AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.9.2.4

The carbon footprint and its reduction

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.

5.9.2.4 The carbon footprint and its reduction

Answer 01 · Mark scheme June 2018 | 8464/C/2H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	methane		1	AO1 5.9.2.2
02.2	any **two** examples from: • rising sea levels • melting ice • agricultural problems • extremes of weather • loss of habitats	allow effects from the same bullet point ignore global warming ignore acid rain ignore global dimming do **not** accept reference to ozone	2	AO1 5.9.2.3
02.3	$\frac{6.0}{4.1} \times 0.0235$ = 0.0344(kg)	an answer of 0.0344(kg) scores **2** marks allow correct rounding allow calculator reading if no mark awarded: allow **1** mark for 34.4 or 0.344 allow **2** marks for 34.4 g	1 1	AO2 5.9.2.4
02.4	use less plastic **or** use recycled plastic	allow carbon capture ignore any reference to energy / fuels	1	AO1 5.9.2.4 5.10.2.2

5.9.2.4 The carbon footprint and its reduction

Answer 01 · Mark scheme

June 2018 | 8464/C/2H | Original Q2

Question	Answers	Mark	AO / Spec. Ref.
02.5	**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to give a clear account.	5–6	AO1 5.9.1.2 5.9.1.3 5.9.1.4
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content nitrogen increased • because volcanoes produced nitrogen • because (denitrifying) bacteria produced nitrogen • because ammonia was converted to nitrogen oxygen increased • because algae and plants produced oxygen • by photosynthesis carbon dioxide decreased • because algae and plants used carbon dioxide • by photosynthesis • because oceans formed and carbon dioxide dissolved in the water • because carbon dioxide formed carbonates, which precipitate as sediments or formed sedimentary limestone rocks • because algae / plants and animals formed fossil fuels / coal / crude oil / natural gas		
Total			**12**

5.9.2.4 The carbon footprint and its reduction

Answer 01 · Mark scheme June 2018 | 8464/C/2H | Original Q2

Answer 02 · Mark scheme June 2019 | 8464/C/2H | Original Q2

02.1	high temperatures (in the engine) enable oxygen and nitrogen (from air) to react	 allow combine / bond for react	1 1	AO1 5.9.3.1	E

Answer 02 · Mark scheme

02.2	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5–6		E
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.	3–4		
	Level 1: Relevant points are made. They are not logically linked.	1–2		
	No relevant content	0		
	Indicative content Examples of relevant points might include: • car **C** produces the most CO_2 during manufacture • car **A** produces the most CO_2 per km when driving • car **C** produces the most CO_2 from manufacture and 40,000km when driving • car **B** produces the most CO_2 from manufacture and 100,000km when driving Examples of linked statements might include: • car **A** produces least CO_2 during manufacture, but most CO_2 per km • car **C** produces most CO_2 during manufacture, but least CO_2 per km • car **A** produces least CO_2 during manufacture, but car **C** produces the least CO_2 per km Examples of judgements might include: • overall car **A** has the smallest carbon footprint as it has the smallest CO_2 production during manufacture, the smallest mass of CO_2 after 40,000km of driving and the smallest mass of CO_2 produced after 100,000km of driving. • car **A** eventually (after 157,895km) will have the largest carbon footprint because the mass of carbon dioxide produced per km is highest.		AO3 5.9.2.2 5.9.2.45.10.2.1	

Total			**8**

5.9.2.4 The carbon footprint and its reduction

Answer 02 · Mark scheme

June 2019 | 8464/C/2H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.9.2.4 The carbon footprint and its reduction

Answer 03 · Mark scheme

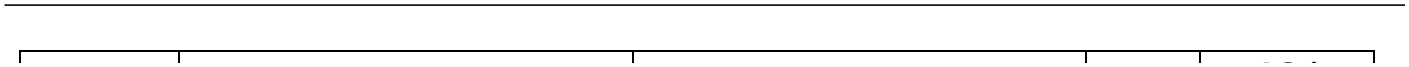
November 2021 | 8464/C/2H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	at high temperatures (in the engine) nitrogen reacts with oxygen (to produce nitrogen dioxide)		1 1 1	AO1 5.9.3.1
05.2	(**X**=) (33×7) – [(37×3)+35+34+29] = 22 (micrograms per m^3)	allow 33x7 = (37x3)+35+34+29+**X**	1 1	AO2 5.9.3.1
05.3	countryside data has smallest values (so) 2 is a higher proportion / percentage of the value	 allow (so) countryside is ± 2 out of a value between 6 to 8	1 1	AO3 5.9.3.1
05.4	$2\,NO_2 \rightarrow N_2 + 2\,O_2$	allow multiples or halves allow 1 mark for N_2 **and** O_2	2	AO2 5.3.1.1 5.10.1.1
05.5	a resource which will run out	allow a non-sustainable resource	1	AO1 5.10.1.1
05.6	(because carbon dioxide is emitted in) extracting / processing raw materials (and) manufacturing (and) disposal at the end of its useful life		1 1 1	AO2 5.9.2.4 5.10.2.1
Total			**13**	

5.9.2.4 The carbon footprint and its reduction

Answer 03 · Mark scheme

November 2021 | 8464/C/2H | Original Q5



5.9.2.4 The carbon footprint and its reduction

Answer 04 · Mark scheme

June 2025 | 8464/C/2H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	(test) glowing splint (result) relights	do **not** accept burning / lit splint allow glows more brightly MP2 is dependent upon MP1 being awarded	1 1	AO1 5.8.2.2

5.9.2.4 The carbon footprint and its reduction

Answer 04 · Mark scheme

Question	Answers	Mark	AO / Spec. Ref.
02.2	**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	AO1
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	AO3
	No relevant content	0	5.9.1.1 5.9.1.2 5.9.1.3 5.9.1.4
	Indicative content • **the percentage of carbon dioxide has decreased** ○ (because) carbon dioxide dissolved in the oceans ○ forming sediments ○ (because) algae / plants ○ photosynthesised ○ by the formation of sedimentary rocks ○ by the formation of fossil fuels • **the percentage of nitrogen has increased** ○ (because) volcanic activity produced nitrogen ○ denitrifying bacteria released nitrogen • **the percentage of oxygen has increased** ○ (because) algae / plants ○ photosynthesised for **Level 3** answers must include each of the gases with an explanation for different gases		

5.9.2.4 The carbon footprint and its reduction

Answer 04 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	any **two** from: • reduce livestock farming • reduce the number of rice / paddy fields • reduce the amount of rubbish going to landfill • use methane from landfill as an energy source • reduce fossil fuel use • reduce the destruction of peat bogs	 allow reduction of specific animals / product allow reduce area of wetlands allow recycle more (so less rubbish to landfill)	2	AO1 5.9.2.2 5.9.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	fossil fuels (containing sulfur) are burnt sulfur reacts with oxygen (to produce sulfur dioxide)	allow fuels containing sulfur are burnt	1 1	AO1 5.9.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	any **one** from: • respiratory problems • acid rain	 allow immediate consequence of acid rain	1	AO1 5.9.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	any **one** from: • less use of fossil fuels (containing sulfur) • sulfur is removed from fossil fuels (before burning) • sulfur dioxide is removed from waste gases (after burning) • new legislation / regulations (since 1980)	allow any named fossil fuel allow less use of fuels containing sulfur allow increased use of renewable energy allow increased use of electric vehicles	1	AO3 5.9.3.1

Total Question 2	14

5.9.2.4 The carbon footprint and its reduction

Answer 01 · Examiner comments

June 2018 | 8464/C/2H | Original Q2

Question 2 (standard demand)

02.1 Methane was recognised by 85% of students as a greenhouse gas. Nitrogen was the most commonly seen incorrect response.

02.2 60% of students were able to name two effects of climate change, with a further 29% of students able to name one effect. Students give a wide range of creditworthy responses; melting polar ice caps, named extremes of weather and / or desertification.

Students who did not gain credit were sometimes too vague, for example giving responses such as unspecified changes in the weather, or unspecified effects on people. Others gave causes rather than effects of climate change or referred to acid rain.

02.3 51% of students achieved some credit on this question. Many of those who knew the correct method failed to convert from grams to kilograms and consequently achieved only one mark for the calculation. The remainder of students attempted a single division or multiplication with two of the numbers given but were unable to continue to complete the calculation required.

Some students were able to apply the correct method, but did the calculation in two parts, and their rounding after the initial calculation gave rise to an incorrect final answer. Students should be aware that they should not undertake any rounding until they reach their final answer.

5.9.2.4 The carbon footprint and its reduction

Answer 01 · Examiner comments

02.4 27% of students suggested using less plastic or recycled plastic in the manufacture of plastic bottles or gave a reference to carbon capture. Some incorrect responses focussed on the disposal, including burning plastic, rather than the manufacture of plastic or transportation of the plastic bottles, releasing carbon dioxide in to the air. Planting trees to capture the carbon or using renewable energy sources to provide energy for manufacturing the bottles proved popular ideas.

02.5 This 'extended response' question discriminated well. It asked for an explanation of how the levels of three gases have changed since the Earth's early atmosphere. To achieve marks in level 1, statements of change for the three main gases in the Earth's atmosphere was required. When explanations were linked to the changes, marks in levels 2 or 3 were awarded. The clearer, more logical and more detailed accounts achieved level 3 marks.

19% of students achieved a level 3 mark on this standard demand question. Some accurate and well-expressed responses were seen, succinctly explaining the changes to all three gases. Many students gave detailed responses that showed a greater depth and understanding, giving numerous linked explanations for the changes in composition of the gases in the Earth's atmosphere. The most logically sequenced of these discussed each of the three gases in turn, resulting in very readable and accessible accounts. 33% of students achieved a level 2 mark, and a further 27% achieved a level 1 mark.

However, many of the lower-attaining students discussed post Industrial Revolution changes to the Earth's atmosphere, rather than addressing the changes since the formation of the Earth's early atmosphere. These students attempted to explain increases in carbon dioxide levels due to industrial manufacturing or other human activity; decreases in oxygen due to increasing population or deforestation. Some of these accounts were less logically sequenced and suggest that lower-attaining students are challenged by the concept of evolutionary timescales or are failing to read the question carefully.

As mentioned in the general comments for this paper, students should note the command word for an extended response question carefully. In this question students were asked to 'Explain'. Many students qualitatively described the changes in amounts of nitrogen, oxygen or carbon dioxide since the formation of the Earth's early atmosphere but were not successful at linking these changes to explanations. The most popular explanation was the effects of photosynthesis on changes in the percentages of both oxygen and carbon dioxide. The dissolving of carbon dioxide into the newly formed oceans was better known than those of the volcanic action on the change in percentage of nitrogen.

5.9.2.4 The carbon footprint and its reduction

Answer 02 · Examiner comments — June 2019 | 8464/C/2H | Original Q2

Question 2 (standard demand)

02.1 Just under a quarter of students gained some credit, mostly for stating that oxygen and nitrogen react together in the engine. Fewer students highlighted the need for high temperatures to be present for the reaction to occur. Many students stated that the nitrogen originated as part of the fuel rather than from the atmosphere.

02.2 This question proved very accessible to the students. More than half of the responses were judged at level 2, with approximately further 14% judged at level 3.

The command word for this question was 'Evaluate', which requires students to give a judgement strongly linked and logically supported by a sufficient range of correct reasons. In their responses many students simply gave a weak judgement, including a sentence at the end of the answer offering an opinion as to which car was 'best' or 'efficient' or 'the most eco-friendly'. To be a valid level 3 judgement, students should directly link the judgement to several items of data drawn from Table 3.

Some students were able to use the data in Table 3, and project each car's carbon footprint beyond 100 000km: 'Although, car A has the lowest mass of CO_2 produced during manufacture, it has the highest value of CO_2 kg/km when driven and this will mean that eventually it will become the most polluting vehicle', or writing the converse argument for car C.

A substantial number of students gave linked comparisons between the cars, or linked a judgement with a single reason, for example, 'Car A produces the least carbon dioxide during manufacture, but the most per km when driving'. These students were awarded a mark in level 2.

A few students simply added the values from the four columns in Table 3, 'Car C produces 75160.044kg carbon dioxide which is bigger than the others'.

Answer 03 · Examiner comments — November 2021 | 8464/C/2H | Original Q5

Question 5 (standard, standard / high and high demand)

The idea that nitrogen and oxygen from the air react together in the engine was not well known. Many students incorrectly stated that nitrogen dioxide was present in the fuel. Heat from the engine was insufficient to gain marking point 1 as there must be an indication of high temperature.

Non-renewable was a common response for a "finite resource" which did not gain credit as marks were awarded for the definition.

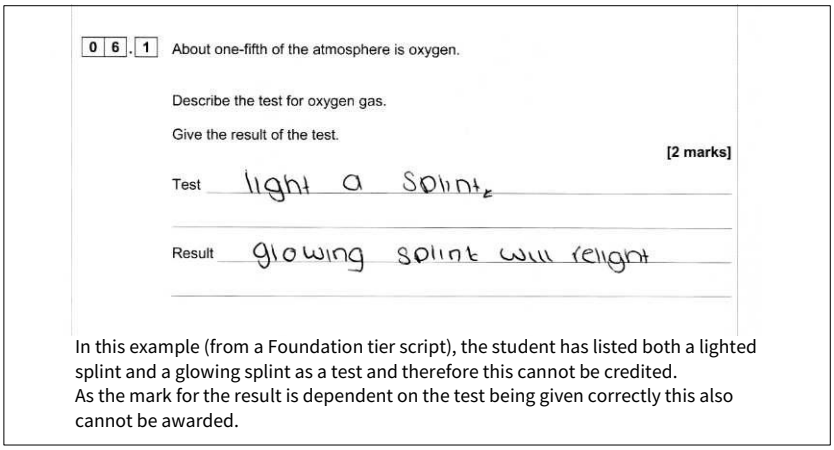
Students appeared to have a good understanding of the idea of a carbon footprint. Some excellent answers were seen where carbon emissions were linked to each stage in the life cycle of the car. Some students simply focused on the manufacture of both the car and its raw materials and failed to address the disposal.

5.9.2.4 The carbon footprint and its reduction

Answer 04 · Examiner comments June 2025 | 8464/C/2H | Original Q2

Question 2 (Standard demand)

02.1 There were many responses referring to lit or burning splints, or sometimes both glowing and lit together. Also, a significant number of students referred to smouldering splints, or splints that had been previously lit as opposed to a glowing splint. Students who were awarded marking point 1 were nearly always awarded marking point 2 as well. The most common incorrect response was using the test for hydrogen, with students referencing a lighted splint and a squeaky pop.



In this example (from a Foundation tier script), the student has listed both a lighted splint and a glowing splint as a test and therefore this cannot be credited.
As the mark for the result is dependent on the test being given correctly this also cannot be awarded.

02.2 This was an 'extended response' style of question. Such questions are marked holistically. There are overall generic descriptions for the three levels of response at the top of the mark scheme, giving a hierarchy of response. Within each level there are 2 marks.

Simply quoting the data from the table was not creditworthy. Students who did not use comparative language, such as higher, lower, only or just, to compare percentages failed to gain credit. Quoted figures needed to be correct.

Simple comparative statements limited the student to Level 1.

To access Level 2, the student had to offer at least two comparisons of percentage composition along with some correctly linked explanations, although all three gases did not have to be addressed. A third of all students gained marks at this level.

To access Level 3, students had to correctly identify the change in percentage composition for all three gases from the early atmosphere to the current day, and offer an explanation for at least two of them. Just over a quarter of all students gained 5 or 6 marks.

A decrease in carbon dioxide and an increase in oxygen could both be linked to 'algae / plants' and 'photosynthesis'. For nitrogen, whilst many students recognised that the percentage had increased, very few stated that it was due to volcanic activity or denitrifying bacteria. This was the main reason for a number of students working at Level 3, not being awarded the upper mark.

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5.9.2.4 The carbon footprint and its reduction

Answer 04 · Examiner comments

June 2025 | 8464/C/2H | Original Q2

Explain how the percentages of gases have changed from Earth's early atmosphere to Earth's atmosphere today.

You should refer to all three gases in **Table 5**.

[6 marks]

- The earth's early atmosphere had 95% carbon dioxide but now here is only 0.04%.
- In the Earth's early atmosphere there was 3% Nitrogen gas but now here is 78%.
- In the earth's early atmosphere there was less than 1% of oxygen whereas now here is 21%.

This is a weak response. The student has basically just written figures from the table. The only weak comparison is carbon dioxide now being 'only' 0.04%. Two relevant statements are needed to access lower Level 1 so 0 marks were awarded.

Explain how the percentages of gases have changed from Earth's early atmosphere to Earth's atmosphere today.

You should refer to all three gases in **Table 1**.

[6 marks]

- in early earth carbon dioxide was 95% where as no it has decreased to 0.04%.
- in early earth Nitrogen had a total of 3% in the atmosphere, whereas now it is 78% of Nitrogen gases this has increased by 75% percent!
- in the early earth oxygen levels were less than 1% of the earths atmosphere. it is now 21% of the earths atmosphere it has increased by just over 20%!

Extra space

This was a common response. The student has identified how the concentrations of all 3 gases have changed but has failed to offer any explanation as to why these changes have occurred. 2 marks in Level 1 are awarded.

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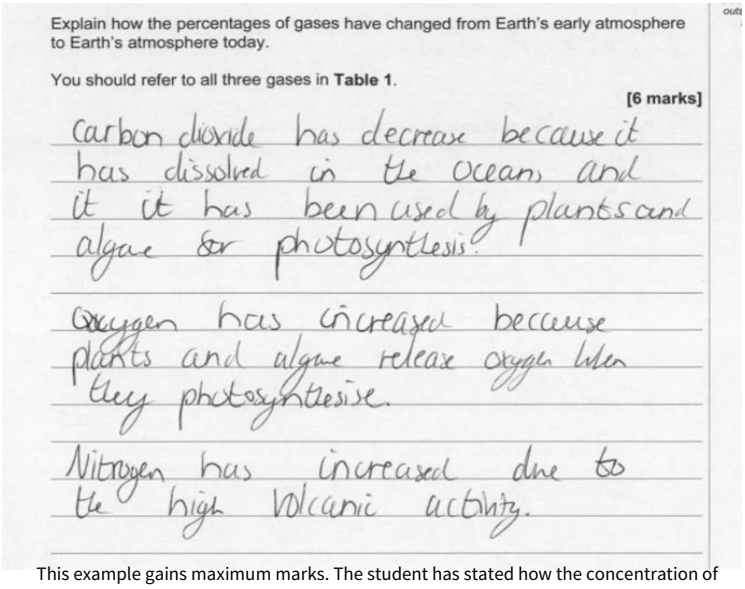
5.9.2.4 The carbon footprint and its reduction

Answer 04 · Examiner comments


Explain how the percentages of gases have changed from Earth's early atmosphere to Earth's atmosphere today.

You should refer to all three gases in **Table 1**.

[6 marks]

carbon dioxide has decrease because it has dissolved in the ocean, and it it has been used by plants and algae for photosynthesis.

Oxygen has increased because plants and algae release oxygen when they photosynthesise.

Nitrogen has increased due to the high volcanic activity.

This example gains maximum marks. The student has stated how the concentration of each gas has changed and offered an explanation for each one.

02.3 All of the ideas on the mark scheme were accessed by the students, although the most common responses referred to livestock farming and fossil fuels. However, there were many responses that answered as an absolute, rather than a comparison, which was insufficient for the mark. The question was looking for the idea that '*less* farming of livestock' or '*less* use of fossil fuels' would reduce methane for example, not stopping farming or stopping the use of fossil fuels altogether. This resulted in a third of students who answered the question not gaining credit.

02.4 The most common insufficient response was that 'fuels' were being burnt rather than 'fossil fuels'. Students also often used the incorrect terminology for sulfur reacting with oxygen, with many referring to 'binding' or 'joining'. If bonding was used, it had to be *chemical* bonding for the mark to be awarded. A number of students referred to the sulfur reacting with carbon dioxide. Consequently, over half the students failed to score any marks.

02.5 This question was well answered by the majority of students with over two thirds being able to correctly name a harmful effect of sulfur dioxide. The most common insufficient response was a simple reference to lung damage or breathing issues rather than the correct terminology of respiratory problems.

02.6 Students found this question difficult. From all the acceptable responses, the most common by far referred to the use of fossil fuels, with a significant minority listing new laws/legislation. A few students used statements referring to the increased use of renewable energy/resources as an alternative to using less fossil fuels. Students could also link the increased use of electric vehicles to less use of fossil fuels. The common error here was that students had to clearly imply

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5.9.2.4 The carbon footprint and its reduction

Answer 04 · Examiner comments

June 2025 | 8464/C/2H | Original Q2

'increased' use and many did not. A common misconception appeared to be that sulfur dioxide itself is used as a fuel and we now do not use it as much. Less than a third of students gained any credit in this question.

0 2 . 6 Suggest **one** reason why the percentage of sulfur dioxide in the Earth's atmosphere has decreased since 1980.

[1 mark]

Increase in renewable resources replacing non-renewable resources.

14

In this response, the student has correctly linked the using of less fossil fuels to the increased use of renewable resources.