**Formula help**

Copper carbonate is a green compound. Its formula is CuCO3.



Copper oxide is a black compound. Its formula is CuO.



1. Some copper carbonate is heated. This makes it decompose (break apart). Black copper oxide and one other substance are made.

What is the formula of the other substance formed?

A CO3

B CO

C CO2

D C

*Chemistry > Big idea CPS: Particles and structure > Topic CPS3: Chemical change > Key concept CPS3.1: Rearrangement of atoms*

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| --- |
| **Diagnostic question** |
| **Formula help** |

**Overview**

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| Learning focus: | During a chemical reaction, atoms are rearranged and a new substance (or substances) is formed with different properties. |
| Observable learning outcome: | Use a chemical formula to predict possible products of a thermal decomposition reaction. |
| Question type: | simple multiple choice |
| Key words: | formula, substance, compound, thermal decomposition. |

**What does the research say?**

Some student explanations of observed chemical changes considered that the change was as a result of the mixing of the two starting substances (Johnson, 2000) . These students thought that the substances mixed, rather than that they combined to form new substances. Interestingly the same students did not seem to consider ‘unmixing’ as a possibility. It could therefore be inferred that the idea of decomposition may not have occurred to these students.

Other research (Stavridou and Solomonidou, 1998) found that even where students acknowledged that the formation of new substance was the distinguishing feature of a chemical reaction they added the additional requirement that there must be two starting substances. For these students the idea of thermal decomposition may also be problematic.

**Ways to use this question**

You may wish to start this question by demonstrating the thermal decomposition of copper carbonate. For instructions see

<http://www.rsc.org/learn-chemistry/resource/res00000450/thermal-decomposition-of-metal-carbonates>

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

When discussing the reason for the correct answer it is important not to inadvertently encourage the misconception that copper carbonate is made up of separate CuCO3 molecules. Careful use of language may help to avoid this. For example, “Every copper atom joins with an oxygen atom to make copper oxide. For each copper atom that does this there are two more oxygen atoms and a carbon atom left.”

**Expected answers**

C CO2

**How to respond - what next?**

Students may not be confident with the idea that during a chemical reaction the atoms are rearranged. No new atoms are created, and no atoms are destroyed. This means that they may think that other products are possible, when in fact they are not. Understanding of this idea is explored further in key concept CPS4.2: Conservation of mass.

Option A adds an additional oxygen atom. Option B loses an oxygen atom and option D loses 2 oxygen atoms.

Students may still have misunderstandings about the meaning of both letters and numbers in the chemical formulae. You may wish to revisit diagnostic questions and response activities from key concept CPS2.2: Symbols and formulae.

Students who remain unconvinced that a chemical reaction can take place with one starting substance could be encouraged to look carefully at a demonstration (or video) of the reaction in which the production of carbon dioxide causes movement in the powder.

The following BEST ‘response activities’ could be used in follow-up to this diagnostic question:

* Possible products

**Acknowledgments**

Developed by Helen Harden (UYSEG).

Images:

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copper oxide - Adam Rędzikowski [CC BY-SA 3.0 (https://creativecommons.org/licenses/by-sa/3.0)], from Wikimedia Commons

**References**

Johnson, P. (2000). Children's understanding of substances, part 1: recognizing chemical change. *International Journal of Science Education,* 22(7)**,** 719-737.

Stavridou, H. and Solomonidou, C. (1998). Conceptual reorganization and the construction of the chemical reaction concept during secondary education. *International Journal of Science Education,* 20(2)**,** 205-221.