**Heating a compound**

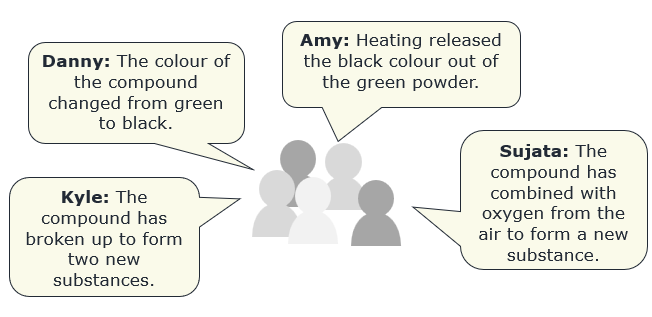
A sample of a green compound is heated.

The table describes what is observed.

|  |  |
| --- | --- |
| **Stage** | **Observation** |
| Before heating | Green powder |
| During heating | No flames |
| After heating | Black powder |

Some students try to explain the observations.

Who do you agree with? Why?



*Chemistry > Big idea CCR: Chemical reactions > Topic CCR1: Chemical change > Key concept CCR1.1: Formation of new substances*

|  |
| --- |
| **Diagnostic question** |
| **Heating a compound** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | During a chemical reaction a new substance (or substances) are formed with different properties. |
| Observable learning outcome: | Explain observations of a thermal decomposition reaction in terms of the formation of new substances. |
| Question type: | talking heads |
| Key words: | substance, compound |

**What does the research say?**

A summary of research into students’ conceptions of matter (Andersson, 1990) developed five categories of the types of answers students gave when explaining chemical reactions, only the last is scientifically correct.

|  |  |  |
| --- | --- | --- |
| **Category of explanation** | **Description** | **Example** |
| disappearance | The substance has simply gone. | Petrol is ‘used up’. |
| Displacement  (movement) | The new product has moved from somewhere else. | When solid lead nitrate and potassium iodide are mixed the yellow colour (lead iodide) comes out of the white grains of powder. |
| modification | The original substance keeps its identity, but its properties change. | When alcohol burns it turns into alcohol vapour. |
| transmutation | A substance changes into another substance or a substance is changed (partly) into energy. | When magnesium burns it turns into energy. |
| chemical interactions | Substances combine to form a new substance (or split up to create two or more substances). | Magnesium reacts with oxygen forming magnesium oxide. |

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**

Whilst this question could be use as a pen and paper exercise you may wish to consider showing ‘before and after’ samples of copper carbonate and copper oxide.

You may also wish to demonstrate the thermal decomposition of copper carbonate. See <http://www.rsc.org/learn-chemistry/resource/res00000450/thermal-decomposition-of-metal-carbonates?cmpid=CMP00005971>

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

The specifics of the thermal decomposition reaction are covered in key concept: CPS3.1 Rearrangement of atoms so the focus of discussion should be on whether the student explanations *could* be correct in terms of understanding that a chemical reaction forms a new substance (or substances).

**Expected answers**

Students should be able to recognise that Danny and Amy are definitely wrong, but that Kyle or Sujata could be correct in terms of correctly recognising that a new substance has been formed.

Kyle’s answer is scientifically correct.

**How to respond - what next?**

A student who thinks that Danny is correct may be explaining the observed change in terms of a modification to the original substance. The substance is regarded as the same but with changed properties (colour).

Thinking that Amy is correct, indicates that the student may be explaining the observed change in terms of displacement (movement) of the observed product from elsewhere, potentially implying that they think the product has always been in existence but has now become apparent.

A student who does not think that Kyle’s explanation could be correct may consider that a chemical reaction can only take place when there are two substances at the start. Alternatively, they may not have considered that a product may form that is in the gas state and therefore may not be observed.

If students have misunderstandings about the causes of the observed colour change then it may be beneficial to make them aware of the specific misconceptions described above. Key concept:3.1 Rearrangement of atoms may be used to find out how students perceive the same change at the sub-microscopic level. If they do not already think in terms of the rearrangement of atoms, then this may help them understand how thermal decomposition can also create new substances.

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

* Copper compounds

**Acknowledgments**

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Images: None

**References**

Andersson, B. (1990). Pupils' conceptions of matter and its transformations (age 12-16). *Studies in Science Education,* 18**,** 53-85.

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.