**Thinking in diagrams**

Iron and sulfur are both elements.

Iron reacts with sulfur. This makes the compound iron sulfide.

1. Draw a diagram to show the arrangement of atoms in
   1. iron
   2. sulfur
   3. iron sulfide

*Chemistry > Big idea CPS: Particles and structure > Topic CPS3: Chemical change > Key concept CPS3.1: Rearrangement of atoms*

|  |
| --- |
| **Diagnostic question** |
| **Thinking in diagrams** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | During a chemical reaction, atoms are rearranged and a new substance (or substances) are formed with different properties. |
| Observable learning outcome: | Use particle diagrams to represent the reactants and products of a reaction between elements. |
| Question type: | drawing diagram |
| Key words: | element, compound, reaction |

**What does the research say?**

Research (Kern et al., 2010) found that whilst over half (65%) of the more than one thousand U.S. high school students who took part in the study could correctly balance the given chemical equation, less than half (31%) could provide an adequate particle representation.

The introduction to another research paper (Cheng and Gilbert, 2017) described the importance of ‘model-based reasoning’. Model-based reasoning requires the ability to explain physical phenomena using theoretical and unobservable entities.

Whilst the expert chemist can move easily between the macroscopic and sub-microscopic levels this is much more challenging for the novice student (Johnstone, 1991).

**Ways to use this question**

The aim of this question is for students to draw a particle representation of the reactants and products of a simple reaction between elements. You may wish to explain to students that the ability to ‘think in diagrams’ should help them to understand what happens to the atoms during a reaction.

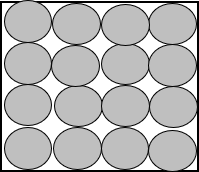
It may help students to observe the actual reaction to ensure they are aware that both the reactants and product are in the solid state.

*Differentiation*

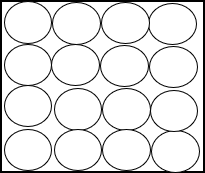
Some students may need some support such as providing a key to show how to represent two types of atoms by using different colours.

Some students could be challenged further to consider quantitatively what happens to the atoms. They should recognise that if drawing a diagram to represent the reaction (rather than the individual substances) the number of atoms should stay the same. The idea is explored in a later key concept: CPS4.2 Conservation of mass.

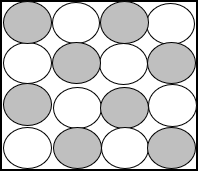
**Expected answers**

a

= iron atom

b

= sulfur atom

c

**How to respond - what next?**

A student who has difficulty in drawing particle representations of the reactants may not be making links with their understanding of the particle model. They need to extend the conventional representation of a substance in the solid state to make clear that iron and sulfur are made of different types of atom.

If students have misunderstandings about how to represent compounds, then they may benefit from revisiting previous work on elements and compounds. See key concept 2.1: Atoms and molecules.

**Acknowledgments**

Developed by Helen Harden (UYSEG) from an idea by Maurice Cheng (University off Hong Kong) and John Gilbert (King’s College London).

Images: Helen Harden

**References**

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