GCSE

Combined Science: Trilogy

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

Report on the exam

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Contents

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Overview

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 seven questions.

- Approximately 40% of marks assess AO1; 40% of marks assess AO2; and 20% of marks assess AO3.
- Approximately 60% of marks target Low demand and 40% of marks target Standard demand.

Questions 6 and 7 on this paper and questions 1 and 2 on the Higher Tier paper are common. These questions are identical and are targeted at standard demand.

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

- **Low demand** questions are designed to broadly target grades 1–3.
- **Standard demand** questions are designed to broadly target grades 4–5.

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

Summary of overall performance

Students were often able to start a description of a trend from a graph, but frequently focussed on one part of the graph.

The familiar calculation of a relative formula mass (question 01.6) proved difficult for many students.

Other maths skills, particularly unfamiliar calculations (questions 05.1 and 05.2), were well attempted; however, plotting a bar chart (question 04.6) proved more challenging than expected.

The questions that were common with the Higher tier proved quite challenging for students on this tier, particularly question 06.5, which is the chemical test for an alkene.

Similarly, although not a common question, the chemical test for chlorine gas (question 02.5) also proved to be very challenging. Generally, students found AO1 questions that required them to write something, rather than multiple-choice, difficult and many of these questions were not well answered.

Students struggled to apply the method for the Required Practical Activity, even when given a diagram of the apparatus, to a different independent variable.

The explanation of the effect of changing temperature (question 07.2) lacked the precision of language for many students to access all the marks.

Question 1 (low demand)

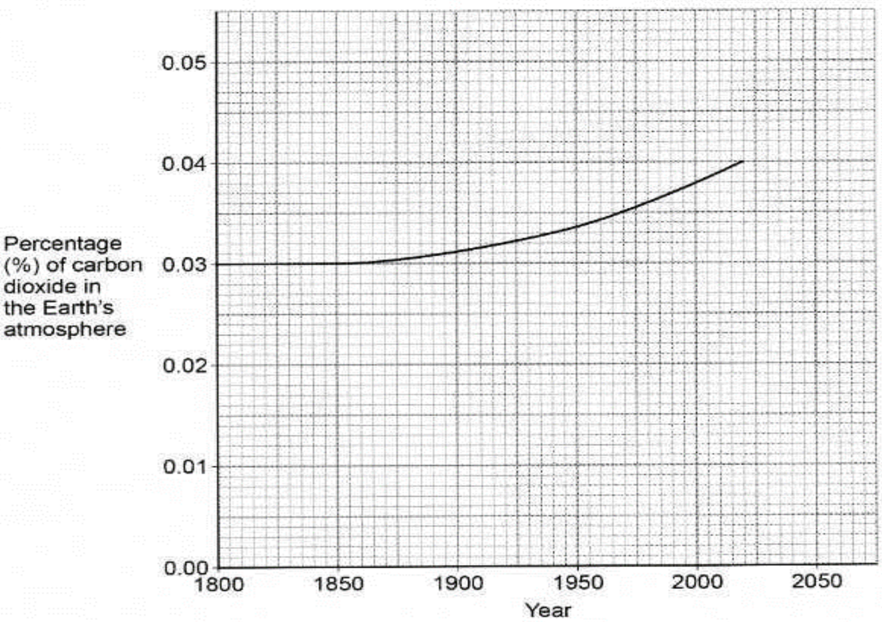
01.1 This AO1 question proved a challenging start to the paper, with just over a quarter of students gaining both marks and more than half of students not gaining any marks. Many students gave the percentage of oxygen in the air as 80%.

01.2 Two-thirds of students could identify at least one of the reasons why the percentage of carbon dioxide decreased in the Earth's early atmosphere, with photosynthesis being the most common correct answer. Deforestation and respiration were the most common incorrect responses.

01.3 About 40% of students were able to gain 1 mark on this AO2 question, often for recognising that the trend was increasing. Mention of the constant level from 1800 was less often seen, although about a third of students were able to gain all 3 marks. Some students not only described the trend but suggested reasons for it, which was not necessary for this 'describe' question; students would benefit from a clear understanding of the expectations of the command word.

0 1 . 3 **Figure 1** shows the change in the percentage of carbon dioxide in the Earth's atmosphere from 1800 to 2020.

Figure 1



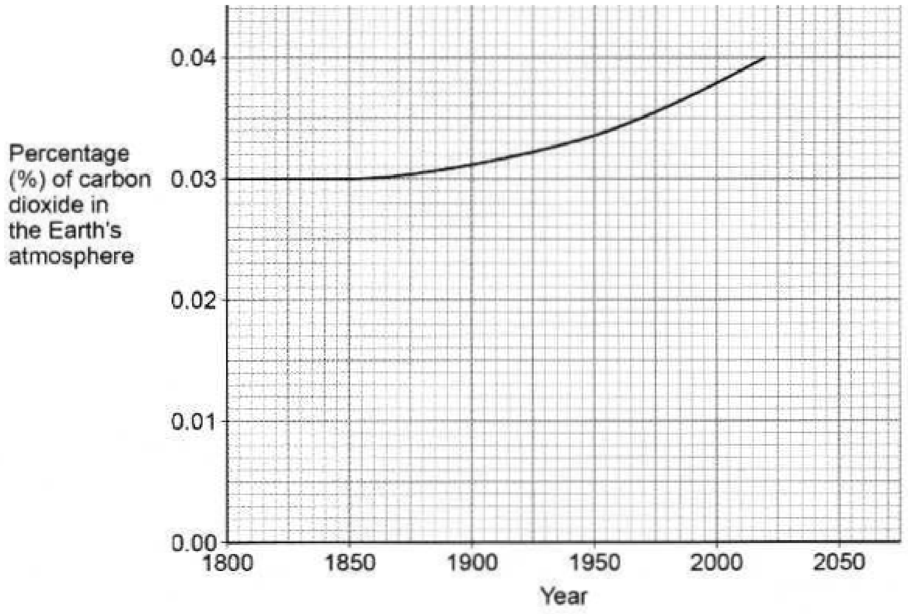
Describe the trend in the percentage of carbon dioxide in the Earth's atmosphere from 1800 to 2020.

Use data from **Figure 1**.

[3 marks]

as the years go on, the percentage of carbon dioxide in the Earth's atmosphere increases slowly. from 0.03 in 1800 to 0.04 in 2020.

This is a typical response that only gained 1 of the 3 marks: the student has identified the upwards trend but has not described the constant levels nor the date at which the change happens.



Describe the trend in the percentage of carbon dioxide in the Earth's atmosphere from 1800 to 2020.

Use data from **Figure 1**.

[3 marks]

from 1800 to 1850 the percentage of carbon dioxide in the earths atmosphere stayed the same however from 1850 - 2000 the percentage of carbon dioxide increased in the earths atmosphere

This student has gained all 3 marks, by identifying that the percentage was constant, then increased and giving the date (1850) where the change was observed.

01.4 Methane was well known as a greenhouse gas.

01.5 The link between climate change and greenhouse gases was also well known.

01.6 The method of calculating a relative formula mass as not well known, with fewer than a third of students correctly performing this calculation. Common mistakes were to add the two A_r values, multiply them together or subtract one from another.

0 1 . 6 Calculate the relative formula mass (M_r) of carbon dioxide (CO_2).

Relative atomic masses (A_r): C = 12 O = 16

[2 marks]

16-12

Relative formula mass of carbon dioxide = 4

0 1 . 6 Calculate the relative formula mass (M_r) of carbon dioxide (CO_2).

Relative atomic masses (A_r): C = 12 O = 16

[2 marks]

12 x 16 = 192

C x O = 192

Relative formula mass of carbon dioxide = 192

0 1 . 6 Calculate the relative formula mass (M_r) of carbon dioxide (CO_2).

Relative atomic masses (A_r): C = 12 O = 16

[2 marks]

16 + 12 = 28

Relative formula mass of carbon dioxide = ~~4~~ 28

These examples demonstrate common errors shown by students in answering this question.

In the first response, the student has subtracted one A_r value from another; in the second the student has multiplied the two A_r values together; in the third the student has added the two A_r values together.

None of these responses gained any marks.

Question 2 (low demand)

02.1 Just over half of students correctly identified the pure substance in this AO3 question for 1 mark. Three-quarters of those students went on to give the reason. We were looking for the idea that B did not have a range of melting points or that it was a specific value. Where students did not achieve this mark, it was due to reasons not being clear enough.

The most common wrong answer was D, with the main reason being that it had the highest melting point, followed by C because it had the lowest melting point or because it was closest to room temperature. The response of A was very rare.

02.2 Both marking points were not scored very often. White was the colour seen as one of the answers the greatest number of times, either correctly or incorrectly, but every combination of colours possible was seen with roughly equal regularity.

02.3 Most students gained the mark for this AO2 question. The most common incorrect responses simply stated 'the reversible symbol' without drawing or describing the symbol or copying out the symbol given in the question.

02.4 Just under half of all students gave the correct answer for this application question.

02.5 Very few responses showed knowledge of the test for chlorine, with nearly 80% of students not gaining any marks. Of the few that gained 1 mark many scored marking point 2 but did not describe the litmus paper as 'damp'. The tests for other gases such as hydrogen, oxygen, carbon dioxide and ammonia were all seen many times, with the 'squeaky pop test' being the most common.

0 2 . 5 Chlorine is a gas.

Describe the test for chlorine.

Give the result.

[2 marks]

Test Damp litmus paper

Result the litmus paper turns white if chlorine is present.

This student has given the all the points required for both marks.

Question 3 (low & standard demand)

03.1 Fewer than half of students gained the mark for formulation, formula being the most common distractor chosen.

03.2 About 70% of students gained the first mark for stating that the line should be drawn with a pencil, but the second mark was less often attained due to weak use of language. Instead of stating the pencil would not dissolve, there were many comments about mixing, smudging, moving and running, and other vague explanations that were not acceptable. Some students suggested that the line should be drawn in pencil so it could be rubbed out if necessary.

Some said the line should be drawn in black pen, so it would be clear. Many students had not read the question properly and said the line should be drawn with a ruler, so it would be straight.

03.3 This question was generally well answered, with about two-thirds of students gaining 2 or more marks. Most students were able to correctly measure the distance moved by the red colour; fewer were able to measure the distance moved by the solvent. There was a large variation in the distances given for this value, which suggests students did not know what the solvent front was rather than not having the skills to measure the distance correctly.

Over half of students were then able to correctly substitute their numbers into the R_f expression and attain marking point 3. Some students substituted the numbers into the expression upside down.

About a third of students were correctly able to evaluate the R_f expression and state the correct value for their calculation. The most common reason for not gaining the fourth mark was incorrect rounding.

03.4 Most students correctly identified Prussian in this AO3 question and over half went on to give the correct explanation. Some students incorrectly explained that the answer was Prussian because it had the highest value. Other incorrect answers included Cobalt, because it was the lowest value or Ultramarine because it was the same number but the digits had been written the wrong way round.

Question 4 (low demand)

04.1 This question proved very accessible, with 90% of students correctly identifying potable water.

04.2 Over half of students gained at least 1 mark on this question: electrolysis and filtration were the most common incorrect responses given.

04.3 Most students correctly identified the measuring cylinder.

04.4 The majority of students achieved this mark. Those who did not, had not understood that the answer was achieved by subtracting the mass of the evaporating basin from the basin plus solids, even though they had been given two examples in the table.

04.5 This AO1 question based on a Required Practical Activity was not well answered, with a third of students gaining 1 mark and 20% gaining both. Many students were either not clear about what control and dependent variables are or did not relate this question back to the method on the previous page. This lack of going back to information given earlier in a question continues to be a limiting factor for many students who simply focus on the information directly above the question.

04.6 Only 40% of students achieved the full 3 marks here. The most common mark awarded was for correctly numbering the *y*-axis. However, quite a few students only labelled 2 and 2.5, missing out 3, whilst others did not follow the scale given lower down the axis.

Most students remembered to label the two bars but many of them did not plot to the scale. The most common mistake was taking one small square to equal 0.1 g and therefore plotting magnesium too low (at 1.15). Many students then went on to plot sulfate too high (2.85), seeming to count down from 3 rather than up from 2.5.

Question 5 (low & standard demand)

05.1 This calculation proved accessible to many students, with over half gaining at least 1 mark.

A common error included unnecessary unit conversions, particularly multiplying by 1 000 000, but such students could still get the compensation mark. Failure to divide by 100 for the percentage often appeared, meaning no credit could be given. Many students divided 212 by 68% rather than multiplying them together.

A few students coincidentally arrived at the correct numerical value by incorrectly subtracting, 212 – 68 = 144, but this gained no credit.

05.2 Although unfamiliar, this AO2 calculation was well attempted by many students, with just over 50% gaining full marks.

For marking point 1 incorrect conversions, such as 15.8 × 1000, or 4 ÷ 1000, were commonplace although marks could still be awarded consequentially. Some students inappropriately rounded 15.8 to 16 and used this in their calculations, which meant marking points 2 and 3 could not be awarded. Marking point 4 was often missed by students rounding up instead of down, or not reading the question properly and leaving a decimal point in their final answer.

All the alternative mathematical methods on the mark scheme were used in arriving at the right answer. Some students arrived at the correct answer by simply scaling up 15.8 many times until they got to (eg) 253 cans = 3997.4 g and 254 cans = 4013.2 g, then correctly choosing the lower value. Simple incorrect use of the values (eg 15.8 × 4) was seen, giving an answer of 63.2 which could not gain credit, but the consequential whole number of 63 cans could be awarded marking point 4 because the values in the question had been used.

05.3 Fewer than 10% of students were able to achieve marks in Level 2 on this AO3 extended response evaluation question. To access marks in Level 2 students needed to provide a judgement supported by appropriate comparisons and links.

Simply repeating data from the table without interpretation or using it was common and was not credited.

Most comparisons were made between steel and wood, but also comparisons made horizontally across the table (eg most wood is wasted) were quite common. Some solid answers with more than one link were lacking in a judgement, which did not address the command word and so were restricted to Level 1.

Judgements were often muddled by describing both wood and steel as sustainable 'because they're both recycled', failing to see the advantage of steel. Wasting wood was often considered to be a good thing as it could be used for animal habitats, or because it rots back into the ground and burning wood was seen as a good thing since it is a good fuel. Imprecise language such as 'steel can be re-used' (rather than 're-cycled') was often used.

Of the links, carbon dioxide and climate change was most used; landfill descriptions were a rarity and no mention was seen of conserving non-renewable resources.

0 5 . 3 **Table 5** shows three methods used to dispose of wood and steel after use.

Table 5

	Percentage (%) of material disposed of by each method		
	As waste	**Recycled**	**Burnt**
Wood	58	36	6
Steel	15	85	0

Evaluate the sustainability of the disposal of wood and steel.

[4 marks]

Steel is more Sustainable than wood as the table shows it is recycled more and less put into waste

Despite making a judgement in their opening sentence and then going on to make two valid comparisons ('it [steel] is recycled more' and 'less put into waste'), this student has not made any links so is limited to the top of Level 1 and gains 2 marks.

0 5 . 3 **Table 5** shows three methods used to dispose of wood and steel after use.

Table 5

	Percentage (%) of material disposed of by each method		
	As waste	**Recycled**	**Burnt**
Wood	58	36	6
Steel	15	85	0

Evaluate the sustainability of the disposal of wood and steel.

[4 marks]

~~Out of 100 only 58%~~ ~~of w~~ 58% of wood wasted. 36% Recycled and put to use 6% Burned which Releases CO_2 which is a greenhouse gas, contributing to global warming

Only 15% Steel waste as its hard to Dispose off

In this response, the student is quoting numbers from the table without adding anything, which is not creditworthy; however, they have made a link to burning wood releases carbon dioxide which is a greenhouse gas. There is no judgement given and no comparisons, which are required to access Level 2, so this response is at the top of Level 1 and gains 2 marks.

0 5 . 3 Table 5 shows three methods used to dispose of wood and steel after use.

Table 5

	Percentage (%) of material disposed of by each method		
	As waste	Recycled	Burnt
Wood	58	36	6
Steel	15	85	0

Evaluate the sustainability of the disposal of wood and steel.

[4 marks]

the sustainabillity of wood and steel is wood as 58% of waste, 36% recycled and 6% burnt. Steel has 15% waste, 85% recycled, 0% burnt so Steel would be more sustainably as there less of it.

This student has only quoted numbers from the table, again not doing anything with them, which is not creditworthy. The final sentence is a judgement; however, it is not logically supported so is also not creditworthy. This response gained no marks.

Question 6 (standard demand)

06.1 Few students knew the definition of a hydrocarbon. A 'mixture' and an 'atom' were seen frequently.

06.2 This AO2 determination of a formula of a hydrocarbon was not done very well, with fewer than a fifth of students gaining the mark. Many responses had 'n' in the formula, and it was expected that the tops of the numbers were clearly below the tops of the letters, following chemical convention in writing formulas.

06.3 This question has typically been targeted at high demand in previous years. However, this year it was set at standard demand, with the diagram containing more detail and the mark scheme for loosened a little to separate the first two marking points. Most students were able to make a start on the explanation of fractional distillation.

Four marks were available for this question. Most students who gained 1 mark did so for correctly identifying that the crude oil is heated. Some students indicated that the crude oil was heated once it was in the fractional distillation column itself, which was not creditworthy. Fewer students were able to explain that some of the hydrocarbons were vaporised/evaporated/boiled or turned into a gas for marking point 2. Very few students explained that there was a temperature gradient in the column even though this could have been explained as a comparative statement, for example, the column is cooler at the top or by using sensible temperature values. Few students were able to explain that the hydrocarbons/fractions condensed or were able to give a clear description of condensation.

The most common responses that gained no marks referred to the different sizes and boiling points of the hydrocarbons/fractions.

06.4 Many students were able to correctly balance the equation. The most common incorrect response was to rewrite the formula C_3H_6 on the answer line.

06.5 The test for alkenes was not well known by students. The most common incorrect responses referred to using universal indicator, limewater or a lit splint.

When students correctly identified bromine (water) as the correct test most also then gained the second marking point for the correct colour change. The most common incorrect response identified bromine (water) as being red.

06.6 Given the prompts in the stem of this question it was expected that it would be well answered; however, this was not the case. The most common creditworthy answer was for identifying the poly(propene) as being a hydrocarbon with a few students identifying it as being a polymer or plastic. The most common incorrect response referred to it being an alkene.

Question 7 (standard demand)

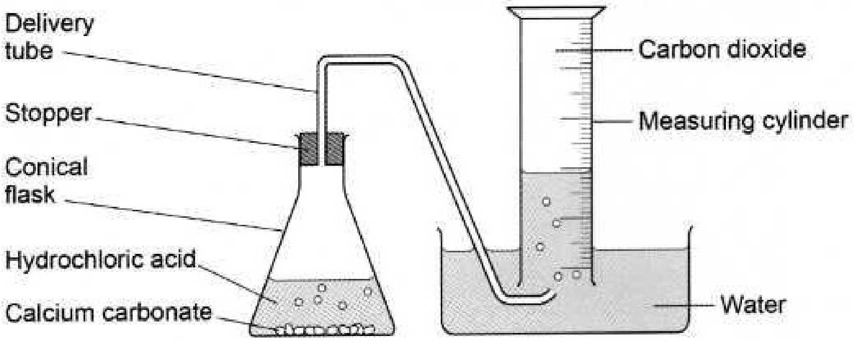
07.1 This AO2 and AO3 variation of one of the rates Required Practical Activities proved challenging to most students, with over a quarter of students not attempting it. Of the 30% of responses that did gain any marks most were limited to Level 1. To reach Level 2, three key steps, or two with control variables, were required. To achieve Level 3 marks, all key steps and control variables were needed.

The two most common steps identified were adding the hydrochloric acid to the calcium carbonate in the conical flask and then attaching the stopper and delivery tube. Many students made no further progress as they often referred to ‘counting bubbles’ or to ‘reading the volume when the reaction had finished’ with no link to timing so that calculating a rate would be impossible. Another common response was to ‘repeat with a different mass of calcium carbonate’ instead of using different sized pieces.

0 7 . 1 A student investigated the effect of changing the particle size of calcium carbonate on the rate of reaction with hydrochloric acid.

Figure 6 shows the apparatus.

Figure 6



Describe a method the student could use to produce valid results.

[6 marks]

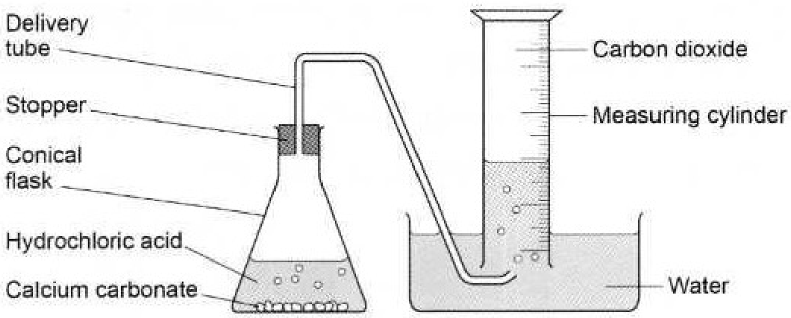
Add hydrochloric acid to a conical flask and add calcium carbonate. Then add a stopper and put in a delivery tube and put that in some water. Calculate the calcium carbonate that the gas has forced to move in the measuring cylinder.

This student has described the two most common key steps but has not gone on to add anything further so has not met the Level 2 descriptor: 1 mark was awarded.

0 7 . 1 A student investigated the effect of changing the particle size of calcium carbonate on the rate of reaction with hydrochloric acid.

Figure 6 shows the apparatus.

Figure 6



Describe a method the student could use to produce valid results.

[6 marks]

1.) Measure the mass of the calcium carbonate

2.) Add 50 cm^3 of hydrochloric acid into the conical flask and place the ~~delivery~~ stopper over to trap the gases in.

3.) connect the delivery tube to the water so that the gases can enter it.

4.) Measure the ~~amount of the particle size~~ amount of carbon dioxide.

5.) ~~Also measure the amount of Repeat the experi~~ Record the results of carbon dioxide and how much calcium carbonate was used.

6.) Repeat steps 1-5 ~~but~~ with different masses of calcium

Turn over ▶

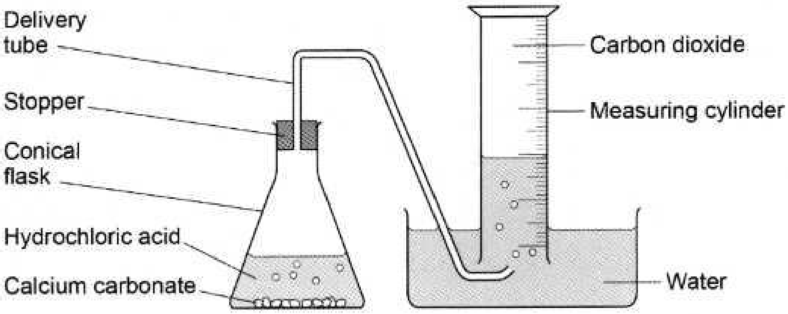
This student has achieved the first two key steps; however, they have not described what they are going to measure or change in the repeats to achieve the other key steps.

The student has specified 50 cm^3 of hydrochloric acid and done repeats (of something) so that they have given a control variable. This would therefore just place this answer into Level 2 and 3 marks are awarded.

0 2 . 1 A student investigated the effect of changing the particle size of calcium carbonate on the rate of reaction with hydrochloric acid.

Figure 3 shows the apparatus.

Figure 3



Describe a method the student could use to produce valid results.

[6 marks]

- Use a balance to ~~find out the M~~ make sure your using the correct mass of calcium carbonate
- then place the calcium carbonate into the hydrochloric acid and place the stopper with the delivery tube on very quickly.
- record the amount of carbon dioxide in the measuring cylinder every 30 seconds ~~repeat this~~ until the calcium carbonate stops bubbling.
- repeat this method but with bigger particle size of calcium carbonate but they have to be the same mass as the smaller particles.

In this response the student has suggested that the 'correct mass' of calcium carbonate should be used in the first bullet point. This is insufficient for a control variable, but in the final bullet point the 'same mass' has been identified, so there is one control variable here. The first two key steps are identified in the second bullet point. Key steps 3 and 4 are given in the third bullet point. 'Amount' would not be acceptable in a points-based mark scheme, but this response should be marked holistically as it is an extended response. There is no explicit mention of starting a stopwatch; however, it is implied in the statement 'every 30 seconds.' The final bullet point gives the repeats with a different particle size and one control variable.

Therefore, there are all five key steps, and one control variable so this is a Level 3 response and is awarded 5 marks. An additional control variable is needed for 6 marks.

07.2 Over half of the students gained at least 1 mark on this AO1 question, with 40% gaining 2 or more. The first two marking points were the more commonly awarded marks. Linking an increase in temperature to an increase in rate was the most common. However, very few students linked rate to the *frequency* of collisions, ie the more collisions per second, and are more likely to just talk about more collisions.

0 7 . 2 The student investigated the effect of increasing the temperature on the rate of a reaction.

Explain the effect of increasing the temperature on the rate of a reaction.

Refer to particles and collisions in your answer.

[3 marks]

Increasing temp. increases the energy in particles, making them move around a lot faster, resulting in more collisions, which allows for a faster rate of reaction the higher the temperature gets.

0 7 . 2 The student investigated the effect of increasing the temperature on the rate of a reaction.

Explain the effect of increasing the temperature on the rate of a reaction.

Refer to particles and collisions in your answer.

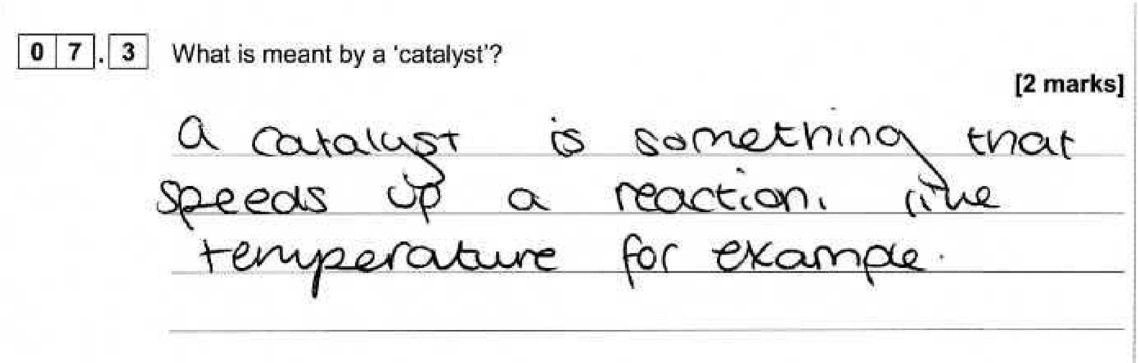
[3 marks]

Increasing the temperature increases the energy of the particles. More energy means that the particles collide more often. Speeding up the rate of reaction.

The first student has achieved the first two marking points, but ‘more collisions’ is insufficient for marking point 3.

The second student has achieved all 3 marks. In addition to identifying that the energy of the particles increases, speeding up the reaction, ‘particles collide more often’ is equivalent to’ more frequent collisions’ as the collisions are linked to time.

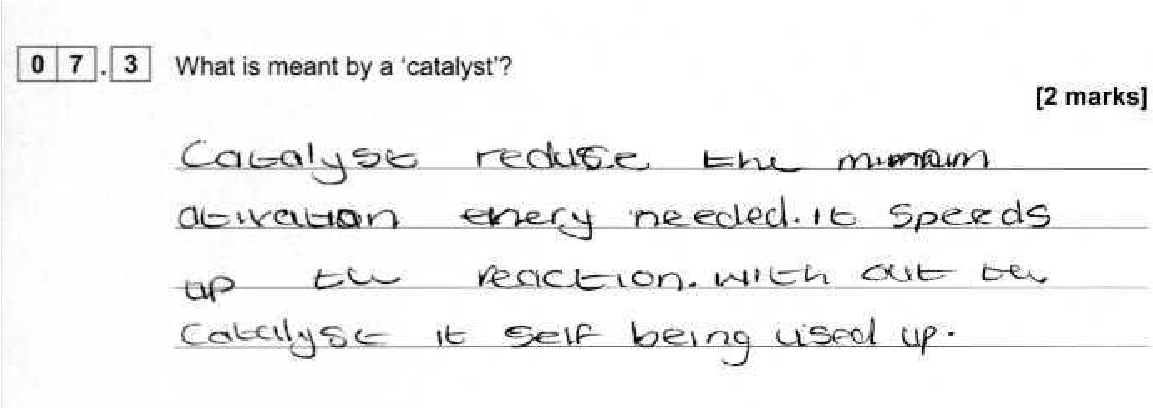
07.3 Over 40% of students were able to gain at least 1 mark for the AO1 definition of a catalyst. The first marking point was most seen; however, many misconceptions were also seen. One common misconception is that a catalyst is *any* change that speeds up the reaction. This contradicts what a catalyst is, so the first mark cannot be awarded.



0 7 . 3 What is meant by a 'catalyst'?

[2 marks]

a catalyst is something that speeds up a reaction. (the temperature for example.



0 7 . 3 What is meant by a 'catalyst'?

[2 marks]

Catalyst reduse the minmum ativation enery needed. it speeds up the reaction. with out the catalyst it self being used up.

The first student starts off well; however, they suggest that temperature is a catalyst, so the mark is not awarded.

The second student clearly defines a catalyst for 2 marks, but includes information which is unnecessary, the idea that a catalyst reduces the activation energy. This would be required in an 'Explain' question, rather than the much simpler 'What is?', but does not affect the marks awarded.

07.4 Enzymes are in both the Chemistry and Biology sections of the specification; however, very few students were able to recall that biological catalysts are called enzymes.

Contact us

Our friendly team will be happy to support you between 8am and 5pm, Monday to Friday.

Tel: 01483 477756
Email: gcsescience@aqa.org.uk

aqa.org.uk