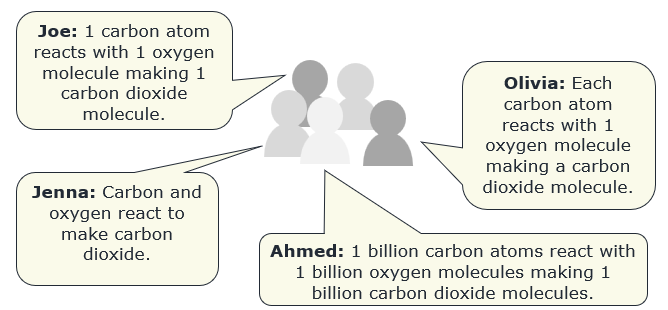
**Interpreting chemical equations**

1. Some students create sentences to describe what the chemical equation C +O2 → CO2 means.

Who do you agree with, and why?



*Chemistry > Big idea CPS: Particles and structure > Topic CPS4: Understanding reactions > Key concept CPS4.2: Conservation of mass*

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| --- |
| **Diagnostic question** |
| **Interpreting chemical equations** |

**Overview**

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| --- | --- |
| Learning focus: | During a chemical reaction no atoms are created or destroyed. Mass is conserved. |
| Observable learning outcome: | Interpret the quantitative meaning of a chemical equation. |
| Question type: | talking heads |
| Key words: | chemical equation, atom, molecule |

**What does the research say?**

An overview of research into students’ understanding of chemical formulae (Taskin and Bernholt, 2012) describes three different meanings of a chemical symbol. A chemical symbol can represent the element, one atom of the element or the substance itself. A variety of research papers such as (Al-Kunifed, Good and Wandersee, 1993) found that many students assume that a chemical symbol is just an abbreviation for the name of the element and similarly that a chemical formula is shorthand for the name of a compound. From this perspective a symbolic chemical equation is merely a shorter version of the word equation for the reaction.

Reading a chemical equation using the interpretation that a symbol represents one atom of an element can lead to misconceptions regarding ionic compounds where NaCl is regarded as a separate small molecule. Whilst one atom of carbon does go on to form one molecule of carbon dioxide this interpretation misses out an important quantitative feature of a chemical reaction, namely stoichiometry. Rather than telling the reader what happens to one atom of carbon it shows the ratio of carbon atom and oxygen molecules that react.

The meaning of a chemical equation may be made clearer by careful use of language. For example:

“Each atom of carbon reacts with one molecule of oxygen”.

**Ways to use this question**

This task is intended for discussion in pairs or small groups. It can be done as a pencil and paper exercise or projected onto a screen.

Students should read the statements and follow the instructions on either the worksheet or the PowerPoint. Listening in to the conversations of each group will often give you insights into how your students are thinking. Each member of a group should be able to report back to the class.

Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*Differentiation*

The quality of the discussions may be improved with a careful selection of groups; or by allocating specific roles to students in each group. For example, you may choose to select a student with strong prior knowledge as the scribe. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

**Expected answers**

Jenna’s answer gives a correct interpretation of the chemical equation. However, Olivia’s answer is preferable as it explains the quantitative information that the chemical equation provides. The other answers are correct in terms of the numerical relationships but do not reflect the more generalised quantitative meaning of the chemical equation.

**How to respond - what next?**

A student who agrees only with Jenna may not understand that a chemical equation also provides quantitative information about a chemical reaction.

A student who agrees with Joe may be interpreting the symbols in the chemical equation as representing single atoms or molecules. Whilst the symbol C is, confusingly, sometimes used to represent an atom of carbon, in a symbolic chemical equation it represents carbon, the substance, as a collection of carbon atoms.

A student who agrees with Ahmed has understood that the chemical equation represents a large number of atoms however this description is very specific and so cannot be a description of the more generalised chemical equation.

If students have misunderstandings about what a chemical equation represents it may help to support students in switching between the symbolic representation of the equation and a sub-microscopic visualisation of the atoms and molecules.

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

* Sulfur reaction diagram

**Acknowledgments**

Developed by Helen Harden (UYSEG).

Images: Helen Harden

**References**

Al-Kunifed, A., Good, R. and Wandersee, J. (1993). Investigation of high school chemistry students' concepts of chemical symbol, formula and equations: Students' prescientific conceptions. ERIC Document ED376020.

Taskin, V. and Bernholt, S. (2012). Students' understanding of chemical formulae: A review of empirical research. *International Journal of Science Education,* 36(1)**,** 157-185.