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GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY BIOLOGY B

J257
For first teaching in 2016

J257/04 Summer 2018 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

Paper J257/04 series overview

J257/04, Depth in Biology, is the second of two higher tier papers for Twenty First Century Science Biology B.

The paper assessed content from across the specification and allowed candidates to demonstrate their depth of understanding. As well as short answer response questions there were structured questions, calculations and questions based on practical skills. This paper had two extended response questions, each with a total of 6 marks.

There was no evidence that time constraints affected the performance, as most candidates completed the whole paper.

There was a good spread of marks, candidates scores ranged from below 10 to 77 out of a maximum of 90 marks, with a mean score of approximately 35 marks.

Many candidates appeared to have been well prepared for the examination, attempting the majority of questions. However many candidates had problems with Q5 and a number of sections of other questions which are detailed in the next section.

Most candidates used the spaces provided for their responses, very few extending their answers to other parts of the paper. Some candidates however did not seem able to limit their answers to the provided space and used the additional examination sheets.

Question 1 (a)

1 Nina is learning about substances absorbed by plants. She finds out that plants absorb nitrate ions from the soil.

(a) Explain why nitrate ions are essential for plant growth and survival.

.....

.....

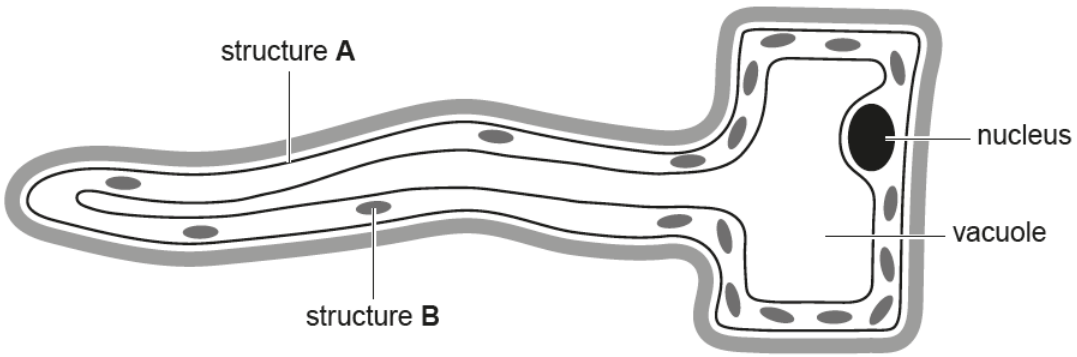
..... **[2]**

This question required candidates to recognise that nitrates were the plant's source of nitrogen and that nitrogen was needed to make amino acids or other nitrogenous compounds.

Question 1 (b)(i)

(b) Nitrate ions are absorbed into a plant root through root hair cells.

Nina finds this diagram of a root hair cell.



(i) State the names of structures **A** and **B**.

A .....

B .....

[2]

Most candidates were able to recognise that structure A was the cell membrane. Fewer candidates identified structure B as a mitochondrion and many identified it as a chloroplast - failing to take into account that the question was about a root hair cell.

Question 1 (b)(ii)

(ii) Explain the roles of **A** and **B** in transporting nitrate ions into the root hair cell.

A .....

.....

B .....

.....

[2]

Only a few higher ability candidates were able to demonstrate that nitrate ions had to be actively transported into the root hair cell and mitochondria provided ATP to enable this process to occur.

Exemplar 1

(ii) Explain the roles of **A** and **B** in transporting nitrate ions into the root hair cell.

A ~~to~~ Structure A is a partially permeable membrane, which ~~allow~~ regulates active transport of nitrate ions into the root hair cell.

B Mitochondria is where ~~resp~~ cellular respiration occurs. This produces ATP, which is required to actively transport the nitrate ions into the root hair cell. **[2]**

This response contains both marking points.

Question 1 (b)(iii)

(iii) The shape of the root hair cell is an adaptation.

Explain how this adaptation helps the root hair cell to absorb nitrate ions more effectively.

.....

.....

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

A number of candidates were able to link the shape of the cell to its ability to absorb ions more effectively. A lower number also linked this to the increased uptake of ions.

Question 1 (c)

(c) The root hair cells also absorb water from the soil.

Complete the sentences below to describe how water is transported through a plant.

Choose the correct words from the list.

Each word may be used once, more than once or not at all.

diffusion **flowers** **meristem** **osmosis**

phloem **stomata** **xylem**

Water is transported from the soil into the root cells by .....

Water is pulled from roots to leaves through the ..... tissue

in the plant stem.

Water molecules are lost from the leaves into the atmosphere because of

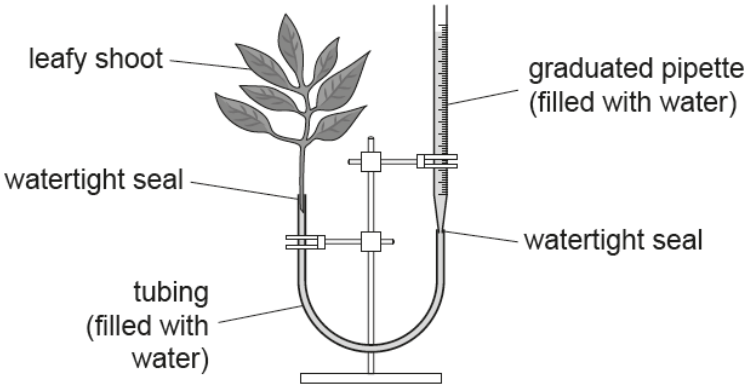
..... through open ..... . **[4]**

Most candidates were credited with at least three marks in this question. A number of candidates confused xylem and phloem tissue.

Question 1 (d)

(d)* Nina wants to investigate how changing the light intensity affects the rate of water uptake by a leafy shoot.

She sets up a leafy shoot in a simple potometer as shown in the diagram.



Nina has access to other apparatus including:

fan **glass tank filled with water** **lamp** **metre ruler**

small heater **stopwatch** **thermometer**

She does **not** have to use all the apparatus.

Describe the experimental procedure Nina should follow and how she should process her results.

.....

.....

.....

..... **[6]**

Over 50% of candidates were credited with a Level 3 mark and it was clear that this practical had been studied during the course. Amongst those candidates that did not achieve Level 3 were some who attempted to describe how they would investigate several factors, such as temperature, wind etc, despite the question asking for the effect of light. Some candidates did not observe that the graduated pipette should be used to measure the volume of water transpired and wrote about the method that they had probably used involving a capillary tube to measure the distance a bubble would move.

Exemplar 2

Nina has access to other apparatus including:

~~fan~~ **glass tank filled with water** **lamp** **metre ruler**

small heater **stopwatch** **thermometer**

She does **not** have to use all the apparatus.

Describe the experimental procedure Nina should follow and how she should process her results.

Nina should ~~use~~ set up the potometer and place a meter ruler alongside it. She should then choose e.g. 5 distances that ~~increase~~ decrease by an equal amount each time e.g. 60 cm, 50cm, 40 cm, 30cm, 20 cm. She will place the lamp at these distances on the ruler. The light intensity at each distance can be calculated using $I \propto \frac{1}{d^2}$ or using a light meter which is more accurate. A glass tank filled with water should be placed between the lamp and the potometer to control the temperature (a heat shield) as temperature must be controlled (a thermometer can be used in the ~~water~~ water to ensure this is the case).

L3

Once all is set up (allow plant to calibrate) ~~she should~~, she should turn on the lamp at the furthest distance and use a stopwatch e.g. for 1 minute. She should record the change in volume of water (change in graduation in potometer) in arable. She should repeat this at least three times and calculate a mean. The mean can be used to calculate rate using $\frac{\text{change in volume (e.g. cm}^3\text{)}}{\text{time (60s.}}$ (e.g. cm^3/s) She should do this for each distance (light intensity) and compare the results. (If necessary, the fan and small heater can be used to control air movement and temperature) ~~kept~~ constant. [6]

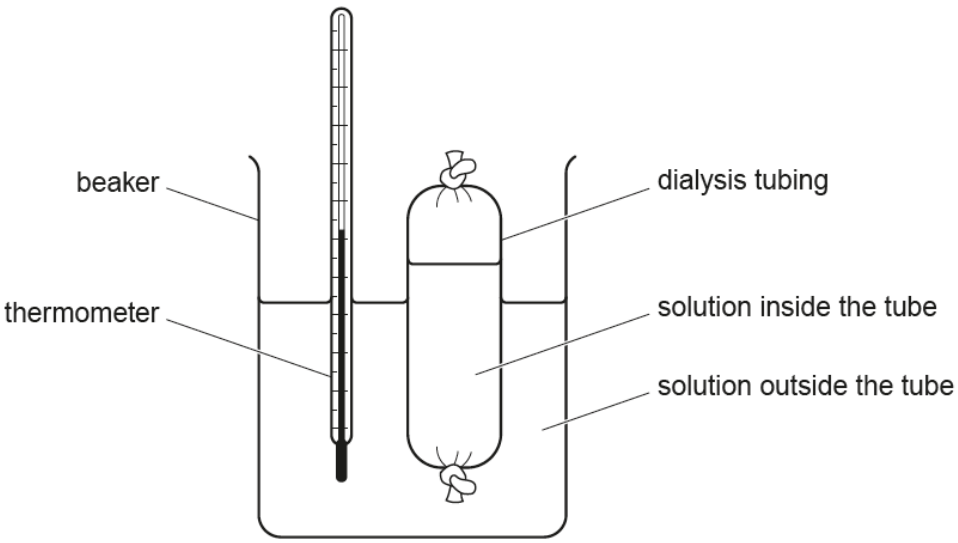
This response perfectly covers all points required for Level 3, with 6 marks achieved.

Question 2 (a)

2 Eve sets up three experiments using dialysis tubing.

Dialysis tubing is a partially-permeable membrane.

Each experiment is set up as shown in the diagram:



(a) What is the purpose of the thermometer?

Tick (✓) **one** box.

- To control the temperature. ☐
- To record the temperature. ☐
- To measure the temperature. ☐
- To stir the solution. ☐

[1]

This question was generally well answered although some candidates confused 'record' with 'measure'.

Question 2 (b)

(b) Eve wants to do each of her three experiments at exactly 30 °C.

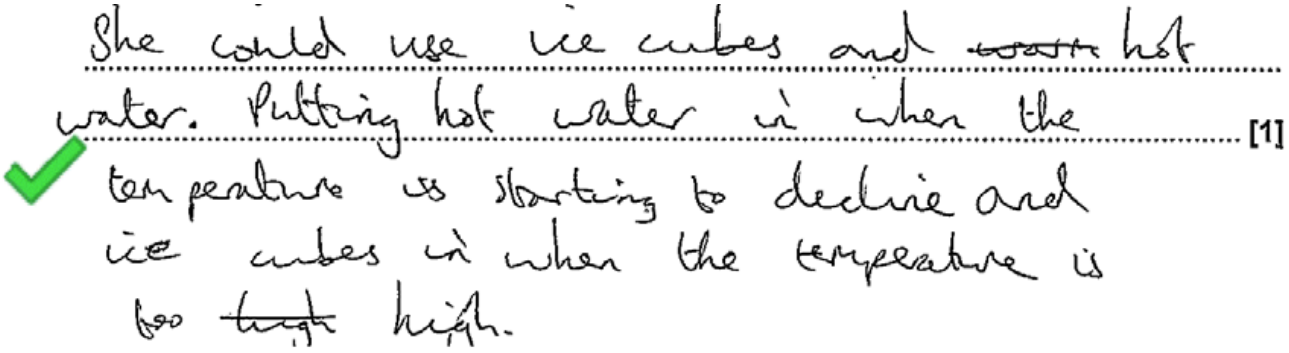
Describe how Eve could ensure the temperatures of the solutions in each experiment are kept at exactly 30 °C.

.....

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

Only about half of the candidates gave the correct response of a water bath (or a description of such) as the means to keep the experiment at the correct temperature.

Exemplar 3



This response although not specifying 'water bath', does have an acceptable description of one, possibly reflecting the method that they have used in the laboratory. It gained 1 mark.

Question 2 (c)

Eve sets up the solutions as shown in **Table 2.1**.

Amylase is an enzyme.

Experiment	Solution inside the tube	Solution outside the tube
1	starch + tap water	tap water
2	glucose + tap water	tap water
3	starch + amylase + tap water	tap water

Table 2.1

After 3 minutes she removes a small sample of each solution.

(c) Describe how she could test each sample for the presence of glucose.

.....

.....

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

Candidates were very unsure of the correct reagent to use and the resulting colour to test for glucose. (Benedict's (reagent) with the resulting red precipitate).

Question 2 (d)(i)

(d) She also uses iodine solution to test each sample for the presence of starch.

Her results are shown in **Table 2.2**.

Experiment	Sample from inside the tube		Sample from outside the tube	
	Test for starch	Test for glucose	Test for starch	Test for glucose
1	positive	negative	negative	negative
2	negative	positive	negative	positive
3	positive	positive	negative	positive

Table 2.2

(i) What conclusions can you make from Eve's results?

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.....

..... **[4]**

One of the problems encountered here was that candidates did not follow the rubric (conclusion) and described the results. Another problem here and also in (d)(ii) & (e) was the incorrect references to osmosis when diffusion was required.

Question 2 (d)(ii)

(ii) Eve repeats experiment 3, but this time she boils the amylase before using it.

Write a testable prediction for this repeat of experiment 3.

Explain the science behind your prediction.

Prediction .....

.....

Explanation .....

.....

.....

..... [3]

The first mark required a testable prediction to be stated. Very few candidates did so, some merely stating that glucose would not be present. A considerable number also stated that boiling the enzyme would make the reaction work at a faster rate and did not link the information about amylase and the effect that high temperature would have on it.

Exemplar 4

(ii) Eve repeats experiment 3, but this time she boils the amylase before using it.

Write a testable prediction for this repeat of experiment 3.

Explain the science behind your prediction.

Prediction ..Only starch and tap water will be present inside the ~~test~~ tube. Neither glucose nor starch will be present outside the tube.

Explanation ..Boiling is a high temperature which will probably denature the enzyme amylase. It will therefore not break down starch into glucose as its active site shape will change and the enzyme-substrate complex will be unable to form. Neither starch nor glucose will be present outside the tube as the starch will not be allowed to pass through the membrane and no glucose is present inside so no diffusion can occur. [3]

This response answers the explanation part well but the prediction is not testable. It gained 2 marks.

Question 2 (e)

(e) Eve sets up one more experiment as shown in **Table 2.3**.

Experiment	Solution inside the tube	Solution outside the tube
4	starch + tap water	tap water + iodine solution

Table 2.3

The molecules of iodine in the iodine solution are smaller than molecules of glucose.

Eve watches this experiment for 5 minutes.

Describe and explain the changes she is likely to observe during the 5 minutes.

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..... **[4]**

The table in this question clearly had two places, inside the tube and outside the tube. Also it required the candidate to take into account the start as well as the final observations. Very few candidates described the situation at the start, and limited the marks available. Most marks that were credited were for the colour change from brown to (blue) black inside the tube. There was some confusion as to the correct colour change that should occur.

Exemplar 5

(e) Eve sets up one more experiment as shown in **Table 2.3.**

Experiment	Solution inside the tube	Solution outside the tube
4	starch + tap water	tap water + iodine solution

Table 2.3

The molecules of iodine in the iodine solution are smaller than molecules of glucose.

Eve watches this experiment for 5 minutes.

Describe and explain the changes she is likely to observe during the 5 minutes.

At the start of the 5 minutes inside the tube the solution will be clear. However, as the time passes, the ~~starch will diffuse~~ iodine will diffuse across the partially permeable membrane into the solution inside the tube as its concentration there is lower. As it does so the solution will turn blue-black as starch is present and iodine turns blue-black when starch is present: At the end of the experiment, the tube will be blue-black and outside will be a paler orangey-brown (less concentrated with iodine solution), the starch does ~~not~~ NOT move as its molecules are too big to pass across the partially permeable membrane [4]

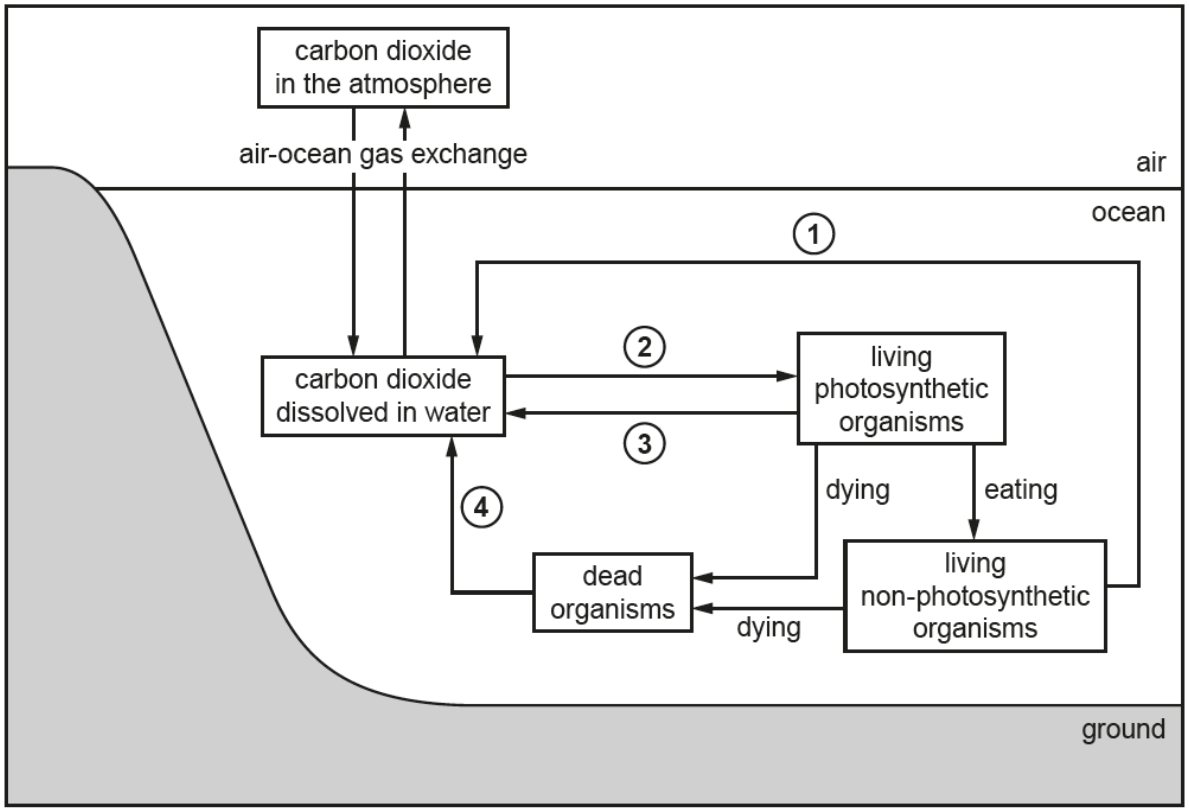
This response answers all four of the five available mark points available and gained 4 marks

Question 3 (a)(i)

3 Oceans cover two thirds of the Earth's surface and absorb one third of the carbon dioxide created by human activities.

Oceans play a very important part in cycling carbon.

(a) The diagram shows the parts of the carbon cycle that take place in the ocean.



(i) Write down the names of the processes that have been labelled **1**, **2**, **3** and **4** in the diagram.

1 .....

2 .....

3 .....

4 ..... **[3]**

Most candidates were aware of the different processes in this version of the carbon cycle, however the correct terminology for process 4 (decomposition), was often wrongly stated.

Question 3 (a)(ii)

(ii) Explain the roles of microorganisms in the ocean carbon cycle shown in the diagram.

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..... **[3]**

Candidates were required to link the processes in the diagram (respiration, decomposition & photosynthesis) to the production or use of carbon dioxide. The role of respiration and decomposition was explained by some candidates but very few recognised the role of photosynthesis in this situation.

Question 3 (a)(iii)

(iii) The processes shown in the diagram cycle carbon relatively quickly.

Carbon in the ocean is also cycled back to the atmosphere very slowly via another set of processes.

Describe these other processes and explain why this way of cycling carbon is very slow.

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

This question was asking about the production of fossil fuels and their subsequent combustion. Some higher ability candidates recognised the link.

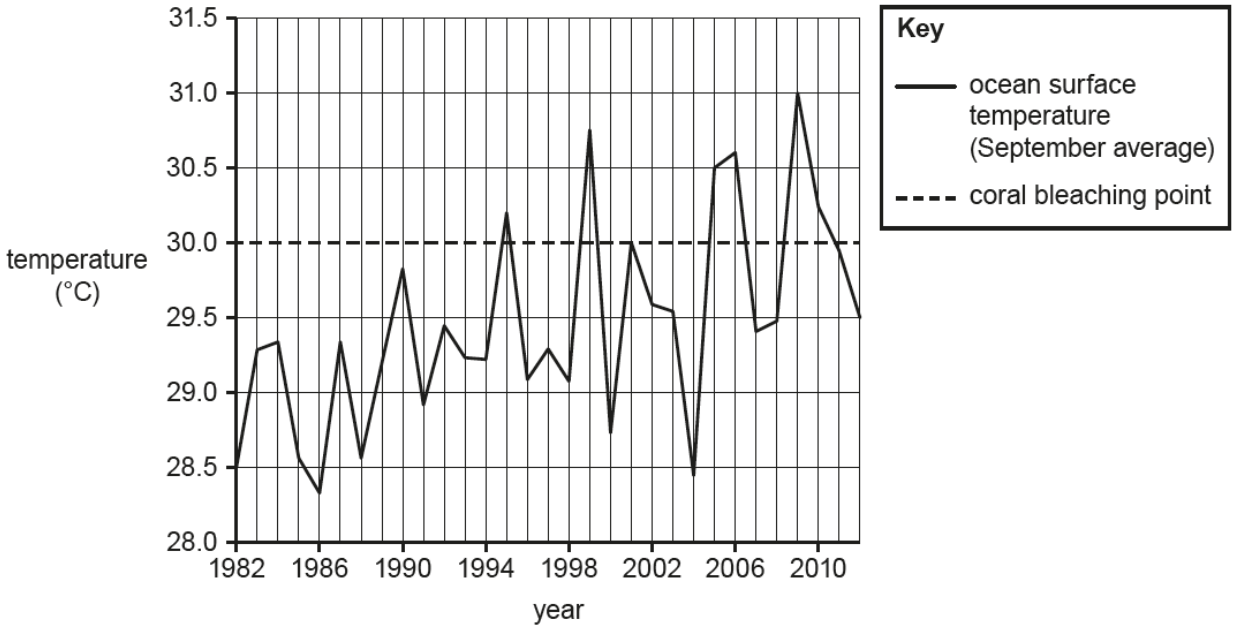
Question 3 (b)(i)

(b) Human activities are increasing the amount of carbon dioxide in the atmosphere. Carbon dioxide is a greenhouse gas.

Scientists are concerned about the effects that changes in temperature can have on coral reefs in the ocean.

If the ocean temperature rises above 30.0 °C, the coral starts to die and turns white. This temperature is called the 'coral bleaching point'.

The graph shows the ocean surface temperature around the Cayman Islands between 1982 and 2012.



(i) The graph shows an overall increase in ocean surface temperature from 1982 to 2012.

Describe **two other** patterns that are visible in the ocean surface temperature data on the graph.

1 .....

.....

2 .....

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

Most candidates were able to recognise that the temperature was fluctuating but the link to bleaching of the coral was missed by the majority.

Question 3 (b)(ii)

(ii) Scientists say long-term studies are needed when investigating the effects of climate change.

Use evidence from the graph to justify the scientists' view.

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

Candidates struggled to use the data to justify the scientists' view.

Question 3 (b)(iii)

(iii) Calculate the **overall rate** of change in the ocean surface temperature from 1982 to 2012.

Overall rate of change = ... °C per year **[2]**

The correct calculation was credited in approximately 50% of answers. There were a number of candidates who completed the first part of the calculation but left their answer as a fraction.

Question 3 (b)(iv)

(iv) Predict how the line on the graph may have looked in the five years after 2012, **and** explain what this would have meant for coral in the Cayman Islands.

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

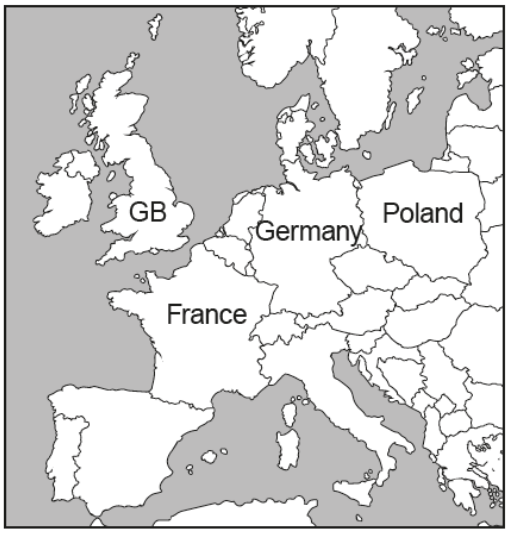
This question was well answered by most candidates.

Question 4 (a)

4 Plants can be infected by diseases caused by pathogens.

The plant disease ash dieback was first recorded in the early 1990s in Poland.

Since then, many thousands of trees in northern Europe have become infected.



Ash dieback was first found in eastern parts of Great Britain (GB) in 2012, and has been spreading across the country ever since.

(a) Suggest **two** ways in which ash dieback could have been spread from mainland Europe to Great Britain.

1 .....

.....

2 .....

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

Many candidates recognised that spores could be carried in the air or infected material could be imported into the country.

Question 4 (b)(i)

(b) The British outbreak of ash dieback started in woodland in Norfolk.

Much of the woodland has died, but one ash tree has shown tolerance to the disease. This tree was named 'Betty' by scientists. Tolerant trees have also been found in mainland Europe.

(i) Explain how scientists could use selective breeding to produce ash trees with improved tolerance.

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.....

..... **[3]**

In the slightly unfamiliar scenario of plants rather than the animals, candidates did not explain the process of selective breeding and gave responses involving taking cuttings, cloning or genetic engineering. The key words 'selective breeding' appear to have been ignored.

Question 4 (b)(ii)

(ii) New woodland could be planted using cuttings from Betty.

Explain why this could be a **disadvantage** during a future outbreak of plant disease.

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

Many candidates were able to recognise the fact that clones were genetically identical and a number then went on to explain that they would be susceptible to another disease (rather than the same one). Additionally there was some confusion between resistance of the tree and of the pathogen. A common misconception was the use of the term immunity in relation to the tree.

Question 4 (b)(iii)

(iii) Explain how gene technology could be used to produce ash trees with improved tolerance.

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..... **[4]**

This longer response question was designed to assess candidates' knowledge of the whole process of genetic engineering, set in a slightly different scenario. Higher ability candidates produced responses which included sequencing of genomes and the use of genetic engineering.

Question 4 (c)(i)

(c) Amir works in a laboratory. His job is to identify pathogens that cause plant diseases.

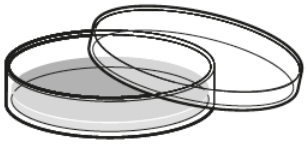
Amir has a sample of one species of bacteria from an infected plant.

He wants to test the effectiveness of different antibiotics against this species of bacteria.

Amir must start by transferring bacteria from the sample bottle into four Petri dishes containing agar jelly.

He needs to set up four identical dishes of this species of bacteria.

glass bottle containing the sample of bacteria



Petri dish containing agar jelly

He intends to pour some of the liquid from the glass bottle into each Petri dish.

(i) Write down **two** ways he could improve his method and explain why each is an improvement.

Improvement 1 .....

.....

Explanation .....

.....

Improvement 2 .....

.....

Explanation .....

..... **[4]**

Aseptic techniques are a key element to one of the practical activities in section B2.4 of the specification and it was evident that many candidates were aware of methods involved. However, the explanations were not always linked to the improvements.

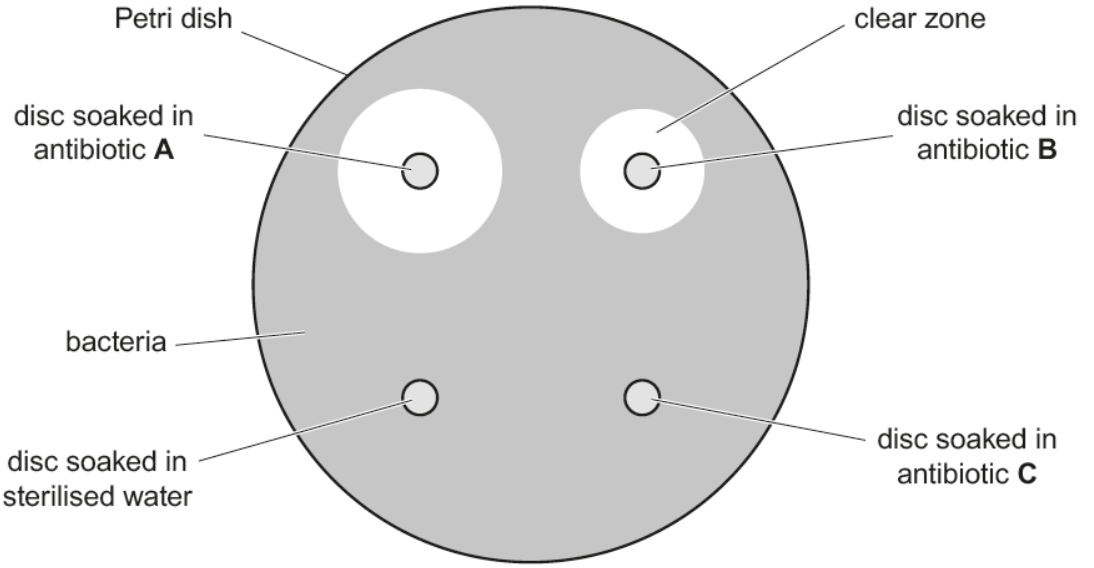
Question 4 (c)(ii)

After transferring bacteria from the sample to the four Petri dishes, Amir adds four different paper discs to each dish.

The paper discs have been soaked in different solutions.

Amir places the dishes in an incubator overnight.
The bacteria grow to cover the surface of the agar jelly.

The diagram shows what Amir sees on one of the dishes after it has been incubated.



not to scale

(ii) The diameter of the clear zone around the disc soaked in antibiotic **A** is 23 mm.

Calculate the area of this clear zone.

Use the equation: area of clear zone = $3.14 \times r^2$.

Give your answer to **3** significant figures.

Area of clear zone = ... mm^2 **[3]**

Most candidates were able to calculate the area of the clear zone. There were a number of common mistakes including the use of the diameter instead of the radius and giving the answer to 3 decimal places and not to 3 significant figures.

Question 4 (c)(iii)

(iii) **Table 4.1** shows Amir's results for all four dishes.

Disc soaked in	Area of clear zone (mm^2)			
	Petri dish 1	Petri dish 2	Petri dish 3	Petri dish 4
Antibiotic **A**		363	346	346
Antibiotic **B**	227	254	227	214
Antibiotic **C**	0	0	0	0
Sterilised water	0	0	0	0

Table 4.1

Suggest **two** possible explanations for the results for antibiotic **C**.

1 .....

.....

2 .....

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

Common mistakes involved the use of the word 'immune' when 'resistance' was required as well as the use of 'antibodies/antigens' instead of 'antibiotic'. Also some candidates wrongly referred to disc A as a placebo.

Question 4 (d)(i)

(d) **Table 4.2** gives information about plant cells and pathogens.

Cell type	Mean diameter (μm)	Mean diameter (m)
Plant cell		8×10^{-5}
Bacterium	2	
Virus	0.25	

Table 4.2

(i) Give the mean diameter of the plant cell in μm.

Mean diameter = ... μm **[1]**

This question assessed mathematical skill 1b, recognise and use expressions in standard form. Candidates appeared to be unaware of how many (μm) were in a (m) or could not deal with the number in standard form.

Question 4 (d)(ii)

(ii) Give the mean diameter of the bacterium in m.

Give your answer in standard form.

Mean diameter = ... m **[1]**

This question assessed mathematical skill 1b, recognise and use expressions in standard form. Only approximately 20% of candidates correctly stated that 2 µm was equivalent to 2 x 10^{-6} m.

This is a key area for candidates to improve their knowledge.

Question 4 (d)(iii)

(iii) Give the mean diameter of the plant cell, in m, to the nearest order of magnitude.

Mean diameter = ... m **[2]**

This question assessed mathematical skill 2h, make order of magnitude calculations. Most candidates could not carry out the calculation.

Exemplar 6

(iii) Give the mean diameter of the plant cell, in m, to the nearest order of magnitude.

$m = 8 \times 10^{-5}$
$= 10 \times 10^{-5}$
$= 10^{-4}$
$= 1 \times 10^{-4}$

Mean diameter = 10^{-4} m **[2]**

This response is credited with both mark points as they have shown that the diameter is 8 x 10^{-5} which is nearly 10 x 10^{-5} giving the nearest order of magnitude to be 10^{-4}.

Question 4 (d)(iv)

(iv) Show that the sizes of the bacterium and the virus are the same order of magnitude.

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

This question assessed mathematical skill 2h, make order of magnitude calculations. Most candidates could not carry out the calculation.

As with parts (i) & (ii) this is an area that candidates require an improvement in their knowledge.

Exemplar 7

(iv) Show that the sizes of the bacterium and the virus are the same order of magnitude.

bacterium = 2×10^{-6} m = 1×10^{-6} = 10^{-6} m

virus = 0·25 ÷ 1000000 = $2 \cdot 5 \times 10^{-7}$

2×10^{-6} m ÷ $2 \cdot 5 \times 10^{-7}$ m = 8 . 8 < 10 ∴ same order of magnitude [2]

This response shows that the bacterium is 8 times larger (1st mark point) and that this is less than 10 times larger, so they are of the same order of magnitude. .

Question 5 (a)

5 The human body responds to changes so that it can maintain a constant internal environment.

(a) Many of these responses involve muscles as effectors.

Muscles are made of cells.

Explain why muscle cells have more mitochondria than most other types of cell in the body.

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

This question required candidates to make a link between the fact that muscles require ATP/energy to contract and that mitochondria provide this from the process of respiration. There was some misconception that mitochondria produce glucose.

Question 5 (b)

(b)* When temperature receptors in the skin and hypothalamus detect a drop in temperature, the hormone adrenaline is released from the adrenal gland.

Explain how the release of adrenaline could help the body to raise its core temperature back to normal.

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..... **[6]**

This was a high demand question requiring clear links between the effects of adrenaline on the body, how this effects cellular respiration and how thermoregulation mechanisms warm the body. Candidates responded well with approximately 80% credited Level 2/3. A common misconception concerning vasoconstriction, involved candidates talking about blood vessels/capillaries moving away from the surface of the skin.

Question 5 (c)(i)

(c) The sensitivity of cells to the hormone adrenaline is increased by the hormone thyroxine.

(i) Explain how the production of thyroxine is regulated by negative feedback.

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..... **[3]**

Some candidates were aware of thyroxine being made in the thyroid gland, however very few were aware of TSH and its role in this process.

Exemplar 8

When thyroxine levels are too high in the body, a negative feedback response occurs where ~~the pituitary gland releases~~ ~~TSH is inhibi~~ the release of TSH is inhibited in the pituitary gland. This means the thyroid gland does not ~~release~~ produce any more thyroxine and levels can return to normal. When levels are too low, the pituitary gland releases more TSH and so the thyroid gland releases more thyroxine and levels can return to normal. [3]

This response clearly identifies where both hormones are made and the effect that each have on each other. It gained 3 marks.

Question 5 (c)(ii)

(ii) Hormones stimulate cells by binding to receptors on the cell surface. These receptors are protein molecules.

Suggest how the hormone thyroxine could cause a cell to become more sensitive to the hormone adrenaline.

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..... [4]

Candidates' knowledge of this section of the specification (B5.3.1 & 5.3.2) is in need of improving.

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