**Explaining metals**

Some students have drawn diagrams to show how they think about a metal.

A picture containing lamp, light

Description automatically generatedA picture containing light

Description automatically generated

B

A

A picture containing drawing

Description automatically generated

D

C

A close up of a logo

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1. Who do you think will be able explain the following?

*Explain your answer.*

aluminium conducts electricity

copper can be hammered into shape

copper is a better electrical conductor than aluminium

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

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| **Response activity** |
| **Explaining metals** |

**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: | Evaluate the metallic structure model in terms of its ability to explain physical properties of metals. |
| Activity type: | Thinking heads |
| Key words: | electron, ion, model, electrical conductor |

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

* Metal properties

**What does the research say?**

Cheng and Oon (2016) introduce their paper on understanding of metallic bonding with a quote from Gilbert (2004) which describes the learning of school science as the progressive study of different models of physical phenomena.

A paper (Harrison and Treagust, 1996) uses a system devised by Grosslight et al. (1991) to categorise different levels of thinking about models.

Level 1- Thinking of models as simple copies of reality

Level 2- Recognising that models have an explicit purpose which affects how the model is constructed and that the model does not have to correspond with reality

Level 3 – Recognising that a model serves the development and testing of ideas.

Students at level 3 would be able to construct and manipulate multiple models.

Students are usually introduced first to a basic particle model and only later to models of chemical bonding. As students progress, they are required to change the model that they are using. Understanding that models have an explicit explanatory purpose may help students to make this transition. More advanced chemistry requires a more advanced explanatory model.

As well as thinking using an appropriate model for a purpose, an expert chemist, according to Johnstone (1991) can fluently switch between thinking at a macroscopic level, sub-microscopic level and symbolically. This three-level way of thinking is summarised in the paper as Johnstone’s triangle. The mental models required to think about chemical bonding all require a sub-microscopic way of thinking.

**Ways to use this activity**

This task is intended for discussion in pairs or small groups. It can be done as a pencil and paper exercise or projected onto a screen.

Students should read the statements and follow the instructions on either the worksheet or the PowerPoint. Listening in to the conversations of each group will often give you insights into how your students are thinking. Each member of a group should be able to report back to the class.

Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in each group. For example, you may choose to select a student with strong prior knowledge as the scribe. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

NB in any class, small group discussions typically improve over time and a persistence with this strategy is often very successful in the medium to long term.

**Expected answers**

Student A can explain a and b. Student B can explain b. None can explain c.

**Acknowledgments**

Developed by Helen Harden (UYSEG).

Images:

Metal image by [PublicDomainPictures](https://pixabay.com/users/PublicDomainPictures-14/?utm_source=link-attribution&utm_medium=referral&utm_campaign=image&utm_content=18906) from [Pixabay](https://pixabay.com/?utm_source=link-attribution&utm_medium=referral&utm_campaign=image&utm_content=18906)

Diagrams by Helen Harden (UYSEG)

**References**

Cheng, M. M. W. and Oon, P.-T. (2016). Understanding metallic bonding: Structure, process and interaction by Rasch analysis. *International Journal of Science Education,* 38(12)**,** 1923-1944.

Gilbert, J. K. (2004). Models and modeling: Routes to more authentic science education. *International Journal of Science and Mathematics Education,* 2(2)**,** 115-130.

Grosslight , L., et al. (1991). Understanding models and their use in science: Conceptions of middle and high school students and experts. *Journal of Research in Science Teaching,* 28**,** 799-822.

Harrison, A. G. and Treagust, D. F. (1996). Secondary students' mental models of atoms and moelcules: Implications for teaching chemistry. *Science Education,* 80(5)**,** 509-534.

Johnstone, A. H. (1991). Why is chemistry difficult to learn? Things are seldom what they seem. *Journal of Computer Assisted Learning,* 7**,** 75-83.