Cambridge Assessment International Education

Specimen Paper Answers

Paper 4

Cambridge International AS & A Level

Marine Science 9693

For examination from 2022

Version 1

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Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge International AS & A Level Marine Science 9693, and to show examples of very good answers. We have selected questions from Specimen Paper 4, for examination from 2020. There are five exercises in Specimen Paper 4 and candidates must answer all of the questions and sub-questions in each exercise.

In this booklet, we have provided answers for all the questions, along with examiner comments. All questions are compulsory and candidates are required to write their answers in the spaces provided. The paper consists of structured and extended response questions based on the A Level syllabus content but knowledge of the AS Level syllabus content may be required. Marks for each part-question range from 1 mark to a maximum of 12 marks. The mark scheme provides the answers required to gain the marks.

Each response is accompanied by a brief commentary explaining the strengths and weaknesses of the answers.

Each question is followed by an example of a high grade answer with an examiner comment on performance. Comments are given to indicate where and why marks were awarded, and how additional marks could have been obtained. In this way, it is possible to understand what candidates have done to gain their marks and how they could improve.

The mark schemes for the Specimen Papers are available to download from the School Support Hub at www.cambridgeinternational.org/support

2022 Specimen Paper 4 Mark Scheme

Past exam resources and other teacher support materials are available on the School Support Hub www.cambridgeinternational.org/support

Assessment overview

Paper 4 – A Level Data-handling and investigative skills

Written paper, 1 hour 45 minutes, 75 marks

Structured and extended response questions

Questions are based on the A Level syllabus content (topics 6 to 9) but knowledge of the AS Level syllabus content (topics 1 to 5) may be required

Candidates may use calculators

The paper is an externally set assessment, marked by Cambridge.

25% of the A Level

Assessment

AO1 Knowledge and understanding – weighting 20%

AO2 Handling and applying information – weighting 47%

AO3 Experimental skills and investigations – weighting 33%

Paper 4 – Question 1

Question 1 (a)(i)

1 Rock lobsters are caught commercially in areas of sea around New Zealand. In 1990, to conserve stocks, the fisheries ministry placed an annual quota on the mass of rock lobsters that could be caught from an area. They monitored the success of the quotas by determining the catch per unit effort (CPUE) each year.

The CPUE was calculated each year by determining the mean mass of rock lobsters caught in a trap.

The results are shown in Table 1.1.

Table 1.1

year	annual quota / tonnes	CPUE / kg trap^{-1}
1980	unlimited catches	1.20
1985	unlimited catches	0.85
1990	400	0.70
1995	300	0.50
2000	250	0.85
2005	250	1.35
2010	275	1.50
2015	300	

(a) (i) In 2015, 230 000 pots were used.

1 tonne = 1000 kg

Calculate the CPUE for 2015.

Give your answer to the appropriate number of significant figures.

Include the unit.

CPUE = catch / number of traps

= (300 x 1000) / 230 000 (1)

= 300 000 / 230 000

= 1.3043

Answer (to 3 sig. figs.) = 1.30 kg trap^{-1} (2)

..... [3]

Examiner comment

The catch was given in tonnes but has been converted to kilograms as the units of CPUE are kg trap^{-1}. The question states how many kilograms are in one tonne. 1 The table shows that the data has been given to three significant figures so the answer is rounded to 1.30. Units are correct. 2

Total marks awarded 3 out of 3

Common mistakes

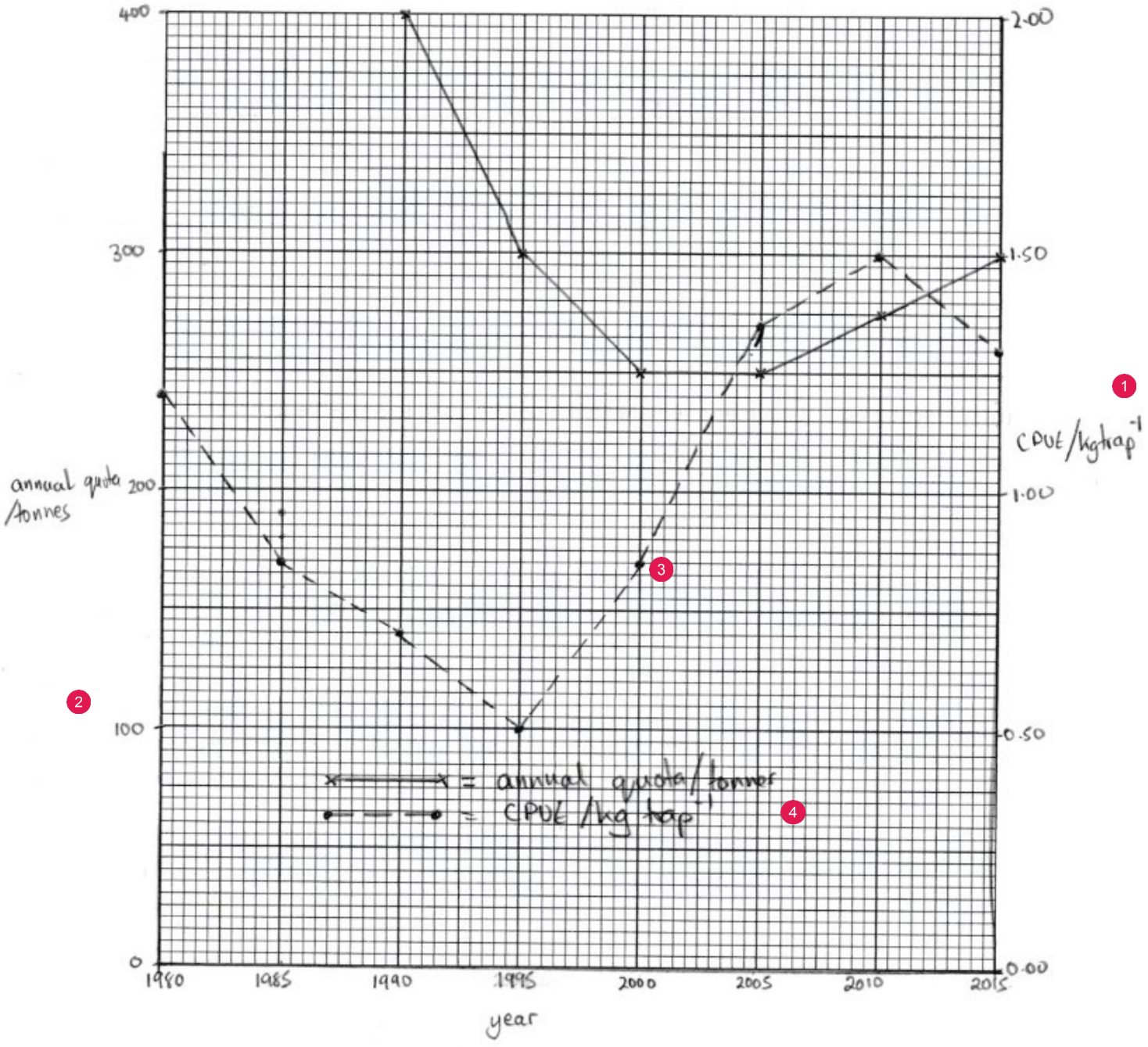
Many candidates forget to convert between units of different magnitudes. It is also essential to give units for all answers. At AS and A Level, units should be given in the form of kg trap^{-1} rather than kg / trap.

Question 1 (a)(ii)

(ii) Plot a graph to show the changes in annual quota and CPUE between 1980 and 2015.

Do **not** plot the annual quota for 1980 and 1985.

Use a sharp pencil.



[5]

Examiner comment

This is a good line graph as all axes are labelled, and linear scales have been used. 1 The increments used for the *y*-axes enable full use of the grid and also make plotting points relatively easy. 2 Although the points are plotted accurately and joined with straight, ruled lines, the CPUE data should have been plotted using a dot in a circle. 3 Therefore the mark has not been awarded. Two *y*-axes have been used correctly and a key has been given for the data. 4 A bar chart would have been acceptable for this data as well. Lines of best fit should only be used when intermediate points are strongly expected to be around the line of best fit.

Total marks awarded 4 out of 5

Common mistakes

Many candidates do not give linear scales or give scales that do not have increments that are easy to use (it is best to pick scales that go up in 2s, 5s, 10s, 25s, 100s etc.).

Some candidates try to use one *y*-axis for both scales – at A Level, it is expected that candidates can use both axes. Many candidates do not add keys or forget to label the axes.

Question 1(a)(iii)

(iii) Describe the changes in CPUE between 1980 and 2010.

The CPUE falls 1 between 1980 and 1995. 2 From then on it rises until it peaks in 2010 before falling in 2015.

[2]

Examiner comment

This answer would gain both marks. A 'describe' question with two marks will often require a description of the patterns shown together with the identification of any turning points. One mark is awarded for the idea of a decrease and increase 1 and the second mark for the identification of 1995 as a turning point. 2

Total marks awarded 2 out of 2

Common mistakes

Many candidates give vague statements, often giving correct trends, but do not give turning points or recognise patterns such as a levelling off.

Question 1(a)(iv)

(iv) Use the data in Table 1.1 and your graph to discuss the evidence that the use of annual quotas has allowed stocks of rock lobster to recover.

As the quotas fall between 1980 and 2005, the CPUE begins to rise (1) – this suggests that more lobsters are being caught so that the population (2) could be rising (so the quotas are working.) Before the quotas were introduced, the CPUE was already falling but was actually quite high in 1980 (even though there were no quotas.) (3) There is a time delay between the quotas and the CPUE because it takes time for the lobsters to reproduce. There may be other factors acting though – a high CPUE could be due to better traps (5) and nothing to do with higher populations of lobsters. Things like weather patterns and climate change could also affect the lobster populations and change the CPUE. (4) [4]

Examiner comment

This answer would gain four marks. The command word is 'discuss,' so several aspects of the data should be considered although no final conclusion is necessary (unlike if 'evaluate' were used.) Mark points 1 and 2 are evident in the first two lines – the recognition that lower quotas leads to higher CPUE (1) and that this could be linked to the population of lobsters. (2) Mark point 6 is awarded for the idea that without quotas, there was a high CPUE and this contradicts that idea that quotas are working. (3) Mark points 5 and 8 are awarded for the ideas that other factors may also affect the result (4) and that trap 'efficiency' may have changed. (5) This answer is a good example of how to show how the data both supports and does not support the conclusion – this is important when answering questions with the command words, 'discuss', 'evaluate', and 'assess.'

Total marks awarded 4 out of 4

Common mistakes

Many candidates often give answers that identify one aspect of the problem – it is essential to consider as many aspects as possible. It is also important to relate answers to the data and use knowledge from the study of the syllabus.

Question 1(b)

(b) Describe how consumer-orientated tools can be used to preserve fish stocks.

Fish products can be clearly labelled (1) *so that consumers can make a choice as to what they are eating. The labels can say that the food has been sustainably caught, for example, tuna that has been caught by pole and line. Eye catching designs can be used to make it clear to consumers what they are buying. The Marine Stewardship Council campaigns* (2) *to make the subject of sustainable fishing public knowledge and help consumers to make the right choices.* [3]

Examiner comment

This answer would gain two marks: mark points 1 and 2 for the labelling of the food (1) and the role of public campaigns (2). The answer tends to focus on two points – it is a three-mark question and so candidates should look for three points. It is also a question that is taken directly from the syllabus which gives three clear methods that are used to preserve fish stocks.

Total marks awarded 2 out of 3

Common mistakes

Candidates can often become too focused on one or two aspects of a question – it is always important to look at the mark allocation of a question as a guide.

Paper 4 – Question 2

Question 2 (a)

2 Rainbow trout, *Oncorhynchus mykiss*, is a species of cold-water fish. Part of their life cycle is spent in fresh water rivers and part is spent in sea water.

Fig. 2.1 shows a rainbow trout.

Fig. 2.1

Rainbow trout use pumped and ram ventilation. They use pumped ventilation when swimming at slow speeds and ram ventilation when swimming at higher speeds.

(a) Outline the process of pumped ventilation.

The trout opens its mouth to suck in water.[1] *It then closes its mouth and contracts the muscles*[2] *in its mouth to increase the pressure on the water (as the volume decreases.)*[3] *This causes the water to be forced over the gills, opening the operculum*[4] *as the water flows out. The gills extract the oxygen from the water.*

[3]

Examiner comment

This answer would gain three marks. Mark point one is given in the first line [1] and mark points two [2] and three [3] are given in the following lines. Mark points four and five are given in the penultimate sentence [4], although the candidate has already supplied enough correct answers so cannot be awarded additional marks. It is a well organised answer that gives a description in a sensible order. The last sentence is irrelevant as the question is about the mechanism of ventilation, rather than gas exchange.

Total marks awarded 3 out of 3

Common mistakes

Candidates often underestimate the depth of detail required to gain full marks. It is common to see vague answers that just state that water is taken in and passed out through the operculum. Answers are frequently muddled rather than being written in a sensible order. The last sentence of this answer is irrelevant to the question – candidates should try to ensure that their answers are all relevant to the question asked.

Question 2 (b)

(b) Scientists think that rainbow trout may alter the rate of pumped ventilation in response to different temperatures. This may be because temperature affects the rate of cellular respiration.

The rate of ventilation of the rainbow trout can be measured by the rate at which the operculum opens and closes.

Plan an ethical investigation that you could do to investigate the effect of changing the temperature on the rate of ventilation.

Your plan should:

- include a clear statement of the hypothesis
- identify the key variables
- include full details of the method
- describe how you would analyse your results
- be safe and ethical.

Hypothesis: The trout will increase the rate of ventilation as the water temperature increases. This is because the temperature will increase the rate of respiration in the cells of the trout (it will move faster and be more active) and so it will need a faster supply of oxygen. Aerobic respiration uses oxygen. 1

Independent Variable: The independent variable is the temperature of the water.

Dependent Variable: The dependent variable is the number of times the trout opens its operculum in a time period (rate of ventilation.) 2

Controlled Variables: Variables that will need to be kept constant include: species, age, mass and sex of fish; oxygen concentration of the water, size of tank, activity of fish, light intensity, pH of water, salinity, food given to fish.

Method

I will take six tanks of water, each with a constant volume (2m x 2m x 1m). I will place three trout into each tank and place a thermostat heater into each. 4 *I will set the tanks temperatures to 5oC, 10oC, 15oC, 20oC, 25oC, 30oC.* 3 *All the trout will be the same age and sex. I will use a stopwatch to record a period of 5 mins and during this time, I will count the number of times each fish opens its operculum.* 5 *I will record the fish with a video camera to make it easier to count the opercula opening and closing. I will do this for each fish at each temperature and calculate the mean number of openings in a five minute period for each temperature.*

(continued)

(it is important to do replicates to reduce the effect of anomalies.) 6 I will calculate the rate of opening by dividing the number of times the opercula open by 5 minutes. I will make sure that the fish are treated humanely by not letting the temperature go beyond 30oC and letting them have rest breaks. 7 All the fish will get the same food, light and I will make sure that the oxygen level is kept constant by using an air bubbler.

Analysis

I will draw up a results table to collect my data and then a graph of rate of ventilation against temperature. I will calculate standard deviations for each group and draw error bars onto the graph to see if there is any overlap (this will help to see if there is a significant difference in ventilation rates.) 9

Risks

I don't think that there are many risks but I would wear eye protection. 8

[12]

Examiner comment

This would be a very good plan that would get 12 marks. All the requisite sections are made clear (hypothesis, variables, method and analysis) and although there are no marks on this mark scheme for describing the results table and graphs that may be drawn, it is good practice to do so as future questions could require these skills.

The hypothesis is explained and supported by theory – this gains mark point 1. 1

The independent, dependent and control variables are all correctly identified (mark points 2, 7, 6 and 10). 2 Both biotic (fish species / age / sex) and abiotic (volume of water / salinity) are identified. There is also very good explanation as to how to actually control these variables (a bubbler is used to keep oxygen concentrations constant).

Mark points 3 and 4 are awarded for giving at least five different temperatures (six are given) and a sensible range of temperatures. 3 Mark point 5 is also awarded for giving a method by which the temperature is changed and maintained. 4

Mark points 7 and 8 are awarded for stating how the dependent variable (rate of ventilation) is measured 5 – very good detail is given here in terms of the use of video recording (although it is not required for this mark scheme.) A method for calculating rate is also given.

Mark point 9 is awarded for carrying out replicates AND calculating means – simply doing repeats is not enough for the mark, and the calculation of means is necessary. 6

Mark point 10 is awarded for a correct reference to the ethical treatment of the fish – it would not be enough to simply state 'treat the fish humanely.' 7

Mark point 11 is not awarded as although eye protection is suggested, no real risk is identified. 8

Mark points 12 and 13 are awarded for the calculation of standard deviations and for how to use them in terms of drawing error bars. It is good practice to always state how data will be analysed in terms of statistical tests and may be appropriate to also give a null hypothesis. 9

Total marks awarded 12 out of 12

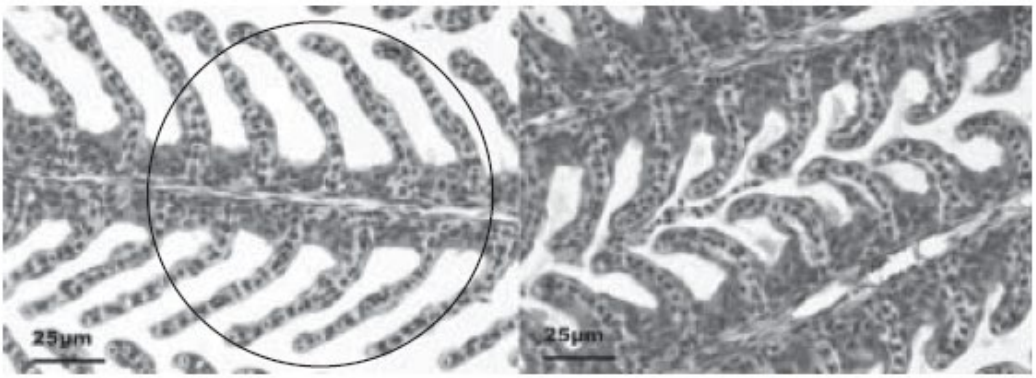
Common mistakes

Many candidates identify the variables correctly but do not suggest at least five values and a range for the independent variable. Candidates also often correctly identify the dependent variables but give no detail as to how it is measured. Control variables should also be identified with some explanation as to how they are kept constant. Many candidates forget to state that means will be calculated and / or do not state how the data will be analysed. It is important to state exactly how rates should be calculated (the idea of a measurement in a fixed time).

Question 2 (c)(i)

(c) Chemicals called anionic polymers are sometimes added to soil to prevent soil erosion around rivers and estuaries. Scientists investigated the effect of these anionic polymers on the gill lamellae of rainbow trout.

Fig. 2.2 shows light micrographs of the gill lamellae from rainbow trout kept in clean water, **A**, and water containing anionic polymers, **B**.



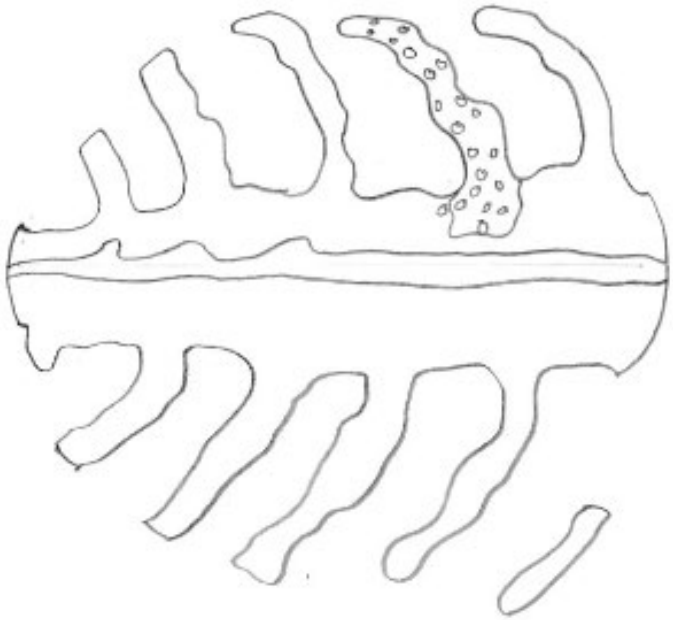
A **B**

Fig. 2.2

(i) Draw, with a magnification of ×2, the area of gill lamellae within the circle shown in Fig. 2.2. Show the details within only **one** of the lamellae.

Do **not** label your drawing.

Use a sharp pencil.



1

[4]

Examiner comment

This diagram would gain all four marks. The outlines are clear with no broken lines (mp1) and there is an approximately x2 magnification. The proportions are correct (mp3) and there are the correct number of lamellae (mp4). More detail is correctly given for one lamella. There is no shading and lines are clear and defined. 1

Total marks awarded 4 out of 4

Common mistakes

Many candidates draw lines with gaps – they should be clear and defined and not sketchy. Candidates should also ensure that they use a sharp pencil. It is also important to not include shading unless requested. Candidates should also ensure that they follow the instructions and draw the details requested. If labels are required, lines should be drawn with a ruler and labels should be printed neatly.

Question 2 (c)(ii)

(ii) Use the information in Fig. 2.2 to suggest why the anionic polymers may adversely affect trout.

The gill lamellae are much thicker so less oxygen can be taken up. 1

[2]

Examiner comment

This answer would gain one mark (mark point three.) 1 Mark point one would be awarded if reduced surface area was included.

Total marks awarded 1 out of 2

Common mistakes

Many candidates, when giving explanations only give part of the answer. This example shows that the candidate has recognised the change in structure but has not gone on to give an explanation for how this affects the fish.

Paper 4 – Question 3

Question 3(a)(i)

3 **(a)** Fig. 3.1 shows the mass of carbon dioxide that is removed and released into the atmosphere in one year by some of the processes in the carbon cycle.

All figures are $\times 10^{12}$ kg of carbon dioxide.

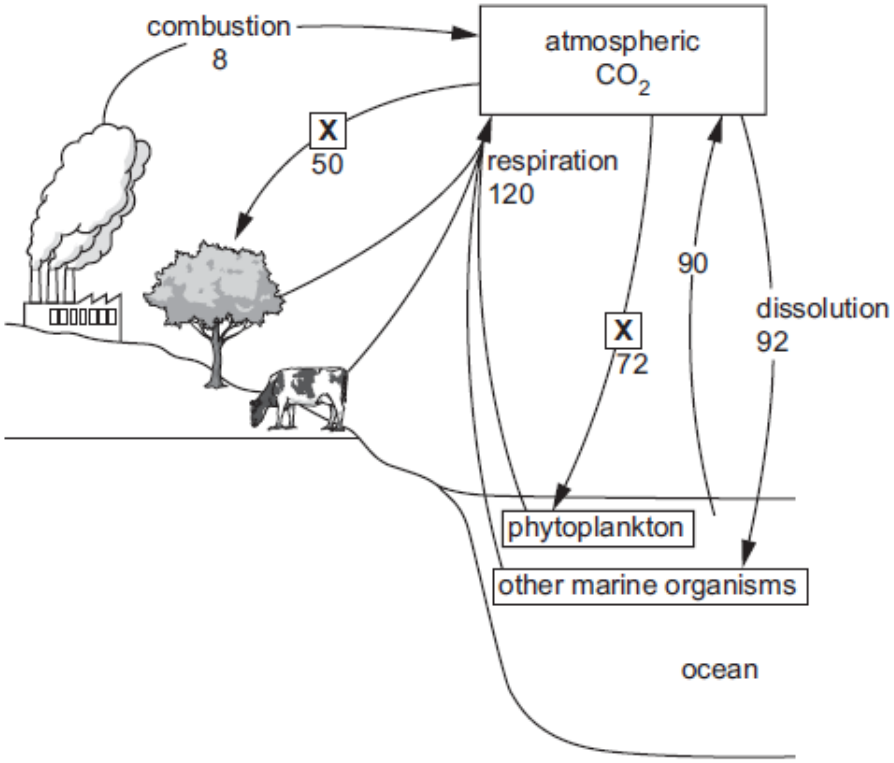


Fig. 3.1

(i) Name the process labelled **X** in Fig. 3.1.

Photosynthesis 1 ..... [1]

Examiner comment

This answer would gain the mark. 1

Total marks awarded 1 out of 1

Common mistakes

Some candidates confuse photosynthesis with respiration and / or decomposition. Candidates should also be reminded not to give lists in case one of their other suggestions is incorrect.

Question 3(a)(ii)

(ii) Use Fig. 3.1 to calculate the percentage change in atmospheric carbon dioxide in one year if the starting mass of atmospheric carbon dioxide is 750×10^{12} kg.

Carbon dioxide released = 120 +8 + 90 = 218 x 10 12 kg

Carbon dioxide removed = 72 + 50 + 92 = 214 x 10 22 kg

Increase in carbon dioxide = 218 = 214 = 4 x 10 22 kg 1

Therefore, the percentage increase = 4 / 750 x 100 = 2

.....0.53....% [3]

Examiner comment

This answer would gain all three marks. The increase in atmospheric carbon dioxide has been correctly calculated. 1 The percentage increase has also been correctly calculated. 2

Total marks awarded 3 out of 3

Common mistakes

Many candidates find calculating percentage changes very challenging. Candidates should make sure that they are familiar with all the required mathematical skills.

Question 3 (a)(iii)

(iii) With reference to Fig. 3.1, predict **and** explain how increased combustion would affect the pH of sea water.

1 2

It would fall as more carbon dioxide would dissolve in the water and carbon dioxide is an acidic gas.

..... [2]

Examiner comment

This is quite a straightforward question and this answer would gain both marks for correctly giving the change in pH 1 and then explaining that carbon dioxide would dissolve in the water. 2

Total marks awarded 2 out of 2

Common mistakes

Some candidates confuse an increase in acidity with an increase in pH.

Question 3 (b)(i)

(b) A student investigated the effect of pH on the loss of mass of bivalve mollusc shells.

They measured the mass of each shell and made up solutions, each with a different pH. One shell was placed into each solution for three weeks and then its mass measured again.

The student then carried out the Spearman's rank correlation test to determine whether there was a significant correlation between pH and the decrease in mass of the shells.

The results of the experiment, and their rankings, are shown in Table 3.1.

Table 3.1

pH of solution	rank pH	decrease in mass of shell / g	rank decrease mass of shell	D	D^2
1	1	3.35	7	–6	36
2	2	3.37	6	–4	16
3	3	3.10	5	–2	4
4	4	2.71	3.5	0.5	0.25
5	5	2.71	3.5	1.5	2.25
6	6	0.42	2	4	16
7	7	0.10	1	6	36
				$\Sigma D^2 =$	110.5

1

2

Σ = sum of (total)
D = difference in rank between each pair of measurements

(i) Complete Table 3.1. [2]

Examiner comment

This answer would gain both marks. The ranks for the decrease in mass of the shells has been calculated correctly 1 – this is quite challenging for some candidates as the decreases in mass are the same. The rest of the calculations have then been carried out correctly. 2

Total marks awarded 2 out of 2

Common mistakes

This question illustrates a common difficulty with Spearman's rank calculations – ranking values that are the same (in this case 2.71). Some candidates try to rank them in a random order or, for example rank them both as 3 or 4. Candidates should also be clear on how to use the table to calculate D and D^2.

Question 3 (b) (ii)

(ii) State a null hypothesis for this experiment.

The pH causes the shells to dissolve more as it acidity breaks down the calcium compounds in the shell. [1]

Examiner comment

This answer would not gain any credit as the candidate has given a hypothesis rather than a null hypothesis. The correct answer should state that there is no correlation between acidity and the decrease in mass of the shells.

Total marks awarded 0 out of 1

Common mistakes

Many candidates confuse hypothesis and null hypothesis when using statistical tests. They should be clear as to the difference between them.

Question 3(b)(iii)

(iii) Use the formula to calculate the Spearman's rank correlation coefficient for the data in Table 3.1.

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

r_S = Spearman's rank correlation coefficient

Σ = sum of (total)

D = difference in rank between each pair of measurements

n = number of pairs of items in the sample

0.973 [1]

Examiner comment

This answer would not gain the mark as the correct answer should be – 0.973. For Spearman's rank tests, the coefficient can be positive or negative and this denotes whether the correlation is positive or negative.

Total marks awarded 0 out of 1

Common mistakes

May candidates forget that coefficient can be positive or negative and assume that the number should always be positive.

Question 3 (b)(iv)

(iv) Table 3.2 is a critical values table for Spearman's rank correlation coefficient.

Table 3.2

number of pairs, *n*	r_s (P < 0.05)
5	1.000
6	0.886
7	0.786
8	0.700
9	0.648
10	0.618
11	0.587

Use your calculated value from **3(b)(iii)**, and Table 3.2, to determine whether there is a significant correlation between pH and decrease in mass of shells.

Justify your conclusion.

There is a significant correlation between pH and the decrease in mass of the shell because the value of r_s > critical value of 0.786. (1) *This means that the null hypothesis is rejected* (2) *and the probability that the correlation is due to chance is less than 5 %.* (3)

[3]

Examiner comment

This answer would gain three marks – mark points 1, 3 and 4. The candidate has clearly stated that the calculated value is greater than the critical value,(1) that the null hypothesis is rejected (2) and that there is a less than 5% probability that the correlation is due to chance.(3) Mark point 2 would not be given as there is no indication of the direction of the correlation.

Total marks awarded 3 out of 3

Common mistakes

Many candidates forget to state whether a correlation is positive or negative. It is also important for candidates to state the correct critical value. There is often confusion over whether the calculated value must be greater than or less than the critical value to signify a significant correlation. The probability can be cited as 5 % or 0.05.

Question 3 (b)(v)

(v) Suggest how the student could modify the experiment to increase confidence in their conclusion.

They should repeat it many times and they should also try to use smaller differences between the different pHs. [1] I would also make sure that all other variables were the same. [2]

..... [2]

Examiner comment

This answer would gain both marks. The candidate clearly states that repeating the experiment and using more pHs with smaller increments between them would improve confidence in the conclusion. [1] The statement about keeping all variables the same would not gain mark point three as it does not suggest any variables. [2]

Total marks awarded 2 out of 2

Common mistakes

Many candidates are aware that variables must be controlled but do not suggest any specific variables. It is often insufficient to simply write that 'everything must be kept constant so that the test is fair.'

Paper 4 – Question 4

Question 4 (a)(i)

4 Scientists investigated how temperature and the addition of hydrogen sulfide affected carbon fixation by chemosynthetic bacteria taken from the sea bed.

(a) (i) Explain why chemosynthetic bacteria are important to hydrothermal vent food webs. 1

These bacteria fix energy and carbon for the food webs. There is no light at hydrothermal vents, so it is impossible to photosynthesise there.

[2]

Examiner comment

This answer would gain both mark point one and mark point three. Although they have not used the term producer, the description of carbon fixation for the food web is an equivalent answer. 1

Total marks awarded 2 out of 2

Common mistakes

Most candidates understand the conditions around hydrothermal vents, but some are not aware that photosynthesis cannot take place there.

Question 4 (a)(ii)

(ii) The equation for one type of chemosynthesis is:

$$12H_2S + 6CO_2 \rightarrow C_6H_{12}O_6 + 6H_2O + 12S$$

Use this equation and your own knowledge to compare this type of chemosynthesis with photosynthesis.

The equation for photosynthesis is:

$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

Both processes make glucose.

Both processes use carbon dioxide.

Chemosynthesis does not use water but instead uses hydrogen sulphide.

Chemosynthesis does not make oxygen but instead makes sulfur.

Light is the energy source for photosynthesis, chemicals provide energy for chemosynthesis.

[4]

Examiner comment

This answer is well set out and organised. There are clear similarities and differences which are both essential in questions that require a comparison. Four marks would be awarded – mark points 1, 2, 3, 4, 5, 6. The only mark point not gained is mark point 7. It is also a good strategy for candidates to write down the equation for photosynthesis.

Total marks awarded 4 out of 4

Common mistakes

Many candidates do not learn the equation for photosynthesis accurately and think that it requires oxygen. When answering ‘compare’ questions, candidates should look for both similarities and differences, many candidates only give one side of the argument.

Question 4(b)(i)

(b) Samples of bacteria taken from the sea bed were placed into beakers and provided with carbon dioxide. Samples were incubated at 15 °C, 50 °C, 60 °C and 80 °C for 24 hours in the dark. The mean rate of carbon fixation was then determined.

The experiment was repeated with samples that had hydrogen sulfide added.

The results are shown in Fig. 4.1.

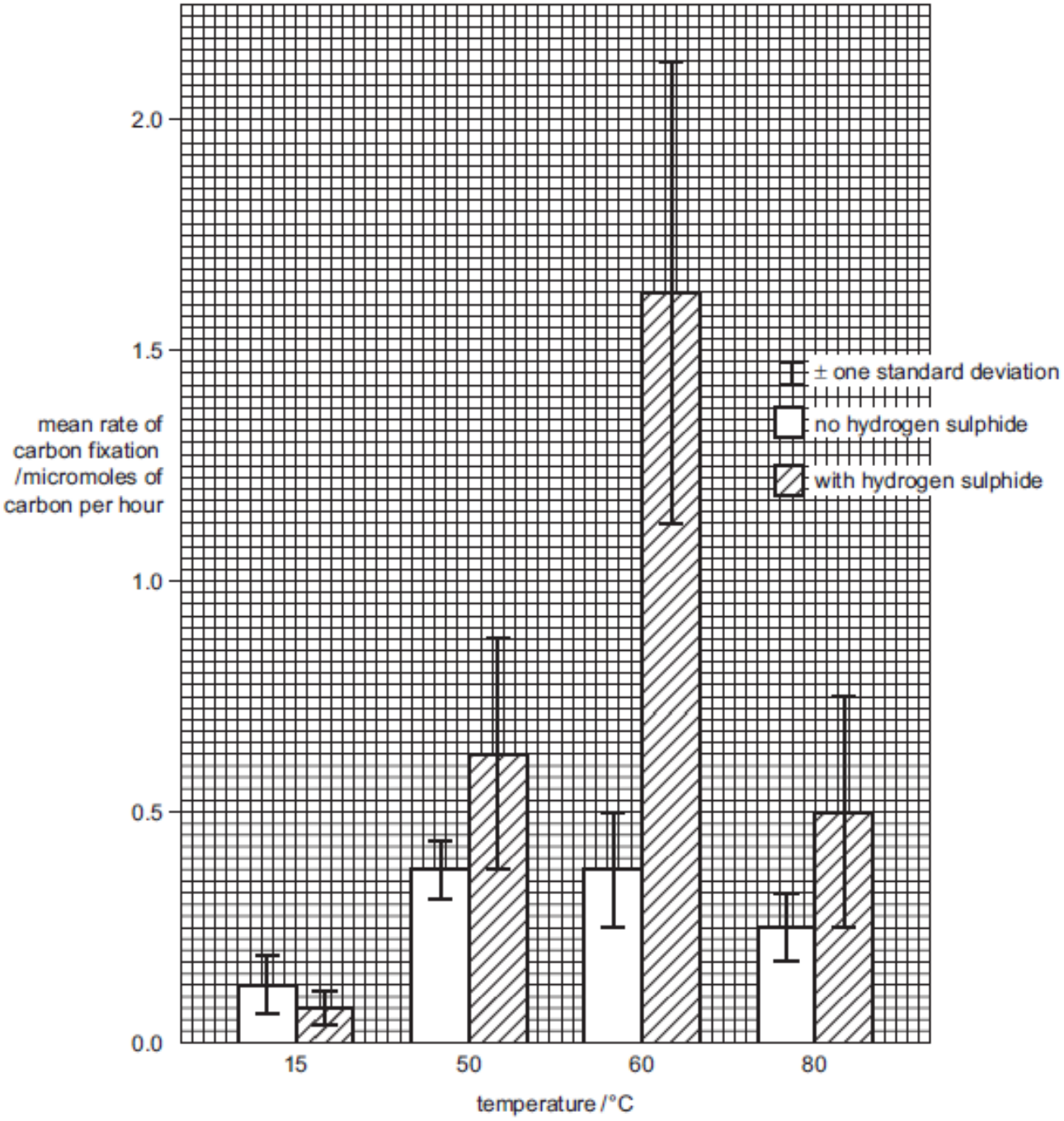


Fig. 4.1

(i) Suggest why the samples were incubated in the dark.

There might be algae present – by placing them in the dark, they would not be able to photosynthesise. [1]

Examiner comment

This answer would gain the mark. The candidate has correctly recognised that the lack of light would prevent any photosynthesis by algae that may be present.

Total marks awarded 1 out of 1

Common mistakes

Candidates often think that light is required for respiration. When answering suggest questions, they should also use their own knowledge – many give answers that are not relevant to the question. This question required candidates to make the link between lack of light and photosynthesis.

Question 4 (b)(ii)

(ii) Use data from Fig. 4.1 to describe the effect of increasing temperature on the rate of carbon fixation when hydrogen sulfide is added.

The rate goes up to a maximum at 60 °C and then falls at 80 °C. 1 *The rate is highest at 60 °C.* 2

[3]

Examiner comment

This answer would gain two marks, mark point one for describing the increase and decrease 1 and mark point two for stating that the highest rate is at 60 °C. 2 This question requires a description and has a mark allocation of three marks. It is good practice for candidates to carry out some form of data manipulation and look for key data points and trends if there are several marks allocated to a question.

Total marks awarded 2 out of 3

Common mistakes

When given two sets of data, candidates must be careful to discuss the correct data series and also the correct comparison. On this question, some candidates may have tried to describe the experiment without hydrogen sulfide or compare the results of the two experiments. Some candidates will also try to give explanations for the results of an experiment – this is not necessary if the command word is 'describe.' It is good practice to include some form of data manipulation, but this should not be quoting numbers from a graph; in this example, a change in rate could have been calculated.

Question 4 (b)(iii)

(iii) The scientists added error bars on their graph to represent the standard deviation of the results.

Use Fig. 4.1 to discuss whether the addition of hydrogen sulfide increased the rate of carbon fixation.

It does increase the rate at 50, 60 and 80 °C, but it fell at 15 °C.[1] *The error bars overlap for all the temperatures, except for 60 °C,*[2] *this shows that the increase at 60 °C is the only significant increase.*[3] *At lower temperatures, temperature is probably a limiting factor and it is only when the water is warm enough that the effect of adding extra hydrogen sulfide increases the rate.*[4] *At 80 °C, the bacteria are probably beginning to die as their enzymes are denaturing.* [3]

Examiner comment

This answer would gain all three marks. Mark point one is awarded for describing the effect of adding hydrogen sulfide at the different temperatures.[1] The candidate has recognised that the error bars overlap for most temperatures and this means that the differences are not significant (mark point three.)[2] They explain that at 60 °C, the increase is significant as there is no overlap (mark point two.)[3] They also gain mark point five for recognising that at lower temperatures, increasing the hydrogen sulfide does not have a big effect and so temperature is probably a limiting factor.[4]

Total marks awarded 3 out of 3

Common mistakes

May candidates find complex data patterns very challenging. They often only pick out one or two features. Many also ignore error bars or standard deviations – these are often included in a question for a reason and candidates should consider them.

Paper 4 – Question 5

Question 5(a)

5 The effect of different salinities on a killifish, *Fundulus heteroclitus*, was investigated.

Killifish are euryhaline, osmoregulatory fish.

(a) State the meaning of euryhaline and osmoregulator.

euryhaline *Euryhaline: these are fish that live in both salty and fresh water.*

.....

osmoregulator *Osmoregulator: these are fish that can control their salt and water levels.*

.....

[2]

Examiner comment

This answer would gain both marks as the definitions are correct.

Total marks awarded 2 out of 2

Common mistakes

There is often a great deal of confusion regarding the meaning of the terms euryhaline, stenohaline, osmoconformer, and osmoregulatory. Candidates should ensure that they know the definitions of these terms and understand them. They should also know some examples of marine organisms that fit each of the terms.

Question 5 (b)(i)

Fig. 5.1 shows a diagram of an osmoregulatory cell taken from the gill of a killifish that had been placed in water with a salinity of 35 parts per thousand (ppt).

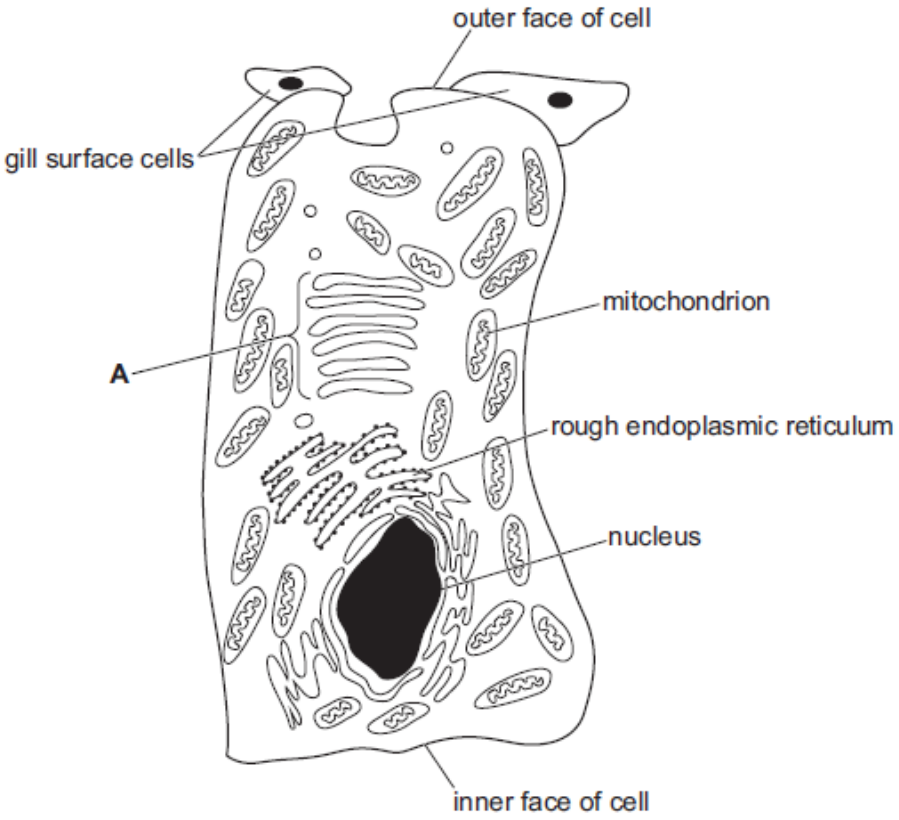


Fig. 5.1

(b) (i) State the name and function of structure **A** in Fig. 5.1.

name *Golgi apparatus*

function *synthesising proteins*

[2]

Examiner comment

This answer would gain one mark for correctly identifying the Golgi apparatus. The suggested function, however, is incorrect. Although the Golgi apparatus is involved in protein manufacture, its function is the modification (or glycosylation) of proteins.

Total marks awarded 1 out of 2

Common mistakes

Some candidates mistake the Golgi apparatus for the endoplasmic reticulum and are also confused about its function. Candidates should ensure that they know the structures and functions of all organelles.

Question 5 (b)(ii)

(ii) Use the information shown in Fig. 5.1 to suggest how the cell is adapted for its function as an osmoregulatory cell.

This cell has mitochondria that respire and release energy (1) *for the pumping of salt ions* (2) *by diffusion during osmoregulation. It also has a nucleus that contains DNA that has the genes for the cell.* (3)

[3]

Examiner comment

This answer would gain two marks. It does not gain mark point one, as although mitochondria are mentioned, all cells have mitochondria – it Is important to stress that the adaptation is <u>many</u> mitochondria. It gains mark points two (energy) (1) and four (pumping of salt). (2) Diffusion is incorrect and there is no mention of active transport or the gradient of salt. The sentence about the nucleus is irrelevant so no credit is awarded nor is the candidate penalised. (3)

Total marks awarded 2 out of 3

Common mistakes

Some candidates refer to mitochondria, but do not state that there are many present in this cell. There is often a great deal of confusion about active transport and diffusion. Candidates should have a clear understanding of the different roles of active transport and diffusion and always give as much information as possible to the examiners when referring to them (e.g. need for energy, direction of transport).

Question 5 (c)

(c) The scientists compared the number of these osmoregulatory cells found in the gills of killifish that had been placed in salinities of 50 ppt, 35 ppt and 15 ppt.

The results are shown in Table 5.1.

Table 5.1

salinity / ppt	osmoregulatory cell density / cells per mm^2
50	320
35	210
15	260

Suggest an explanation for the differences in osmoregulatory cell densities.

At 50 ppt, the fish will lose water by osmosis so it has to work hard to pump salt out of the gills because the fish have to keep drinking saltwater to compensate for the loss of water. This means that it has lots of cells to pump salt out. At 35 and 15 ppt, less salt needs to be pumped out so fewer cells are needed. There are more cells at 15 ppt compared to 35 ppt. [2]

Examiner comment

This answer would gain one mark – mark point one, for recognising that there are more cells at 50 and 15 ppt. The candidate almost gets mark point two but has only referred to salt pumping at 50 ppt and not at 15 ppt. There is also no comment that at 35 ppt, fewer cells are needed as this is probably the isotonic salinity.

Total marks awarded 1 out of 2

Common mistakes

Candidates should be careful to consider all data. In this example, it is easy to miss the fact that there are more cells at 50 and 15 ppt, and only focus on the 50 ppt. It is essential for candidates to spend time exploring data fully.

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