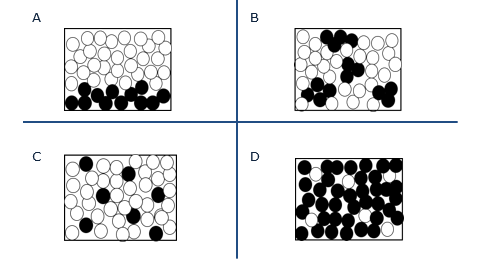
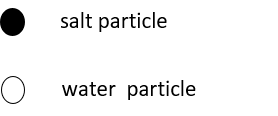
**Solution diagram**

1. Some salt is dissolved in water.

Which particle diagram do you think is the best representation of the solution?





*Chemistry > Big idea CPS: Particles and stucture > Topic CPS1: Substances and mixtures > Key concept CPS1.2: Particles in solutions*

|  |
| --- |
| **Diagnostic question** |
| **Solution diagram** |

|  |  |
| --- | --- |
| Learning focus: | Understand how a particle model of matter can be used to describe and explain solutions. |
| Observable learning outcome: | Use the particle model to represent a solute dissolved in a solvent. |
| Question type: | simple multiple choice |
| Key words: | dissolve, particle, solution |

**What does the research say?**

Johnstone (1991) explains the difficulties that many students face in understanding science as the degree of ‘multilevel’ thought required. In chemistry students are frequently required to think about very different types of thing all at once.

Johnstone presented this in the form of a triangle:



*(after Johnstone, 1991, p78)*

Taber (2013) and Talanquer (2011) discuss how this triangle (or chemistry triplet) has been interpreted in chemistry education. Understanding chemistry macroscopically can be interpreted as the everyday observations of chemical phenomena and also the way in which these are explained in terms of substances elements or compounds. Sub-microscopic may refer to models such as the particle model or the real-life sub-microscopic structure of substances and materials. Symbolic may refer specifically to the symbolic systems used to communicate chemistry or apply more widely to representations. However, representation at the particle level could be regarded as sub-microscopic so the categorisation of how students are required to think about chemistry is not clearly defined.

Regardless of variations in the specific use of Johnstone’s triangle and its terminology there is general agreement that the ‘expert’ chemist is familiar and confident in thinking in a variety of ways about a phenomenon. In comparison, the ‘novice’ is not, which adds greatly to the level of processing required of students in order for them to understand chemistry.

Solutions form a key part of many chemistry topics studied and therefore it is important to assess whether students can confidently think about a solution at both a macroscopic and sub-microscopic level.

**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.

**Expected answers**

C

**How to respond - what next?**

Option A shows two liquids that are layered. Selection of option A could indicate that the student thinks that the salt becomes a liquid and therefore becomes clear and colourless like the water.

Option B is a more appropriate diagram for a suspension (although of course the tiny solid fragments in a suspension are made of a great many more particles). This option indicates that the student does not understand that the solute breaks down into individual particles.

Option D checks that students think carefully about which particles are represented by the black and white circles. Option D shows water ‘particles’ interspersed within liquid salt, which is not correct.

If students have difficulties in translating from a particle diagram to what it shows in real life it is important to ensure that they have repeated opportunities to link particle diagrams to macroscopic observations. Students could be asked to look again at these diagrams and to discuss what they show macroscopically.

Alternatively, the following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Particle diagram matching

**Acknowledgments**

Developed by Helen Harden (UYSEG).

Images: Helen Harden

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