Questions matter

GCSE

Combined Science: Trilogy

8464/C/1F Combined Science: Trilogy Chemistry Paper 1F

Report on the exam

Published: August 2025

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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

The questions that were common with the Higher tier proved quite challenging for students on this tier, particularly question **07.3**, where planning a method was not well answered.

Students had several opportunities to demonstrate use of correct chemical terminology and understanding of chemical processes (**05.1** and **05.7**).

Generally, students found application (AO2) and analysis (AO3) questions that required a written response, rather than multiple-choice, challenging and several of these questions were not well answered (**03.8** and **05.5**).

The questions assessing maths skills in this paper (**01.5**, **02.6** and **03.6**) were generally answered well, with the exception of less structured calculations (**06.4** and **07.2**) and graph plotting (**06.2**).

The questions about practical techniques proved more difficult for many students. Most of the practical questions had the highest ‘not attempted rates’ in the paper (often in excess of 20%) which may be because some centres do not carry out the required practicals or offer little practical experience beyond these. Students need to be more familiar with the required practicals so that they are able to describe why different steps are taken in these investigations and interpret results (**06** and **07.3**).

Question 1 (Low and Standard demand)

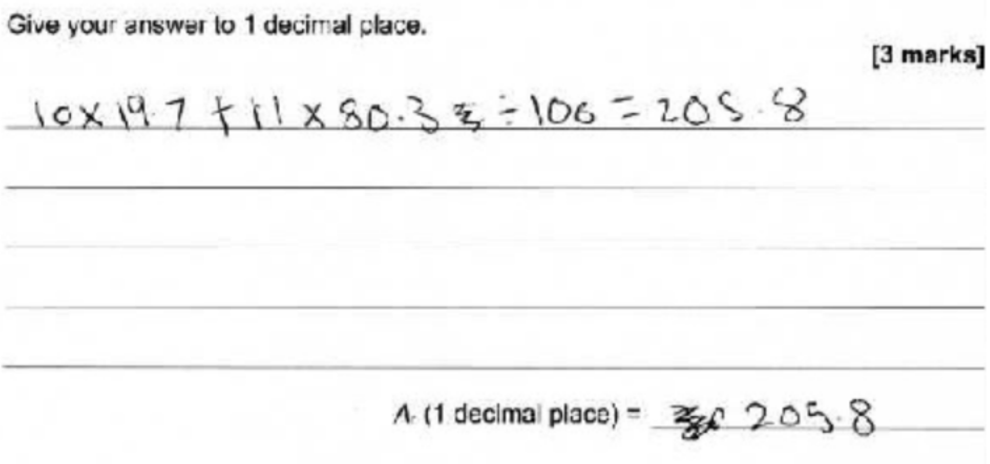
01.1 Just under half of students could name the electron as the first subatomic particle to be discovered. Proton was the most common incorrect response.

01.2 The majority of students knew that the name of the centre of an atom is the nucleus. Phonetic spellings were credited. Common incorrect answers were proton and neutron.

01.3 The majority of students correctly linked the relative charges with each subatomic particle. Many gained 1 mark for showing that the neutron has no charge.

01.4 Less than half of students knew that the atomic number is the number of protons in an atom. The number of number of neutrons + the number of protons in an atom was a more popular incorrect distractor.

01.5 The calculation of the relative atomic mass using the mass numbers and percentage abundance was correctly carried out by nearly two-third of students. The first mark was for the mathematical expression although some students did not divide 1080.3 by 100 and others used their calculator incorrectly. A small number of students who evaluated the expressions as 10.803 did not round their answer to 1 decimal place.



Give your answer to 1 decimal place.

[3 marks]

$10 \times 19.7 + 11 \times 80.3 \div 100 = 205.8$

A_r (1 decimal place) = 205.8

This student did not gain any credit. They only divided the last number (80.3) by 100 so their calculation evaluates as:
10 × 19.7 = 197 then added [11 × (80.3÷100) = 8.833] so 197 + 8.833 = 205.8

01.6 Many students correctly arranged the 8 electrons on the two levels on the figure as 2,8. A number arranged the 8 electrons as 4,4 or 0,8 and others used a different numbers of electrons.

01.7 Less than 20% of students gained 2 marks for Model B shows the 3D arrangement of the ions and the relative sizes of the ions. The most popular incorrect distractors were the charges on the ions and the electronic structures of the ions.

Question 2 (Low demand)

02.1 Many students correctly wrote the chemical symbol of lithium with a capital L followed by a lower case i. When writing symbols lowercase letters must be discernibly smaller than capitals.

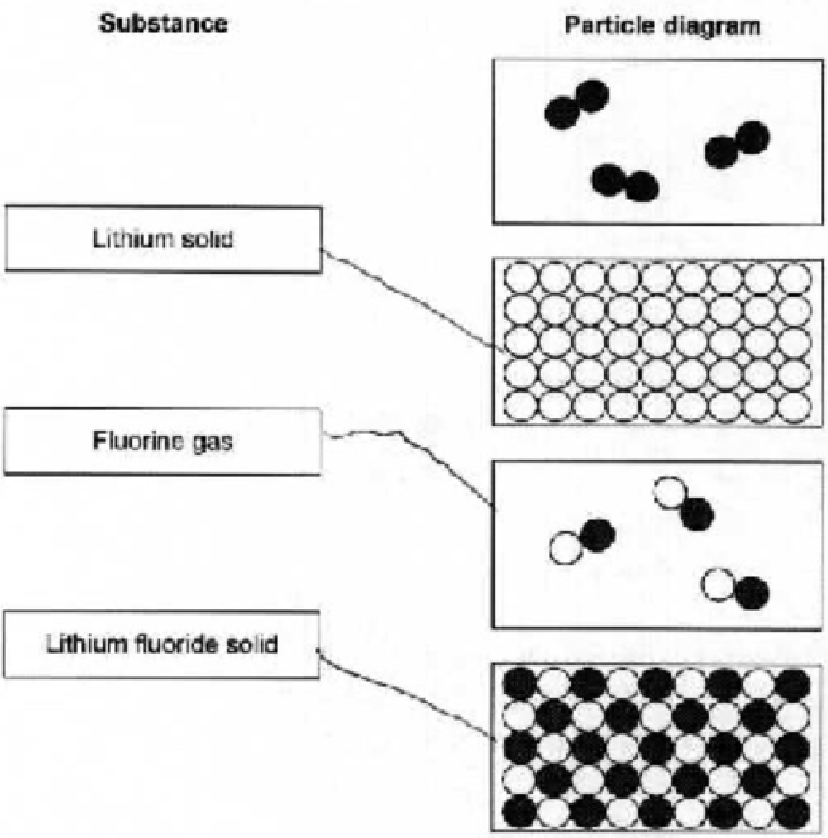
02.2 More than half of students knew that delocalised electrons from the outer shell are involved in metallic bonding. Fixed electrons in the outer shell was the most popular incorrect distractor.

02.3 Students should recognise particle diagrams for solid and gaseous states and for elements and compounds. Different colour circles are used to represent different atoms or ions so students should deduce that both the (diatomic) fluorine gaseous molecule and lithium solid particle diagram would only have one colour circle whereas the ionic compound lithium fluoride solid particle diagram would have two different colour circles. The majority of students correctly linked the substance to the particle diagram that represents the substance.

0 2 . 3 Lithium reacts with fluorine to produce lithium fluoride.

Draw **one** line from each substance to the particle diagram that represents the substance.

[3 marks]



This was a common incorrect response which gained 2 marks. Fluorine gas has been linked to a particle diagram showing gaseous molecules, but the link is to a compound, not to an element.

02.4 Just over half the students were able to use the electrical conductivity of a substance when solid and liquid to identify the ionic compound lithium fluoride.

02.5 Just over half the students recognised the structure of diamond. Graphite was the most common incorrect response.

02.6 A third of students gained both marks for 88 with or without working. Some gained 1 mark for the correct mathematical expression or writing 12 + 76. Many students did not multiply the number of atoms by the relative atomic mass of the atom so gave either 31 or 288 by adding or multiplying the A_r values of carbon and fluorine or used the 4 (atoms of fluorine) as a power giving a M_r of several thousand.

02.7 Just over half the students identified that six shared electrons were shown in the overlap of energy levels in the diagram representing a molecule of nitrogen. Three pairs would have been an acceptable answer although 3 was a common incorrect answer.

02.8 Only 5% of students were able to select the word from the box to complete the name of the compound with the formula Li_3N. The most common answer was nitrogen. Credit was awarded if the student identified the correct answer in the box, provided this was not contradicted by what was written in the answer space.

02.9 Just under half of students knew that neon does not react with other elements because neon has a stable arrangement of electrons. The most popular incorrect distractor was neon is a non-metallic element.

Question 3 (Low and Standard demand)

03.1 Three quarter of students added magnesium oxide to complete the word equation. Phonetic spellings were credited. Those students who wrote a correct formula were awarded the mark. Water was a common additional product.

03.2 The majority of students were able to select the word from the box to describe the process of magnesium reacting with oxygen as oxidised. Credit was awarded if the student identified the correct answer in the box.

03.3 More than half of students were able to use the data to determine the mass of magnesium in the crucible before heating by subtracting the mass of the empty crucible from the mass of the crucible and magnesium before heating. 0.2 g was the mass of oxygen that reacted, a common answer obtained by subtracting the wrong data.

03.4 Less than a third of students knew that when magnesium is heated with oxygen in a crucible the reaction results in an increase in the mass of the contents of the crucible because a solid reacts with a gas to produce a solid. Just over half the students selected the incorrect response that the reactants have a greater mass than the product.

03.5 The graph had 8 points. A straight line (of best fit) could be drawn through 7 of these with the point at (0.25, 0.35) being anomalous which required a ring to be drawn around it. Students were not expected to draw a line when answering this question although many did. Those who drew a line without a positive identification of the anomalous point were not credited.

03.6 The calculation of the mean mass was correctly carried out by nearly three-quarters of students. Most students achieved either 2 or 0 marks.

0 3 . 6 The student did the experiment using 0.60 g of magnesium four times.

Table 4 shows the results.

Table 4

	Test 1	**Test 2**	**Test 3**	**Test 4**	**Mean**
Mass of the contents of the crucible after heating in grams	0.96	0.93	0.92	0.95	**X**

Calculate mean value **X**.

[2 marks]

0·96 + 093 + 0 92 + 0·95 ÷ 4 = 3·0475

Mean value **X** = 3·0475 g

This was a common incorrect response. The student has only divided the 4th number by 4 (rather than the total of all four)
i.e. 0.95÷4 (= 0.2375) and adding this to the first 3 numbers (0.96+0.93+0.92 = 2.81)

03.7 Just over half the students knew that a water bath is not hot enough to allow magnesium to react with oxygen. The crucible would dissolve in a water bath was the most popular incorrect distractor.

03.8 Few students were able to give a correct reason for why a student who heated the crucible for 1 minute instead of for 5 minutes obtained different results. The answer was that a reaction has not taken place or that the reaction was incomplete. Common incorrect responses focussed on time (not long enough) or temperature (not high enough).

Question 4 (Low demand)

04.1 Half the students were able to select the word from the box to complete the sentence that most metals are found in the Earth as compounds. Elements was the common incorrect distractor. Credit was awarded if the student identified the correct answer in the box.

04.2 Half the students knew that iron is extracted from iron oxide by reduction with carbon because iron is less reactive than carbon. A third of students selected the incorrect converse response that iron is more reactive than carbon.

04.3 Less than half of students knew that cryolite is added to aluminium oxide to reduce the amount of energy used in the extraction of aluminium from aluminium oxide by electrolysis. The most popular incorrect distractor was to reduce the rate of reaction.

04.4 In the extraction of aluminium from aluminium oxide by electrolysis the positive electrodes need to be replaced. Fewer than 20% of students knew that this is because the electrodes react with oxygen gas. The other three options were all more popular. The electrodes react with aluminium was the most common incorrect response.

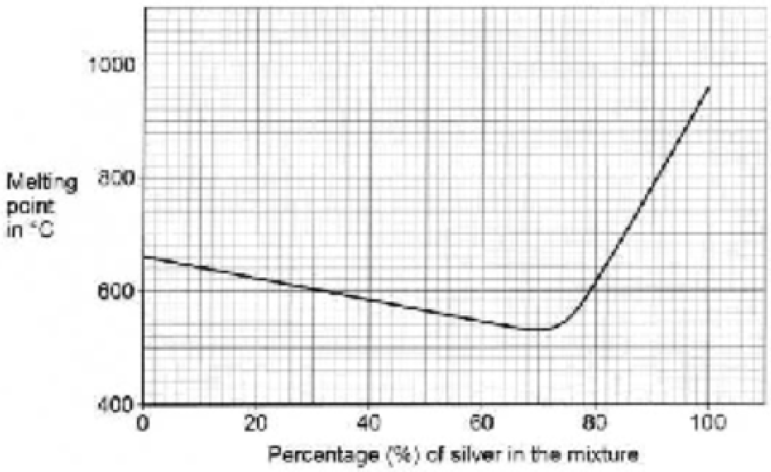
04.5 Just under half of students recalled that an alloy is harder than a pure metal. The converse statement an alloy is less hard than a pure metal was the most popular incorrect distractor.

04.6 When describing trends in graphs examiners are looking for students to state how the change in the *x*-axis (an increase in the independent variable) affects the value plotted on the *y*-axis (the dependent variable). In figure 9 as the percentage of silver in the mixture (*x*-axis) increased the melting point (*y*-axis) decreased. However, there was a marked change in the trend at 70% silver (where the curve was a minimum) after which the melting point increased. Students may have realised how the 3 marks were allocated. Examiners were not looking for a description of the rate of changes e.g. a sharp increase after 70% silver. Some students were careless with their terminology referring to the percentage of aluminium not silver and the boiling point of the alloy. A third of students gained all 3 marks. Many were awarded 1 mark usually for the initial decrease in melting point.

0 4 . 6 Aluminium can form an alloy with silver.

Figure 9 shows how the melting point of the alloy changes with the percentage (%) of silver in the mixture.

Figure 9



Describe how the melting point of the alloy changes as the percentage of silver in the mixture increases.

Use data from **Figure 9**.

[3 marks]

the melting point decreases as the percentage of silver increases, however once the mixture is over 70% the melting point significantly increases.

All 3 marking points were awarded. The student has described an initial decrease (in melting point), followed by an increase and has also indicated the point at which the change occurs.

Question 5 (Low and Standard demand)

05.1 Improvements to methods are assessed as AO3 and are often not well attempted. Answers needed to improve the accuracy of measuring the volume of alkali, so creditworthy responses included measuring the volume of the alkali (e.g. with a measuring cylinder), ensuring that the reagents reacted by stirring the mixture or repeating <u>and</u> calculating a mean. This was not a high scoring question. There were many insufficient responses of 'repeat' without the necessary 'mean' included. Many responses used the inadequate terms 'amount' or 'how much' alkali, and others suggested altering the size or weight of the universal indicator paper rather than using a solution. Other uncreditworthy responses included attempting to control the 'time' or using 'more acid'. Others mentioned the need to use a measuring cylinder but referred to the acid and therefore gained no credit.

0 5 . 1 The method does **not** give an accurate volume of alkali needed to react completely with the acid.

Suggest **two** improvements to the method.

[2 marks]

1 repeat this method, a couple times

2 calculate a mean

The first suggestion was a common insufficient response. This student was awarded 1 mark as they then wrote calculate a mean as the response was read as a whole.

05.2 Nearly two thirds of students knew that universal indicator paper turns green when pH = 7. The most popular incorrect distractor was pH = 5.

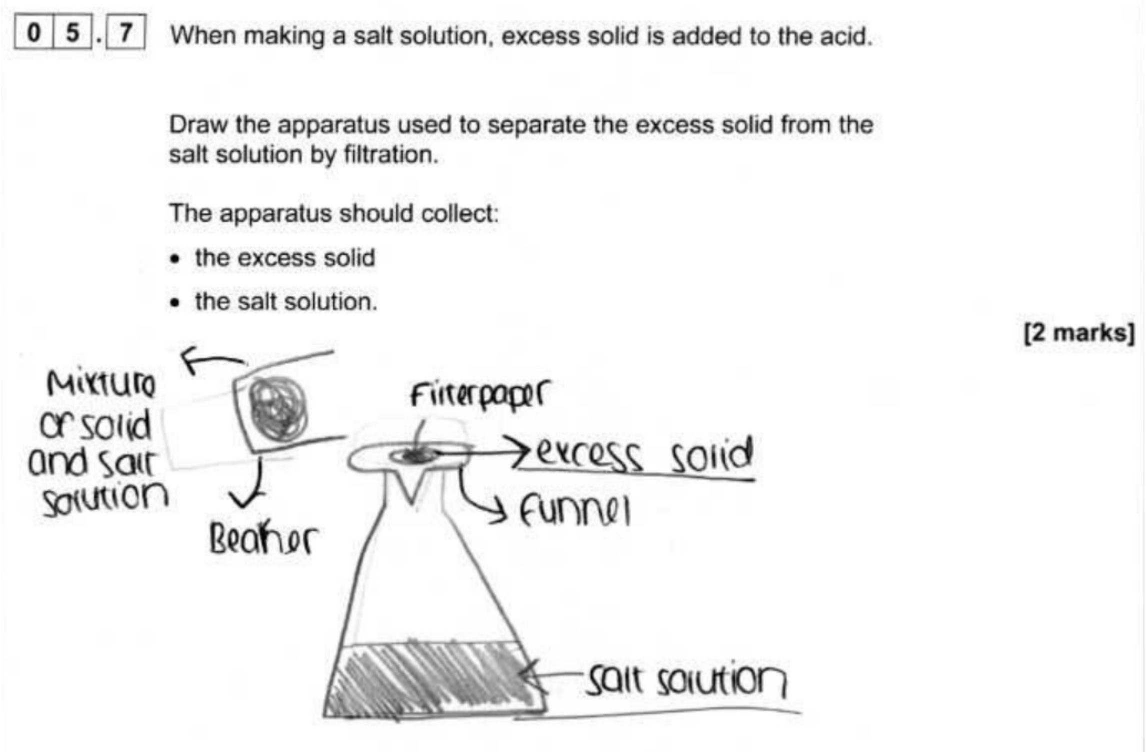
05.3 Nearly two thirds of students knew that neutralisation is the name of the reaction between an acid and an alkali. Combustion was the most common incorrect response.

05.4 Half of students knew that acids contain H^+ ions. The most popular incorrect distractor was Na^+ ions.

05.5 Nitric acid was the unknown acid that reacted with sodium hydroxide to produce sodium nitrate. This was not well known. Common responses that were not awarded the mark were nitrogen, nitrate (possibly because they had appeared earlier in the paper), hydrochloric acid, sulfuric acid and sodium.

05.6 A third of students were able to select the labels from the box to complete the reaction profile. Reactants and products were common incorrect distractors. Credit was awarded if the student identified the correct answer in the box.

05.7 Students had to draw apparatus used to separate excess solid from salt solution by filtration. Filter paper inside a filter funnel gained the first mark. Many diagrams had either the funnel or paper missing but those students who clarified their diagrammatic response with labels (for the paper and funnel) were awarded credit even if it was not clear that both pieces of equipment were drawn. The second mark was for any container to collect the filtrate although this could only be accessed if there was some evidence of filtration apparatus even if incorrect. Those students who included additional equipment which would affect the filtrate, for example, a Bunsen burner to heat the collection vessel with were not awarded the second mark. More than a quarter of students did not attempt this question.


0 5 . 7 When making a salt solution, excess solid is added to the acid.

Draw the apparatus used to separate the excess solid from the salt solution by filtration.

The apparatus should collect:

- the excess solid
- the salt solution.

[2 marks]

Both marking points were awarded. It is not clear that there is filter paper inside a filter funnel but this student has clarified their diagram with two labels. A conical flask after filtration is creditworthy.

05.8 Half the students knew that the zinc reacts with hydrochloric acid to produce zinc chloride and hydrogen gas. Phonetic spellings were credited. Chlorine was the main incorrect response, zinc oxide/hydroxide often appeared, and there were a few other metals e.g. iron, infrequently.

Question 6 (Standard demand)

06.1 The most common response of reducing the risk of harm from chlorine gas was 'wear a mask' which was insufficient to gain credit, as was 'face mask', when what was required was the use of 'a gas mask'. Conducting the experiment 'in a fume cupboard' was a rarely seen correct response as was good ventilation which was well-remembered from the required practical.

06.2 Many students were able to plot the six points. Drawing a curve as a line of best fit remains problematic; lines failed to go through the points, lines between the points were drawn with a ruler or double lines are drawn, lines were stopped and restarted and many were drawn with a thick pen or blunt pencil that was more than half a small square thick. Numerous students drew a straight line, despite the points clearly indicating a curve and some drew both a straight line and a curve.

06.3 This question was poorly answered. Some students referred to the graph for their answer, when the question demanded that they use the results from Table 5. The results show that as time increased in 60 second intervals the mass of the negative electrode increased but at a decreasing rate until 300 seconds when the mass remained constant. Rather than stating 'increase/changes in mass' in their responses, many students referred to 'it'; this was ambiguous and did not gain credit. The most common correct answer was that the mass was constant after 300 seconds. Using two correctly determined <u>changes</u> in mass was creditworthy, but many students simply quoted numbers from the table which was insufficient.

0 1 . 3 A student made the hypothesis:

'The negative electrode will increase by a constant mass every 60 seconds.'

How do the results in **Table 1** show that the hypothesis is **not** correct?

[1 mark]

It does not increase by the same amount each time

An example of a response (from a Higher tier paper) where 'it' was been used; 'it' was ambiguous and not creditworthy.

06.4 The calculation proved difficult for many students with answers achieving all 3 marks rarely seen. A large number did not attempt this question. Many students were able to convert 25 cm^3 to 0.025 dm^3 for 1 mark but were unable to take the calculation further. Others attempted the unit conversion but either divided by 100 or multiplied by 100 or 1000. Numerous students laid out their working clearly, giving units throughout, although few used words e.g. 'concentration ='. Those who didn't quote an equation for concentration very frequently went on to get mass and volume the wrong way up or multiplied them.

06.5 More than half of students knew that when potassium chloride solution is electrolysed hydrogen gas is given off at the negative electrode because hydrogen is less reactive than potassium. The reverse statement hydrogen is more reactive than potassium was the most popular incorrect distractor.

Question 7 (Standard demand)

07.1 The definition for an ‘exothermic’ reaction was not well known. Students rarely stated that energy or heat was released or transferred to ‘the surroundings’. Answers were mostly general explanations, describing how energy or heat were ‘given off’ or ‘released’. Common non-creditworthy responses referred to energy or heat being *produced*, the idea of heat or energy being ‘lost’ or references to an increase in temperature. Some answers stated that ‘oxygen’ or ‘a gas’ was given off by the reaction.

07.2 This question was poorly answered, and 20% of students did not attempt this question. The majority of students didn’t understand the use of brackets in a formula as they ignored the subscript 2. Evidence of 32 in their answers was not commonly seen. Students were unclear about how to calculate a percentage. Lots of different variations on the use of 16 and 74 were often seen such as 74+16, 74-16 or 74÷16. Many students attempted to calculate the M_r when it was already given.

0 7 . 2 The formula of calcium hydroxide is $Ca(OH)_2$

Calculate the percentage by mass of oxygen in calcium hydroxide.

Relative atomic mass (A_r): O = 16

Relative formula mass (M_r): $Ca(OH)_2$ = 74

[3 marks]

$\frac{16}{74} \times 100 = 21.621$

Percentage = 21 %

This response has not accounted for 2 oxygen atoms in the formula so does not gain MP1. However, MP2 is awarded for the correct mathematical expression (using an incorrectly determined mass of oxygen) but then truncate their answer. Had they rounded correctly to 22 or 21.6 or left their answer as 21.621 they would have been awarded MP3 (correctly rounded to at least 2 significant figures).

07.3 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.

Students were asked to plan a method to investigate how changing the mass of calcium oxide affects the temperature change of the reaction when calcium oxide is added to water. The indicative content includes 5 key steps and the control variable, along with some additional information.

At Level 1, students needed to identify some relevant steps. To enter Level 2, three key steps, or two with the control variable, were required. To achieve marks in Level 3, all 5 key steps and the control variable were needed. Only a very small minority of students were able to obtain 6 marks.

0 7 . 3 When solid calcium oxide is added to water, the temperature of the reaction mixture changes.

Plan a method to investigate how changing the mass of calcium oxide affects the temperature change of the reaction mixture.

[6 marks]

Step 1 - Measure out the calcium oxide, place into a conical flask

Step 2 - Measure out 100ml of water, and place into the same conical flask

Step 3 - ~~M~~ record the before temperature, using a thermometer

Step 4 - Place stopper and let reaction occur.

Extra space Step 5 - Record after temperature, and measure + calculate the change in temperature.

In this response, the student has stated a valid volume of water but omitted 'mass' of calcium oxide. In step 3 they record the 'before' temperature, but this is after both reactants have been added to the conical flask so is not credited with taking the initial temperature. They have not stated when the subsequent temperature is measured nor described how the temperature change is determined. Had the student 'repeated the experiment with different masses of calcium oxide' they would have been credited with the control variable as this would imply fixing the volume stated. The students uses a thermometer which is a valid point in the mark scheme.

Only one key step is stated with some additional information (correct use of a thermometer) so this is a Level 1 response and is awarded 1 mark.

Most students added calcium oxide to water but many omitted either volume (of water) or mass (of solid) although 'amount' was creditworthy for both here. Students usually described taking the 'initial' temperature (but often after they had added solid to water). Many were less clear on when and how the subsequent temperature or temperatures were to be taken. Too frequently it was stated that the 'temperature change' was to be measured which is not creditworthy, as this requires a calculation. The need for a control variable, whilst rarely stated as such, was often found in a Level 2 response due to the students realising that the volume of water needed to be fixed along with the experiment being repeated in some way. An indication of how the temperature change was to be determined was rarely seen.

0 7 . 3 When solid calcium oxide is added to water, the temperature of the reaction mixture changes.

Plan a method to investigate how changing the mass of calcium oxide affects the temperature change of the reaction mixture.

[6 marks]

- Place water in a polystyrene cup with a thermometer and lid
- ~~Add in~~ measure out different masses of calcium oxide
- add smallest mass to cup, place lid on top and measure maximum temperature and temperature change
- repeat with increasing masses of calcium oxide
- repeat previous steps to make sure investigation is accurate
- ~~measure~~ find the mean temperature

Extra space of each reaction of increasing calcium oxide mass and water.

In this response, the student has omitted volume of water but stated mass of calcium oxide. The initial temperature is not recorded but the maximum temperature is. They repeat for accuracy and then repeat with different masses of calcium oxide. They have not stated how the temperature change is determined nor that they need to use the same volume of water when repeating. The student uses a suitable container (an insulated cup) and a thermometer which are valid ideas from the mark scheme.

There are three key steps with some additional information (thermometer and insulated cup) so this is a Level 2 response and is awarded 3 marks.

0 2 . 3 When solid calcium oxide is added to water, the temperature of the reaction mixture changes.

Plan a method to investigate how changing the mass of calcium oxide affects the temperature change of the reaction mixture.

[6 marks]

1. Measure $25cm^3$ of water using a measuring cylinder and pour into a polystyrene cup.
2. Place the cup into a beaker and measure initial temperature using a thermometer
3. Measure 4g of calcium oxide using a balance
4. Add the calcium oxide and ~~~~ put on a lid
5. Once the temperature has come to a stable point take final temperature reading using a thermometer
6. Calculate temperature change by doing final temp - initial temp
7. Repeat steps 1-6 with different masses of calcium oxide e.g 6g, 8g. and compare results.

(for more accurate results use cotton wool in the beaker as an insulator and use a digital thermometer)

In this response (from a Higher tier paper), the student has stated a valid volume of water and mass of calcium oxide. The initial temperature (before the solid is added) and final temperature are recorded. They repeat with different masses of calcium oxide and are using the same volume of water so are credited with having a control variable. They have shown how the temperature change is determined. The student uses a measuring cylinder, suitable container (an insulated cup), balance and a thermometer which are additional valid points in the mark scheme.

There are all five key steps, a control variable, how the temperature change is determined with lots of additional information, so this is a Level 3 response and is awarded 6 marks.

Contact us

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

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