**Metallic structure**

Aluminium is a metal. It has a metallic structure.

A close up of a building

Description automatically generated

According to the basic atomic model, an aluminium atom is made up of a central nucleus, inner electrons and outer electrons.

A picture containing clock

Description automatically generated

**1** Complete the following sentence.

The structure of aluminium is made up of a regular arrangement of …

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

|  |  |  |
| --- | --- | --- |
| **A** | aluminium nuclei, inner and outer electrons |  |
|  |  |  |
| **B** | aluminium nuclei and inner electrons |  |
|  |  |  |
| **C** | aluminium nuclei only |  |
|  |  |  |
| **D** | outer electrons |  |

**2** Complete the following sentence.

The outer electrons…

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

|  |  |  |
| --- | --- | --- |
| **A** | can move between positive ions. |  |
|  |  |  |
| **B** | still belong to a specific nucleus. |  |
|  |  |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Metallic structure** |

**Overview**

|  |  |
| --- | --- |
| 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: | Describe a model of metallic structure (positive ions and ‘free’ outer electrons). |
| Question type: | Simple multiple choice |
| Key words: | nucleus, nuclei, electron, model |

**What does the research say?**

Taber and Coll (2002) list possible sources of student misunderstandings as early experiences, folk science and everyday meanings of technical words. However, the authors note that chemical bonding does not fall within everyday experience, so misunderstandings are more likely to have arisen from teaching.

Taber (2003) proposes that anachronistic notions of the atom that survive in the chemistry curriculum encourage students to give atoms priority in their thinking. For example, it is common to talk about an element being made up of one type of atom. This level of simplification may be appropriate for younger students but whilst an experienced chemist knows that a metal is not actually made up of bonded atoms a learner of chemistry may think that the whole atom is involved. The model of metallic structure commonly used when teaching fourteen to sixteen year olds consists of metal ions surrounded by ‘free’ outer electrons. Making this explicit and exploring how this model has progressed from a basic particle model may therefore help to reduce student misconceptions.

**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.

**Expected answers**

1 B, 2 A

**How to respond - what next?**

A student who selects option A may be thinking of metals as being made of atoms. This is not surprising as younger students are often introduced to elements as being made of one type of atom.

Selection of topic C could suggest that the student does not understand that only the outer electrons are delocalised in this model of a metallic structure. The idea of delocalised electrons is explored more in the diagnostic question: Sea of electrons.

A student who chooses option D may not have noted that the question relates to the entities that are regularly arranged.

If students have difficulties in moving their understanding from the particle model to a model of metallic structure that involves part of the atom, it may help to support students to look at or create a visual representation of metallic structure that combines the particle model and diagrams of atomic structure.

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

* Atom overlays

**Acknowledgments**

Developed by Helen Harden (UYSEG)

Images: Helen Harden (UYSEG)

**References**

Taber , K. S. (2003). The atom in the chemistry curriculum: Fundamental concept, teaching model or epistemological obstacle? *Foundations of Chemistry,* 5**,** 43-84.

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.