**Chemical equation checking**

1. Methane burns in oxygen. The products of this combustion reaction are carbon dioxide and water.

Check each chemical equation below.

* 1. Which chemical equation is correct?
  2. What is incorrect about the other chemical equations?

A CH4 +O2 → CO2 + H2O

B CH4 + 2O2 → CO2 + 2H2O

C CH4 +O2 → CO2 + 2H2

D CH2 +O3 → CO2 + H2O

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

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| **Diagnostic question** |
| **Chemical equation checking** |

**Overview**

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| Learning focus: | During a chemical reaction no atoms are created or destroyed. Mass is conserved. |
| Observable learning outcome: | Check a chemical equation to find out if the number of atoms in the reactants is the same as in the products. |
| Question type: | simple multiple choice |
| Key words: | chemical equations, combustion, atom, chemical formula |

**What does the research say?**

A review of empirical research (Taskin and Bernholt, 2012) describes student misunderstandings in translating chemical formulae into particle diagrams. The inclusion of a multiplying coefficient (for example 2N2O) caused additional difficulties.

Some students confused the meaning of a subscript with a multiplying coefficient. They drew O2 as two separate atoms and 2N as two atoms joined.

The review also summarises research findings that concluded that these misunderstandings were contributory factors to student difficulties in balancing chemical equations.

This is consistent with ideas presented by Johnstone (1991) which describe student difficulties in switching between macroscopic, sub-microscopic and symbolic ways of thinking. In the case of checking a chemical equation to find out if there are equal numbers of each type of atom on both sides, it is necessary for students to move between the symbolic chemical equation and a sub-microscopic understanding of the atoms and molecules it represents

**Ways to use this question**

Students should complete the question individually. This could be a pencil and paper exercise, or you could use an electronic ‘voting system’ or mini white boards and the PowerPoint presentation.

If any students are unable to check the chemical equations, this may be because they do not understand that number of each type of atom should be the same on both sides of the chemical equation. Once explained, support could be provided, such as a table to complete, to prompt appropriate counting of atoms. This will allow you to establish whether students are able to interpret the numbers in the chemical equation.

*Differentiation*

It may assist some students if they are first asked to draw a particle diagram for each chemical equation. This may more clearly reveal any misunderstandings of the chemical equation.

**Expected answers**

1a B is correct.

b A does not have the same number of H and O atoms on each side of the equation.

C and D do have the correct number of atoms, but A has changed a product from water to hydrogen and D has changed the substances reacting.

**How to respond - what next?**

A student selecting option A may be simply regarding the chemical equation as a shorthand way of describing the reactants and products of the reaction.

Option C achieves an equal number of each type of atom on both sides of the equation by removing O from water. Combustion of methane does not produce hydrogen (H2) so this is incorrect.

Option 3 also has the correct number of atoms but only by altering the reactants. CH2­ is no longer methane. O3 is actually ozone and not oxygen.

If students have misunderstandings about how to ensure that there are equal numbers of each type of atom on both sides of an equation it may help to reinforce that the distinctive properties of a substance, that give it its identity, arise from the arrangement of atoms in that substance. If the type or number of atoms are changed, then this is no longer the same substance.

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

* Counting atoms

**Acknowledgments**

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Images: None

**References**

Johnstone, A. H. (1991). Why is chemistry difficult to learn? Things are seldom what they seem. *Journal of Computer Assisted Learning,* 7**,** 75-83.

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.