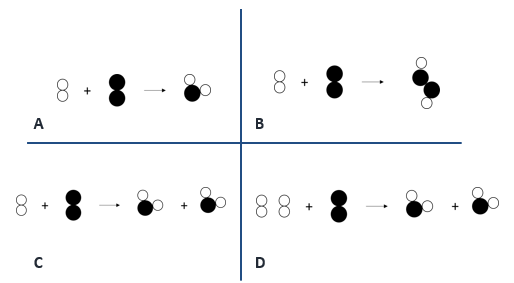
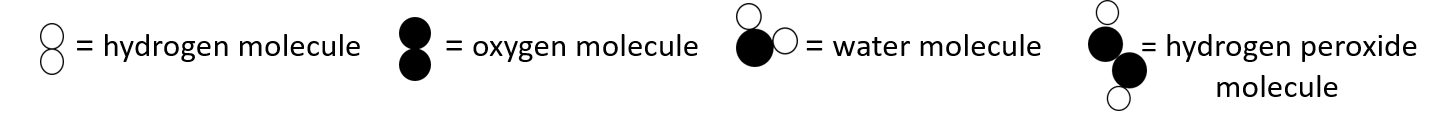
**Reaction diagrams**

1. Hydrogen reacts with oxygen making water.

Which particle diagram best represents this reaction? Why?



Key:



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

|  |
| --- |
| **Diagnostic question** |
| **Reaction diagrams** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | During a chemical reaction no atoms are created or destroyed. Mass is conserved. |
| Observable learning outcome: | Select a particle diagram to correctly show the rearrangement of atoms during a chemical reaction. |
| Question type: | simple multiple choice |
| Key words: | chemical equation, atom, molecule, reactants, products |

**What does the research say?**

This diagnostic question uses particles diagrams in order to focus on student understanding of the rearrangement (and hence conservation) of atoms during a reaction without the addition of misunderstandings regarding the interpretation of chemical formulae and symbolic equations

Research (Al-Kunifed, Good and Wandersee, 1993) found that some students considered a chemical equation to be simply a ‘shorthand’ way of describing a reaction. These students had a poor understanding of the quantitative aspects of a chemical equation. This research finding inspired the distractor answer A in which names of the reactants and products in the word equation for the reaction (hydrogen + oxygen → water) have been replaced by the appropriate particle diagram from the key.

According to Johnson (2000) “Properties (which define identity) are determined by the bonding between atoms and the kinds of structures formed”. In the case of distractor answer B, in which the numbers of atoms are correct, the final product has a different number and arrangement of atoms to water. It is therefore another substance (hydrogen peroxide). This links to an understanding that is essential for the correct balancing of equations, namely that the subscript numbers of formulae must not be altered, otherwise the substance changes.

**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.

The answers to the question will show you whether students understood the concept sufficiently well to apply it correctly.

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs.

*Differentiation*

It may help some students to clarify the meanings of the different ‘circles’ using the key before asking them to answer the question.

**Expected answers**

D – because all the atoms that make up the reactants rearrange to make the products (with none left over).

**How to respond - what next?**

A student choosing option A may be mentally replacing the names of the reactants (hydrogen and oxygen) and the product (water) with the correct diagrams without understanding that the atoms of the former must rearrange to form the latter.

Selection of B may imply that the student does realise that the number of atoms in the reactants should be the same as products but that they have not understood that the joining of H and O atoms in a different way (H2O2) makes a compound with different properties to water. It is therefore a different substance.

A student opting for C may have correctly identified the need for two water molecules as products (given the two oxygen atoms in the reactants) but has not realised that two hydrogen molecules are also needed.

If students have misunderstandings about the need for the number of each type of atom in the reactants to equal the number of each type in the products, it may help to use some type of physical manipulative such as counters. The students can then rearrange the atoms for themselves and should see more clearly the need for the same numbers of atoms.

**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.

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