Questions matter

GCSE

Combined Science: Trilogy

8464/C/2H Combined Science: Trilogy Chemistry Paper 2H

Report on the exam

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Contents

The below table is interactive. You can press the control button click on the title of the question to go directly to that page.

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Overview

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Delete if working on the Foundation tier report

This paper is one of the six examined components for Combined Science: Trilogy. All of these papers follow a similar structure and test the same assessment objectives.

This paper has 70 marks available to students and is made up of six questions.

- Approximately 40% of marks assess AO1; 40% of marks assess AO2; and 20% of marks assess AO3.
- Approximately 40% of marks target Standard demand, 40% of marks target Standard/high demand and 20% of marks target High demand.

Questions 1 and 2 on this paper and questions 5 and 6 on the Foundation Tier paper are common. These questions are identical and are targeted at standard demand.

Questions are set at three levels of demand for this paper:

- **Standard demand** questions are designed to broadly target grades 4–5.
- **Standard/high demand** questions are designed to broadly target grades 6–7.
- **High demand** questions are designed to broadly target grades 8–9.

A student's final grade is based on their attainment across all six papers.

Summary of overall performance

On the whole, students found this paper to be accessible, with the majority attempting to answer all questions.

In the extended response question common with the Foundation tier (question **02.2**) students were confident in comparing data from a given table, however they were less confident in explaining these differences. Good differentiation was evident.

Students had opportunities throughout the paper to demonstrate the use of correct chemical terminology and show understanding of chemical processes , however knowledge of equilibrium, bioleaching and phytomining were not well demonstrated.

Particularly towards the end of the paper, where the level of demand of the questions is greater, many responses lacked the correct terminology and precision of language needed to answer the question effectively. For example, in question **05.3**, describing 'more collisions' happening is not the same as 'more frequent collisions', and 'more particles' is not the same as 'more particles in a given volume'. Likewise, 'amount' is not equivalent to 'yield' in **06.4**.

Students generally demonstrated good mathematical skills, (questions **03.3, 05.6** and **06.1**) however there was evidence of confusion where conversions were required, or standard form was used.

A significant minority of students mixed up standard tests for the common gases hydrogen and oxygen.

Question 1 (Standard demand)

01.1 Many students were able to give the correct formula for dodecane, however a significant number failed to write the numbers as subscript therefore not being awarded the mark. Correct use of subscript and superscript is always required when writing chemical formulae.

01.2 Students found it difficult to explain why a water bath was used in preference to a Bunsen burner. Very few recognised that dodecane was flammable. Common incorrect responses included reference to speed of heating or the Bunsen being too hot. Only a quarter of students recognised the idea of the water bath controlling the temperature.

01.3 **T**his question was attempted by the vast majority of students. Students were able to state the volume of dodecane as either 40 cm^3, 100 cm^3, just 'cm^3' alone, or simply 'volume'. The most common incorrect response was using the terminology of 'amount of dodecane', as amount is not equivalent to volume. Consequently, only just over half of responses gained this mark.

01.4 Students found the extrapolation of the line quite difficult. It was often horizontal or poorly drawn with many thick lines, double lines and feathery lines. They were better at reading the value from their line. A significant number however applied an incorrect scale when reading from their extrapolated line.

01.5 Students were often able to state the relationship between increase in temperature and time taken for the dodecane to flow using the graph to help them. They were less confident however in stating how this linked to viscosity. A significant number linked faster flowing to being more viscous.

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.

0 6 . 1 About one-fifth of the atmosphere is oxygen.

Describe the test for oxygen gas.

Give the result of the test.

[2 marks]

Test light a splint

Result glowing splint will relight

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.

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 there is only 0.04%.
• In the Earth's early atmosphere there was 3% Nitrogen gas but now there is 78%.
• in the earth's early atmosphere there was less than 1% of oxygen whereas now there 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.

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 ‘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.

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

Question 3 (Standard and Standard /High demand)

03.1 The majority of students could explain that a finite resource is one that will run out. The most common incorrect responses were linked to either it ‘taking a long time to make more’ or ‘using it up too fast’, neither being sufficient for the mark.

03.2 While the majority of students correctly identified hydrogen and carbon, the mark could often not be credited because it was not made clear that these were the *only* atoms present.   A significant number of students used the incorrect terminology for describing a compound/molecule or an atom. Subsequently only half of all students were credited the mark.

0 3 . 2 Most of the compounds in crude oil are hydrocarbons.

Define the term ‘hydrocarbon’.

[1 mark]

A compound made up of hydrogen and carbon molecules only.

In this example the student has correctly stated that only carbon and hydrogen are present in the compound but have incorrectly called the particles ‘molecules’ rather than ‘atoms’, so the mark cannot be awarded.

0 3 . 2 Most of the compounds in crude oil are hydrocarbons.

Define the term 'hydrocarbon'.

[1 mark]

A mixture of hydrogen and carbon atoms

In this example the student has incorrectly used the terminology 'mixture' rather than 'compound' and have failed to state that hydrogen and carbon are the **only** atoms there, no marks were awarded.

03.3 The large majority of students attempted this question, and a variety of different approaches were seen, with over half of students gaining all four marks. Students not gaining full marks, were often able to identify which values they needed to use but were not so confident in using them correctly. A significant number failed to give their answer correctly rounded to 3 significant figures.

0 3 . 3 Crude oil found in different areas has different compositions.

Table 2 shows the percentage (%) composition of crude oil from one area.

Table 2

Fraction	Percentage (%) of fraction
Petrol	31.3
Kerosene	13.4
Diesel oil	14.4
Heavy fuel oil	40.9

The volume of crude oil is measured in a unit called 'barrels'.

1 barrel = 159 dm^3

Calculate the volume of **petrol** in dm^3 in 90 barrels of crude oil.

Give your answer to 3 significant figures.

[4 marks]

$159 \times 90 = 14310 \, dm^3$

$0.313 \times 14310 = 4479.03$

Volume of petrol (3 significant figures) = 4480 dm^3

This example shows the most commonly used approach. Students generally showed good mathematical skills in this question. The total volume of oil in 90 barrels is first calculated, followed by then working out 31.3% of this value. The answer is then correctly rounded to 3 significant figures. 4 marks awarded.

03.4 By selecting lubricants, over half of students answered correctly. The most common incorrect response was fertilisers.

03.5 Less than half of students could recall the correct method. Students who did not gain credit generally confused other processes involving hydrocarbons and often referred to fractional distillation. A significant number just wrote 'steam' which is not a method and therefore did not gain credit.

03.6 Only half of all students gained credit in this question. The majority of students who could recall bromine water as the required test then went on to successfully state the correct colour change, to colourless. Bromine alone was insufficient for the mark, although students were allowed a mark for the correct result if they went down this path. A significant number of students were not able to recall the test and often confused it with limewater leading to a cloudy solution.

Question 4 (Standard, Standard/High and High demand)

04.1 Although well attempted, only a third of students were able to accurately describe a formulation. Several students knew that it was a mixture but did not expand on this any further to give the reason for the mixture. Several knew that you needed to add a number of substances together for a purpose but did not know that this would then be a mixture.

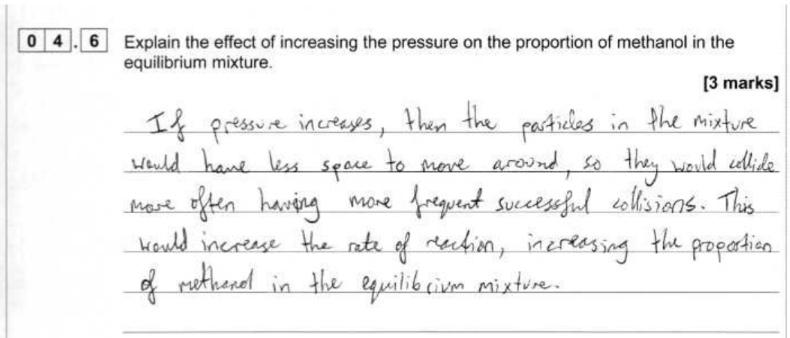
04.2 Well over half of students were able to select the correct response of 91 kJ/mol.

04.3 Half of all students could identify Le Chatelier as the scientist, although there were a variety of spellings offered.

04.4 Half of all students were able to select the correct response of 'the proportion of methanol decreases'. The most common incorrect answer was the opposite, being the proportion of methanol increases.

04.5 Again, half of all students were able to select the correct response of the proportion of methanol stays the same. A significant number however selected the proportion of methanol increases.

04.6 Students found equilibrium difficult. A large number of students related the increase in pressure to an increase in energy and number of collisions and hence an increase in the rate of reaction, but did not make any link to the effect on equilibrium.
A common misconception appeared to be that the proportion of methanol in the mixture was equivalent to the yield of methanol. Only a quarter of students gained 1 mark, with very few scoring 2 or 3.



0 4 . 6 Explain the effect of increasing the pressure on the proportion of methanol in the equilibrium mixture.

[3 marks]

If pressure increases, then the particles in the mixture would have less space to move around, so they would collide more often having more frequent successful collisions. This would increase the rate of reaction, increasing the proportion of methanol in the equilibrium mixture.

This was a very common response. The student links the increase in pressure to rate of reaction and hence to increased proportion of methanol. One mark is awarded for the increase in proportion of methanol.

04.7 Most students were able to state that a catalyst will increase the rate of a reaction. Less were able to explain that this is due to a lowered activation energy, and even fewer could link this to an alternative reaction pathway.
There was a common misconception that catalysts increase the rate of a reaction due to there being more frequent collisions, as this is a common explanation for how changing other factors affects the rate of reaction. Some students also incorrectly stated that catalysts cause the particles to gain energy.

04.8 Only half of all students answered this question well. Most of these identified that less energy used would be cheaper, but very few linked the idea of less fuels burning and the reduced contribution to global warming.
Some students gave ideas around the speed of the reaction decreasing at a lower temperature so the reaction could be controlled/monitored/more accurate results, lower temperatures being safer to work with, or lower temperatures resulting in less evaporation of methanol.

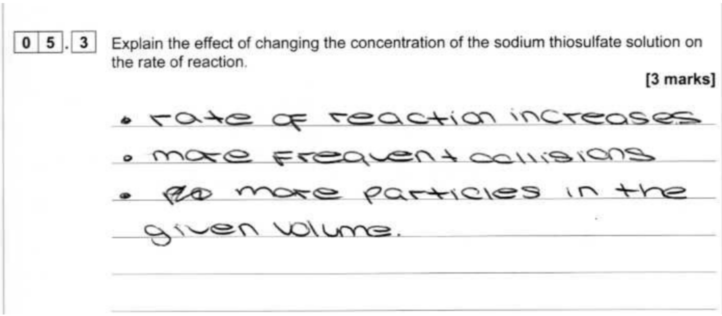
04.9 Just under a third of students gained both marks.
A large number of students did not know the formula for hydrogen and 6H was commonly used instead of $3H_2$
A small number of students could not gain marks due to errors in the size of the letter used eg Co_2 rather than CO_2 and H2o rather than H_2O.
Students are expected to use subscript, superscript and size of letters appropriately.

Question 5 (Standard, Standard/High and High demand)

05.1 This question was answered well by half of all students. The most common incorrect link to time taken was ‘time taken for reaction to go cloudy’.

05.2 Although a significant number of students recognised that sulfur was formed and is a solid, they often then linked sulfur dioxide bubbling through the solution as a contributory factor causing the cross to become obscured thus not accessing full marks. Another common error was mistaking S for sodium rather than sulfur.

05.3 Several students misinterpreted this question and simply stated 'changing the concentration' without clarifying whether they meant 'increasing' or 'decreasing'. This resulted in them not having access to any of the marks.
Those who did achieve credit mainly did so by correctly linking the directional change in concentration to a directional change in rate of reaction and then linking this to an appropriate description of frequency of collisions. Descriptions of 'more particles per unit volume/ in the same volume' were rarely seen, with many students simply stating 'more particles'.


0 5 . 3 Explain the effect of changing the concentration of the sodium thiosulfate solution on the rate of reaction.

[3 marks]

- rate of reaction increases
- more frequent collisions
- ~~po~~ more particles in the given volume.

The student has not stated how the concentration is changing and therefore what appears to be a good response scores 0 marks.

05.4 The majority of students did not recognise that the reaction would start immediately and that some gas would inevitably escape from the conical flask. They therefore answered in terms of an absolute such as 'to stop gas escaping' or 'to prevent the gas escaping' rather than expressing the fact that the insertion of the bung would 'minimise' or 'reduce' the volume of gas lost. Consequently, very few students gained this mark.

05.5 Over half of students answered this question well, however there was a significant number who mixed up the standard tests for hydrogen and oxygen giving perfect answers but for the wrong gas.

05.6 More students attempted this question than in previous years. Where a tangent was drawn further marks were nearly always achieved.
Common errors included misreading the scales to calculate the *x*-step or *y*-step, using these figures incorrectly (change in *x*/change in *y*), or simply trying to calculate the gradient from a single point (often 56,75).

Question 6 (Standard/High and High demand)

06.1 Students found the format the numbers were presented in difficult, and often incorrectly used figures such as 1.73 and 2.48, rather than 1.73×10^{-4} and 2 480 000
Many students were unable to carry out the full calculation, but most gained some credit for successfully multiplying by 2.48 million.
Of the students who successfully carried out the calculation many did not complete the correct conversion from grams to kilograms correctly, often using a factor of 100, rather than 1000.

06.2 By selecting 1.04×10^{20}, the majority of students answered correctly.

06.3 The process of bioleaching was not well known.
Of the students that gained credit in this question many did so as they were able to identify that bacteria were involved.
Although some students were able to make a link to the idea of a leachate or solution, very few were able to explain that the leachate or solution contained gold compounds or gold ions.
When methods of extraction were included in a response they were often correctly identified.

0 6 . 3 The materials in printed circuit boards can be recycled.

Bioleaching is one method used to extract gold from printed circuit boards.

Describe how bioleaching is used to extract gold.

[3 marks]

Bacteria is grown on low grade ores producing leachates. Add acid and do electrolysis.

This example was awarded 1 mark for stating that bacteria are used. The student did not state that the leachate contains gold compounds/ gold ions and has not stated that it is the gold that is extracted by electrolysis.

0 6 . 3 The materials in printed circuit boards can be recycled.

Bioleaching is one method used to extract gold from printed circuit boards.

Describe how bioleaching is used to extract gold.

[3 marks]

Bioleaching produces a leachate solution and it is extracted by electrolysis or a displacement reaction.

This answer did not score any marks. The student has not mentioned bacteria, does not state that the leachate solution contains gold compounds/gold ions, and the 'it' actually refers to the leachate solution not gold.

06.4 Many students understood that phytomining is a time-consuming process and when marks were credited this was by far the most common correct response.

Some students were aware that only small yields were produced and that a lot of land is needed but these ideas were not always clearly expressed using the correct terminology. Amount is not equivalent to yield, and lots of space is not equivalent to lots of land, for example. Many students gave the answer of being expensive or damaging to the environment which are not specific to the process of phytomining.

Contact us

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