**Making sodium chloride**

Sodium metal reacts with chlorine to form sodium chloride. Two students draw particle diagrams to represent the reaction.

The chemical equation for the reaction is

2Na(s) + Cl2(g) → 2NaCl(s)

Particle diagram A:

A picture containing icon

Description automatically generated

Particle diagram B:

A picture containing drawing

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**1.** Describe a benefit of particle diagram one. What does it help the student to understand?

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**2.** Describe a disadvantage of particle diagram one. What misunderstandings could it cause the student?

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**3.** Describe how particle diagram two could help to avoid these misunderstandings.

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*Chemistry > Big idea CPS: Particles and structure> Topic CPS8: Ionic bonding > Key concept CPS8.1: Ionic lattice*

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| **Response activity** |
| **Making sodium chloride** |

**Overview**

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| Learning focus: | Ionic bonding occurs through the electrostatic attraction between ions in an ionic lattice. |
| Observable learning outcome: | Recognise the limitations of what is represented by a dot-and-cross diagram. |
| Activity type: | Critiquing a representation |
| Key words: | ion, ionic bond |

This activity can help develop students’ understanding by addressing the misunderstandings revealed by the following diagnostic question:

* Dot and cross diagram

**What does the research say?**

Taber and Coll (2002) comment that diagrams often show reactants as separate atoms and that this simplification, which fails to represent the molecular or lattice structures, may lead to misconceptions. Students may think of elements in reactions as being present as separate atoms and the compounds formed as being made of molecules. The misconception that ionic lattices contain molecular species is considered to be very common.

Another paper (Taber, Tsaparlis and Nakiboğlu, 2012) describes the implications of a student holding the idea that an ionic bond is formed by the process of electron transfer between particular atoms. Misconceptions that can arise from this idea include the idea that ionic compounds are made of ion-pair molecules, that ions can only be bonded to ions with which electron transfer has taken place and that interactions with other adjacent ions cannot be proper ionic bonds and are “just” forces of attraction.

**Ways to use this activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. It is through the discussions that students can check their understanding and rehearse their explanations.

Students should work together to answer the questions on either the worksheet or the PowerPoint. Giving each group one worksheet to complete between them is helpful for encouraging discussion, but each member should be able to report back to the class. Listening in to the conversations of each group will often give you insights into how your students are thinking.

Ending with the students completing the worksheet or questions from the PowerPoint individually, might help them to consolidate their learning.

*Differentiation*

You may choose to use simplified worksheets for some students, for example with gaps to fill in so they can focus on the science. In some situations, it may be more appropriate for a teaching assistant to read and/or scribe for one or two students.

**Expected answers**

1. Particle diagram A helps to show the ratio in which sodium atoms and chlorine atoms react. A student could use a diagram like this to help them to balance the chemical equation.
2. Particle diagram A might cause student misunderstandings about the structure of sodium and encourage students to think that sodium is made up of separate atoms. It could make students think that sodium chloride is made up of molecules. It could also cause confusion about the state of the reactants and products.
3. Particle diagram B relates more closely to the particle model and it can be clearly seen that sodium and sodium chloride have a giant structure typical of substances that are in the solid state at room temperature and that chlorine is made up of separate molecules (which is consistent with it being in the gas state at room temperature).

**Acknowledgments**

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Images: Helen Harden (UYSEG)

**References**

Taber, K. S. (2019). Conceptual confusion in the chemistry curriculum:exemplifying the problematic nature of representing chemical concepts as target knowledge. *Foundations of Chemistry,* 22**,** 309-334.

Taber, K. S. and Coll, R. K. (2002). Chemical Education: Towards Research-based Practice. In Gilbert, J. K., DeJong, O., Justi, R., Treagst, D. F. & Van Driel, J. H. (eds.) *Chemical Education: Towards Research-based Practice.* Dortrecht: Kluwer Academic Publishers.

Taber, K. S., Tsaparlis, G. and Nakibo ğlu, C. (2012). Student conceptions of ionic bonding: Patterns of thinking across three European contexts. *Internationl Journal of Science Education,* 34(18)**,** 2843-2873.