A body of water with a mountain in the background

Description automatically generated**Sea of electrons**

The ‘free’ outer electrons in a metallic structure are often described as a ‘sea of electrons’.

**1.** Complete the following sentences.

The ‘free’ outer electrons in this model are like the sea because…

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The ‘free’ outer electrons in this model are not like the sea because…

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*Chemistry > Big idea CPS: Particles and structure > Topic CPS7: Metallic bonding Key concept CPS7.1: Metallic structure model*

|  |
| --- |
| **Response activity** |
| **Sea of electrons** |

**Overview**

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| --- | --- |
| Learning focus: | A model of metallic structure, made up of positive metal ions surrounded by ‘free’ outer electrons, can explain some properties of metals. |
| Observable learning outcome: | Critique representations of metallic structure. |
| Question type: | Critiquing language |
| Key words: | electrons |

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

* Metallic structure diagrams

**What does the research say?**

Taber and Coll (2002) report that some students describe metallic bonding as involving a ‘sea of electrons” but that they had learnt this as a term, rather than understanding the model. Some students seemed to have been influenced by the ‘sea’ metaphor to the extent that they drew diagrams of the ‘sea’ as a vast excess of electrons.

Other research (de Posada, 1999) into the presentation of metallic bonding in textbooks found that several metaphors are used in relation to metallic bonding including electron ‘sea’ and also the idea of a metallic ‘lattice’. The authors caution that as students use these terms in everyday contexts, they can form fixed ideas that are then difficult to shift. The diversity of models used in the books was also a potential source of challenge for students with some diagrams showing a particulate representation of electrons but others a delocalised electron cloud. Some diagrams confusingly mixed the two by showing particulate electrons in a shaded area labelled as the electron ‘sea’.

**Ways to use this activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions.

Students may discuss ideas such as:

The ‘free’ outer electrons are like the sea because they are free to move away from the charged metal ions.

The ‘free’ outer electrons are not like the sea because there are only as many electrons as there are metal cations.

*Differentiation*

Students could be encouraged to make links with learning in English lessons regarding metaphors. Other examples from chemistry could be given, for example, a lattice of metal ions could be compared with a picture of a lattice topped pie.

**Expected answers**

**Acknowledgments**

Developed by Helen Harden (UYSEG)

Images: Helen Harden (UYSEG)

**References**

de Posada, J. é. M. (1999). The presentation of metallic bonding in high school science textbooks during three decades: Science educational reforms and substantive changes of tendencies. *Science Education,* 83**,** 423-447.

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.