**Revision language**

A child sitting at a table using a computer

Description automatically generated

Alice is trying to revise how to draw dot and cross diagrams to show the formation of ions.

A revision website says:

The sodium atom loses one electron, and the chlorine atom gains one electron because atoms need a full outer shell.

Graphical user interface, application

Description automatically generated

[This Photo](https://www.blogs.hss.ed.ac.uk/pubs-and-publications/2016/10/17/preparing-for-your-literature-review/) by Unknown Author is licensed under [CC BY-NC-ND](https://creativecommons.org/licenses/by-nc-nd/3.0/)

* 1. How might the language used by the revision site help Alice to remember what to draw?
  2. How might the language lead to misunderstandings?

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

|  |
| --- |
| **Response activity** |
| **Revision language** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Ionic bonding occurs through the electrostatic attraction between ions in an ionic lattice. |
| Observable learning outcome: | Recognise the uses and limitations of the idea of full outer shells. |
| Activity type: | Critiquing language |
| Key words: | ion, atoms |

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

* Full shells

**What does the research say?**

In an essay Gillespie and Robinson (2007) describe the origins of the octet rule in which shared electrons were said to count towards a total of eight electrons in the valence (outer) shell of atoms in covalently bonded molecules. The rule was consistent with the outer shell of many stable ions containing eight electrons. However this essay describes how the idea was picked up by Langmuir and used in his teaching leading to an over emphasis on the rule which moved from being a simple rule to derive formulae (with exceptions) based on empirical observations to something closer to a fundamental law of nature.

One small research study (Joki and Aksela, 2018) found that whilst students at first had an adequate model of bonding that emphasised electrostatic interactions, by upper secondary level students had developed an equally strong alternative framework of thinking that related to the idea of full outer shells (octet rule).

The paper suggests that this way of thinking is linked to the intuitive idea that “emptiness needs filling”. In contrast the electrostatic framework of thinking is based on the idea that “opposites attract”.

The researchers also explored the challenges of teaching bonding using the electrostatic framework and found that students preferred an explanation where the full outer shell becomes the cause for what happens (chemical reactions). The recommendation is made is to increase students’ metacognitive awareness of different frameworks for thinking and their uses.

The paper mentions a third framework that relates to minimum energy however this is not usually introduced in the school curriculum until later.

**Ways to use this activity**

Students should discuss the questions in pairs before sharing suggestions with the whole class.

Listening into discussion will help reveal student thinking which may inform further questions and discussion points with the whole class.

*Differentiation*

Some groups of students may benefit from teacher-guided discussion to support their thinking.

**Expected answers**

The language may help Alice to remember that when she draws the ions the number of electrons in the outer shell must equal eight (or two in the inner shell). However, the language gives the impression that an atom has needs and that the reaction happens because of these needs.

**Acknowledgments**

Developed by Helen Harden (UYSEG).

Images:

Student image by [Jan Vašek](https://pixabay.com/users/jeshoots-com-264599/?utm_source=link-attribution&utm_medium=referral&utm_campaign=image&utm_content=3087585) from [Pixabay](https://pixabay.com/?utm_source=link-attribution&utm_medium=referral&utm_campaign=image&utm_content=3087585)

Diagram by Helen Harden (UYSEG)

**References**

Gillespie, R. J. and Robinson, E. A. (2007). Gilbert N. Lewis and the chemical bond: The electron pair and the octet rule from 1916 to the present day. *Journal of Computational Chemistry,* 28**,** 87-97.

Joki, J. and Aksela, M. (2018). The challenges of learning and teachng chemical bonding at diffeent school levels using electrostatic interactions instead of the octet rule as a teaching model. *Chemical Education Research and Practice,* 19.