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MARINE SCIENCE**9693/23**

Paper 2 AS Level Data-handling and Investigative Skills

October/November 2025**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 **24** pages. Any blank pages are indicated.

Answer **all** questions.

- 1 (a) Fig. 1.1 shows a species of starfish.

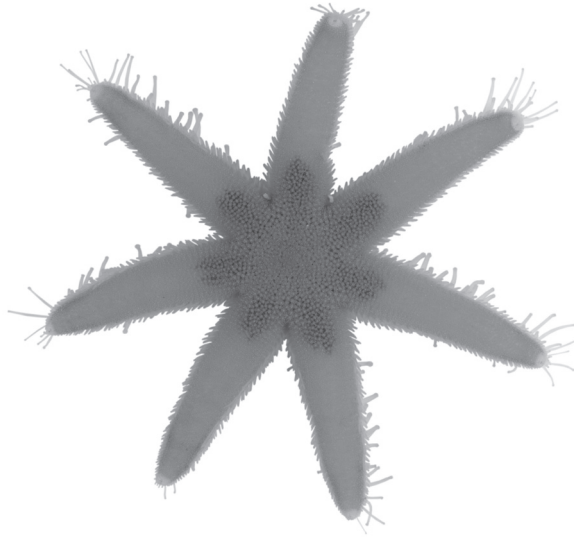


Fig. 1.1

- (i) Make a large drawing of the starfish shown in Fig. 1.1.

Do **not** include markings.

Do **not** label your drawing.



(ii) State why this starfish species is **not** a typical echinoderm.

.....

..... [1]

(b) Starfish regrow their arms if they become damaged.

Fig. 1.2 shows a different starfish species with a damaged arm.



Fig. 1.2

Starfish arms can be damaged by the impact of humans.

Suggest **one** other way a starfish arm can become damaged.

.....

..... [1]



- (c) Scientists investigated if the number of arms damaged affected the rate at which the arms can regrow.

Starfish with damaged arms were collected from one shoreline.

The starfish were placed in a tank of sea water in a laboratory and fed daily.

The scientists measured the length of the damaged arms every 50 days over a period of 300 days.

Fig. 1.3 shows the results.

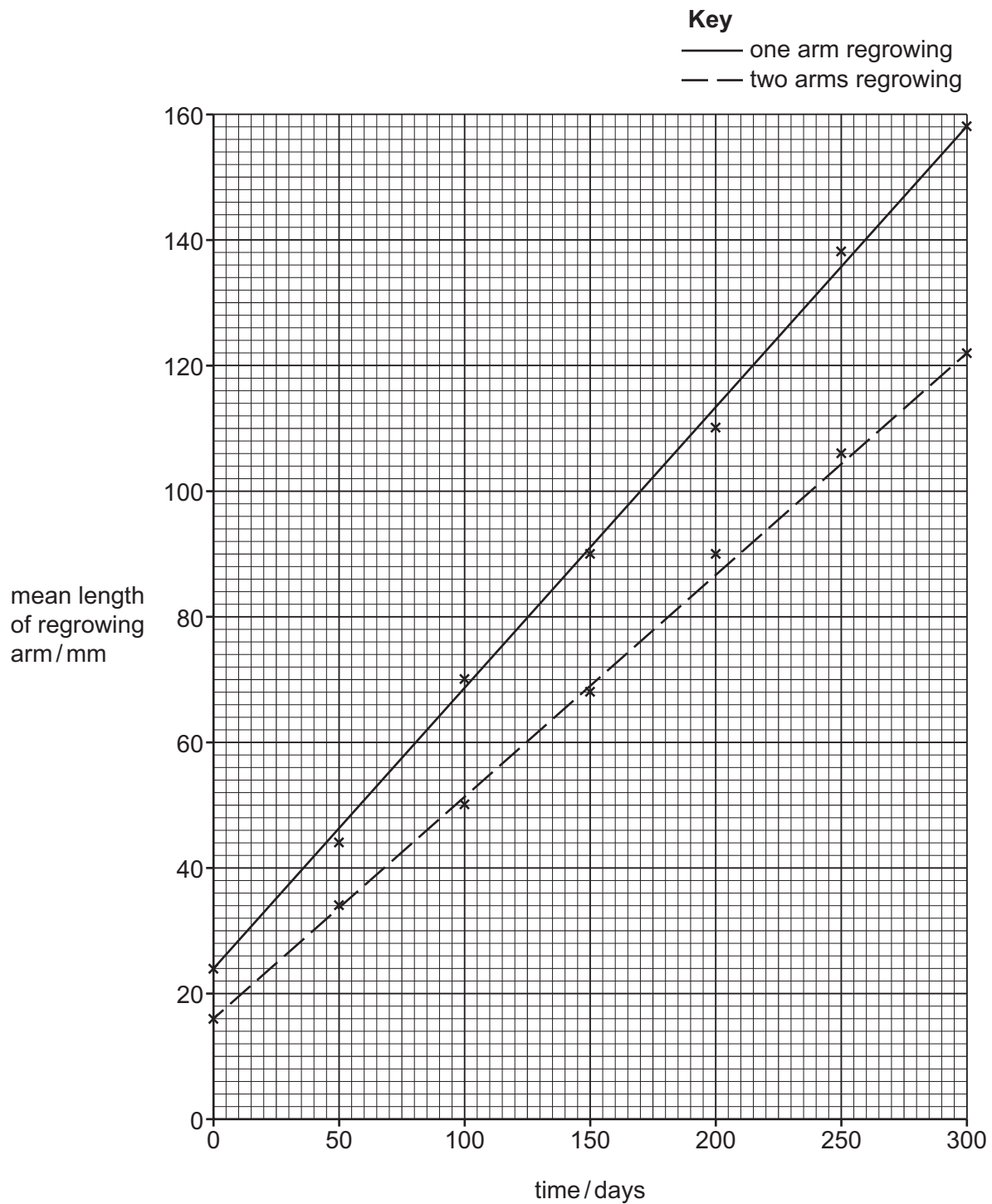


Fig. 1.3



- (i) Suggest **one** abiotic factor the scientists should keep the same as the natural environment of the starfish.

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

- (ii) Use the line of best fit on Fig.1.3 to calculate the mean rate of growth of the damaged arm for starfish with **one** arm regrowing.

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

growth rate = mm per day [3]

- (iii) The scientists predicted that the mean rate of growth of damaged arms would be greater for starfish with only one damaged arm.

Discuss the extent to which the results support this prediction.

.....
.....
.....
..... [2]

- (iv) Describe **one** safety and **one** ethical consideration for this investigation.

safety
.....
ethical
..... [2]

[Total: 14]



- 2 A student investigated the effect of salinity on the freezing point of water.

They made a stock solution of water with a salinity of 40 ppt.

The stock solution was used to make a range of solutions of lower salinity from 10 to 30 ppt.

Distilled water was also used with a salinity of 0 ppt.

Each solution and the distilled water were placed in a freezer with a temperature probe as shown in Fig. 2.1.

The temperature probes were all connected to a data logger and the freezing point recorded. A data logger automatically records the temperature at regular intervals.

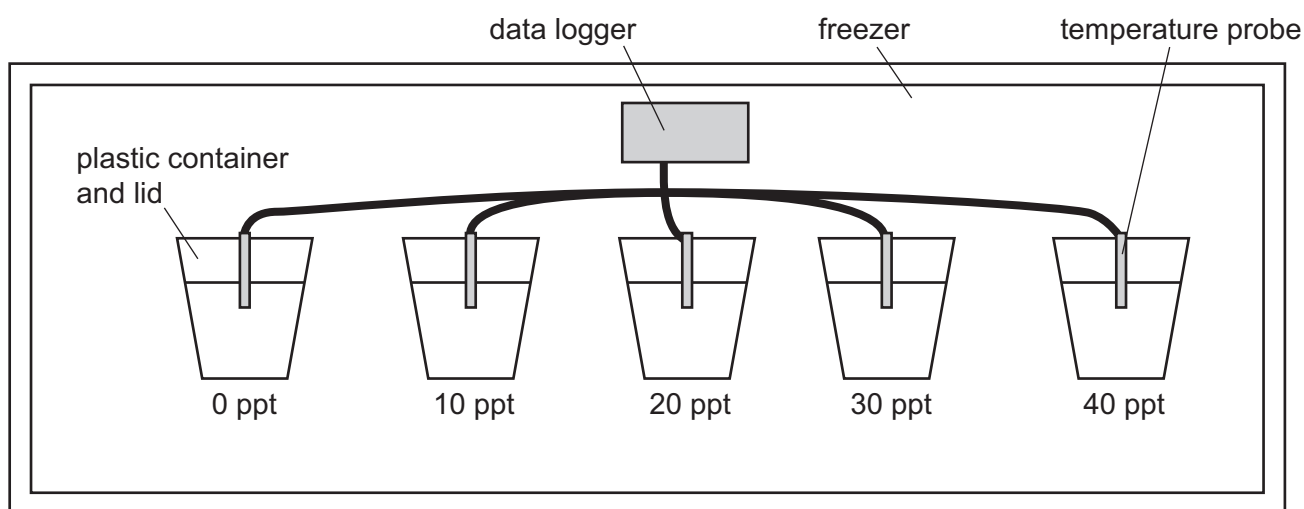


Fig. 2.1

- (a) (i) Explain why the student used plastic containers rather than glass.

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..... [2]

- (ii) State a method to make the stock solution with a salinity of 40 ppt.

.....

.....

.....

..... [2]



(iii) Describe how to use the stock solution to make 500 cm³ of solution with a salinity of 20 ppt.

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.....

..... [2]

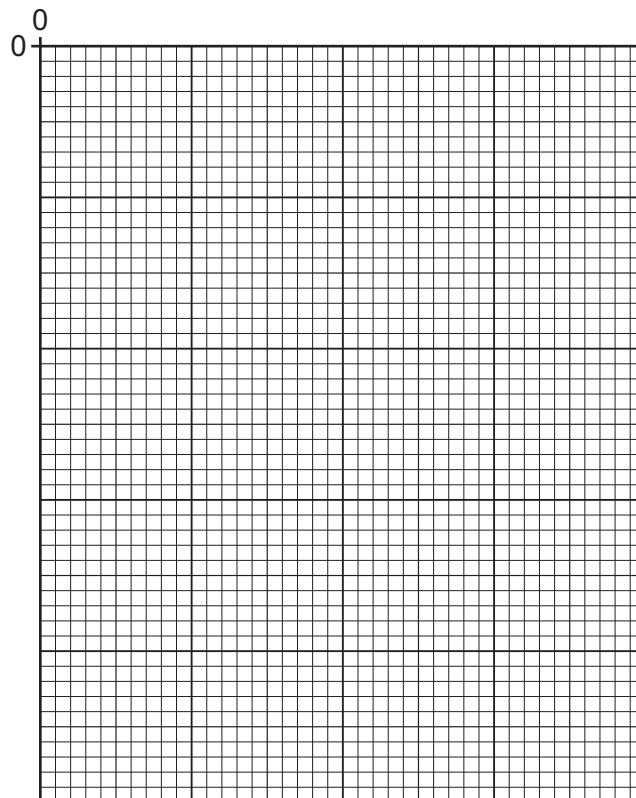


(b) Table 2.1 shows the results from the investigation.

Table 2.1

salinity of solution /ppt	freezing point /°C
0	0.00
10	−0.56
20	−1.18
30	−1.80
40	−2.35

- (i) Use the data in Table 2.1 to plot a line graph showing the relationship between the salinity of solution and the freezing point.



[4]

- (ii) Use the graph to predict the freezing point of water with a salinity of 35 ppt.

..... [1]



(c) Explain why the salinity of sea water may decrease.

.....

.....

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..... [2]

(d) The student investigated how salinity affected the pH of the five salinities of water.

Explain the advantage of using a pH probe rather than Universal Indicator to obtain the results.

.....

.....

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..... [2]

[Total: 15]



- 3 A student investigated how light intensity affected the rate of photosynthesis in two species of macroalga, **X** and **Y**.

Fig. 3.1 shows the apparatus used.

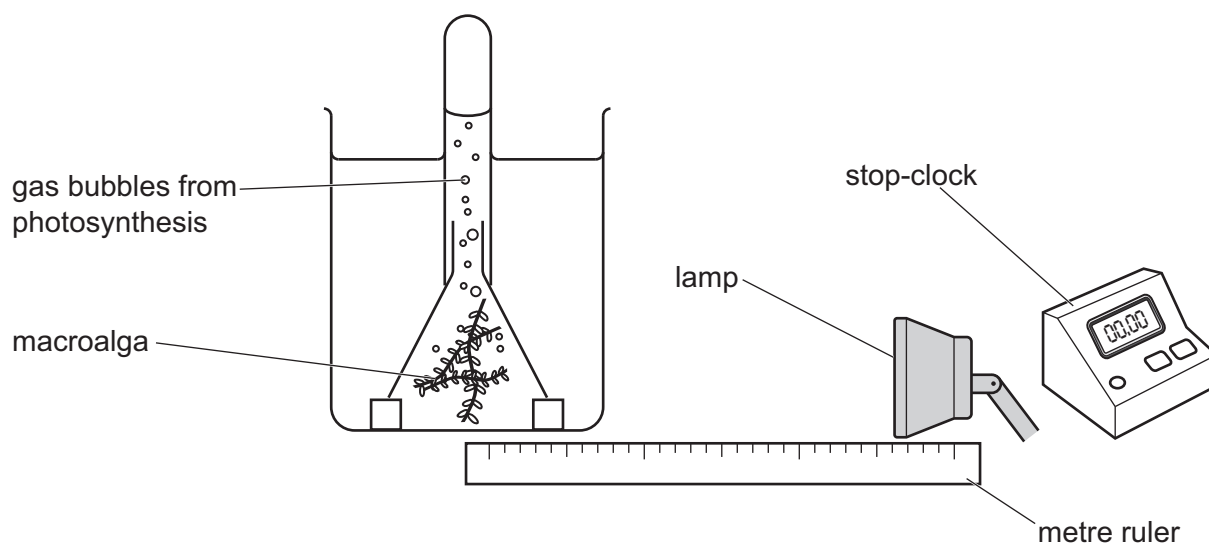


Fig. 3.1

- (a) Name the gas produced by photosynthesis.

..... [1]

- (b) (i) Describe a method to compare the rate of photosynthesis at different light intensities in each species of macroalga.

Use **only** the apparatus shown in Fig. 3.1.

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..... [5]





(ii) Draw a results table for the investigation in (b)(i).

Include full headings and units in the results table.

Do **not** write in any results.

[3]

(iii) Predict the relationship between light intensity and rate of photosynthesis in macroalga.

.....

..... [1]

(c) Suggest **two** improvements that could be made to the apparatus used in this investigation.

Give a reason for each suggestion.

1

.....

reason

.....

2

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reason

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[4]





(d) Explain the importance of photosynthesis to consumers.

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..... [3]

[Total: 17]





- 4 Living walls are used to help increase diversity on human made structures.

Fig. 4.1 shows several different designs used to create living walls.

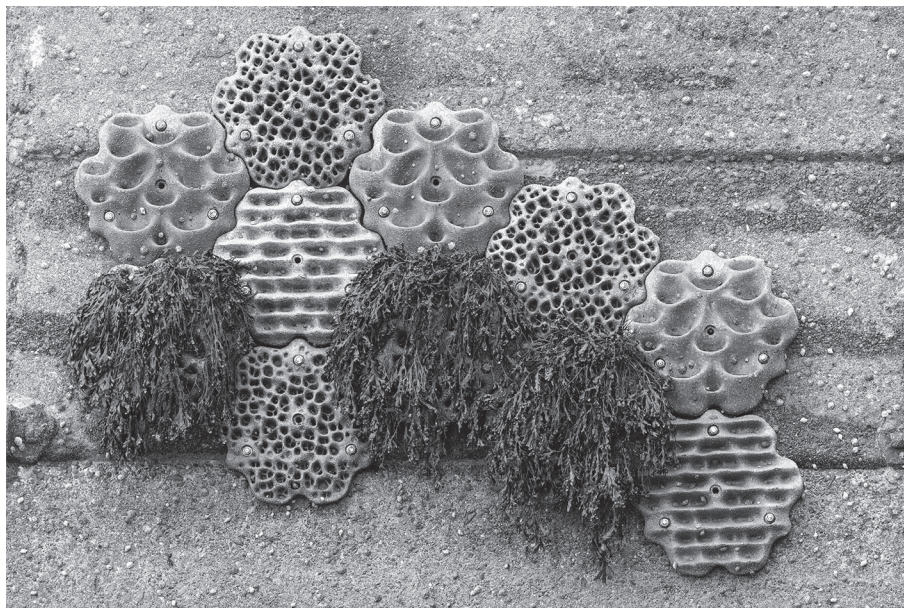


Fig. 4.1

Scientists investigated how three different designs of living wall, design **A**, design **B** and design **C**, affect diversity.

Ten of each design were attached to a sea wall at the mean low water mark.

The scientists recorded the total number of individuals of all species found on each design and on a control area after 12 months.

Simpson's index of diversity was used to calculate the diversity of each design.

The equation for Simpson's index of diversity is given below:

$$D = 1 - \left(\sum \left(\frac{n}{N} \right)^2 \right)$$

Σ = sum of (total)

n = number of individuals of each **different** species

N = the total number of individuals of **all** species



The results for design **C** are shown in Table 4.1.

Table 4.1

species	number of individuals of each different species (n)	$\frac{n}{N}$	$\left(\frac{n}{N}\right)^2$
1	34	0.168	0.028
2	7	0.035	0.001
3	21	0.104	0.011
4	6	0.030	0.001
5	37	0.183	0.033
6	12	0.059	0.003
7	59	0.292	0.085
8	19	0.094	0.009
9	7	0.035	0.001
total number of individuals of all species (N)	202		

(a) Suggest what the scientists used for the control area.

.....

.....

.....

..... [2]

(b) (i) Use the information in Table 4.1 to calculate D for design **C**.

$$D = \dots\dots\dots [2]$$





- (ii) Table 4.2 shows the values for Simpson's index of diversity (D) in design **A**, design **B** and in the control area.

Table 4.2

	design A	design B	control area
Simpson's index of diversity (D)	0.674	0.818	0.143

Compare the effectiveness of designs **A** and **B** for increasing diversity.

Use the values for D from Table 4.2 to support your answer.

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..... [3]

- (iii) Evaluate the extent to which the results from this investigation support the idea that living walls increase diversity on human made structures.

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..... [3]



(c) Suggest reasons why the different designs shown in Fig. 4.1 affect the diversity of the sea wall.

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..... [3]

(d) State **three** examples of the benefits that marine biodiversity provides.

1

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2

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3

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[3]

[Total: 16]





5 Weathering and erosion affect the shape and structure of coastlines and shores.

(a) (i) Explain the difference between weathering and erosion.

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..... [2]

(ii) Erosion can be caused by the action of water.

State **two** other causes of erosion.

1

2 [2]



(b) Scientists investigated the effect of sediment diameter on sinking speed during deposition.

Sediments of three different diameters, 1 mm, 3 mm and 5 mm, were allowed to fall through a cylinder of sea water.

Data loggers were used to record their sinking speed over time.

Fig. 5.1 shows the mean results from the investigation.

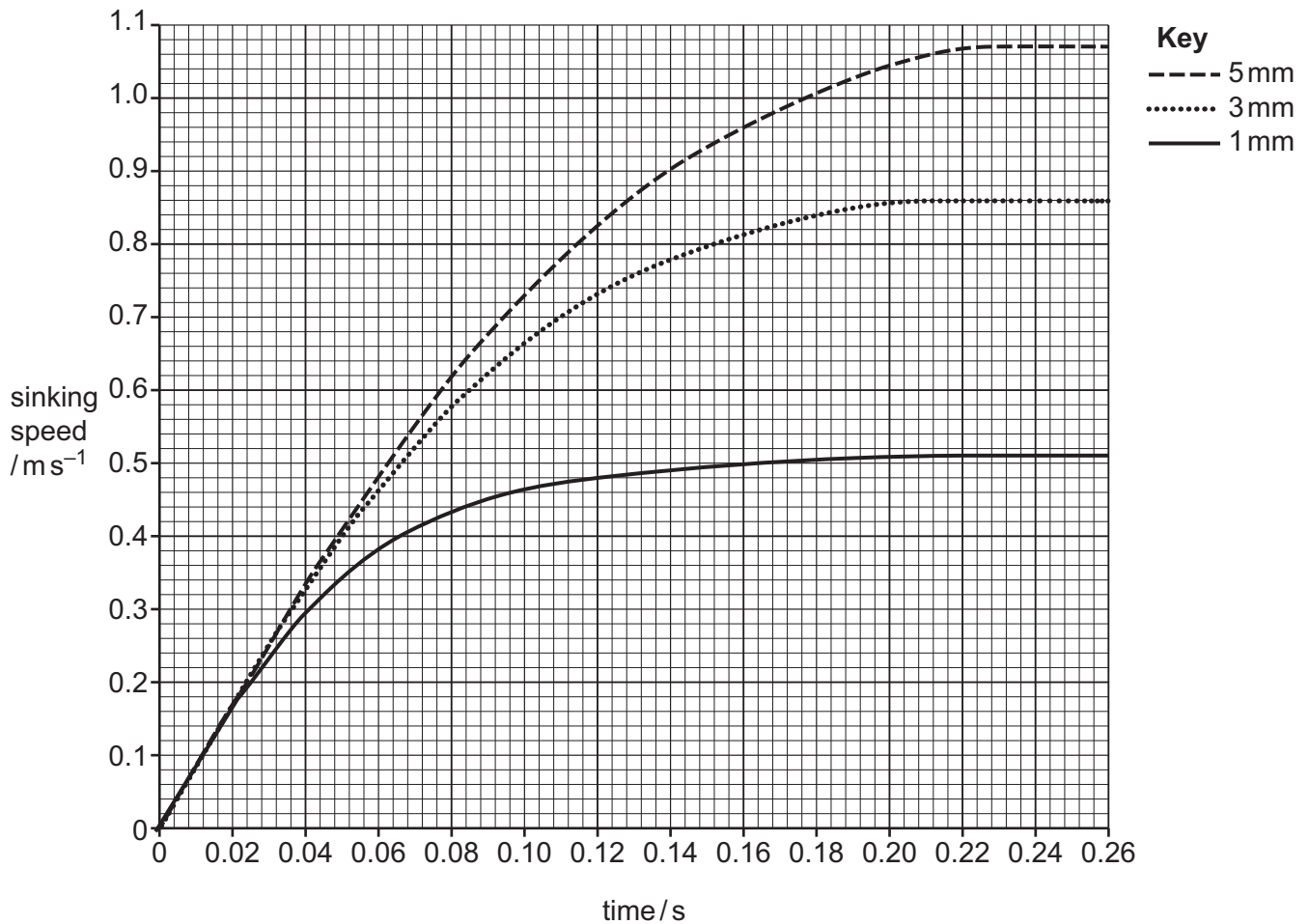


Fig. 5.1



- (i) Calculate the maximum difference in sinking speed for sediments of 1 mm and 5 mm diameter.

difference in sinking speed = ms^{-1} [1]

- (ii) Use Fig. 5.1 to compare the effect of sediment diameter on sinking speed.

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..... [3]

- (iii) Suggest **one** factor, other than diameter, that will affect the sinking speed of sediments.

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..... [1]

- (c) Mangrove forests are tidal ecosystems which have a major influence on biodiversity and the distribution of sediments.

- (i) Explain how mangrove forests affect the distribution of sediments.

.....
.....
.....
..... [2]

- (ii) Other than increasing biodiversity, explain the ecological importance of mangrove forests trapping sediments.

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..... [2]

[Total: 13]









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