Thermal Decomposition of Copper (II) Carbonate

# Timothy Langer 4E

## Results and conclusion

When performing the reaction, having decomposed, the copper carbonate turned black, and the limewater turned cloudy/milky. One could see bubbles coming up in the limewater, presumably carbon dioxide gas.

Before the decomposition, the test tube with copper carbonate weighed **29.40g**

After the decomposition, the test tube with copper oxide weighed **29.15g**

The total weight loss is equal to 29.40 – 29.15 = **0.25g reduction in mass**

**Decomposition – word equation**

*Copper (II) carbonate(solid) → Copper (II) oxide(solid) + Carbon dioxide(gas)*

**Formula:** CuCO3 (s) → CuO (s) + CO2 (g)

**Bubbling through limewater – word equation**

*Limewater(aqueous) + Carbon dioxide­(gas) → Calcium carbonate(solid) + Water(liquid)*

**Formula:** Ca(OH)2 (aq) + CO2 (g) → CaCO3 (s) + H2O(l)

Heating the green copper carbonate powder caused the substance to decompose, leaving behind black copper oxide and forming an odourless, colourless gas, carbon dioxide, that when bubbled through limewater (calcium hydroxide / slaked lime) turned the limewater milky due to the production of calcium carbonate.

## Extension Questions

1. Whilst doing this experiment student **A** and student **B** were discussing when to stop heating in considering the instruction, *“when you think decomposition is complete.”*

Student **A** states: *“We will know when the decomposition is complete since the solid will be all black and no green bits will be seen.”*

Student **B** is not convinced: *“We can only see the colour on the surface, in the centre of the stuff in the test tube there could still be undecomposed starting material. The best and most accurate way to ensure complete decomposition would be to do a number of re-heatings and re-weighings.”*

Student **B** means that only the green copper carbonate *on the surface* will have reacted to form black copper oxide on the surface and that at the centre there may still be unreacted material. By saying *“a number of re-heatings and re-weighings”*, he means that by keeping on heating the substance, they should stop once the mass of the material stops decreasing.

 **→**

1. The teacher states that 2.00g of copper (II) carbonate decomposing will have a theoretical mass loss value of **0.71g.**

|  |  |
| --- | --- |
| **Experiment** | **Mass lost /g** |
| 1 | 0.70 |
| 2 | 0.71 |
| 3 | 1.15 |
| 4 | 0.69 |
| 5 | 0.71 |

1. To what degree of accuracy does the mass balance they are using appear to measure?

The mass balance they are using appears to measure to two decimal places.

1. Their teacher asks them to complete the statement below:

*By experiment when 2.00g of copper (II) carbonate is completely thermally decomposed the mass lost was found to be \_\_\_? g*

Student **A** completed the statement with **0.79g.**

Student **B** completed the statement with **0.70g.**

How did student **A** handle/process the data to get a value of 0.79g?

He calculated the mean average by adding all the values together and dividing the value by the total number of values added together, getting a value of **0.792g**, which he then rounded to the nearest two decimal places to get a value of **0.79g.**

1. How did student **B** handle/process the data to get a value of 0.70g?

Student **B** removed the clear anomaly of the third result and then calculated the mean average of the remaining four results, getting an average of **0.7025**, which he then rounded to the nearest two decimal places to get a value of **0.71g.**

1. Comment on the conclusion that student **B** (who had processed the data more sensibly/scientifically than student A) made. Do you think the results failed to support the teacher’s calculated value?

The results did not necessarily mean they *failed* to support the teacher’s calculated value, and although the values were not *the same*, they were still very close with student **B**’s practical value at **0.70g** and the teacher’s calculated theoretical value at **0.71g** – a difference of a mere 0.01g. People are subject to human error, and there are ways in which the practical could have had the tiniest of mistakes that affected the overall average. In any case, the average was rounded down so it is even closer to the teacher’s value than it seems.

1. What do you think would happen to the value obtained from processing the results if the experiment were repeated one hundred times?

Having removed the anomalies and performed the practical with as little human error as possible, the average would most likely average out to the teacher’s predicted value of **0.71g.**

1. Students **C** and **D** have a reputation for not following experimental instructions carefully.
* Firstly, they put four (not two) spatulas of copper (II) carbonate in the test tube.
* Secondly, they decide to use a clamp to heat the carbonate without having to hold the Bunsen burner or anything else.

Having taken advantage of the ‘hands-free’ situation, though, they become distracted.

When they return, the decomposition looks complete on the basis of the colour change of the residue in the test tube, but the limewater is not ‘milky’ and looks like the same colourless solution they started with.

What has happened? (There is a genuine explanation!)

The produced calcium carbonate (the ‘milky’ part of the solution, a white solid) can react with carbon dioxide in the presence of water. So, here is what exactly happened.

* + 1. The first carbon dioxide passes through limewater, forming calcium carbonate and water, turning it milky.
		2. More carbon dioxide continues to pass through the mixture, reacting with the calcium carbonate and the water, forming **calcium bicarbonate.** Calcium bicarbonate is soluble in water, so the liquid in the test tube goes clear again.