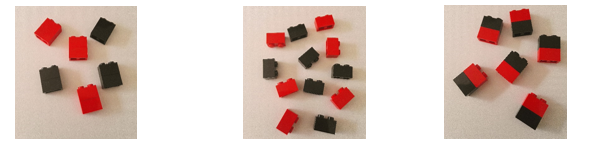
**Modelling reactions**

A teacher uses building bricks to model a chemical reaction.

The model shows two elements in the gas state reacting.

They make a new compound. The compound is also in the gas state.



1. In the model one single brick represents an atom.
   1. State two ways in which the model is a **good** representation of the rearrangement of atoms during a chemical reaction.
   2. State two ways in which the model is **not** a good representation.

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

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| **Diagnostic question** |
| **Modelling chemical reactions** |

**Overview**

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| Learning focus: | During a chemical reaction, atoms are rearranged and a new substance (or substances) are formed with different properties. |
| Observable learning outcome: | Evaluate models of the rearrangement of atoms during a chemical reaction between two elements. |
| Question type: | critiquing a representation |
| Key words: | chemical reaction, atom, model, representation |

**What does the research say?**

Research (Kern et al., 2010) found that in a large sample of U.S. high school students whilst over half could successfully balance a chemical equation, less than half could provide an adequate particle representation.

Research (Jaber and BouJaoude, 2012) concluded that part of the challenge students appeared to face in considering the scope and function of particulate representations was an inadequate understanding of the nature and role of models. Some students considered models to be a ‘source of truth’ rather than a tool for reasoning that could provide a simplified representation of reality.

Any particle representation is in itself still a model and is not a direct copy of reality.

Although students may be expected to draw or interpret particle diagrams, this question provides an alternative model using building bricks that can be physically manipulated. The activity asks students to reflect upon how the model is a good, and not so good, representation of the rearrangement of atoms during a chemical reaction. This provides an opportunity to reinforce with students that a model may be a good way to explain a phenomenon but, as it is not an exact copy of reality, it will also have limitations.

**Ways to use this question**

Students should work independently at the outset before sharing answers with the class.

*Differentiation*

Students could be provided with building bricks so that they are able to try out the model for themselves.

**Expected answers**

Answers could include:

*Good representation*

You can physically rearrange the bricks (atoms) to see how the elements at the start can turn into the compound.

The single bricks can attach to each other (unlike a diagram where the circles just touch).

*Not a good representation*

Atoms are not rectangular/ not coloured.

If you take apart an element it looks as if a single atom (brick) is just a small part of that element.

The colours suggest that when atoms join, the original elements are still there so that the compound may have properties resulting from a combination of the properties of the original elements.

**How to respond - what next?**

If students still hold misunderstandings about elements and compounds (for example that an atom is a small fragment of the bulk substance) then they may either not recognise some limitations of the model or they may consider them benefits. It may therefore be necessary to tackle these continuing misconceptions by referring back to an earlier key concept (see key concept CPS1.1: Particle model for the solid, liquid and gas states).

If students have difficulty in evaluating the model it may help to provide possible responses that students could then discuss. The following BEST ‘response activities’ could be used in follow-up to this diagnostic question:

* Sweet model

**Acknowledgments**

Developed by Helen Harden (UYSEG).

Images: Helen Harden

**References**

Jaber, L. Z. and BouJaoude, S. (2012). A macro-micro-symbolic teaching to promote relational understanding of chemical reactions. *International Journal of Science Education,* 34(7)**,** 973-998.

Kern, A. L., et al. (2010). A qualitative report of the ways high school chemistry students attempt to represent a chemical reaction at the atomic/molecular level. *Chemistry Education Research and Practice,* 11**,** 165-172.