Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

MARINE SCIENCE **9693/21**

Paper 2 AS Level Data-handling and Investigative Skills **May/June 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 **28** pages. Any blank pages are indicated.

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Answer **all** questions.

1 Zooplankton is composed of a variety of organisms, including copepods.

(a) Fig. 1.1 shows a copepod found in zooplankton.

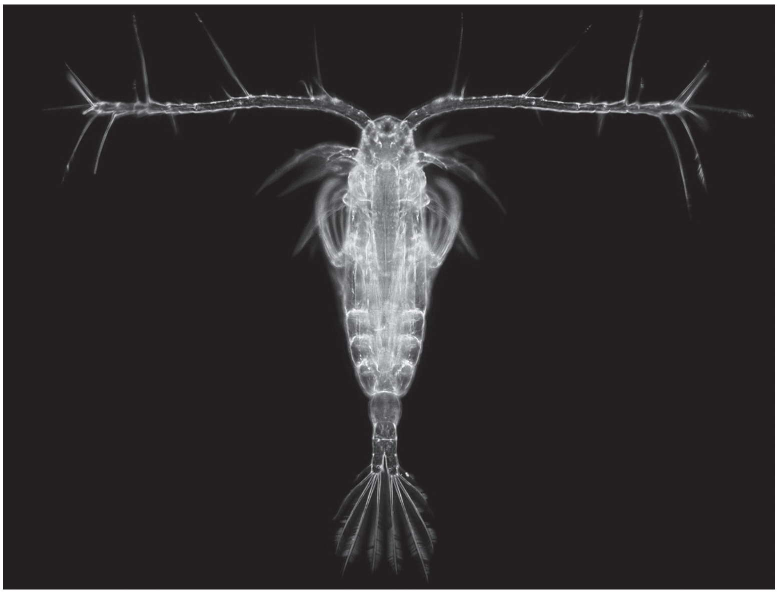

Fig. 1.1

Make a large drawing of the copepod in Fig. 1.1.

Do **not** include the internal structure of the copepod.

Do **not** label your drawing.

[4]

(b) Describe the roles of zooplankton in marine ecosystems.

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.... [2]

(c) Sea water samples were taken from different depths in the Arctic Ocean.

Fig. 1.2 shows the percentage composition of eight species of copepod zooplankton found in the samples.

Not all species occurred at each depth.

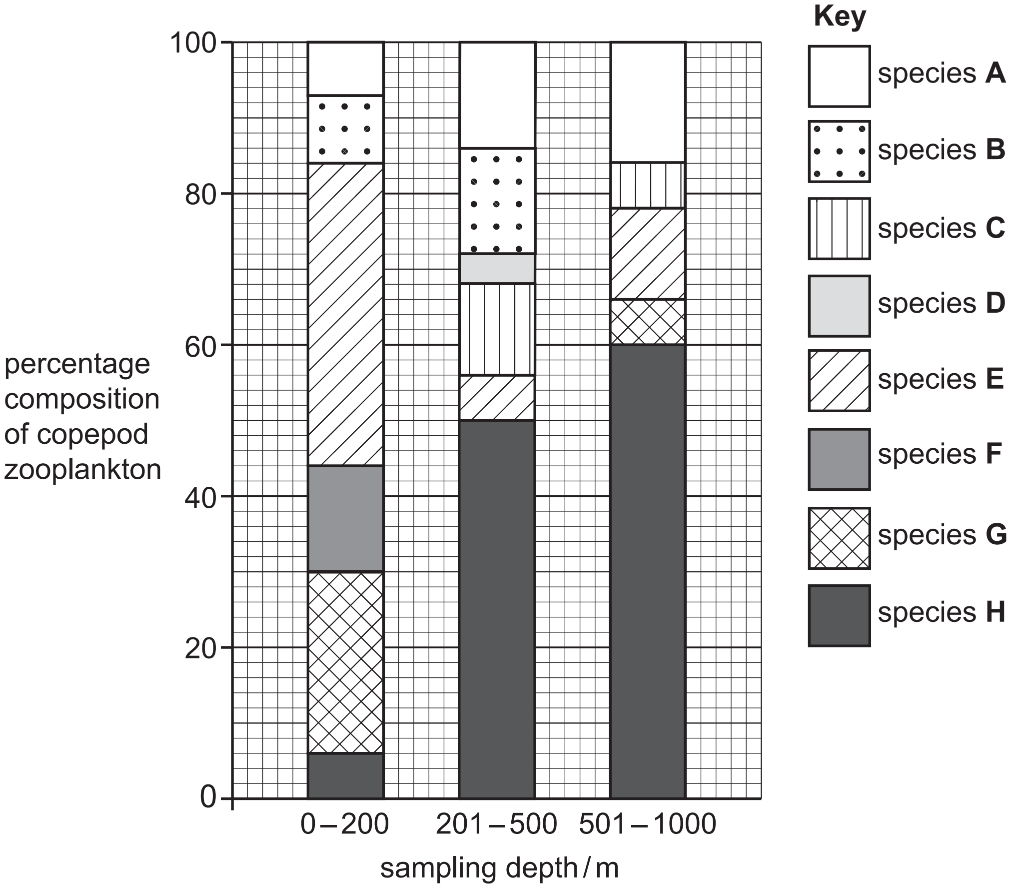

Fig. 1.2

(i) State how many of the eight species of copepod zooplankton are found in all three depth ranges.

.... [1]

(ii) Use Fig. 1.2 to compare the changes in percentage composition of species **A** and species **H**.

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.... [3]

(iii) Suggest why the percentage compositions of the copepod zooplankton species change with increasing depth.

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.... [3]

(d) A student compared the copepod zooplankton communities by calculating the biodiversity at different depths.

Table 1.1 shows the number of individuals per dm^3 of sea water for the six species present at depths 0–200 m.

Table 1.1

species of copepod zooplankton	number of individuals / dm^3
A	58
B	95
E	380
F	133
G	228
H	56
total number of individuals of all the species (*N*)	950

Simpson's index of diversity (*D*) can be used to calculate biodiversity.

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

Σ = sum of (total)
n = number of individuals of each different species
N = the total number of individuals of all the species

(i) Using the data in Table 1.1, complete Table 1.2 for species **G**.

Table 1.2

species of copepod zooplankton	***n* / *N***	**(*n* / *N*)^2**
A	0.061	0.004
B	0.100	0.010
E	0.400	0.160
F	0.140	0.020
G	....	....
H	0.059	0.004

[1]

(ii) Use Table 1.2 **and** the equation to calculate *D* for the biodiversity of copepod zooplankton between 0 – 200 m.

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

Show your working.

D = ... [3]

(iii) The student calculated the value for *D* for the depth range 201 – 500 m to be 0.699.

Use this value for *D* **and** your answer to **(d)(ii)** to describe the change in the biodiversity of copepod zooplankton as the depth increases.

Justify your answer.

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.... [2]

[Total: 19]

2 A student investigated photosynthesis in three species of macroalga, **P**, **Q** and **R**.

All three species can be found in the littoral zone of a rocky shore.

(a) Define the term littoral zone.

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.... [2]

(b) The student cut five discs from macroalga species **P**.

The discs were then dropped into a beaker of sea water, as shown in Fig. 2.1, and placed at a low light intensity.

The time taken for each disc to rise to the surface was recorded and the mean time calculated.

The student repeated this procedure at increasing light intensities.

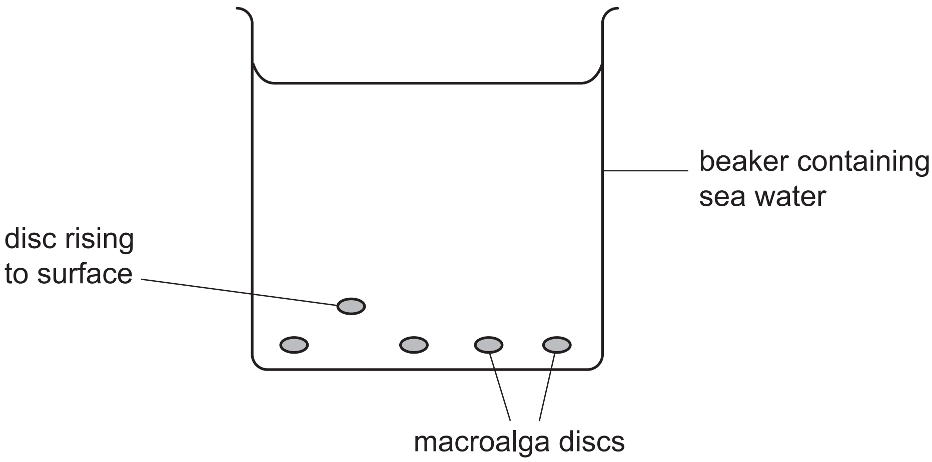

Fig. 2.1

(i) The student used the following table to record the results.

light intensity / arbitrary units	time taken for discs to rise to surface / s

Suggest **one** improvement that could be made to this table of results.

....

.... [1]

(ii) In this investigation, the pH and the salinity of the sea water are examples of standardised variables.

Suggest **two** other variables that need to be standardised during the investigation.

1 ....

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2 ....

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[2]

(iii) Suggest why the macroalga discs rise to the surface during this investigation.

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.... [2]

(c) The investigation was repeated with macroalga species **Q** and **R**.

Fig. 2.2 shows the results of the investigation.

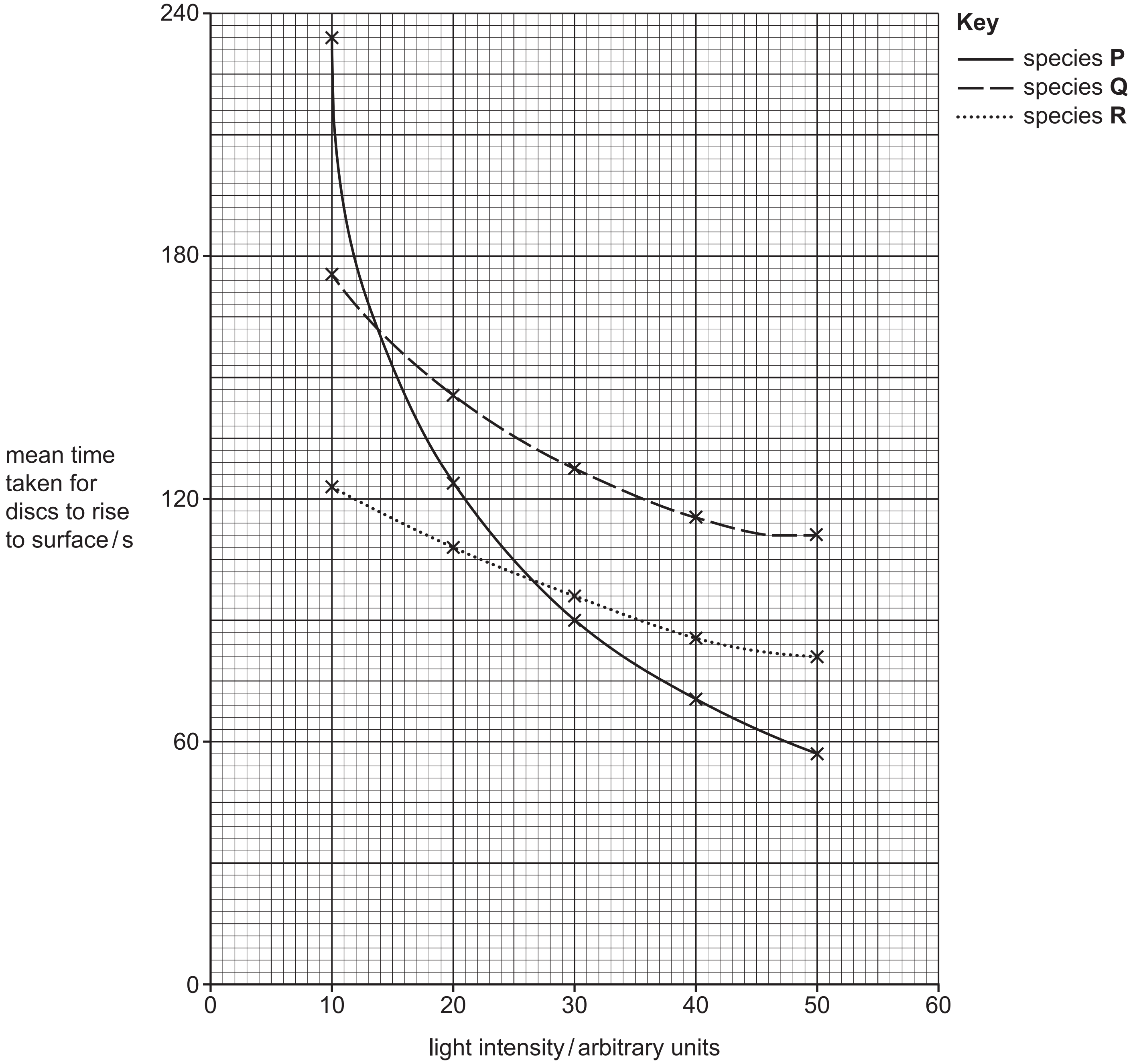

Fig. 2.2

(i) Use Fig. 2.2 to suggest which species of macroalga is best adapted for living lower down the rocky shore.

Explain your answer.

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.... [3]

(ii) Use Fig. 2.2 to predict the expected mean time for discs to rise to the surface if the investigation was repeated with species **Q** at a light intensity of 60 arbitrary units.

.... s [1]

[Total: 11]

3 Damselfish and wrasse are two types of small predatory fish found on tropical coral reefs, feeding on a variety of prey.

Research was carried out to establish if either damselfish or wrasse are important predators of the crown of thorns starfish (CoTS) larvae.

In an investigation, the same number of damselfish were introduced into six large tanks containing equal volumes of sea water.

Each tank contained a different concentration of CoTS larvae. All other factors were standardised.

The mean number of CoTS larvae consumed at each concentration was recorded.

This method was then repeated for the wrasse.

The results are shown in Table 3.1.

Table 3.1

initial CoTS larvae concentration / arbitrary units	mean number of CoTS larvae consumed by predator	
	damselfish	wrasse
50	48	16
100	84	30
150	116	33
200	130	40
250	138	38
300	141	42

(a) Fig. 3.1 shows the mean number of CoTS larvae consumed by wrasse at each initial CoTS larvae concentration. A line of best fit has been drawn to show the trend.

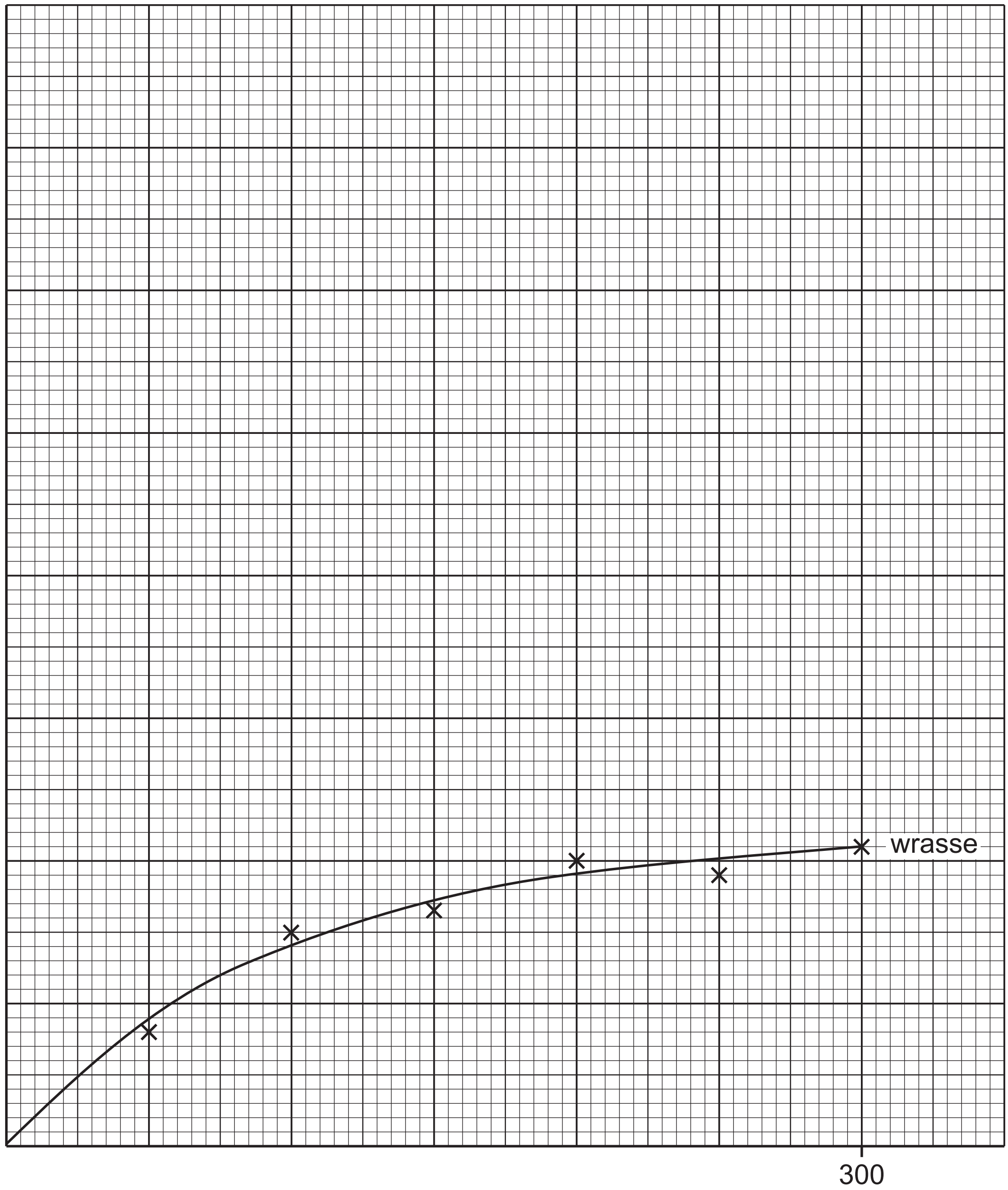

Fig. 3.1

Complete the scale **and** the labels for **both** axes. One scale value has already been added.

Plot the values from Table 3.1 for damselfish.

Draw a line of best fit to indicate the overall trend for the data you have plotted.

[4]

(b) Use Fig. 3.1 to compare the relationship between the initial CoTS larvae concentration and the mean number of CoTS larvae consumed by damselfish and by wrasse.

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.... [3]

(c) A scientist made the following hypothesis:

'Removing predatory fish from coral reefs leads to an increase in damage to corals.'

(i) Explain why the removal of predatory fish may increase damage to corals.

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.... [2]

(ii) Use all the information in this question to evaluate whether this investigation provides sufficient evidence to support the scientist's hypothesis.

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.... [4]

[Total: 13]

4 Lugworms are a species of worm found on sandy and muddy shores.

Each lugworm lives in a single burrow where it consumes sediment, digesting any food sources within the sediment.

Any undigested material is released by the worm from the end of the burrow, which at low tide forms 'casts' on the surface of the shore.

Fig. 4.1 shows a lugworm in its burrow with a cast.

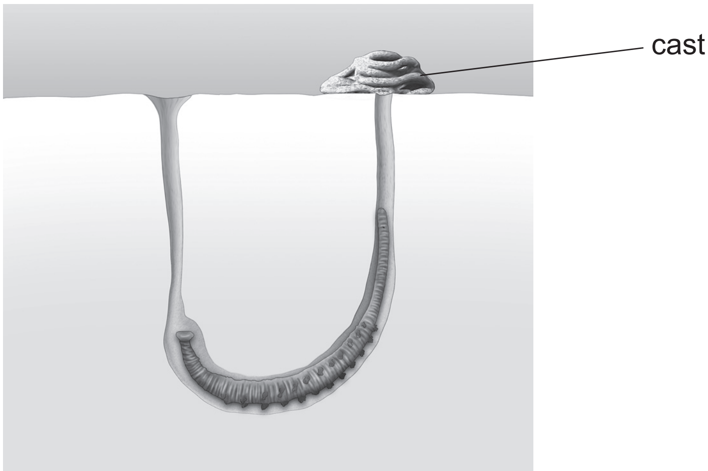

Fig. 4.1

Fig. 4.2 shows a muddy shore with lugworm casts on the surface.

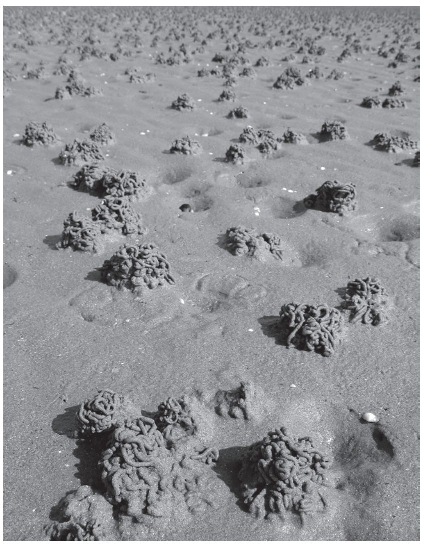

Fig. 4.2

(a) A student investigated the population density of the lugworms on three different shores, **A**, **B** and **C**, by counting the casts visible on the surface.

The results are shown in Table 4.1.

Table 4.1

shore	**mean number of lugworm casts / casts per m^2**
A	32.21
B	4.64
C	17.56

(i) Describe a safe method to obtain the data shown in Table 4.1.

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.... [4]

(ii) Suggest **two** reasons why counting casts may **not** give an accurate estimate of the lugworm population density.

1 ....

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2 ....

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[2]

(b) Sediment analyses were also carried out for each shore. Table 4.2 shows the results, including the percentage of organic matter and the mean particle size.

Table 4.2

shore	mean number of lugworm casts / casts per m^2	percentage organic matter in sediment	mean particle size / μm
A	32.21	7.73	250
B	4.64	3.25	500
C	17.56	4.12	100

(i) Use Table 4.2 to suggest a hypothesis for a factor affecting the population density of lugworms.

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.... [1]

(ii) Suggest how this investigation could be extended to test your hypothesis in **(b)(i)**.

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.... [2]

(c) Research shows that lugworms pump water into their burrows whilst submerged at high tide.

Fig. 4.3 shows the mean flow rate of water pumped into the burrow over a period of time for one lugworm at high tide.

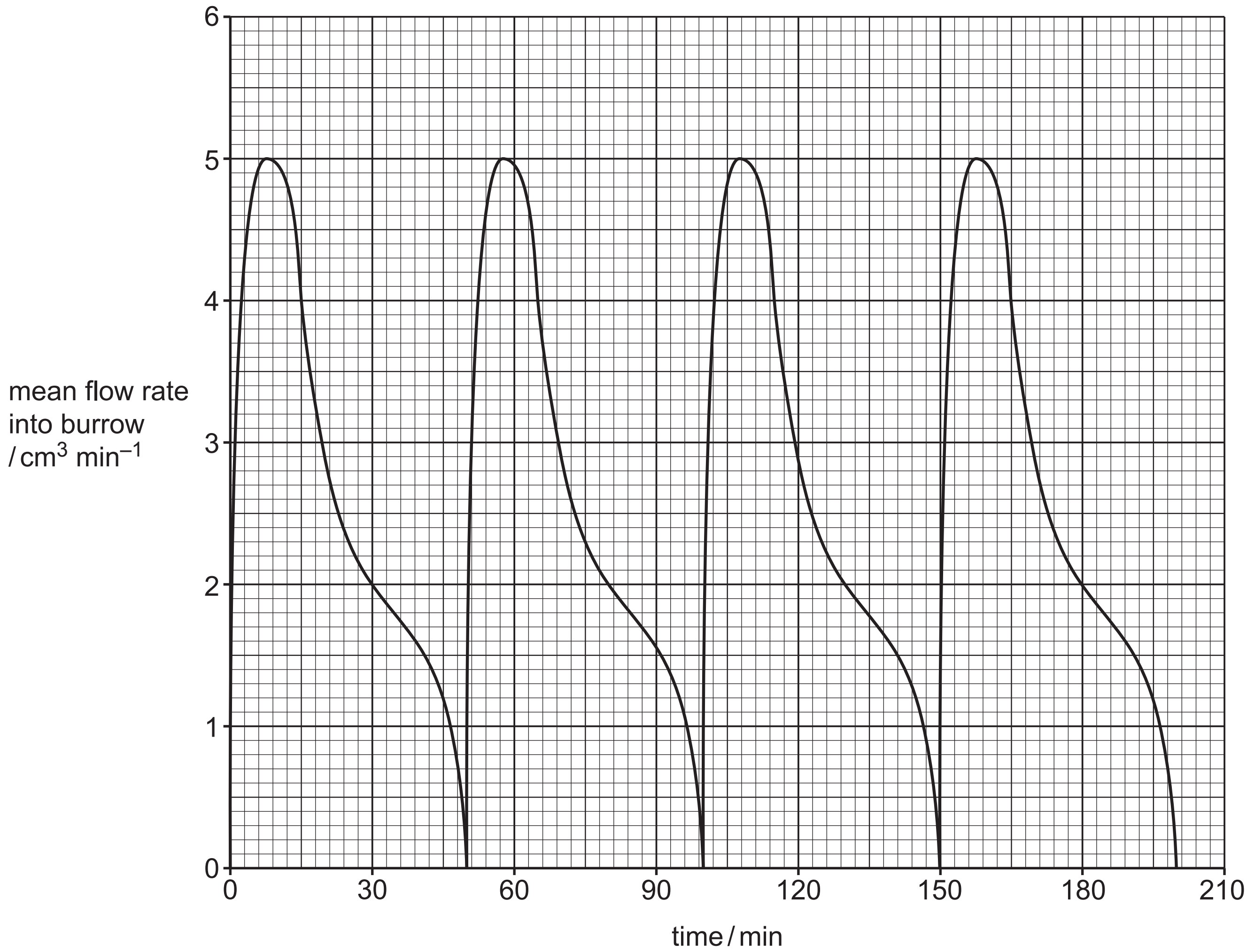

Fig. 4.3

(i) Use Fig. 4.3 to describe the changes in flow rate used by the lugworm.

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.... [3]

(ii) Suggest advantages for the lugworm of pumping water into its burrow.

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.... [3]

[Total: 15]

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5 **(a)** Magnesium sulfate and sodium chloride are examples of solutes.

(i) Define the term solute.

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.... [1]

(ii) State the chemical formulae for magnesium sulfate and sodium chloride.

magnesium sulfate ....

sodium chloride ....
[1]

A student investigated the solubility of magnesium sulfate and sodium chloride in water at different temperatures.

(b) **(i)** Describe how the student could determine the solubility of each salt in water.

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.... [2]

Fig. 5.1 shows the student's results.

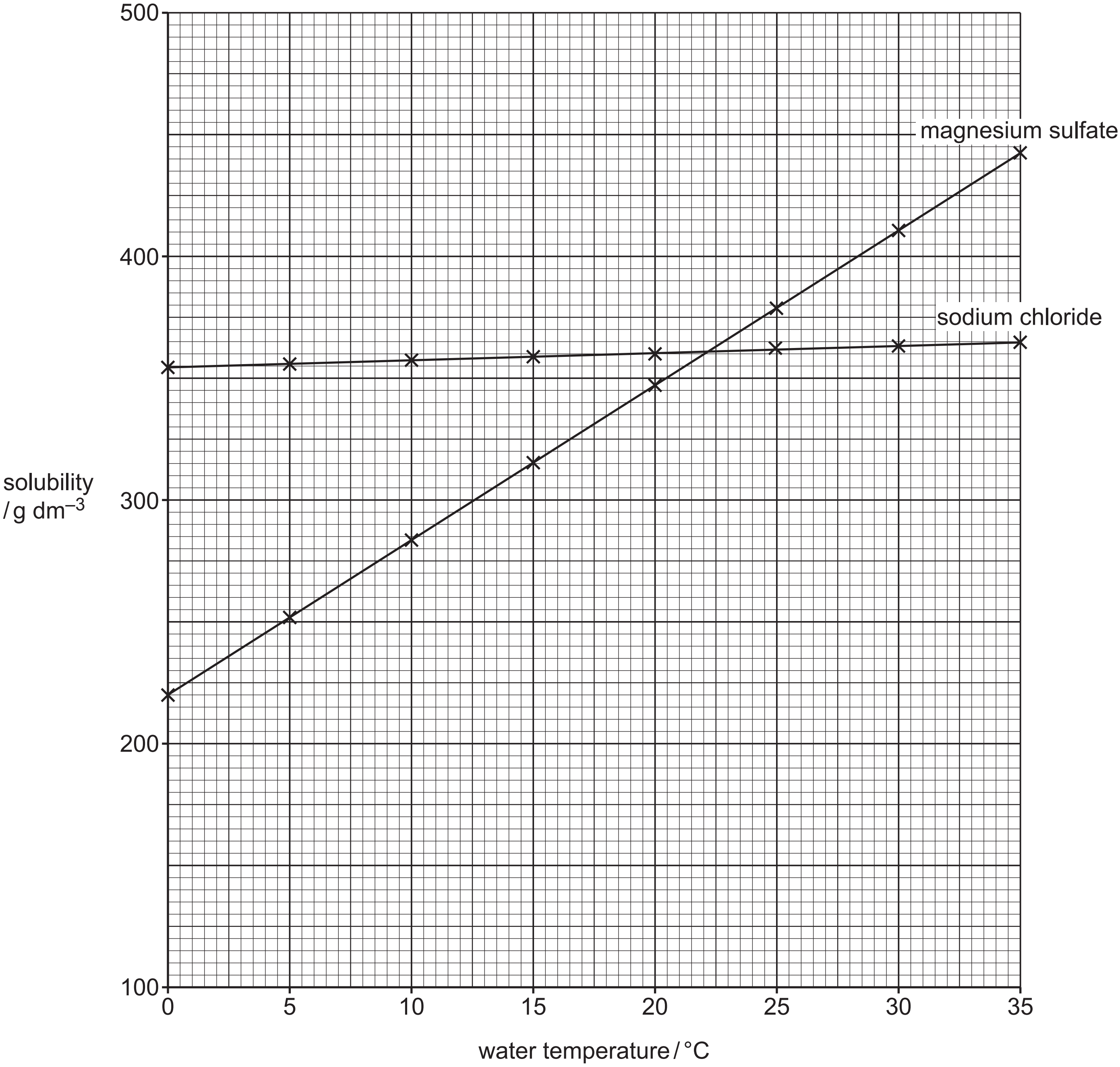

Fig. 5.1

Table 5.1 shows the ocean surface temperature at a location in the Atlantic Ocean and at a location in the Indian Ocean.

Table 5.1

ocean location	**ocean surface temperature / °C**
Atlantic Ocean	8
Indian Ocean	27

(ii) Use the results in Fig. 5.1 **and** the information in Table 5.1 to compare the solubilities of magnesium sulfate and sodium chloride at the two ocean locations.

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.... [3]

(c) Hydrothermal vents are usually found along plate boundaries close to mid-ocean ridges.

(i) State the type of plate boundary found at mid-ocean ridges.

.... [1]

The water coming out of these hydrothermal vents is usually under pressure, at a high temperature and contains a high concentration of dissolved salts.

(ii) Explain how chimneys form at hydrothermal vents.

Use the trends shown in Fig. 5.1 **and** your own knowledge in your answer.

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.... [3]

(d) Latitude is a measurement of position on the Earth's surface between the equator and the poles.

Fig. 5.2 shows values for latitude on the Earth's surface.

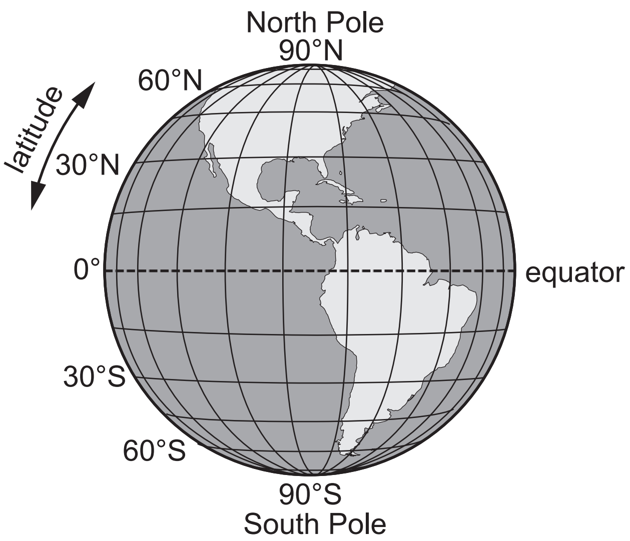

Fig. 5.2

Fig. 5.3 shows the mean annual precipitation and mean annual evaporation experienced by oceans at different latitudes.

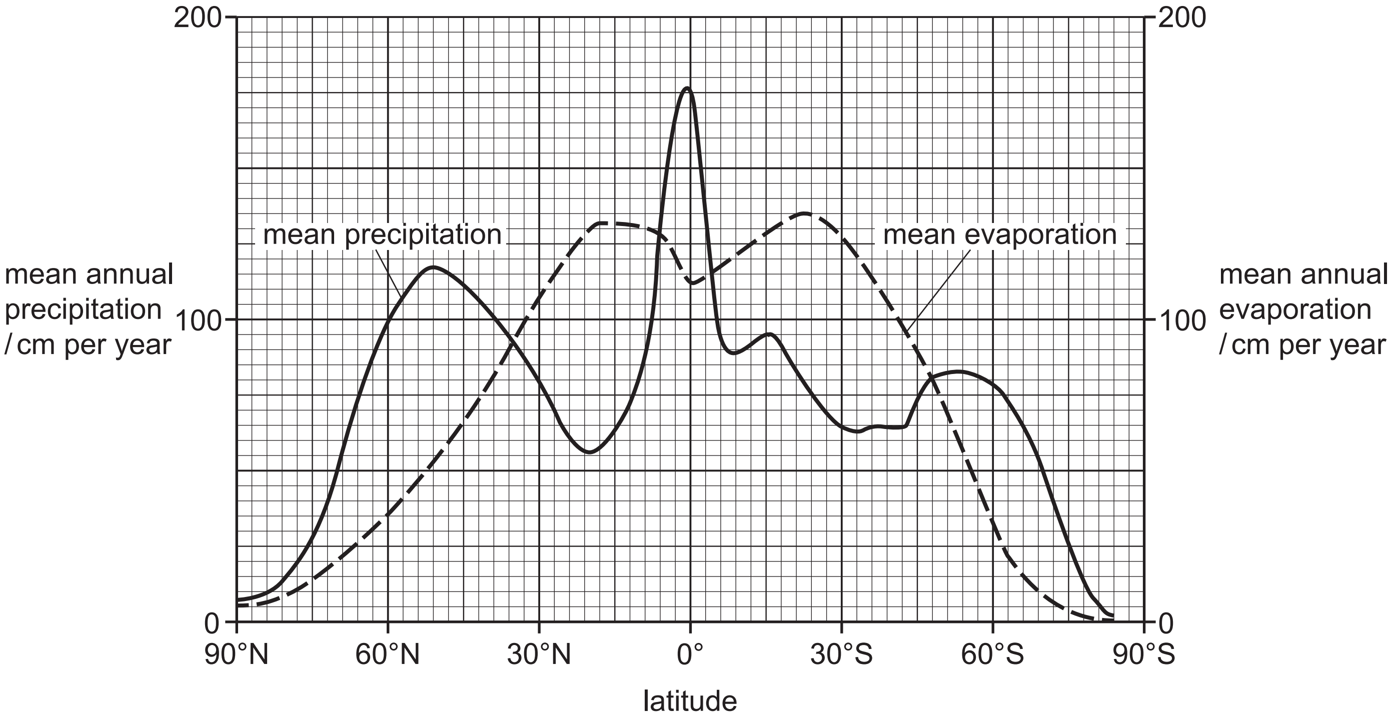

Fig. 5.3

(i) Use Fig. 5.3 to calculate the difference between the mean annual evaporation and the mean annual precipitation at a latitude of 50°N.

Show your working.

.... cm per year [2]

Fig. 5.4 shows variation in ocean surface salinity at different latitudes.

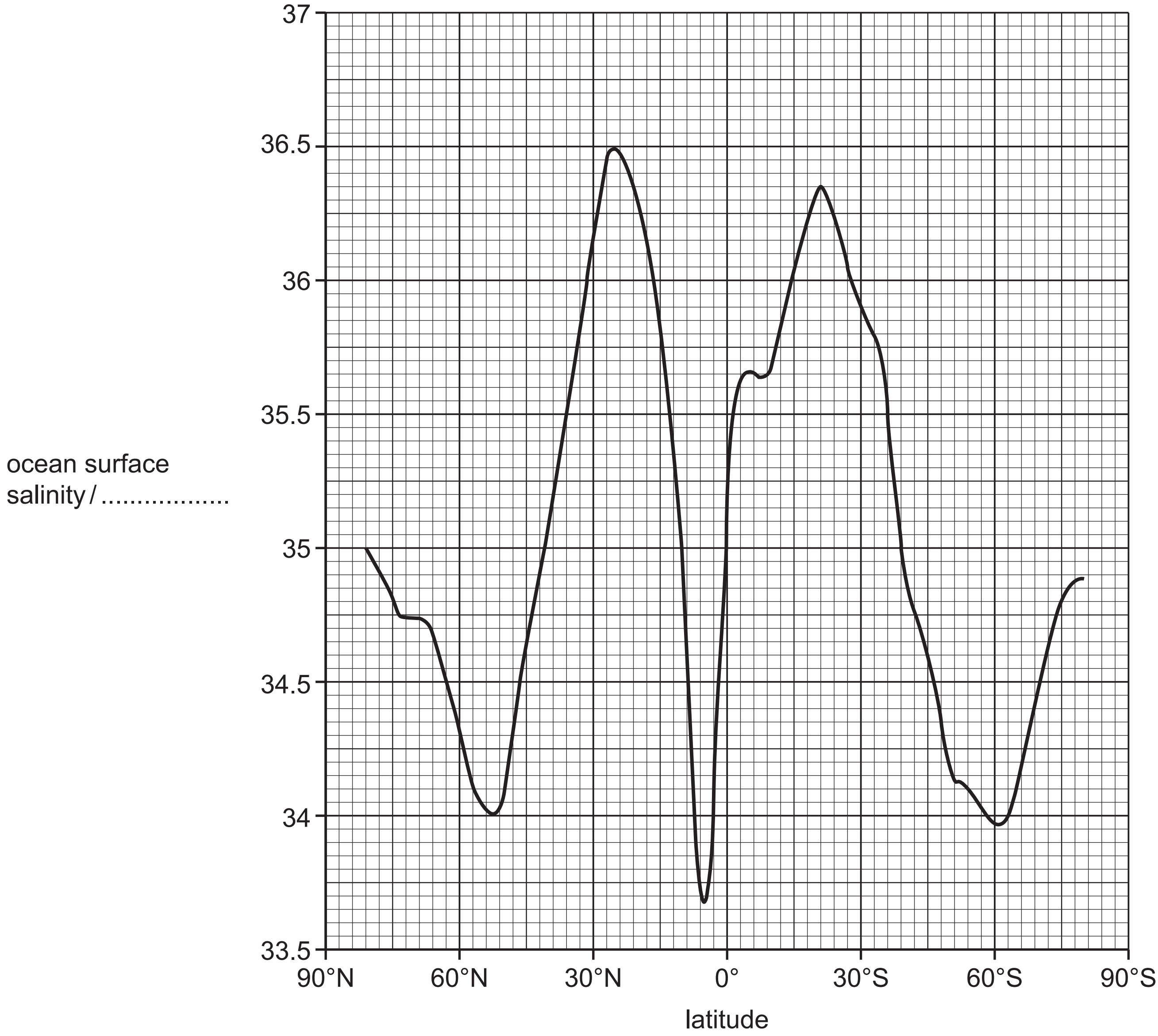

Fig. 5.4

(ii) On Fig. 5.4, complete the axis for ocean surface salinity with a suitable unit. [1]

(iii) Use Fig. 5.4 to calculate the difference in ocean surface salinity between latitudes of 50°N and 30°S.

Give your answer with the unit you have used in **(d)(ii)**.

.... [1]

(iv) Use all the information in **5(d)** to explain the difference in the ocean surface salinity at latitudes of 50°N and 30°S.

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.... [2]

[Total: 17]

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