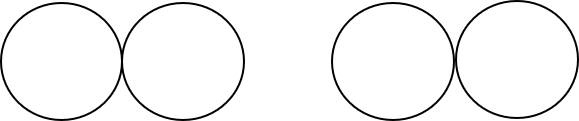
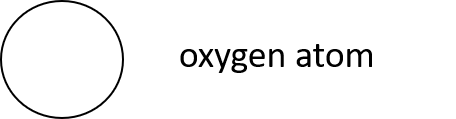
**More than one molecule**

1. Which expression best describes the diagram below?



Key:



A O4

B 4O

C 2O2

D O2O2

*Chemistry > Big idea CPS: Particles and structure > Topic CPS2: Elements and compounds > Key concept CPS2.2: Symbols and formulae*

|  |
| --- |
| **Diagnostic question** |
| **More than one molecule** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | A chemical formula provides information on the composition of a substance. |
| Observable learning outcome: | Select an appropriate expression to represent more than one molecule. |
| Question type: | simple multiple choice |
| Key words: | atom, molecule, 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.

Another study observed that some students who were given the expression 2NO2 matched it with a diagram showing two separate N atoms and an O2 molecule. In other words, they did not recognise that NO2 was an integrative formula for a substance that could not be broken down into discrete particles. Instead they appeared to have regarded 2N as separate to O2.

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

**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.

*Differentiation*

Students could be provided with physical props (for example counters) with which to make each answer option.

**Expected answers**

C

**How to respond - what next?**

Selection of options A and B suggests that a student is counting atoms but is not expressing the existence of two discrete molecules. The expression in A suggests that the four oxygen atoms are all joined whereas B implies that the four atoms are separate. Selection of option D shows that the student has recognised the presence of two molecules but may be unfamiliar with the use of a ‘large number’ as a multiplying factor.

If students have misunderstandings about how to express more than one molecule it may help to draw what each of the incorrect answers represents.

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

* Molecule expressions

**Acknowledgments**

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Images: Helen Harden

**References**

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.