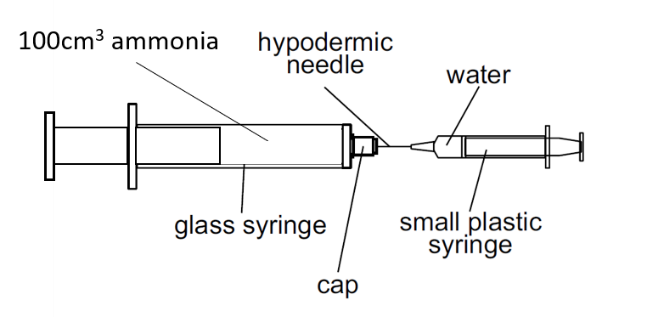
**Dissolving ammonia**

**Predict**

How will the volume of ammonia change when 1cm3 water is injected into the syringe?



**Explain**

Explain the thinking behind your prediction.

**Observe**

Describe what happens

**Explain**

Now that you have seen what happens, can you explain your observations?

(If your prediction and explanation earlier were right, just say so. There is no need to write it again.)

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

|  |
| --- |
| **Diagnostic question** |
| **Dissolving ammonia** |

|  |  |
| --- | --- |
| Learning focus: | Understand how a particle model of matter can be used to describe and explain solutions. |
| Observable learning outcome: | Explain observations of dissolving using the particle model. |
| Question type: | predict- explain-observe-explain |
| Key words: | gas, liquid, state, particle, dissolve, volume |

**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.

Jaber and Boujaoude (2012) carried out research into whether a macroscopic-sub-microscopic-symbolic teaching approach could improve students’ relation understanding of chemical reactions. Their research showed that most students were able to interpret chemical reactions at the macroscopic level but that they tended to apply macroscopic reasoning to explain phenomena at the sub-microscopic level. They also frequently regarded models, that are designed to support explanations, as exact copies of reality. Their research focused on the explicit teaching of concepts at the micro, sub-microscopic and symbolic levels at first discretely and then interrelated. Their research showed an improvement in students’ relational understanding.

**Ways to use this question**

This question may be carried out as a pencil and paper exercise using the presentation provided. The diagram on the second slide provides the observation of what happens.

However, this question may also be delivered with a demonstration of the experiment. The student worksheet does not include a diagram of the observation and is therefore better suited to use alongside a demonstration

For information on how to carry out the demonstration see ‘Stuff and Substance: Ten Key Practical in Chemistry’ activity 5 (Gatsby Science Enhancement Programme).

<https://www.stem.org.uk/elibrary/resource/29586>

A video of the demonstration is available on the ‘Stuff and Substance’ online resource

<https://11567.stem.org.uk/i3_2.html>

Please be aware that resources have been published on the website in the form that they were originally supplied. This means that procedures reflect general practice and standards applicable at the time resources were produced and cannot be assumed to be acceptable today. Website users are fully responsible for ensuring that any activity, including practical work, which they carry out is in accordance with current regulations related to health and safety and that an appropriate risk assessment has been carried out.

*Differentiation*

Ensure that students have been introduced to the concept that a substance in the gas state can still dissolve in a liquid.

**Expected answers**

The correct prediction is that the volume on the gas syringe will decrease significantly because the ammonia dissolves in the water. In the gas state the particles of ammonia are very spread out, so all the ammonia is able to dissolve in 1cm3 of water.

**How to respond - what next?**

Students may not expect such a large volume of ammonia to dissolve in the water. Particle diagrams in books show the particles far closer in the gas state than they really are.

If students have misunderstandings about the dissolving of substances in the gas state, they could investigate the volume of carbon dioxide dissolved in a bottle of carbonated water (Stuff and Substance activity A5).

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

* Representing solutions

**Acknowledgments**

Developed by Helen Harden (UYSEG), from an idea selected from ‘Stuff and Substance’, Gatsby Science Enhancement Programme

Images: York Science adapted by Helen Harden

**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

Taber, K.S. (2013). Revisiting the chemistry triplet: drawing upon the nature of chemical knowledge and the psychology of learning to inform chemistry education. *Chemistry Education Research and Practice*, 14, 156

Talanquer, V. (2011). Macro, sub-micro and symbolic: The many faces of the chemistry “triplet”. *International Journal of Science Education*, 33(2) 179-195

Jabar, L.Z., Boujaoude, S. (2012). A macro-micro-symbolic teaching to promote relational understanding of chemical reactions. *International Journal of Science Education*, 34(7) 973-998