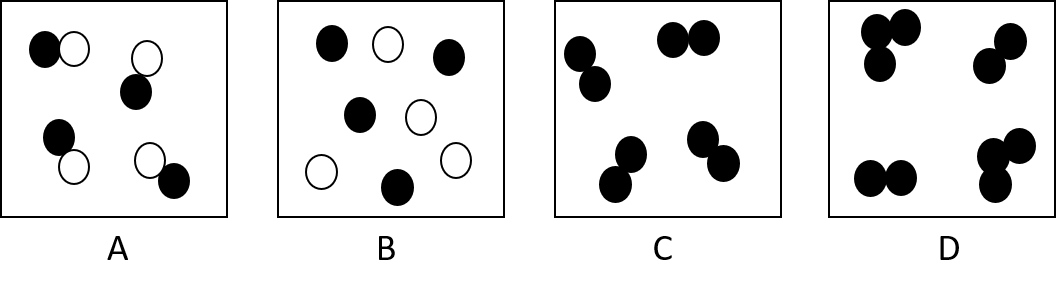
**Counting substances**

1. Which of the diagrams below represent more than one substance?



A A, B and D

B B only

C A, C and D

D B and D

*Chemistry > Big idea CPS: Particles and structure> Topic CPS2: Elements and compounds > Key concept CPS2.1: Atoms and molecules*

|  |
| --- |
| **Diagnostic question** |
| **Counting substances** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | The properties of elements and compounds arise from the structural arrangement of their constituent atoms. |
| Observable learning outcome: | Identify the number of substances (elements or compounds) represented in a particle diagram. |
| Question type: | simple multiple choice |
| Key words: | substance, atom, molecule |

**What does the research say?**

Research carried out through the Children’s Learning in Science Project (Briggs and Holding, 1986) showed that a large proportion of students failed to appreciate that two circles in contact represented atoms that were joined (combined). Instead, they regarded the atoms as being intermingled in some way. This led to confusion for students in distinguishing a diagram showing a single compound made up of molecules containing two different types of atom with another diagram showing a mixture of atoms of two elements.

**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.

**Expected answers**

D

**How to respond - what next?**

Selection of option A suggests that a student does not realise that the touching of circles in the diagrams means that the atoms are joined and therefore the molecules shown in diagram a are a single substance that is different to either of the substances shown in diagram b.

Selection of option B means that the student has not recognised that d also shows more than one substance. This may mean that they do not understand that different number of atoms in a molecule result in different properties and hence a different substance.

Option C includes all the diagrams which show atoms joined as molecules. Although these could mistakenly be thought of as compounds by a few students they are unlikely to confuse the number of substances.

If students have misunderstandings about how different arrangement of atoms in molecules result in different substances (and properties) they could be introduced to some real-life comparisons. For example, they could be provided with molecule diagrams for oxygen molecules (O2) and ozone molecules (O3) or water (H2O) and hydrogen peroxide (H2O2) and then find out the differences in their properties.

**Acknowledgments**

Developed by Helen Harden (UYSEG), from an idea by the Children’s Learning in Science Project.

Images: Helen Harden

**References**

Briggs, H. and Holding, B. (1986). *Children's Learning in Science Project. Aspects of secondary students' understanding of elementary ideas in chemistry: Full repoty.* [Online]. Available at: <https://www.stem.org.uk/elibrary/resource/26944>.