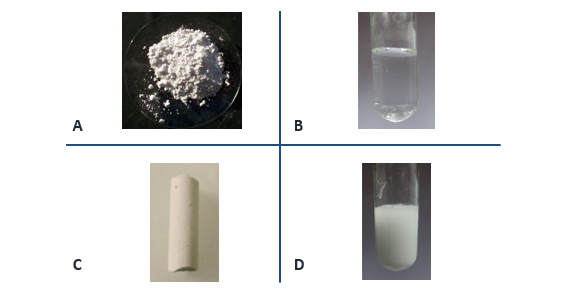
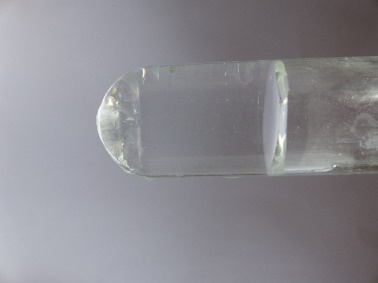
**State symbols**

1. Which of the following could contain CaCO3 (s)?

You may select one or more option.



1. Look at the test tube.



Which of the following could correctly represent its contents?

You may select one or more option.

A H2O(aq)

B H2O (l)

C NaCl (aq)

D NaCl (s)

*Chemistry > Big idea CPS: Particles and structure > Topic CPS4: Understanding reactions > Key concept CPS4.1: Representing reactions*

|  |
| --- |
| **Diagnostic question** |
| **State symbols** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | A chemical reaction can be summarised by a chemical equation. |
| Observable learning outcome: | Match a chemical formula and state symbol to a macroscopic observation. |
| Question type: | simple multiple choice |
| Key words: | state symbol, solid, liquid, gas, aqueous |

**What does the research say?**

Johnstone (1991) used a triangle to summarise three levels of representation that he proposed are needed in order to understand chemistry.



*Figure 1 Johnstone’s triangle*

Johnstone (2000) highlights how in chemistry teaching students are often introduced to all three levels of representation simultaneously. Whilst an experienced chemist may be able to manipulate all three, he suggests that this may overload the “working space” (working memory) of school students.

Jaber and BaJaoude (2012) build on previous work (Treagust, Chittleborough and Mamiala, 2003) that links levels of understanding to the use of different levels of representation in chemistry.

They propose that at an instrumental level of understanding (knowing how) students learn chemical concepts at the three levels separately. This may lead to fragmented and compartmentalised knowledge.

They then suggest that in order to acquire a relational level of understanding (knowing why) students need to develop ways to move easily and skilfully within Johnstone’s triangle.

The researchers then compared an experimental group with a control group where the experimental group received:

* explicit teaching at and about macro, micro and symbolic levels and the interplay between them
* use of multiple schematic and symbolic representations
* explicit teaching about models

In conclusion, the research recommends the adaption of a macro-micro-symbolic approach to instructions and suggests that this should become a ‘habit of teaching’.

This diagnostic question checks whether students are able to make the link between a symbolic representation (chemical formula and state symbol) and a macroscopic observation of a substance in the solid state or solution.

**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.

Asking students to then share their answers and reasons may help to provide more information about their understanding.

*Differentiation*

Some students may benefit from being able to observe real life samples.

**Equipment**

For each student/pair/group (optional):

* calcium carbonate powder
* test tube containing water
* chalk stick (or a marble chip)
* test tube containing calcium carbonate powder suspension.

**Expected answers**

1 A, C and D

2 B, C

**How to respond - what next?**

A student who does not select either A or D for question 1 may not realise that powder is a solid form of a substance or that a suspension contains a powder.

Selection of A for question 2 suggests that a student may not understand that aqueous refers to a solution.

If students have misunderstandings about what a chemical formula and state symbol represent in terms of a macroscopic observation, then they may benefit from ongoing practice and reinforcement when encountering a range of chemical reactions. The following BEST ‘response activities’ could be used in follow-up to this diagnostic question:

* State symbol observations

**Acknowledgments**

Developed by Helen Harden (UYSEG).

Images: Johnstone’s triangle based upon original illustration in (Johnstone, 1991)

**References**

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