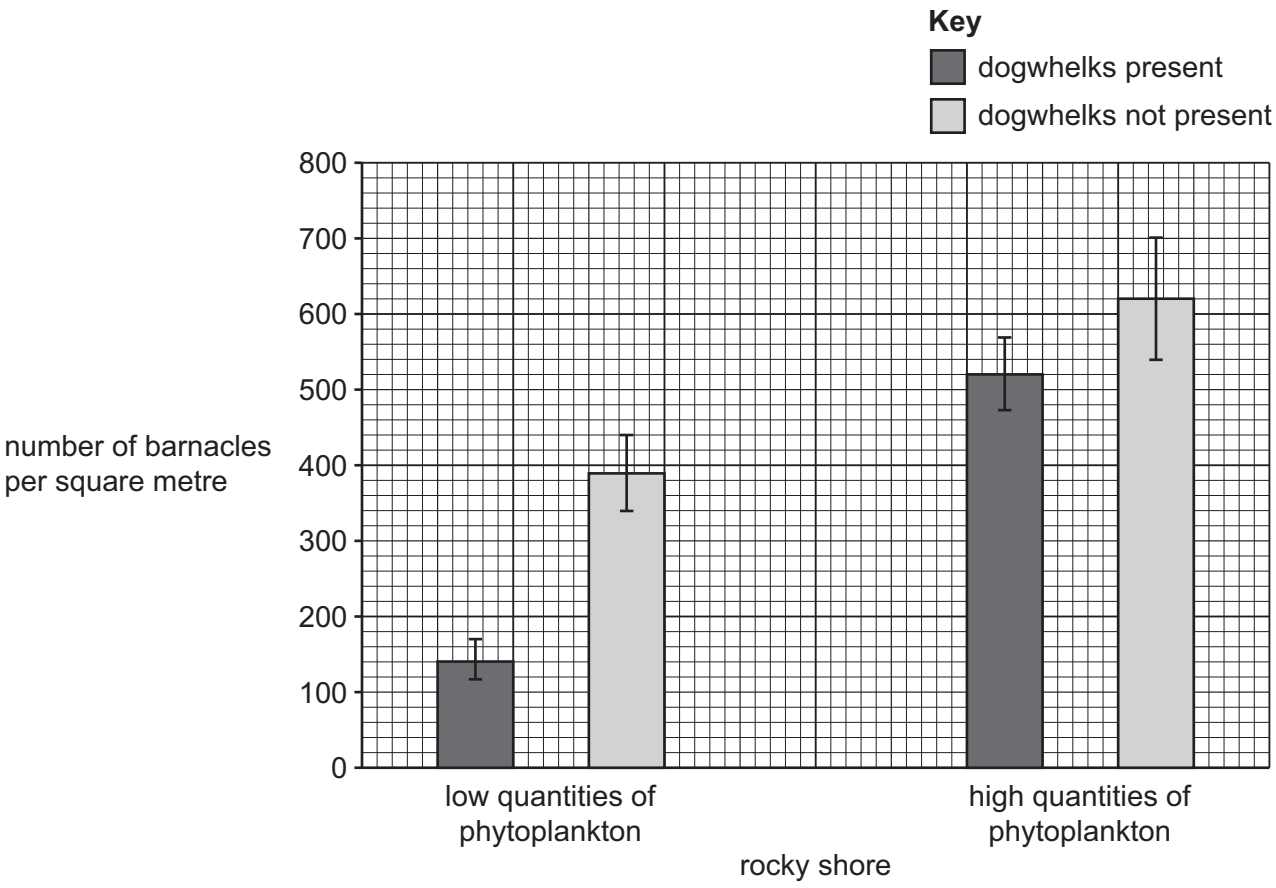

Fig. 1.3

(ii) Summarise the results of the investigation shown in Fig. 1.3.

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(iii) The scientists concluded that there was a strong probability that the presence of dogwhelks affects the settlement of barnacles onto rocks.

Discuss the extent to which the error bars for standard deviation shown in Fig. 1.3 support the scientists' conclusion.

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(iv) Suggest explanations for the effect of dogwhelks **and** quantities of phytoplankton on the settling of the barnacles.

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(c) The acorn barnacle has spread all around the world on ships and is now considered to be an invasive species.

(i) Explain why invasive species are a risk to ecosystems.

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(ii) It has been suggested that introducing dogwhelks into new areas colonised by acorn barnacles could be a method of control.

Suggest a possible negative consequence of introducing dogwhelks into areas with acorn barnacles.

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[Total: 15]

2 Plaice is a benthic flatfish caught by commercial fishing ships. Plaice gather in breeding areas during breeding seasons.

Scientists investigated the effect of benthic trawling on the fishing mortality of plaice.

The scientists determined the fishing mortality of male and female plaice of different ages during the breeding season and outside the breeding season.

The results are shown in Fig. 2.1.

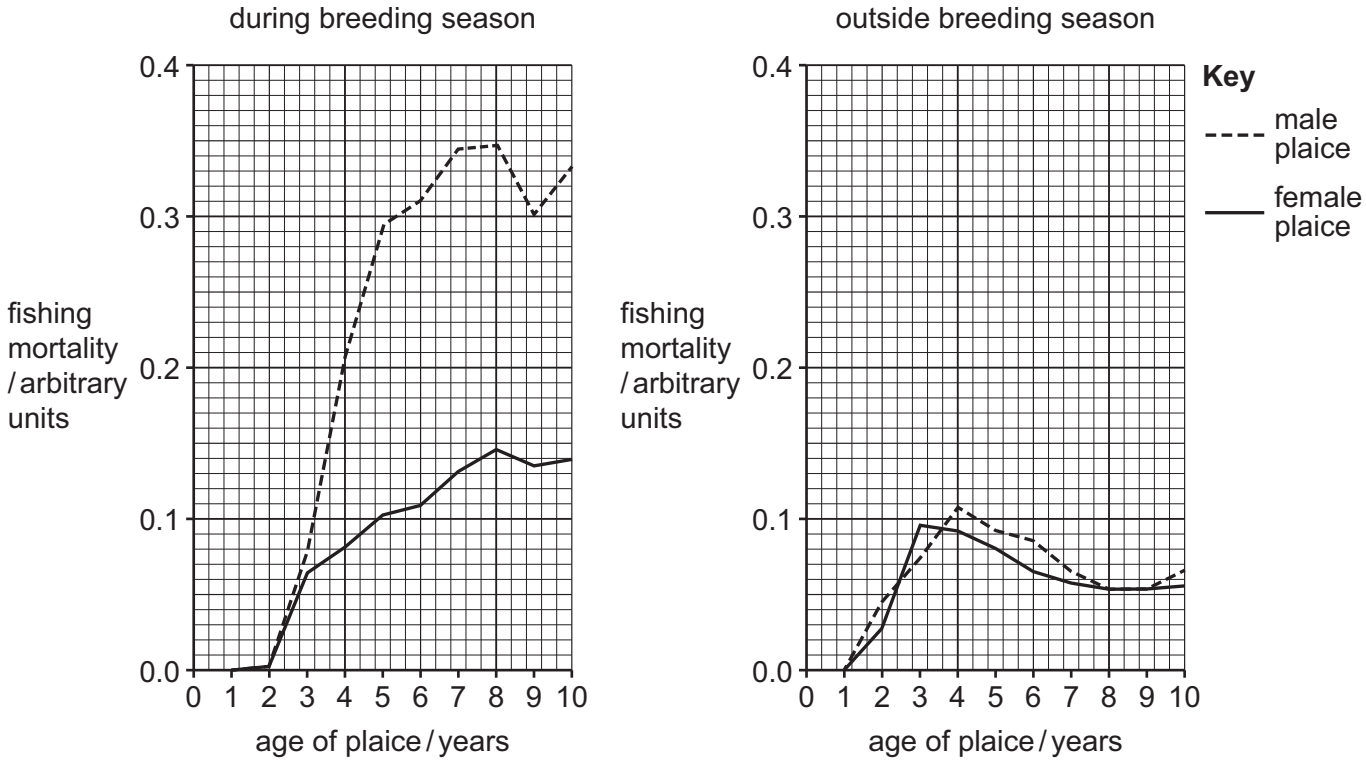

Fig. 2.1

(a) (i) Compare the fishing mortality of plaice during the breeding season and outside the breeding season.

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(ii) Suggest a reason for the difference in fishing mortality of male and female plaice during the breeding season.

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(iii) Suggest a reason for the difference in the fishing mortality of plaice during the breeding season and outside the breeding season.

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(iv) Use Fig. 2.1 to explain why intensive harvesting of plaice during the breeding season would affect the sustainability of the population.

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(b) In a further investigation, scientists investigated the gonadosomatic index (GSI) and price of plaice over a period of 48 weeks.

Gonad tissues are ovaries and testes. Gonad tissue increases in size during breeding seasons.

The gonadosomatic index (GSI) is the mass of gonad tissue divided by the total body mass.

The results are shown in Table 2.1.

Table 2.1

week	mean gonadosomatic index (GSI)	mean price per kilogram / USD ($)
1	0.14	1.8
12	0.03	2.5
24	0.02	3.4
36	0.03	3.8
48	0.10	2.1

(i) GSI is calculated using the formula:

$$\text{GSI} = \frac{\text{mass of gonad tissue}}{\text{total body mass}}$$

Calculate the mass of gonad tissue in a plaice with a total body mass of 825 g caught during week 1.

State the unit.

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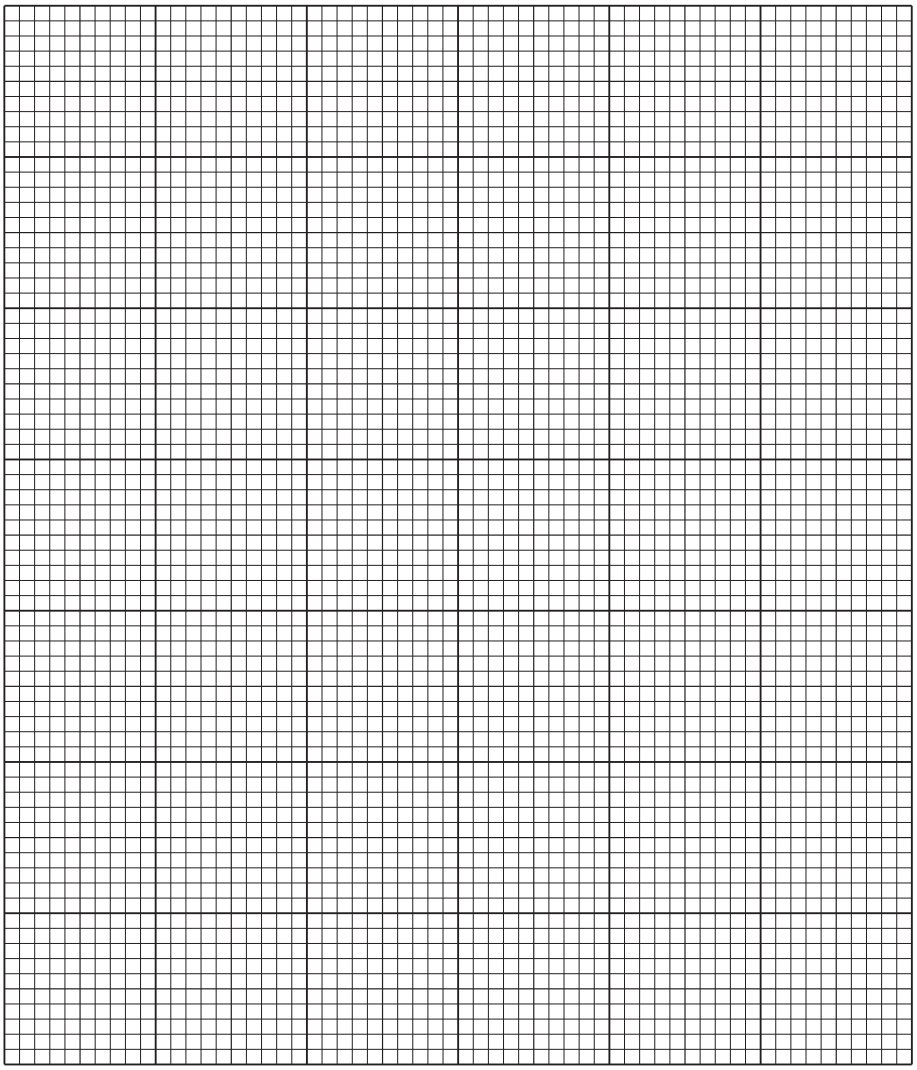
[2]

(ii) Use Table 2.1 to draw a graph to show the GSI and price per kilogram of fish over the 48-week period.

Join your points with straight, ruled lines.



[6]

(iii) Discuss the changes in GSI **and** the price of plaice over the 48-week period shown in Table 2.1 **and** the implications for the conservation of plaice.

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[Total: 19]

3 Agriculture poses a threat to coral reefs in many parts of the world due to the run-off of fertilisers and herbicides into the sea.

(a) Explain how fertiliser run-off can pose a threat to coral reefs.

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(b) Herbicides are chemicals that are used to kill weeds on farmland.

Scientists investigated the effect of herbicides on the production of ATP, the production of reduced NADP and the rate of carbon fixation by dinoflagellates.

Suspensions of chloroplasts taken from dinoflagellates were placed into a test-tube in bright light. The concentrations of ATP, reduced NADP and glucose were measured at time 0.

Herbicide was added to the test-tube and the concentrations of ATP, reduced NADP and glucose were measured after 10 minutes, 20 minutes and 30 minutes.

The results are shown in Table 3.1.

Table 3.1

time / min	concentration of ATP / arbitrary units	concentration of reduced NADP / arbitrary units	concentration of glucose / arbitrary units
0	25	21	15
10	15	15	15
20	10	5	10
30	10	1	5

(i) Compare the change in concentration of ATP with the change in the concentration of reduced NADP over the 30-minute period.

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(ii) The herbicide reduces the concentration of chlorophyll in the chloroplasts of dinoflagellates.

Explain the effect of adding herbicide on the changes in concentration of ATP and reduced NADP shown in Table 3.1.

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(iii) Explain the effect of adding herbicide on the change in concentration of glucose shown in Table 3.1.

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(c) Marine diatoms are planktonic producers.

Fig. 3.1 shows a photograph of some marine diatoms.

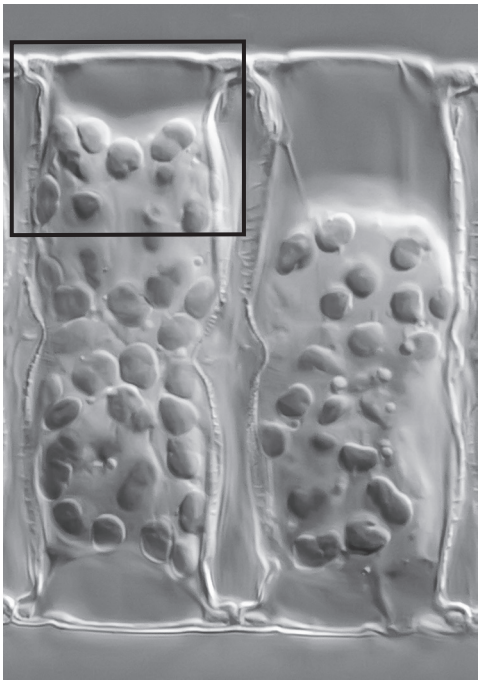

Fig. 3.1

Make a large drawing of the part of the diatom shown inside the box in Fig. 3.1.

Do **not** label your diagram.

[4]

[Total: 15]

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4 Fig. 4.1 shows a female green sea turtle returning to the sea after laying eggs in a nest.

Fig. 4.1

Conservationists are concerned that global warming could lead to a reduction in populations of green sea turtles.

(a) Explain how an enhanced greenhouse effect leads to global warming.

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(b) The sex of turtles is controlled by the temperature at which the eggs develop within the nest.

Fig. 4.2 shows the effect of temperature on the percentage of hatched turtles that are female.

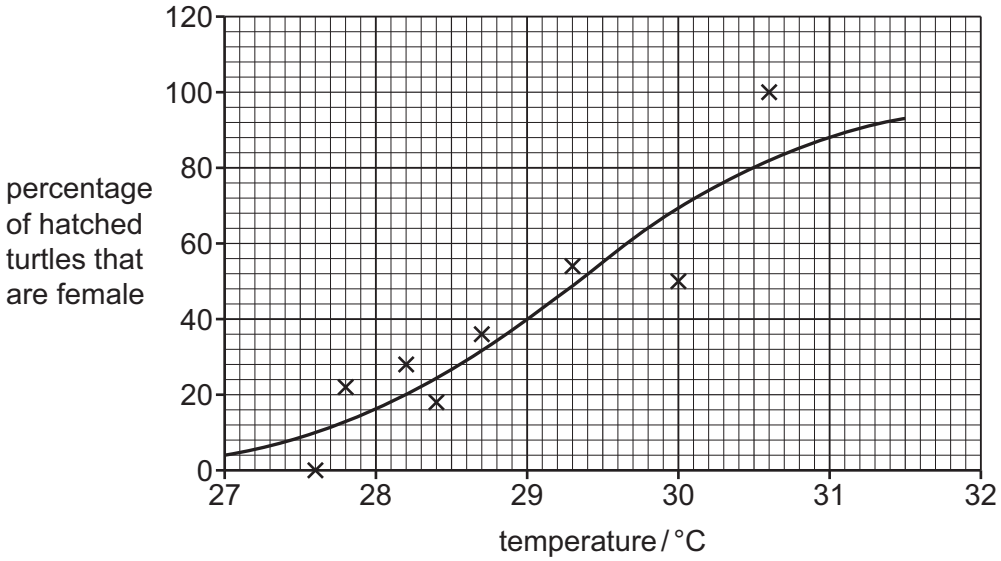

Fig. 4.2

(i) Use Fig. 4.2 to predict the percentage of turtles that would be female when eggs develop at a temperature of 29.5 °C.

.....% [1]

(ii) Green sea turtles nest on beaches in Suriname between June and November.

During the breeding period in 2001 the temperature of the sand ranged between 29 °C and 31 °C. Some scientists are predicting that the mean global temperature will rise between 2 °C and 4 °C by the year 2100.

Use Fig. 4.2 **and** your own knowledge to suggest **and** explain the impact of a global temperature rise on green sea turtle populations.

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(c) Conservationists have been running captive breeding and release programmes to help conserve green sea turtles since 1990.

Eggs are taken from nests and incubated in protected areas. After hatching, the young are released into the sea from the beach that the eggs were taken from.

Female turtles return to the beach that they were released from and lay their eggs.

The number of eggs on a beach was estimated every month over a period of five months in 1990 and 2017. The results are shown in Table 4.1.

Table 4.1

month	estimated number of eggs	
	1990	**2017**
June	530	790
July	650	890
August	750	990
September	690	980
October	610	800

These data were used to calculate the mean estimated numbers of eggs per month and standard deviations. The results are shown in Table 4.2.

Table 4.2

year	mean estimated number of eggs per month	standard deviation
1990	646	83
2017	890	95

(i) Calculate the standard error for the mean estimated number of eggs per month on the beach in 2017.

Use the formula:

$$\text{standard error, } S_M = \frac{s}{\sqrt{n}}$$

s = standard deviation
n = sample size (number of months that samples were collected)

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[1]

(ii) Use your answer to **(c)(i)** to calculate the 95% confidence interval for the mean estimated number of eggs per month on the beach in 2017.

Use the formula:

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

$\bar{x}$ = mean
S_M = standard error

95% confidence interval: ..... to ..... [1]

(iii) The 95% confidence interval for the mean estimated number of eggs per month on the beach in 1990 is 646 ± 74.

Use your answer to **(c)(ii)** to assess whether the captive breeding and release of the turtles has successfully led to an increase in the mean estimated number of turtle eggs per month in 2017 compared with 1990.

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[Total: 12]

5 Marine organisms are affected by the salinity of sea water.

(a) Explain why tuna need to constantly drink sea water.

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(b) Some kelp species can adapt the water potential of their cells to match the surrounding sea water.

Plan a laboratory investigation that you could do to compare the water potential of cells of kelp collected from an estuary **and** a rocky shore.

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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