



CANDIDATE
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9693/21

May/June 2023

1 hour 45 minutes

You must answer on the question paper.

No additional materials are needed.

- 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.

- 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 **28** pages. Any blank pages are indicated.

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Answer **all** questions.

- 1 Fig. 1.1 shows apparatus used to investigate the rate of photosynthesis.

The distance of the lamp from the boiling tube can be altered, which changes the intensity of the light falling onto the aquatic plant. Oxygen released by the photosynthesising aquatic plant is collected by the gas syringe and the volume measured.

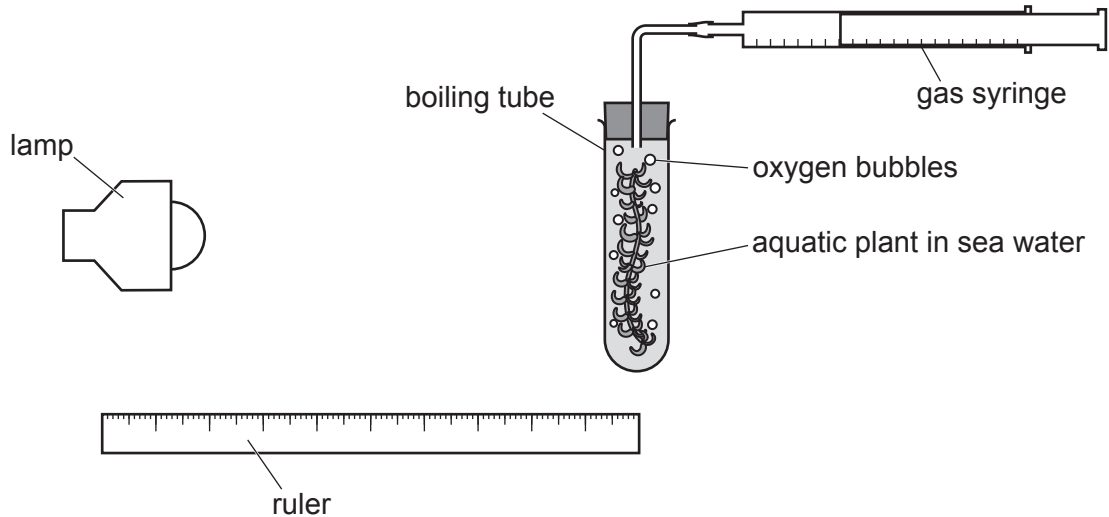


Fig. 1.1

- (a) (i) Identify the independent variable and dependent variable in this investigation.

independent variable

.....

dependent variable

.....

[2]

- (ii) The temperature and nutrient content of the water was standardised.

Suggest **two** other variables that should be standardised.

1

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2

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[2]

(b) Table 1.1 shows a set of results collected using the apparatus shown in Fig. 1.1.

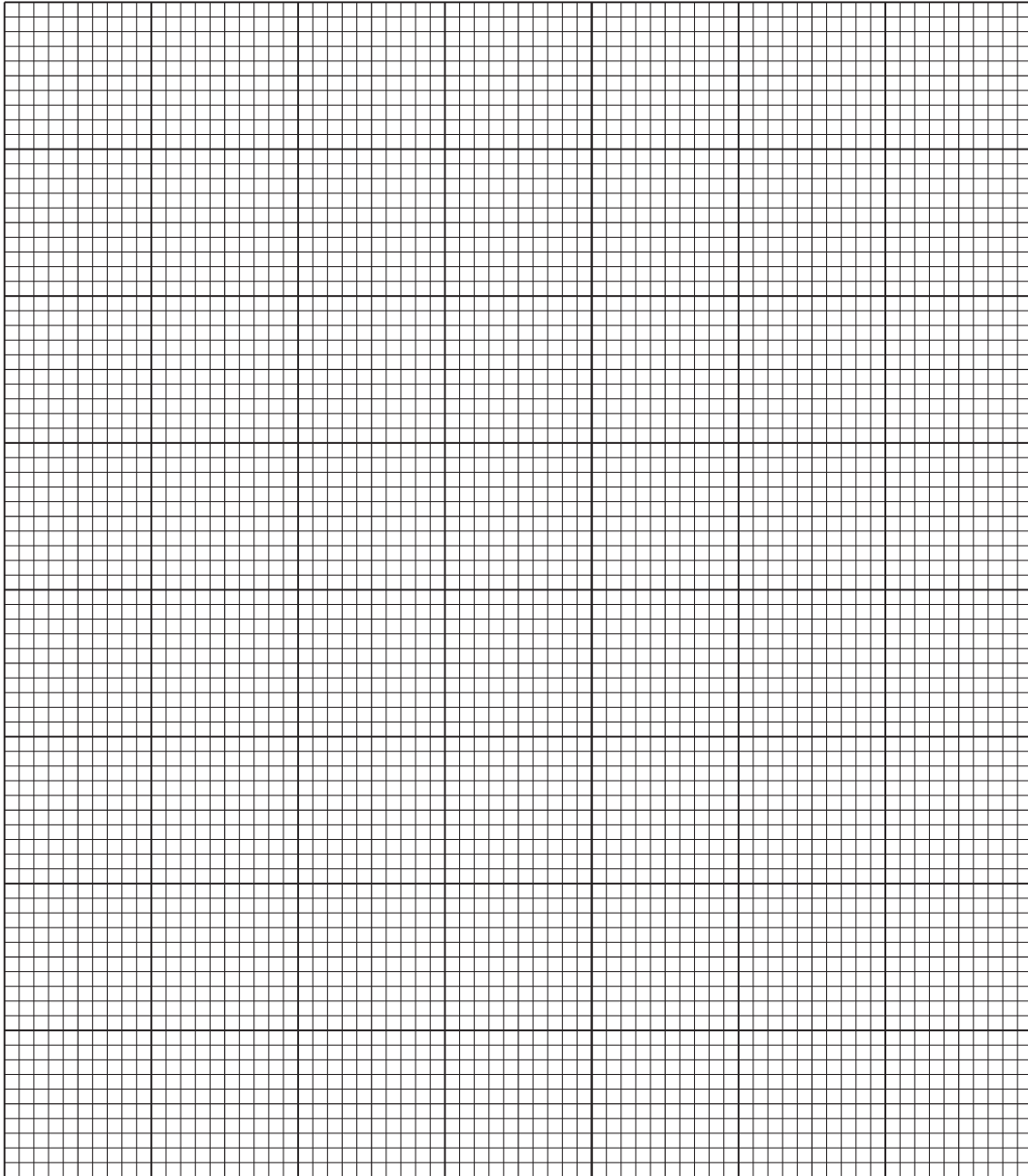
Table 1.1

distance of lamp from boiling tube/cm	volume of oxygen produced in 60 minutes/cm ³			
	trial 1	trial 2	trial 3	mean
10	7.0	7.3	7.3	7.2
20	6.2	5.7	5.8	5.9
30	4.6	4.9	4.6	4.7
40	3.5	3.5	3.5	3.5
50	2.8	2.9	3.0	2.9
60	2.5	2.2	2.5	2.4

(i) Name **one** additional piece of laboratory equipment needed to collect these results.

..... [1]

- (ii) Plot a graph showing the relationship between the distance of the lamp from the boiling tube and the mean volume of oxygen produced in 60 minutes.



[4]

- (iii) Explain the relationship shown between the distance of the lamp from the boiling tube and the volume of oxygen produced in 60 minutes.

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..... [3]

- (c) In a further investigation, phytoplankton were placed in tanks containing either sea water that was enriched with nitrate ions, or sea water that was deficient in nitrate ions. Nitrate ions are a source of nitrogen for producers.

Scientists measured the rate of photosynthesis in phytoplankton in nitrate-enriched and nitrate-deficient sea water.

The investigation was repeated at a range of different temperatures.

The results are shown in Fig. 1.2.

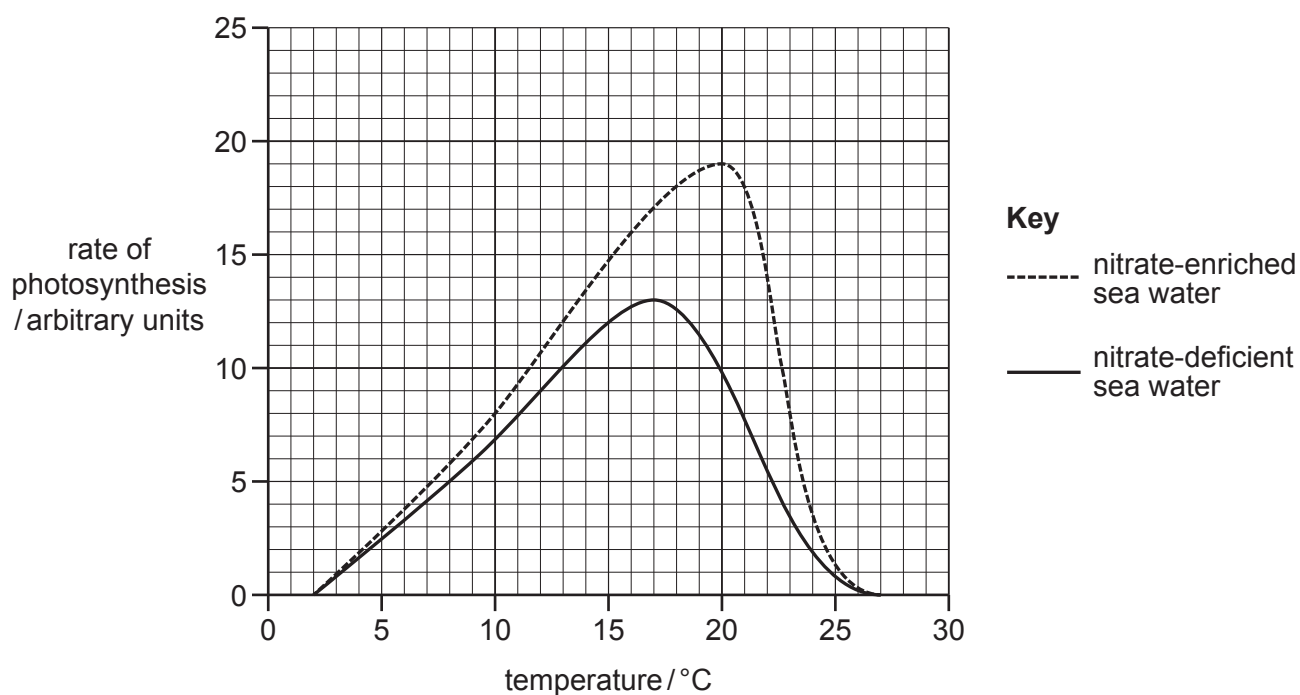


Fig. 1.2

- (i) Compare the effect of temperature on the rate of photosynthesis in nitrate-enriched and nitrate-deficient sea water.

Use data from Fig. 1.2 to support your answer.

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..... [3]

- (ii) Explain why the productivity of the phytoplankton would be higher in nitrate-enriched sea water.

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..... [2]

[Total: 17]

- 2 Scientists investigated the effect of sea water pH on the change in mass of a species of coral, species **A**.

The coral was grown in separate tanks containing sea water of different pH values.

The increase in mass of the coral at each pH was recorded after 60 days.

- (a) (i) The pH of a solution is a measurement of the concentration of an ion.

Name this ion.

..... [1]

- (ii) Suggest **one** way of measuring the pH of sea water in each tank.

..... [1]

- (b) Draw a table that is suitable to record the results of this investigation.

Include full headings in the results table, but do **not** write in any results.

Include units where appropriate.

[2]

- (c) The investigation was repeated with another species of coral, species **B**.

The percentage change in mass for each coral species was calculated.

Fig. 2.1 shows the results for the two species of coral.

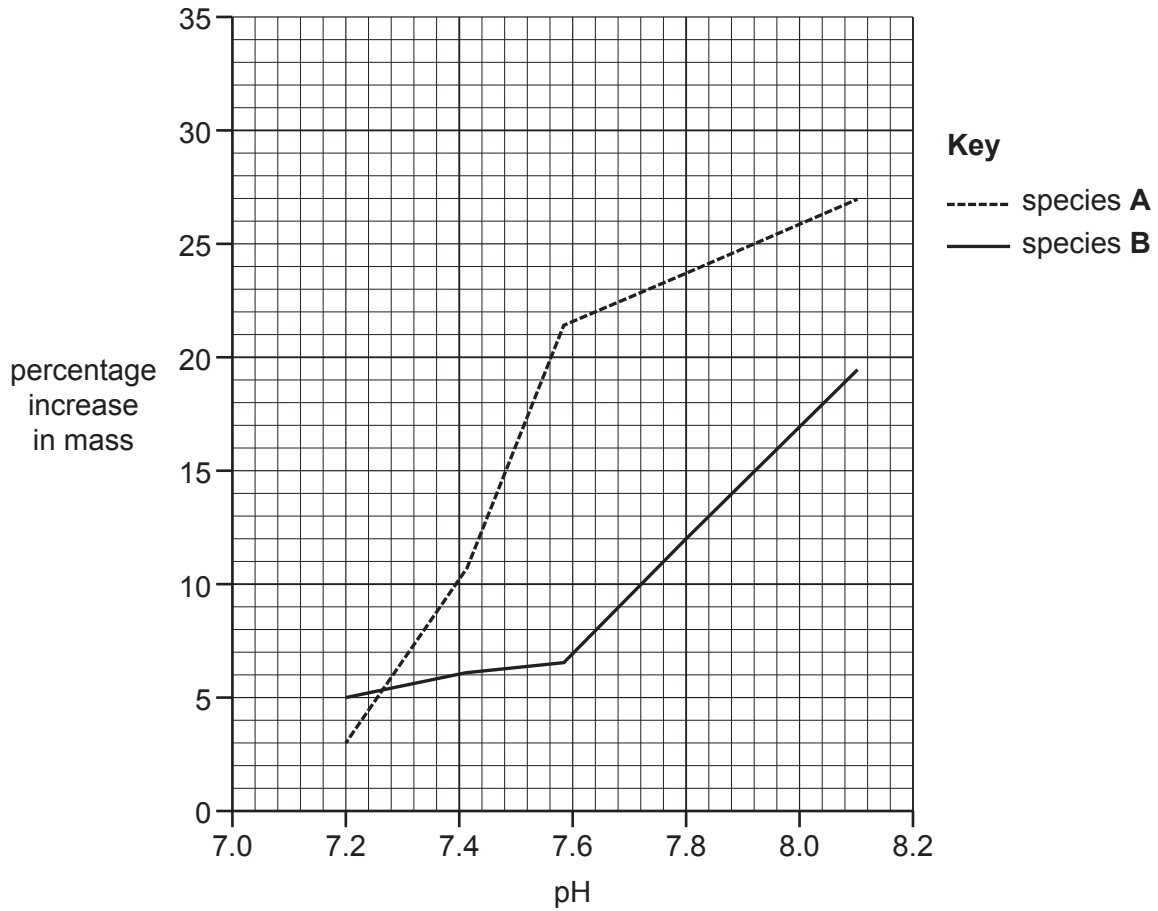


Fig. 2.1

- (i) The mean global pH of sea water is 8.1.

Predict which species will be more affected if the sea water pH drops by 0.2.

Use the data in Fig. 2.1 to support your answer.

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..... [2]

- (ii) Predict what would happen to the growth of each species of coral if the investigation was repeated at pH 7.0.

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..... [2]

(d) A decrease in sea water pH contributes to reef erosion.

State **two** other factors that contribute to reef erosion.

1

2

[2]

[Total: 10]

3 Mangrove forests are globally threatened ecosystems.

(a) Describe **one** adaptation of the red mangrove tree (*Rhizophora mangle*) for its environment.

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 [1]

(b) Mangrove forests can be regenerated by growing mangrove seedlings in controlled conditions and planting them into their native forest ecosystems.

Scientists investigated the survival of three species of mangrove seedlings (species **X**, **Y** and **Z**) in different salinities of sea water.

50 seedlings of each species were grown in three different salinities:

- low salinity (4 ppt)
- moderate salinity (16 ppt)
- high salinity (34 ppt).

The seedlings were kept at these salinities for 30 weeks.

The percentage of seedlings surviving was recorded every two weeks.

(i) Suggest how the scientists created the different salinity treatments.

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 [2]

(ii) Describe **two** ways in which this investigation could be improved.

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 [2]

(c) Fig. 3.1 shows the results from this investigation.

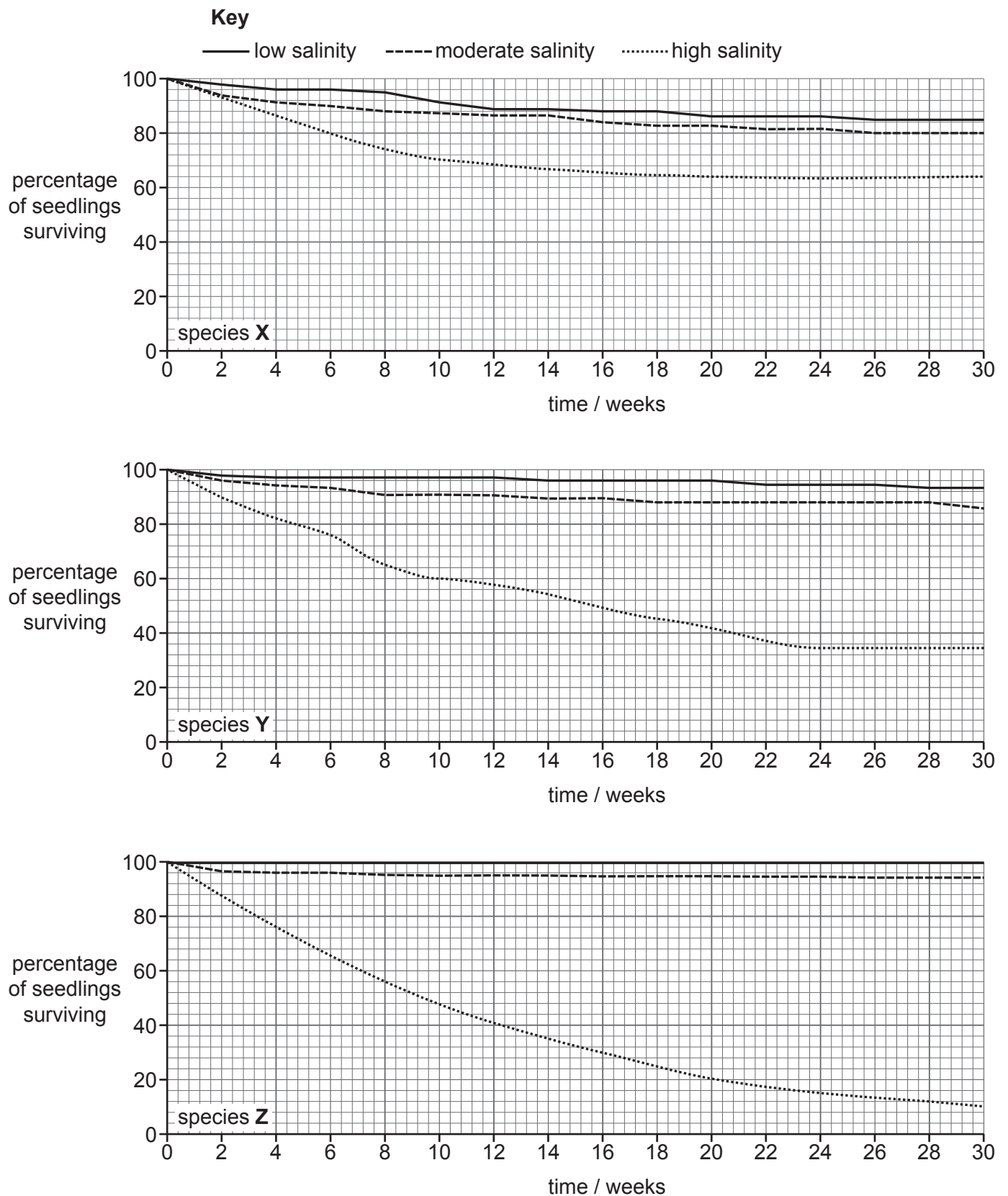


Fig. 3.1

- (i) Describe how the percentage of seedlings surviving in each salinity was calculated.

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

- (ii) Calculate how many seedlings of species **Z** survived the first 10 weeks of the investigation in the highest salinity.

Show your working.

..... [2]

(d) Fig. 3.2 shows three locations, **A**, **B** and **C**, in a delta.

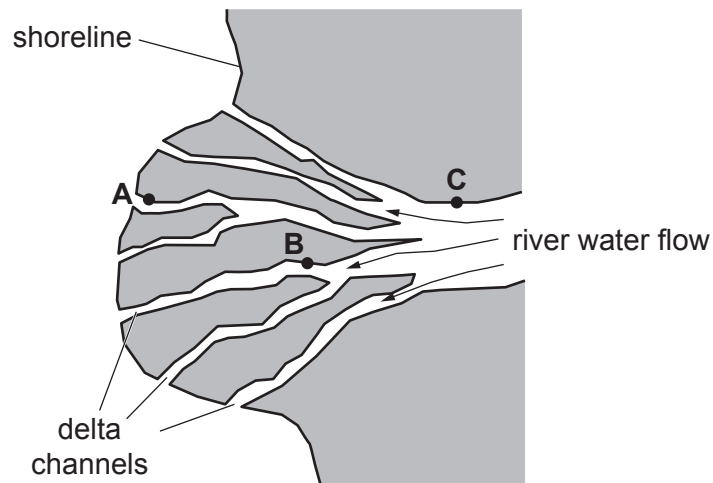


Fig. 3.2

Use the information in Fig. 3.1 **and** Fig. 3.2 to suggest which species is best adapted to survive at location **A**.

Explain your answer.

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..... [3]

(e) At the delta, seedlings will be exposed to changes in the tidal cycle.

Suggest why the tidal cycle will cause variations in the salinity of the water at location **B**.

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..... [3]

- (f) The conservation of mangrove ecosystems is important for human populations.

State **two** benefits.

1

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2

..... [2]

[Total: 16]

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4 Sandy shore ecosystems often have low biodiversity.

Scientists investigated abiotic factors that affect biodiversity on sandy shores.

(a) State the meaning of the term abiotic factor.

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..... [1]

(b) The scientists investigated the relationship between the gradient of the shore, particle size and biodiversity on 12 sandy shores, **A–L**, at low tide.

The gradient of each shore was recorded as a percentage: the higher the percentage, the steeper the gradient.

The mean number of species per m² on each shore was estimated using sampling techniques.

Describe a method that could be used to sample the mean number of species per m² present on each shore.

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..... [5]

(c) Table 4.1 shows the data collected from the investigation.

Table 4.1

shore	shore gradient percentage	mean particle size/ μm	mean number of species per m^2
A	10.7	538	4.5
B	8.8	959	1.2
C	4.2	319	8.0
D	11.4	895	2.9
E	3.5	253	9.4
F	6.5	474	5.7
G	6.2	311	7.5
H	6.4	316	5.3
I	4.5	313	7.9
J	6.9	449	4.7
K	4.2	264	5.6
L	9.6	460	4.6

Fig. 4.1 is a scatter diagram showing the relationship between the mean number of species per m^2 and shore gradient percentage.

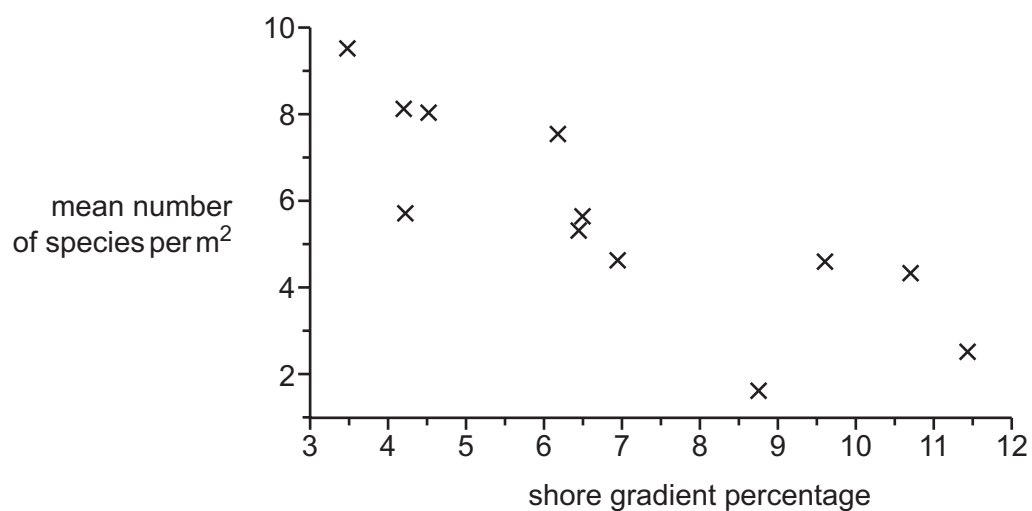


Fig. 4.1

- (i) Scientists used Spearman's rank correlation (r_s) to decide if there was a correlation between the mean number of species per m² and shore gradient percentage.

The calculation for Spearman's rank correlation (r_s) uses the following equation:

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

where,

Σ = sum of (total)

n = number of pairs of items in the sample

D = difference in rank between each pair of measurements

A value of 539.5 was calculated for ΣD^2 .

Use this value and the information in Table 4.1 to calculate the value for r_s .

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

Show your working.

$$r_s = \dots\dots\dots [3]$$

- (ii) Use your calculated value for r_s in (c)(i) to describe the correlation between mean number of species per m² and shore gradient percentage.

Explain your answer.

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..... [2]

- (iii) Fig. 4.2 is a scatter diagram showing the relationship between mean number of species per m^2 and mean particle size.

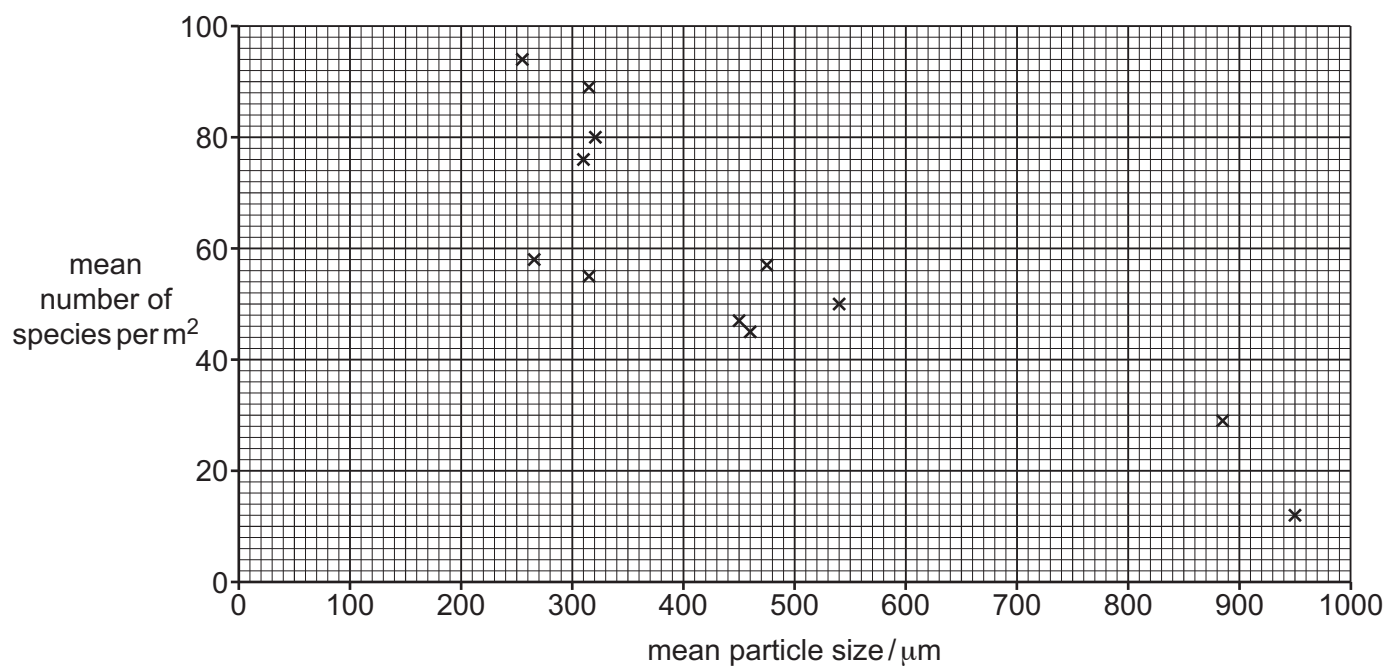


Fig. 4.2

Spearman's rank correlation was performed again for this data and an r_s value of -0.80 was calculated.

Use this value and the one calculated in part (c)(i) to discuss the effect of shore gradient percentage **and** particle size on the biodiversity of sandy shores.

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..... [3]

- (d) Suggest why particle size **and** shore gradient percentage may have an effect on the number of species per m² found on each shore.

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..... [4]

- (e) Simpson's index of diversity could be used to assess the biodiversity on each shore.

Suggest why this would be a better measure of biodiversity than data used in this investigation.

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..... [1]

[Total: 19]

5 Fig. 5.1 shows a blue shark.

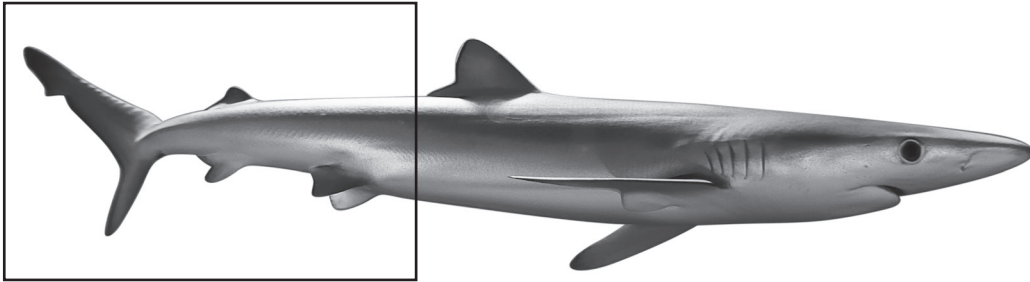


Fig. 5.1

(a) Make a large drawing of part of the blue shark shown in the box in Fig. 5.1.

Do **not** label your diagram.

- (b) Blue sharks mainly inhabit the epipelagic zone.

State what is meant by the epipelagic zone.

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

- (c) Explain why blue sharks are described as carnivores **and** predators.

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..... [2]

- (d) Blue sharks have been extensively fished in many parts of the world, but little is known about their population size.

Information about their population size is estimated by studying catch data from blue shark fisheries.

Fig. 5.2 shows the global annual blue shark catch and the catch effort from 1980 to 2017. The catch effort is the global number of days that all boats spend fishing for blue shark.

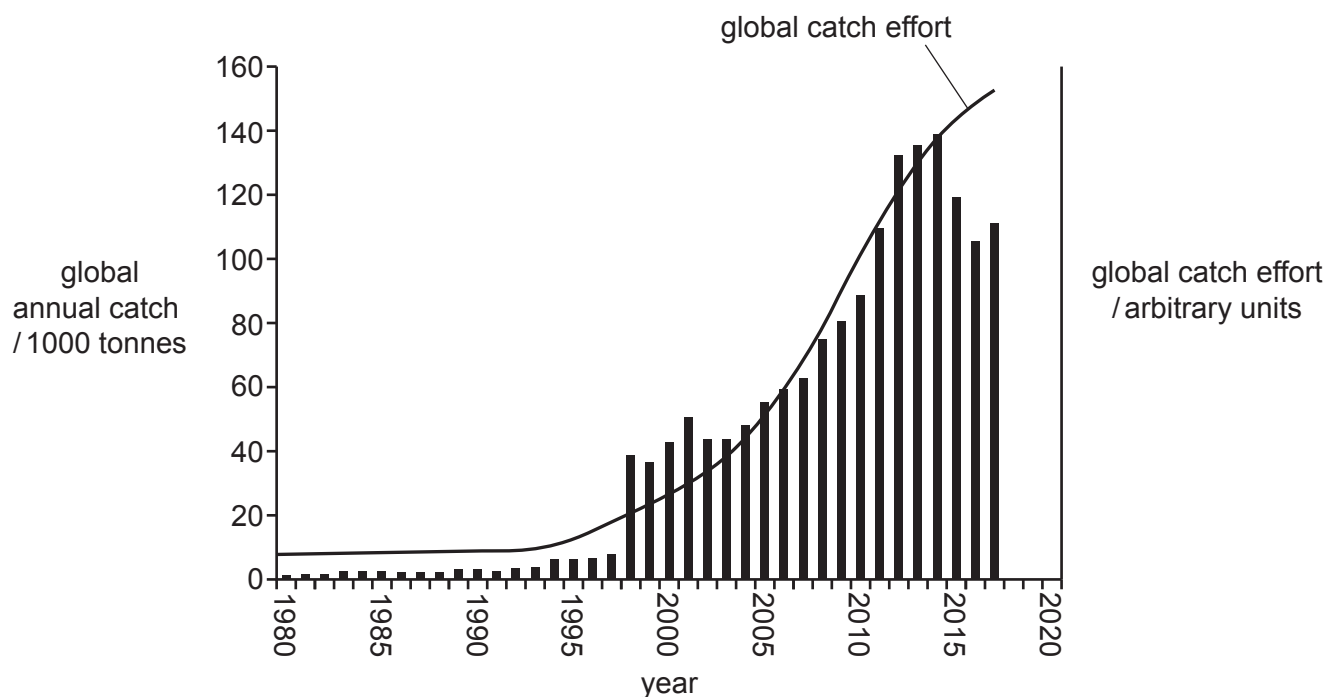


Fig. 5.2

- (i) Compare the catch **and** catch effort trends shown in Fig. 5.2.

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..... [2]

- (ii) Evaluate how useful these data are for understanding the population trends of the blue shark.

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..... [2]

- (iii) The size of some populations can be estimated using the Lincoln index.

Suggest why this index is **not** suitable to use for a mainly epipelagic species such as the blue shark.

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..... [2]

[Total: 13]

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