**Lattice model**

A picture containing indoor, small, table, sitting

Description automatically generated

A teacher shows her class a “ball and stick” model of the lattice structure of sodium chloride.

What do the sticks represent in the model?

*Put a tick (✓) in the box next to the best answer.*

|  |  |  |
| --- | --- | --- |
| **A** | ionic bonds only |  |
|  |  |  |
| **B** | forces of attraction (but not bonds) only |  |
|  |  |  |
| **C** | ionic bonds and forces of attraction |  |
|  |  |  |
| **D** | physical connections |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Lattice model** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Ionic bonding occurs due to the electrostatic attraction between oppositely charged ions in an ionic lattice. |
| Observable learning outcome: | Recognise that ionic bonding occurs in all directions between oppositely charged ions in an ionic lattice. |
| Question type: | Simple multiple choice |
| Key words: | ion, lattice, electrostatic attraction |

**What does the research say?**

In their paper on student conceptions of ionic bonding Taber, Tsaparlis and Nakiboğlu (2012) cite earlier research which found that many students held an alternative “molecular framework” about ionic bonding. Some students thought an ionic bond was only formed between ions where electron transfer had occurred. These students thought of ions as being bonded in pairs. This one misconception was found to lead to further misunderstandings which combined to form an alternative way of thinking about ionic bonding.

This alternative “molecular framework” of thinking is thought to arise due to the inferences that are drawn from the initial idea. If students think that an ionic bond is formed by the transfer of electrons, then this implies to them the existence of ionic molecules made up of pairs of ions. This in turn implies that in an ionic lattice each ion can only form an ionic bond with one other ion leading students to conclude that the interaction with other ions is not ionic bonding but rather some other “force of attraction”. Some students think that an ionic lattice is made up of a combination of ion pairs.

The paper recommends that the focus of teaching (and curricula) should be on the idea of an ionic lattice held together by mutual attraction between oppositely charged ions. This would encourage students to learn about the idea of ionic bonding as a lattice phenomenon from the outset. Learning about the idea of an ionic bond through methods like dot and cross diagrams risks implying to students that ions form ion pairs hence causing some to develop the “molecular framework” instead of the more scientifically appropriate “electrostatic framework”.

**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.

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs.

*Differentiation*

You may choose to read the questions to the class, so that everyone can focus on the science. In some situations, it may be more appropriate for a teaching assistant to read for one or two students.

**Equipment**

For the class:

* ball and stick model of sodium chloride (optional)

**Expected answers**

A

**How to respond - what next?**

A student who selection option D may be taking the model as being a representation of reality. The physical connectors in the model in fact represent electrostatic interactions.

Selection of option B indicates that the student may not be familiar with ionic bonding. Selection of option C suggests that the student may hold an alternative molecular framework in which an ionic bond forms, through the transfer of electrons, between an ion pair. Other interactions are therefore relegated to the status of “forces of attraction”.

If students have misunderstandings about ionic bonding as a lattice phenomenon it may help to think about teaching that could have given the impression that ions for ion pairs (for example typical dot and cross diagrams). Making students explicitly aware of the limitations of simple models like this may help to reduce misconceptions.

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

* Thinking about ionic bonding

**Acknowledgments**

Developed by Helen Harden (UYSEG

Images: Ausis via Wikimedia Commons <https://upload.wikimedia.org/wikipedia/commons/d/de/Nacl-structure.jpg>

**References**

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.