AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 4.6.2.4

# Genetic engineering

## Mark schemes and examiner comments

| | |
|---|---|
| Tier | **Higher** |
| Question groups | **4** |
| Available paper years | **2018–2025** |

## Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

**Name:** _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

### 4.6.2.4 Genetic engineering

**Answer 01 · Mark scheme** June 2018 | 8464/B/2H | Original Q5

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.1** | (the scientists) | | | |
| | chose / used (traditional varieties of) rice plants with short stems and rice plants with large grains<br>**or**<br>chose rice plants with short stems and large grains. | | 1 | AO2<br>4.6.2.3 |
| | (cross) bred the rice plants | allow cross pollinated the rice plants | 1 | AO1<br>4.6.2.3 |
| | (from the offspring) chose the plants with best / desired characteristics<br>**or**<br>chose plants with short(est) stems and big(gest) grains | | 1 | AO1<br>4.6.2.3 |
| | bred repeatedly until all plants had desired characteristics<br>**or**<br>bred repeatedly until they bred true<br>**or**<br>bred repeatedly until they produced IR8 | | 1 | AO1<br>4.6.2.3 |

4.6.2.4 Genetic engineering

Answer 01 · Mark scheme

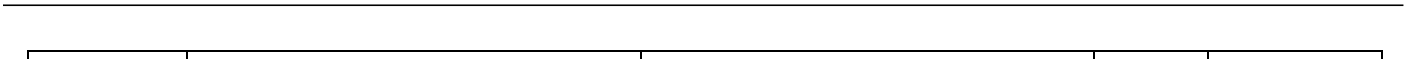
June 2018 | 8464/B/2H | Original Q5

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 05.2 | agree (**max 3** marks)<br>• resistance to disease / pests / pathogens so higher yield<br>• resistant to herbicides so less competition for (sun)light / water / minerals / ions (from weeds)<br>• larger / more grains per plant or higher yield so more food for people or more income for farmers<br>• better nutritional content (vitamins / protein / low GI index) so will improve health<br><br>disagree (**max 3** marks)<br>• may affect wild plants (if genes transfer) so making them herbicide resistant<br>• use of herbicides may reduce biodiversity because other plants are killed<br>• traditional varieties no longer grown so reduction in biodiversity<br>• may affect health of people who eat the rice because not enough research done yet | each reason must be explained to gain credit<br><br>allow improved survival in harsh conditions so can be grown in wider area<br><br>allow (GM) seeds are expensive for farmers because they have to buy new seeds every year **or** because farmers have to buy specific herbicide<br><br>if no explanations allow **1** mark for one agree reason **and** one disagree reason | 4 | AO3<br>4.6.2.4 |
| **Total** | | | **8** | |

### 4.6.2.4 Genetic engineering

**Answer 01 · Mark scheme**

June 2018 | 8464/B/2H | Original Q5



4.6.2.4 Genetic engineering

Answer 02 · Mark scheme

June 2019 | 8464/B/2H | Original Q3

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 03.1 | vectors are used to insert genes into cells | | 1 | AO1 4.6.2.4 |
| | vectors are usually plasmids or viruses | | 1 | |
| 03.2 | wheat not affected by spraying / herbicide | allow only weeds affected / killed by spraying / herbicide | 1 | AO1 AO2 4.6.2.4 4.7.1.1 |
| | (so) wheat gets more light / water / nitrates / ions / minerals | allow less competition for light / water / nitrates / ions / minerals<br>ignore nutrients<br>ignore carbon dioxide<br>ignore space | 1 | 4.4.1.1 |
| | (so) more photosynthesis / glucose / proteins (for more yield) | idea of more needed at least once for mp 2 and 3 | 1 | |
| 03.3 | any **two** from:<br>• production of human insulin / medicines<br>• crops resistant to diseases / pests<br>• crops resistant to frost<br>• crops resistant to drought<br>• crops / foods with added nutrients<br>• plants / crops with more / bigger fruits **or** higher yield<br>• crops with improved taste<br>• crops with improved shelf life | allow examples such as potatoes resistant to blight<br>allow examples such as golden rice with vitamin A gene<br>allow examples such as larger tomatoes | 2 | AO1 4.6.2.4 |

4.6.2.4 Genetic engineering

Answer 02 · Mark scheme

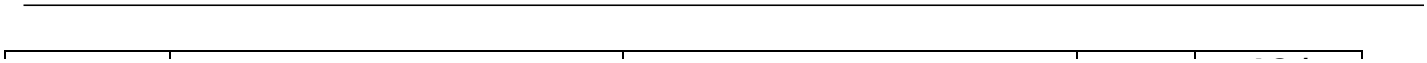


| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 03.4 | identify genes linked to (certain) disease<br><br>so can lead to better prevention / treatment of that disease<br><br>**or**<br><br>identify genes causing inherited disorders (1)<br><br>so may prevent children being born with the disorder by using IVF **or** gene therapy (1)<br><br>**or**<br><br>tracing human migration patterns from the past **or** evolution of humans (1)<br><br>so to better understand the ancient history of humans (1) | allow correctly named diseases such as cancer / diabetes | 1<br><br>1 | AO1<br>AO2<br>4.6.1.3 |
| **Total** | | | **9** | |

### 4.6.2.4 Genetic engineering

**Answer 02 · Mark scheme**

June 2019 | 8464/B/2H | Original Q3



4.6.2.4 Genetic engineering



## Question 2

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.1** | domain | | 1 | AO1<br>4.6.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.2** | offspring are genetically identical | | 1 | AO1<br>4.6.1.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.3** | a gamete contains half of the number of chromosomes | | 1 | AO1<br>4.6.1.1<br>4.6.1.2 |

4.6.2.4 Genetic engineering

Answer 03 · Mark scheme



| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 02.4 | any **one** from:<br>• similar / same structure / characteristics / phenotype (as potatoes) | allow named similar structure / characteristics such as same shape / leaves / flowers / taste<br><br>allow studied with microscopes<br><br>ignore 'look the same / similar' unqualified | 1 | AO1<br>4.6.4 |
| | • similar DNA / genes | allow DNA analysis<br>allow analysis of genetic material<br>allow similar genetic material<br>ignore genetic information<br>do **not** accept same DNA / genes | | |
| | • similar / same biochemistry | | | |
| | • same first part of binomial (name) | allow same first part of Latin / scientific name | | |

| Question | Answers | Mark | AO / Spec. Ref. |
|---|---|---|---|
| 02.5 | **Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account. | 5–6 | AO3 |
| | **Level 2:** Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear. | 3–4 | AO2 |
| | **Level 1:** Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking. | 1–2 | AO1 |
| | **No relevant content** | 0 | |
| | **Indicative content**<br><br>allow reference to named crop throughout<br><br>**effects of climate change**<br>• climate change will change weather patterns / trends<br>• climate change causes flooding **or** drought **or** temperature change<br>• farming land decreased by sea level rise / flooding / desertification<br>• current crops cannot grow / survive (in changing conditions)<br><br>**benefits of GM**<br>○ GM may allow crops to grow in wider range of conditions<br>○ GM may allow crops to be resistant to wider range of pests / diseases<br>○ GM may allow crops to be stored for longer<br>○ GM may increase crop yield **or** increase growth rate<br><br>○ to feed the increasing human population<br>○ useful if less area available for farming<br>○ larger human population needs more land for housing<br><br>**other relevant content**<br>▪ variation amongst current crops reduced by asexual reproduction **or** selective breeding<br>▪ rate of evolution (by natural selection) may be slower than rate of climate change<br><br>For **Level 3**, answers must explain effect(s) of climate change **and** benefit(s) of GM with logical link. | | 4.6.2.4<br>4.7.3.2<br>4.7.3.5<br>4.7.3.6 |

| | |
|---|---|
| **Total Question 2** | **10** |

4.6.2.4 Genetic engineering

Answer 04 · Mark scheme



## Question 4

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.1 | herbicide is added / sprayed (on soil / land / field / crop / maize) | | 1 | AO1 |
| | (so) weeds killed **and** (GM) maize / crop not killed | allow (so) unwanted plants killed **and** (GM) maize / crop not killed<br>allow **only** the weeds are killed | 1 | AO2 |
| | (so) (GM) maize / crop has less competition for light / water / minerals / ions / space | allow (so) (GM) maize / crop has more light / water / minerals / ions / space<br><br>ignore reference to nutrients<br>ignore (GM) maize / crop has less competition unqualified | 1 | AO2 |
| | (so more) photosynthesis to produce glucose which produces protein / cellulose / starch / fat (for growth) | allow (so more) photosynthesis to produce glucose which produces amino acids (for growth) | 1 | AO2<br><br>4.4.1.1<br>4.6.2.4<br>4.7.1.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.2 | use of herbicide kills weeds / wildflowers / plants (that are not the crop) | allow increased use of herbicide / weedkiller<br><br>ignore (more) use of pesticides<br>ignore herbicide kills animals / insects | 1 | AO3<br>4.6.2.4<br>4.7.3.1 |
| | (causes) fewer weeds **or** fewer other plants therefore less food for animals / insects | allow fewer wildflowers therefore less food for animals / insects<br><br>allow less variety of food therefore lower number of species of animals / insects<br><br>allow fewer weeds / wildflowers **or** fewer other plants therefore more competition for food | 1 | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.3 | crops / plants may be insect / bee pollinated<br><br>insects may be predators of (crop) pests | allow for pollination<br><br>allow a description eg insects eat crop pests<br>allow bees may be predators of (crop) pests | 1<br><br>1 | AO2<br>4.7.1.1<br>4.7.2.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.4 | provides source of food / shelter (for insects / bees / pollinators) | allow protection / hiding from predators | 1 | AO2<br>4.7.3.6 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.5 | (as oxygen level increases decay increases due to aerobic) respiration of microorganisms<br><br>(which) releases carbon dioxide causing global warming | allow (aerobic) respiration of bacteria / fungi / decomposers<br><br>allow (which) releases carbon dioxide which is a greenhouse gas<br><br>allow (which) releases carbon dioxide causing the greenhouse effect<br><br>ignore (which) releases carbon dioxide causing climate change | 1<br><br>1 | AO2<br><br>AO1<br><br>4.7.3.3<br>4.7.3.5<br>4.7.2.2<br>4.4.2.1 |

| Total Question 4 | 11 |
|---|---|

4.6.2.4 Genetic engineering

Answer 01 · Examiner comments



## Question 5 (standard / high & high demand)

**05.1** The basic principle behind selective breeding was understood by a good number of students with 49% credited with at least one mark. However, they missed marks by not being precise enough in relating their answer to the particular context of this question. Many referred to ‘a bigger yield’ or the general ‘desired characteristics’ instead of short stems and large grains.

The question was often misread as a genetic modification (GM) question. Students who followed this route seldom achieved any marks. There were a lot of answers in terms of GM, cutting out enzymes, injecting genes, asexual reproduction and cloning. A large number wrote about breeding the plants together using asexual reproduction and generally showed little understanding of how asexual and sexual reproduction are different. Often these students would go on to talk about transfer of pollen being a part of the asexual process.

Marking points two and three were most often given. However, some students went on to incorrectly describe breeding as adding pollen to seeds. The most common error for marking point three was to breed all the offspring together rather than choosing the ones with short stems and large rice grains. If students answered a generic question instead of this one about IR8 rice they were still able to achieve a maximum of three marks.

In marking point four many students demonstrated an understanding of continuing to breed, but only a minority obtained the mark by also referring to an end point. ‘Bred true’ was not seen but ‘until IR8 is produced’ or ‘until all plants have this characteristic’ was noted. 3% of students achieved all four marks.

**05.2** This high demand question was not well answered due to lack of biological detail in explanations. 4% of students achieved two or more marks. A great many students only provided half of any mark point. The compensation mark was awarded a few times, but was often missed because the 'for' response gave only the explanation, not the reason. Many students did not give explanations. Answers only listing statements or explanations tended to be weak suggesting that students were not as strong with regards to the issues surrounding GM.

A typical answer gaining no marks was ‘agree as can provide enough food to feed the population so less people are starving in India but disagree because it uses chemicals’.

Many students made references to unnatural, going against nature, against god, dangerous due to the use of chemicals, against religion, unethical, scientists playing god or the idea that an embryo is a potential life which is killed. Other ideas put forward which did not gain credit were rice producing methane which affects global warming, inbreeding causing diseases to spread so if one plant gets it they all will die and vague references to biodiversity.

‘Superweeds’ were mentioned occasionally, which if correctly described with reference to transfer of herbicide resistant genes a mark was achieved. Those students who referred to the concern about the effect on people’s health rarely gained the mark because they did not talk about ‘not enough research having been done yet’.

4.6.2.4 Genetic engineering

Answer 02 · Examiner comments

June 2019 | 8464/B/2H | Original Q3

**Question 3 (standard, standard/high & high demand)**

**03.1** Half of the students gave one correct statement about vectors, usually that they were used to insert genes into an organism. A further 23% also knew that vectors were usually plasmids or viruses.

**03.2** Students were asked to explain why a herbicide resistant variety of wheat will give a higher yield than a non-herbicide resistant variety. The first marking point was the one most commonly awarded, for the idea that when a herbicide is applied, it will not affect or kill the resistant wheat. However, very few students went on gain any further marks and to fully answer the question, failing to give the consequence of the weeds being killed and the resistant wheat not killed. 40% of students gained the first mark, with 1% gaining more.

Many students do not appear to understand what a herbicide is, with some stating that herbicides eat the wheat and so herbicide resistant varieties don't get eaten. Clear indications of pests or diseases resulted in zero marks. Others simply stated that non-herbicide resistant varieties do get killed by herbicides, but this on its own was insufficient to gain a mark. Students should be reminded to avoid vague terms such as 'nutrients', as this was ignored in the second marking point. There was some misuse of the term 'immune' when answering this question.

**03.3** Some students gave excellent descriptions of examples of genetic engineering in use today, which they may well have found out when researching uses of genetic engineering. 'Golden rice with added nutrients' was a common correct answer, as was 'crops with higher yields' or 'disease resistant crops'. However, many students are still giving answers which are too vague to gain credit, such as 'GM crops' or 'disease resistance'. Crops may be resistant to certain pests but are never resistant to pesticides.

There appeared to be some confusion between selective breeding and genetic engineering from some students. Additionally, some students referred to designer babies, IVF and embryo screening, all of which were incorrect answers. Some students were confused between genetic engineering and gene therapy and described replacing defective genes, which did not gain credit. Novelties such as 'glow in the dark' animals and the many instances of natural genetic mutations such as featherless chickens, seedless fruits and

4.6.2.4 Genetic engineering

Answer 02 · Examiner comments



white sunflowers were not acceptable. Half of the students were able to correctly give one or two examples.

**03.4** Students found this question challenging, with a significant number of them describing the designer baby idea which did not gain credit. Some thought that by mapping the human genome we would be able to more easily predict if a child would be born with a genetic disorder, which again was not correct. There were also lots of vague statements such as 'help cure diseases' which were insufficient.

A few students did appreciate the importance of understanding the human genome for use in tracing human migration patterns from the past. A number also realised that if a gene could be identified as causing an inherited disorder this would lead to being able to offer parents embryo screening or maybe gene therapy in the future.

16% of students correctly gave a use and only a minority of students were able to follow this up with an explanation of how it could help in the future.

Answer 03 · Examiner comments



# Question 2 (standard demand)

**02.1** More than 50% of students could select that the classification group 'Eukaryota' is a domain.

**02.2** Almost all students knew that asexual reproduction produces genetically identical offspring.

**02.3** More than 80% of students knew that a gamete contains half the number of chromosomes compared to the other cells in a potato plant.

**02.4** Most students could describe how a new plant species could be identified as being in the same genus as potatoes. DNA analysis or similar characteristics were the most common correct answers.

Misconceptions were seen, such as the idea that the species would have identical DNA.

**02.5** Most students followed the direction of the question, stating that GM crops can be made to grow even if the climate changes.

Some students were aware of food insecurity as a result of climate change, and this could be given credit for the idea that current crops will not be able to grow/survive.

Lists of possible benefits of GM were limited to Level 1 if there was no link to climate change. Most students made very good attempts at this question and many recognised some of the effects of climate change and were able to link these to the idea that current crops would struggle to grow in these conditions. This was an attempt at a logical link and achieved a Level 2 mark.

Some students further developed this idea, and clearly had a grasp of the question being asked, as they then went on to describe how GM would enable crops (or potatoes) to survive the conditions that climate change brings. They could further strengthen their account with suggestions that more crops could be grown or crops could be grown faster. These responses were detailed and logically linked accounts and were therefore Level 3 responses.

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### 4.6.2.4 Genetic engineering

**Answer 03 · Examiner comments** June 2024 | 8464/B/2H | Original Q2

Some students gave explanations of causes of climate change, but this did not answer the question.

Some students responded in terms of 'how' GM crops can be produced, mentioning enzymes and vectors. This was not answering the question and therefore could not be given credit. These responses often gained marks from the rest of their explanation.

**0 2 . 5** Scientists have collected and stored seeds from species in the same genus as potatoes.

In the future, these seeds may be used for genetic modification of potato plants.

Genetically modified potato plants could help supply food to the human population as the climate changes.

Explain why genetic modification of crop plants may be important for the human population to survive climate change.

**[6 marks]**

As climate changes occurs the global temperature could get warmer. This means that agriculture will become harder and it will become harder for crops to be grown under hot conditions. This means that genetically modified crops could be modified to withstand greater heat and be produced in bigger yields. These crops could be produced with more nutrients and be bigger so that humans could get more energy in the future where there will be limited resources.

The student has described two effects of climate change (global temperature getting warmer and that it will be harder for crops to be grown). They then give two relevant benefits of GM linked to these ideas. This meets and exceeds the description for entry into Level 3, for both logical linking and detail, therefore 6 marks were awarded.

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Answer 04 · Examiner comments

June 2025 | 8464/B/2H | Original Q4

# Question 4 (Standard/high and High demand)

**04.1** Many students understood the term 'resistant'. However, it was clear that some students did not understand the term 'herbicide'. Some students confused herbicides with herbivores. Misconceptions surrounding herbicides were evident in statements such as 'herbicides can no longer eat the crops' and 'GM crops that are herbicide resistant cannot be eaten by herbivores' and some students confused herbicides with pesticides. Very few students were awarded marking point 1 as they often overlooked the idea that herbicide would be applied (to the crops).

For marking point 2, many students were seen to write that 'GM crops are less likely to be killed by herbicides' but did not then go on to state that the other plants / weeds would be killed. Many students incorrectly believed that maize and GM maize are grown simultaneously in the same field by the same farmer. This demonstrates a fundamental misunderstanding of how GM crops are used. Students need to be careful in their use of the word 'affected' as this was too vague for this marking point. For example, 'weeds are affected'.

Where students described the idea of competition in marking point 3, most were able to name a factor that would be competed for. However, it was very rare to see marking point 4.

Accounts of the steps involved in the process of producing GM plants were not relevant in this question but were seen in answers. In these instances, the students filled the answer space with their description before concluding with a short statement such as GM crops won't be killed. A small number of students went down the route of describing selective breeding instead of answering the question.

0 4 . 1 Maize is a crop plant.

A variety of maize has been genetically modified (GM) to be resistant to a herbicide.

Explain how growing GM herbicide-resistant maize can produce a larger yield than growing non-GM maize.

[4 marks]

as the genetically modified (GM) maize is resistant to a herbicide, it means that the maize can be sprayed by the herbicide, causing no damage to the plant but making it so no insects or bugs that will damage the maize, so more maize survives and will continue to produce a larger yei yield than growing non-GM maize.

This student gains marking point 1 but then continues to incorrectly describe function of the herbicide with a common misconception, so only marking point 1 was awarded.

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### 4.6.2.4 Genetic engineering

**Answer 04 · Examiner comments** June 2025 | 8464/B/2H | Original Q4

**04.2** This question asked students how growing GM crops decreases the biodiversity of animals. Some students made no reference to animals in their answers at all. Either they did not read the question properly or did not understand what they were being asked. A commonly seen insufficient response was 'the GM crops are genetically identical' and some students wrote about monoculture.

Many students failed to use the word herbicide correctly in this answer and as in question **04.1**, a lack of understanding of the word herbicide proved problematic. It was common for students to state that animals would not be able to eat the GM herbicide resistant crop after herbicide had been applied or that if animals ate the crop they would die. A frequently seen insufficient idea was that growing GM crops would take up more land leaving less habitat space for animals. The most frequent marking point here was marking point 2 with the idea of fewer other plants meaning less food for animals.

**04.3** Very few students were awarded 2 marks for this question. Some students did not understand the term yield in the question. The most commonly awarded mark was for marking point 1, for the idea of insects as pollinators. However, there were a lot of misconceptions surrounding pollen and pollination. Commonly seen misconceptions regarding pollination included:

- bees making pollen or being a source of pollen
- bees collecting pollen for nectar
- pollination being where seeds get stuck to a bee's body
- pollen being needed by crops for photosynthesis / respiration
- the idea that bees themselves fertilise the plants, rather than facilitating pollination as a step leading to fertilisation.

Where insufficient attempts at marking point 2 was seen, some students were not clear about insects eating or destroying pests, instead suggesting insects simply deter or scare crop pests.

The idea of insects dying and decomposing and therefore providing minerals for the crops was insufficient. Some students repeated information from the question, giving answers such as 'insects increase crop yields'.

**04.4** The most common correct answer for this question was 'hedgerows provide places for insects to reproduce / breed'. 'Hedgerows provide a source of food' or 'hedgerows provide a source of shelter' were also commonly seen correct answers.

The most common insufficient response was 'more hedgerows provide more habitats / places to live' as this was repeating the information given. Students must take care not to simply repeat information given to them in the question stem. Many students made vague references to increased biodiversity without linking this to the context of the question or wrote about the hedgerow providing 'ideal living conditions' for the insects without specifying what those conditions are.

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### 4.6.2.4 Genetic engineering

**Answer 04 · Examiner comments** June 2025 | 8464/B/2H | Original Q4

**04.5** This was a challenging question for many students as they failed to link microorganisms with respiration, instead writing answers implying the peat itself respired. It also appeared to be quite challenging to keep to the topic of the question, instead students frequently mentioned combustion rather than decay. There was a lot of repetition from the wording of the question, which didn't gain any marks. Very few students attained both marks available on this question, with marking point 1 rarely seen. Students who gained 1 mark, commonly gained the mark for stating that the released carbon dioxide is a greenhouse gas or that the release of carbon dioxide leads to global warming. Some students had the correct idea for marking point 2 but wrote the symbol for carbon dioxide incorrectly (e.g. 'CO2' or 'Co2', or with the 2 written superscript to the letters) and so were not awarded the mark. Refer to page 4 of the mark scheme for guidance on the use of formulae.

Most of the students achieving marking point 2 had not made the link to the source of the carbon dioxide being decomposers or respiration, with many stating that oxygen reacted with the peat to form carbon dioxide. There were not many students who could link the idea to increase oxygen enabling the microbes to respire, which produces carbon dioxide. Of the students who were not awarded marking point 2 it was frequently because the students identified that carbon dioxide would be released but did not go on to state the effect of this or simply reiterated the phrasing from the question stem (i.e. that carbon dioxide causes climate change). Several students made irrelevant references to methane or the ozone layer or stated that the process of cutting the peat released stored carbon dioxide. Another common error was stating that carbon is released into the atmosphere as opposed to carbon dioxide.

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