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# Examiners' Report
# June 2023

## GCE Biology B 9BI0 03

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June 2023

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## Introduction

There was a wide variety of questions on the paper covering large parts of the specification and overall candidates did well. Questions were set on six of the core practicals and many candidates were able to recall the methods followed as well as being able to explain the reasons behind them.

Several indirect practical skills were tested, including commenting on experimental design and evaluating methods, writing a null hypothesis, identifying variables to be controlled, plotting graphs, processing and analysing data and applying scientific knowledge to practical contexts. Overall these were done well.

There was a more mixed response to questions testing maths skills, and candidates would benefit from more practice in several areas including making up dilutions of stock solutions, calculation of the biodiversity index, carrying out and analysing the results of stats tests and use of the Hardy-Weinberg equation.

There were some excellent and thoughtful answers to extended writing questions including the nine-mark levels-based question and some five-mark questions, and candidates deserve credit for their ability to organise data, facts, and expressing themselves clearly. It was particularly pleasing to see candidates applying their scientific knowledge to real world data and situations.

It is clear that some of the advice given in the 2022 examiners report has been implemented and centres are to be commended for the way they have prepared candidates for this exam.

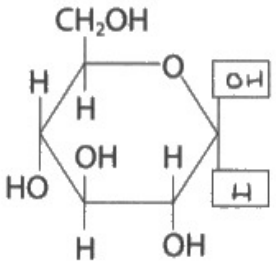
## Question 1 (a)

Almost all candidates were able to complete the diagram to show the structure of beta-glucose.

**1** Glucose is a monosaccharide.

(a) Complete the diagram to show the structure of beta-glucose.

**(1)**




**ResultsPlus**
**Examiner Comments**

This is basic information which should be learned.

## Question 1 (b)

This question asked for three differences between the structure of starch and cellulose. Generally it was well answered, with over half of the candidates gaining at least two marks.

Many candidates knew the properties of starch and cellulose, but not all could clearly give three differences. Candidates who lost marks usually did not give matching pairs of statements or gave only one half of the information.

Some candidates included information about the functions of starch and cellulose, eg that cellulose is found in cell walls and starch is a storage molecule. These gained no marks.

A few candidates confused the properties of starch and cellulose completely.

- Starch contains ∝ glucose only and cellulose is made of β glucose only.

**ResultsPlus**
**Examiner Comments**

This is a clearly stated difference.

- Starch is made of amylose & amylopectin.
- Cellulose is made of β glucose that alternate every other / rotate 180° & starch is made of alpha. glu.
- Cellulose has 1,6 bonds & starch has both 1,4 & 1,6 bonds.
- cellulose is linear.

ResultsPlus
Examiner Comments

This candidate knew a lot of relevant information but did not make clear and matching points.

In their first bullet point, they commented only on starch, not cellulose.

In their second bullet point, they gained marking point 1, but gave only half of marking point 4.

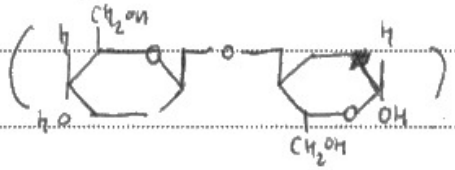
Their third bullet point did not get credit because they did not refer to **glycosidic** bonds, and the information given about cellulose was incorrect.

- starch has α-glucose as a monomer

  cellulose has β-glucose as a monomer

- starch have both 1,6-glycosidic bond (amylopectin) and 1,4-glycosidic bond (amylose) join its monomer together

  cellulose only have 1,4-glycosidic bond join its monomer together.

- when joining, monomer (β-glucose) of cellulose is inverted  while starch monomer don't.



**ResultsPlus**
**Examiner Comments**

This is a very well organised answer making three clear points. A diagram can be a simple way to show something that is hard to explain.

| Starch | Cellulose |
| --- | --- |
| - contains α glucose (not beta) | - contains beta-glucose (not α) |
| - no inversion of glucose molecules. | - every other glucose is inverted (upside down). |
| - contains (1-4) and (1-6) glycosidic bonds - is branched. | - only has 1-4 glycosidic bonds - no branching. |

**ResultsPlus**
**Examiner Comments**

This is another way to make sure you make clear and matching points. This candidate made four relevant points and gained the full three marks.

**ResultsPlus**
**Examiner Tip**

Setting out your answer as a table of differences helps to keep you organised.

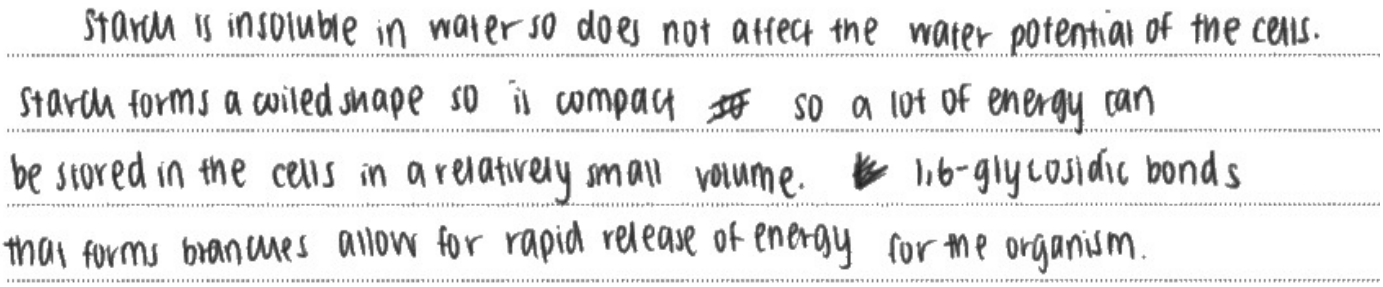
## Question 1 (c)

This question required a matched pair of answers explaining how a property of starch makes it suitable for energy storage in cells. The command word was **explain**, so the property had to be linked to a relevant comment about energy storage for full credit.

There were three creditworthy pairs:

- insoluble, so has no osmotic effect.
- compact, so a lot can be stored in a small space.
- branched, so hydrolysed quickly.

Almost half of the candidates scored two marks in this question, choosing a relevant property and explaining how this makes it suitable for energy storage. The most common errors were to give one or more properties, but not link them to energy storage or to give explanations that lacked detail.




**ResultsPlus**
**Examiner Comments**

This candidate scored full marks for their explanation about insolubility. They could also have achieved two marks for their second point about being compact.

→ Compact , so lots of storage

→ tertiary structure held by Hydrogen bonds

→ Branched so can release energy when needed by hydrolysis

**ResultsPlus Examiner Comments**

This candidate scored one mark. They knew a lot about the properties of starch but did not give enough detail to score the second mark for explanation in either case.

Compact gained one mark, but they did not refer to a small space.

Branched gained one mark but they did not say that hydrolysis happened more quickly.

- IT IS INSOLUBLE SO IT DOESN'T AFFECT WATER POTENTIAL IN THE CELLS.
- IT IS COMPACT SO DOESN'T TAKE UP SPACE.
- GLYCOSIDIC BONDS ARE EASILY BROKEN SO ALLOWS FOR QUICK RELEASE OF ENERGY.

**ResultsPlus Examiner Comments**

This answer scored two marks for the first two lines.

It would have scored one mark for compact, but not the second for the explanation as it does not refer to energy storage.

The last points would not have scored at all, because they did not refer to branching (just glycosidic bonds) and they referred to energy release rather than breakdown of starch.

## Question 2 (a)(i)

This question is about Core Practical 7: dissect an insect to show the structure of the gas exchange system.

Candidates were asked to add a line to a diagram of a locust to show where it would be cut to expose the gas exchange system.

To gain credit, candidates were expected to draw a line which was roughly horizontal (straight or curved), going through the thorax and abdomen, in the upper part of the body (which was lighter grey on the diagram).

Some candidates drew lines which would have exposed the gas exchange system well. The most common errors were to not include the thorax, or to draw the line either far too high or far too low.

A few candidates drew a vertical line through the body.

**2** Insects, such as locusts, can be dissected to show their gas exchange system.

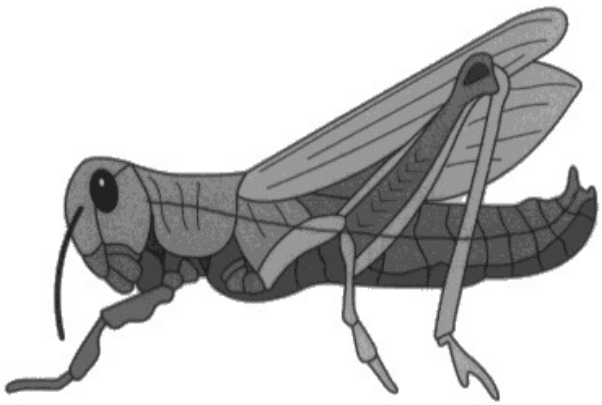
(a) (i) The diagram shows a dead locust.



Draw a line on this locust to show where you would cut through the exoskeleton to expose the gas exchange system.

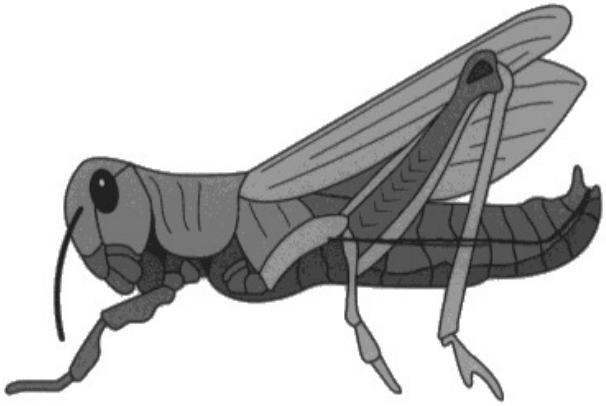
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Examiner Comments

This gained one mark for a correctly placed line going through the thorax and abdomen.



ResultsPlus
Examiner Comments

This also gained one mark for a correctly placed line – curved this time.



ResultsPlus
Examiner Comments

This line was too short as it did not reach the thorax, so did not get a mark.



**ResultsPlus**
**Examiner Comments**

This line is too low and it does not go through the thorax.

## Question 2 (a)(ii)

Candidates were asked why the dissected locust would be covered with water.

Almost half achieved this mark, saying that it would make the gas exchange system (or a named visible part of it) easier to see. Some candidates described how the air-filled structures would appear silvery-grey.

If candidates named a structure that would not be visible, eg tracheoles, this was ignored.

A surprising number of candidates think locusts have blood, and that the water would wash this away. This did not gain credit.

To allow the gas system structures to become silvery so they can easily be seen.

ResultsPlus Examiner Comments

This scored one mark.

So that the internal structures appear as a silvery-grey.

ResultsPlus Examiner Comments

This answer did not score, as "internal structures" is too vague.

ResultsPlus Examiner Tip

When you are carrying out core practicals, make sure you know why the steps you are following are needed.

(1)

to make the air filled tracheoles / tracheae visible as they appear silvery grey with water

**ResultsPlus Examiner Comments**

This scored one mark.

Here the candidate mentioned making tracheoles more visible. As tracheoles are not visible to the naked eye this was ignored, but credit was given for saying that the tracheae are visible with water.

this removes any blood left inside it, it cleans inside and makes it easier to see the respiratory system

**ResultsPlus Examiner Comments**

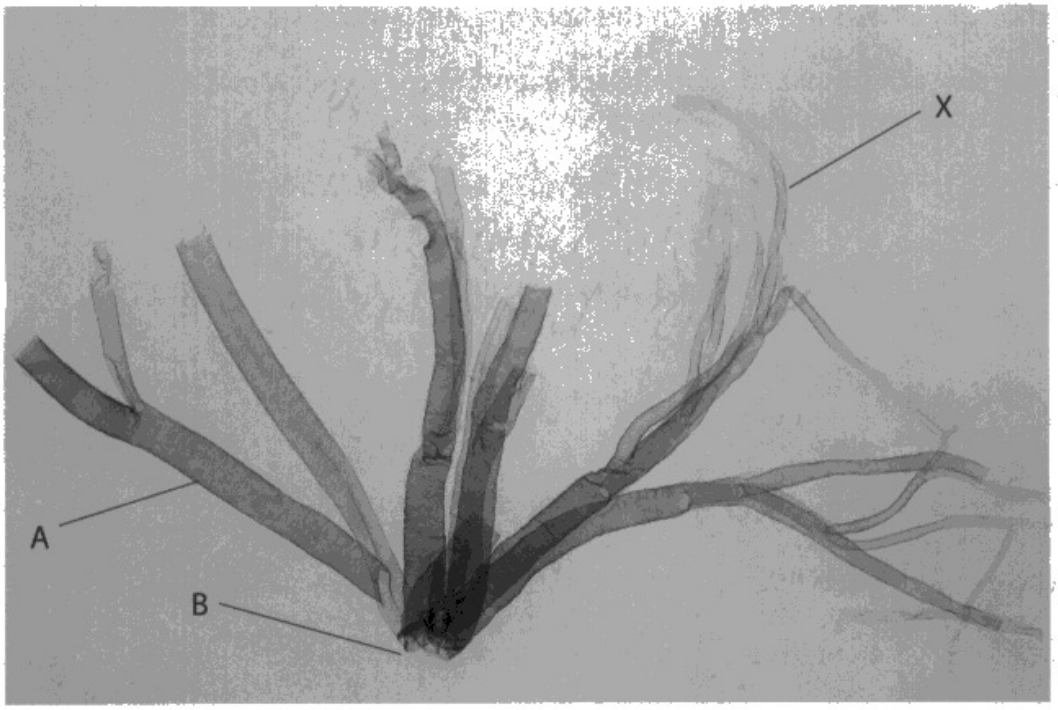
Any reference to locust blood prevented an answer from achieving the mark.

## Question 2 (b)(i)

Candidates were given a photomicrograph of a dissected locust gas exchange system and asked to label two parts. Around half of all candidates scored both marks, but about a third were unable to name either structure.

Common errors included naming the wrong parts of insect systems eg tracheoles, or naming part of the gas exchange systems of other animals eg lamellae, alveoli, bronchi etc.

(b) The photograph shows part of the dissected gas exchange system, as seen using a microscope.




(Source: © blickwinkel/Alamy Stock Photo)

(i) Name the structures labelled A and B.

**(2)**

A trachea

B spiracle

**ResultsPlus**
**Examiner Comments**

This answer scored both marks.

## Question 2 (b)(ii)

Candidates were asked to name the structure that supplies oxygen directly to the muscle tissue in a locust. Over half correctly named the tracheole.

Errors included naming the wrong part of the insect gas exchange system eg spiracles / air sacs, or part of the gas exchange systems of other animals. A surprising number of candidates gave an answer involving blood, eg capillaries, haemoglobin, red blood cells etc.

(ii) Name the structure that supplies oxygen directly to the muscle tissue. (1)

tracheoles.

ResultsPlus
Examiner Comments

This correct answer scored one mark.

## Question 2 (b)(iii)

This question involved making two measurements from a photomicrograph (at points A and X) and using these to calculate the actual size of the structure at X.

The majority of candidates carried out the measurements accurately and used them to calculate the actual size as 0.18mm, or achieved an answer within the accepted tolerance levels.

It was pleasing to see that many candidates laid out their answers logically, with some using the formula: magnification = image size divided by actual size.

Around three quarters of candidates achieved both marks in this question. The most common error was to give an answer a factor of 10 out – this was usually due to confusion when converting from centimetres to millimetres (which was not actually necessary if the original measurement was made in millimetres).

Candidates who made an error and gave an incorrect final answer could still score one mark if they had clearly given an image size for either A or X. Almost all candidates took note of the instruction to give the final answer to two decimal places.

(iii) At the point labelled A, the structure is 0.9 mm in diameter.

Calculate the diameter of the structure at the point labelled X.

Give your answer to **two** decimal places.

(2)

A Image diameter = 5mm

Magnification = $\frac{5}{0.9}$ = 5.555...

X Image diameter = 1mm

Actual diameter = $\frac{1}{5.55...}$ = 0.18mm

Answer 0.18 mm

**(Total for Question 2 = 7 marks)**

**ResultsPlus**
**Examiner Comments**

This answer scored both marks.

They clearly showed the image size at A and at X and used these correctly to get the final answer.

Give your answer to **two** decimal places.

0.9mm corresponds to 0.5mm in actual diameter (2)

÷5 → 0.18 mm → 1mm

Answer 0.18 mm



**ResultsPlus**
**Examiner Comments**

This candidate also scored 2 marks for a correct answer. It was obtained by a different method but was equally logical and well set out.

Give your answer to **two** decimal places.

image / actual X = 1mm (2)

actual / image A = 0.5 cm = 50 mm

55.56 = 1/x  1/55.56 =

∴ mag. = 50/0.9 = 55.56x

Answer 0.018 mm



**ResultsPlus**
**Examiner Comments**

This candidate measured A correctly in centimetres as 0.5 cm but made an error converting this to millimetres. Their final answer was therefore wrong.

They could not have credit for the measurement of A, as 0.5cm and 50mm are contradictory.

They achieved one mark for correct measurement of X as 1mm.



**ResultsPlus**
**Examiner Tip**

Always set out your working clearly in calculations. If you make a mistake you may still get credit for an interim step.

(2)

5mm for A

0.9 ↑ x 5.56

x = 0.1

0.1 x 5.56 = 0.556

Answer 0.556 mm

**ResultsPlus**
**Examiner Comments**

This candidate scored one mark for correctly measuring A as 5mm. Their calculation was incorrect, as they divided 5 by 0.9 instead of dividing 0.9 by 5.

This candidate would not have scored marking point 2 even if their answer had been correct, as it was not to 2 decimal places.

## Question 3 (a)(i)

In a flow diagram of the steps in genetic modification of soya beans, almost half of all candidates could name DNA ligase as the enzyme needed to insert a gene into a plasmid in step C. The most common error was to name the enzyme as restriction endonuclease.

**3** In genetic modification, DNA from one species is joined to DNA from another species, to form recombinant DNA.

This recombinant DNA is inserted into the host organism using a vector.

The diagram shows a simplified sequence of events in the formation of herbicide-resistant, genetically modified (GM) soya beans.

Herbicides are chemicals that kill plants. They can be used to kill unwanted plants, such as weeds.

lig
Poly
nucleas
prot

**Step A** Plasmids are extracted from *A. tumefaciens* bacteria

↓

**Step B** Plasmids are cut using an enzyme

↓

**Step C** The gene for herbicide-resistance is inserted into the plasmids.

↓

**Step D** Plasmids are returned to *A. tumefaciens* bacteria

↓

**Step E** A soya bean plant is infected with the modified *A. tumefaciens* bacteria

↓

**Step F** Herbicide-resistant soya bean plants are cloned from the infected plant.

(a) (i) Name the enzyme used in **Step C**.

**(1)**

DNA ligase

ResultsPlus
Examiner Comments

This candidate scored one mark for correctly naming DNA ligase.

## Question 3 (a)(ii)

Almost three quarters of candidates could use the information given in the stem of the question to identify the vector in this process.

Acceptable answers included bacteria / *A. tumfaciens* / plasmid. The most common incorrect answers were vectors not named in the flow diagram eg viruses or gene guns; some candidates thought that the soya bean plant was the vector.

(ii) Name the vector in this process.

(1)

plasmids

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Examiner Comments

One mark for a correct answer.

(ii) Name the vector in this process.

(1)

A. tumefaciens bacteria

ResultsPlus
Examiner Comments

Another correct answer gaining a mark.

ResultsPlus
Examiner Tip

Always use the information you are given in the stem of a question – it is there for a reason.

## Question 3 (b)

Candidates were asked why it is possible to clone many herbicide-resistant plants from one infected plant. This proved very challenging, with only around a fifth of candidates scoring any marks at all.

All four marking points were seen, with marking points 2, 3 and 4 equally common. Mark point 1 was less often seen.

There was a lot of confusion with many candidates suggesting taking cuttings or using seeds, rather than collecting infected cells from the tumour that grew and propagating these.

(b) Explain why it is possible to clone many herbicide-resistant plants from one infected plant in **Step F**.

**(2)**

• Because ~~infective~~ infected plant with the plasmid from agrobacterium tumefaciens bacteria produces a gall outgrowth ~~from~~ from the plants which contains cells which contain the recombinant herbicide-resistant DNA ∴ cells can be extracted from the outgrowth gall and cloned in lab using mitosis to ~~form~~ clone more resistant plant

**ResultsPlus**
**Examiner Comments**

This was a strong answer which scored marking points 2, 3 and 4, achieving maximum 2 marks.

One infected plant produces a gall. ~~OR its~~ Cells can then be extracted from the gall and used to grow ~~a new plo~~ many new resistant plants. the cells are ably to rapidly divide by mitosis.

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Examiner Comments

Another strong answer which achieved marking points 4 then 3.

Ceus containing the gene for herbicide resistance can be extracted from the crown gall of the infected plant and cultured to produce more genetically identical plant.

ResultsPlus
Examiner Comments

This candidate achieved maximum marks with marking points 2 and 4.

- By fertilisation of other plants with the pollen grains from the injected plant
- New plants formed also possess the herbicide-resistant gene

ResultsPlus
Examiner Comments

This candidate did not score. They referred to sexual reproduction rather than cloning, and although they mentioned herbicide resistance, they did not make it clear that the gene for resistance was in the cells.

- The Herbicide-resistant Soya been has the gene/ allele for resistance against herbicids. So when it reproduces to form more Soya been the gene/ allele for this resistance will be passed on to the next generation and so on until many herbicide-resistant plants have been produced

ResultsPlus
Examiner Comments

This answer did not gain any marks. They do not make it clear that the gene for herbicide resistance is in the cells, and they mention reproduction, rather than cloning.

## Question 3 (c)

Candidates were asked why herbicide resistance would improve the yield of GM soya bean plants compared to non-GM soya bean plants. The stem of the question had told them that herbicides are chemicals that kill plants and that they can be used to kill unwanted plants.

This question proved unexpectedly difficult for some candidates.

It was expected that candidates would write that herbicide resistant plants could be sprayed with herbicide, and that this would kill weeds around them, but not kill the plants. This would result in lack of competition (from weeds) for named resources, eg water, light, mineral ions, leading to greater photosynthesis or synthesis of a named product eg chlorophyll, in herbicide resistant plants.

The answer could have been written in terms of non-GM plants, which would be killed by herbicides; so herbicides could not be used, therefore competition with weeds for light, minerals etc was high, and photosynthesis / synthesis of a named product was reduced.

There was no credit for simply saying that yield was increased in GM plants (or reduced in non-GM plants) as this was in the stem of the question.

Many candidates misunderstood and thought that spraying would occur anyway, and that the dead non-GM plants would have a lower yield than the live GM plants. A small number of candidates did not use the information given in the stem and thought that herbicides killed insects which might eat the plants.

• herbicides kills plants such as weed plants

• when its used to kill unwanted plants ↗ herbicides can also kill soya bean plants nearby

• herbs herbicide resistance ~~gene~~ in GM plants allows those soya beans to ~~survive~~ survive but not the non-GM soya plants

• meaning yield of GM soya plants would ~~more~~ be higher compared to those not GM.

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Examiner Comments

This answer scored marking point 1 for stating that the herbicide kills the weeds, but not the GM plants nearby.

They go on to suggest that non-GM plants will be killed by the herbicide and so will have a lower yield, so do not get any further marks.

(c) Explain how herbicide resistance would improve the yield of GM soya bean plants compared to non-GM soya bean plants.

**(3)**

The herbicide would be used to kill weeds however it wouldn't effect the soya bean plants because of the herbicide resistance. Now weeds killed means more space and resources availble for GM soya bean plants ∴ increasing the yield

**ResultsPlus**
**Examiner Comments**

This answer achieves marking point 1 on lines 1 – 3.

They do not refer to competition directly, so cannot get marking point 2.

Although they give examples (space and resources), neither of these are enough for marking points 3 or 4.

If herbicides can be used on the GM soya bean plants, it will reduce their competition by killing weeds but not the soya plants. This means the soya plants have more access to minerals and water from the soil and do not have to compete with other species for space and light so the rate of photosynthesis can increase and the plants grow more.

**ResultsPlus**
**Examiner Comments**

This is a very strong answer which covers all five marking points, achieving maximum three marks.

It gets marking points 2 (less competition) and 1 in lines 1 – 3. Then marking points 3 and 4 in lines 4 – 6 for water, minerals and light.

In line 6 – 7 they link the increased light to increased rate of photosynthesis, achieving marking point 5.

The yield of GM soy bean plants would increase as the plant would be unaffected by herbicides. Therefore, the non-GM soy bean plants would have reduced / less yield as compared to GM plants as they can be affected by herbicides which can reduce the population.

ResultsPlus
Examiner Comments

This answer did not get any of the marking points.

They misunderstood what would happen and thought that both GM and non-GM plants would be sprayed with herbicides, that the non-GM plants would be killed and that this would reduce the yield. There is no reference to weeds or competition at all.

## Question 4 (a)(i)

Question 4 related to Core Practical 14: investigate the effect of gibberellin concentration on the production of amylase in cereals using a starch agar assay.

In Q04(a)(i) candidates were asked to describe how to dilute a stock solution of 1g per $dm^3$ to make a test solution of 300µg per $dm^3$.

This could be done as a two-step process:

- dilution by {1 in 1000 / 1 : 999}.
- dilution in ratio of {3 in 10 / 3 : 7}.

or as a single step process eg 0.3 $cm^3$ stock + 999.7 $cm^3$ water.

These are examples and equivalent volumes could be used.

Many candidates found this extremely challenging and were unable to gain any credit. The most common errors were adding a mass of gibberellin to a volume of water (instead of using the 1g per $dm^3$ stock solution) or being out by a factor of 10.

About a quarter of candidates scored one mark, usually for the idea of diluting in a ratio of 3 : 7, and some managed the one-step process correctly. A small number of candidates were able to describe the method needed to reach the desired concentration and scored both marks.

**4** When cereal grains germinate, stored starch is broken down by amylase.

(a) A student investigated the effect of gibberellin concentration on the production of amylase in cereal grains.

This method was used:

**Step 1** Dilute a stock solution of gibberellin to give five different concentrations.

**Step 2** Cut the cereal grains in half and discard the half containing the embryo.

**Step 3** Soak the remaining halves of the grains in sodium hypochlorite solution for five minutes.

**Step 4** Soak one grain in each of the gibberellin solutions for 24 hours.

(i) The stock solution of gibberellin has a concentration of 1 g per $dm^3$.

Describe how you would dilute this stock solution to give a test solution of 300 µg per $dm^3$.

$3 \times 10^{-4}$ g

**(2)**

Put 3$cm^3$ of the gibberellin solution into a test tube and add 7$cm^3$ of water to make a solution with 0.3 g per $dm^3$. Add 1$cm^3$ of this solution to a different test tube then add 9$cm^3$ of water and mix the solution. Add 1$cm^3$ of that solution to a test tube then add 9$cm^3$ of water and then repeat once more with the produced solution

**ResultsPlus**
**Examiner Comments**

This is a strong answer, gaining both marks. They diluted in the ratio of 3:7, then carried out three rounds of serial dilution to achieve the desired concentration.

300µg per dm³ ↓ 0.3g  1g = 1000 mg = 1000,000 µg (2)

need to use 3:9997 ratio of stock solution to water. ~~E.g to~~ ~~If~~ ~~max~~ ~~ratio~~ of ~~10~~

e.g 3 cm³ of stock solution with 9997 cm³ of distilled water.

ResultsPlus Examiner Comments

This answer also scored two marks, this time for the one step process.

300 µg per dm³.  0.3mg  1g = 1000mg → 300 → 30 → 3 → 0.3 (2)

Add 3 ~~g~~ cm³ of the stock solution to 7cm³ of distilled water. Use a new pipette to take 1cm³ of this solution and add 9cm³ of distilled water. Do that twice more. ~~@~~ This is serial dilution.

ResultsPlus Examiner Comments

Another strong answer gaining 2 marks.

- 1g = 1000 µg ~~1000/1~~ ~~tt~~ Pipette 3 cm³ of stock solution into testtube
- Then add 7cm³ of distilled water

ResultsPlus Examiner Comments

This answer gets mark point 2.

In a 10 $dm^3$ solution dilute 0.3 $dm^3$ of stock solution to 9.7 $dm^3$ water using a pipette.

ResultsPlus
Examiner Comments

This is a variation of the 3 in 10 method, as they are diluting 3 in 100 and gains mark point 2.

## Question 4 (a)(ii)

Candidates were given a method for the investigation and asked the reason for two of the steps: cutting the grains in half and discarding the half containing the embryo; and soaking the remaining halves of the grain in sodium hypochlorite solution.

There were some excellent answers, with the majority of candidates scoring at least one mark. Where candidates did not score it was not clear if this was because they were not familiar with the practical, or that they did not know the reasons behind the steps they had followed.

Many candidates knew that the embryo could produce gibberellin, so this should be removed; far fewer gave the alternative marking point that the endosperm part was retained because it produces the amylase.

The most common misconception was that the sodium hypochlorite was needed to increase uptake of gibberellin, rather than killing any microbes which may produce amylase.

(ii) State **one** reason for each of the following steps in the method.

**(2)**

**Step 2**

The ~~[illegible]~~ embryo half contains the gibberellin which would affect the results as there would be varying concentrations of gibberellin.

**Step 3**

To disinfect them ~~[illegible]~~ and kill any bacteria as they can produce amylase which would affect the results.

**ResultsPlus**
**Examiner Comments**

This is a good answer which gets both marking points.

**Step 2**

The embryo half contains giberelin that may affect the resvin by causing more amylase to be produced.

**Step 3**

To sterilise the endosperm half in order for ~~an~~ aseptic technique to be achieved and reduce contamination.

ResultsPlus
Examiner Comments

This also gains both marks.

**Step 2**

embryo does not contain starch, part with cotyledon does.

**Step 3**

breaks down cellulose cell walls to enable gibberilin to enter.

ResultsPlus
Examiner Comments

This candidate did not score any marks.

They did not give a correct explanation relating to gibberellins or amylase in step 2 and suggested that sodium hypochlorite allows uptake of gibberellins in part 3.

## Question 4 (b)(i)

Candidates were asked to name an abiotic factor and a biotic factor that should be controlled and describe how to control them.

This was not very well done, with only around one in ten candidates scoring both marks.

The most common error was to name the factor but not to give an effective method of control, eg using a water bath rather than an incubator for agar plates; or controlling species of grain by choosing the same species, rather than by collecting the grains from the same plant or from the same packet.

A few candidates gave a method of control, eg use of an incubator, without saying that it was temperature they were controlling; or collecting seeds from the same parent plant without saying that this would control species.

Some candidates suggested controlling the concentration of starch in the agar plates or the concentration of iodine in potassium iodide solution – these were not given credit as they are made to standard recipes.

A small number of candidates confused biotic and abiotic factors.

(b) The student completed the investigation using the following steps:

- the grains soaked in gibberellin solution were transferred to starch agar plates using forceps
- after 12 hours the surface of each plate was covered with iodine in potassium iodide solution, which was then poured away
- the diameter of the clear zone around each grain was measured.

(i) Describe how you would control **one** named abiotic variable and **one** named biotic variable.

**(2)**

Abiotic

~~Temperature is controlled using a~~ pH controlled using a buffer solution

Biotic

The grains used should be of the same species, mass and age.

**ResultsPlus**
**Examiner Comments**

This answer gets marking point 1 for the abiotic factor, but not marking point 2.

For the biotic factor, the candidate knows which factors should be controlled, but has not given a method of control for any of the factors mentioned.

**ResultsPlus**
**Examiner Tip**

Make sure that you know what the question requires – here it was two named factors and the methods of control.

**Abiotic**

Temperature, After transferred to agar plate, use an Incubator to keep at 25°C to prevent Pathogenic growth

**Biotic**

bacteria, Sterilise ~~equipment~~ Forceps and Surfaces to prevent unwanted bacteria from entering sterile agar plates, use Aseptic technique

**ResultsPlus**
**Examiner Comments**

This is a strong answer, gaining both marks.

They name temperature and describe controlling it in an incubator.

They state that aseptic technique should be used to prevent unwanted bacteria from entering the plates.

Abiotic

Temperature - incubate the seeds at the same set temperature e.g 25°C in an incubator for the 12 hours.

Biotic

Species of cereal grain - ensure all seeds used are from the same species, such as getting them from the same packet or crop.

ResultsPlus
Examiner Comments

Another good answer which got 2 marks.

They correctly describe how to control temperature and suggest getting the grains from the same parent or crop to control species.

Abiotic

The type of agar plate (starch) should be kept the same for each seed.

Biotic

The species of cereal gain should be kept the same - use seeds from the same species.

ResultsPlus
Examiner Comments

This candidate did not score any marks for this answer.

The suggestion that the type of agar plates should be the same was not given credit as these would be made to a standard method. They recognised that the species of grain was important but did not give an effective method of control.

## Question 4 (b)(ii)

This question asked candidates to describe three further improvements to the method outlined in parts (a) and (b).

Credit was given for:

- rinsing the grains in water after soaking in hypochlorite.
- using more than one grain at each concentration of gibberellin.
- giving an example of aseptic technique.
- measuring the diameter of the clear zone several times.
- using a control without gibberellin.

All marking points were seen.

As the command word was describe, candidates were not required to provide a reason for these improvements, although in practice many did.

The most common errors were to give additional biotic and abiotic factors to control. A few candidates suggested controlling the concentration of starch in the agar plates or the concentration of iodine in potassium iodide solution, but this was not given credit as these are made to standard recipes.

Almost three quarters of candidates achieved one or two marks.

(ii) Describe **three** further improvements to the method outlined in parts (a) and (b) that would improve the validity of the results.

**(3)**

Soak multiple grains (at least 3) in each gibberellin concentration and repeat so a mean or standard deviations can be calculated

Use a control e.g. seeds ~~not~~ not placed in gibberellin or an agar plate with no seeds to act as a comparison to results

The forceps used to transfer seeds should be ~~the~~ sterile to prevent ~~cross~~ contamination and incorrect results

The ~~area~~ area of the clear zone should be calculated rather than the diameter

**ResultsPlus**
**Examiner Comments**

This is an excellent answer which scored full marks.

The candidate got marking point 2 on lines 1 – 4, marking point 5 on lines 5 – 6, marking point 3 on lines 8 – 10, then marking point 4 on lines 11 – 12.

I would also soak a ~~bee~~ grain in distilled water rather than a gibberellin solution, this is a control experiment.

I would prepare enough grains to repeat the experiments 3 times for each gibberellin solution (and the control experiment). I'd then find mean values.

After step 3, I would wash the ~~bee~~ grains with distilled water to remove the sodium hypochlorite solution.

ResultsPlus
Examiner Comments

Another good answer, this time achieving marking point 5 on lines 1 – 2, marking point 2 on lines 4 – 5, and marking point 1 on lines 7 – 8.

Repeat test further 3 times at least to check for anomalys.

Repeat test using different concentrations of gibberellin.

Change control variables such as temperature to see effect.

ResultsPlus
Examiner Comments

This candidate gained marking point 2 on lines 1 – 2 of their answer.

No credit was given for using additional concentrations of gibberellin as this would not improve validity.

The suggestion of carrying out the investigation at different temperatures was also not creditworthy.

Run a Control - See how much produced by normal embryo Completely untouched.

Smaller increments between concentrations, Larger Range of Concentrations Covered.

ResultsPlus
Examiner Comments

This candidate recognised that a control would improve validity but did not describe this as being without gibberellin solution, so did not achieve marking point 5.

The suggestion of using smaller increments between concentrations would also not improve validity.

## Question 5 (a)(i)

Candidates were asked to give two differences in the structure of prokaryotic and eukaryotic cells. Almost half scored both marks and the majority of the rest scored one mark.

The main problems were non-matching statements or only half of a statement given, and inaccurate descriptions relating to DNA.

Where the cell wall was the factor being compared, candidates were expected to say that prokaryote cell walls contain peptidoglycan (or other suitable material), whereas eukaryote cell walls contain cellulose or chitin; they could also say that all prokaryotic cells have a cell wall but not all eukaryotic cells do.

References to plasmids were ignored.

**5** (a) Bacteria are prokaryotes.

(i) Give **two** differences between the structures of a prokaryotic cell and a eukaryotic cell.

**(2)**

Prokaryotic cells have 70s ribosomes, eukaryotic cells have 80s ribosomes. Prokaryotic cells have circular DNA, eukaryotic cells have linear DNA with histones.

ResultsPlus
Examiner Comments

This is an example of an answer scoring 2 marks.

They get marking point 5 in lines 1 – 2 and marking point 1 in lines 2 – 3.

- different size ribosomes (70s and 50s)

- prokaryotic cells do have a cell wall while eukaryotic cells don't and just have membranes.

ResultsPlus
Examiner Comments

This answer scored zero.

This candidate attempted marking point 5 but did not say which cells have which ribosomes (and also compared 70s with 50s, which is incorrect).

The last statement about cell walls is also incorrect as some eukaryotic cells have cell walls.

Prokaryotes have smaller 70s ribosomes

~~Eukaryotes~~ Eukaryotes have a ~~nucleus~~ nucleus

ResultsPlus
Examiner Comments

This candidate has given two correct statements:

- prokaryotes have smaller 70S ribosomes.
- eukaryotes have a nucleus.

but both are incomplete answers as they do not make a comparison.

To achieve credit the statement should have read:

- prokaryotes have smaller 70S ribosomes and eukaryotes have 80S ribosomes.
- eukaryotes have a nucleus and prokaryotes do not.

## Question 5 (a)(ii)

This question tested knowledge of Gram staining and how the information gained can be used to inform treatment. Overall it was well done with over a third of candidates scoring 3 marks, about a quarter scoring 2 marks and a quarter scoring 1 mark.

Some candidates had only very basic knowledge (or none at all) but there were some excellent answers to this, giving lots of relevant details.

Marking point 4 was for saying that the information should be used to determine which antibiotics to use. The most common error was to refer to treatment (which was in the stem of the question) rather than antibiotics. No details of antibiotics were expected.

(ii) Gram staining is often used to help identify bacteria.

A sample of bacteria from an infected person was tested by using Gram staining.

The bacteria stained red.

Explain why the bacteria stained red **and** why this information is useful for treating the infected person.

**(3)**

- stained red so must be gram negative bacteria ; saffin binds to gram negative bacteria after layer of lipopolysaccharides has been dissolved in alcohol
- useful so doctors know what antibiotics they can prescribe to the infected person to treat them

ResultsPlus
Examiner Comments

This answer got full marks.

Marking point 1 for Gram negative on lines 1 – 2, marking point 2 for reference to layer of lipopolysaccharide in lines 3 – 4, and marking point 4 for reference to antibiotics in lines 6 – 8.

- The gram stained red as it is a gram negative bacteria
- Therefore it cannot hold a purple gram stain.
- This is useful as the person can take antibiotics that are specific to the bacteria structure. Such as in [redacted] gram positive bacteria you would take antibiotics that affect peptidoglycan structure while for gram negative you take antibiotics that can affect the outer membrane made of lippopolysaccharides and protein.

ResultsPlus
Examiner Comments

This answer also scored full marks, for marking points 1, 2 and 4.

Gram-positive & Gram-negative bacteria have differing cell wall structure, identifying which type allows the bacteria to be ~~directly~~ targeted more effectively by using medication suited for destruction of the cell wall.

ResultsPlus
Examiner Comments

This answer scored zero, as there was not enough detail on any of the marking points.

The bacteria stained red because washing in ethanol removed the purple stain from the thin peptidoglycan wall and the red safranin stain was taken up. This means that the bacteria were gram negative and contained lipopolysaccharides. This is important in deciding which antibiotics to give.

ResultsPlus
Examiner Comments

This is a very strong answer which included all four marking points, achieving maximum marks.

→ the bacteria staining red means that the person is injected by a pathogen and now they can focus on figuring out which one to provide the right treatment for it.

ResultsPlus
Examiner Comments

This candidate did not include enough detail to achieve any marks.

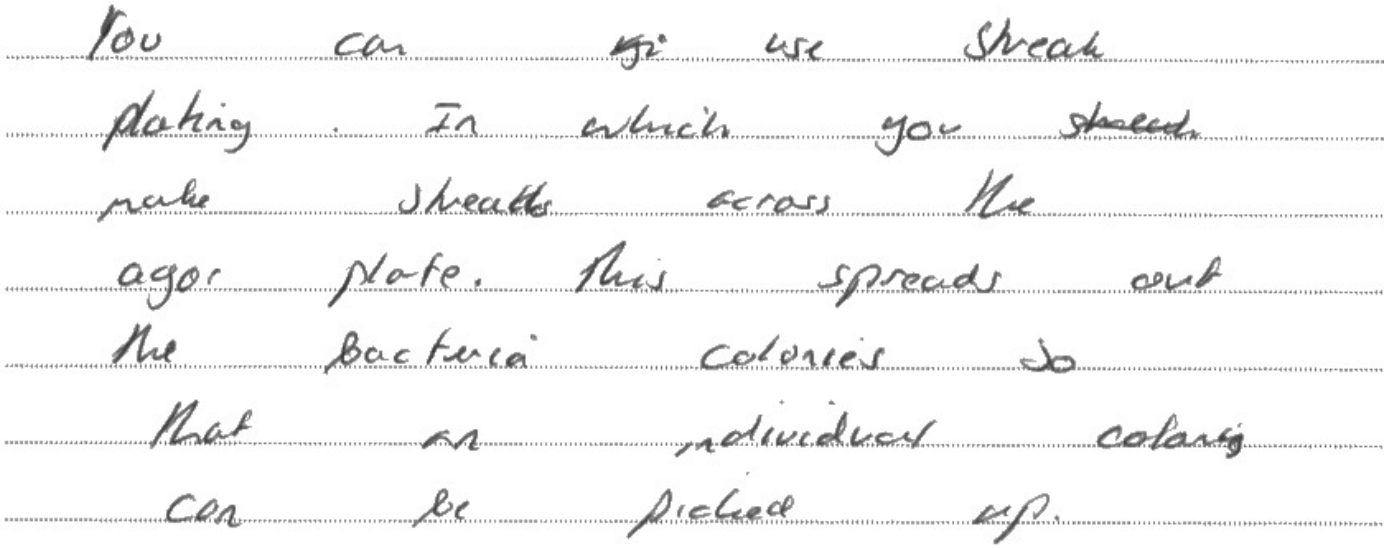
## Question 5 (b)(i)

This question asked candidates to describe the method used in Core Practical 13: isolate individual species from a mixed culture of bacteria using streak plating.

It generated a wide range of responses – some candidates had clearly done it and could remember the key points, but others had only very basic knowledge of the steps. Far too many candidates stopped at the point that bacteria had been transferred to the agar plate, so could not get beyond two marks. Credit was given for:

- use of inoculating loop to transfer bacteria.
- {description / diagram} of streak plating.
- incubation for suitable period.
- incubation at suitable temperature.
- identification of {bacteria / colonies} by {colour / shape}.
- transfer to separate agar plates.

There were some excellent answers covering all six marking points.




ResultsPlus
Examiner Comments

This answer does not include enough details to get credit.

For marking point 2, the words "streak plating" are not enough, we need a diagram or description.

At the end, they suggest that the individual colonies can be picked up, but for marking point 6 they need to be transferred to separate agar plates.

(b) (i) Describe the method used to isolate individual species from a mixed culture of bacteria in nutrient broth.

**(4)**

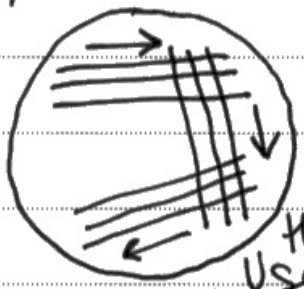
A flamed inoculating loop is dipped in the mixed culture and is streaked onto a sterile agar gel plate. This is carried out by streaking the plate 3 times rotating the plate 90° and repeating 4 times. The last streaks should not overlap with the first streaks. The agar gel plate is incubated at 20 - 25°C for 24 hours. After 24 hours pure, discrete colonies should have formed on the agar gel plate. Colour, size and texture of colonies should be compared to identify individual species which can be transferred to a seperate agar

**ResultsPlus**
**Examiner Comments**

This is a very strong answer which gained maximum marks:

Marking point 1 on lines 1 – 2, marking point 2 for the description of streak plating, marking points 3 and 4 on line 8, marking point 5 on line 12 and marking point 6 on lines 13 – 14.

burner. Pour agar into a petri dish and let it set. Flame your innoculating loop and dip it into the bacteria sample. Carry out streak plating - streak 3 straight lines in one direction and then three more which overlap the previous lines and 3 more which again overlap.



Incubate the bacteria at 25°C - any higher is too close to human body temperature. Leave for 24 hours and the different species should be visible. Use a flammed innoculating loop to obtain one species and use the same streak plating technique to distribute it on a new agar on a different petri dish.

**ResultsPlus**
**Examiner Comments**

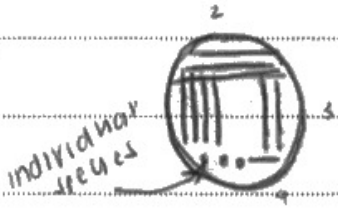
This candidate scored maximum marks, achieving mark points 1, 2, 3, 4, and 6.

They provided an excellent, clear diagram of streak plating.

- Streak plating
- Flame inoculating + other loop (aseptic technique)
- Dip in the mixed culture once at the start
- Streak the innoculating loop across agar jelly in a straight line, moving the plate 90° each time

~~The final streak~~ 3.

- This dilutes the bacteria on the innoculating loop as you streak, so on the last streak, individual colonies can be found.
- Incubate agar plate for 48 hours in sterile conditions
- Isolate the individual species




**ResultsPlus**
**Examiner Comments**

This is a strong answer which gained three marks (mark points 1, 2 and 3). However, they did not include enough details to achieve marking point 5 or 6.

## Question 5 (b)(ii)

This related to the previous question and asked for an explanation of three precautions to avoid the growth of pathogenic bacteria.

There were 4 marking points, some including groups of alternatives. Candidates generally knew the steps of aseptic technique and described them adequately. Marking point 1 could be given for either saying that aseptic technique should be used, with a suitable reason, or for giving an example of aseptic technique with a reason. Marking point 2 was for an example of aseptic technique with a reason.

However, less than one in ten candidates scored 3 marks, and around a third scored zero. This was usually because although they gave a list of precautions to be taken, they did not **explain** why they were needed, ie to avoid contamination / kill bacteria / prevent the growth of anaerobes etc.

The most common error apart from this was to say that working next to a lit Bunsen burner would kill bacteria in the air, rather than creating a convection current to draw bacteria away from an open petri dish. A surprising number of candidates thought that putting a lid on an agar plate (rather than leaving it uncovered) was an example of aseptic technique; we were looking for the idea of partially opening the plate or opening for the shortest possible time.

(ii) Explain **three** precautions that would be taken to reduce the growth of pathogenic bacteria.

**(3)**

Aseptic techniques such as sterilising work-surfaces and equipment before and after the inoculation.
Working near a Bunsen Burner.
~~Her~~ Flaming the inoculating loop
Wearing protective gloves, goggles and a lab coat.
Maintaining a temperature of 25 °C

**ResultsPlus**
**Examiner Comments**

This candidate has given three suitable suggestions, but no reasons, so has scored zero.

**ResultsPlus**
**Examiner Tip**

When the command word is **explain** make sure you are providing an explanation, not just a description.

Only open lid slightly so pathogens can't enter.
Work near a bunsen burner so pathogens taken up by ~~the~~ the convection current.
Flame streak loop. ~~so~~ to kill any pathogens.
Work at temperatures lower than 30° ~~to~~ so no human pathogens develop.
Don't fully tape lid so no pathogenic anaerobic ~~bacteria~~ bacteria grow.
Leave loops to cool for a little

**(Total for Question 5 = 12 marks)**

ResultsPlus
Examiner Comments

This very good answer includes correct precautions with reasons and therefore scores maximum marks.

It gets marking points 1 and 2 on lines 1 – 3, marking point 3 on lines 5 – 6 and marking point 4 on lines 7 – 8.

## Question 6 (a)(i)-(ii)

In this pair of linked questions, candidates carried out a simple calculation of water potential then deduced and explained the direction of movement of water.

Quite a few candidates struggled with the calculation, even though it was very straightforward – this seems to be an area which needs more revision. The most common errors were to get answers of – 900kPa, 900kPa, – 20,000 kPa and – 0.8kPa.

The answers to Q06(a)(ii) were expected to match Q06(a)(i), so if a candidate carried out the calculation wrongly, they could still achieve both marks in Q06(a)(ii).

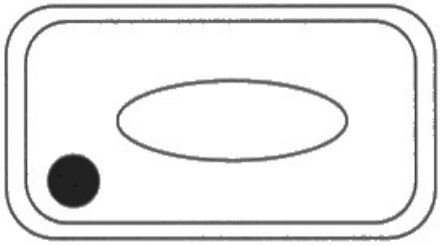
Answers for marking point 3 could be phrased in several ways, but in all cases they had to be comparative to gain credit eg water moves from an area of high water potential to an area of low water potential.

The most common errors in Q06(a)(ii) were to fail to mention osmosis for marking point 2 and to get confused with terminology or direction for marking point 3.

Around a third of candidates scored all 3 marks, about a quarter scored one mark (usually for the calculation) and a significant minority of candidates scored zero marks.

**6** Water potential determines the direction of movement of water in and out of cells.

(a) The diagram shows a plant cell.



The turgor pressure (P) of the cell is 400 kPa and the osmotic potential ($\pi$) is –500 kPa.

(i) Calculate the water potential ($\psi$) of this cell.

(1)

= Tp + osmotic potential

400 - 500

=

Answer -100 kPa

(ii) Explain the direction of net movement of water for this plant cell when it is placed in a sucrose solution with a water potential ($\psi$) of –400 kPa.

(2)

The water potential is lower outside the cell, therefore water leaves the plant cell by osmosis ~~to~~ from a higher to lower concentration of water by a semi-permeable membrane.

**ResultsPlus**
**Examiner Comments**

This candidate got all three marks.

The answer to Q06(a)(i) was correct at – 100kPa.

In Q06(a)(ii) they correctly stated that water moves out of the cell by osmosis and explained this in terms of moving from a higher to lower concentration of water.

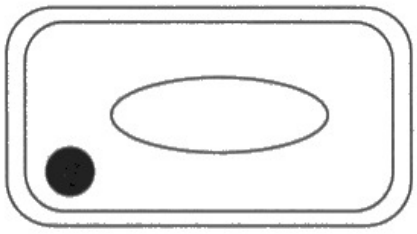


**ResultsPlus**
**Examiner Tip**

Water potential calculations are pretty straightforward. Make sure you know the formula and that you can do them.

**6** Water potential determines the direction of movement of water in and out of cells.

(a) The diagram shows a plant cell.



The turgor pressure (P) of the cell is 400 kPa and the osmotic potential ($\pi$) is –500 kPa.

(i) Calculate the water potential ($\psi$) of this cell.

**(1)**

-500 + 400 = = -100 kPa

Answer -100 kPa

(ii) Explain the direction of net movement of water for this plant cell when it is placed in a sucrose solution with a water potential ($\psi$) of –400 kPa.

**(2)**

Water moves from less negative to more negative water potential. Since the water potential of this cell is less negtive than the sucrose water will move out of the cell causing plasmolysis.

**ResultsPlus**
**Examiner Comments**

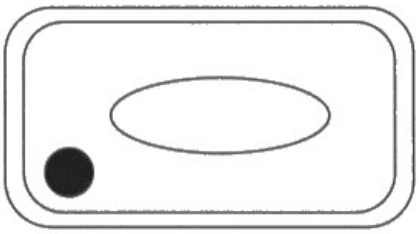
This candidate got the correct answer of – 100kPa for Q06(a)(i), gaining one mark.

They gave the correct direction of movement of water in Q06(a)(ii), but did not mention osmosis, so did not get marking point 2.

They got marking point 3 for a correct explanation, so overall, two marks awarded.

**6** Water potential determines the direction of movement of water in and out of cells.

(a) The diagram shows a plant cell.



The turgor pressure (P) of the cell is 400 kPa and the osmotic potential ($\pi$) is –500 kPa.

(i) Calculate the water potential ($\psi$) of this cell.

**(1)**

$\psi = P + \pi$

$= 400 + -500 = -100$

Answer −100 kPa

(ii) Explain the direction of net movement of water for this plant cell when it is placed in a sucrose solution with a water potential ($\psi$) of –400 kPa.

move out of cell?

**(2)**

water moves from low water potential to high water potential. As the water potential of the sucrose solution is low, water will move from the sucrose solution into the cell.

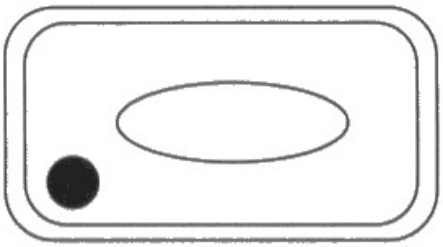
**ResultsPlus**
**Examiner Comments**

This candidate carried out the calculation correctly in Q06(a)(i), gaining 1 mark.

They did not explain correctly how water moves, saying it was from low to high water potential and therefore that it would move from the solution into the cell. For these reasons they scored zero for Q06(a)(ii).

**6** Water potential determines the direction of movement of water in and out of cells.

(a) The diagram shows a plant cell.



The turgor pressure (P) of the cell is 400 kPa and the osmotic potential ($\pi$) is –500 kPa.

(i) Calculate the water potential ($\psi$) of this cell.

**(1)**

Answer −0.8 kPa

(ii) Explain the direction of net movement of water for this plant cell when it is placed in a sucrose solution with a water potential ($\psi$) of –400 kPa.

**(2)**

The concentration gradient would increase and osmosis would occur.

**ResultsPlus**
**Examiner Comments**

This candidate got Q06(a)(i) wrong, as they divided – 500 into 400 instead of subtracting – 500 from 400.

They could have gained marks for using their incorrect value from Q06(a)(i) correctly in Q06(a)(ii) ie for saying that if the water potential of the cell was – 0.8kPa, water would move into the cell by osmosis and explaining it.

This candidate did not provide a correct description of water movement or suitable explanation, so did not score any marks.

## Question 6 (b)(i)-(ii)

Q06(b) related to a water potential investigation using potato cylinders. This is Core Practical 6: determine the water potential of plant cells.

In Q06(b)(i) candidates were asked to plot a graph of percentage change in mass at various concentrations of sucrose solution and to identify the intercept point. As there were both positive and negative changes this was not completely straightforward, but it was generally well done.

Marks were given for:

- axes correctly orientated and labelled with units.
- all values accurately plotted on a linear scale.
- points joined with straight lines.

The most common errors were to choose an odd scale which made plotting accurately very difficult, to make other plotting errors, to draw a line of best fit, or to forget to label axes. Many candidates made life more difficult for themselves by choosing a very small scale which covered less than half of the graph paper.

In Q06(b)(ii) they were asked to determine the concentration of sucrose solution which caused no change in mass. This was done by reading off the value of the intercept point and most candidates scored this mark.

Almost three quarters of candidates scored three or four marks for this question, which tested indirect practical skills that they should be very comfortable with.

(b) A student carried out an investigation to determine the water potential of cells from a potato tuber, using a range of concentrations of sucrose solutions.

Cylinders of potato were cut using a cork borer, and the cylinders were then cut into discs.

The mass of each disc was recorded. One disc was placed in each sucrose solution and left for 12 hours. Each disc was then reweighed.

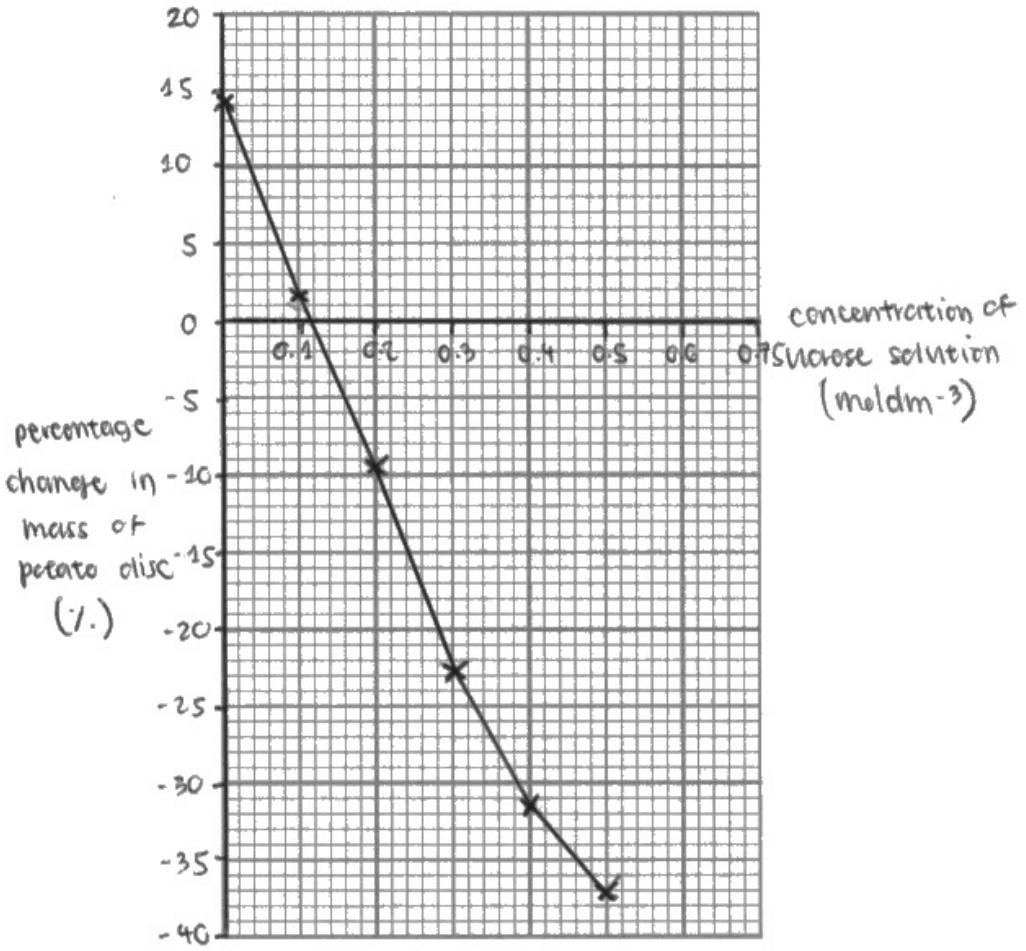
The table shows the data collected.

| **Concentration of sucrose solution / mol dm$^{-3}$** | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
|---|---|---|---|---|---|---|
| **Percentage change in mass of potato disc** | +14.2 | +1.9 | −9.8 | −22.7 | −31.9 | −37.1 |

(i) Plot a suitable graph of these results.

Join the points with straight lines.

**(3)**



(ii) Determine the concentration of sucrose solution that causes no change in mass, using your graph.

**(1)**

Answer 0.12 mol $dm^{-3}$

**ResultsPlus**
**Examiner Comments**

This answer scored all three marks for graph drawing and a further mark for a correctly determined intercept.

The graph is accurate, with a suitable scale, correctly labelled axes, and carefully plotted points joined with straight lines, so scored maximum marks.

(b) A student carried out an investigation to determine the water potential of cells from a potato tuber, using a range of concentrations of sucrose solutions.

Cylinders of potato were cut using a cork borer, and the cylinders were then cut into discs.

The mass of each disc was recorded. One disc was placed in each sucrose solution and left for 12 hours. Each disc was then reweighed.

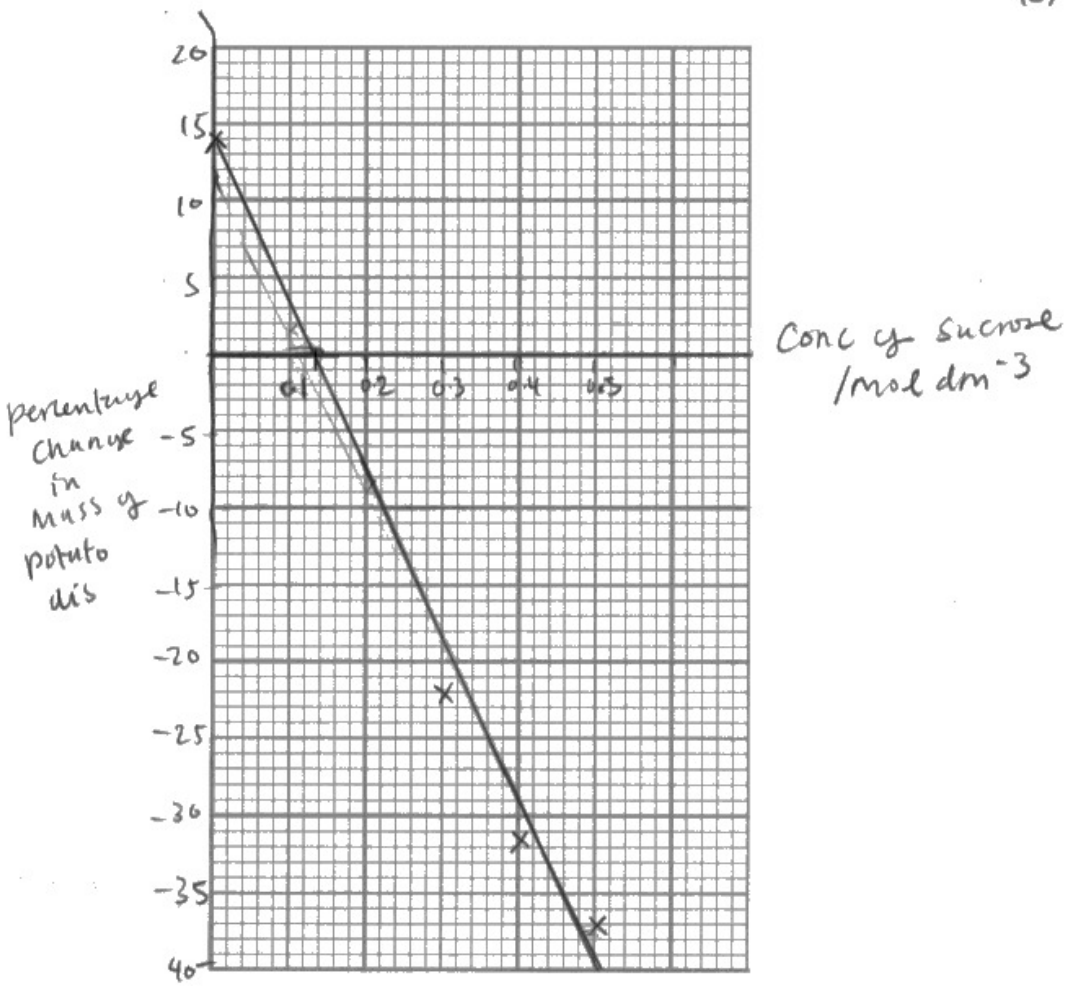
The table shows the data collected.

| Concentration of sucrose solution / mol $dm^{-3}$ | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
|---|---|---|---|---|---|---|
| Percentage change in mass of potato disc | +14.2 | +1.9 | −9.8 | −22.7 | −31.9 | −37.1 |

(i) Plot a suitable graph of these results.

Join the points with straight lines.

**(3)**



(ii) Determine the concentration of sucrose solution that causes no change in mass, using your graph.

0.13 (1)

Answer 0.13 mol $dm^{-3}$

ResultsPlus
Examiner Comments

This graph scored only one mark (mark point 1). The points at 0.2 and 0.3 mol $dm^{-3}$ were plotted incorrectly, and the points were joined with a line of best fit, rather than straight lines.

However, the intercept was correctly read from the graph, scoring a further mark for Q06(b)(ii).

(b) A student carried out an investigation to determine the water potential of cells from a potato tuber, using a range of concentrations of sucrose solutions.

Cylinders of potato were cut using a cork borer, and the cylinders were then cut into discs.

The mass of each disc was recorded. One disc was placed in each sucrose solution and left for 12 hours. Each disc was then reweighed.

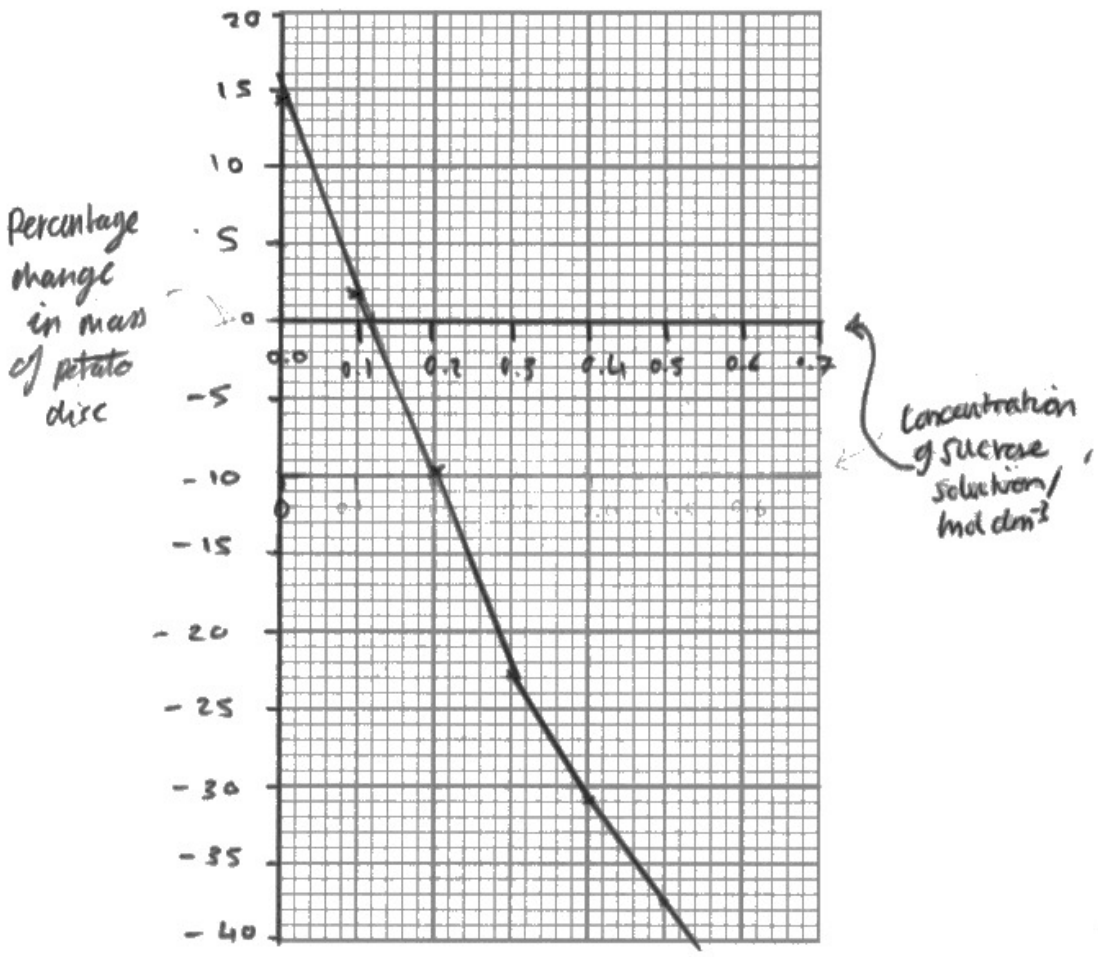
The table shows the data collected.

| Concentration of sucrose solution / mol dm$^{-3}$ | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
|---|---|---|---|---|---|---|
| Percentage change in mass of potato disc | +14.2 | +1.9 | −9.8 | −22.7 | −31.9 | −37.1 |

(i) Plot a suitable graph of these results.

Join the points with straight lines.

**(3)**



(ii) Determine the concentration of sucrose solution that causes no change in mass, using your graph.

(1)

Answer 0.11 mol $dm^{-3}$

**ResultsPlus**
**Examiner Comments**

This graph scored only one mark (mark point 1). The point at 0.4 mol $dm^{-3}$ was plotted incorrectly, and the points were incorrectly joined. The line was also extrapolated beyond the 0.5 mol $dm^{-3}$ point, which would have lost marking point 3 even if the rest of the line had been drawn accurately.

However, the intercept was correctly read from the graph, scoring a further mark for Q06(b)(ii).

**ResultsPlus**
**Examiner Tip**

Graph drawing is an important scientific skill to learn. Make sure you can choose a suitable scale, plot points accurately and follow instructions about the type of line that is required.

(b) A student carried out an investigation to determine the water potential of cells from a potato tuber, using a range of concentrations of sucrose solutions.

Cylinders of potato were cut using a cork borer, and the cylinders were then cut into discs.

The mass of each disc was recorded. One disc was placed in each sucrose solution and left for 12 hours. Each disc was then reweighed.

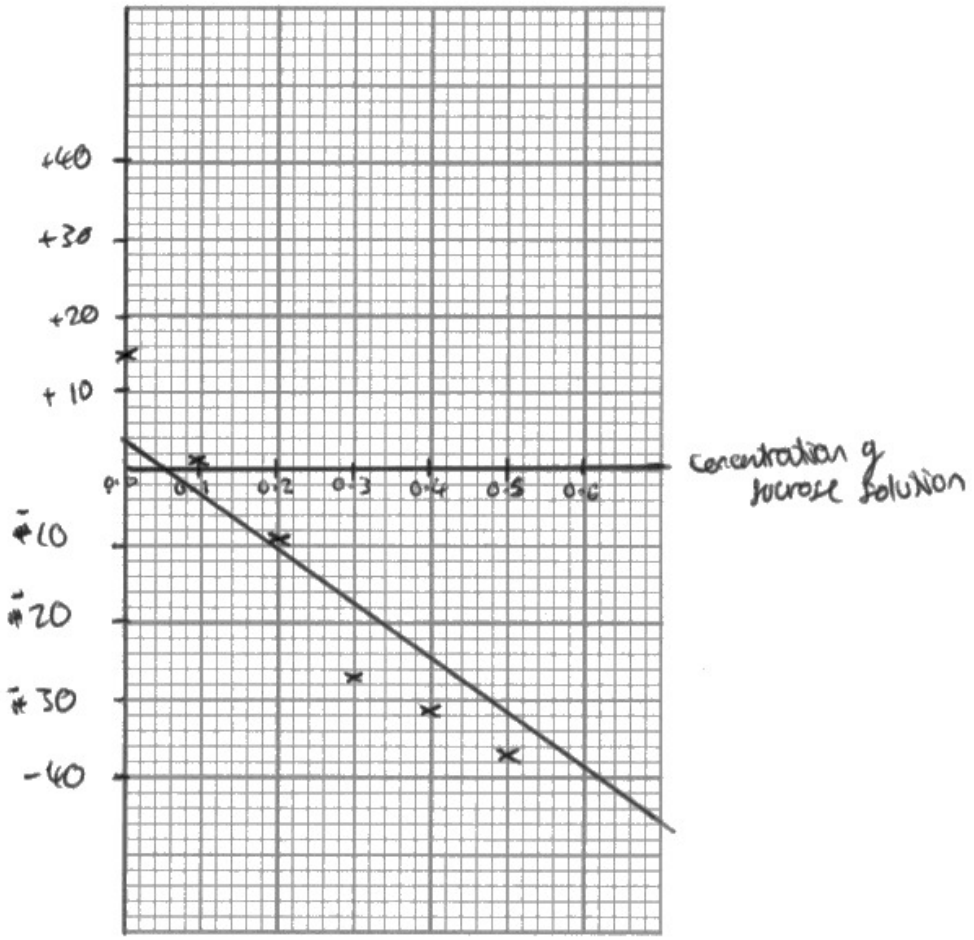
The table shows the data collected.

| **Concentration of sucrose solution / mol dm$^{-3}$** | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
|---|---|---|---|---|---|---|
| **Percentage change in mass of potato disc** | +14.2 | +1.9 | −9.8 | −22.7 | −31.9 | −37.1 |

(i) Plot a suitable graph of these results.

Join the points with straight lines.

**(3)**



(ii) Determine the concentration of sucrose solution that causes no change in mass, using your graph.

(1)

Answer 0.05 mol $dm^{-3}$

**ResultsPlus**
**Examiner Comments**

This graph scored no marks. The axis label is missing from the y axis and there are no units on the x axis. The point at 0.4 mol $dm^{-3}$ was plotted incorrectly, and the points were joined with a line of best fit, rather than straight lines.

Because the plotting was wrong and the line of best fit was incorrectly placed the intercept gave a value outside the tolerance levels, so Q06(b)(ii) also scored zero.

## Question 6 (b)(iii)

Candidates were asked to evaluate whether the method described for this investigation would give valid results. This question discriminated very well, and some candidates gave excellent answers, identifying a balance of strengths and weaknesses in the method.

Many candidates realised that the cork borer gave a standardised size; they noted that temperature was not controlled, the discs were not cut to a uniform thickness, that more than one disc should have been placed in each solution, they should have been dried before being reweighed, and that more molarities should have been tested near the intercept point.

Marking points 1, 7, 8, 9, 10 and 11 were most commonly seen and marking points 2, 3, 5 and 12 were least common; all marking points were seen.

The most common error was to assume that different potatoes had been used in this investigation, rather than all of the discs coming from the same potato cylinder.

For marking point 3, a lot of candidates said that it was good that discs had been left for the same time but did not recognise that this was long enough for no further water movement to occur.

For marking point 10, it was not enough to say that more molarities should be tested; these had to be near the intercept point.

A small number of candidates ignored the command word evaluate (and the method they had been given), and instead wrote a plan for the investigation. This allowed them to gain marks for weaknesses (by suggesting improvements), but not to recognise strengths. For full marks at least one strength and one weakness had to be identified.

This was generally well done with over half of candidates scoring 3 marks or more and less than 2% scoring zero.

(iii) Evaluate whether the method used in this investigation would provide valid results for the water potential of potato cells.

**(5)**

discs that are cut the thickness is not specified if they are all the same SA:V as that will affect speed of osmosis / diffusion.

no information on species / age of potato

potato is not blotted to remove excess water before ~~or after~~ weighing

↳ could cause an underestimate / overestimate of mass change.

no repeats or SD to look for anomalies or overlap ∴ significance.

↳ more discs in each conc.

They do use a control & good range of sucrose conc. could repeat with smaller intervals to find exact sucrose conc. for no mass change.

**(Total for Question 6 = 12 marks)**

cork borer ensures ever circumference.

ResultsPlus
Examiner Comments

This is a very strong answer which gained maximum marks. They got marking points 7, 9, 8, 5, 10 and 1.

(iii) Evaluate whether the method used in this investigation would provide valid results for the water potential of potato cells.

(5)

→ Cutting with a cork borer guarantees same diameter for each disc, however the thickness does not seem to be controlled so surface area : volume ratio may vary between discs

→ Range of concentrations of sucrose provides a good range of data which shows a fairly consistent trend.

→ Only one disc was used per solution however so there is no way of excluding anomalous results or taking an average, which would increase accuracy.

→ More repeats of the experiment would be desirable too.

→ Variables such as temperature are not controlled, this may affect the rate of osmosis.

ResultsPlus
Examiner Comments

Another very good answer scoring maximum marks. They got marking points 1, 7, 5, 8 and 11.

(iii) Evaluate whether the method used in this investigation would provide valid results for the water potential of potato cells.

**(5)**

The student left the discs for 12 hours which is sufficient time for osmosis to occur. They cut the potato using a cork borer, so the discs would have had the same cross-sectional area. The student also used a wide range of sucrose concentrations. However, it is not known if the cylinders were from the same potato, so they may not be the same age or species. The discs might not have been cut to the same length so the surface area to volume ratio may be different for each disc. Furthermore, at least five discs should have been placed in each sucrose solution to identify anomalies and calculate a mean and standard deviation. The discs should have been dried using blotting paper before reweighing to remove excess water. A wider range of concentations between 0.1 mol $dm^{-3}$ and 0.2 mol $dm^{-3}$ should have been used to calculate a more accurate value. Overall, the method would not produce valid results as too many variables were not controlled

**(Total for Question 6 = 12 marks)**

ResultsPlus
Examiner Comments

Another excellent answer which gained maximum marks. This got marking points 3, 1, 7, 8, 9 and 10.

## Question 7 (a)(i)

Q07 related to an investigation into the area of leaves in sun and shade. Candidates were told that 20 leaves of a single species (hedge woundwort) were collected from areas in the sun and shade, and that their area was measured to find the effect of light intensity on leaf area.

Q07(a)(i) asked them to write a null hypothesis for this investigation.

Around a third of candidates wrote an appropriate null hypothesis that could be tested, while two thirds did not. This is an area that centres could usefully work on.

Common errors were to look for a correlation, rather than a difference; to refer to light intensity rather than sun and shade (or high and low light intensities); or to give an answer related to effect or relationship. Inexplicably, some candidates gave height of the plant as the dependent variable.

It was very rare to see candidates referring to the named species in the null hypothesis, with most simply saying that there would be a difference in leaf area in the sun and shade. This could be taken to refer to leaf area of all species, rather than the species being investigated. Please note that in future years, the name of the species being investigated will be needed to gain credit when writing a null hypothesis.

**7** The photograph shows hedge woundwort (*Stachys sylvatica*).



(Source: © imageBROKER/Alamy Stock Photo)

This plant grows on the edge of woodlands and can be up to one metre in height.

A student investigated whether light intensity had an effect on the leaf area of hedge woundwort.

The student measured the area of 20 leaves from plants growing in full sun and 20 leaves from plants growing in shady conditions.

(a) (i) Give a suitable null hypothesis for this investigation.

**(1)**

• There is no difference between leaf area of hedge woundwort in the sun or shade.

**ResultsPlus**
**Examiner Comments**

A clear answer that provided a null hypothesis which could be tested. This scored one mark.

There is no significant difference in area of leaves of plants grown in full sun & shady conditions.

ResultsPlus
Examiner Comments

This gained one mark.

ResultsPlus
Examiner Tip

Remember to include the name of the species being investigated in the null hypothesis.

There is no statistically significant correlation between light intensity and the area of a leaf in the plant hedge woundwort

ResultsPlus
Examiner Comments

This did not score as the candidate suggested that they were looking for a correlation.

the leaves growing in full sun will have a greater leaf area than ~~plan~~ leaves growing in shady conditions.

ResultsPlus
Examiner Comments

This is not a null hypothesis – a null hypothesis would state that there was no difference in leaf area, rather than that one of the conditions would have a bigger leaf area.

## Question 7 (a)(ii)

Candidates were asked to devise a fieldwork method that could have been used to carry out this investigation. This is Core Practical 16: investigate the effect of one abiotic factor on the distribution or morphology of one species.

Credit was given for:

- random selection of plants to be studied.
- measuring the leaf area of {hedge woundwort / *Stachys sylvatica*}.
- describing the method of measurement eg using squared paper.
- suggesting a method of control of which leaf to measure.
- (selecting leaves in) light and shade.
- {controlling / monitoring} one other relevant named factor.

There were some good answers which outlined how bias could be avoided (by using random sampling to select plants and having a system to determine which leaf on the plant to measure), gave details of how to measure the leaf area and suggested a variable which should be controlled or monitored.

The most common error was to carry out a transect from the light to the shade, despite the fact that 20 leaves were measured in sunny areas and 20 in shade.

Many candidates did not suggest a method they could use to measure leaf area, or even restrict their measurements to the single species named in the investigation. There were some attempts at standardising which leaf to measure eg the biggest on each plant, and some suggested monitoring / controlling other variables eg soil water / pH / time of year. Many candidates did not realise that controlling the time of day the leaf area was measured would not have a measurable effect on the outcome.

Around a quarter of candidates scored three marks or more. This was disappointing for a relatively straightforward description of fieldwork sampling.

(ii) Devise a valid fieldwork method that the student could use to compare the leaf areas of the plants growing in full sunlight with the leaf areas of the plants growing in shady areas.

with hedge woundwort

(4)

Find an area with full sunlight, and find a shady area. In each area use random sampling ~~to~~ by using a random number generator to generate coordinates to place the 1m x 1m quadrats. Measure the leaf areas, by using the rulers and measuring diameters, of the hedge woundwort in the quadrat. Repeat 20 times at each ~~sit~~ area to calculate the mean and standard deviation and do a t-test. At each site, also measure the temperature, soil pH and wind speed at the sample sites.

ResultsPlus
Examiner Comments

This is a good answer which gained four marks.

They got marking point 5 on line 1, marking point 1 on lines 2 – 3, marking point 2 on lines 3 – 4 and marking point 6 at the end.

- Set up a 10 × 10 metre grid in an area of full sunlight where hedge woundwort grows - use a random number generater to generate random co-ordinates at which leaf areas will be recorded
- At each generated co-ordinate, pick the largest leaf on a plant and measure its width and length in centimetres - multiplying these to get leaf area.
- Repeat this until 20 leaf areas have been recorded - calculate a mean leaf area for plants growing in full sunlight
- Repeat the investigation in an area of shade, compare the three means
- Do both investigations at the same time of day during the summer where water content in both areas is likely to be similar

ResultsPlus
Examiner Comments

Another good answer gaining four marks.

They got marking point 1 on lines 1 – 3, marking point 4 on line 4 (for largest leaf), marking point 2 on lines 2 and 5, and marking point 5 on line 1 and 8.

They did not achieve marking point 3 as the method described (multiplying length by width) would not give an accurate value. Controlling time of day that the measurements were taken is not creditworthy for marking point 6.

Establish a 10 x 10 metre grid in the sunny and shaded area*. Generate 10 random coordinates within this grid. Place quadrats at these coordinates and locate any hedge woundworts. Select a mature leaf from each plant to draw around.

Calculate the area of these leaves by counting up the number of 1mm² boxes on graph paper filled in.

*Ensure each area is shaded / sunny for the majority of the day for valid results.

ResultsPlus
Examiner Comments

This answer gets mark points 1, 2, 3 and 5.

Although it is not initially clear on lines 1 – 2 whether the grid is in a single area which has both sun and shade, lines 11 – 12 make it clear that there are two areas being tested by saying "ensure **each** area is shaded / sunny....".

This candidate described a suitable method to measure leaf area.

- The student could use a belt transect that has a gradient of light to shade. eg a tree which has shade and 20m away from it.
- At each 2m at the quadrant along the transect measure the lighting intensity and the plant species abundance.
- estimate the coverage of plant coverage in each quadrant
- repeat experiment every 2m until you reach 20m
- once got your abundance percentage estimate you can make a comparison

**ResultsPlus**
**Examiner Comments**

This candidate suggested using a transect from light to shade with quadrats at 2 metre intervals – this method would not provide the data required ie 20 leaves in the light and 20 in the shade.

They suggest estimating the abundance and coverage of plants in the quadrat, rather than measuring leaf area, so did not get mark point 2.

They get mark point 5 for measuring the light intensity at each sampling point.

## Question 7 (b)(i)

Candidates were given the mean and standard deviation for sun and shade leaves and told that 95% of all leaves fell within + / – two SD of the mean. They were asked to calculate this range.

This should have been a straightforward calculation, requiring candidates to:

- select the correct mean and SD from the stem of the question.
- calculate the value for two SD (here it was 19.24).
- add this to the mean and subtract it from the mean to get the upper and lower values of the range.

Many candidates misunderstood and although they calculated the two values correctly (8.31 and 46.79) they subtracted one from the other giving a value of 38.48. This was given credit.

The most common error was to find a value based on +/ – one SD of the mean.

(i) The mean leaf area for leaves from plants in full sun is 27.55 $cm^2$ with a standard deviation of 9.62 $cm^2$.

The mean leaf area for leaves from plants in shady conditions is 55.50 $cm^2$ with a standard deviation of 13.40 $cm^2$.

Two standard deviations on either side of the mean will include 95% of the leaves.

Determine the size range that would include 95% of leaves from plants in full sun, using the standard deviation value.

**(2)**

$27.55 + 2(9.62) = 46.79$

$27.55 - 2(9.62) = 8.31$

~~size range = 4~~

Answer 8.31 – 46.79 $cm^2$

**ResultsPlus**
**Examiner Comments**

This candidate set out the working clearly and followed the right steps to get the correct answer. Full marks.

(2)

$\mu = 27.55$

$\sigma = 9.62$

$27.55 + 9.62 \times 2 = 46.79$

$27.55 - 9.62 \times 2 = 8.31$

$46.79 - 8.31$

$= 38.48$

Answer 38.48 $cm^2$

**ResultsPlus Examiner Comments**

This candidate followed the right steps and calculated the upper and lower values of the range (46.79 and 8.31). They then carried out a subtraction to give 38.38.

This got 2 marks.

(2)

$9.62 \times 2 = 19.24$

Answer 19.24 $cm^2$

**ResultsPlus Examiner Comments**

This candidate calculated 2 SD, which gave them marking point 1.

## Question 7 (b)(ii)-(iii)

In this pair of linked questions candidates were asked to calculate the *t* value from data provided, and to use this value to comment on the results of the investigation.

Q07(b)(ii) was generally well done. Most candidates could use the formula they were given to calculate *t*, and achieved 3 marks. However, a significant number gave a negative *t* value. Whilst this was not penalised here, it caused a lot of problems for candidates in Q07(b)(iii).

Candidates should realise that whether the *t* value is positive or negative simply depends on the order of the subtraction and it does not matter. They should ignore the sign and proceed with the number as if it is positive. A simple rule to avoid confusion is to always subtract the smaller value from the larger one (here it would be 55.50 – 27.55) and get a positive *t* value.

In Q07(b)(iii) candidates were asked to comment on the results of the investigation using their *t* value. This was less well done and some candidates who had carried out the calculation with no problems left this section blank.

Around a third of all candidates could find the critical value, compare it to the *t* value, reject the null hypothesis and give a suitable conclusion. The word significant was required in the conclusion, as this was the point of doing the *t* test.

The most common errors were:

- to say that – 7.58< 2.02, which led to further errors.
- to use the wrong number of degrees of freedom (although this often gave the same critical value so was not penalised in this case).
- to give an incorrect conclusion either linked to correlation or to changing light intensity.

(ii) The student analysed the data using a *t*-test.

Calculate the value of *t*.

Use the formula

$$t = \frac{(\bar{x}_A - \bar{x}_B)}{\sqrt{\frac{(S_A)^2}{n_A} + \frac{(S_B)^2}{n_B}}}$$

where:

$\bar{x}$ is the mean for each set of data

n is the number of samples in each set of data

S is the standard deviation for each set of data

**(3)**

$\bar{x}_A = 27.55$ $\bar{x}_B = 55.50$

$S_A = 9.62$ $S_B = 13.40$

$n_A = 20$ $n_B = 20$

$$t = \frac{(27.55 - 55.50)}{\sqrt{\frac{(9.62)^2}{20} + \frac{(13.40)^2}{20}}}$$

$= \#7.58$

Answer #7.58

Comment on the results of this investigation.

Use the information in the table to support your answer.

**(3)**

The degrees of freedom are 40-2 = 38.

We reject reject the null hypothesis because the t value is greater than the critical value of 2.02 at the 5% significance level. This means there is a significant difference between leaf area in areas of sun and areas of shade. This means that light intensity must affect leaf area.

**ResultsPlus**
**Examiner Comments**

This is a very strong answer, gaining all six available marks.

In Q07(b)(ii) they correctly calculated the t value as 7.58, gaining three marks.

In Q07(b)(iii) they stated that their t value was greater than the critical value of 2.02 (they had also circled this value in the table), that they would therefore reject the null hypothesis and that there is a significant difference in the leaf area in the sun and shade. Full marks for Q07(b)(iii).

Comment on the results of this investigation.

Use the information in the table to support your answer.

(3)

The value of t is greater than all the critical values for t given in the table, and since the number of degrees of freedom is 40-2=38, t exceeds the critical value for p=0.1, p=0.05 and p=0.01. This means there is sufficient evidence to reject $H_0$ in favour of $H_1$, and conclude that there is no significant difference in the leaf area of hedge woundwort grown in shady and sunny conditions

ResultsPlus
Examiner Comments

This candidate correctly calculated the t value as 7.58 and gained 3 marks for Q07(b)(ii)

In Q07(b)(iii) they did not state the critical value (or circle it in the table), so could not get mark point 1.

They got mark points 2 and 3.

ResultsPlus
Examiner Tip

Always make a clear statement of the critical value and how it compares to your test value when you are analysing a statistical test. it is not enough just to say that your value is bigger than the critical value, you must show what the critical value is.

Comment on the results of this investigation.

Use the information in the table to support your answer.

**(3)**

at the 39th degree of freedom (40-1) and a p of 0.05 the critical value is 2.02. −7.58 < 2.02 ∴ reject Ho as there is sufficient evidence that there is a statistical difference between light intensity and leaf area on hedge woundwort and it is not by chance.

**ResultsPlus**
**Examiner Comments**

This candidate gained 3 marks for Q07(b)(ii) for a correct calculation. However they gave the t value as – 7.58.

In Q07(b)(iii) they incorrectly said that – 7.58 < 2.02, so could not get mark point 1.

## Question 8 (a)(i)

Candidates were asked to explain how the structure of haemoglobin enables it to combine with oxygen in the lungs.

This was generally well done with many candidates giving relevant details of structure, eg four polypeptide chains, binding between haem or iron and oxygen, and describing co-operative binding. There were some excellent descriptions of co-operative binding.

The most common errors were to describe binding between haemoglobin and oxygen, rather than haem or iron and oxygen for marking point 2; or to omit the detail that there are **four** subunits, so **four molecules** of oxygen can be carried for marking points 1 and 3.

A surprising number of candidates confused haemoglobin and red blood cells, stating that haemoglobin had a biconcave shape and no nucleus.

**8** Haemoglobin transports oxygen around the human body.

(a) (i) Explain how the structure of haemoglobin enables it to combine with oxygen in the blood vessels of the lungs.

**(3)**

~~Hea~~ Haemoglobin is a quaternary protein that has 4 haem groups, that are tightly packed together. This makes it hard for the first ~~$O_2$ molecule~~ oxygen. After it has binded ~~to~~, the structure changes, making it easier for the 2nd and 3rd oxygen to bind. The last oxygen would find it hard to bind to Hb as ~~the no~~ it is quite saturated with oxygen (this is called cooperative binding)

ResultsPlus
Examiner Comments

This answer gains 3 marks: mark point 1 on lines 1 – 2, mark point 4 on the last line and mark point 5 for lines 3 – 6. They do not clearly say that the oxygen is binding to haem, so cannot have mark point 2.

**8** Haemoglobin transports oxygen around the human body.

(a) (i) Explain how the structure of haemoglobin enables it to combine with oxygen in the blood vessels of the lungs.

**(3)**

- biconcave shape allows it to be easily transported and absorbed in bloodstream
- lack of nucleus so can absorb more oxygen
- haem group which binds to oxygen so has high affinity for oxygen

**ResultsPlus**
**Examiner Comments**

This candidate has confused haemoglobin and red blood cells, so there are no marks in the first four lines.

However on line 5 they clearly say that haem binds to oxygen so achieve mark point 2.

## Question 8 (a)(ii)

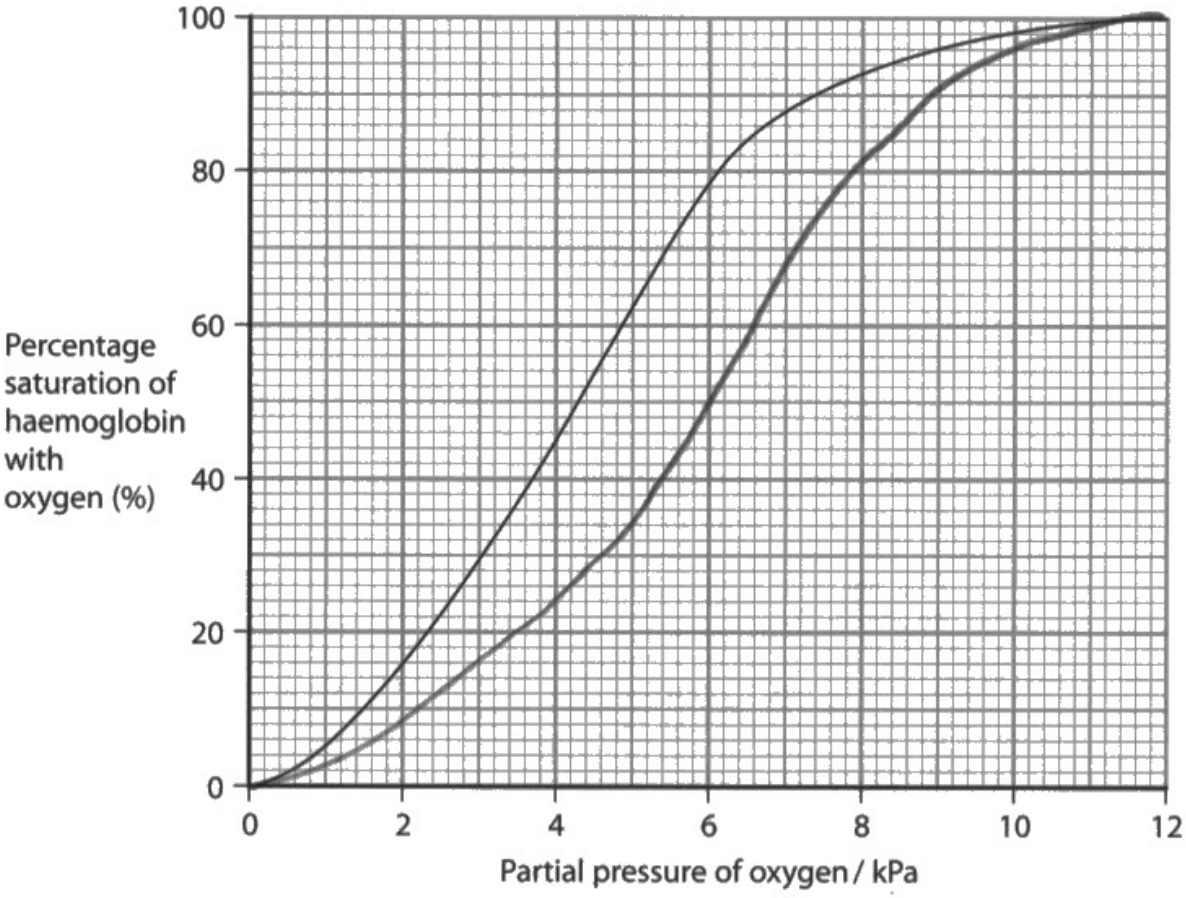
Candidates were provided with an oxygen dissociation curve for haemoglobin in blood in the lungs and asked to add a line to show the curve for haemoglobin in blood in respiring muscle tissue. This proved exceptionally difficult for some candidates – there were all permutations of lines drawn.

We were looking for a curve drawn lower and to the right of the existing curve, with the same start and end points. Some candidates were close to scoring but did not if the line did not reach 100% saturation.

Only about a quarter of candidates achieved this mark.

(ii) The partial pressure of carbon dioxide affects how readily haemoglobin picks up and releases oxygen.

The graph shows an oxygen dissociation curve for haemoglobin in blood in the lungs.




The oxygen dissociation curve for haemoglobin in blood in the tissues of respiring muscle is different.

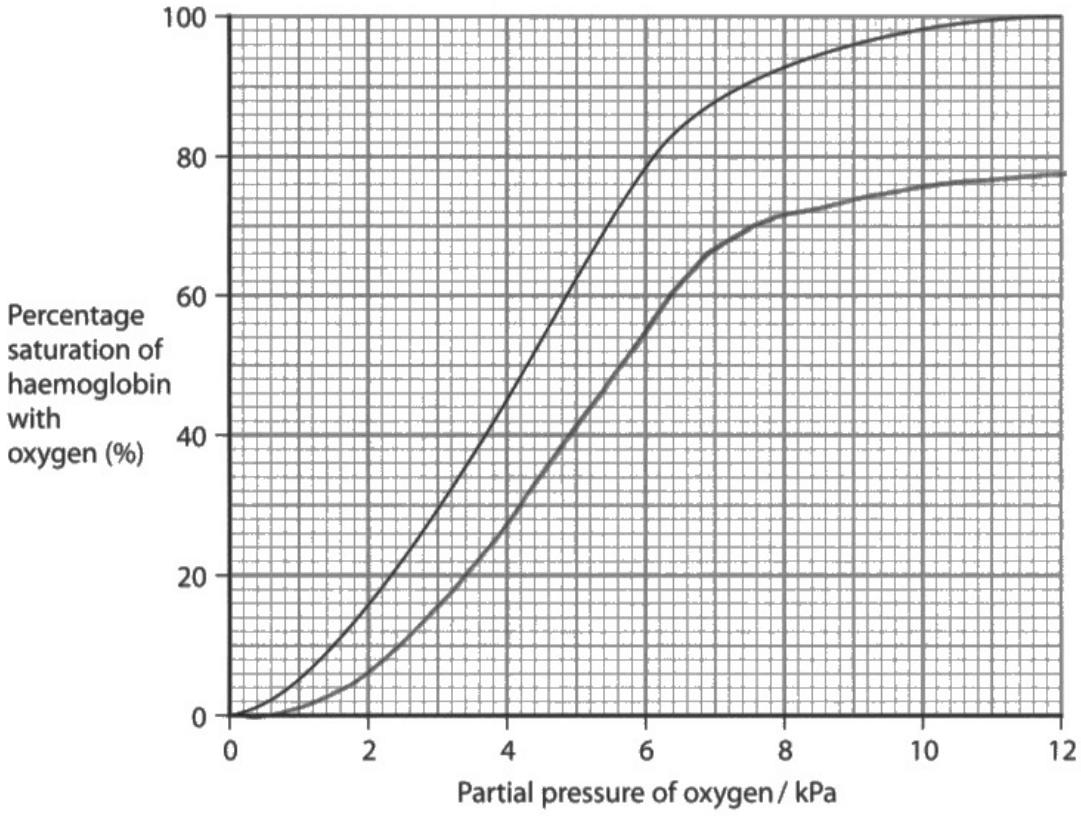
Sketch this curve onto the axes.

**ResultsPlus**
**Examiner Comments**

This curve gained the mark. It is a bit wobbly, but started and ended in the correct place and was always below and to the right of the existing curve.

(ii) The partial pressure of carbon dioxide affects how readily haemoglobin picks up and releases oxygen.

The graph shows an oxygen dissociation curve for haemoglobin in blood in the lungs.




The oxygen dissociation curve for haemoglobin in blood in the tissues of respiring muscle is different.

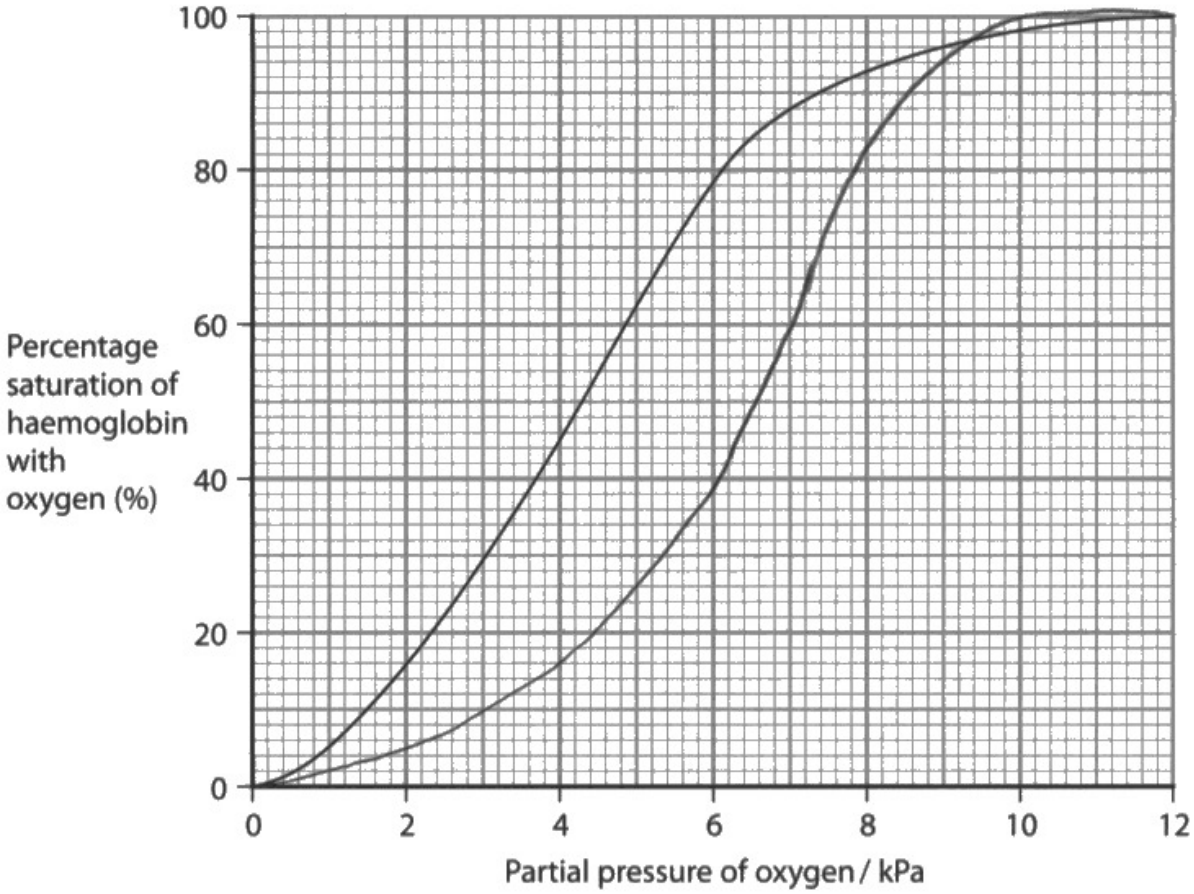
Sketch this curve onto the axes.

**ResultsPlus**
**Examiner Comments**

This was the most commonly seen error. The curve is in the right place but ends far too low, not reaching 100% saturation, so did not score the mark.

(ii) The partial pressure of carbon dioxide affects how readily haemoglobin picks up and releases oxygen.

The graph shows an oxygen dissociation curve for haemoglobin in blood in the lungs.




The oxygen dissociation curve for haemoglobin in blood in the tissues of respiring muscle is different.

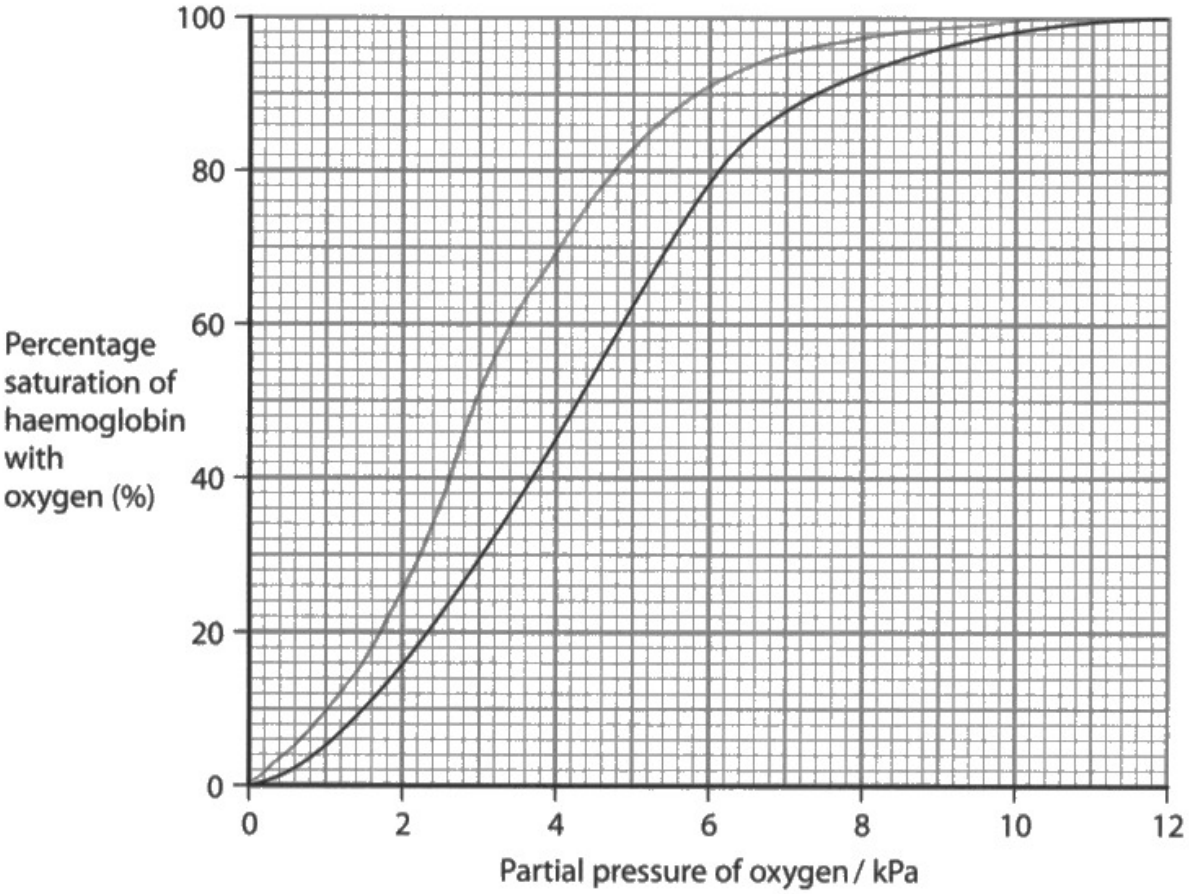
Sketch this curve onto the axes.

ResultsPlus
Examiner Comments

This came close to scoring but did not, as the line they have drawn overlaps the existing line at around 9kPa.

(ii) The partial pressure of carbon dioxide affects how readily haemoglobin picks up and releases oxygen.

The graph shows an oxygen dissociation curve for haemoglobin in blood in the lungs.




The oxygen dissociation curve for haemoglobin in blood in the tissues of respiring muscle is different.

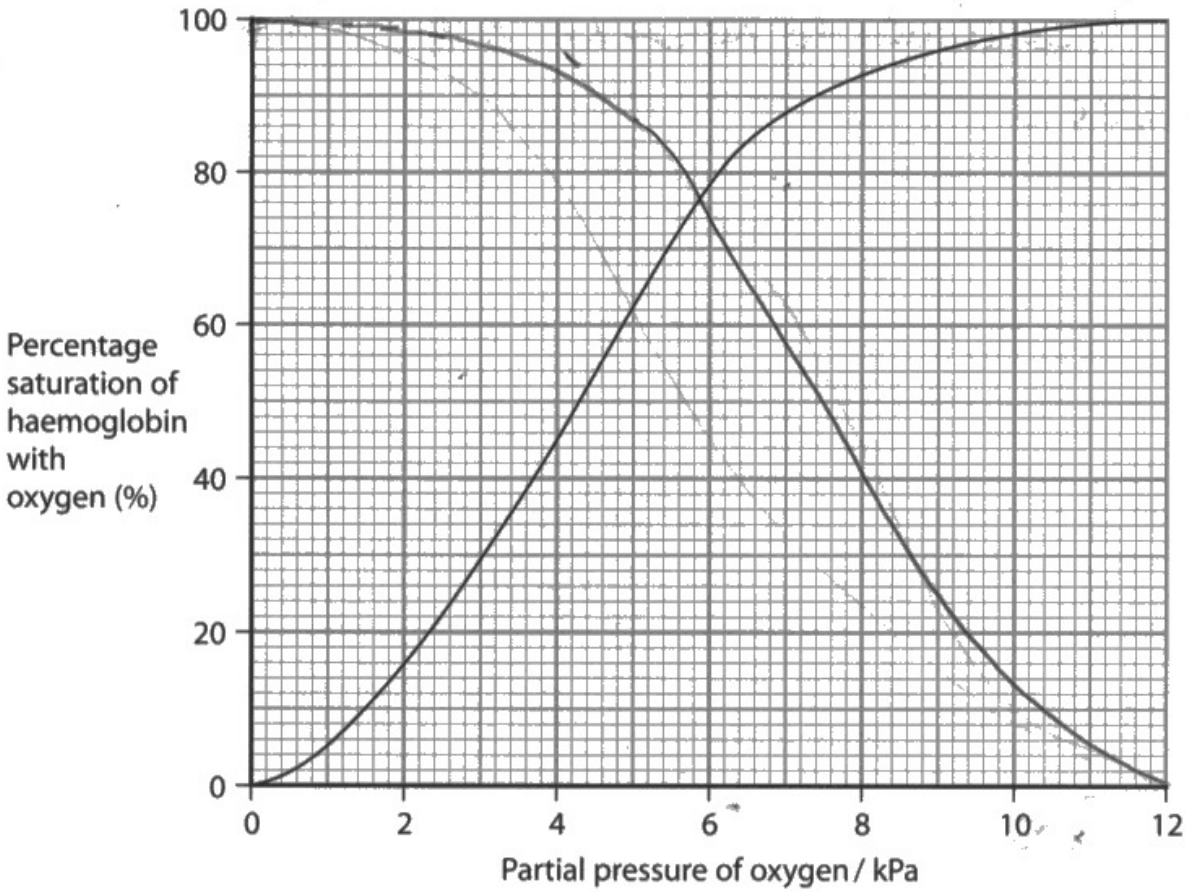
Sketch this curve onto the axes.

ResultsPlus
Examiner Comments

Another common error – this line is drawn higher and to the left of the existing line, so did not score.

(ii) The partial pressure of carbon dioxide affects how readily haemoglobin picks up and releases oxygen.

The graph shows an oxygen dissociation curve for haemoglobin in blood in the lungs.




The oxygen dissociation curve for haemoglobin in blood in the tissues of respiring muscle is different.

Sketch this curve onto the axes.

ResultsPlus
Examiner Comments

Variations of this line were seen several times and did not score.

## Question 8 (a)(iii)

Candidates were asked to explain the advantage of this change in position of the curve.

Marking point 1 was for a simple statement that oxygen was more likely to be released from haemoglobin in the respiring tissue. This was the most commonly seen mark.

The other two marking points required a reference to carbon dioxide concentration and were more rarely seen – candidates did not make the link between the statement above the graph in Q08(a)(ii) (that partial pressure of carbon dioxide affects how readily haemoglobin picks up and releases oxygen) and the answer in Q08(a)(iii).

Marking point 2 was for stating that the concentration or partial pressure of carbon dioxide is higher is respiring tissue.

Even when candidates referred to the Bohr shift, they rarely linked this to increasing carbon dioxide, so could not get marking point 3.

(iii) Explain the advantage of this change in the position of the oxygen dissociation curve.

(2)

The Bohr shift at high $CO_2$ concentrations means that Haemoglobin releases $O_2$ more readily (as the $O_2$ affinity lowers), ensuring that $O_2$ is released at sites of active respiration where it is most needed by cells.

**ResultsPlus**
**Examiner Comments**

This is a strong answer which gains maximum marks.

They get mark point 3 at the start for linking the Bohr shift to high carbon dioxide concentration, then mark point 1 in lines 2 – 4 for saying the haemoglobin releases oxygen more readily at the site of active respiration.

(iii) Explain the advantage of this change in the position of the oxygen dissociation curve.

**(2)**

The change in position is caused by the Bohr shift. This is where higher partial pressures of $CO_2$ at the respiring tissues ~~reduces~~ reduces the affinity of haemoglobin for $O_2$, causing $O_2$ to be unloaded and released to the respiring tissues.

**ResultsPlus**
**Examiner Comments**

This is another very strong answer which gained maximum marks.

They get mark point 3 on lines 1 – 2, then mark point 2 on lines 2 – 3 (high partial pressure of carbon dioxide in respiring tissue), then mark point 1 in lines 3 – 6.

(iii) Explain the advantage of this change in the position of the oxygen dissociation curve.

**(2)**

Oxygen dissociates more readily from haemoglobin at the respiring tissues, so more is released at a higher pp of $O_2$. This means that the respiring tissue is supplied with more oxygen and so respiration (aerobic) can occur more rapidly resulting in more ATP being produced.

ResultsPlus
Examiner Comments

This candidate gets marking point 1 for the clear statement that oxygen dissociates more readily from haemoglobin at the respiring tissues.

(iii) Explain the advantage of this change in the position of the oxygen dissociation curve.

**(2)**

Oxygen is more readily combined with haemoglobin so the organism can respire aerobically for longer. This means that the production of lactic acid will be delayed.

ResultsPlus
Examiner Comments

This candidate has understood that oxygen is needed for aerobic respiration but there is confusion about where the oxygen combines with haemoglobin (in the lungs) and where it should be dissociating (at the respiring tissues).

This answer does not score.

## Question 8 (b)(i)

Q08(b) was about beta thalassaemia.

Q08(b)(i) asked for the probability that two heterozygous parents would have an affected child, and almost all gave the correct answer of 0.25 / 25% for 1 mark.

Many candidates drew a Punnett square to support their answer.

The most common errors were incorrect probabilities (50% was most often seen) and candidates who gave two conflicting answers eg 25% and 1:4.

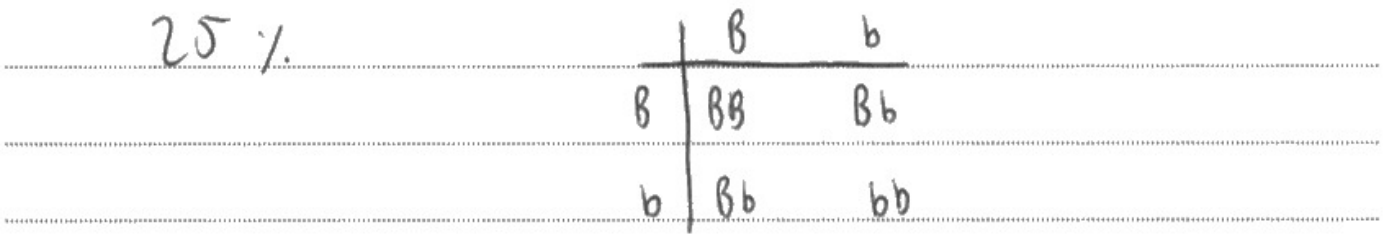
(b) Beta thalassaemia is an inherited condition affecting the gene for beta-globin (HBB gene).

People with beta thalassaemia have less or no beta-globin.

The most common form is a recessive condition caused by a mutation in the HBB gene.

(i) State the probability that two parents who are heterozygous for this condition would have a child who has beta thalassaemia.

**(1)**




**ResultsPlus**
**Examiner Comments**

A well set out answer gaining one mark. The Punnett square was not needed, but helped the candidate to avoid making a mistake.

(b) Beta thalassaemia is an inherited condition affecting the gene for beta-globin (HBB gene).

0·4983

People with beta thalassaemia have less or no beta-globin.

The most common form is a recessive condition caused by a mutation in the HBB gene.

(i) State the probability that two parents who are heterozygous for this condition would have a child who has beta thalassaemia.

**(1)**

3:1 or 25%

**ResultsPlus**
**Examiner Comments**

This candidate scored zero.

25% is the correct answer for the probability that two heterozygous parents would have an affected child.

3:1 is not the correct answer, as they are not more likely to have an affected child – if they had written it as 1:3, it would have been correct.

Where there are two contradictory answers, no credit is given.

## Question 8 (b)(ii)

Candidates were asked why a heterozygous person does not show the symptoms of the disease.

About three quarters could explain that a heterozygous person has one dominant and one recessive allele or that for the condition to show in the phenotype, both alleles must be recessive. Very few candidates went on to say that this means heterozygotes could make the beta globin protein, so marking point 2 was rarely seen.

The most common error was to write about genes instead of alleles.

(ii) Explain why a person who is heterozygous does not show the symptoms of beta thalassaemia.

**(2)**

- Due to the condition being recessive, two recessive alleles are required for the condition to actually have effect
- this person does not have the disease, they are only a carrier

**ResultsPlus**
**Examiner Comments**

This answer was typical of most that we saw.

The candidate provides a very good explanation for marking point 1 but does not attempt marking point 2.

(ii) Explain why a person who is heterozygous does not show the symptoms of beta thalassaemia.

**(2)**

- for the phenotype of beta thalassaemia to show, the person needs to be homozygous recessive because it is a recessive condition.
- the dominant allele (which a heterozygous person has) will always be expressed so beta-globin will be present in the haemoglobin structure and they will not show any symptoms.

**ResultsPlus**
**Examiner Comments**

This is a strong answer which covers both marking points well.

(ii) Explain why a person who is heterozygous does not show the symptoms of beta thalassaemia.

**(2)**

- The gene is ressesive so is only presented when both genes are present
- The dominant gene will mask the mutated HBB gene.

**ResultsPlus**
**Examiner Comments**

This answer was typical of those that did not score.

The candidate has confused alleles with genes and refers to genes throughout.

(ii) Explain why a person who is heterozygous does not show the symptoms of beta thalassaemia.

**(2)**

Since beta thalassaemia is a recessive ~~effete~~ trait you need two recessive alleles for beta thalassaemia to be present. If ~~thee~~ two are not present the body continues to produce normal ~~beta~~ amount of beta-globin so they don't suffer any symptoms.

**ResultsPlus**
**Examiner Comments**

Another very strong answer gaining both marking points.

## Question 8 (c)(i)

This was a Hardy-Weinberg calculation related to proportions of people with beta thalassaemia on a Mediterranean island.

Candidates were told that 280 in 1000 people have beta thalassaemia and asked to calculate the probability that a person on the island is heterozygous, giving the answer to 2 significant figures.

Almost 40% of candidates were able to carry out this calculation correctly and gain three marks. Some who knew the method involved, but made errors, were able to pick up marking points 1 or 2 for interim steps in the calculation – this shows the value of setting out working clearly.

However there were a significant number of candidates who had no idea what was needed in this calculation.

(c) Overall, the proportion of people with beta thalassaemia is 30 in 1000.

In some parts of the world it is much higher.

In one Mediterranean island, 280 in 1000 people have beta thalassaemia.

(i) Calculate the probability that a person on this island is heterozygous for beta thalassaemia.

Use the Hardy–Weinberg equation

$$p^2 + 2pq + q^2 = 1$$

Give your answer to two significant figures.

(3)

~~30~~ / 1000 $\frac{280}{1000} = 0.28$

$q^2 = 0.28$

$q = 0.53$

$p = 0.47$

$p^2 = 0.22$

$0.22 + 2(0.47 \times 0.53) + 0.28$

$= 1$

$2(0.47 \times 0.53) = 0.50$

$= 0.4982 = 0.4982$

Answer ~~0~~ 50 %

ResultsPlus
Examiner Comments

This answer gains maximum marks.

The working is well set out and easy to follow, leading to a correct answer of 50%.

(c) Overall, the proportion of people with beta thalassaemia is 30 in 1000.

In some parts of the world it is much higher.

In one Mediterranean island, 280 in 1000 people have beta thalassaemia.

(i) Calculate the probability that a person on this island is heterozygous for beta thalassaemia.

Use the Hardy–Weinberg equation

$$p^2 + 2pq + q^2 = 1$$

Give your answer to two significant figures.

(3)

$q^2 = 0.28$

$q = 0.52915$

$1 = p + q$

$1 - q = p$

$p = 0.47084973378$

$2 \times (0.52915 \times 0.47084973378)$

$= 0.498$

$= 0.50$

Answer 0.50

ResultsPlus
Examiner Comments

Another answer gaining full marks, this time with the probability expressed as 0.50

(c) Overall, the proportion of people with beta thalassaemia is 30 in 1000.

In some parts of the world it is much higher.

recessive.

In one Mediterranean island, 280 in 1000 people have beta thalassaemia.

(i) Calculate the probability that a person on this island is heterozygous for beta thalassaemia.

Use the Hardy–Weinberg equation

dominant homo $p^2$ + Heterozygous. $2pq$ + $q^2$ = 1 → recessive homo

Give your answer to two significant figures.

(3)

280 ÷ 1000 = 0·28 = recessive homozygous

0·72 = dominant homozygous

$\sqrt{0{\cdot}72} = 0{\cdot}848528137\,4$ p

$\sqrt{0{\cdot}28} = 0{\cdot}529150262\,2$ q

0·901

0·90

Answer 0·90

**ResultsPlus**
**Examiner Comments**

This person got the final answer wrong but was able to get mark point 1 for 0.28 and mark point 2 for q = 0.529.

(c) Overall, the proportion of people with beta thalassaemia is 30 in 1000.

In some parts of the world it is much higher.

In one Mediterranean island, 280 in 1000 people have beta thalassaemia.

(i) Calculate the probability that a person on this island is heterozygous for beta thalassaemia.

Use the Hardy–Weinberg equation

$$p^2 + 2pq + q^2 = 1$$

Give your answer to two significant figures.

**(3)**

$\frac{280}{1000} = 0.28 = q^2$

$q = 0.529$

$p = 0.68$

$p^2 = 0.47$

$0.686$

$2 \times 0.68 \times 0.529$

$= 0.72$

$\times 100$

$= 72.6\%$

$= 73\%$

Answer 73%

**ResultsPlus**
**Examiner Comments**

This person got the final answer wrong as well. However they got mark point 1 for $q^2 = 0.28$ and mark point 2 for $q = 0.529$.

**ResultsPlus**
**Examiner Tip**

This shows how important it is to show working and to set it out clearly. This person got 2 marks for the interim steps, although the final answer was completely wrong.

## Question 8 (c)(ii)

Candidates were asked for two reasons why the value they had calculated in Q08(c)(i) might not be accurate. Many candidates realised that they were being asked about the assumptions made for Hardy-Weinberg, and it was pleasing to see that many related them to the island context,
eg migration.

Answers could either be phrased as the assumptions that are made for Hardy-Weinberg (it should be a large population) or what is actually happening on the island leading to possible inaccuracy (the population on the island may be small).

Overall this was well answered and almost half of all candidates scored two marks.

Some missed the point and thought that not everyone had been tested or that people may not realise they had the disease.

It was clear from the answers given that some candidates have become confused between the assumptions made for Hardy-Weinberg and the conditions needed for mark-release-recapture to give an accurate estimation of population size.

(ii) Give **two** reasons why this value may not be accurate.

(2)

- Is a small population on an Island.
- People migrate away (gene flow occurs).

ResultsPlus
Examiner Comments

This answer scored full marks for mark points 3 and 1.

(ii) Give **two** reasons why this value may not be accurate.

**(2)**

the hardy weinburg equation only works with no mutations and an inbred population → hard to manage and to maintain (cannot prevent mutations)

**ResultsPlus**
**Examiner Comments**

Another strong answer scoring both marks, this time mark points 5 and 1.

(ii) Give **two** reasons why this value may not be accurate.

**(2)**

→ assumes that theres no mutation

→ assumes no migration

**ResultsPlus**
**Examiner Comments**

This answer scored 2 marks (mark points 5 and 1) expressed as the assumptions that are made.

(ii) Give **two** reasons why this value may not be accurate.

**(2)**

Not all of the people may have been tested for beta thalassaemia.

Not all will be presenting so they could be Homozygous dominant.

ResultsPlus
Examiner Comments

This answer shows the one of the most common errors – to assume that they cannot tell how many heterozygotes there are, because people have not been tested for the disease.

## Question 9 (a)

Candidates were asked to explain how atherosclerosis can cause CHD and can lead to death.

Although most candidates had a reasonable idea of the sequence of events involved, imprecise language and lack of detail prevented some from scoring more highly. We were looking for:

- {plaque / clot / atheroma} forms in (coronary) artery.
- causing {narrowing / blockage} of the **coronary** artery.
- therefore reducing the blood supply to {cardiac / heart} {muscle / tissue / cells}.
- so {cardiac / heart} muscle dies.
- heart (muscle) stops contracting (if enough cardiac muscle cells die).
- so oxygen not supplied to brain cells (causing death).

There were some very strong answers and around a third of candidates scored at least three marks. The most commonly seen marking points were 1, 4 and 5.

However, a lot of candidates missed out on marks they came close to achieving, due to lack of detail. Examples of this included:

- referring to a blood vessel rather than an artery (mark point 1).
- referring to an artery rather than a coronary artery (mark point 2).
- saying less blood reached the heart rather than reached the heart muscle or cells (mark point 3).
- not considering what happens if the heart stops contracting (mark point 6).
- not explaining how this could lead to death (mark point 6).

**9** Coronary heart disease is a major cause of death in Europe.

(a) Explain how atherosclerosis can cause coronary heart disease and can lead to death. (4)

often due to stress and high blood pressure

Atherosclerosis occurs when wall of the artery are damaged. As a result, the immune response is triggered and cholesterol is laid down in the vessel. This hardens into plaque, forming an atheroma. The atheroma can grow and eventually block the artery. If this happens upstream in the coronary artery, then cardiac muscle will be starved of oxygen from the blood so cannot respire to produce ATP. This can lead to death as no ATP means cardiac muscle cannot contract and pump blood. This means overtime the brain will be starved of $O_2$ and the heart wont be strong enough to beat and will go into fibrilation.

**ResultsPlus**
**Examiner Comments**

This is a very well structured answer which contained correct biological details and achieved maximum marks.

They got mark points 1, 2, 3 and 5.

Not mark point 4 as they do not say that cardiac muscle dies and not mark point 6 as they refer to the brain, not brain cells.

**9** Coronary heart disease is a major cause of death in Europe.

(a) Explain how atherosclerosis can cause coronary heart disease and can lead to death.

**(4)**

→ high blood pressure due to smoking, diet etc

→ inflammatory response and arrival of white blood cells

→ deposits of cholesterol

→ formation of plaque | atheroma

→ causes blockage of blood vessels, increasing blood pressure

**ResultsPlus**
**Examiner Comments**

Although this candidate knew some of the steps of the process they did not score as there was lack of detail.

Not mark point 1 as although they said a plaque forms, they did not say it was in an artery. They did not explain how high blood pressure could lead to death.

**9** Coronary heart disease is a major cause of death in Europe.

(a) Explain how atherosclerosis can cause coronary heart disease and can lead to death.

**(4)**

Formation of plaque in the arteries can build up in the arteries which causes a blockage making it harder for blood to get through as the more plaque formed narrows the artery which can lead to a heart attack or heart disease.

Poor diet can can cause substances such as fat to build up and lead to the formation of an atheroma and plaque which narrows the artery.

**ResultsPlus**
**Examiner Comments**

This answer started very well but did not develop the stages of the process fully.

They achieved mark point 1 on line 1 and mark point 4 on lines 6 – 7.

**9** Coronary heart disease is a major cause of death in Europe.

(a) Explain how atherosclerosis can cause coronary heart disease and can lead to death.

**(4)**

If a person has atherosclerosis, they have atheromas and plaques in the coronary artery / in blood vessels. Hence if more cholesterol and platelets stick to the plaque / atheroma, the atheroma would become large and would block the blood from flowing to the heart muscles, hence blood flow to the heart is low. As atherosclerosis increases blood pressure, due to a narrow lumen, hence it's more likely for a clot as endothelium is damaged to form. If heart muscles receives less blood, it receives less oxygen hence less aerobic respiration occurs and less ATP is generated hence the heart is unable to contract so can lead to death if no blood can reach the body via the heart.

**ResultsPlus**
**Examiner Comments**

This is a strong answer which gained four marks.

It got mark point 1 on lines 1 – 2, mark point 2 on lines 2 and 4, mark point 3 on line 5 and mark point 5 on lines 10 – 11.

"It can lead to death if no blood can reach the body" was too vague for mark point 6.

**9** Coronary heart disease is a major cause of death in Europe.

(a) Explain how atherosclerosis can cause coronary heart disease and can lead to death.

**(4)**

Atherosclerosis is caused when fats and cholesterols built up in blood artery & sticks to the wall of the artery. This will accumulates over time, resulting in atheroma getting bigger. Platelets and fibrin will also try to form a mesh network, clotting the atheroma The built of atheroma could lead to higher pressure as the artery lumen becomes narrower. This could result in damage of elastic fibres and muscle fibres. Eventually built up Atheroma will result in insufficient supply of oxygen to targeted organ leading to death

**ResultsPlus**
**Examiner Comments**

Although everything in this answer is correct it only gets one mark, because it focuses entirely on marking point 1.

## Question 9 (b)

This was the 9-mark levels-based question. Candidates were given data: a table of deaths from CHD in several European countries in 1990 and 2019 and a graph showing deaths from CHD for males in the UK between 1979 and 2013.

They were asked to discuss the validity of the following suggestion: that the change in deaths from coronary heart disease in the UK is due to improved lifestyle choices, and that coronary heart disease could be reduced to almost zero in the UK if people made better choices.

The command word **discuss** requires candidates to explore all aspects of the situation being considered and to investigate it using reasoning.

The indicative content was divided into three areas:

- L points, which were factors that could reduce deaths (including better lifestyle choices, healthcare, improved awareness).
- C points, which were factors that could prevent deaths reaching zero (including genetic predisposition, age, sex).
- D points, which were for data analysis.

To achieve Level 1, candidates could make points from any of the three areas.

To achieve Level 2, candidates must make points from a minimum of two areas, including D points.

To achieve Level 3, candidates must make points from all of the three areas and consider validity. For 9 marks the answer must include a reasoned argument assessing validity.

Generally candidates did very well on this question, using the information given and their own knowledge to build strong arguments. There were many excellent, thoughtful answers including relevant biological detail which scored 9 marks.

A small number of candidates got stuck at a particular level because they did not meet the criteria to progress, eg if they had lots of L and C points they could not get more than 3 marks unless some D points were also included.

Overall 40% of candidates achieved Level 3, 36% achieved Level 2, 23% achieved Level 1 and a very small number of candidates failed to score at all, usually for leaving the pages blank.

style. However there is quite a drastic decrease of deaths caused by coronary heart disease in the last 29 years which shows there has been some sort of improvement this could be due to better / more accurate health care however as there are now medicine and more food substitutes to reduce cholesterol levels, overhaul more exercise equipment has become available and it is a popular thing to go to the gym and eat healthier foods which could be why the level of deaths is increasing there is a -58% decrease in deaths in just 29 years which could keep decreasing over the years and

ResultsPlus
Examiner Comments

This candidate shows that they know some of the factors involved in CHD eg lack of exercise and build-up of cholesterol in arteries due to diet. However they do not give an A-level standard explanation of why this happens, so scored a single L point for knowing the factors, but not describing the effect of them.

On line 12 – 13 they scored an L point for recognising that better healthcare would have an effect.

They go on to quote data from the table (that there is a 58% decrease in deaths in 29 years) but this is not a D point as it is simply quoted, not used in any way.

This candidate went on to score a C point and therefore achieved 3 marks overall.

ResultsPlus
Examiner Tip

Do not just quote data from the stem of the question, as this will not gain credit. Use it in some way to build your argument. Here the candidate could have compared the decline in the UK to other countries in Europe.

- Nowadays it's easier to eat food with sahrated fats in, which increase cholesterol.
- There is a much wider food range of things to eat compared to even as early as 100 years ago.
- Foods like fast food are cheaper and much easier to find and eat than whole foods.
- Medication and healthcare has improved so much we now know what is better to eat than other things

**ResultsPlus**
**Examiner Comments**

This candidate recognises the effect of diet on CHD but does not make a valid A-level standard point.

They get one L point for improved healthcare on line 10.

Ireland has seen a -63% decrease. Coronary heart disease can be caused by factors like lack of exercise, obesity, ^stress, smoking and gender. While some of these are modifiable risk factors, others, like gender, are not. In males CHD is more likely as males do not produce oestrogen which is said to reduce cholesterol buildup. Similarly, age increases risk as as you age, vessels lose elasticity so an atheroma in the coronary arteries is more likely to block them and cause CHD. However, the UK can encourage healthy eating and exercise to reduce the risk factors. Arguably, factors beyond lifestyle choices play a role as ^medical technology across

Europe has improved over time. The UK may have seen a decrease in deaths as more treatment and diagnosis has been made available overtime. It is fair to suggest this has had a bigger impact than lifestyle choices as lifestyle choices can only reduce incidence. The only country to not see improvement on the table is Montenegro Bargeana. This may link to the cost of surgeries for coronary heart disease, however, it may be down to cultural differences but, this can be disproved by the fact that other Balkan European countries like Albania have still seen a decrease in deaths. It could be argued that

**ResultsPlus**
**Examiner Comments**

This candidate lists some of the factors involved in causing CHD and gets one L point for the list.

They go on to give a more detailed description of the effect of sex and age, achieving two C points.

They get one L point for stating that improved medical technology has an effect and another for recognising that this may have a bigger effect than lifestyle choices in reducing deaths.

They get a D point for comparing Montenegro to other Balkan countries.

Overall, this candidate produced an excellent answer. They went on to make further L, C and D points and scored 9 marks.

↳ No data has been provided to show lifestyle has improved within the UK so cannot say this is definity true and ~~th~~ it has caused the 58% decrease in the UK over 29 years

- The healthcare technology has massively increased meaning people are staying alive for much longer which could increase the ~~risk~~ amount of heart disease as the elderly are more likely to suffer with it.
- Gender is a factor in heart disease, with males being more likely to have it
  ↳ this is mainly down to genetics and males having a worse, more manually labour based lifestyle
  ↳ males who have heart disease is ~~incr~~ decreasing by around 340M per 1000 between 1979 and 2013 but female decrease is not shown in comparison and this data is now relatively old.

**ResultsPlus**
**Examiner Comments**

This candidate correctly states that data has not been provided to back up the claim that lifestyle choices have caused this effect and gets a D point.

They state that healthcare has improved, but link this to living longer, and therefore being more at risk from CHD due to age, so get a C point.

They recognise that males are more at risk, so get another C point.

In their last bullet point they get two D points because they read figures from the graph to get the decrease in data for males, and also recognise that the data is incomplete because no data is given for females.

Overall this candidate made a lot of D and C points and two L points, so was able to score 9 marks.

It has been suggested that the change in deaths from coronary heart disease in the UK is due to improved lifestyle choices, and that coronary heart disease could be reduced to almost zero in the UK if people made better choices.

Discuss the validity of this suggestion.

Use the data and your own knowledge to support your answer.

**(9)**

We can see that there is a decrease of deaths from coronary heart disease in the UK since 1990, however it is unfair to assume this is solely down to people making healthier life style choices the data given shows no signs or causes for the decrease so we cannot assume. there are many factors that could be decreasing the death rate by CHD such as better healthcare, better treatment, ways to find it before its deadly, improved knowledge of what causes CHD. The data only shows who died from it not who suffered from it so it could be possible more people had it but the treatment has improved significantly. Montenegro's death rate has increased slightly this could be caused by a lack of knowledge or healthcare. ~~It is likely that~~

It is likely that improved lifestyle choices do reduce your risk of CHD such as no smoking but its not appropriate to suggest this is the leading factor without proper evidence

**ResultsPlus**
**Examiner Comments**

This candidate made quite a lot of L and D points, but no C points, therefore they were restricted to Level 2.

Overall they scored 6 marks.

It has been suggested that the change in deaths from coronary heart disease in the UK is due to improved lifestyle choices, and that coronary heart disease could be reduced to almost zero in the UK if people made better choices.

Discuss the validity of this suggestion.

Use the data and your own knowledge to support your answer.

(9)

- This suggestion is supported because regular exercise, no smoking, less stress, less obesity and a healthier diet would ~~improve~~ decrease chance of developing atherosclerosis, so reduce heart disease as less stress reduces blood pressure so reduces chance of damage to artery wall and less ~~so so less~~ saturated fats and cholesterol in diet reduces ~~solor~~ cholesterol available for build up in arteries so less atheromas formed and less fat build up reduces blood pressure so less chance of damaged caused.
- Also, table shows an average number of deaths decrease from 1990 to 2019 as information on lifestyle choices is more research and more educated on so people tend to lead healthier lifestyle reducing chances of atherosclerosis and ∴ reducing chances of heart disease and death.
- However, atherosclerosis can be cause by genes and age and gender

ResultsPlus
Examiner Comments

This candidate achieved three L points (for the list of factors and then details of how stress and cholesterol in the diet increase CHD).

They achieved two C points for genes and age.

However there were no D points, so they were restricted to Level 1, 3 marks.

It has been suggested that the change in deaths from coronary heart disease in the UK is due to improved lifestyle choices, and that coronary heart disease could be reduced to almost zero in the UK if people made better choices.

Discuss the validity of this suggestion.

Use the data and your own knowledge to support your answer.

**(9)**

- The table shows that the UK had the 2nd biggest percentage decrease in deaths from 1990 to 2019 it was -58% (not as much as republic of ireland at -63%) so in the space of 29 years deaths decreased by half, this makes the discussion less valid as it took 29 years to halve the number of deaths so it will take a very long time to reduce deaths to zero and so a very long time to reduce coronary heart disease to zero. Also this suggestion isn't valid as one factor of increasing risk of coronary heart disease is genetics which isn't a lifestyle choice and it would therefore mean that coronary heart disease can't be reduced to almost zero since its unethical to not allow people who's families have lots of coronary heart disease to reproduce. In the table the UK had a larger % decrease in deaths (-58%) compared to Europe as a whole (-38%), however this decrease may just correlate with the fact that lifestyle choices have improved rather than be caused by it (correlation not causation). Stress also causes heart disease and people can't control it. Also the decrease in % of heart disease deaths may be due to the improved healthcare system and medicines and scientific knowledge which can treat heart disease rather than improved lifestyle conditions especially since fast food is more available now and people sit on their phones and don't

walk around as much as they used to in 1997, so despite the fact that there is a little less smoking now doesn't mean that lifestyle choices have improved as saturated fats and cholesterol are more available to be eaten and people in general have more sedentary lifestyles now. I think the statement is right to say that coronary heart disease could be reduced if people made better lifestyle choices because lack of exercise, eating high cholesterol food and smoking will all increase the risk of heart disease ~~however~~ so making better choices not to do these things should decrease the risk however the statement is wrong to say that the change in deaths was due to improved lifestyle choices as there's no evidence to say lifestyle choices have improved and there's no evidence to say that lifestyle choices were responsible for the decrease i.e it could have been better healthcare that reduced the number of deaths. The graph shows a decrease from 450 to 120 deaths ~~for~~ from heart disease from 1979 to 2013 but its only data for men so no evidence that number of deaths also reduces for females, also just because the number of heart disease related deaths has decreased doesn't mean that the number of people with heart disease has decreased.

Also in the table the number of deaths in Montenegro has increased by 4% and there is no evidence to say whether lifestyle choices have got better or worse there because lifestyle choices could have gotten better but deaths could have increased due to poor healthcare system

Overall I don't think the suggestion is valid because firstly there is no evidence that the % of deaths due to coronary heart disease is due to improved lifestyle choices as other factors like genetics also affect it, also no evidence that coronary heart disease cases have been reduced only evidence that the number of deaths from it has reduced, although I agree with the fact that heart disease could **(Total for Question 9 = 13 marks)**

reduce if people made better choices I don't think it would reduce to almost zero as genetics also contribute to heart disease and gender as males are more likely to get heart disease

ResultsPlus
Examiner Comments

This is an excellent answer which fully deserved the 9 marks it achieved.

They cover a lot of ground:

D points – that it may be correlation not causation, no evidence that lifestyle choices have changed, no evidence that lifestyle choices are responsible for decline, data read from graph, no data for females in the UK, fewer people dying but no data on incidence of CHD.

C points – genetics increases risk, males are more at risk, deaths very unlikely to reach zero.

L points – better healthcare decreases risk, more sedentary lifestyle/ smoking / poor diet increase risk, stress increases risk.

These points are put together to build a strong argument with validity being discussed throughout.

## Question 10 (a)

Q10 related to a simple respirometer containing maggots. This is Core Practical 9: investigate factors affecting the rate of aerobic or anaerobic respiration using a respirometer. Candidates were given a diagram and the results of an investigation achieved by 5 groups of candidates.

Q10(a) told them oxygen uptake was measured in $mm^3$ per minute per gram and asked what additional measurements must be made to calculate rate of oxygen uptake in these units.

Many candidates realised that mass of maggots was required and some also suggested radius or diameter of the capillary tube.

About a third of candidates did not score, and most suggested what was already in the description of the investigation: the time the maggots were left or the distance moved by the coloured liquid.

(a) The rate of aerobic respiration was determined as the oxygen uptake calculated in $mm^3$ per minute per gram.

State the **two** additional measurements that you would make to calculate the rate using these units.

**(2)**

- The diameter of the ~~tube~~ capillary tube
- The mass of the maggots

**ResultsPlus**
**Examiner Comments**

A clear answer scoring both marks.

(a) The rate of aerobic respiration was determined as the oxygen uptake calculated in $mm^3$ per minute per gram.

State the **two** additional measurements that you would make to calculate the rate using these units.

**(2)**

- the diameter of the capillary tube so that the volume can be calculated using $\pi r^2 l$.
  ↳ diameter needed for the radius.
- the mass of the maggots only in grams should be calculated / measured.

**ResultsPlus**
**Examiner Comments**

Another strong answer which scored both marks.

For mark point 2 the candidate said that diameter should be measured, as well as giving the formula to calculate the area.

(a) The rate of aerobic respiration was determined as the oxygen uptake calculated in $mm^3$ per minute per gram.

State the **two** additional measurements that you would make to calculate the rate using these units.

**(2)**

- Distance moved by coloured liquid in ~~mm~~ mm
- Time taken for investigation in $s^{-1}$

**ResultsPlus**
**Examiner Comments**

This answer is typical of those that did not score.

The candidate has suggested two measurements that were already given in the stem of the question – this was in the sentence "The distance the coloured liquid had moved was measured after 15 minutes".

## Question 10 (b)

Candidates were asked to justify two improvements to ensure the validity of the investigation.

The command word **justify** requires candidates to give evidence to support their choice – in this case the reason that the improvements they are suggesting would ensure validity.

As expected, candidates found this challenging, with over three quarters scoring zero.

Many candidates were able to suggest suitable improvements, eg controlling the age of the maggots, but did not say why they were needed (because age may affect respiratory rate).

Some candidates left out key details of the answer, eg suggesting using a control but without saying it had no maggots in it or using a water bath that was not thermostatically controlled.

Several candidates suggested replacing the potassium hydroxide regularly, but as there was no evidence that the apparatus was used more than once by each group, this was not given credit.

A number of candidates thought that reading the position of the liquid every minute (instead of once, after 15 minutes) would improve validity; however this is likely to introduce errors as small changes in position are being read frequently.

(b) Justify **two** improvements that would ensure the validity of this investigation.

(2)

Let the maggots acclimatise to the new conditions for at least 5 minutes, so the oxygen uptake accounts for the lag. Ensure that the maggots were of the same age and were all healthy, so this would not affect the rate of oxygen uptake.

ResultsPlus
Examiner Comments

This is a strong answer which scored two marks, mark point 5 and 2.

ResultsPlus
Examiner Tip

When the command word is **justify**, make sure you give a reason for the improvements you suggest.

(b) Justify **two** improvements that would ensure the validity of this investigation.

**(2)**

Allow 5 minutes with the 3-way tap open before starting the stopwatch to allow the maggots to adjust on to the new environment, as their behaviour while adjusting could affect their rate of respiration.

Place the beaker of water in a thermostatically controlled water bath at 15°C to ensure the temperature remains the same throughout since temperature affects the rate of respiration

**ResultsPlus**
**Examiner Comments**

This candidate has explained their points very clearly and achieved mark points 5 and 1.

(b) Justify **two** improvements that would ensure the validity of this investigation.

**(2)**

- repeat at least 5 times to ensure the elimination of anomalous results and validity, and that the results can be replicated.
- refresh potassium hydroxide each repeat and the beaker of water in a water bath to ensure temperature is maintained and constant.

**ResultsPlus**
**Examiner Comments**

This candidate did not score. There was no credit for repeating the investigation or for refreshing the potassium hydroxide solution.

They came close to mark point 1 with the suggestion of putting the beaker of water in a water bath but they did not say it should be thermostatically controlled.

## Question 10 (c)(i)

Candidates were told that in enzyme-controlled reactions, a 10°C rise in temperature doubles the rate of reaction. They were asked to predict the rate if there was a 10°C decrease in temperature.

To do this, they had to complete two steps:

- calculate the mean rate from the results for 5 groups.
- halve this value.

Around two-thirds of candidates were able to carry out the calculation necessary to achieve this mark.

(c) (i) For enzyme-controlled reactions, a 10°C rise in temperature will double the rate of reaction.

Predict the mean rate of oxygen uptake if the water bath had been set at 5°C.

(1)

$0.14 + 0.16 + 0.13 + 0.12 + 0.14 = 0.69$

$= 0.14$

Answer 0.07 $mm^3 min^{-1} g^{-1}$

**ResultsPlus**
**Examiner Comments**

A correct calculation for one mark.

(c) (i) For enzyme-controlled reactions, a 10°C rise in temperature will double the rate of reaction.

Predict the mean rate of oxygen uptake if the water bath had been set at 5°C.

**(1)**

15 → 25°C
×2
0.138 → 0.276
÷2

0.0138
0.069

Answer 0.069 $mm^3 min^{-1} g^{-1}$

**ResultsPlus**
**Examiner Comments**

Although this candidate appeared to be going in the wrong direction, they came to the right answer for one mark.

## Question 10 (c)(ii)

Candidates were asked to explain why decreasing temperature affects the rate of respiration in maggots.

About a third of candidates scored 1 mark, usually for recognising that enzymes had less kinetic energy. Stronger candidates also scored the second mark for saying that collisions were less likely or less frequent. However, around half of all candidates scored zero on this question.

The most common problems were:

- referring to number of collisions rather than likelihood or frequency.
- saying that enzymes work more slowly (no reason).
- that they are denatured at lower temperatures.

A surprising number of candidates did not realise they were being asked about enzymes at all and wrote about maggots needing to generate heat to stay warm, or said that maggots were ectotherms and if they were cold they would become less active.

(ii) Explain why decreasing the temperature affects the rate of respiration of maggots.

(2)

As temperature decreases, enzymes like ATP synthase involved in aerobic respiration have less kinetic energy. As a result, less collision occurs so a enzyme-substrate complexes form less freauently so rate of uptake of oxygen is reduce and

**ResultsPlus**
**Examiner Comments**

This is a strong answer which scores both available marks:

- mark point 1 for enzymes have less kinetic energy.
- mark point 2 for E – S complexes form less frequently.

(ii) Explain why decreasing the temperature affects the rate of respiration of maggots.

**(2)**

- decreasing the temperature reduces the rate of respiration because the enzymes involved in respiration and the substrates have less kinetic energy.
- therefore they are less likely to collide and bring about the next stage of respiration.

**ResultsPlus**
**Examiner Comments**

Another strong answer gaining both marks:

- mark point 1 for enzymes and substrates have less kinetic energy.
- mark point 2 for they are less likely to collide.

(ii) Explain why decreasing the temperature affects the rate of respiration of maggots.

**(2)**

decreasing temperature lowers the kinetic energy of particles so ~~as~~ enzymes move slower (i.e. enzyme CoA in link reaction) so less enzyme substrate complexes form per unit time so the rate of respiration is slower as respiration is controlled by enzymes.

**ResultsPlus**
**Examiner Comments**

Two points clearly explained for two marks:

- mark point 1 for lowers the kinetic energy of particles, so enzymes move more slowly.
- mark point 2 for less E-S complexes form per unit time.

(ii) Explain why decreasing the temperature affects the rate of respiration of maggots.

**(2)**

enzymes have less kinetic energy so don't work at optimum temperature so less collisions + less enzyme substrate complexes so respiration rate lowers to conserve energy

**ResultsPlus**
**Examiner Comments**

This answer gets mark point 1 but there is no reference to likelihood or to frequency for mark point 2.

(ii) Explain why decreasing the temperature affects the rate of respiration of maggots.

**(2)**

Respiration is an enzyme controlled reaction
enzyme activity will decrease as temperature decreases

**ResultsPlus Examiner Comments**

Both of the statements in this answer are true, but they lack the detail needed to score any marks, as no reason is given for the decrease.

(ii) Explain why decreasing the temperature affects the rate of respiration of maggots.

**(2)**

The maggots are exotherms and therefore need the environment to be warm enough to continue to function appropriately. decrease rate of respiration
temperature would ~~increase respiration as increased~~
or the organism begins to shut down / die.

**ResultsPlus Examiner Comments**

This candidate probably means that maggots are ectotherms. However they have not linked respiration to enzyme activity and therefore do not score any marks.

chemical reactions with enzymes are slower due to denaturing of the enzymes, so reactions and other processes won't happen as fast as usual.

ResultsPlus
Examiner Comments

This answer scores zero.

They incorrectly say that enzymes denature at low temperatures.

## Question 10 (d)

Candidates were asked to describe the role of oxygen in the formation of ATP during aerobic respiration.

Credit was given for:

- oxygen is the {final / terminal} {hydrogen acceptor / electron acceptor}.
- allows electrons to pass down electron transport chain.
- allows {FAD / NAD} to be replaced.
- {hydrogen ions / protons} move through {ATP synthase / ATPase} forming ATP.

About a third of candidates gained one mark for saying that oxygen was the final electron acceptor, but further knowledge was limited for most.

Stronger candidates got two marks (usually for describing hydrogen ions moving through ATPase) and but very few were able to get a third mark. Around a third of candidates did not score at all.

(d) Describe the role of oxygen in the formation of ATP during aerobic respiration.

(3)

→ oxygen acts as a terminal electron acceptor

→ allows the release of ATP when it is reduced

→ forms water $O^{2-} + 2H^{+} \rightarrow H_2O$

→ ATP is formed when electron passed down electron transport chain.

**ResultsPlus**
**Examiner Comments**

This answer scores mark point 1 on line 1. There is not enough detail for any of the other marking points.

(d) Describe the role of oxygen in the formation of ATP during aerobic respiration.

**(3)**

Oxygen is the final electron acceptor in the (ETC)
Electron transport chain, during aerobic respiration.
Oxygen is vital in the ETC as it allows
electrons to move through carriers to pump $H^+$
ions into the intermembrane space, as it is the
final electron acceptor, without it, the electrons would
not be able to move through the carriers. This is necessary, as the pumped $H^+$ ions
create a concentration gradient to then flow through
ATP synthase by chemiosmosis down their electrochemical
gradient, which results in ATP being formed.

**(Total for Question 10 = 10 marks)**

ResultsPlus
Examiner Comments

This is a rare example of an answer scoring all three marks:

- mark point 1 on line 1.
- mark point 2 on lines 6 – 8.
- mark point 4 on lines 8 – 11.

## Question 11 (a)(i)

Q11 related to a citizen science project to find the number of wildflowers in lawns in the UK in 2019 and 2020. Candidates were given an outline method and a table of data for the five most commonly recorded plant species in 2020, showing their percentage change relative to 2019.

Q11(a)(i) told them that scientists thought that the warm weather in spring 2020 might be responsible for the changes and asked them to suggest a factor other than temperature that could cause a change in the number of flowers.

Many candidates approached this from a fieldwork point of view and thought about what they would like to measure or control, rather than thinking of it in relation to a garden in two different years.

We were looking for things that may change from one year to the next, eg rainfall, mowing / trampling / disease, or factors relating to how the data was collected, eg at a different time of year.

Only a quarter of candidates named a suitable factor, with light intensity being by far the most common incorrect answer.

**11** Citizen science involves members of the public collecting scientific data.

In 2019 and 2020, a citizen science project was carried out in the UK to investigate the numbers of flowers of wild plant species found in lawns.

Volunteers across the UK were asked to survey their own lawns to find out which wild flowering plants were growing there.

Participants were asked to mark out a one metre-squared area on their lawn, chosen at random, and count the number of flowers of each species within this area.

In 2020, the data were recorded from over 9 000 one metre-squared areas.

The table shows data for the five most commonly recorded wild plant species in 2020.

| Wild plant species | Total number of flowers recorded in 2020 | Percentage change from 2019 (%) |
|---|---|---|
| Daisy | 208 589 | –40 |
| White clover | 101 117 | +16 |
| Selfheal | 73 344 | –11 |
| Creeping buttercup | 56 719 | +48 |
| Bird's-foot trefoil | 30 646 | –32 |

(a) Scientists who analysed the data suggested that the unusually warm weather in Spring 2020 might be responsible for the change in the numbers of flowers recorded in 2020 compared to 2019.

(i) Name **one** factor, other than temperature, that could cause the change in the numbers of flowers of these five species.

**(1)**

water availability.

ResultsPlus
Examiner Comments

One mark for water availability.

**11** Citizen science involves members of the public collecting scientific data.

In 2019 and 2020, a citizen science project was carried out in the UK to investigate the numbers of flowers of wild plant species found in lawns.

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(i) Name **one** factor, other than temperature, that could cause the change in the numbers of flowers of these five species.

**(1)**

Rainfall.

ResultsPlus
Examiner Comments

One mark for rainfall.

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(i) Name **one** factor, other than temperature, that could cause the change in the numbers of flowers of these five species.

**(1)**

light intensity affected by number of cloudy days

ResultsPlus
Examiner Comments

One mark for number of cloudy days.

**11** Citizen science involves members of the public collecting scientific data.

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(a) Scientists who analysed the data suggested that the unusually warm weather in Spring 2020 might be responsible for the change in the numbers of flowers recorded in 2020 compared to 2019.

(i) Name **one** factor, other than temperature, that could cause the change in the numbers of flowers of these five species.

**(1)**

The length of sunlight present in a day
= length of daylight

ResultsPlus
Examiner Comments

Although this is not expressed very clearly, length of daylight is enough for a mark.

**11** Citizen science involves members of the public collecting scientific data.

In 2019 and 2020, a citizen science project was carried out in the UK to investigate the numbers of flowers of wild plant species found in lawns.

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(a) Scientists who analysed the data suggested that the unusually warm weather in Spring 2020 might be responsible for the change in the numbers of flowers recorded in 2020 compared to 2019.

(i) Name **one** factor, other than temperature, that could cause the change in the numbers of flowers of these five species.

**(1)**

~~Change in pollinator populations~~ More time at home leading to more time mowing and treating lawns.

ResultsPlus
Examiner Comments

One mark for more time mowing and treating lawns.

## Question 11 (a)(ii)

Candidates were asked to evaluate the method of data collection in this survey.

Most commonly seen marking points were 1, 3, 4, 5, 6 and 7. Marking points 2 and 8 were more rarely seen, but all points were seen in the course of marking.

There were many excellent, considered answers recognising the strength and weaknesses of the method. For full marks, candidates had to include at least one strength and one weakness.

Some candidates approached this from a fieldwork perspective and criticised the method for not controlling things like soil pH or shade which could affect the number of flowers, without realising that the purpose was to simply survey how many flowers were present, not why the numbers differed.

Some candidates misunderstood the table of data and thought that data was only collected for these five species, rather than that these were the most commonly found species.

A few candidates ignored the instruction to evaluate the method they were given and simply wrote a new one; they were able to score marks for weaknesses when their method could be compared to the original.

There was a big spread of marks with around 40% of candidates scoring at least 3 marks.

(ii) The scientists concluded that for all species recorded, the number of flowers of wild plants in lawns decreased 19% in 2020 compared to 2019.

Evaluate the method of data collection in this survey.

**(5)**

Its effective as it generates a high number of trials with data. This allows results to be more reliable.
However as it is left up to volunteers to carry out there is a slightly higher chance of human error.

**ResultsPlus**
**Examiner Comments**

This candidate scored mark point 1 for recognising it was a large data set.

Their comment about human error was too vague to score any of the marking points – if they had provided more details it could have achieved mark point 4, 6 or 7.

(ii) The scientists concluded that for all species recorded, the number of flowers of wild plants in lawns decreased 19% in 2020 compared to 2019.

Evaluate the method of data collection in this survey.

**(5)**

→ Volunteers may not be the same people both years, so areas + lawns being surveyed may differ.

→ Volunteers may not produce accurate results due to misidentification of species, miscounting, etc. – no way to validate the results

→ Very large-scale project, however, so produces a large set of data meaning that the uncertainties are less significant

→ Volunteer-based = cost effective, saves time

→ Squares on lawns may not be very randomly chosen – people may subconsciously choose most dense area.

**ResultsPlus**
**Examiner Comments**

A well thought through answer which gained mark point 9 on lines 1 – 2, mark point 6 and 7 on line 4, mark point 1 on lines 6 – 7 and mark point 5 on line 10 – 12. Many candidates realised that volunteers may select an area with lots of flowers when sampling.

This achieved 5 marks.

(ii) The scientists concluded that for all species recorded, the number of flowers of wild plants in lawns decreased 19% in 2020 compared to 2019.

Evaluate the method of data collection in this survey.

**(5)**

- There were many participants so a large sample size ~~may have~~ is good to validify results
- the ~~plants~~ same gardens may not have been surveyed each time (in 2 differing years)
- people ~~who~~ may not have randomly chosen the garden point they were surveying with randomly generated numbers which would mean that bias was introduced to the experiment.
- People who have lawns may not represent certain parts of UK.
- People may have weeded the wildflowers out from 2019 to 2020 as gardening increased in popularity due to lockdown ∴ less wildflowers in 2020. This introduces biased data.
- people may misidentify the plants is they are not versed and study flowers ∴ inaccurate data.
- Involving the public increases interest for the results of survey - more people invested in plant growth.

**ResultsPlus**
**Examiner Comments**

Another excellent answer, gaining full marks.

Mark point 1 on lines 1 – 2, mark point 8 on lines 3 – 4, mark point 5 on lines 5 – 8, mark point 4 on lines 9 – 10, and mark point 6 on lines 15 – 17.

While correct, the other points they made (increased weeding during lockdown, and increased interest in plants) did not gain any credit.

(ii) The scientists concluded that for all species recorded, the number of flowers of wild plants in lawns decreased 19% in 2020 compared to 2019.

Evaluate the method of data collection in this survey.

**(5)**

The method relies on volunteers and the process is not monitored to ensure it is being carried out properly. It is observational and therefore the data is subjective, this can also lead to human error for example a miscount. Different areas will have different abiotic factors such as rainfall, temperature, light intensity. However, the method is effective in ensuring there is a large sample size, as it is much faster at getting results.

**ResultsPlus**
**Examiner Comments**

This answer scored mark point 7 on lines 4 – 5 for miscounting and mark point 1 on lines 7 – 8.

27 (ii) The scientists concluded that for all species recorded, the number of flowers of wild plants in lawns decreased 19% in 2020 compared to 2019.

Evaluate the method of data collection in this survey.

**(5)**

Having 9000 samples ~~means~~ means the investigation is reliable as there is a large amount of data. ~~However, it is~~ Using a random area removes human bias and makes the results more valid, however participants may not have adhered to this rule. No scientists validated the data from the citizens ~~so~~ so some reports may have been false. People may also have misidentified some plants. It is unclear how ~~many~~ samples were taken in 2019, so the data set for this year may have been less reliable if it had fewer samples. Different participants may have sent in data each year, so there may be a shift in wildflower species due to different lawns in different areas being used. This study may not have been representative of the whole UK as sample distribution may have been clumped if volunteers encouraged people in their local community to contribute.

ResultsPlus
Examiner Comments

This was a very strong answer gaining maximum marks.

Mark point 1 on lines 1 – 2, mark point 3 on lines 2 – 3 and mark point 5 on lines 3 – 4, mark point 6 on lines 5 – 6, mark point 8 on lines 8 – 10 and mark point 4 on lines 11 – 13.

(ii) The scientists concluded that for all species recorded, the number of flowers of wild plants in lawns decreased 19% in 2020 compared to 2019.

Evaluate the method of data collection in this survey.

**(5)**

Valid:

- Large group of people provided data → large number of gardens counted → more representative of the entire population
- % change calculated instead of raw difference
  ↳ more valid comparison
- Across the UK – large spread of locations → more general conclusion

Not valid:

- Number of one meter-squared areas unknown for 2019 – invalid comparison
- One meter-squared area in gardens may not be : 1) accurate area ; 2) randomly chosen (human bias hard to eliminate).
- Cannot conclude without data of other flowers
- Identification of flowers not all to species level
- Some flowers may be planted instead of grown naturally

**ResultsPlus**
**Examiner Comments**

Another excellent answer gaining maximum marks.

It got mark point 1 on lines 2 – 4, mark point 8 on lines 10 – 11, mark point 4 on lines 12-13, mark point 5 on line 13, and mark point 6 on line 16.

## Question 11 (b)(i)

Candidates were given data from one quadrat containing four species and asked to calculate the biodiversity index.

Over half of all candidates were able to use the formula they were given to get the correct answer.

Some candidates made mathematical errors when calculating n(n – 1) for each species, and some were able to gain at least one interim mark.

Some simply had no idea what to do; surprisingly, a quarter of all candidates scored zero.

(b) The table shows the total data collected in one quadrat placed on a lawn.

| Wild plant species | Total number of flowers recorded | |
|---|---|---|
| Daisy | 11 | 110 |
| Dandelion | 8 | 56 |
| Cat's-ear | 14 | 182 |
| Selfheal | 2 | 2 |

(i) Calculate the biodiversity index (D) for the quadrat, using the data in the table.

Use the formula

$$D = \frac{N(N-1)}{\Sigma n(n-1)}$$

(3)

$N(N-1) = 35(35-1) = 1190$

$110 + 56 + 182 + 2 = 350$

$\frac{1190}{350} = 3.4$

Answer 3.4

ResultsPlus
Examiner Comments

This candidate scored 3 marks for a correct answer.

The working is well laid out and it is possible to see the correct calculation of N(N – 1) and each value of n(n – 1).

(b) The table shows the total data collected in one quadrat placed on a lawn.

| Wild plant species | Total number of flowers recorded |
|---|---|
| Daisy | 11 |
| Dandelion | 8 |
| Cat's-ear | 14 |
| Selfheal | 2 |

(i) Calculate the biodiversity index (D) for the quadrat, using the data in the table.

Use the formula

$$D = \frac{N(N-1)}{\Sigma n(n-1)}$$

(3)

11 (11 - 1) = 110
8 (8 - 1) = 56
14 (14 - 1) = 182
2 (2 - 1) = 2
350

4(4-1) / 350 = 0.034285714

Answer 0.034

**ResultsPlus**
**Examiner Comments**

This candidate scored one mark.

They made one of the most common errors and calculated N(N – 1) wrongly. However they gained mark point 2 as they had correctly calculated each value of n(n – 1).

(b) The table shows the total data collected in one quadrat placed on a lawn.

| Wild plant species | Total number of flowers recorded |
|---|---|
| Daisy | 11 |
| Dandelion | 8 |
| Cat's-ear | 14 |
| Selfheal | 2 |

(i) Calculate the biodiversity index (D) for the quadrat, using the data in the table.

Use the formula

$$D = \frac{N(N-1)}{\Sigma n(n-1)}$$ total species / total flower

(3)

$\frac{4(4-1)}{35(35-1)} = 0.010084033613$

Answer 0.01

ResultsPlus
Examiner Comments

This candidate made two of the other most common errors and scored zero.

## Question 11 (b)(ii)

Candidates were asked for two improvements to the method to give a more accurate measure of biodiversity – we expected to see counting number of plants rather than number of flowers and counting all plant species not just wild flowers.

Only 1% scored both marks and 20% scored 1 mark.

The most common incorrect answers suggested repeating the investigation, using a bigger quadrat or using random sampling.

(ii) Describe **two** improvements which should be made to the method to give a more accurate measure of the biodiversity index for this quadrat.

**(2)**

Count the number of actual plants (by the stem) instead of the flowers.

Count all the species in the quadrat, not just flowering plants.

**ResultsPlus**
**Examiner Comments**

A rare example of a candidate who scored two marks.

Mark point 2 for counting plants not flowers, then mark point 1 for counting all species, not just flowering plants.

(ii) Describe **two** improvements which should be made to the method to give a more accurate measure of the biodiversity index for this quadrat.

**(2)**

Don't just count flowers ~~count~~ count the number of plants, as one plant may have more than one flower and some plants may not have flowered. ~~Don't~~ Include other plant species, not just ones that flower (eg. grasses) as this gives a more accurate value for the biodiversity as it takes into account all species.

**ResultsPlus**
**Examiner Comments**

Another two mark answer, this time explained a bit more fully.

Mark point 2 on lines 1 – 3 and mark point 1 on lines 4 – 7.

(ii) Describe **two** improvements which should be made to the method to give a more accurate measure of the biodiversity index for this quadrat.

**(2)**

→ random generator of coordinates on the lawn should be used.

→ if more than 50% of plant in the quadrat, it should be counted but if not it shouldn't be.

**ResultsPlus**
**Examiner Comments**

This answer is much more typical. The candidate focuses on where the quadrat is placed and how the plants are counted, rather than thinking about the actual data collected. This does not score.

(ii) Describe **two** improvements which should be made to the method to give a more accurate measure of the biodiversity index for this quadrat.

**(2)**

- use a larger quadrat to get a wider representation of the lawn.
- use of two transects and a random number generator to place the quadrat at a particular coordinate to enforce a random sampling strategy.

**ResultsPlus**
**Examiner Comments**

Again, a very typical answer involving size and placement of quadrat. This does not score.

## Question 11 (c)(i)-(ii)

This pair of linked questions compared the amount of nectar per unit area in 2019 and 2020 and explored the possible consequences of this.

Q11(c)(i) related to the amount of nectar produced in a standard area in 2019 and the number of bees it could support. Candidates were given the amount of nectar produced in 2020 and asked to calculate the number of bees it could support. Many were able to do this and achieved the two marks available.

Q11(c)(ii) asked them to explain the possible short and long term consequences of the decline in wildflowers in lawns in 2020.

While most candidates realised that there would be fewer bees as there was less nectar (and gained 1 mark), many were unable to go on to explain the consequences of this; less pollination of flowers resulting in less seed produced, leading to further decline in the number of wildflowers in future years, leading to further decline in number of bees.

There was also credit for considering effects on other plants pollinated by bees, effects on genetic diversity and effects on predators of bees.

There were four marks for Q11(c)(ii).

There was a very wide spread of marks for Q11(c); of the six marks available, around a quarter of candidates scored 0 or 1, around a quarter scored 2 marks, around a quarter scored 3 marks and around a quarter scored 4 – 6 marks.

(c) (i) Bees feed on nectar in flowers.

The mean mass of nectar sugar produced per square metre of lawn was calculated for 2019 and 2020.

Scientists then calculated the mean number of bees per square metre that could be supported by the nectar.

The table shows the data.

| 2019 | | 2020 | |
|---|---|---|---|
| Mean mass of nectar sugar / mg $m^{-2}$ | Mean number of bees supported per $m^2$ | Mean mass of nectar sugar / mg $m^{-2}$ | Mean number of bees supported per $m^2$ |
| 41 912 | 3.8 | 38 885 | 2.7 |

Calculate the mean number of bees supported per square metre of lawn in 2020.

**(2)**

41 912 / 38885 = 1.08 or 1.1

Answer 2.7

3.8 - 1.1 = 2.7

(ii) Bees are important pollinators of a variety of plants.

Explain the possible short-term **and** long-term consequences of the decline in flowers of wild plant species in lawns in 2020.

**(4)**

This could result in a decrease of bee's which in long term could also & have a permanent decline of flowers as there will be no pollinators. This could have a long term effect on honey production and a short term effect on the reproduction of bees

**ResultsPlus**
**Examiner Comments**

This candidate scored one mark for the calculation in Q11(c)(i).

Although the final answer was incorrect, they got a mark for the interim step 41912 divided by 38885 = 1.08

Their answer to Q11(c)(ii) also scored 1 mark, mark point 4 for decline of wildflowers.

Not mark point 1 as they did not link the decrease of bees to a lack of food, and not mark point 5 as they did not describe the effect on the reproduction of bees, simply saying it had an effect.

(c) (i) Bees feed on nectar in flowers.

The mean mass of nectar sugar produced per square metre of lawn was calculated for 2019 and 2020.

Scientists then calculated the mean number of bees per square metre that could be supported by the nectar.

The table shows the data.

| 2019 | | 2020 | |
|---|---|---|---|
| Mean mass of nectar sugar / mg $m^{-2}$ | Mean number of bees supported per $m^2$ | Mean mass of nectar sugar / mg $m^{-2}$ | Mean number of bees supported per $m^2$ |
| 41912 | 3.8 | 38885 | |

Calculate the mean number of bees supported per square metre of lawn in 2020.

**(2)**

0.00000090666

11029.473.

$\frac{38885}{11029.473}$ = 3.5255.

Answer 3.5.

(ii) Bees are important pollinators of a variety of plants.

Explain the possible short-term **and** long-term consequences of the decline in flowers of wild plant species in lawns in 2020.

**(4)**

- would be fewer food for the bees.
- ~~food~~ could cause changes in bees behaviour (~~behavioured~~, (more agitated)
- over a long period of time there will naturally be less bees, due to the lack of food for them.
- changes in behaviour would only be short term due to the lack of food and having to ~~bee~~ feed too ~~many~~ many with little food.

**ResultsPlus**
**Examiner Comments**

This candidate scored 2 marks for a correct answer in Q11(c)(i).

In Q11(c)(ii), they scored mark point 1 but did not go on to think about the consequences of there being fewer bees, so did not gain any more marks.

(c) (i) Bees feed on nectar in flowers.

The mean mass of nectar sugar produced per square metre of lawn was calculated for 2019 and 2020.

Scientists then calculated the mean number of bees per square metre that could be supported by the nectar.

The table shows the data.

| 2019 | | 2020 | |
|---|---|---|---|
| Mean mass of nectar sugar / mg $m^{-2}$ | Mean number of bees supported per $m^2$ | Mean mass of nectar sugar / mg $m^{-2}$ | Mean number of bees supported per $m^2$ |
| 41912 | 3.8 | 38885 | |

Calculate the mean number of bees supported per square metre of lawn in 2020.

(2)

$\frac{41912}{3.8} = 11029$ mg of nectar needed to support 1 bee

$\frac{38885}{11029} = 3.5$

Answer 3.5

(ii) Bees are important pollinators of a variety of plants.

Explain the possible short-term **and** long-term consequences of the decline in flowers of wild plant species in lawns in 2020.

**(4)**

A short term consequence is that the ~~mean~~ mass of nectar sugar decreases as there are less flowers, so the ~~mean~~ number of bees decreases. This will decrease the biodiversity of the lawns as there as less species. In the long term, less bees means less pollination of the flowering plants so less plants are fertilised. This decreases the number of ~~so~~ offspring of the plants so will decrease the number of flowering plants, decreasing the number of flowers so the bee population decreases more. Plants that do not rely on bees for pollination may increase in number as there is less competition for light. Over time, the bees and plants pollinated by bees may go extinct for the lawns, decreasing the biodiversity of the lawns

ResultsPlus
Examiner Comments

This candidate achieved both marks for a correct answer in Q11(c)(i).

They gave a strong answer to Q11(c)(ii).

They worked methodically through the sequence of events, achieving mark point 1 on lines 1 – 3, mark point 3 on lines 4 – 6, mark point 4 on lines 7 – 8 and mark point 5 on line 8. Credit was not given for extinction.

Overall this answer got full marks with 2 marks for Q11(c)(i) and 4 marks for Q11(c)(ii).

(c) (i) Bees feed on nectar in flowers.

The mean mass of nectar sugar produced per square metre of lawn was calculated for 2019 and 2020.

Scientists then calculated the mean number of bees per square metre that could be supported by the nectar.

The table shows the data.

| 2019 | | 2020 | |
|---|---|---|---|
| Mean mass of nectar sugar / mg $m^{-2}$ | Mean number of bees supported per $m^2$ | Mean mass of nectar sugar / mg $m^{-2}$ | Mean number of bees supported per $m^2$ |
| 41 912 | 3.8 | 38 885 | |

Calculate the mean number of bees supported per square metre of lawn in 2020.

**(2)**

1 bee = 11029.5

38885 ÷ ↓ = 3.525

Answer 3.5

(ii) Bees are important pollinators of a variety of plants.

Explain the possible short-term **and** long-term consequences of the decline in flowers of wild plant species in lawns in 2020.

**(4)**

short term

- many bees would die / population would decrease due to the lack of nectar to support them
- reducing food for birds - causing their population to decline too.

long term

- plant populations would decrease as there are fewer bees to pollinate them
- in turn causing ~~less~~ even less bees and birds
- has an effect on entire food chain
- as well as human goods such as honey

**ResultsPlus**
**Examiner Comments**

Another pair of answers scoring full marks.

In Q11(c)(i) they correctly calculated 3.5 for 2 marks.

In Q11(c)(ii) they scored mark point 1 in lines 2 – 3, mark point 7 in lines 4 – 5, mark point 4 in lines 7 – 8 and mark point 5 in line 9.

(c) (i) Bees feed on nectar in flowers.

The mean mass of nectar sugar produced per square metre of lawn was calculated for 2019 and 2020.

Scientists then calculated the mean number of bees per square metre that could be supported by the nectar.

The table shows the data.

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| Mean mass of nectar sugar / mg $m^{-2}$ | Mean number of bees supported per $m^2$ | Mean mass of nectar sugar / mg $m^{-2}$ | Mean number of bees supported per $m^2$ |
| 41912 | 3.8 | 38885 | |

Calculate the mean number of bees supported per square metre of lawn in 2020.

(2)

$41912 = \frac{\text{sugar}}{\text{mg}} \times m^2$ $1m^2$ $= 9000\ m^2$ total.

~~1m² = 4.888~~

$3.8 \times 19\% = 0.722$

$3.8 - 0.722$
$= 3.078$

762034

Answer ~~3.078~~ 3.8

41912 : 3.8
38885 : 3.82

(ii) Bees are important pollinators of a variety of plants.

Explain the possible short-term **and** long-term consequences of the decline in flowers of wild plant species in lawns in 2020.

**(4)**

Decline in wild flowers reduces in the short term reduces the food supply for bees which results in reducing population of bees in lawns. This therefore reduces food supply of animals and birds that feed on bees therefore reducing biodiversity.

Long term consequences include reducing the wild flower population and diversity as many flowering plants rely on bees to pollinate the flowers plants. With reducing bee populations, fewer wild flowers are pollinated which reduces the amount of seeds produced which reduces the genetic diversity within wildflower population that could result in genetic bottlenecks causing an increase probability of inheritance of recessive alleles causing a higher rate of genetic diseases within wildflower populations.

**ResultsPlus**
**Examiner Comments**

In Q11(c)(i) they got two marks for a correct answer.

In Q11(c)(ii) they produced a very strong answer covering four of the marking points.

Mark point 1 on lines 1 – 2, mark point 7 on lines 2 – 4, mark point 4 and 3 on lines 5 – 8.

They also referred to genetic diversity of wildflowers decreasing which was the alternative mark point 4.

Overall, full marks for this question.

## Paper Summary

Based on their performance on this paper, candidates should:

- Be familiar with the command words used in this specification and make sure that your answers reflect the information required. The words justify, discuss and evaluate cause particular difficulties for some candidates.
- Always show working in calculations and set out this working clearly – this can help you get marks if the final answer is wrong.
- Make sure, if you are asked to give an answer to a particular number of significant figures or decimal places, that you do this.
- Make sure that you know how to write a null hypothesis, and that you can analyse the results of a stats test as well as carrying out the calculation of the test value.
- Ensure that where lists of differences are required, you always give them in matching pairs, eg A has a nucleus but B does not.
- Know the key points of all the core practicals and be prepared to explain the reasons for the steps.

## Grade boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

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